UBAS

University of Bergen Archaeological Series

Soapstone in the North
Quarries, Products and People
7000 BC – AD 1700

Gitte Hansen and Per Storemyr (eds)

UNIVERSITETET I BERGEN

9

2017

Soapstone in the North

Quarries, Products and People

7000 BC – AD 1700

UBAS

University of Bergen Archaeological Series

Soapstone in the North

Quarries, Products and People

7000 BC – AD 1700

Gitte Hansen and Per Storemyr (eds)

UNIVERSITY OF BERGEN

9

2017

UBAS – University of Bergen Archaeological Series 9

University of Bergen
Bergen University Museum and
Department of Archaeology, History, Cultural Studies and Religion
P.O. Box 7800
NO-5020 Bergen
NORWAY

ISBN: 978-82-90273-90-8 UBAS 9
UBAS: ISSN 0809-6058

Editors of this book
Gitte Hansen
Per Storemyr

Layout
Beate Helle, Bergen University Museum
Cover: Arkikon, www.arkikon.no

Print
07 Media as
Peter Møllers vei 8
Postboks 178 Økern
0509 Oslo

Paper: 100 g Arctic volume white
Typography: Adobe Garamond Pro and Myriad Pro

Preface

This book has been a long time in the making. It is an outcome of the five Norwegian University Museums' joint research programme Forskning i Felleskap (FIF, 2010–2015), supported by the Research Council of Norway. FIF kindly facilitated a number of workshops and meetings between archaeologists, geologists and craftspeople, all with a common interest in premodern soapstone quarrying and use. The result is the chapters of this book, which are based on studies carried out over the last two decades and, for the most part, are published scientifically for the first time. We very much thank the authors for participating in this venture. We also thank several colleagues – archaeologists, geoscientists and craftspeople – that assisted the editors in peer-reviewing the chapters: Irene Baug, Birgitta Berglund, Laura Bunse, Poul Baltzer Heide, Richard Jones, Tor Grenne, Torbjørn Løland, Therese Nesset, Astrid J. Nyland, Lars Pilø, Kevin Smith, Lars F. Stenvik, Frans Arne Stylegard and Stephen Wickler; we are very grateful for the job you have done. Not least, thanks go to Tromsø University Museum, NTNU University Museum (Trondheim) and the University Museum of Bergen for their economic support in publishing the book.

Bergen/Hyllestad, Spring 2017
Gitte Hansen
Per Storemyr

Contents

Gitte Hansen and Per Storemyr

A Versatile Resource – The Procurement and Use of Soapstone in Norway and The North Atlantic Region

'…We would like to know if The Museum wants to recieve such Bagatelles...'
(A soapstone spinning whorl, sent to the University Museum of Bergen in 1949)

'…science is built upon Bagatelles… so nothing is too small… However some things, such as this spindlewhorl, can nevertheless be too small to be stored in a museum…So we hereby return your find…'
(The polite answer from the curator at the University Museum of Bergen in 1949).[1]

Introduction

Soapstone is a remarkable rock. While it is very workable due to a high content of talc, the softest known mineral in existence, it is also durable, heat-resistant and has a high heat storage capacity. These properties have been recognised and valued since prehistory across the world and soapstone has been used for a very broad range of products. This book addresses soapstone use in Norway and the North Atlantic region, including Greenland (here: the North). Although the majority of papers deal with the Iron Age and Middle Ages, the book spans the Mesolithic to the early modern era, dealing with themes related to quarries, products and associated people and institutions in a wide sense. Recent years have seen a revival of *basic* archaeological and geological research into the procurement and use of stone resources. With authors from the fields of archaeology, geosciences and traditional crafts, this anthology reflects cross-disciplinary work grown out of this revival.

Soapstone and geology

Soapstone is a metamorphic rock in which talc is mixed with minerals such as chlorite, amphibole and carbonates. It mainly originates from deposits of ultramafic and mafic (dark) magmatic rocks such as dunite and peridotite, sometimes also gabbro, that have been subject to intensive transformation (metamorphose) through geological history. This transformation took place deep in the Earth's crust along the boundaries of colliding tectonic plates, which resulted in the formation of mountain chains such as the present-day Alps and Himalayas. However, soapstone deposits also occur in very old, Precambrian landscapes and along mountain chains that are now part of geologically stable continents and that are in the process of eroding, for example the mountains of Norway. Some 400 million years ago, the Norwegian mountains were part of a grand chain known as the Caledonides that also included present-day Greenland, several Atlantic isles, part of Scotland and part of the

American North-East. Since then, Norway and America have drifted apart due to the opening of the Atlantic Ocean (Ramberg et al. 2008).

Given their varying mineral content, soapstones also exhibit a range of properties. Some soapstones are rather hard, some extremely soft, while others grade into rocks often called talc schist or chlorite schist, the latter of which may have a different geological history, being sometimes formed from volcanic tuff and basalt. Some soapstones are transformed only a little from their parent rock; these are rather hard and may contain a certain amount of the mineral serpentine. Some soapstones are massive, but most are schistose and sometimes full of fissures. In fact there is no such thing as soapstone 'proper'; soapstone is a generic term for soft or 'weak' stone, usually rich in talc. If the talc content is very high, approaching 100%, we often use the term steatite. Most of the papers in the present book deal with various types of soapstone (used here as a generic term, since some of the following contributions also address chlorite schist).

The use of soapstone in the North

Around 200 old soapstone quarries are known in Norway, also Shetland and Greenland host such quarries. The earliest use of soapstone in Norway dates back to the Mesolithic, when the rock was formed into small animal figures, star-shaped hatchets, mace heads and tools, sometimes with decoration (Bjørgo 1981; Bergsvik 2002; Skår 2003). Throughout prehistory and history, everyday objects such as fishing tackle (Olsen 2004; Sørheim 2004), textile tools (Hofseth 1985; Øye 1988), soapstone tempered pots (Engevik 2009), lamps (Bernhardt 2003), vessels (Lossius 1979; Resi 1979; Pilø 1989; Vangstad 2003) and griddles (bakestones, baking slabs) (Weber 1984; Tengesdal 2010; Baug 2015a) were produced for use in households of all social strata. From the Middle Ages onward, soapstone was massively quarried as a building and decorative stone for churches and other monumental constructions (Ekroll 1997; Storemyr 2015), with baptismal fonts (Solhaug 2001) and gravestones also often made of soapstone, the latter up until the early modern period (e.g. Voldheim 1995). In prehistory and the Middle Ages the stone was also used in connection with metalworking, e.g. as casting moulds (e.g. Rønne 1996; Pedersen 2010) and forge-stones (tuyères) (Baug 2011).

In some periods of prehistory, soapstone objects were distributed via long-distance networks. Presumably originating in Scandinavia (although the Alps is also a possibility), Bronze Age soapstone moulds are found in considerable numbers in Denmark (Skjølsvold 1961:107; Rønne 1996). During the Viking Age, cooking vessels were an important export article from Norway (and western Sweden) (Resi 1979; Risbøl 1994), and when pioneer settlers from Norway migrated across the North Atlantic, stone vessels were in their luggage (e.g. Forster 2004; Sindbæk 2015:200). The extraction, manufacture, distribution and use of soapstone raw materials and products from the outfields have thus been important for people in the North on a local, regional and at times also on a cross-regional and international scale.

Soapstone in Europe and across the world

The North is a soapstone region, but not unique as such. Soapstone is found and used in many parts of the world. There are extensive traditions, for example, in the Middle East, the Indian subcontinent and in parts of the Americas, most notably in Canada, along the Appalachians and in Brazil (overviews in Rapp 2009; Storemyr 2015). In Europe, key traditions are found across the Alps, but also in several parts of Italy and the Mediterranean. Importantly, most traditions show a development that is very similar to that which took place in the North, including the transition from figurines in the Stone Age, to cooking vessels and later building and decorative stone procurement. Long-distance export also took place. The Romans brought Alpine soapstone vessels to their northern *limes*, not far from

Figure 1. *Soapstone impressions from places beyond the North Atlantic region. Top left: One among hundreds of old soapstone quarries in Egypt's Eastern Desert. Top right: Prehistoric Mesopotamian soapstone vessel, c. 4500 years old, now in British Museum. Bottom left: Extremely intricate soapstone sculpture at the Hoysaleshwara temple in Halebidu, Karnataka, India, 12th century AD. Bottom right: The Roman Caurga quarry in Chiavenna, North-Italy. (Photos except bottom left: P. Storemyr; bottom left: Rakhee Goyal, with permission).*

where soapstone from the North ended up in the Viking Age (north Germany/Friesland).

The many names given to soapstone in Europe not only reflect the many uses of the stone, but also the fact that it is soft and workable. The contemporary English term *soapstone*, as well as the German *Speckstein* and the Danish *fedtsten*, are related to the 'soapy' or 'fatty' sensation one gets when handling the stone. However, the present Norwegian name is *kleberstein*, derived from *klåstein* or *kliberg* (loom weight). In Scandinavia alone, one may encounter perhaps a dozen names, including *jarstein*, (fishing line sinker), *esjestein* (tuyère, forge stone), *tolgestein/täljsten* (stone that can be worked with a knife), *mjukstein* (soft stone) and *veksten* (weak stone). The Romans used the name *lapis ollaris*, where *olla* means pot, just as the French and Italians do today (*pierre ollaire*, *pietra ollare*). The German *Topfstein*, or 'pot stone', has exactly the same meaning as the key term *grjotstein* (*grytestein*) in Old Norse (overview in Storemyr 2015; see also Helland 1893; Rütimeyer 1924; Skjølsvold 1961; Lhemon & Serneels 2012; Dipartimento dell' Ambiente Ticino 1986).

Figure 2. *Nidaros Cathedral in Trondheim, by far the largest 'soapstone building' in Europe. The West Front, one of Norway's most celebrated artistic works, was reconstructed/rebuilt and finished by 1969. (Photo: P. Storemyr).*

In Europe, soapstone was in use by the late Palaeolithic c. 20–30,000 years ago, when it was carved into several so-called Venus figurines (e.g. White & Bisson 1998). In the Bronze Age and later in the Graeco-Roman period and Middle Ages, the use of soapstone was widespread in the Alps and the Mediterranean, as was the large-scale export of vessels and other items such as statuary and altars, and even wine glasses and plates (Rütimeyer 1924; Boscardin 2005; Lhemon & Serneels 2012; see also Bevan 2007 for Bronze Age vessels in general). Just as in Norway, soapstone was used in Alpine architecture during the Middle Ages, mainly for decorative purposes (e.g. de Quervain 1969). Otherwise, soapstone production in the Alps from the 16th century onward was related to stoves, a development again similar to that seen in Norway.

In the modern period, soapstone became part of the industrial revolution, not only in the North and in Europe, but also world-wide; during this time it was heavily used for lining industrial kilns and when processed to talcum powder it could be employed as a lubricant. Today, talc is used in many industries, including paper making, plastics, paints and coatings, rubber, food, electric cable, pharmaceuticals, cosmetics and ceramics (overview in Wikipedia's *Talc* article). Soapstone has also been used for architectural purposes during the modern period, in Europe but especially in Scandinavia during the late 19th and early 20th centuries (e.g. Ringbom 1987).

However, the largest-scale use of soapstone for one single building in the modern period was probably for the restoration of Nidaros Cathedral in Trondheim (Figure 2). When restoration started in 1869 the medieval cathedral was a half-ruin, yet exactly 100 years later, after hundreds of craftsmen had carved more than 30,000 tonnes of soapstone obtained from 30 quarries across Norway (as well as other stone from a further 40 quarries), the cathedral was finally restored to its former glory. Nevertheless, restoring a cathedral is an unending task, with work currently ongoing for the foreseeable future through The Restoration Workshop of Nidaror Cathedral (NDR), one of the largest of its kind in Europe (Storemyr 2015).

Research revival in the North

Research into soapstone resources and their use in the North goes back to observations made by early historians in the 16th century, becoming a true field of research within archaeology and geology from the late 19th century onward (e.g. Friis 1632; Schøning 1778; Rygh 1885; Helland 1893). Nevertheless, until the early 2000s the list of standard references in the North was rather short. Regarding the extraction of soapstone, Arne Skjølsvold's (1961) survey of Viking Age quarries in southern Norway is the most frequently cited study on soapstone in the country. In terms of studies focussing on soapstone products, those carried out by Håkon Schetelig (1912), Sigurd Grieg (1933), Jan Petersen (1951), Siri Myrvoll Lossius (1977), Heid Gjøstein Resi (1979), Lars Pilø (1989) and Ole Risbøl (1994) formed almost the entire list. For more detailed overviews regarding the history and use of soapstone for multiple purposes in Norway, the contributions by Per Storemyr and Tom Heldal (2002) and Laura Bunse (2016) should be consulted, while for Britain and the North Atlantic including Greenland, see Jette Arneborg (1984) and Amanda K. Forster (2004).

The surge of interest in soapstone studies that has taken place in the last decade or so is due to several factors. Within archaeology, domestic raw materials derived from the outfields, such as iron and stone used for everyday objects, have received increasing attention (see e.g. Holm et al. 2005; Larsen 2009; Baug 2013; Hansen et al. 2015; Indrelid et al. 2015), while the firmer establishment of medieval archaeology as a designated part of archaeology studies at university level in Scandinavia and Great Britain has been important for increased academic production (e.g. Risbøl 1994; Berglund 1995; Carelli & Kresten 1997; Baug 2002; Østerås 2002; Brodshaug 2005; Lundberg 2007; Schou 2007; Høegsberg 2009; Tengesdal 2010; Baug 2015b; Øye 2015). Irene Baug's long-term work on querns, millstones and bakestone procurement stands out among these studies, since it focused on large quarrying landscapes, several excavations, as well as defining actors and networks involved in the stone trade (Baug 2002, 2015b).

Simultaneously, geoscientists have become a driving force in research on stone and quarries as seen in a historical and cultural context. This development was initiated through the geoarchaeological work of Storemyr (1997, 2003, 2015) in Central Norway from the early 1990s onward, together with Heldal at the Geological Survey of Norway (NGU) and the NDR (e.g. Heldal & Storemyr 1997; Storemyr & Heldal 2002; Storemyr et al. 2002, 2010). This research was later widened in the form of regional and international studies involving NGU as a coordinator of large-scale, cross-disciplinary research projects, such as *QuarryScapes* ('Conservation of Quarry Landscapes in the Eastern Mediterranean', 2005–2009, www.quarryscapes.no, main results in Abu-Jaber et al. 2009) and the *Millstone* project (2009–2013, several contributions in Selsing 2014). Within these projects, new research strategies and methodologies were developed that have also been instrumental in the field of soapstone studies.

In particular, geoarchaeological research taking place from the late 1990s onward, as summarised in the monography *Steinbyen Bergen* (Heldal et al. 2000), focusing on stone procurement in the Bergen region was of key significance for the development of soapstone studies. This work was later extended to probably the most extensive programme of soapstone provenance ever undertaken worldwide. Some of the first results of this programme were published in 2009 (Jansen et al. 2009), with many of the more recent studies included in the current volume.

In Britain, geoscientists have generally become more strongly involved in the study of stone and

Figure 3. *Archaeological fieldwork as winter is approaching at Norway's oldest dated soapstone quarry (pre-Roman Iron Age) – Kvikne in Hedmark county. (Photo: T. Heldal).*

quarries, as part of what one may call the 'natural science turn' in archaeology (e.g. Jones et al. 2006; Jones et al. 2007; see also Kristiansen 2014).

The current book presents research carried out in Norwegian, British and Danish contexts during recent years and, for the most part, is scientifically published here for the first time. The papers can be read individually but can also be quarried (sic!) thematically. Classical aspects related to quarries and quarrying range from tool marks to property owners, while those related to products range from basic research on typology and chronology to provenance. The social context of the procurement and use of soapstone is also discussed in several contributions.

Quarries

Quarry surveys

Despite being published nearly 125 years ago, Amund Helland's (1893) description of Norwegian soapstone quarries remains the most comprehensive overview existing for this country. Indeed, Skjølsvold's (1961) seminal work on south Norwegian soapstone quarries as Viking Age production centres relied on (and extended) Helland's findings, although Birte Weber's (1984) survey of the Ølve-Hatlestrand bakestone quarries in Hardanger provided important new insight. It was not until the 1990s that Helland's picture was truly extended, especially on the coast of Helgeland in Nordland County (Berglund 1995, 1999) and in central Norway (Heldal & Storemyr 1997; Østerås 2002; Storemyr 2003, 2015; Lundberg 2007; Østerås 2008; Storemyr et al. 2010). In the Hordaland region, quarries have been investigated in connection with Baug's doctoral work (Baug 2015b) and with

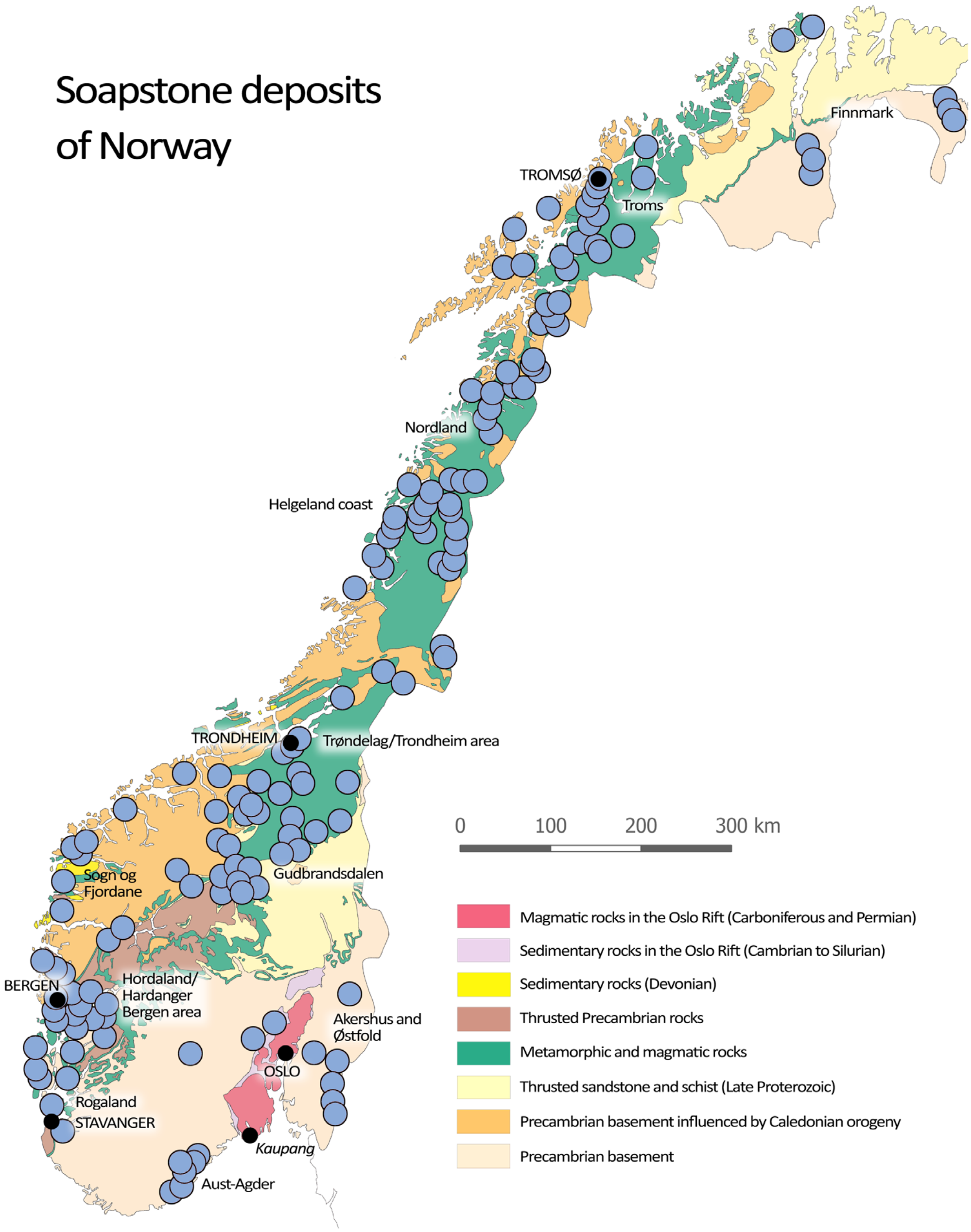


Figure 4. *Simplified geological map of Norway with most of the known soapstone deposits plotted (blue circles). Almost all of the deposits have been used as quarries. Note that most deposits are located within Caledonian/Cambro-Silurian rocks (green color), but that there are also deposits in the Precambrian basement. (Map P. Storemyr based on data from the Geological Survey of Norway (http://geo.ngu.no/kart/mineralressurser).*

Øystein J. Jansen and Heldal's studies of stone use in Bergen and the Bergen uplands (Heldal et al. 2000; Jansen et al. 2009). With the research presented in the current book, the number of Norwegian soapstone quarries that have been studied and the work published has increased considerably.

Stephen Wickler, Ingvar Lindahl and Lars Petter Nilsson, give a first overview of geological and archaeological evidence for soapstone deposits and quarries in northern Norway, beyond (Saltfjellet in Nordland County)(see also Wickler 2015), with the authors evaluating the current state of knowledge regarding this resource in the northernmost part of the country. This survey initially prepared the ground for Bunse's Ph.D. research. In the present volume Bunse presents data from 11 soapstone deposits in northern Norway. Birgitta Berglund, Heldal and Tor Grenne discuss quarries on the Helgeland coast in Nordland County in relation to the extraction of ashlars for local churches. Soapstone and chlorite schist quarries for building stone in the Hordaland and Trøndelag regions are discussed in the contribution by Jansen and Heldal. And Hordaland's quarries are also discussed in relation to vessel production during the Viking Age and Medieval period by Gitte Hansen, Jansen and Heldal.

The quarry as a workspace

There may be large differences between individual quarries, reflecting the extent and quality of resources at hand, availability, the 'market' situation and traditions that developed in certain places. Some quarries are very small and were only active over short time spans; others may best be described as quarry landscapes that have been in use over centuries, even millennia, comprising many quarry faces, spoil heaps and infrastructure such as access roads, paths, shelters and smithies, even harbour facilities. It is a relatively simple task to work a small vessel extraction site, at which only one or a few persons are active. Larger building stone quarries must be organised much like a building site, including a 'master' supervising many people with different levels of qualification and experience. In between – and this probably includes the majority of Norwegian soapstone quarries – a variety of organisational forms may have been implemented.

Although Skjølsvold's archaeological and ethnographic work (1961, 1969, 1979) touched upon quarry organisation, it was with Baug's research on millstone and bakestone quarries (2002, 2015b) and the many studies within the QuarryScapes and Millstone projects (see above), as well as with Storemyr's (2015) work in central Norway, that workspaces and – not least – the term *quarryscape* (quarry landscape) were first studied and elaborated upon. Notably, quarryscape is now not only defined as a technical term, but also with a view to social space, i.e. how people interacted within and beyond the confines of a production site. The latter may include boundaries and ownership and will be mentioned below.

In recent research, Skjølsvold's focus on detailed observations of toolmarks, extraction techniques and estimates of extraction volume are coupled with geological information regarding rock properties and craftspersons' knowledge of workability and tool use (e.g. Storemyr 1996; Storemyr et al. 2002; Østerås 2002; Turner & Sherratt 2009; Heldal 2015; Bunse & Stavsøien 2016). Such cross-disciplinary work has raised the study of quarry sites to a new level of qualitative insight.

In this volume, Eva Stavsøien describes how iron pickaxes were used experimentally to reproduce the main medieval soapstone extraction technique for building stone, which involved carving channels around the blocks and loosening them with wedging along the cleavage at the bottom. This method is reminiscent of vessel extraction techniques, but was refined, adapted and used all the way up to the early 20th century in Norway. Stavsøien's work relies – implicitly – on domestic observations, but also on a several thousand years old tradition of soft stone quarrying that encompassed Ancient Egypt, the Roman world and the European Middle Ages. In fact, it may well be that the quarrying techniques used in e.g. the Trondheim region in the Middle Ages were influenced by English and, by extension, Roman practices, as Storemyr and Heldal argue in their contribution. In addition to showing that manual extraction of stone is not as time-consuming as one would expect, Stavsøien also underlines the tacit knowledge involved in stone quarrying. Although the quality of the rock sets the limits, it is the fine-tuned, 'timeless' interaction between the craftperson, the tools at hand and the rock with its varying properties, that determines the end-quality of the extracted stone product.

Stone extraction always destroys marks from previous quarrying; researchers thus only find traces of the most recent activity. Although in many cases it is possible to reconstruct quarrying processes, as shown by Heldal (2015), many soapstone quarries were used over thousands of years and it has not yet been possible to find or reconstruct the earliest extraction methods, such as those employed by Mesolithic people who carved soapstone figurines and other artefacts, which were most certainly derived from domestic quarries (that were also used in later periods), as argued by Knut Andreas Bergsvik in this volume. Grenne, Bodil Østerås and Lars F. Stenvik also address the problem of time-depth in their contribution on the Kvikne pre-Roman Iron Age soapstone vessel quarry.

The same authors show how spades made from wood, some perhaps reinforced with iron, were used to relocate quarry spoil in order to ensure ample working space for the extraction of more stone. Originally found and discussed by Skjølsvold (1969), the spades in question constitute a group of rare finds directly related to everyday work in a quarry.

Further regarding everyday work, a groundbreaking discovery is reported by Østerås, related to the largest, mainly late Viking Age and medieval vessel quarry in central Norway, at Slipsteinsberget in Trøndelag. For the first time, buildings unequivocally used by medieval quarryworkers are documented in Norway. One of the buildings was used as a workshop for manufacturing vessels, the other probably as living quarters. Østerås argues that the buildings, among many other observations, are testimony to the significance of the quarry as a site of professional craftsmanship that potentially exported up to 30,000 vessels over a 400-year period.

Østerås uses the volume of spoil as the main indicator of the amount of vessels produced at the Slipsteinsberget quarry. Similarly, Storemyr and Heldal, in their 'biography' of the Bakkaunet building stone quarry in Trondheim, use the volume of the large spoil heaps as a clue to estimate the total amount of stone extracted (up to 15,000 m^3 over c. 150 years). Bakkaunet supplied Nidaros Cathedral and several other regional buildings with stone in the Middle Ages. The authors argue that the majority of the stone was extracted via large underground galleries – galleries that are now hidden behind scree and thus not available for inspection.

Bakkaunet may have been the largest underground quarry active during the Norwegian Middle Ages, but it is also important in a European context, with very few underground quarries known from this early period across the continent. However, Bakkaunet was not the only underground quarry in Norway; several, mainly small-scale, vessel quarries are recorded. Baug, in this volume, describes underground operations at the Ølve-Hatlestand bakestone and building stone quarries in Hordaland County. Although these quarries are generally younger and were worked over a longer time span, they are nevertheless very substantial, overall perhaps matching Bakkaunet.

The above examples show that some of the quarrying taking place during the Norwegian Middle Ages was driven by people with competence beyond the knowledge needed for the operation of the earlier, traditional, relatively small-scale vessel quarries. Larger-scale quarrying was mainly introduced alongside Christianity, with the extraction of building stone generally not undertaken before the first churches were erected in the 11th century.

Products

Repertoire: 'Small objects' and beyond

Whereas vessel, bakestone and building stone production sites attracted a certain degree of attention in earlier research (Helland 1893; Skjølsvold 1961, 1969; Weber 1984), little archaeological documentation is available on the production of small objects such as spindlewhorls, casting moulds or fishing tackle (but see Tuastad 1949; Hansen 2005:168–170, 194–196; Baug 2011).

In Bunse's study of north Norwegian soapstone outcrops the extraction of small objects were documented in five quarries, although no blanks or objects were found in the associated spoil heaps. In the chapter by Bunse indirect evidence – tool marks and techniques used in the quarries, as well as the range of objects found in consumer contexts in the quarry uplands – is studied in order to assess the chronology of the quarries and their presumed products, with the latter potentially including fishing tackle, moulds for casting, as well as scoops, i.e. small vessels with a handle. This is the first modern study of quarries focusing on small objects in Norway.

Grenne, Østerås and Stenvik also address an 'unidentified' object type. In 2004, rectangular extraction marks were uncovered at the Kvikne quarry. The authors argue that forge-stones or tuyères may have been produced there to supply the large-scale iron production that took place in the region from around 500 BC through to the Roman Iron Age. Baug gives an overview of the range of products quarried at the Ølve-Hatlestrand chlorite schist quarry landscape in Hordaland County. Although this area was by far Norway's most important producer of bakestone during the Middle Ages, Baug shows that the repertoire of products went well beyond bakestones throughout the Middle Ages and the early modern period, and included building stone, slate and crosses. Evidence for the latter is substantiated by Jansen and Heldal in their contribution on the provenance of building stone used in the vanished church(es) at Onarheim (Tysnes, Hordaland), in which it is shown that the Ølve-Hatlestrand quarries were responsible for stone delivery.

Typology and chronology of 'small objects' and vessels

Stray soapstone finds were seldom kept in Norwegian museum collections in the early days of archaeological research; since no typology had been established for such plain domestic objects, the finds could not be dated without contextual information and their origin/provenance could not be determined. This said, the earliest study with relevance to the typology and chronology of soapstone objects was published by Oluf Rygh in 1885, in which Stone Age star-shaped hatchets and Iron Age vessels were listed among the finds.

Yet, dating artefacts typologically is an archaeological tool that requires basic research in order to establish types and subsequently date the established types through independent means. Among portable soapstone finds, vessels have been given most attention. Schetelig (1912) established the first more complete chronology of prehistoric vessels, with other early works including Petersen (1951) and O. Møllerop (1960). Pilø (1989) later revised Schetelig's chronology and suggested that the earliest Norwegian vessels were manufactured in the late Bronze Age. Production continued throughout the pre-Roman Iron Age, after which there was a hiatus until the beginning of the Viking Age, although soapstone was an important temper in so-called bucket-shaped ceramic vessels during both the Roman and Migration periods (e.g. Engevik 2009).

In archaeological research on the Viking Age and Medieval period, emphasis on the exotic, foreign and/or luxurious has long prevailed, with material culture bearing evidence of long-distance contacts, trade and powerful institutions traditionally receiving more attention than ordinary

Figure 5. *The first scientific drawings of soapstone vessels in Norway, mainly from the Iron Age. (Illustrations from Rygh 1885).*

domestic products testifying everyday life. It is probably not a coincidence that studies of Viking Age soapstone vessels have been carried out mostly on vessels found 'abroad' in Denmark, north Germany and the North Atlantic region, far from their origin. As foreign and exotic, such displaced objects show the diverse contact networks and diaspora of the Vikings (see e.g. Resi 1979; Risbøl 1994; Forster 2004; Sindbæk 2015). In contrast, contributions dedicated to Viking Age soapstone artefacts found in domestic contexts are far fewer (see e.g. Resi 1987; Forster 2004; Baug 2011).

Medieval soapstone vessels in Norway have been the subject of only a few typological studies, with Grieg's work (1933) on artefacts from medieval Norwegian towns being the sole overview available for some time. More recently, the comprehensive works of Myrvoll Lossius (1979) and Hilde Vangstad (2003) stand out, while for the North Atlantic region the comprehensive contributions of Arneborg (1984), Forster (2004) and Mogens S. Høegsberg (2009) are important. From the Middle Ages onward, soapstone and chlorite schist were used as building materials in both Norway and Greenland.

Several papers in this volume present basic research on soapstone products. A common tool type made of soapstone in Mesolithic western Norway includes the 'coffee bean shaped' objects associated with fishing. Based on earlier investigations, Bergsvik divides the objects into types and discusses their chronological and geographical distribution. Through comparative study of the objects' weight, the size of fish hooks and fish caught at contemporary coastal residential sites, he argues that the objects were line-sinkers used in connection with rod fishing or trolling.

The contribution by Wickler, Lindahl and Nilsson provides the first published overview of the range and amount of soapstone objects found in the northernmost parts of Norway. Among datable finds, only a small percentage predate the late Iron Age, with most from the Middle Ages or later. There is also considerable variety; bronze-casting moulds and forge-stones are among the finds, but household vessels and tools related to textile production and fishing constitute the largest groups.

Høegsberg presents part of his doctoral work (Høegsberg 2009) on Norse Greenland from the Viking Age to c. AD 1450. Portable soapstone objects are the most frequent find category and Høegsberg gives a synopsis of almost 1200 objects from six sites at the so-called Eastern and Western settlements of western Greenland. Just as in north Norway, the category with the most numerous finds is vessels, although textile tools and moulds for casting, e.g. spinning whorls, are also found. The inventory has close parallels in contemporary finds of soapstone across the Norse world. However, a few unique vessel types are found, with the Norse Greenland assemblage generally characterised by its many ornamented objects, which are rarely found in Norway (cf. Lossius 1977; Vangstad this vol.).

Vangstad's chapter presents the main results of the largest typological and chronological study of Norwegian medieval soapstone vessels to date (Vangstad 2003). Based on a detailed study of 806 cooking vessels from the harbour and living quarters on the *Bryggen* wharf in Bergen, western Norway, she extends the typology of medieval vessels established by Myrvoll Lossius (Lossius 1977) and provides a well-dated overview of the use of soapstone vessel types from the late 11th century throughout the medieval and early modern periods. Temporal changes in the consumption of soapstone vessels in Bergen are discussed in the context of changing food habits and shifts in the mode of vessel production.

In Forster and Richard Jones' contribution, an overview of vessel types found in the North Atlantic region is given, based on Forster's previous studies (Forster 2004).

Quarries and products

Provenance studies

Object provenance is a pillar of archaeological research, especially with regard to the study of distribution and trade networks. However, it is often very difficult to determine the origin of soapstone objects. When Skjølsvold (1961:10) brought up the question with a geologist colleague, he was warned that such attempts would involve a tremendous amount of work and would probably lead nowhere. Generally, the reason for this supposition is that there may be limited geological variation between different deposits and simultaneously significant internal differences within one single deposit. Nevertheless, this pessimism did not deter the researchers who used geochemistry in the first attempt in the North at locating the origins of the soapstone objects found at Haithabu (Alfsen & Christie 1979; Resi 1979).

Over the past two decades, archaeologists and natural scientists have explored the fuller potential of visual observation and analytical methods, such as petrography, mineralogy and geochemistry, to determine the provenance of soapstone (see Jones et al. 2007 with references; Jansen et al. 2009 with references; Jansen 2015). Common to these studies is the insight that the success rate is higher if multiple methods are applied, preferably within cross-disciplinary work involving both cultural and natural historical approaches.

In this volume, British and Norwegian researchers present explorative, multi-approach and cross-disciplinary provenance studies on building stone for churches and monuments, as well as on household vessels. Berglund, Heldal and Grennes's contribution addresses the link between quarries on the Helgeland coast and six medieval churches. Through field survey of possible Viking Age and medieval soapstone quarries, four quarry areas are identified as the most likely suppliers of building stone. Through a combination of building archaeological studies, visual geological characterisation of masonry and quarries, and comparison of the soapstone's main and trace element (MTE) composition, successful links are made between the churches and a number of quarries.

The study by Jansen and Heldal also addresses the provenance of building stone. The now vanished medieval and early modern generations of Onarheim church in Hordaland were built in, among other stone types, soapstone and chlorite schist. Analyses of geochemical datasets including MTE, strontium (Sr)/neodymium (Nd) isotopes and rare earth elements (REE) are combined with visual geological characterisation of masonry and quarries. Whereas the authors suggest a local as well as a regional origin for the soapstone ashlars, the chlorite schist ashlars were extracted at the nearby Ølve-Hatlestrand quarry landscape (cf. Baug this vol.). The reference material used for the analyses of chlorite schist is derived from all the known medieval chlorite schist bakestone quarries in Norway, including the Øysand quarries at Trøndelag and Ertenstein in Rogaland County. An important outcome of the study is that chlorite schist quarries in Norway can be distinguished on the basis of Sr/Nd isotopes, a finding that will certainly aid future studies on the distribution and trade of chlorite schist bakestone.

Forster and Jones' contribution investigates the provenance of Norwegian-style vessels used by pioneering settlers during the 9th–10th century *landnám* phase of the North Atlantic region, as well as Shetland-style vessels from the 10th–13th century. With Forster's morphological studies as a point of outset, matches between 17 vessels found in Shetland, Orkney, the Faroe Islands and York (England) and quarry datasets from Norwegian and Shetland quarry areas are addressed. Visual geological characterisation is combined with a comparison of the soapstone's REE composition, while an exploratory analysis of MTE composition is carried out using a portable XRF device. The latter method is non-destructive, so its use on artefacts is promising for future research. Since datasets for the relevant south Norwegian quarries are still limited, the authors were not able to track objects to specific Norwegian quarries. The study, however, identifies groups of artefacts that are of similar origin.

Hansen, Jansen and Heldal address the provenance of 146 cooking vessels from Viking Age Hordaland and early medieval Bergen, with the vessels' geochemistry (MTE and REE) compared with similar data from 38 quarries across the Hordaland region. This research thus represents a very extensive study on soapstone provenance even in a wide international perspective. Geochemical matches between vessels and quarries are evaluated using knowledge of the geological history of the region, as well as an array of archaeological data and methods. Finally, each vessel is given a score expressing the reliability of the match – or lack thereof – between the vessel and the regional quarries. The success rate of this interdisciplinary effort is high and the study provides a fresh dataset to be explored as regards cultural and social implications in future research. The authors draw attention to the following immediate results: many quarries have now tentatively been dated via vessel matching; quarry-districts have been discerned; contours of regional production and trade in soapstone vessels are substantiated, and it is seen that Viking Age rural households received fewer vessels from areas beyond the Hordaland region than their early medieval urban counterparts. In other words, there must have been a cross-regional trade in soapstone vessels during the early Middle Ages.

Cultural and social aspects

Was the production of vessels and other small objects aimed at the producers' own household, or was it undertaken by professional actors for sale on a wider market or for distribution through other mechanisms? How was building stone procurement organised? Were there markets for building stone, or was the stone commissioned? These classical research questions are typically asked in studies investigating stone resources.

Several works have provided a better understanding of the ownership and control of soapstone resources (e.g. Skjølsvold 1961; Østerås 2002; Schou 2007; Baug 2015b; Storemyr 2015), although in recent years the social identity of the people who carried out work in connection with production and distribution has also received attention (e.g. contributions in Hansen et al. 2015). Both the organisation of production and the social identity of the actors involved are reflected in many of the contributions in the present volume.

Based on considerations of extraction volume and the organisation of workspace during the pre-Roman Iron Age at Kvikne, Grenne, Østerås and Stenvik argue that vessel and possible forge-stone production was carried out periodically by artisans and that production was most likely aimed at regional consumption. They also suggest that the artisans were local to the region.

Torbjørn P. Schou addresses Viking Age production and trade in vessels in the Agder region, the southernmost part of Norway, connecting data from quarry sites close to waterways and rich grave finds in the region that indicate prosperity. Schou argues that soapstone production was organised by local magnates and that the industrial-scale production of the quarries was directed towards consumers in southern Scandinavia. Soapstone vessel production was important for the power structures and hierarchical development in the region; production and distribution is thus seen from both a local and international perspective.

Østerås discusses ownership, workspace and the scale of medieval vessel production at Slipsteinsberget in Trøndelag. She shows that production must have been aimed at a wide market and that it was carried out by professional craftspeople.

Figure 6. *The soapstone quarry as a workspace, as a cultural and social space. Eva Stavsøien experimenting with extraction of ashlars in the Klungen soapstone quarry (Øysand quarry landscape) by Trondheim. The picture gives a fairly good idea of how work was carried out in a medieval soapstone quarry aimed for production of building stone. (Photo: P. Storemyr).*

The Ølve-Hatlestrand chlorite schist quarries in Hordaland have been subject to more extensive archaeological research than any of the other quarries covered in this publication (Baug 2015b). Baug discusses the organisation of ownership and workforce connected to the large-scale production of bakestones in these quarries. Based on detailed reconstruction of ownership, she discusses models of organisation and shows that the quarries were owned by powerful ecclesiastical institutions. She argues that whereas bakestone was a commodity that could be regularly traded, other products such as building stone and perhaps crosses were most likely commissioned. She also suggests that although people from surrounding farms worked as 'semi-professional' craftspeople, some of the larger quarries may have demanded a different organisation and a larger workforce.

Storemyr and Heldal similarly reconstruct ownership at the medieval Bakkaunet building stone quarry in Trondheim, arriving at similar conclusions to those of Baug. The Archbishopric at Nidaros would have owned the quarry, just as it did all the substantial quarries used for Nidaros Cathedral and many other regional churches. The authors argue that these quarries were operated by the Cathedral workshop (lodge) and worked in a highly professional manner, including a quarry master that supervised the work. Stone extracted was not sold on markets, but was instead used solely for the Cathedral or commissioned for other churches.

A different situation may have existed in Bergen. Alf Tore Hommedal addresses the link between the Lyse quarry, operated by the Cistercians of Lyse Abbey close to Bergen, and 13th century royal and ecclesiastical building projects in the town, contextualising the results of previous geological provenance studies carried out by Jansen and Heldal on building stone in medieval monumental architecture. Hommedal shows that Lyse Abbey was instrumental in providing large royal and ecclesiastical institutions with soapstone from the 13th century onwards, and also argues that the work force at the Lyse quarry comprised lay brothers from the abbey.

Berglund, Heldal and Grenne discuss control and ownership of the building stone quarries that delivered stone for six churches in Helgeland, contextualising the results of provenancing studies. The authors suggest that whereas church builders supported by state power obtained their soapstone from quarries owned by clerical institutions, churches built on private initiative used soapstone from quarries that do not seem to have been owned by clerical institutions. Control and ownership of quarries thus seems to have been diverse.

The social and cultural background of quarrying and the consumption of soapstone is further addressed by several authors. Bunse calls attention to the ethnic dimensions of soapstone use; the northern Norwegian deposits in her study are located in areas containing primarily Sámi or mixed Sámi and Norse settlements during the late Iron Age and Medieval period, which may indicate a multi-ethnic use. Furthermore, some deposits were not used as quarries and may instead perhaps have served as sacred places in Sámi traditions. Bergsvik points out that soapstone sinkers are a regional feature of Mesolithic hunter-fisher populations in western Norway. Høegsberg suggests that Norse Greenlanders' keenness to decorate soapstone objects was related to continuity with the past and with cultural connections to Scandinavia. Vangstad also comments on the issue of identity in relation to the use of indigenous soapstone vessels in an urban context characterised by a large international population. Forster and Jones track migration and settlement of Norwegians and people of Norwegian decent in the North Atlantic region through vessel analysis.

Outlook

The resolution of interesting and relevant research questions is dependent on the analytical methods available. Recent advances in *basic* research on soapstone quarries and objects, as well as collaboration between archaeology, geoscience and traditional crafts (and history, ethnography etc.) have introduced a range of new methods and approaches. While this anthology may, correctly, give the impression that many questions have been resolved over the last few decades, new research always provides new questions to answer and tasks to pursue.

Although soapstone has been very important over millennia in many parts of the world, very little cross-cultural research has been carried out. When designing future studies, comparative ethnological, geoarchaeological and experimental investigations should be considered, not only from a theoretical perspective, but also in a practical manner, e.g. as cross-cultural fieldwork. There is much to be learnt from comparative research, not least as to how and why people extracted, traded and used soapstone the way they did.

Recalling the citation at the beginning of this article, soapstone objects and fragments were previously regarded as difficult artefacts to handle rather than as valuable archaeological sources to be included in museum collections. Today even the smallest stray finds are kept and cared for in museum archives. This shows that times have changed; a small stray find may potentially be the 'missing link' in understanding the *Chaîne opératoire* from quarry, via workshop, to consumer. Moreover, a humble find on an archive shelf may be just the material needed in modern provenance studies.

Likewise, the restoration of buildings made from soapstone used to involve the removal of original medieval ashlar and decoration, which ended up on waste heaps. Today, most soapstone buildings are well cared for, and, following the standards of modern heritage management, original objects are rarely replaced but are instead kept at the buildings as authentic testimonies to medieval craftsmanship.

However, the conservation of soapstone quarries deserves much more attention, with many destroyed by urban expansion and the building of new infrastructure over the last 10–50 years. Furthermore, merely a handful of quarries across Norway and the North Atlantic feature some form of signage for visitors, while only one quarry in Norway (Kvikne) is subject to a dedicated management plan. Clearly, there is a need to intensify conservation in a broad sense if we want to maintain the field of soapstone research – all the way from quarry, artefact and building to people involved with this important outland resource.

References

Abu-Jaber, N., Bloxam, E. G., Degryse, P. & Heldal, T. (eds) 2009. *QuarryScapes: Ancient Stone Landscapes in the Eastern Mediterranean*. Geological Survey of Norway, Special Publication, vol. 12. Geological Survey of Norway, Trondheim.

Alfsen, B. E. & Christie, O. H. J. 1979. Massenspektrometrische analysen von specksteinfunden aus Haithabu und wikingerzeitlichen specksteinbrüchen i Skandinavien. In Schietzel K. (ed.) *Berichte über die Ausgrabungen in Haithabu*, vol. Bericht 14, 170–84. Karl Wachholtz Verlag, Neumünster.

Arneborg, J. 1984. *De norrøne bebyggelser i Nipaitsoq of Niaquusat: Materiel kultur, udlandsforbindelser, kulturelt særpreg, kronologi og ophør – belyst især ud fra oldsagerne udgravet 1976–1977*. Unpublished hovedfagsspeciale. Det Humanistiske Fakultet, Aarhus Universitet, Aarhus.

Baug, I. 2002. *Kvernsteinsbrota i Hyllestad. Arkeologiske punktundersøkingar i steinbrotområdet i Hyllestad i Sogn og Fjordane*. Norsk Bergverksmuseums skriftserie, vol. 22. Norsk Bergverksmuseum, Kongsberg.

Baug, I. 2011. Soapstone finds. In Skre, D. (ed.) *Things from the Town. Artefacts and Inhabitants in Viking-age Kaupang*. Norske Oldfunn, vol. 3. Aarhus University Press & The Kaupang Excavation Project, Aarhus.

Baug, I. 2013. *Quarrying in Western Norway: an archaeological study of production and distribution in the Viking period and the Middle Ages*. Ph.D. dissertation, Institutt for arkeologi, historie, kulturvitenskap og religion, University of Bergen, Bergen.

Baug, I. 2015a. Actors in quarrying. Production and distribution of quernstones and bakestones during the Viking Age and the Middle Ages. In Hansen, G., Ashby, S. P. & Baug, I. (eds) *Everyday products in the*

Middle Ages. Crafts Consumption and the Individual in Northern Europe c. AD 800–1600, 229–250. Oxbow, Oxford & Philadelphia.

Baug, I. 2015b. *Quarrying in Western Norway. An archaeological study of production and distribution in the Viking period and Middle Ages.* Archaeopress Archaeology, Oxford.

Berglund, B. 1995. *Tjøtta-riket. En arkeologisk undersøkelse av maktforhold og sentrumsdannelser på Helgelandskysten fra Kr.f. til 1700 e.Kr. Dr.philos. avhandling* NTNU Vitenskapsmuseet, Fakultet for arkeologi og kulturhistorie, Arkeologisk avdeling. Norges teknisk-naturvitenskapelige universitet NTNU, Trondheim.

Berglund, B. 1999. Middelaldersk klebersteinsindustri på Helgelandskysten. *Ottar* 1999/2, 13–24.

Bergsvik, K. A. 2002. *Arkeologiske undersøkelser ved Skatestraumen. Bd. 1.* Arkeologiske rapporter og avhandlinger, vol. 7. Bergen Museum, Bergen.

Bernhardt, H. B. 2003. *Et lyspunkt i tilværelsen. Klebersteinslamper og ildsteder fra middelalderens Trondheim*. Unpublished hovedfagsoppgave, Institutt for arkeologi og kulturhistorie, Norges teknisk-naturvitenskapelige universitet NTNU, Vitenskapsmuseet, Trondheim.

Bevan, A. 2007. *Stone Vessels and Values in the Bronze Age Mediterranean*. Cambridge University Press, Cambridge.

Bjørgo, T. 1981. *Flatøy. Et eksempel på steinalderens kronologi og levbergingsmåte i Nordhordland*. Unpublished Mag.art.-avhandling Arkeologisk institutt, University of Bergen, Bergen.

Boscardin, M-L. 2005. Production and use of soapstone vessels in the Swiss Alps. In Holm, I., Innselset, S. & Øye, I. (eds) *'Utmark' The outfield as Industry and Ideology in the Iron Age and the Middle Ages*. University of Bergen's archaeological series UBAS, International Series, 91–97. University of Bergen, Bergen.

Brodshaug, E. 2005. *Det anonyme dagliglivet. Klebersteinsmateriale fra de arkeologiske utgravningene av Borg III, Vestvågøy i Lofoten.* Unpublished hovedfagsoppgave. Institutt for arkeologi, Universitetet i Tromsø, Tromsø.

Bunse, L. 2016. Exploring production and use of soapstone in Norway: Towards an interdisciplinary approach? In Brun, W. & Pedersen, E. S. (eds) *Tverrfaglige perspektiver 3*. AmS-Varia, 58, 45–59. Arkeologisk museum, Universitetet i Stavanger, Stavanger.

Bunse, L. & Stavsøien, E. 2016. I kryssningspunktet mellom arkeologi of håndverk. En undersøkelse av hoggeteknikk og verktøyspor i nordnorske klebersteinsbrudd. *Primitive tider* 18, 25–44.

Carelli, P. & Kresten, P. 1997. Give Us This Day Our Daily Bread. A Study of Late Viking Age and Medieval Quernstones in South Scandinavia. *Acta Archaeolgica* 68, 109–37.

de Quervain, F. 1969. *Die nutzbaren Gesteine der Schweiz*. Bern.

Dipartemento dell' Ambiente Tichino. 1986. *2000 anni di pietra ollare.* Bellinzona.

Ekroll, Ø. 1997. *Med kleber og kalk. Norsk steinbygging i mellomalderen*. Det Norske Samlaget. Gjøvik.

Engevik Jr., A. 2009. Bucket-shaped Pots, Technological Style, Regions and Identity in Norway in the Late Roman and Migration Periods. *The 58th international Sachsen-symposium. 1–5 September 2007*. Vitark Acta Archaeologica Nidarsiensia, vol. 7. Tapir akademisk forlag, Trondheim.

Forster, A. K. 2004. Shetland and the Trade of Steatite Goods in the North Atlantic Region During the Viking and Early Medieval Period. Unpublished Ph.D. dissertation, Department of Archaeological Sciences, University of Bradford, Bradford.

Friis, P. C. 1632. Norriges oc omliggende Øers sandfærdige Bescriffuelse : indholdendis huis vært er at vide, baade om Landsens oc Indbyggernis Leilighed oc Vilkor, saa vel i fordum Tid, som nu i vore Dage/ korteligen tilsammen fattit aff Peder Claussøn, Kiøbenhaffn, København.

Grieg, S. 1933. *Middelalderske Byfund fra Bergen og Oslo*. Det Norske Videnskapsakademi, Oslo.

Hansen, G. 2005. *Bergen c 800– c 1170, The Emergence of a town*. Bryggen Papers Main Series, vol. 6. Fagbokforlaget, Bergen.

Hansen, G., Ashby, S. P. & Baug, I. (eds) 2015. *Everyday Products in the Middle Ages: Crafts, Consumption and the Individual in Northern Europe c. AD 800–1600.* Oxbow Books, Oxford & Philadelphia.

Heldal, T. 2015. Perspectives on the characterization of ancient soapstone quarries. In Indrelid, S., Hjelle, K. L., Stene, K., Berglund, B., Callanan, M. Kaland, S. S. H. & Stenvik, L. F. (eds) *Exploitation of Outfield Resources – Joint Research at the University Museums of Norway.* Universitetsmuseet i Bergens skrifter 32, 175–90. Universitetet i Bergen, Bergen.

Heldal, T., Jansen, Ø. J. & Sunde, H. 2000. *Steinbyen Bergen : fortellingen om brostein, bygg og brudd*. Forlaget Nord 4, Bergen.

Heldal, T. & Storemyr, P. 1997. *Geologisk undersøkelse og arkeologisk registrering av de middelalderske bruddene ved Øye, Klungen og Huseby i Sør-Trøndelag*. Norges Geologiske Undersøkelse NGU, Trondheim.

Helland, A. 1893. *Takskifre, heller og vekstene*. vol. 10. Norges Geologiske Undersøkelse NGU, Trondheim.
Hofseth, E. H. 1985. Det går i spinn. Forsøk på klassifikasjon av spinnehjul i Rogaland. Spinning a tale. A classification of spindle whorls in Rogaland. In Næss, J-R. (ed.) *Artikkelsamling I*. AmS-Skrifter, 33–62. Arkeologisk museum i Stavanger, Stavanger.
Holm, I., Innselset, S. & Øye, I. (eds) 2005 *'Utmark' The outfield as Industry and Ideology in the Iron Age and the Middle Ages*. University of Bergen's archaeological series UBAS, International Series. University of Bergen, Bergen.
Høegsberg, M. S. 2009. Material kultur og kulturel identitet i det norrøne Grønland. Material culture and cultural identity in Norse Greenland. Unpublished Ph.D. afhandling, Det Humanistiske Fakultet, Aarhus Universitet, Aarhus.
Indrelid, S., Hjelle, K. L., Stene, K., Berglund, B., Callanan, M., Kaland, S. S. H. & Stenvik, L. F. (eds) 2015. *Exploitation of Outfield Resources – Joint Research at the University Museums of Norway*. Universitetsmuseet i Bergens skrifter, 32. Universitetet i Bergen, Bergen.
Jansen, Ø. J. 2015. Provenancing soapstone – experiences from different geochemical methods. In Indrelid, S., Hjelle, K. L., Stene, K., Berglund, B., Callanan, M., Kaland, S. S. H. & Stenvik, L. F. (eds) 2015. *Exploitation of Outfield Resources – Joint Research at the University Museums of Norway*. Universitetsmuseet i Bergens skrifter 32, 167–174. Universitetet i Bergen, Bergen.
Jansen, Ø. J., Heldal, T., Pedersen, R. B., Ronen Y. & Kaland, S. H. H. 2009. Provenance of Soapstone used in Medieval Buildings in the Bergen Region, Western Norway. In Maniatis, Y. (ed.) *Asmosia VII, Proceedings of the 7th International Conference of Association for the Study of Marble and Other Stones in Antiquity. Thassos 15–20 September 2003*. Bulletin de Correspondance Hellénique, 581–95. École Francaise d'Athénes, Athens.
Jones, R., Kilikoglou, V., Olive, V., Bassiakos, Y., Ellam, R., Bray, I. S. J. & Sanderson, D. C. W. 2007. A new protocol for the chemical characterisation of steatite – two case studies in Europe: the Shetland Islands and Crete. *Journal of Archaeological Science* 34, 626–41.
Jones, R., Olive, V. & Ellam, R. 2006. *Chemical (rare earth element) analysis of Viking staetite artefacts from Kaupang: a preliminary report*. Museum of Culture History, University of Oslo, Oslo.
Kristiansen, K. 2014. Towards a New paradigm? The Third Science Revolution and its Possible Consequences in Archaeology. *Current Swedish Archaeology*, vol. 22, 11–34.
Larsen, J. H. 2009. *Jernvinneundersøkelser. Faglig program, bind 2*. Varia, vol. 78. Kulturhistorisk Museum, Oslo.
Lhemon, M. & Serneels, V. (eds) 2012. Les récipients en pierre ollaire dans l'Antiquité. *Minaria Helvetica* 30.
Lossius, S. M. 1979. Klebermaterialet. In Schia, E. (ed.) *De arkeologiske utgravninger i Gamlebyen, Oslo. 'Oslogate 3 og 7' Bebyggelsesrester og funngrupper*. De arkeologiske utgravninger i Gamlebyen, Oslo, vol. 2, 64–71. Akademisk Forlag, Øvre Ervik.
Lossius, S. M. 1977. *Klebermaterialet fra Borgund*. Arkeologiske avhandlinger fra Historisk museum, vol. 1. Historisk museum, Universitetet i Bergen, Bergen.
Lundberg, N. 2007. Øye *– en arkeologiske undersøkelse av et klorittskiferbrudd*. Unpublished hovedfagsoppgave, Institutt for arkeologi og kulturhistorie, Norges teknisk-naturvitenskapelige universitet NTNU, Vitenskapsmuseet, Trondheim.
Møllerop, O. 1960. Kleberkar fra keltertid. *Stavanger Museum.* Årbok 1959, 21–40.
Olsen, O. M. 2004. Medieval fishing tackle from Bergen. In Øye, I. (ed.) *Medieval Fishing Tackle from Bergen and Borgund*. The Bryggen Papers. Main Series, vol. 5, 7–106. Fagbokforlaget Vigmostad & Bjerke AS, Bergen.
Pedersen, U. 2010. I smeltediglen. Finsmedene i vikingtidsbyen Kaupang. Ph.D. avhandling, Institutt for arkeologi, konservering og historie. Universitetet i Oslo, Oslo.
Petersen, J. 1951. *Vikingtidens redskaper*. Skrifter utgitt av det norske vitenskaps-akademi i Oslo. Historisk filosofisk klasse, vol. 2, Oslo.
Pilø, L. 1989. Early soapstone vessels in Norway. From the Late Bronze Age to the Early Roman Iron Age. *Acta Archaeologica* 60, 87–100.
Ramberg, I. B., Bryhni, I., Nøttvedt, A. & Rangnes, K. (eds) 2008. *The Making of a Land. Geology of Norway*, Trondheim.
Rapp, G. 2009. Archaeomineralogy. *Natural Science in Archaeology*. Berlin/Heidelberg.
Resi, H. G. 1979. Die specksteinfunde aus Haithabu. In Schietzel, K. (ed.) *Berichte über die Ausgrabungen in Haithabu*, vol. Bericht 14, 9–167. Karl Wachholtz Verlag, Neumünster.

Resi, H. G. 1987. Reflections on Viking Age local trade in stone products. In Knirk, J. E. (ed.) *Proceedings of the Tenth Viking Congress. Larkollen, Norway, 1985*. Universitetets Oldsaksamlings Skrifter. Ny rekke, vol. 9, 95–102. Universitetets Oldsaksamling, Oslo.

Ringbom, S. 1987. Stone, style and truth. The vogue for natural stone in Nordic architecture 1880–1910. *Finska fornminnesföreningens tidsskrift* 91.

Risbøl, O. 1994. Socialøkonomiske aspekter ved vikingetidens klæberstenshandel i Sydskandinavien. *LAG* 5, 115–61.

Rygh, O. 1885. *Norske Oldsager*. Forlaget af Alb. Cammermeyer, Christiania.

Rütimeyer, L. 1924. Gefässe aus Topfstein und Geschichte der Topfsteinsindustrie in der Schweiz. In Rütimeyer, L. (ed.) *Ur-Etnographie der Schweiz. Ihre Relikte bis zur Gegenwart mit prähistorischen und etnolographischen Parallelen.* Schriften der Schweizerischen Gesellschaft für Volkskunde, vol. XVI, 94–143, Basel.

Rønne, P. 1996. Bronse for kleber. *SPOR* 21, 14–17.

Schetelig, H. 1912. Kar av kleberstein fra jernalderen. *Oldtiden, tidsskrift for Norsk forhistorie*, 49–73.

Schou, T. P. 2007. Handel, produksjon og kommunikasjon – en undersøkelse av klebersteinsvirksomheten i Aust-Agders vikingtid med fokus på Fjære og Landvik. Unpublished masteroppgave. Arkeologisk institutt, Universitetet i Bergen, Bergen.

Schøning, G. 1778. *Reise, som gjennem en Deel af Norge i de Aar 1773, 1774 og 1775 paa H. M. Kongens Bekostning er gjort og beskreven*. 1910-utgave, 2 bind, Trondheim.

Selsing, L. (ed.) 2014. *Seen through a millstone.* AmS-skrifter, vol. 24. Arkeologisk museum, Universitetet i Stavanger, Stavanger.

Sindbæk, S. M. 2015. Steatite vessels and the Viking diaspora: Migrants, travellers and cultural change in Early Medieval Britain and Ireland. In Barrett, J. H. & Gibbon, S. J. (eds) *Maritime Societies of the Viking and Medieval World*. Society for Medieval Archaeology Monograph 37, 198–218. Maney, Oxford, Oakville.

Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden*. Universitetsforlaget, Oslo-Bergen.

Skjølsvold, A. 1969. Et keltertids klebersteinsbrudd fra Kvikne. *Viking*, bd XXXIII, 201–36.

Skjølsvold, A. 1979. Redskaper fra forhistorisk klebersteinsindustri. *Universitetets Oldsaksamling Jubileumsårbok 1979*, 165–172. Universitetets Oldsaksamling, Oslo.

Skår, Ø. 2003. Rituell kommunikasjon i seinmesolitikum. Unpublished hovedfagsoppgave, Arkeologisk institutt, Universitetet i Bergen, Bergen.

Solhaug, M. 2001. Middelalderens døpefonter i Norge. *Acta humaniora* 89.

Storemyr, P. 1996. A study on the weathering of Norwegian greenschist. *8th Int. Congress on Deterioration and Conservation of Stone, Proceedings*, 1,185–200, Berlin.

Storemyr, P. 1997. *The Stones of Nidaros: An Applied Weathering Study of Europe's Northernmost Medieval Cathedral*. Dr.ing.-avhandling, NTNU, Trondheim.

Storemyr, P. 2003. Stein til kvader og dekor i Trøndelags middalderkirker. Geologi, europeisk innflytelse og tradisjoner. In Imsen, S. (ed.) *Ecclesia Nidrosensis. Søkelys på Nidaroskirkens og Nidarosprovinsens historie*, 445–463, Trondheim.

Storemyr, P. 2015. *Nidarosdomens grunnfjell. I steinbryternes fotspor fra Det gamle Egypt til Europas nordligste katedral*. Nidaroe Domkirkes Restaureringsarbeiders forlag, Trondheim.

Storemyr, P., Berg, A. & Heldal, T. 2002. Problems in reopening medieval stone quarries: A study of Norwegian failures. In Lazzarini, L. (ed.) *ASMOSIA 6, Interdisciplinary Studies on Ancient Stone*, 63–72, Padova.

Storemyr, P. & Heldal, T. 2002. Soapstone production through Norwegian history: geology, properties, quarrying, and use. In Herrmann Jr., J. J., Herz, N. & Newman, R. (eds) *Asmosia V, Interdisciplinary Studies on Ancient Stone. Proceedings of the Fifth International Conference of the Association for the Study og Marble and Other Stones in Antiquity, Museum of Fine Arts, Boston 1998*, 359–369. Archetype Publications Ltd., London.

Storemyr, P., Lundberg, N. Østerås, B. & Heldal, T. 2010. Arkeologien til Nidarosdomens middelaldersteinbrudd. In Bjørlykke, K., Ekroll, Ø. & Syrstad Gran, B. (eds) *Nidarosdomen – ny forskning på gammel kirke*. Nidaros Domkirkes Restaureringsarbeiders forlag, 238–267, Trondheim.

Sørheim, H. 2004. Borgund and the Borgundfjord Fisheries. In Øye, I. (ed.) *Medieval fishing tackle from Bergen and Borgund.* The Bryggen Papers, Main Series, 107–133. Fagbokforlaget Vigmostad & Bjerke AS, Bergen.

Top. Ark. Topografisk arkiv, Universitetsmuseet i Bergen.

Tengesdal, S. S. 2010. Å steike! En kontekstuell materialeanalyse av steikeheller funnet i et bygårdskompleks i middelalderens Bergen. Unpublished masteroppgave, Institutt for arkeologi, historie, kulturvitenskap og religion. Universitetet i Bergen, Bergen.
Tuastad, N. H. 1949. Tolgesteinsbrota ved Haugesund. Garnstein eller vevlodd? *Stavanger Museum Årbok*, 47–68.
Turner, V. E. & Sherratt, T. 2009. Living Soapstone: reclaiming the skills. In Forster, A. K. & Turner, V. E. (eds) *Kleber. Shetland's Oldest Industry. Shetland Soapstone Since Prehistory*, 118–25. Shetland Amenity Trust, Lerwick.
Vangstad, H. 2003. Kleberkarene fra Bryggen i Bergen. En arkeologisk analyse av kleberkarene funnet på Bryggen i Bergen fra middelalder og etterreformatorisk tid. Unpublished hovedfagsoppgave, Arkeologisk institutt, Universitetet i Bergen, Bergen.
Voldheim, K. R. 1995. 1000 år med stein. Utvinning av kleber i Sel kommune. In Krekling, K., Aaraas, O., Stavdahl, L., Sæverud, D.H. & Solli, I. J. (eds) *Det mjuke berget – Kleberstein i Gudbrandsdalen. Maihaugen* Årbok*,* 9–18.
Weber, B. 1984. I Hardanger er Querneberg og Helleberg... og Hellerne, det er tyndhugne Steene, bruger man til at bage det tynde Brød Fladbrød paa... *Viking* 47, 149–160.
White, R & Bisson, M. 1998. Imagerie féminine du Paléolithque. L´apport des nouvelles statuettes de Grimaldi. Gallia prehistoire, vol. 40 no. 1, 95–132.
Wickler, S. 2015. Soapstone in northern Norway: Research status, production evidence and quarry survey results. In Indrelid, S., Hjelle, K. L., Stene, K., Berglund, B., Callanan, M., Kaland, S. S. H. & Stenvik, L. F. (eds) *Exploitation of Outfield Resources – Joint Research at the University Museums of Norway* Universitetsmuseet i Bergens skrifter vol. 32, 117–128. Universitetet i Bergen, Bergen.
Østerås, B. 2002. Slipsteinsberget i Sparbu. Unpublished hovedfagsoppgave, Institutt for arkeologi og kulturhistorie, Norges teknisk-naturvitenskapelige universitet NTNU, Vitenskapsmuseet, Trondheim.
Østerås, B. 2008. Rapport arkeologisk utgravning. Klebersteinsbrotet på Bakkaune, Veimester Kroghs gate 2B, Trondheim, Sør-Trøndelag. NTNU, Vitenskapsmuseet.
Øye, I. 1988. *Textile Equipment and its Working Environment, Bryggen in Bergen 1150–1500*. The Bryggen Papers Main Series vol. 2. Norwegian University Press, Bergen.
Øye, I. 2015. Fra felt til fag. Hvor står middelalderarkeologien i Norge i dag? In Brattli, T., Risvåg, J. A. & Berge, R. (eds) *Inn i fortida – ut i verden – i museet!* Vitark vol. 9, 18–27. Museumsforlaget, NTNU Vitenskapsmuseet & Vitark, Trondheim.

Internet sources

The National Natural Stone Database, Geological Survey of Norway: http://geo.ngu.no/kart/mineralressurser
Wikipedia: https://en.wikipedia.org/wiki/Talc
Quarryscapes: http://www.quarryscapes.no/

Endnote

[1]Free translation of correspondence between a lay finder and the University Museum of Bergen's curator in 1949. The finder sends a stray found soapstone spindle whorl to the museum, and writes like this: *'…Steinen er kanskje ikkje av so stort vitskapeleg verd men vi ville gjera vor plikt med aa senda han. Av interesse er det aa faa vita om vi skal senda slike bagatellar oftare…'*. The curator at the museum politely answers like this: *… Takk for den tilsendte steinen… slike snellehjul seier i regelen ingenting, då dei var i bruk i same form gjenom 1000 år, og vi brukjar ikkje samle på dei utan dei kjem frå förhistoriske graver… Ei anna sak er at De spør om De oftare skal sende slike 'bagateller'. Jo, det er det vi helst vil. Vitskap er bygd opp av bagateller. Ingen ting er for smått til å samlast inn, men eit og anna kan nok - som her – vere for smått til å samlast på i eit museum…* (Topografisk arkiv, University Museum of Bergen).

Eva Stavsøien

Soapstone Quarrying, a Stoneworker's Approach

Practical activities are best expressed and understood through practice. Present understanding of former times' crafts practice are mainly based on theoretical interpretations of the traces and products left behind. By contrast, a stoneworker sees the crafts' process as a source of knowledge. This is the thought behind The traditional quarrying project, carried out in the Klungen soapstone quarry, close to Trondheim, Norway in 2011. The project intended to achieve a more detailed insight into quarrying methods of the past. Main fields of interest were the methods themselves, time consumption, choice and use of tools and similarities/differences in techniques applied to shape the pieces to be quarried. One may rightfully ask if this project, carried out by a present day stoneworker, can provide answers relevant for aspects of past times' quarrying. The factors assessed were reduced to those essential in any stone working process; the material, the craftsperson and the tools. Regardless of time and purpose, the material stands out as an unchangeable or static factor, and it sets the premises for what can be done and how. A material-related 'timelessness' is thus revealed and makes the craftsperson's answers relevant for soapstone working in general.

Introduction

Crafts, like any kind of practical activity, are best expressed and understood through practice. During a process, both practitioner and observer are involved – although in different ways. When the product is finished, the process, with its entire contents, becomes history. Those who quarried soapstone for cooking pots and building materials in the past left a long time ago and their quarrying methods are forgotten. What they *did* leave behind are the traces of their activity. Through interpretations of these visible remaining traces, main features of soapstone quarrying in former times are revealed; the details, however, are often still hidden. Even if the exact process from soapstone outcrop to object is impossible to recreate (Stavsøien 2012:55), a process with similarities can be a suitable tool for exploration of soapstone working in prehistory and the Middle Ages. Today a few craftspersons are still working soapstone in what often is referred to as the *traditional way*; carving with old-fashioned chisels and hammer. This may represent a link backwards in time and thus provide a basis for extended knowledge of our predecessors' quarrying methods. In 2011 an experiment within *The traditional quarrying project* took place in the Klungen soapstone quarry, located 17 km from Trondheim in central Norway. The experiment was carried out as part of my Bachelor's studies at the Sør-Trøndelag University College. The aim of this paper is to provide a glimpse into a stoneworker's theoretical and practical approaches to soapstone quarrying in former times. Despite the incompleteness in written descriptions of practical activities, a tinge of the 'hidden' knowledge will hopefully be made available.

Background

Throughout history, soapstone resources have been utilized for various purposes in Norway, first in household and primary industries. To varying extents, this production continued into modern times; in the late 19th century, it was still possible to buy soapstone cooking pots in the Gudbrandsdalen area of eastern Norway (Helland 1893:107). Inspired by cathedrals and churches built in stone elsewhere in Europe, soft rocks such as greenchist and soapstone came into use as a building material in Norway during the early Middle Ages (Ekroll 1997). With the Reformation, and in time also due to lack of maintenance, many stone buildings decayed in the following centuries. During the 19th century, a growing national consciousness led to renewed interest in stone churches, and after centuries of neglect, large rebuilding and restoration projects were required. For the necessary supply of stone for these projects, some of the old soapstone quarries were reopened and new came into use. After all the years gone by, the basic quarrying technique was seemingly unchanged; channels were chiselled or picked around the desired piece of stone before the last connection with the solid rock was broken, for example, by wedging it out along a foliation plane; a technique similar to what can be observed in soft stone quarries all over the world (Storemyr 2000:13). In the years to come, however, the traditional quarrying methods gradually were replaced by less labour intensive and more efficient solutions. And during the first half of the 20th century, the old methods had basically disappeared. Today existing knowledge of soapstone quarrying in former times is mainly based on interpretations of the visible and tangible results of the utilization; artefacts, buildings and traces from working the soapstone outcrops. A different – theoretical and practical – approach can probably contribute to extend this knowledge.

A stoneworker's approach

All professions have methods and rules regulating the way their work should be done in order to attain their goals. The stoneworker's method is quite simply the craft's process. Under ordinary circumstances, the craft's complex content is used to transform raw materials into products. A visible and tangible object is the goal; the way towards this goal is, however, rarely found interesting or documented. In what follows, the primary focus is the *process* towards the finished product. During any process, numerous factors influence how the craft is performed. In this context, it will be far too comprehensive to pay attention to all of these. Numbers of factors will therefore be reduced to those considered essential in the process: the material, the tools and the craftsperson (Stavsøien 2012:55).

The material

Soapstone is often described in general terms as a soft, dense and easily workable rock. In reality, like other natural materials, it is not a homogenous industrial product and appears in innumerable varieties and compositions. Some of these variations may be visible, such as colour differences; a wide range of shades from light to darker grey, sometimes with greenish, bluish or brownish-red tones. Differences in grain size and mineral orientation, as well as veins and fissures, can also be observed. This diversity is due to its origin and the following processes it has undergone, issues beyond the scope of this paper. Visible differences can sometimes be reflected in the workability. Dark colours often indicate a stone harder than the lighter coloured ones. With mottled appearance, hardness can be uneven and so on. Despite a certain relationship between appearance and properties, the true character of the stone is first revealed during the work. One of the important invisible factors is the soapstone's texture. Even if it consists of soft particles/minerals, these can be strongly interlocked, which can make the stone feel tough and tenacious to work. To describe fully what the term workability includes is difficult – it has to be felt! Briefly and incomplete, it can be considered as the feeling of working the material and how this affects the effort needed to achieve the desired results. Even though the soapstone undoubtedly is easily worked compared to many other rocks, it still is a rock. Its nature implies lack of elasticity; the material cannot be squeezed, bent or stretched to the desired shape. Consequently, all working operations require parts of the material to be removed. Despite the soapstone's relative softness, it is impossible to do this by hands only; some type of tool is a necessity.

The tools

Primarily, the tools can be something as simple and primitive as a slightly sharp stone, harder than the soapstone. Although the needs and requirements related to the tools are basically modest, there has been a certain development. Edged tools made from steel with pointed or straight edges in different sizes and a hammer is the current basic equipment.

The craftsperson

What happens when working the soapstone and how does the performer experience this? It has to be taken into account that there are basic rules for what can be done and how it has to be done; these will not be discussed here. When working the material with the tools energy is transmitted. This mechanical impact contributes to break the connection between the particles in the material. How this is experienced depends not only on the quality of the material and the tools used, but also on whether the processing is rough or fine. Rough processing requires hard and fixed blows in a slow rhythm, the latter to give the energy time to affect the material before the next blow. This results in large fracture surfaces with few tool marks. The finer parts of the work require less energy, the blows are more cautious and the rhythm faster. Less energy transmitted needs less time to affect the material. Here, the ratio fractured surface/tool marks are opposite to the previously mentioned. One step in the working process primarily removes traces of the previous step.

The foundation of skills and knowledge in crafts are built on performance of practical activities under the guidance of experienced craftsperson(s). When a certain level is attained, you are qualified to work independently – this is when the experience-based learning process really begins. With time, the craftsperson develops a personal relationship to what is going on when working the material. This is rarely thought of, discussed or communicated; it is just too obvious and personal. For this reason, it is often termed tacit knowledge. In my opinion, this is quite simply based on sensory input and experience from these. When working the soapstone, something visible and audible indicates what is happening. In addition, the material is responding to what is done, which can be felt as more or less resistance. All of these signals are unconsciously saved and over time a large 'database' is built. When working, the new sensory inputs are continuously compared to what is already stored and further progress will be based on this. This happens without the craftsperson being aware of it and can be described as some sort of communication with the material. There are not many written sources based on experience relating to this, one of the few is a description of block splitting with wedges on Purbeck Island in Great Britain:

> *To an outsider looking on it is only six wedges standing in six holes across a stone, but the man using the hammer has felt vibrations which seem to come out of the stone up through the wedges and into his arms by way of the hammer and handle. Some men who have cut thousands of stones will say they never felt it, but even they know just when to apply the last blows, the blows which really break the stone (Benfield 1940:96).*

Experience-based interaction such as this is the core in rational and successful processes. What can be achieved depends on the craftsperson's understanding and ability to interact with the material. This is what forms the basis for what to do and how, as well as for how to evaluate and interpret the outcome of the attempt at 'traditional' soapstone quarrying.

The traditional quarrying project

The Klungen quarry is one of the medieval soapstone quarries used for the construction of the Nidaros Cathedral in Trondheim and other medieval buildings in the Trondheim region. During the second half of the 1800s, the medieval quarry was reopened and a new quarry was also established just beside it, both to provide stone for the restoration work at the Cathedral. This activity came to an end in 1899, and it was not until nearly 100 years later that lack of stone for upcoming restoration projects led to a renewed interest. After geological investigations and archaeological excavations in the late 1990s, two attempts of test quarrying were undertaken: both with modern quarrying methods and with rather discouraging results. The quarried blocks developed many cracks and fissures, probably due to the release of remaining stress in the rock (Storemyr 2000).

Situated within the security zone surrounding the heritage listed quarry, the test quarrying left a part of the soapstone outcrop easily accessible for experimenting with 'traditional' quarrying methods. With permission from the cultural heritage authorities (Riksantikvaren), 3 x 3 x 3 m of the test area was put at my disposal for The traditional quarrying project (Figure 1). Permission was granted on the basis of the project's opportunity to attain new knowledge. The quarrying experiment was carried out

Figure 1. *Part of the Klungen soapstone quarry. The framed part shows the area at disposal for The traditional quarrying project, with the author working. (Photo: Ø. Digre & H. Grøtt).*

in the summer 2011. The purpose was primarily to achieve more detailed insight into past quarrying methods. Tools and their use, similarities and differences in technique related to the shape of quarried object and time consumption were of interest. My practical approach to this was to quarry angled and circular pieces from the rock, using suitable tools. As a side effect, with the discouraging results of the use of modern quarrying methods in mind, I hoped to discover whether the material would react differently with the use of a supposed slow quarrying method. It was not an aim to copy extraction marks from prior quarrying neither in this nor in other soapstone quarries. To recreate ordinary operating conditions was not the purpose, as attention was aimed at the process, not the product. Results obtained are thus limited to apply for the available material and tools.

Tools for quarrying

A practical study aimed at the performance of outdated working operations can give some challenges. One is the lack of suitable tools. The traditional way to quarry (and work) the soapstone is considered conservative and tools and techniques from the late 19th/early 20th century are assumed to shed light on how the Medieval stoneworkers performed their craft (Lidén 1974:17). For *carving* the soapstone, these tools and techniques are similar to what is still in use. Regarding the tools for quarrying one of the last glimpses of such is from the 1930s (Voldheim 1995:12), later these single stone axes (locally called *spetto*) and similar tools (NEG Varia 3389) used in the last days of traditional soapstone quarrying seemingly just disappeared.

When it comes to archaeological tool findings clearly related to soapstone extraction (and processing) in earlier times, the selection is limited. In this context, it is important to remember that only a small number of the quarries have been subject to archaeological excavations, so there may be more to find. What so far is found, however, are variations on the same theme as the current stonemason's tools; edged tools with a pointed or straight edge (e.g. Bergström's diary 2.12 1876; Bergström's sketches Gb-0159; Skjølsvold 1961:57, Fig. 16). The latter (straight edged) has significant similarities to woodworking tools. There may be several reasons for the meagre selection of archaeological tools (Stavsøien 2012:23): The tools could be durable and last for generations, the availability of tools/raw materials for those could be limited, which would be a good reason to take care of what you have. With time, the craftsperson develops a personal relationship with the tools; they become a 'part of the body'. The tools may also have been re-used for other purposes in primary industries or recycled; damaged tools were (and still are) a raw material in the production of new tools or other items.

Without being familiar with the archaeological tool findings, one might imagine the axes/adzes as large and heavy. Apparently it was not so, the 'large' ones seem to be 20–30 cm long with a weight around 1 kg. Nevertheless, their shaft holes are quite large and their necks solid, indicating that the tools were designed for rough use. While the tools are mostly lost, the marks they left in the quarries sometimes can be a valuable source of knowledge. The tool marks indicate use of straight or curved axes/adzes or chisels with a pointed or straight edge. Interpretation of tool marks suggests that various types of tools were used at different times during history (Heldal 2006:20). In my experience, the axes/adzes can be divided into three categories: 1) Celts or slightly curved adzes (sometimes with curved/rounded edges), 2) double pickaxes and 3) single pickaxe/stone axes (about the same size/weight as the double pickaxes).

The single stone axe is only slightly different from the single pickaxe in shape, but it has a narrow straight edge instead of a pointed one. Chronologically, the tools seem to have appeared in the order mentioned above. Tool marks in the pre-Roman Iron Age quarry of Sandbekkdalen (previously referred to as *Bubakk*) quarry, at Kvikne in south central Norway, seem to stem from tools in category

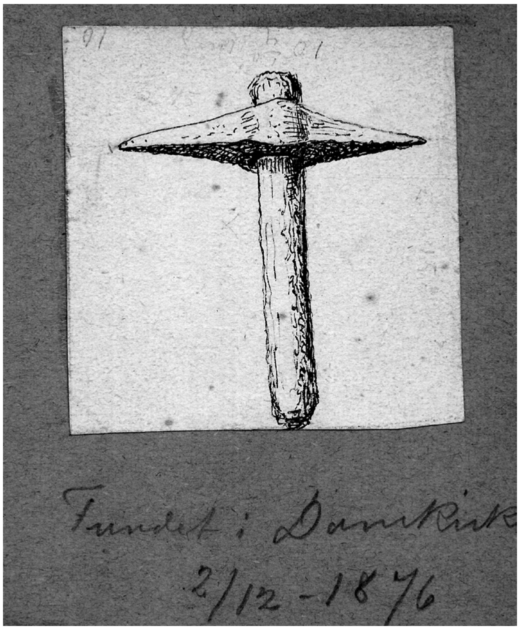


Figure 2. *The 12th century pickaxe found in the Nidaros Cathedral, Master Builder Bergström's sketch. (The Restoration Workshop of Nidaros Cathedral, historical archieves, Gb-0159).*

Figure 3. *The tools used during The traditional soapstone quarrying project at the Klungen quarry (Photo: E. Stavsøien & H. Grøtt).*

1 (see Skjølsvold 1969:210; Grenne et al. this vol.). A double pickaxe (Figure 2) found inside a wall at Nidaros Cathedral has, from the archaeological find context, been dated to the 12th century (Bergström's diary 2.12 1876), and the single stone axes can be seen in photos from the last days of traditional soapstone quarrying (Voldheim 1995:12). This does not necessarily mean that one type replaced another; the selection of tools was rather broadened.

For The traditional quarrying project, tools representative of a time with extensive cooking pot production as well as for the early quarrying of soapstone for building purposes were desired. Temporally, this means the late Viking Age/early Medieval period. It was decided to reconstruct and produce one double pickaxe and two adzes, all found inside the Nidaros Cathedral during the early years (1870-80s) of the restoration period (Figure 2). Selecting tools that were found in a building and comparing them with tools used for quarrying may seem somewhat strange. However, the rough dressing of stone in the construction process can have similarities with what happens when stone is extracted from the solid rock. In addition, the find contexts gave good indications for use connected to soapstone working and at least the pickaxe had close to appropriate dating. The chosen tools have remarkable similarities in shape (not size and weight) with tools found in Bøurda, Telemark County (Skjølsvold 1961:57, Fig. 16). With this choice, the blacksmiths also had the benefit of available originals during the reconstruction process. In this process, weight, size and shape were taken into account; similarities in material quality and forging were not emphasized.

Tools from the distant past rarely have their shafts intact. The pickaxe from Nidaros Cathedral was an exception; according to the master builder's sketches and diary, it was found with a wooden shaft, but unfortunately it fell apart when touched (Bergström's diary

2.12 1876). If the sketches are correctly proportioned, this shaft was short (Bergström's sketches Gb-0159).

When it comes to shape of shafts, other shapes than the straight were seemingly (from historic illustrations) not an option before it appeared on timber axes in modern times. Length and design of the shafts were discussed before the choice fell on a long and straight variant. A long handle delivers more power and extends the reach, in addition, it could easily be shortened if necessary. With these axes/adzes, the basic equipment was in place. A large pointed chisel, a hammer and a couple of steel wedges completed the supposed need (Figure 3).

Pre-assessment and planning

Before the quarrying experiment could commence I had to map the test area in the Klungen quarry and make a plan for how to approach the rock. The modern quarrying methods had left a vertical, sawn surface/'a wall'. And combined with a relatively steep slope up-/backwards from this (see Figure 1) it was a challenge to find a foothold while working. A simple working platform beside the 'wall' and small steps hewn out of the rock seemed to be an appropriate solution. Scaffoldings might have been more comfortable but as work progressed, rebuilding would be required and the resources this would take made me consider the disadvantages greater than the benefits.

In a soapstone outcrop surface material is often considered to be of poorer quality than the parts protected by overlying rock and soil. This is due to the influence from natural weathering processes. Under regular operating conditions, most of the available material would most likely be considered unusable and removed. Without experience, it was impossible to estimate time consumption for this work. Therefore, it was decided to quarry from existing surfaces.

Basically, stone quarrying is to free the desired part of the material from its surroundings. Prior to the quarrying, an evaluation of the materials' visible characteristics, such as cracks and fissures in the stone, should take place to estimate how these can affect the working process. While some characteristics provide opportunities to ease the work others may restrict what can be done. Cracks and fissures hold water; they dry slower than the homogeneous parts of the material and appear as dark veins at the surface. So when a surface dries up after being wet, it is easy to 'read' the stone. Furthermore mineral orientation is often more visible on fractured surfaces.

The test area at my disposal is strongly foliated and fractured. Distinctive foliation or bedding planes (in the continuation the latter term will be used), partly open, appear 20–30 cm apart from each other. They are parallel, following the slope backwards from the sawn surface. With additional intersecting cracks, the size of the blocks to be quarried is limited. The seemingly most rational way to start the quarrying was to take advantage of the bedding planes and think of the stone between these as huge slabs; the width of the slab being defined by the intersecting cracks. To follow a slab in-/backwards from the sawn 'wall' while dividing it into suitable blocks seemed to be a quite efficient approach. By doing it this way, the blocks could be easily slid out and allowed to fall down by the wall onto the spoil heap that would be built up during the work. The spoil heap would serve as a shock absorber, protecting the blocks from damage. Finally, after this mapping and planning, the work could begin.

Quarrying angled objects

To make the first square block two *channels*, angled at each other were marked up (Figure 4). For this task, the pickaxe was chosen. In principle, one cannot cut directly (at right angle) into the stone, this will only create a small hole surrounded by uncontrolled crushing. To break the stone surface, the pickaxe had to be slightly tilted and the blows directed *away* from intended edge of the block. After doing this through the full length of the planned channel, the pickaxe was tilted in the opposite direction and the blows were directed towards the bottom of the first row of tool marks. This resulted in a narrow and shallow v-shaped trace, impossible to make much deeper. I realized that there had to be a relationship between width and depth of the channels. After a couple of attempts, the code was broken; the width of the channel had to be roughly half of its intended depth. When making the channel wider, the two rows of tool marks were situated too far apart from each other to meet in a v-shape; a 'ridge' was left in between. The next step was to dispose of this ridge and make the channel deeper in a controlled way, without causing damage to the intended block. The systematic and assumingly most efficient way was to make tilted cuts down by the ridge towards the bottom of the channel-side tool marks. As a result of this operation, the ridge became smaller and triangular with a v-shaped trace on both sides. This made the channel profile appear as w-shaped. By now it was impossible to make the channel deeper without removing the middle part. For this job, the tiny adze was a better choice than the pickaxe. Having removed this middle part, the channel's profile became u-shaped and the work to increase the depth could continue. The pickaxe was first used down the channel's walls and then from the middle of the flat bottom towards the walls, by this a new w-shape appeared and had to be removed. The described procedures were alternately performed down to the bedding plane. Finally the channel was v-shaped, resulting from the impossibility of keeping the walls vertical throughout the process. With increased depth, the channel walls limited the tilting of the pickaxe, the side of the axe not in use conflicted with the channel wall opposite from the one worked. A possible solution could be a wider channel, but this was rejected because it would be more labour intensive and waste more material. Due to the surroundings, the channel was worked only from one direction; working also from the opposite direction could have been a benefit in keeping the walls straighter.

Perpendicular to the first channel another one was made, using the same tools and technique. At

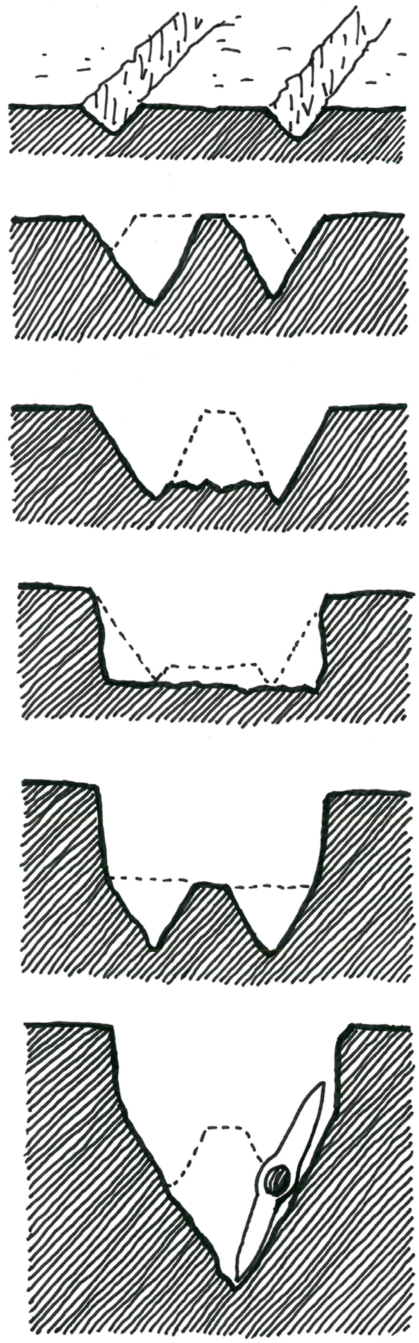


Figure 4. *Stepwise development of the channel during the quarrying of angled objects. (Drawing: E. Sørburø).*

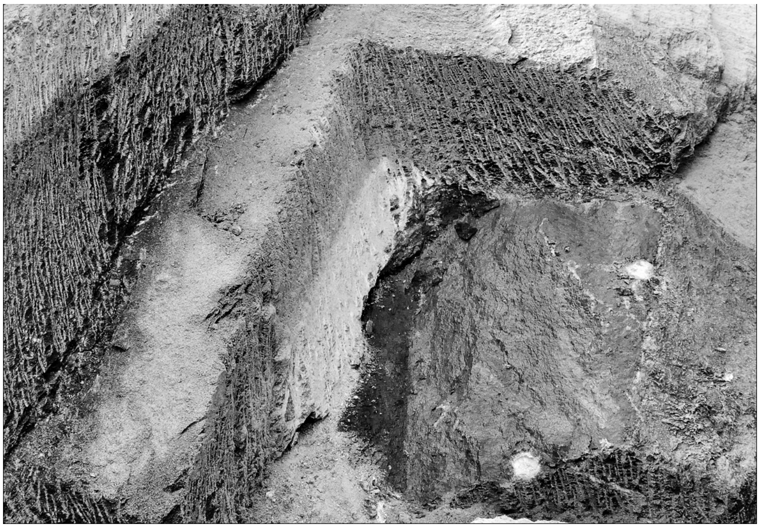


Figure 5. *The stone will always break at its weakest point; here this is the channel's depth. (Photo: Ø. Digre & H. Grøtt).*

their meeting point some challenges appeared, it seemed to be impossible make the channels deep enough in this area. Again, I wished that the surroundings had allowed working the channel from both directions. To make the channels slightly longer and let them cross each other turned out to be somewhat helpful. The distinct bedding planes made it possible to use the wedges without carving holes. Two wedges were used, one at each of the free sides of the block. Only a few blows with the hammer were needed to break the last connection with the solid rock. Where the channel was too shallow (did not go down to the bedding plane), the breach would follow the channel depth rather than the bedding plane in the parts of the block bordering the channels (Figure 5). The stone will always break at its weakest point and here the channel depth is a created weak point working as a breaching guide. Due to the challenges in keeping the channel walls vertical, the bottom side of the quarried blocks was larger than the top side (Figure 6).

Figure 6. *The slanting channel walls resulting in blocks with a larger bottom than top side. (Photo: E. Stavsøien & H. Grøtt).*

Quarrying circular objects

Quarrying stone for a circular object can be done in a manner similar to the angled ones, but is this the most efficient way? A soapstone vessel for cooking or other purposes often has a rounded bottom. What can be seen in some quarries are half finished objects with a rounded surface still connected to the solid rock, indicating that the rough shaping was done during the quarrying.

After marking a circle on the surface, the pickaxe was used to cut a v-shaped channel (as formerly described) all the way around the circle (Figure 7). At this point, some challenges in making the channel deeper were expected to occur. However, as stone was chiselled away in order to create the rounded shape, it was neither a problem to work the channel deeper nor to keep the outer wall of the channel vertical (if desired). The rounding of the object to be quarried actually removed the material that would have hindered the blows of the tilted pickaxe. Another benefit from this approach to the object's shape was its function as an additional quality control of the material. Due to a wider v-shaped area of waste removed, the ridge in the channel never occurred and the channel was v-shaped during the entire process. Also here the channel was supposed to meet the bedding plane and to make wedging possible, some of the surrounding stone had to be removed. What was noticeable in the quarrying of rounded objects was their tendency to loosen during the process.

Clearing and facilitation

As so far described, the quarrying process was fairly uncomplicated and not too labour intensive. However, disposing of dust and debris and the preparation for the next piece to be quarried proved to be rather time-consuming tasks. Stone quarrying produces a large amount of broken stone; from quite big fragments to dust. The larger pieces slid down the sloping surface by means of gravity whereas dust and smaller pieces had to be removed manually. The debris affects visibility when working and absorbs energy from tooling, reducing its effect. In moist conditions, the dust is transformed into slippery mud. Luckily, there was a pond close to the working area, and by pouring water over the rock, the 'problems' were washed away. Preparation for further quarrying had to be made after each piece had been extracted. This included making the remaining channel side (which would also become one side of the next block to be quarried) vertical and to clear the bottom foliation plane. Sometimes larger quantities of poor quality stone had to be removed in order to gain access to material of better quality. By taking advantage of bedding planes, foliation and cracks, parts of unwanted material could be wedged out, and if this was impossible the pickaxe was used.

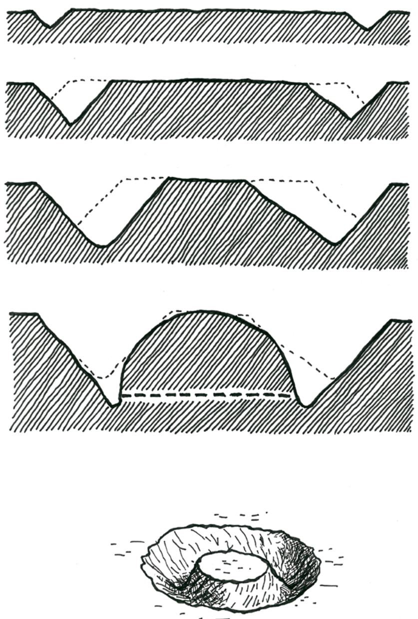


Figure 7. *Stepwise development of the channel during the quarrying of circular, rounded objects. (Drawing: E. Sørburø).*

Results/discussion

Similar rules for what can be done and how apply to all soapstone working processes. Quarrying or extraction of soapstone can be considered as the roughest working operation the material is exposed to. Working operations that appear very different, such as making channels in the block quarrying process or carving letters in an inscription, are basically the same.

It is all about how to remove parts of the material into its depth, the only difference is the dimensions. Due to the nature of the material, one has to start out by making a v-shape to break the surface in a controlled way. This v-shape can be further processed into a u-shape. With an increased channel width, the tool marks do not meet in the middle; a ridge is formed. This remaining ridge will form the basis for two parallel v-shapes: a w-shaped channel profile. Under the current experiment, the width of the channel had to be approximately half of its intended depth. Working soapstone (and other rocks) with different properties could affect this ratio.

In the course of extraction stone for circular, rounded objects, the channel will be v-shaped during the entire process, regardless of depth. The reason for this is the angle or curving of one of the channel walls when approaching the intended shape of the object.

When it comes to the final step, breaking the object's last connection with the solid rock, circular pieces are seemingly easier to loosen than angled. The circular shape can be seen as an unbroken line or 'closed form' that gives the piece a strong internal cohesion. Wedging from any point of the circle will direct the energy towards the middle of the piece and further on to its opposite side. A quadrilateral object, with several meeting or crossing lines creating protruding parts, will have a weakness in its corners as well as a stronger connection with the solid rock. When wedging from a straight side of a block, the energy still is directed towards the middle and further on to the opposite side. To bring enough energy to the corner in the channel's meeting point, wedging at, or very close to, the accessible corners is required. This will most likely cause damage to these and is therefore not recommended.

Compared to modern quarrying methods, the traditional extraction of soapstone is considered a rather slow activity. Surprisingly, it turned out to be less time consuming than expected. In a little less than two hours a rectangular block was quarried, this included working two channels 30–40 cm long, 13/25 cm wide/deep and wedging. A circular piece with a rounded shape, a diameter of 25 cm and 15 cm high, was extracted in a little more than half an hour. What turned out to be the most laborious and time consuming was removal of useless material, clearing of surfaces in preparation for further quarrying, and to carry large quantities of water. Probably, the time consumption could be reduced by training, better organization and improved logistics (for water supply).

The chosen tools proved to work well. Both the pointed and straight edges turned out to be durable, within 80 hours of use sharpening was not necessary. The tools' long shafts and thus extended reach were at great advantage when a foothold close to the working area was impossible to find. Unfortunately, the big adze developed a crack (due to a mistake in the curing process) and became damaged before its uses were properly tested. The adze, however, seemed to be useful in the clearing of the sloping surfaces and worked well for hewing steps for the foothold. The chisel and hammer were found less appropriate for making channels; tools for double hand use are more efficient and less tiring to use for such tasks. However, without other tools available, chisel and hammer would be better than nothing.

In the quarrying process, the Klungen soapstone seemed to respond better to pointed- than straight-edged tools. Experience indicates that this can be the opposite when working soapstone with different characteristics. Such conditions, in addition to local traditions, may have influenced the choice of tools and differences in technique from one quarry to another in former times. It is worth noting that one single tool can leave marks/traces appearing quite different. Some factors contributing to this are; the craftsperson, working position, quality of materials, purpose of the work and amount of force used.

As already mentioned many cracks and fissures developed while working the Klungen soapstone outcrop by modern methods. Whether the outcrop would react in a different way when extracted in the somewhat slower, traditional way is a question difficult to answer, as the material at my disposal was fractured already before the work began. The test quarrying in the late 1990s possibly influenced not only what was extracted but also the remaining adjacent stone. Further fractioning during and after quarrying was, however, not observed and the objects withstood further breakage when they hit ground, or the preferred spoil heap, at the end of a two-metre drop.

One may ask if theoretical and practical experiments by a stoneworker of our time can provide answers relevant for aspects of former time's craft practice? The quarrying *methods* represent one of the primary differences between current and past times soapstone working.

As previously mentioned, the stone working crafts are referred to as conservative. In the present assessment of three factors essential in stoneworking; the material, the tools and the craftsperson, the material stands out as the only unchangeable factor – static in all its diversity. From this, the material can be said to set the conditions for what can be done and how. Regardless of time, place and purpose, this is what the craftsperson has to deal with and what the tools must be adapted to. Our predecessors established the methods and developed the tools for this. It still works well; there is no need for change. Thus, the basics of all soapstone working can be described as timeless when performed the traditional way. There certainly is a risk of subjectivity in assessments and interpretations. Despite this, the material-related timelessness makes the craftsperson's answers relevant for soapstone working in general.

References

Benfield, E. 1940. *Purbeck Shop. A stoneworker's story of stone.* Cambridge University Press, Cambridge.

Bergström, W. (Master builder). *Diary 2.12 1876 and sketches Gb-0159.* Historical archives, The Restoration Workshop of Nidaros Cathedral, Trondheim.

Ekroll, Ø. 1997. *Med kleber og kalk.* Det Norske Samlaget, Oslo.

Heldal, T. 2006. Stein som handelsvare: Hva klebersteinsbruddene kan fortelle oss. In *Stein som handelsvare: Rapport frå fagseminar* 16–24. Hyllestad Kommune, Hyllestad.

Helland, A. 1893. *Tagskifere, heller og vekstene.* Norges Geologiske Undersøgelse No 10, Kristiania.

Lidén, H. E. 1974. *Middelalderen bygger i stein.* Universitetsforlaget, Oslo.

Norsk etnologisk gransking (NEG) Varia 3389.

Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden.* Universitetsforlaget, Oslo-Bergen.

Skjølsvold, A. 1969. Et keltertids klebersteinsbrudd fra Kvikne. In Hougen & Skjølsvold (eds) *Viking XXXIII* 201–236, Oslo.

Stavsøien, E. 2012. *Fra fast fjell til gryte. Å arbeide med kleberstein,– hva skjuler seg i prosessen? (From solid rock to cooking pot. Working with soapstone,–what is hiding in the process?).* Bachelor thesis, Høgskolen i Sør-Trøndelag, Trondheim.

Storemyr, P. 2000. Attempt at reopening Klungen medieval soapstone quarry for modern use at Nidaros Cathedral. In *Report Raphael I Nidaros Cathedral Restoration R99-Lab2/SI2.90474 Project 59,* 91–98. The Restoration Workshop of Nidaros Cathedral, Trondheim.

Voldheim, K. R. 1995. 1000 år med stein. Utvinning av kleber i Sel kommune. In Krekling, K. (ed.) *Det mjuke berget; kleberstein i Gudbrandsdalen,* 9–18. Maihaugen årbok 1995, Lillehammer.

Stephen Wickler, Ingvar Lindahl and
Lars Petter Nilsson

Soapstone in Northern Norway: Archaeological and Geological Evidence, Quarry and Artifact Survey Results

Archaeological research on the extraction, distribution and utilization of soapstone artifacts in northern Norway has been limited, but systematic geological documentation of soapstone exposures that includes quarry activity provides an opportunity to expand archaeological insights into soapstone provenance and extraction. This article brings together geological and archaeological evidence related to soapstone use in northern Norway to the north of Saltfjellet in Nordland in order to evaluate the current state of knowledge for this resource. The initial section provides a chronological overview of archaeological evidence for soapstone use and associated site contexts, including the distribution of artifact types in time and space. This is followed by a presentation of soapstone geology from a historical perspective focusing on quarry documentation. Quarry evidence is reviewed and results from recent collaborative geological and archaeological surveys presented within a framework of relevant research problems. The final section outlines potential avenues for future interdisciplinary soapstone research.

Introduction

The role of soapstone in northern Norway has received limited attention in the archaeological literature and the region has also played a marginal role in attempts to synthesize existing knowledge of this material at the national and international level. Although soapstone artifacts are plentiful in northern Norwegian archaeological sites from the late Iron Age up until the recent historical period, a regional synthesis is still lacking. As was the case with Norwegian soapstone research in general (Shetelig 1912), there was an early focus on the typology of soapstone vessels during the Iron Age linked to trade networks and chiefly control of circulation (see Risbøl 1994). Arne Skjølsvold (1961, 1969) was the first to emphasize the importance of quarry sites and artifact production during the Iron Age, although maintaining the traditional focus on vessels. Sigurd Grieg (1933) systematized the classification of medieval soapstone vessels based on formal attributes. More recent studies such as those by Siri M. Lossius (1977) and Hilde Vangstad (2003, this vol.) have provided an increasingly robust chronology from reliable archaeological site contexts for this period. Although soapstone research has led to an increased awareness and understanding of this resource since the Stone Age, the geographical focus remains on southern and western Norway. Broader studies that have included northern Norway are characterized by a lack of firsthand knowledge and superficial treatment of what has been considered a peripheral region.

This article addresses the current geographical imbalance by providing a general status report for soapstone in northern Norway within the district administrated by Tromsø University Museum that extends from Saltfjellet in the Helgeland region of Nordland County northward through Troms and Finnmark counties to the Russian border. The initial section presents a general archaeological overview of soapstone finds from the Stone Age to the recent historic period and their sociocultural context. This is followed by an examination of soapstone resources and their exploitation over time in the region from geological and archaeological perspectives. Soapstone evidence is reviewed and challenges associated with quarry documentation are discussed. Results from recent collaborative geological and archaeological quarry surveys are presented and the final section raises topics for future soapstone research.

Archaeological soapstone evidence from northern Norway

In order to examine the distribution of soapstone artifacts and their cultural contexts, data from the portion of northern Norway within the administrative district of Tromsø University Museum that appear in the national database for archaeological finds (*gjenstandsbasen*) was utilized. This database is administered by MUSIT (museum IT), a collaborative initiative aimed at managing and disseminating digitized collections in the five University Museums of Norway. Although all archaeological finds held in the collections at Tromsø University Museum should be registered in the database, the quality and reliability of the information that is available varies to a considerable degree and cannot be accepted uncritically. However, it does provide coarse grained information that is deemed adequate for the broad overview presented here.

Early soapstone use (Stone Age to early Iron Age)

Although a variety of soapstone artifacts from the Stone Age has been documented in Norway, both the quantity and types of finds from northern Norway are limited (Figure 1). Of the 27 finds from fairly secure contexts in the national database, a majority are fishing line sinkers from the late Stone Age. There is also an atypical boat-shaped battle axe from the late Neolithic period (2800–2350 BC) found at Storsteinnes near Tromsø (Ts 1648) that may be associated with a grave (Valen 2007:129).

Bronze Age soapstone artifacts are limited to bronze casting molds and thin-walled soapstone vessel sherds from Troms and Nordland counties. Bronzes or molds of Nordic Bronze Age type are present in 15 sites from southern Troms and further south. Twelve of the site localities have been interpreted as votive finds and two as graves (Arntzen 2013). Three sites with soapstone molds are within Tromsø Museum's district. The northernmost location is a settlement site at Sandvika near Tromsø where a soapstone celt mold and a thin-walled soapstone vessel sherd were found during test excavations in 1994. Additional sherds from the same soapstone vessel were recently excavated at Sandvika by Johan Arntzen (2015). The other soapstone molds are from Grøtavær on Grytøya Island in Troms (Munch 1966) and Kolvika on the island of Vestvågøy in Nordland. Two stray finds of soapstone bronze casting molds dating to the early Metal Age (second millennium BC) have been found at Jarfjord, Sør-Varanger, Finnmark. These are interpreted as depot finds from the textile ceramic period with similarities to bronzes from central Russia (Olsen 1994:125–126).

Soapstone used as a tempering agent is associated with northern Norwegian 'asbestos ceramics', a term applied to a number of pottery types used during the late Stone Age and early Metal Age. Two of the most important and widespread, yet geographically distinct, ceramic types are referred to as Risvik and Kjelmøy (Jørgensen and Olsen 1988). Risvik ceramics are commonly associated with agri-

Figure 1. *Distribution of soapstone artifacts by site type and chronological period in northern Norway.*

Site type	Finnmark	Troms	Nordland	Total
Occupation site	141	172	1248	1561
Urban site	--	--	139	139
Farm mound	2	19	85	106
Grave site	2	20	62	84
Boathouse	1	--	1	2
Soapstone quarry	--	5	--	5
Other / unknown	109	327	909	1345
TOTAL	255	543	2444	3242
Chronological Period	**Finnmark**	**Troms**	**Nordland**	**Total**
Recent	100	35	48	183
Recent / Medieval	8	132	340	480
Medieval	21	178	939	1138
Medieval / Iron Age	--	33	273	306
Iron Age / late Iron Age	1	60	595	656
Early Iron Age	--	7	18	25
Bronze Age / early Metal Age	2	3	8	13
Stone Age	10	4	13	27
Unknown	113	91	210	414
TOTAL	255	543	2444	3242

cultural settlement and restricted to sites along the outer coast in Troms and Nordland. However, it should be emphasized that these typological categories are open to debate and mask a substantial degree of internal variation that has yet to be adequately investigated. Kjelmøy ceramics are the most abundant and geographically widespread asbestos pottery type and date to the Kjelmøy phase of the early Metal Age (900–0 BC). Although most common in Finnmark, they extend along the entire coast of northern Norway within Tromsø Museum's district. In contrast to Risvik ceramics, they are associated with non-agricultural settlement. A distinct subgroup of Kjelmøy ceramics, the so-called shell and mica tempered ceramics, only occur in a restricted area of Sør-Varanger in eastern Finnmark. At the sites of Kjøøy and Kjelmøy, they account for nearly two-thirds of the ceramic assemblages (Jørgensen & Olsen 1988:24) and always occur in the same stratigraphic contexts as asbestos tempered Kjelmøy ceramics. A small percentage of these ceramics are tempered with crushed soapstone and some sherds also have mica temper mixed with the soapstone. Sherd thickness ranges from 6–8 mm and a flat-bottomed vessel has been identified (Olsen 1984:37). Recent excavation of occupation sites from the late Iron Age to early Medieval period in Pasvik has also documented soapstone tempered Kjelmøy ceramics below the main cultural deposit (Hedman & Olsen 2009:11).

Lars Pilø (1989) revised Håkon Shetelig's 1912 chronology for early Iron Age soapstone vessels and confirmed that production began in the late Bronze Age (700–900 BC) and ceased at the end of the pre-Roman Iron Age at the close of the first millennium BC when soapstone vessels are replaced by ceramics. Pilø (1989:97–98) also notes a morphological similarity between his soapstone vessel type 2 and late asbestos tempered ceramics in northern Norway. Roger Jørgensen (2011) comments on the close similarity in form between the early thin-walled soapstone vessel type and asbestos tempered Risvik ceramics, which have been found at 36 sites between North Helgeland in Nordland and northern Troms. According to Jørgensen (2011:123), the association between soapstone vessels and Risvik ceramics indicates a cultural orientation to the south. Dag Magnus Andreassen (2002) suggests that the form of Risvik ceramics was transferred to thin-walled soapstone vessels as asbestos ceramics drop out and soapstone vessels emerge in the pre-Roman Iron Age.

Arntzen (2013) has documented the distribution of thin-walled soapstone vessels and asbestos ceramics in northern Norway from the late Bronze Age and pre-Roman Iron Age in relation to agricultural settlement. At present there are 20 sites with soapstone vessels, 40 sites with asbestos tempered ceramics, and eight sites where both ceramics and soapstone vessels occur. Nineteen settlement sites with soapstone vessels are found in Nordland and eight of these are within Tromsø Museum's district. The only thin-walled soapstone vessel evidence in Troms is from Sandvika. There is no evidence that thin-walled soapstone vessels continue after the pre-Roman Iron Age in northern Norway.

The Sandbekkdalen soapstone quarry site at Kvikne in Hedmark, central Norway is located in a remote mountainous area nearly 1000 m ASL, but it was of central importance in the early pre-Roman Iron Age with apparent abandonment by the end of the pre-Roman Iron Age (Skjølvold 1969; Østerås 2004; Grenne et al. this vol.). Archaeological investigations since the late 1960s have confirmed large-scale vessel production at the quarry. At least two types of vessels were produced, a spherical vessel and a bowl form, and it is likely that vessels were finished or nearly finished at the quarry. The complete absence of early soapstone vessels from the central regions of southeastern Norway suggests that Kvikne supplied the population of Trøndelag north of Hedemark County (Pilø 1989:96). Considering the limited quantity of early thin-walled soapstone vessels in northern Norway, from 19 locations in Nordland and a single site in Troms, the possibility that finished vessels from Kvikne were also being exported northward should be considered. However, a recent geochemical provenance study of soapstone vessel sherds from four pre-Roman Iron Age to late Bronze Age archaeological site locations in Nordland County by NGU geologist Tor Grenne (pers. comm.; Grenne et al. this volume) confirms that the material did not originate from the Sandbekkdalen quarry. Preliminary results of a provenance study using X-ray fluorescence (XRF) elemental analysis suggest a common source for the sherd samples in the southern Helgeland region of Nordland. Soapstone sherds from three site locations; Bakkan av Bø in Vesterålen (Ts 13755.1), Øvreværet in Svolvær, Lofoten (Ts. 11297.8) and Våg in Gildeskål (Ts. 5990a) most closely resemble soapstone sources along the Helgeland coast (see Berglund 1999, 2015) while a sherd from Bøsanden on Engeløya in Steigen is most similar to the Bjørnå quarry site to the south of Mosjøen (Tor Grenne: pers. comm.).

There is no evidence for the production of soapstone vessels during the Roman Iron Age and Migration period in Norway, although objects such as spindle whorls and loom weights were being produced in northern Norway and elsewhere (Pilø 1989: 93). Soapstone was also used as a tempering agent in bucket-shaped pots during the later Roman Iron Age and Migration period (AD 350–575). A detailed analysis of Norwegian bucket-shaped pots by Asbjørn Engevik jr. (2008, 2010) confirms that a large majority of the vessels have either asbestos (45%) or finely crushed soapstone (33%) temper. A much lower number (6%) have a combination of the two temper types and asbestos is also known to occur as a natural component in clay sources from soapstone quarry sites (Engevik 2008). Engevik (2010:233–236) analyzed 1127 bucket-shaped vessels from throughout Norway, including Nordland (n=61) and Troms (n=19), revealing a markedly uneven temper distribution with asbestos dominant from Sogn and Fjordane and northward, while soapstone is most common from Hardangerfjord and southward in western Norway. The only published petrological microscopy analysis of bucket-shaped pots, reveals a high density of asbestos temper ranging from 65–80% (Kleppe & Simonsen1983).

Soapstone chronology and site types

A review of soapstone finds with a known age (n=2828) from Tromsø Museum's district in the national artifact database (Gjenstandsbasen)(Figure 1) reveals a predominance of medieval material (over 40%) followed by the late Iron Age (23%) and post-Reformation/Recent period (6.5%). Only

2.2% of the dated finds predate the late Iron Age.

The distribution of artifacts by site type (Figure 1) indicates that occupation sites account for nearly all of the soapstone from known contexts (95%), including farm mounds (5.6%) and urban sites (7.4%). Farm mounds are a characteristic site type in northern Norway where they begin to appear in significant numbers towards the end of the late Iron Age. The quantity and size of these sites increase dramatically during the Medieval period with occupation continuing up until the recent historic period. The only site classified as 'urban' is the medieval settlement of Vágar in the Lofoten Islands. Site types of minor importance include boathouses and a single soapstone quarry in Troms (Talgrøtholla) where unfinished artifacts were collected.

Soapstone artifact types

The distribution of soapstone artifact types in northern Norway from the national database is presented in Figure 2. All artifact types represented by more than 10 finds are listed individually in this table. As shown in Figure 1, only a small fraction of the finds predate the late Iron Age and most are from the Medieval period. A majority of the artifact types during this period exhibit only minor variations in form through time and are therefore treated collectively in the following discussion. Soapstone vessels are the dominant artifact category and account for 43% of all finds of known type. Most of this material consists of small sherds and very few complete or nearly complete vessels have been found. Specialized vessel types that can be distinguished from the general category of bowls or trough-shaped vessels used for cooking and as containers include vessels with a handle classified as ladles (2.5%) and lamps for marine mammal and fish oil (4.6%).

Analysis of soapstone artifacts from securely dated archaeological contexts in northern Norway has been minimal. The most detailed analyses have involved soapstone from late Iron Age and medieval settlement at Borg in Lofoten. The Iron Age residential structures of Borg I and II produced 140 soapstone artifacts described in Johansen et al. (2003). The medieval residential structure at Borg III occupied from AD 1000–1300 produced 191 soapstone finds, including vessel sherds, loom weights, spindle whorls, and sinkers (Brodshaug 2005; Brodshaug & Solli 2006; Solli 2006). Vessel types distinguished in the soapstone assemblage included a larger group of type A and a few type B bowl shaped vessels using types defined by Lossius (1977:23). The largest group, however, consisted of crude vessels of coarse grained material suggesting local production (Brodshaug & Solli 2006:296), although no soapstone sources are known in Lofoten.

Apart from vessels, soapstone artifacts associated with textile production are the most widespread and numerous. This category includes spindle whorls (23.7%) and loom weights (7.6%), although loom weights are often difficult to distinguish from fishing net weights due to similarities in size and appearance. Both artifact types also include reworked vessel sherds.

Twenty soapstone forge-stones have been found in Tromsø Museum's district. They provide important supplemental evidence for the presence of smithies, only three of which have been excavated in northern Norway from the late Iron Age and Medieval period. Roger Jørgensen (2012) provides a comprehensive overview of forge-stone distribution in relation to blacksmith activity in northern Norway. The two main types of forge-stones, cylindrical and shield-shaped, served to increase the distance between the bellows and forge. Soapstone, which is heat-resistant and easily worked, is an excellent material for this purpose. Soapstone molds are limited in number (1.9%) but also an important artifact category associated with metalworking ranging from early Metal Age (n=2) and Bronze Age (n=3) bronze casting molds to more plentiful casting molds for a range of objects (buttons, ornaments, etc.) from the Medieval to Recent period (n=27).

Worked slabs of soapstone (*helle*) are a minor artifact category (1.3%) which may include

Figure 2. *Soapstone artifact types from northern Norway.*

Artifact type	Total
Vessel (*kar, gryte*)	980
Oil lamp (*kole*)	103
Ladle (øse)	57
Spindle whorl (*spinnehjul*)	535
Loom weight (*vevlodd*)	172
Forge-stone (*avlstein*)	18
Mold (*støpeform*)	42
Slab (*helle*)	30
Fishing sinker (*fiskesøkke*)	135
Oval line sinker (*jarstein*)	101
Sickle-shaped sinker (*dorgesøkke*)	45
Net weight (*garnsøkke*)	17
Anchor stone (*senkestein*)	16
Minor artifact type / unknown	991
TOTAL	3242

building stone, grave markers, stove parts, bakestones (*baksteheller*) and other objects. Bakestones first appear in the Medieval period and although a significant number of these artifacts from northern Norway are classified as soapstone in the national database, this has not been confirmed by geological identification. A majority of bakestones were manufactured from chlorite-rich talc-bearing green schist (chlorite schist)for which known quarry sites are restricted to three locations; Øye in Sør-Trøndelag (Heldal & Storemyr 1997; Storemyr & Heldal 2002; Lundberg 2007; Storemyr et al. 2010), Rennesøy in Rogaland and Ølve-Hatlestrand in Sunnhordland, the latter representing the largest and most important location with production dating back to c. 1030–1100 (Baug 2015, this vol.). Bakestone quarries are also associated with extraction of medieval building stone (Baug 2015, this vol.; Jansen & Heldal this vol.). Although soapstone bakestones were fairly common in the twelfth century, they were replaced by those made from chlorite schist in the later medieval cultural deposits at Bryggen in Bergen (Tengesdal 2010). The distribution of bakestones in northern Norway is concentrated along the coast and they are only found in interior areas to a minor degree (Baug 2015:38). No bakestone quarries have been identified in northern Norway and the potential source(s) of this material remain undocumented.

The collective category of fishing-related weights and sinkers accounts for a significant proportion of the soapstone artifacts in northern Norway (13.9%). Line sinkers make up most of this material with subcategories for large oval sinkers (*jarstein*) and smaller sickle-shaped sinkers (*dorgesøkke*) identified in the national database (see Helberg 1993; Olsen 2004). A category of heavy sinkers or possible anchor stones (*senkestein*) is also identified. Net weights are usually no more than a piece of soapstone with a perforation and therefore difficult to classify. As such they represent a residual category that can be difficult to distinguish from other artifact types.

In order to assess the degree to which unfinished soapstone artifacts occur and examine their distribution by site type, an overview of roughouts/blanks is presented. Of the 60 unfinished artifacts found in the national database, nearly all of those identifiable by type are either fishing line sinkers (n=14) or spindle whorls (n=15). Surprisingly few unfinished vessels have been identified (n=4). Nearly all unfinished artifacts identified by site type are from occupation sites, including a few from farm mounds. Artifact roughouts, including a bowl with handle, oil lamp and fishing line sinker, were collected from the soapstone quarry Talgrøtholla in Kvæfjord, Troms (Ts. 6554).

Soapstone geology in northern Norway

Soapstone is not a well-defined rock type in geological terminology, but rather a term used for a 'soft rock'. Different types of soapstone have also been mapped and exploited in the northernmost part of Norway. Today work is proceeding to more precisely define the geological parameters for rock defined as soapstone. Soapstone will, however, still continue to be a term for 'soft rock' within the stone industry context.

Many different names have been used for this soft rock through the years (Helland 1893). The importance of soapstone up until modern times may be traced on topographic maps through place names such as *esje*, *gryte*, etc. Over the course of time and sometimes through the efforts of language consultants, names have been changed such as *esje-* to *hesje-* or *hes-* and *gryte-* to *grøt-*, and so forth. One example from the Sámi language is the transformation of *esje-* to *asse-* as in the case of Assebakte near Karasjok which translates to 'soapstone mountain'. The soapstone deposit found here may have been exploited by the Sámi, although a recent archaeological survey failed to document evidence of soapstone extraction (see Bunse this vol.). The study of map place names is often a good starting point in the search for potential soapstone deposits which often occur in the general vicinity.

Previous geological work

Amund Helland (1893) presented the first overview of soapstone in northern Norway, listing the use of soapstone from Stolpe in Misvær, Talgrøtholla in Kvæfjord, Nyeng (Talgrøtberget) in Sørreisa, and Voldstranden close to Alta (see also Sommerfeldt 1799). He also suggested the potential use of soapstone at Assebakte on the basis of the place name evidence. Helland's information on deposits in northern Norway is mainly based on evidence from Kraft (1835). Helland (1899, 1905, 1907) briefly mentions activity in stone quarries, including soapstone, in his extensive publication *Norges Land og Folk*.

More recently, the soapstone deposits of northern Norway have been studied for use as dimension stone and a source for talc. This work has led to new and important insights into the use of soapstone both historically and for potential future exploitation. Information on soapstone deposits has been provided in a number of geological reports. Most commonly, soapstone is an alteration product from ultramafic rocks. An overview of bodies in Norway of this type of rock for use in iron smelting; peridotite, dunite and serpentinite, is presented by Ingvar Lindahl et al. (2003). Karlsen and Nilsson (1999) provide an overview of talc deposits in Norway mostly related to talc carbonate rocks altered from ultramafics. Lindahl (2012) presents a comprehensive overview of dimension stone in Nordland, including soapstone. Lindahl and Nilsson (2002) and Nilsson and Lindahl (2005) have described the soapstone deposits of Troms County. Soapstone deposits in Finnmark have been mentioned by Reusch (1903) and studied by Lars Petter Nilsson during the most recent decades (Karlsen & Nilsson 1999). More detailed information is reported in the Geological Survey of Norway (NGU) national natural stone database (http://geo.ngu.no/kart/mineralressurser).

Soapstone deposits

Karlsen and Nilsson (1999) provide a classification of Norwegian soapstone deposits focusing on its potential for talc. In the northern part of Nordland and Troms and Finnmark counties, the soapstone deposits can be divided into two main groups. These are the deposits of the Precambrian rocks of Finnmark and the northern part of Troms, and the deposits within the Caledonian Mountain belt (see Figure 3).

During the past decade, unexpectedly large soapstone resources have been discovered in the Linnajavri area in Hamarøy Municipality close to the Swedish border in Nordland. Lindahl and Nilsson (2008) provide a review paper summarizing various aspects of this discovery and follow up work. The process where serpentinised ultramafic rocks, and in a few instances also mafic rocks, are transformed to soapstone may here be studied in even the smallest detail due to the exceptionally good outcrops of the deposits. The Linnajavri area was very remote until the development of hydroelectric

Figure 3. *Precursor rocks and soapstone deposits.*

Cal = Caledonian PC = Precambrian

Precursor rock type	Age	Type localities (see Figure 4)
Serpentinite from peridotite	Cal PC	Grunnes, Nyeng, Linnajavri area Tillermoen (Kleberberget)
Mg-rich volcanite (komatiite)	PC	Sør-Varanger: Straumdalen and Karasjok: Rievdjnesvadda
Gabbro, pyroxenite	Cal PC	Talgrøtberget, Stolpelia Gourbmet luobbal

power in the 1980s. There is no evidence for previous use of the soapstone although a few personal initials originating from World War II have been carved on a soapstone rock face situated just across the border in Sweden along an important refugee route through the area.

Soapstone quarry documentation

The Geological Survey of Norway (NGU) has systematically mapped many of the soapstone exposures in northern Norway and included information on quarry activity viewed in relation to the economic potential for modern quarrying, although historical use is also documented. The distribution of known soapstone deposits and quarry sites within Tromsø Museum's district in northern Norway, based in large part on database information from NGU, is shown in the Figure 4 map. Soapstone sources without evidence of quarry activity are listed in Figure 5. Soapstone deposits where quarry activity has either been reported or confirmed are listed in Figure 6. Site data is based on information from geological and archaeological literature, local historical records and literature, and unpublished information that include personal observations. Quarry sites registered in the Norwegian National Cultural Heritage Database (Askeladden) are also indicated. The NGU natural stone database for northern Norway has been regularly updated and documentation of additional quarry sites is anticipated. These are likely to be locations near the coast where minor quarrying took place and earlier historic quarry activity most often undertaken in close proximity to settlements.

Although Helland (1893, 1899, 1905, 1907) collected information related to soapstone quarries in northern Norway during his many travels, the earliest archaeological quarry surveys were undertaken by Harald Egenæs Lund (Lund 1954, 1963, in Skjølsvold 1961:147). These included the Helgeland region of Nordland, Ofoten, and southern Troms (Harstad, Kvæfjord, Gratangen, Dyrøy, inner Senja, and Lenvik). The only soapstone quarry excavation in northern Norway prior to recent work by Laura Bunse (this vol.) was undertaken in 1985 at Remman in Tjøtta, southern Helgeland, Nordland (Berglund 1999). A trench excavated into a spoil heap up to 2.2 m thick produced a radiocarbon date of c. AD 1300 near the base and evidence of quarry use continued up until about 1600. The highest concentration of historic quarry sites in northern Norway occurs in this region and indirect evidence indicates quarry activity since the late Iron Age.

A majority of the quarry sites to the north of Helgeland are concentrated between Saltdal and Sørfold and in the Ofoten region of Nordland, and from Senja southward in southern Troms (see Figure 4 and Figure 6). Of the 12 quarry sites from Nordland within Tromsø Museum's district, two may have been used in the later historic period, and two have potential for medieval or earlier use. Of the 14 quarry sites recorded in Troms, five recently surveyed locations may potentially have been in use prior to the Reformation. There is only one confirmed quarry site in Finnmark (Straumdalen,

Figure 4. *Map of northern Norway with the distribution of soapstone sources and quarry sites. (Graphics: E. Høgtun, Tromsø University Museum).*

Sør-Varanger), although there are historical references to potential quarries near Alta and Karasjok. Although lacking evidence for quarrying, human activity at the soapstone exposure on the island of Kjøøya in Sør-Varanger was documented by NGU in 2013. A series of inscriptions interpreted as ownership marks (*bumerker*) have been cut into the soapstone with at least three, and possibly up to five, different designs partially superimposed upon one another. The most distinctive design is a 'knot' or *valknute* with three arms and loops on the ends. It is possible that the inscriptions are associated with the Pomor trade carried out between northwest Russia and northern Norway from c. 1740 up until the Russian revolution in 1917.

Research problems related to soapstone production

Given the limited scope of archaeological research related to soapstone quarrying in northern Norway, there exists a broad range of research topics that await investigation. The following section provides a brief assessment of central problems to be addressed and their attendant challenges.

More recent quarrying often obscures earlier activity at quarry sites so that only the most recent phase is visible, although quarry locations may also have shifted over time thus preserving older

Figure 5. *Soapstone sources without evidence of quarry activity located within the district administrated by Tromsø University Museum in northern Norway.*

Location	Municipality	Source[1]
FINNMARK		
Hamnebuktfjellet	Sør-Varanger	NGU
Leirvåg	Sør-Varanger	NGU
Kjøøya	Sør-Varanger	NGU – Presence of multiple inscribed historic ownership marks (ID 173300)
Holmengrå	Sør-Varanger	Vigerust 1968
Guorbmet luobbal	Karasjok	NGU
Rivdnjesvadda	Karasjok	NGU
Kongelvika	Måsøy	NGU
Kjelvik	Nordkapp	NGU
TROMS		
Brokskard	Tromsø	NGU
Bukkskinnfjellet	Lenvik	NGU
Grøtsteinsberget	Lenvik	NGU
Baltsfjorden	Lenvik	Lindahl & Nilsson 2002
Gryllefjord	Torsken	Nilsson & Lindahl 2005
Finnhaugen	Salangen	NGU
Middagshaugen	Gratangen	NGU
Åmundvika	Gratangen	NGU
NORDLAND		
Klubbvik	Narvik	NGU
Filtind	Ballangen	NGU
Baugvatn øst	Tysfjord	NGU
Linnajavri (province)	Hamarøy	NGU, Lindahl & Nilsson 2008
Veiskidalen	Sørfold	NGU
Veiskilinsa	Sørfold	NGU
Hellarvik	Sørfold	NGU
Djuposen	Fauske	NGU
Skardhamran	Bodø	NGU
Ørfjellryggen	Saltdal	NGU

[1]The National Natural Stone Database, NGU.

evidence. Evidence from the earliest phases of use may lie deeply buried under accumulated waste material and modern quarry production can also severely impact and compromise evidence of earlier use. Widespread sampling of soapstone since the 19th century to evaluate its suitability by the restoration workshop for Nidaros Cathedral (NDR), established in 1869, has also impacted automatically protected quarry sites.

A fundamental research objective that remains poorly documented is the establishment of a chronological framework for soapstone production in both relative and absolute terms. This will require detailed archaeological documentation of quarry sites with potential for early use, including the excavation of spoil heaps. Excavation will be essential for tracing changes in quarrying characteristics and the documentation of production phases over time. Problems to be addressed include the degree to which activity was continuous or episodic/seasonal and to what degree it expanded or contracted over time. Detailed recording of evidence for the extraction of different types of objects (shape, size, removal technique, etc.) over time is also necessary. Previous quarry studies have focused on vessels and little data exists on attributes associated with the extraction of smaller objects such as sinkers, molds, loom weights, etc.

Documentation of production stages is another key aspect to understanding quarry activity. The degree to which objects were worked on site, from coarse roughouts and blanks to final finishing stages, can provide insights into the organization of production and how this changed over time. Who worked at the quarries – amateurs or specialists? Is there evidence for temporary occupation associated with more intensive quarry activity? Can we document the social structure of

Figure 6. *Reported and documented soapstone quarry sites located within the district administrated by Tromsø University Museum in northern Norway.*

Location	Municipality	National Heritage Database ID	Source	Age estimate[1]
FINNMARK				
Straumdalen	Sør-Varanger	27250 (Langfjorden)	Reusch 1903, Vigerust 1968, Helskog 1975, Nilsson field book 1994, Karlsen & Nilsson 2000	Pre-Reformation
Assebakte	Karasjok		Helland 1893	Pre-Reformation?
Voldstranden	Alta		Sommerfeldt 1799	Pre-Reformation?
TROMS				
Russelv	Lyngen		Nilsson & Lindahl 2005	Historic?
Kleberberget	Målselv		Nilsson & Lindahl 2005	Recent
Myrbakksetra	Målselv		Nilsson & Lindahl 2002, Lindahl 2013	Recent
Grunnes	Målselv		Nilsson & Lindahl 2002	Recent
Tårnvatn	Lenvik		Nilsson & Lindahl 2002	Recent
Kjerringvikskaret	Torsken		Brox 1965, Nilsson & Lindahl 2002	Recent
Nyeng	Sørreisa	28201 (Talgrøtberget)	Sandmo 1997, Lindahl 2013	Pre-Reformation
Rabbåsdalen	Sørreisa		Nilsson & Lindahl 2002, Lindahl 2013	Recent
Lille Vinje (Talgrøtberget)	Dyrøy		Helberg 1987, Knudsen 1990, Lindahl 2013	Pre-Reformation?
Steien	Bardu		NGU	Recent
Hesthølet	Bardu		NGU	Recent
Talgrøtholla	Kvæfjord	8814, 35633	Gunnerus 1761, Lund 1954, Alm 1986, Amundsen & Singstad 1999	Pre-Reformation?
Kanebogen	Harstad	74346	Jørgensen 2000	Historic/Pre-Reformation?
Lavik	Gratangen	173294	Lindahl 2013	Pre-Reformation?
NORDLAND				
Myre (Dverberg / Stallberget?)	Andøy		Lund 1963, Lindahl 2012	Recent
Osvolldalen	Sortland	67649 (Storkvantodalen)	NGU	Pre-Reformation?
Småtuva	Ballangen		Foslie 1942, Lund 1963	Recent
Raudvassdalen	Ballangen		Foslie 1942	Recent
Hesjetuva (Tennstrand)	Tysfjord		Lund 1963, Nilsson field book 2004	Historic?
Hesjeberghola	Sørfold		Lund 1963, Nilsson field book 2004	Recent
Hesjeelva	Bodø		Lindahl 2012	Historic?
Drusås, Klette, Høgset	Bodø		Lund 1963, Lindahl 2012	Recent
Stolpelia	Bodø	57153 (Stolpe)	Jørgensen 1986, NGU	Pre-Reformation
Hessihompvatnet	Saltdal		Holmsen 1932, Lindahl 2012	Recent
Esjeholman	Meløy	17607	J. S. Munch 1960	NB: 2013 survey recorded mafic to ultramafic rock but no soapstone is present.

[1]Recent – past 200 years, Historic – more than 200 years, Pre-Reformation – prior to 1537

quarry activity, such as the degree of elite control vs. unrestricted access? To what degree was control of quarry access dependent upon the nature and scale of activity and products being produced (i.e. small utilitarian objects (sinkers, loom weights) vs. larger vessels)?

Quarry sites should be viewed as integral components of quarry landscapes and documentation of broader archaeological and environmental contexts for the use of quarry locations is esssential. Relevant landscape elements include the importance of agriculture, infield vs. outfield resource exploitation, population distribution, and access to transport networks on land, by sea and along waterways. The potential influence of large farms or other power centers in controlling production is also a critical factor. Soapstone artifacts from archaeological sites in the vicinity of quarries and the presence of waste material or unfinished objects can reveal relationships between production and consumption potentially linked to exchange networks.

Soapstone production is also tied to production and exchange of other stone resources such as millstones (garnet mica schist) and whetstones (schist) that occur in the same site contexts during the late Iron Age and Medieval period. Misvær in Nordland is one area where artifacts representing each of these stone resources occur together in medieval residential sites (Munch 1967). An iron production site from the same period has also been recorded at Rognlivatnet in the hills above Misvær (Jørgensen 2011).

Results from recent soapstone quarry surveys

This section presents results of joint archaeological and geological surveys of soapstone quarry sites by Tromsø University Museum with NGU geologist Gurli B. Meyer carried out in 2011 and 2012. Preliminary results from surveys of two quarry sites in 2013, Stolpe and Straumdalen, by Stephen Wickler and doctoral research fellow Laura Bunse are also briefly mentioned (see Bunse this vol.). The overall results are presented and discussed in light of their potential for future research focusing on the excavation of spoil heaps and geochemical characterization.

Stolpe – Misvær, Nordland

The soapstone quarry at Stolpe/Stolpelia is one of the most promising sites for excavation. The site was briefly surveyed by Tromsø University Museum in the 1980s (Jørgensen 1986) and samples of waste material collected. Stolpelia is situated on a hillside at c. 270–275 m ASL in an outfield area about 300 m from an existing farmstead 4 km south of Misvær in Bodø Municipality, Nordland. The site covers an area of approximately 40 x 40 m with several contiguous quarrying areas and evidence for the removal of a variety of objects, including partially quarried bowl-shaped vessels and rectangular to oval-shaped depressions from blanks for smaller artifacts such as molds, fishing sinkers and loom weights.

A rectangular foundation built of soapstone blocks that is 9 x 4 m and up to 50 cm in height has been constructed on a soapstone exposure along the upper quarry margin. This structure is provisionally interpreted as an attempt to create a level surface for preparation of soapstone block samples by the restoration workshop for Nidaros Cathedral, although there is no written record of sample collection at this locality. Tool marks on some blocks suggest activity dating to the 19th century. The removal of soapstone slabs with closely spaced drill holes represents more recent sampling activity by NGU.

Overgrown mounds of accumulated waste material along the quarry margins may also cover earlier traces of quarrying. Earlier quarry activity along the lower southwestern and southern margins has been impacted by a modern locally based small scale quarry with an access road where soapstone blocks were removed by blasting. Geological evidence indicates that the soapstone deposit, which occurs within a gabbro, can extend more than 200 m (Wennberg 1959). The material is fine-grained and of good quality with sampling by NGU undertaken through drilling in the 1980s (Karlsen & Nilsson 1999).

The area surrounding Stolpe has a well-documented mixture of Norse and Sami cultural influences during the historical period. Settlement reflecting the presence of both ethnic groups extending back at least to the twelfth century has been documented through the excavation of residential sites at Vestvatn in Misvær and Eiterjord in Beiarn (Munch 1967). Soapstone artifacts from these sites exhibit close similarities (e.g. small ladles with incised linear decoration on the handles) and quarrying at Stolpe is likely to reflect the multiethnic nature of settlement in the area.

Talgrøtholla – Kvæfjord, Troms

This quarry site is located in a steep sided bowl-shaped valley below the mountain peak Horntinden to the south of Hemmestad. The soapstone exposures occur at c. 630 m ASL in an area with frequent rockslides and vertical bedrock faces with loose blocks spread across the valley floor. Gunnerus (1761:273) was the first to mention the quarry and Lund (1954) visited the site but was unable to find any definite quarry locations. According to local residents, the quarry had been used historically for stove parts, sinkers, etc.

The site was surveyed by county archaeologists in 1990 (site ID 8814, Svestad & Hauglid 1990), who recorded soapstone exposures at two locations and the presence of waste material and roughouts that were collected and brought to Tromsø Museum. Subsequent surveys were undertaken by the Trondarnes District Museum in 1993 and Amundsen and Singstad (1999) who identified some traces of potential quarrying. No definite evidence of quarrying activity was seen or waste material identified during a survey by Tromsø Museum and NGU in 2012. Speculation that this quarry supplied stone for Trondenes Church appears unfounded on the basis of available survey results.

Talgrøtberget (Nyeng) – Sørreisa, Troms

As with Stolpe, this quarry is automatically protected and may have been in use by the late Iron Age. The soapstone source consists of a freestanding exposed bedrock outcrop largely covered by glacial overburden with an overhang area about 2.5 m deep and 3 m high. The quality of soapstone is highly variable including both coarse-grained material and dense, fine-grained veins (Lindahl 2013:6). The main quarry area is c. 80 x 30 m with traces of quarrying concentrated around the outer margins of the upper rock surface and along the vertical sides. A substantial area with earlier quarry evidence lies undisturbed below a layer of turf. Initials and other graffiti, both modern and historic, have been carved into the rock surface and removal of soapstone during World War II has damaged some earlier quarry evidence (Lindal 2013).

Traces of production vary in shape and size including larger vessels and numerous smaller rectangular depressions. Preparation of a parking area appears to have cut into a substantial spoil heap deposit, from which samples of soapstone waste were collected by NGU. The areal extent and depth of the spoil heap deposits at Talgrøtberget remain incompletely documented.

Kanebogen – Harstad, Troms

This quarry site is situated along the shoreline of a small embayment adjacent to a commercial campground to the south of Harstad previously surveyed by Tromsø University Museum (Jørgensen

2000). Quarrying evidence covers a roughly 10 x 10 m area extending from the high tide level up to 2 m ASL with object removal restricted to rectangular depressions up to 25 x 40 cm, although many are smaller. The quality of stone is highly variable and much of the source is not classified as soapstone. Given the low elevation of the site, quarrying activity is likely to have been relatively recent, although no written sources or oral traditions appear to refer to the site.

Straumdalen, Sør-Varanger, Finnmark

Although eight soapstone sources and three quarry sites have been reported in Finnmark, Straumdalen in Sør-Varanger is the only confirmed quarry site (Helskog 1975). This quarry area is located along a steep rocky slope with soapstone faces situated c. 10–20 m from the shoreline in a roughly south to north orientation that extend for a distance of 85 m. Three spatially distinct quarrying locations are separated from one another by distances of 10–20 m. The most extensive quarry face is about 20 m in length. There are also potentially substantial waste deposits associated with the quarry faces. A majority of the quarry evidence appears to represent removal of relatively small rectangular shaped roughouts that could be worked into smaller artifacts such as fishing sinkers.

The Straumdalen quarry is located within a core Sámi region in close proximity to settlements of central importance from the early Metal Age and Stone Age, including Kjelmøya which is 20 km to the north. Both soapstone objects and soapstone tempered ceramics occur at Kjelmøy and other early Metal Age sites in the area.

Potential for future soapstone research

Given the currently limited state of knowledge concerning soapstone production and use in northern Norway, there is a need to address fundamental research issues related to chronology, production strategies and organization, frameworks for exchange and trade, and sociocultural contexts, including multiethnic expressions of identity.

Excavation of spoil heaps associated with soapstone quarry sites should be a priority in order to establish a general chronological framework that will allow a broader range of issues to be addressed. Based on collective survey results, the most promising quarry sites in each of the three northernmost counties appear to be Stolpe in Misvær, Talgrøtberget in Sørreisa, and Straumdalen in Sør-Varanger, eastern Finnmark. Excavation should be planned and undertaken in close consultation with the aid of geological expertise, and preferably the direct participation of NGU in field investigations. This will also be of critical importance in selecting material for geochemical analysis to build up reference collections for geochemical characterization and sourcing of artifacts. The results of excavations recently undertaken at each of these quarry sites by Bunse (this vol.) will contribute to addressing the research questions raised here.

Attempts at geochemical characterization and sourcing of soapstone are limited in northern Norway but have the potential for producing worthwhile results given the recent advances in geological methods and characterization of soapstone sources. Geochemical analysis of soapstone temper has not yet been attempted and may have considerable potential for both Kjelmøy ceramics and bucket-shaped pots. The inter-regional movement of soapstone vessels during the pre-Roman Iron Age and late Bronze Age should also be explored through further geochemical analysis. Preliminary XRF results from NGU pointing to southern Helgeland as a potential source of thin-walled soapstone vessels suggests that this region served as a production center for pre-Roman Iron Age vessels subsequently transported northward.

Despite the many challenges and unanswered questions regarding soapstone in northern Norway, ongoing research promises to provide a better understanding of the role played by soapstone through time and new insights into the complexities of this resource.

Acknowledgements

SW acknowledges the significant contribution of NGU geologist Gurli B. Meyer whose participation in the survey of soapstone quarries was an invaluable source of knowledge and inspiration. Our thanks to two anonymous reviewers and the editors for their helpful suggestions that improved the quality of the manuscript. Some of the themes in this article were presented by SW at a workshop in 2012 for the outfield resources group of the national research network *Forskning i fellesskap* held at the Norwegian Institute in Rome (Wickler 2015).

References

Alm, T. 1986. Talggrøtholla. En klebersteinsforekomst i Kvæfjord. *Håløygminne* 17, 145–147.

Amundsen, T. & Singstad, H. B. 1999. Registreringsrapport fra Talggrøtholla, Kvæfjord kommune, Troms. Unpublished field report. Tromsø Museum.

Andreassen, D. M. 2002. Risvikkeramikk – En analyse av teknologisk stil på Nordkalotten i sein steinbrukende tid. Unpublished master thesis, University of Tromsø, Tromsø.

Arntzen, J. E. 2013. The empirical basis for research on farming settlements in northern Norway 1200 BC – 0. In Mahler, D. L. (ed.) *The Border of Farming Shetland and Scandinavia. Northern Worlds: papers from the Symposium in Copenhagen, September 19–21, 2012,* 182–197. The National Museum of Denmark, Copenhagen.

Arntzen, J. E. 2015. Sandvika in northern Norway: the northernmost 'Bronze Age' settlement in Scandinavia. *Fennoscandia Archaeologica* XXXII, 3–34.

Baug, I. 2015. Stones for bread. Regional differences and changes in Scandinavian food traditions related to the use of quernstones, bakestones and soapstone vessels c. AD 800-1500. In Baug, I., Larsen, J. & Mygland, S. S. (ed.) *Nordic Middle Ages – Artefacts, Landscapes and Society. Essays in Honour of Ingvild Øye on her 70th Birthday,* 33–47. University of Bergen Archaeological Series (UBAS) 8.

Berglund, B. 1999. Middelaldersk klebersteinsindustri på Helgelandskysten. *Ottar* 225 (2), 13–24. Tromsø.

Berglund, B. 2015. Possibilities for a society analysis by means of soapstone – examples from Helgeland, northern Norway. In Berglund, B., Callanan, M., Kaland, S. & Stenvik, L. (eds) *Exploitation of Outfield Resources: Joint Research at the University Museums of Norway*, 129–140. Universitetsmuseet i Bergen Skrifter nr. 32, Bergen.

Brodshaug, E. 2005. Det anonyme dagliglivet. Klebersteinsmaterialet fra de arkeologiske utgravningene av Borg III, Vestvågøy i Lofoten. Unpublished master thesis, University of Tromsø, Tromsø.

Brodshaug, E. & Solli, B. 2006. Kleber, mat og rom på Borg i middelalderen. *Viking* LXIX, 289–306.

Brox, O. 1965. *Bygdebok for Berg og Torsken, Bind II – Bygdehistoria*. Berg og Torsken kommuner.

Engevik, A. 2008. *Bucket-Shaped Pots. Style, Chronology, and Regional Diversity in Norway in the Late Roman and Migration Periods*. BAR International Series 1816, Archaeopress, Oxford.

Engevik, A. 2010. Technological style, regional diversity and identity. Asbestos regions and soapstone regions in Norway in the Late Roman and Migration Periods. In Barndon, R., Engevik, A. & Øye, I. (eds), *The Archaeology of Regional Technologies. Case studies from the Palaeolithic to the age of the Vikings,* 225–241. The Edwin Mellen Press, Lewiston.

Foslie, S. 1942. Hellemobotn og Linnajavrre. Geologisk beskrivelse til kartbladene. *NGU 150*, 119.

Grieg, S. 1933. *Middelalderske byfund fra Bergen og Oslo*. Det Norske Videnskaps-Akademi, Oslo.

Gunnerus, J. E. 1761. Adskillige Efterretninger, fornemmelig angaaende Mineraler i Nordland og Finmarken. *Det Trondhiemske Selskabs Skrifter*, *Første Deel,* 271–283, Copenhagen.

Hedman, S.-D. & Olsen, B. 2009. Transition and order: a study of Sámi rectangular hearths in Pasvik, Arctic Norway. *Fennoscandia Archaeologica* XXVI, 3–22.
Helberg, B. H. 1987. Rapport fra befaring av Lille Vinje, Gnr. 41, Dyrøy, Dyrøy kommune. Unpublished field report. Tromsø Museum.
Helberg, B. H. 1993. Fiskeriteknologi som uttrykk for sosial tilhørighet. En studie av nordnorsk fiske i perioden 400–1700 e. Kr. Unpublished thesis (magisteravhandling) in archaeology, University of Tromsø.
Heldal, T & Storemyr, P. 1997. Geologisk undersøkelse og arkeologisk registrering av de middelalderske brudene ved Øya, Klungen og Huseby i Sør-Trøndelag. *NGU-rapport nr. 97.149.*
Helland, A. 1893. Tagskifere, heller og vekstene. *Norges geologiske undersøkelse* 10: 1−178.
Helland, A. 1899. *Norges Land og folk. Topografisk-statistisk beskrivelse over Troms Amt.* (2 volumes.) Aschehoug, Kristiania.
Helland, A. 1905. *Norges Land og folk. Topografisk-statistisk beskrivelse over Finnmark Amt*. (3 volumes.) Aschehoug, Kristiania.
Helland, A. 1907. *Norges Land og folk. Topografisk-statistisk beskrivelse over Nordlands Amt* (4 volumes.) Aschehoug, Kristiania.
Helskog, K. 1975. Befaring av klebersteinsbrudd ved Strømmen, Sør-Varanger kommune, Finnmark. Unpublished field report. Tromsø Museum.
Holmsen, G. 1932. Rana. Beskrivelse til det geologiske generalkart 1:250 000. *NGU 136*, 107
Johansen, O. S., Kristiansen, K. & Munch, G. S. 2003. Soapstone artefacts and whetstones. In Munch, G. S., Johansen, O. S. & Roesdahl, E. (eds), *Borg in Lofoten. A Cheiftain's Farm in North Norway,* 141–158. Arkeologisk Skriftserie 1, Lofotr – vikingmuseet på Borg.
Jørgensen, R. 1986. Rapport fra besøk i kleberbrudd på Stolpe. Unpublished field report. Tromsø Museum.
Jørgensen, R. 2000. Rapport fra befaring av kleberbrudd i Kanebogen, Harstad kommune, Troms. Unpublished field report. Tromsø Museum.
Jørgensen, R. 2011. Prehistoric iron production in North Norway. *Acta Archaeologica* 82, 97–128.
Jørgensen, R. 2012. The social and material context of the Iron Age blacksmith in North Norway. *Acta Borealia* 29 (1), 1–34.
Jørgensen, R. & Olsen, B. 1988. *Asbestkeramiske grupper i Nord-Norge 2100 f.Kr. – 100 e.Kr.* Tromura, kulturhistorie nr. 13. Tromsø Museum.
Karlsen, T.A. & Nilsson, L. P. 1999. Talc deposits in Norway. *NGU report 99.135*, 146.
Kleppe, E. J. & Simonsen, S. E. 1983. Bucket-shaped Pots – A West Norwegian ceramic form. Experiments with production methods. *AmS – Skrifter* 10. Archaeological Museum, Stavanger.
Knudsen, O. 1990. Gård nr. 41, Lille Vinje. In *Gårds- og slektshistorie for Dyrøy*, 300–302. Triton, Kårvikhamn.
Kraft, J. E. 1835. Topographisk-Statistisk Beskrivelse over Kongeriget Norge. 6. Del, Grøndahl, 624.
Lindahl, I. 2012. *Bygningsstein i Nordland. En oversikt over bygningsstein i Nordland, om bruken og om de forskjellige geologiske provinsene*. NGU, Trondheim.
Lindahl, I. 2013. Om noen kleberstein- og kvernsteinlokaliteter i sørlige del av Troms fylke. *NGU report 2013.013*, 17.
Lindahl, I., Furuhaug, L., Korneliussen, A. & Nilsson, L. P. 2003. Olivin- og serpentinittforekomster i Finnmark, Troms, Nordland og Nord-Trøndelag. Part 1–3. *NGU report 2003.103*.
Lindahl, I. & Nilsson, L. P. 2002. En vurdering av klebersteinpotensialet i Troms fylke. *NGU report 2002.077*, 92 + maps.
Lindahl, I. & Nilsson, L. P. 2008. Geology of the soapstone deposits of the Linnajavri area, Hamarøy, Nordland, north Norwegian Caledonides – Norway's largest reserves of soapstone. In Slagstad, T. (ed.) *Geology for Society,* 19–36. Geological Survey of Norway, Special Publication 11.
Lossius, S. M. 1977. *Kleberkarmaterialet fra Borgund*. Arkeologiske avhandlinger fra Historisk Museum, Nr. 1, University of Bergen, Bergen.
Lund, H. E. 1954. Klebersteinsforekomst: Talgaholet – høyt oppe under fjellet på S. Hemmestad, Kvæfjorden, Troms. Unpublished field report. Stavanger Museum, Stavanger.
Lund H. E. 1963. Klebersteinsforekomster med nyere og gamle brudd. Kart Nord-Norge 1:1 000 000.
Lundberg, N. 2007. Øye – en arkeologisk undersøkelse av et klorittskiferbrudd. Unpublished hovedfag thesis, NTNU, Trondheim.
Munch, G. S. 1967. Funnene fra Eiterjord i Beiarn og Vestvatn i Misvær. *Viking* XXXI: 99–122.
Munch, J. S. 1960. Antikvariske registreringer i Nord-Norge. Funn og fortidsminner i Meløy - Gnr. 2, Bnr.

21. Unpublished field report, Tromsø Museum, Tromsø.
Munch, J. S. 1966. Et nytt bronsealderfunn fra Troms. *Viking* XXX, 61–76.
Nilsson L. P. & Lindahl, I. 2005. Oppfølgende undersøkelser av utvalgte klebersteinforekomster i Troms fylke. *NGU report 2005.084*, 35.
Olsen, B. 1984. *Stabilitet og endring. Produksjon og samfunn i Varanger 800 f.Kr. – 1700 e.Kr.* Unpublished thesis (magisteravhandling) in archaeology, University of Tromsø, Tromsø.
Olsen, B. 1994. *Bosetning og samfunn i Finnmarks forhistorie*. Universitetsforlaget, Oslo.
Olsen, O. M. 2004. Medieval fishing tackle from Bergen. In Øye, I. (ed.) *Medieval Fishing Tackle from Bergen and Borgund*, 11–106. The Bryggen Papers Main Series, volume 5. Fagbokforlaget, Bergen.
Pilø, L. 1989. Early soapstone vessels in Norway from the Late Bronze Age to the Early Roman Iron Age. *Acta Archaeologica* 60, 87–100.
Reusch, H. 1903. Fra det indre af Finmarken. *NGU 36*, 66.
Risbøl, O. 1994. Socialøkonomiske aspekter ved vikingetidens klæberstenshandel i Sydskandinavien. *LAG vol. 5*, 115–161.
Sandmo, A.-K. 1997. ¨..opad til en klippe kalled Klibersteensbjerget¨. Talgrøtberget og området rundt Straumen. *Fotefar mot nord.* Troms fylkeskommune.
Shetelig, H. 1912. Kar av kleberstein fra jernalderen. In Brøgger, A. W. (ed.) *Oldtiden, tidsskrift for norsk forhistorie*, 49–73. A. W. Brøggers boktrykkeri, Stavanger.
Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingtiden*. Universitetsforlaget, Oslo.
Skjølsvold, A. 1969. Et keltertids klebersteinsbrudd fra Kvikne. *Viking* XXXIII, 201–238.
Solli, B. 2006. Kokegroper fra eldre jernalder og et langhus fra middelalderen på Borg i Lofoten. In Glørstad, H., Skar, B. & Skre, D. (eds) *Historien i forhistorien. Festskrift til Einar Østmo på 60-års dagen,* 281–297. Kulturhistorisk Museum Skrifter 4, Oslo.
Sommerfeldt, O. H. 1799. Kort beskrivelse over Finmarken. Topographic journal.
Storemyr, P. & Heldal, T. 2002. Soapstone production through Norwegian history: geology, properties, quarrying, and use. In Herrmann Jr., J. J., Hertz, N. & Newman, R. (eds) *Asmosia 5: Interdisciplinary Studies on Ancient Stone,* 359-369. Archetype Publications Ltd., London.
Storemyr, P., Lundberg, N., Østerås, B. & Heldal, T. 2010. Arkeologien til Nidarosdomens middelaldersteinbrudd. In Bjørlykke, K., Ekroll, Ø. & Syrstad Gran, B. (eds) *Nidarosdomen – ny forskning på gammel kirke*, 238–267**.** Nidaros Domkirkes Restaureringsarbeiders forlag, Trondheim.
Svestad, A. & Hauglid, M. 1990. Rapport fra befaring av kleberbrot ved Hemmestad, Kvæfjord k., Troms f., jnr. 71/90. Unpublished field report, Troms County Cultural Heritage Division.
Tengesdal, S. S. 2010. Å steike! En kontekstuell materialanalyse av steikeheller funnet i et bygårdskompleks i middelalderens Bergen. Unpublished master thesis, University of Bergen, Bergen.
Valen, C. R. 2007. Jordbruksimpulser i neolitikum og bronsealder i Nord-Norge? En revisjon av det arkeologiske gjenstandsmaterialet og de naturvitenskapelig undersøkelsene. Unpublished master thesis, University of Tromsø, Tromsø.
Vangstad, H. 2003. Kleberkarene fra Bryggen i Bergen. En arkeologisk analyse av kleberkarene funnet på Bryggen i Bergen fra middelalder og etterreformatorisk tid. Unpublished master thesis, University of Bergen, Bergen.
Vigerust, H. 1968. Noter om Varangerområdets geologi og natur. Kommentarer til "Varangerfunnene" I–IV og VI. In Simonsen, P. (ed) *Varanger-funnene VI. Analyseresultater og mindre rapporter*, 97–110. Universitetsforlaget, Tromsø and Oslo.
Wennberg, J. 1959. Rapport om en befaring av klebersteinsforekomster i Skjerstad og Fauske herreder. *NGU Rapport BA 7462*.
Wickler, S. 2015. Soapstone in northern Norway: research status, production evidence and quarry survey results. In Berglund, B., Callanan, M., Kaland, S. & Stenvik, L. (eds) *Exploitation of Outfield Resources: Joint Research at the University Museums of Norway*, 117-128. Universitetsmuseet i Bergen Skrifter nr. 32, Bergen.
Østerås, B. 2004. Forvaltningsplan for klebersteinsbrotet i Sandbekkdalen på Kvikneskogen. Tynset kommune, Hedmark fylke. Hedmark fylkeskommune.

Internet sources

Askeladden: The Norwegian National Cultural Heritage Database: https://askeladden.ra.no/Askeladden/Pages/LoginPage.aspx?ReturnUrl=%2faskeladden

Gjenstandsbasen: The five Norwegian University Museums' Collection Database: http://www.unimus.no/arkeologi/forskning/index.php

The National Natural Stone Database, Geological Survey of Norway (NGU): http://geo.ngu.no/kart/mineralressurser/

Laura Bunse

Multi-ethnic Involvement? Production and Use of Soapstone in Northern Norway

The northern Norwegian soapstone quarries display small, mainly rectangular extractions possibly for the production of smaller types of artifact or a kind of blank or rough out for various objects. In addition, some soapstone deposits might have been more than simply a source of raw material and can have functioned as landmarks or sieidi, a sacred place worshipped in traditional Sámi religion as a possible gateway to the spirit world. The quarries are located in areas with primarily Sámi or mixed Sámi and Norse settlements in the late Iron Age and early Medieval period, indicating a multi-ethnic influence. This raises questions relating both to the chronological framework and to the economic and sociocultural background of soapstone utilization in northern Norway.

Introduction

Many soapstone quarries in Norway are related to the large-scale production of cooking vessels and ashlar and decorative stone for church buildings in the late Iron Age and Medieval period. Recent studies of northern Norwegian quarries, conducted as part of the author's ongoing Ph.D. project, have documented a type of production that till now has attracted little attention in soapstone research. The quarries display small, mainly rectangular extractions possibly for the production of certain smaller types of artifact or a kind of blank or rough out for various objects. The quarries are located in areas with primarily Sámi or mixed Sámi and Norse settlements in the late Iron Age and early Medieval period. The quarries' geographic location and traces of their use indicate a multi-ethnic influence that is also observed in other archaeological finds from northern Norway. This raises questions relating both to the chronological framework and to the economic and socio-cultural background of soapstone utilization in northern Norway. To date, little attention has been paid to ethnicity and possible variations in soapstone utilization arising from a multi-cultural influence. However, ethnicity and different cultural influences may be matters of relevance, both in northern and in more southern parts of Norway. The article starts with an outline of the socio-cultural and economic situation in northern Norway in the late Iron Age and early Medieval period, followed by a presentation of the investigated quarries and indications on their use. Finally, perspectives for further research are outlined.

Resource utilization and production in Northern Norway – Economic specialization and socio-ethnic differentiation

Resource utilization and re-distribution in northern Norway in the late Iron Age and early Medieval period are the result of major social changes that were observable from the late Stone and the early Metal period or Bronze Age, which also may have a wider relevance for the supply of soapstone. These changes gradually led to an increasing socio-economic differentiation that may explain the development of different socio-cultural identities and eventually the emergence of Norse and Sámi ethnicities (Hansen & Olsen 2007, 2014). While the population at the outermost coast of Nordland and up to the northern part of Troms adopted a sedentary lifestyle and introduced agriculture with similarities and connections to south Scandinavian agricultural settlements, the populations in Finnmark and the inner fjords and inland areas of Nordland and Troms maintained an economy based on hunting and fishing. The hunting populations also established contact networks to metal working groups in eastern Russia, Finland and northern Sweden (Johansen 1990; Andreassen 2002; Hansen & Olsen 2007, 2014; Valen 2007). Among the hunting populations, the Sámi ethnicity seems to have emerged to accentuate cultural identity and socio-economic differences with the Norse agricultural settlement and vice versa.

It has long been assumed that the respective settlement areas for the agricultural and hunting populations were determined by natural conditions for agriculture (Sjøvold 1974:302; Johansen 1990:33–34; Hansen & Olsen 2007:78, 2014). Nevertheless, the borders of the settlements also seem to have been influenced by social factors and perceptions of cultural identity. Habitation and subsistence probably were important markers of identity and transgressing settlement borders could challenge social and cultural affiliation (Schanche 1986, 1989; Johansen 1990:34; Hansen & Olsen 2007:78–80, 2014). Accentuation of ethnicity and cultural identity seem to have been particularly important in border areas and during encounters with other groups, probably as a kind of social strategy (Odner 1983; Henriksen 1995; Spangen 2005; Hansen & Olsen 2007:31–34, 75–77, 82–87, 2014). However, as demonstrated by numerous examples of hybridization and exchange, these cultural meetings were not bound to certain geographical areas, and cooperation and different cultural influences are observable across the main areas of Norse and Sámi settlements, indicating that borders were less impermeable than previously assumed (Bruun 2007; Hansen & Olsen 2007:87–90, 2014).

Researchers mostly agree that within the social and economic system in the late Iron Age and early Medieval period, resource utilization and distribution in northern Norway were predominantly administered by Norse chieftains who were the political, economic and religious leaders of society (Johansen 1990:54; Solberg 2003:87; Hansen & Olsen 2007:56). In order to justify and maintain their power, they were dependent on access to and control of resources, as well as on alliances with leaders of equivalent societies, which were ensured by gift exchange and marriage. Resources were collected and shared within a redistributive system controlled by the chieftains, who claimed a part for themselves and divided and redistributed the surplus to the other members of the system (Hansen 1990; Solberg 2003:87–88; Hansen & Olsen 2007:65–66, 2014). Through the exchange of gifts and goods, the chieftains acquired luxury items and prestige goods like weapons, jewelry, glass and precious metal, in addition to other supply goods. This system required that the chieftains themselves had access to products that were in high demand in exchange for these luxury and high status items. In the case of the north Norwegian chieftains, these included items such as ivory from walrus tusk, fur, down, ropes made of walrus skin and train oil produced from marine mammals, i.e. products mainly supplied by Sámi hunting groups. Cooperation and trade with the Sámi thus were of major importance for the Norse chieftains in order to enhance and maintain their status. As experts and

Figure 1. *Map of soapstone deposits investigated in 2013 and 2014. (Illustration: E. Høgtun, Tromsø University Museum.)*

large-scale suppliers of outland resources, the Sámi, on the other hand, also gained increased power as trading partners and were ensured access to important supply goods (Hansen 1990; Storli 2006:90–94; Hansen & Olsen 2007:65–66, 2014).

Due to the quarries' geographic location, a Sámi cultural influence may also be considered for soapstone utilization and supply. The area of study is confined to the administrative district of Tromsø University Museum, which includes Nordland County north of Saltfjellet, as well as the northernmost counties of Troms and Finnmark (Figure 1). Within this area, the majority of quarries are situated in the inner fjord systems and inland areas with primarily Sámi or mixed ethnic settlements, exhibiting both Norse and Sámi cultural features in the late Iron Age and early Medieval period. Hunting, fishing and wild reindeer trapping, which in some areas were combined with stock breeding, agriculture and handicraft production, continued to be an important part of Sámi subsistence throughout the high and late Medieval periods (Hansen & Olsen 2007:175–177, 197–200, 2014). Thus a multi-ethnic context of soapstone production should also be considered for these periods.

The quarries

The Geological Survey of Norway (NGU) (Lindahl & Nilsson 2002; Lindahl 2012) have registered the majority of known soapstone deposits in northern Norway, and collaborative geological and archaeological field surveys were recently conducted as part of the Outfield Research Network directed by the Norwegian university museums (see also Wickler 2015, Wickler et al. this vol.). The actual number of exploited soapstone deposits within the area of study is difficult to estimate and requires further interdisciplinary field surveys (Bunse 2016). According to the Mineral Stone Database (NGU) and the National Database for Cultural Heritage (*Askeladden*), the number of deposits with possible traces of early production or other historic use can widely be defined as 10–15 sites (Figure 1). In connection with the Ph.D. project, 11 deposits were investigated in 2013 and extraction was documented at five of these (Figure 2): *Stolpe* and *Hesjetuva* in Nordland County, *Kanebogen* and *Talggrøtberget* in Troms County and *Straumdalen* in Finnmark County (Bunse 2013a–e). In 2014, minor excavations were conducted in the spoil heaps at Stolpe, Talggrøtberget and Straumdalen (Bunse 2014a–b, 2015). In addition, stone samples for geochemical analyses and studies of provenance were collected at Stolpe, Hesjetuva, *Talggrøtbergan*, Talggrøtberget and Straumdalen. Analysis results and a detailed presentation of the quarries will be given in the author's Ph.D. thesis. An overview of the quarries' most distinct features and traces of use is given here.

Small extractions

The five quarries with traces of previous production are characterized by small, mainly rectangular, extractions. At Stolpe and Hesjetuva, there are some variations in size and shape, whilst at Kanebogen,

Figure 2. *The quarries at a) Talggrøtberget, b) Kanebogen and c) Straumdalen. (Photo: L. Bunse).*

Figure 3. *Small extractions at a) Talggrøtberget, b) Kanebogen and c) Straumdalen. (Photo: L. Bunse).*

Talggrøtberget and Straumdalen, extractions are quite uniform (Figure 3). The quarried items seem to have been about 5–20 cm wide and 15–30 cm long according to the fracture surfaces, whereas the whole area of extraction for each item measured up to 20 cm width and 40 cm length, including the area of removed rock around the quarried objects. Some of the extractions at Straumdalen had rounded corners and an oval shape. At Straumdalen and Stolpe, a few circular extractions were observed, measuring about 15 cm in diameter, whilst the quarry at Hesjetuva displayed several up to 5 cm deep 'disc'- or 'plate'-shaped extractions with a diameter of c. 20 cm.

The small extractions were, in most cases, made in one layer on the outer face of the deposits and there were no signs of other production prior to the small extractions. They thus seem to represent the only type of production in the quarries, except traces from modern black powder blasting at Stolpe, Hesjetuva, Talggrøtberget and Straumdalen. The quarry at Stolpe is the only site that also displays traces from the production of c. 20 vessels in a separate area of the quarry, indicating that the know-how for the quarrying of larger items was also present in northern Norway. The vessel extractions measured up to 80 cm in diameter, while vessel rough-outs that were left on the rock face indicate that the final products were about 50 cm in diameter. The vessels were extracted using hewing channels with pickaxes or pointed tools around the vessel rough-outs in order to more easily remove them from the quarry face. This is a common technique used for quarrying vessels (cf. Skjølsvold 1961) and is one of the basic principles for quarrying soapstone (cf. Stavsøien 2012) and other soft rocks across the globe from the Stone Age until the early modern era (e.g. Abu-Jaber et al. 2009). This technique was also used to quarry most of the small items.

Figure 4. *Small fishing jigs from Noatun (Ts.5208-dd and -ee). The left one is made of slate; the right one is made of soapstone. (Photo: M. Karlstad, Tromsø University Museum).*

Indications of products and chronology

The production of small objects represented in the northern Norwegian quarries has not been studied in detail elsewhere in Norway, and there are only a few parallels to draw upon. Although there are examples of domestic and professional production of small soapstone objects from settlement sites, farmsteads and medieval towns, these items were made primarily from offcuts from vessels or building stones or were reworked from shards of broken vessels. It has also been suggested that raw soapstone could have been transported to the towns for further manufacture (Skjølsvold 1961:32; Johansen et al. 2003; Olsen 2004:35–36; Hansen 2005:194–196, 203–204; Baug 2011). Occasionally, small objects were made as by-products in quarries with production of vessels and building stones (Lundberg 2007; Storemyr et al. 2010; Berglund 2015). Several historic sources also mention the production of net sinkers in recent times, not only at Hesjetuva (Egenes Lund 1963) and Straumdalen (Vigerust 1968) in northern Norway, but also in other parts of the country, in the quarries at Tolgesteinsbrota in Rogaland County (Tuastad 1949) and at Øvre Bjørnå in the southern part of Nordland County (Smedseng 1994). At Tolgesteinsbrota and Øvre Bjørnå, net sinkers were not extracted directly from the rock, however, but were made of waste from previous production of vessels and building stones.

To date, the only known site in Norway with similar small extractions is the early Iron Age quarry at Kvikne/Sandbekkdalen (referred to as Bubakk in earlier literature) in central Norway. In addition to traces from the quarrying of bucket-shaped soapstone vessels in the pre-Roman Iron Age (Skjøldsvold 1969), a quarry face with several hundred small rectangular items has recently been excavated in a separate area of the quarry (Østerås 2004). Because of their size and shape, the extractions were interpreted as casting molds for bronze artifacts, but radiocarbon dating the site to the pre-Roman Iron Age may partly reverse this. The extractions at Kvikne/Sandbekkdalen were made with an adze-like tool (Grenne et al. this vol.) and the tool marks are quite similar to those observed at Straumdalen. Compared to Kvikne/Sandbekkdalen, however, soapstone use in the vicinity of the northern Norwegian quarries and other proxy data give different indications about the range of products and the time span covered.

Straumdalen is possibly an example of quite early use of soapstone. In close proximity to the quarry, ceramics tempered with crushed soapstone and small soapstone flakes with cutting marks and polished surfaces, as well as a small fishing jig (Norwegian: *fiskepilk*) (Figure 4) were found at the late Stone Age site of Noatun in the Pasvik Valley and the early Metal period sites of Makkholla and Mestersanden on Kjelmøy Island. From Jarfjord, c. 20 km from the Straumdalen quarry, there are stray finds of two casting molds and an oval line sinker, also called a deep-sea sinker (Norwegian: *jarstein*). The two molds from Jarfjord are made for casting blades, perhaps daggers of an eastern Seima-Turbino type (Chernykh 1992:Fig. 7), which could potentially date from before 1700 BC (Engedal 2010:67; see also Bakka 1976; Rønne 2008). A possible fragment from a similar casting mold has also been found at Mestersanden on Kjelmøy (Solberg 1909; Bakka 1976; Olsen 1984). The oval line sinker indicates another date of production. Line sinkers of this type were primarily used from AD 1000–1600, but were also possibly used within a shorter period, from AD 400–600 (Helberg 1993).

Figure 5. *Decorated handles from the Stolpe-area. From left to right: Ts.6251-bå from Vestvatn, Ts. 6504-h from Eiterjord, Ts.4647-b and -a from Brekke. (Photo: M. Karlstad, Tromsø University Museum).*

Their use over such a long period can only give a rough indication of the date of production in the quarries.

The vessel extractions at Stolpe indicate production in the Iron Age and Medieval period, and soapstone finds from settlement sites near the quarry seem to confirm this. The excavations of the late Iron Age and early Medieval period sites of Vestvatn, Eiterjord, and Arstad resulted in a number of soapstone finds, including vessel shards, small net sinkers for river and lake fishing, and soapstone scoops with decorated handles (Munch Stamsø 1967, 1973). According to their size, which corresponds well to the extractions in the quarry, all of these items were possibly quarried at Stolpe. The scoops, which are about 15 cm long with a diameter of 5 cm at the bowl and a 10 cm long handle, are found at all three sites (Figure 5). In addition, there have been several stray finds of such scoops in the surrounding area of Stolpe (e.g., at Brekke, the farm closest to the quarry; see *Askeladden*).

At some sites, the production of small soapstone items seems to have taken place in historic or early modern times. The Kanebogen quarry is situated at the shoreline. Extractions are documented on several small quarry faces extending from the high tide level up to 5 m ASL. Due to isostatic uplift, production would first have been possible in the Medieval period or modern times. According to local tradition, net sinkers for fishing were quarried at Hesjetuva and Straumdalen, and the visible extractions at these sites possibly represent quite recent activity (Egenes Lund 1963; Vigerust 1968). This might also be the case at Talggrøtberget. According to the landowner, the locals quarried stone for fireplaces in the early 1900s, but the site was probably regularly used from the Stone Age onwards. An unauthorized excavation inside the rock shelter next to the quarry revealed remains of a Stone Age dwelling site, as well as several soapstone finds, presumably from the Medieval period. They consist of a handle for a scoop or oil lamp, a three-pointed item with a drilled hole in the middle, and two cone-shaped items (Sandmo 1997).

The soapstone material from northern Norway suggests that the quarries were in use at different periods and for different products. At Straumdalen, production possibly has large time depth. Soapstone finds from the vicinity of the quarry suggest that the site was used in the Stone Age and early Metal period, while historic sources mention the quarrying of net sinkers in recent times. Stolpe seems to have been utilized mainly in the late Iron Age and early Medieval period, while the small extractions at Kanebogen surely represent quite recent activity. Radiocarbon dating of samples collected during excavation, as well as studies of provenance conducted in cooperation with the NGU, will hopefully provide more specific information on the chronology of the quarries and the products that were made.

Figure 6. *The Assebakte soapstone deposit. (Photo: L. Bunse).*

Other forms of soapstone use

Some deposits might have been more than simply a source of raw material. The name of the *Assebakte* deposit in Finnmark is derived from the Sámi word, Ássebákti, which means '*soapstone* or *soft rock* that is easy to carve' (Nielsen & Nesheim 1962:5). The deposit is located on the plains of the river Karasjok and consists of a c. 15 m long and 4–5 m high knoll, which clearly stands out against the slightly undulating landscape (Figure 6). The name Ássebákti is also applied to the surrounding area, with several light-grey boulders; as is common in Sámi place names, Ássebákti seems to refer to prominent features in the landscape. Sámi place names give information about, for example, the topography of the area, travel routes, weather specific to the area or its reindeer pasture, and they often function as 'orientation guides' or 'terrain descriptions' (cf. Qvigstad 1935, 1938, 1944; Solbakk 2012; Solbakken 2014:33–34). At Assebakte, a track passing close to the deposit and several nearby fireplaces give the impression that the site was a natural place for a rest. The path and fireplaces seem to have been used recently for reindeer herding, but may also have been used further back in time. In the vicinity is also an investigated settlement site dated to the late Iron Age and early Medieval period, though without finds of any soapstone artifacts (Simonsen 1979).

The *Stabben* deposit in Troms appears to have had a similar function (Manker 1957:113, 292; Lindahl & Nilsson 2002:37–38). Owing to its prominent shape, it is known as a landmark and a *sieidi*, a sacred place worshipped in traditional Sámi religion as a possible gateway to the spirit world (Figure 7). Sieidis are often characterized by rock formations that could have an unusual appearance, a special shape with resemblance to humans or animals, an unusual color or raw material or a fissure in the rock that provides a natural 'portal' (Manker 1957; Mulk 1994; Bradley 2000:6). The Stabben deposit seems to combine several of these significant features into a monumental 20–25 m high rock pillar/knoll with a light brown color consisting of useful and in-demand raw material.

Figure 7. *The Stabben soapstone deposit. (Photo: Ø. Vorren, Tromsø University Museum).*

In this connection, it is interesting that these deposits were not exploited. According to Richard Bradley (2000:28–30), it is common that rocks significant to indigenous people often seem to resist aging and are seemingly invulnerable in their original appearance; a fact which adds to their significance to the people visiting them. Thus, a common feature of sacred natural places, such as rocks, caves or mountains, is that they are usually unaltered and left entirely unmodified.

A multi-ethnic involvement?

When discussing the ethnicity of the soapstone users, different kinds of data can be drawn on. One is the geographical location of the quarries. As elaborated on above, the quarries in the present study are situated in areas with a mixed Norse/Sámi or primarily Sámi settlement in the late Iron Age and early Medieval period (Hansen & Olsen 2007, 2014).

Besides the examples of Assebakte and Stabben, which suggest the use of soapstone deposits as Sámi landmarks and sieidis, a possible multi-ethnic involvement is indicated by soapstone finds from the surrounding areas of the quarries and their archaeological context. The soapstone-tempered ceramics from Makkholla in Finnmark are Kjelmøy-type ceramics, a ceramic group that, together with Risvik-ceramics, has been linked to the increasing cultural dualism that is observable in the archaeological record from the early Metal period and onwards. Risvik ceramics are usually found along the coast of Nordland and the southern parts of Troms in areas with primarily agricultural settlement, whilst Kjelmøy-ceramics are found in hunter-gatherer contexts in northern Troms and Finnmark. These two distinct ceramic traditions have been seen as a symbolic expression of this cultural development and the emergence of Norse and Sámi ethnicity during the Iron Age (Jørgensen & Olsen 1988; Andreassen 2002; Hansen & Olsen 2007:53–56, 2014).

Ethnicity has also been important in the interpretation and discussion of the archaeological material and the soapstone finds from the settlement sites at Vestvatn, Eiterjord and Arstad in the vicinity of Stolpe. The economy at these sites was based on a combination of agriculture, hunting, fishing and the exploitation of several outfield resources, like iron production (cf. Jørgensen 2010) and possibly the quarrying and working of slate and soapstone. Artifacts from these sites include both items that are interpreted as Norse, such as combs made of reindeer antlers (which was the common raw material for combs in medieval Norway) or soapstone vessels, as well as artifacts usually associated with a Sámi cultural context (e.g. bone items with linear decoration). While Gerd Stamsø Munch (1967) interpreted the sites as Norse settlements with Sámi interaction, Knut Odner (1983:68) later argued for interpreting the sites as Sámi or a possible case of hybridization and especially regarded the soapstone artifacts as a Norse cultural feature. Yet, both Odner and Stamsø Munch highlighted the linear decoration on the soapstone scoops as an example of Sámi cultural influence since it is quite similar to the decoration on some of the bone items from these sites. This may be further supported by the confined geographical distribution of these scoops.

In addition to the close proximity of Stolpe, the scoops are also found in Arjeplog, northern Sweden, which is about 170 km from Stolpe. In historic times, a trading route across the mountains connected the Misvær area with Arjeplog (Fjellström 1986:305; Brekke 1989). Each year in the autumn, Sámi reindeer herders came from Arjeplog to Misvær to trade and sell their products (Brekke 1989). Further investigation is required to see if this trading route might have already existed during the late Iron Age or Medieval period and if the scoops were produced at Stolpe. Still, the production and distribution of these specific scoops suggests a Sámi interaction due to the linear decoration on the handles and the fact that they are found in the Misvær and Arjeplog areas, with Sámi cultural influences visible in the archaeological record from the Iron Age and onwards.

Altogether, the sources suggest that a multi-ethnic context and possible involvement should be considered for all investigated quarries. For some sites, the affinity to Sámi culture is more distinct and is sometimes the only indication of use, whilst in other cases, indications on the socio-cultural background of the users and producers of soapstone are mixed. However, when discussing ethnicity, one has to keep in mind that our modern classifications and interpretations do not necessarily capture past peoples' concepts and perceptions of identity. Several researchers have emphasized the problem of applying ethnic 'categories' that are too narrow, as well as a Norse/Sámi dichotomy, to the archaeological material from northern Norway. In recent years, there has been increased focus on the complex relationships between Norse and Sámi cultural features and social identities in northern Norway in the Iron Age and early Medieval period. Hybridization and a mix of cultural expressions did not only take place in border areas between the Norse and Sámi settlements, but also in places that previously were regarded as core regions for either the Norse or the Sámi culture. Like the adaptation of Norse or Sámi ethnicities, hybridization could also have been a conscious choice and a social strategy (Spangen 2005; Bruun 2007). The soapstone finds from the settlements at Vestvatn, Eiterjord and Arstad in the vicinity of Stolpe combine both 'Norse' and 'Sámi' cultural features and could possibly be regarded an example of hybridization.

However, a discussion of ethnicity may be a useful approach to gain increased and more nuanced insight into the socio-cultural background of soapstone production and use. In the same fashion as with the northern Norwegian quarries, hunter-gatherer groups could also have exploited Kvikne/Sandbekkdalen; four soapstone clubs found in the quarry possibly indicate this. Furthermore, nearby pitfall systems for reindeer and elk/moose hunting have been found (Skjølsvold 1969:233–234). On the other hand, such pitfall systems may date to other periods than the quarrying, and without any information about their chronology a possible relationship cannot yet be confirmed (see Grenne et al. this vol.). Still, a discussion of the socio-cultural background and ethnicity of soapstone utilization may also be an issue of relevance for areas further south in Norway (cf. Bergstøl 2008).

Perspectives for further research

The northern Norwegian quarries' geographic location and evidence of their use indicate a multi-ethnic use of the natural resources/places. An awareness and accentuation of this multi-ethnic situation raises questions on the chronological, socio-cultural and economic backgrounds of soapstone production and use that require further investigations:

- When did this kind of utilization and production take place? Was it contemporary to the large-scale production of vessels and building stones in the late Iron Age and Medieval period in the more southern parts of Norway?
- Which factors determined production and why were small soapstone items primarily made? Was it due to natural conditions (e.g. stone quality or accessibility of stone sources) or due to socio-cultural aspects?
- Can different types of soapstone production be linked to different ways of life? Can, for example, the quarrying and use of large and heavy soapstone items, such as vessels production/ large and heavy soapstone items be related to agricultural settlement and the making of small items such as net weights and scoops, be linked to a semi-sedentary lifestyle?
- Who had the right to use the soapstone sources? Who worked in the quarries?
- To which level was production organized; did the products satisfy household/local demands only or were they meant for further distribution and trade?

Some of these questions will be addressed further as part of the author's Ph.D. project and several articles are in progress. In the next step, geochemical analyses will be conducted in cooperation with geologist Gurli Meyer from the NGU, in order to investigate the distribution of locally quarried soapstone products. Samples from five quarries and a selected number of soapstone artifacts from secure archaeological contexts will be compared in order to try to match the products to their original raw material source. A particular concern is trying to match soapstone objects from Sámi cultural contexts to the quarries and to see whether the distribution of the products can be linked to Sámi trading and exchange networks. Another article by the author and stonemason Eva Stavsøien from the Nidaros Restoration Workshop seeks to explore the factors that might have been important in the production process by analyzing quarrying techniques, tool marks and the workability of the different soapstone raw material sources. In this connection, attempts are made to see how the use of certain tools, techniques and types of decoration on soapstone objects can be compared to certain handicraft traditions (e.g. Sámi handcraft tradition; *duodji*)(Bunse & Stavsøien 2016). The final article aims to draw lines between these discussions and the results from radiocarbon dating of the quarries and indications on their chronology.

Acknowledgements

I wish to thank Stephen Wickler for his significant contributions to and participation in fieldwork in 2013. I acknowledge Gurli Meyer from the NGU and Eva Stavsøien from the Nidaros Restoration Workshop for sharing their knowledge and for interesting discussions. I would also like to thank the members of the soapstone network and the referees for constructive feedback and useful suggestions. Finally, I thank my supervisors, Roger Jørgensen and Bjørnar Olsen, for their guidance and comments on the manuscript.

References

Abu-Jaber, N., Bloxam, E. G., Degryse, P. & Heldal, T. (eds) 2009. *QuarryScapes: Ancient stone quarry landscapes in the Eastern Mediterranean*. Geological Survey of Norway, Special Publication 12.
Andreassen, D. M. 2002. Risvikkeramikk. En analyse av teknologisk stil på Nordkalotten i sein steinbrukende tid. Unpublished master thesis, University of Tromsø.
Bakka, E. 1976. *Arktisk og nordisk i bronsealderen i Nordskandinavia*. Miscellanea volume 25, Trondheim.
Baug, I. 2011. Soapstone finds. In Skre, D. (ed.) *Things from the Town. Artifacts and Inhabitants in Viking Age Kaupang*, 311–337. Kaupang Excavation Project, Publication Series Vol. 3. Norske Oldfunn XXIV, Aarhus.
Berglund, B. 2015. Possibilities for a society analysis by means of soapstone – Examples from Helgeland, Northern Norway. In Indrelid, S., Loe Hjelle, K. & Stene, K. (eds) *Exploitation of outfield resources – Joint research at the University Museums of Norway,* 129–140. Bergen University Museum, Bergen.
Bergstøl, J. 2008. Samer i Østerdalen? En studie av etnisitet i jernalderen og middelalderen i det nordøstre Hedmark. Unpublished dr. art. thesis, University of Oslo.
Bradley, R. 2000. *An Archaeology of Natural Places.* Routledge, London.
Brekke, A. 1989. *Ol' Hansogården i Misvær. Litt om Misvær-navnet og grensehandel i gammel tid. Priviligert gjestgiveri og bondehandel i 1775–1792. Gnr. 26 Bnr. 9 i Skjærstad*. Fauske Boktrykkeri.
Bruun, I. M. 2007. Blandede graver – blandede kulturer? En tolkning av gravskik og etniske forhold i Nord-Norge gjennom jernalder og tidlig middelalder. Unpublished master thesis, University of Tromsø.
Bunse, L. 2013a. Klebersteinsforekomsten på Hesjetuva. Årbok for Tysfjord 31, 10–11.
Bunse, L. 2013b. Rapport fra arkeologisk befaring. Hesjetuva, Tysfjord kommune, gbnr. 28/1 og 4, Nordland fylke. Unpublished report, Tromsø University Museum.
Bunse, L. 2013c. Rapport fra arkeologisk befaring av klebersteinforekomster. Unpublished report, Tromsø University Museum.
Bunse, L. 2013d. Rapport fra arkeologisk befaring av et klebersteinsbrudd i Langfjorden, Sør-Varanger kommune, Finnmark fylke. Unpublished report, Tromsø University Museum.
Bunse, L. 2013e. Rapport fra arkeologisk befaring. Stolpe, Bodø kommune, gbnr. 224/2, Nordland fylke. Unpublished report, Tromsø University Museum.
Bunse, L. 2014a. Rapport fra mindre arkeologisk utgraving i et klebersteinsbrudd i Langfjorden, Sør-Varanger kommune, Finnmark. Unpublished report, Tromsø University Museum.
Bunse, L. 2014b. Rapport fra arkeologisk undersøkelse i klebersteinsbruddet Talggrøtberget, Sørreisa kommune, Troms fylke, sommeren 2014. Unpublished report, Tromsø University Museum.
Bunse, L. 2015. Rapport fra arkeologisk utgraving. Stolpe, gbnr. 224/2, Nordland fylke. Unpublished report, Tromsø University Museum.
Bunse, L. 2016. Exploring production and use of soapstone in Norway: Towards an interdisciplinary approach? In Brun, W. & Pedersen, E. S. (eds). *Tverrfaglige perspektiver* 3. AMS Varia 58, 71–87.
Bunse, L. & Stavsøien, E. 2016. I krysningspunktet mellom arkeologi og håndverk. En undersøkelse av hoggeteknikk og verktøyspor i nordnorske klebersteinsbrudd. *Primitive tider,* vol. 18, 25–44.
Chernykh, L. N. 1992. *Ancient Metallurgy in the USSR. The Early Metal Age.* Cambridge University Press, Cambridge.
Egenes Lund, H. 1963. Tennstrand. Tysfjorden/Sörfjorden. Tysfjord pgd. Nordland. Gnr. 27 Tysfjord. Forekomst av kleberstein. Unpublished report, Tromsø University Museum.
Engedal, Ø. 2010. The Bronze Age of Northwestern Scandinavia. Volume 1: text. Unpublished Dr. philos. thesis, University of Bergen.
Fjellström, P. 1986. *Lapskt Silver. Studier* över *en föremålsgrupp och dess ställning innom lapskt kulturliv. I Tekstdel.* Almqvist & Wiksell, Stockholm.
Gjessing, G. 1942. *Yngre steinalder i Nord-Norge.* Aschehoug, Oslo.
Hansen, L. I. 1990. *Samisk fangstsamfunn og norsk høvdingeøkonomi.* Novus forlag, Oslo.
Hansen, G. 2005. *Bergen c800–c1170. The emergence of a town.* The Bryggen Papers, Main Series No 6. Fagbokforlaget, Bergen.
Hansen, L. I. & Olsen, B. 2007. *Samenes historie fram til 1750.* Cappelen Akademisk Forlag, Oslo, 3. opplag.
Hansen, L. I. & Olsen, B. 2014. *Hunters in transition. An outline of early Sámi history.* The Northern World, Volume 3. Brill, Leiden.
Helberg, B. H. 1993. Fiskeriteknologi som uttrykk for sosial tilhørighet. En studie av nordnorsk fiske i perioden 400–1700 e.Kr. Unpublished master thesis, University of Tromsø.
Henriksen, J. E. 1995. Hellegropene: fornminne fra en funntom periode. Unpublished master thesis,

University of Tromsø.
Johansen, O. S. 1990. *Synspunkter på jernalderens jordbrukssamfunn i Nord-Norge.* Stensilserie B, nr. 29. Arkeologiseksjonen, Institutt for samfunnsvitenskap, Universitetet i Tromsø.
Johansen, O. S., Kristiansen, K. & Stamsø Munch, G. 2003. Soapstone artefacts and whetstones. In Stamsø Munch, G., Johansen, O. S. & Roesdahl, E. (eds) *Borg in Lofoten. A chieftain's farm in north Norway,* 141–158. Arkeologisk Skriftserie I, Lofotr – Vikingmuseet på Borg.
Jørgensen, R. & Olsen, B. 1988. Asbestkeramiske grupper i Nord-Norge. 2100 f.Kr. – 100 e.Kr. *Tromura Kulturhistorie* 13.
Jørgensen, R. 2010. Production or trade? The supply of iron to north Norway during the Iron Age. Unpublished dr. philos. thesis, University of Tromsø.
Lindahl, I. & Nilsson, L. P. 2002. *En vurdering av klebersteinspotensialet i Troms.* Report 2002.077. The Geological Survey of Norway, Trondheim.
Lindahl, I. 2012. *Bygningsstein i Nordland. En oversikt over bygningsstein i Nordland, om bruken og om de forskjellige geologiske steinprovinsene.* Geological Survey of Norway, Trondheim.
Lundberg, N. 2007. Øye – En arkeologisk undersøkelse av et klorittskiferbrudd. Unpublished master thesis in archaeology, Norwegian University of Science and Technology, Trondheim.
Manker, E. 1957. *Lapparnas heliga ställen. Kultplatser och offerkult i belysning av nordiska museets och landantikvariernas fältundersökningar.* Acta Lapponica XIII. Gebers, Stockholm.
Melheim. A. L. 2015. *Recycling ideas: Bronze age metal production in southern Norway.* Archaeopress, Oxford.
Mulk, I. -M. 1994. Sacrifical places and their meaning in Saami society. In Carmichael, D. L., Hubert, J., Reeves, B. & Schanche, A. (eds) *Sacred Sites, Sacred Places.* Routledge, London.
Munch Stamsø, G. 1967. Funnene frå Eiterjord i Beiarn og Vestvatn i Misvær. *Viking* XXXI, 99–121.
Munch Stamsø, G. 1973. En gullring fra en hustuft på Arstad i Nordland. *SMYA* 75, Helsinki.
Nielsen, K. & Nesheim, A. 1962. *Lappisk ordbok: Grunnet på dialektene i Polmak, Karasjok og Kautokeino.* Universitetsforlaget, Oslo.
Odner, K. 1983. *Finner og terfinner. Etniske prosesser i det nordlige Fenno-Skandinavia.* Oslo Occasional Papers in Anthropology. Department of social anthropology, University of Oslo.
Olsen, B. 1984. Stabilitet og endring. Produksjon og samfunn i Varanger 800 f.Kr.–1700 e.Kr. Unpublished master thesis, University of Tromsø.
Olsen, O.M. 2004. Medieval Fishing Tackle from Bergen. In Øye, I. (ed.) *Medieval fishing tackle from Bergen and Borgund.* The Bryggen Papers, Main Series No. 5, 11–106. Fagbokforlaget, Bergen.
Prescott, C. 2006. Copper production in Bronze Age Norway. In Glørstad, H., Skar, B. & Skre, D. (eds) *Historien i forhistorien: festskrift til Einar Østmo på 60-års dagen*. Skrifter Kulturhistorisk Museum, Oslo.
Qvigstad, J. 1935. *De lappiske stedsnavn i Troms Fylke.* Aschehoug, Oslo.
Qvigstad, J. 1938. *De lappiske stedsnavn i Finnmark og Nordland Fylker*. Aschehoug, Oslo.
Qvigstad, J. 1944. *De lappiske appellative stedsnavn*. Aschehoug, Oslo.
Rønne, P. 2008. Bronse fra øst. *Spor*, nr. 2, 14–17.
Sandmo, A. -K. 1997. "…oppad til en klippe kalled Klibersteensbjerget". Talgrøtberget og området rundt Straumen. *Fotefar mot nord*. Troms Fylkeskommune, Tromsø.
Schanche, A. 1986. Nordnorsk jernalderarkeologi. Et sosialgeografisk perspektiv. Unpublished master thesis, University of Tromsø.
Schanche, A. 1989. Jernalderens bosettingsmønster i et fleretnisk perspektiv. In Bertelsen, R., Reymert, P. K. & Utne, A. (eds) Framskritt for fortida i nord. I Povl Simonsens fotefar. *Tromsø Museums Skrifter* XXII: 171–184.
Simonsen, P. 1979. *Juntavadda og Assebakte: to utgravinger på Finnmarksvidda.* Acta Borealia B. Humaniora 17. Universitetsforlaget, Tromsø/Oslo/Bergen.
Sjøvold, T. 1974. *The Iron Age settlement of Arctic Norway II.* Tromsø Museums Skrifter X 2, Tromsø.
Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden*. Universitetsforlaget, Oslo – Bergen.
Skandfer, M. 2003. Tidlig, nordlig kamkeramikk: typologi, kronologi, kultur. Unpublished dr. art. thesis, University of Tromsø.
Skjølsvold, A. 1969. Et keltertids klebersteinsbrudd fra Kvikne. *Viking*, XXXIII, 201–238.
Solberg, O. 1909. *Eisenzeitfunde aus Ostfinmarken: lappländische Studien*. Videnskabsselskapet i Kristiania, Historisk-filosofisk klasse, 1909 nr.7. Kristiania.
Smedseng, N. 1994. Kleberstein (Esjestein)- brotet på Øvre Bjørnå. *Vefsen Museum Årbok,* 69–73.
Solbakk, A. 2012. Báikenamat Sámis. Oassi 1: Buolbmát, Hillágurra, Fanasgieddi. ČálliidLágádus, Kárášjohka.

Solbakken, T. 2014. Det urørte landskapet i Øvre Anárjohka nasjonalpark. Unpublished Master thesis in archaeology, University of Tromsø.
Solberg, B. 2003. *Jernalderen i Norge. 500 før Kristus til 1030 etter Kristus.* Cappelen Akademisk Forlag, Oslo. 2. utgave.
Spangen, M. 2005. Edelmetalldepotene i Nord-Norge: komplekse identiteter i vikingtid og tidlig middelalder. Unpublished master thesis, University of Tromsø.
Stavsøien, E. 2012. Fra fast fjell til gryte. Å arbeide med kleberstein, – hva skjuler seg i prosessen? Bacheloroppgave i teknisk bygningsvern og restaurering. BYG819T, prosjektnr. 13–2012. Høgskolen i Sør-Trøndelag.
Storemyr, P., Lundberg, N., Østerås, B. & Heldal, T. 2010. Arkeologien til Nidarosdomens middelaldersteinbrudd. In Bjørlykke, K., Ekroll, Ø., Syrstad Gran, B. (eds) *Nidarosdomen – ny forskning på gammel kirke*. Nidaros Domkirkes Restaureringsarbeiders forlag, Trondheim.
Storli, I. 2006. *Hålogaland før rikssamlingen. Politiske prosesser i perioden 200–900 e.Kr.* Novus forlag, Oslo.
Tuastad, N. H. 1949. Tolgesteinsbrot ved Haugesund. Garnstein eller vevlodd? *Stavanger Museum Årbok,* 47–68.
Valen, C. R. 2007. Jordbruksimpulser i neolitikum og bronsealder i Nord-Norge? En revisjon av det arkeologiske gjenstandsmaterialet og de naturvitenskapelige undersøkelsene. Unpublished master thesis, University of Tromsø.
Vigerust, H. 1968. Noter om Varangerområdets geologi og natur. Kommentar til "Varangerfunnene" I–IV og VI. In Simonsen, P. 1968. *Varanger-funnene 6. Analyseresultater og mindre rapporter.* Tromsø University Museum, Tromsø.
Wickler, S. 2015. Soapstone in Northern Norway: Research status, production evidence and quarry survey results. In Indrelid, S., Loe Hjelle, K. & Stene, K. (eds) *Exploitation of outfield resources – Joint research at the University Museums of Norway,* 117–128. Bergen University Museum, Bergen.
Østerås, B. 2004. Rapport fra arkeologisk utgraving. Kvikneskogen sameige, Sandbekkdalen, Tynset. Unpublished report, Hedmark Fylkeskommune.

Internet sources

Askeladden: The Norwegian National Cultural Heritage Database: https://askeladden.ra.no/Askeladden/Pages/LoginPage.aspx?ReturnUrl=%2faskeladden
Gjenstandsbasen: The five Norwegian University Museums' Collection Database: http://www.unimus.no/arkeologi/forskning/index.php
The National Natural Stone Database, Geological Survey of Norway (NGU): http://geo.ngu.no/kart/mineralressurser/

Knut Andreas Bergsvik

Mesolithic Soapstone Line-sinkers in Western Norway: Chronology, Acquisition, Distribution, Function and Decoration

Soapstone sinkers are commonly found at coastal Mesolithic sites in western Norway. The large majority of these sinkers weigh less than 10 g (small sinkers), and a few weigh between 150 and 200 g (large sinkers). They were used between c. 5900–4000 cal BC and have been found at residential sites along the entire coast of western Norway, from Romsdal in the north to Lista in the south. The main area of distribution is between the districts Nordfjord and Nordhordland. Large soapstone sinkers have only been found in Nordfjord. The sinkers were probably quarried by the users themselves in bedrock outcrops of soapstone, which are common in the main area of distribution. They are only found at sites situated in marine environments. The close match between the sizes of the small sinkers, the sizes of fishhooks and the main sizes of the fish caught strongly indicate that they were used as line sinkers for fishing with a rod or for trolling. A few of the sinkers are ornamented with notches or incised lines. These motifs are common among Palaeolithic and Mesolithic populations in a global perspective.

Introduction

The soft and workable qualities of soapstone have been noticed as early as in the Mesolithic Age in western Norway. During this period, the raw material was carved and formed into elegant objects, such as star-shaped shafthole-hatchets, mace-heads and small animal figures. The most common artefacts of soapstone were, however, sinkers, which were used amongst the coastal populations between c. 5900–4000 cal BC. The large majority of these sinkers weigh less than 10 g, with some of them containing ornaments.

Small Mesolithic soapstone sinkers were first recorded by the biologist Ole Nordgaard in his book on the development of fisheries in Norway (Nordgaard 1908). He called them 'boys' sinkers', in the probable expectation that they were accompanied by large specimen. Eventually, larger sinkers turned up, but small sinkers have continued to dominate the assemblages. They were found for the first time in an archaeological context during the excavations at the site Korsen at Sunnmøre (Bjørn 1921). Later, sinkers of this type were retrieved regularly at Mesolithic sites at the coast of western Norway (Bøe 1934; Jansen 1972; Gustafson & Hofseth 1979; Bjørgo 1981; Ågotnes 1981; Kristoffersen 1990; Olsen 1992; Nærøy 1994; Kristoffersen & Warren 2001; Bergsvik 2002; Skjelstad 2011).

Tore Bjørgo (1981) was the first to explore their significance at any length, and since his contribution, many have discussed their functions, chronological statuses and regional spread in chapters or paragraphs in articles, theses and reports (e.g. Olsen 1992; Warren 1994; Bergsvik 2002; Skjelstad 2003; Åstveit 2008a, d; Bang-Andersen 2009; Skjelstad 2011; Bjerck 2014; Nyland 2016). The current work is an attempt to provide a critical assessment of these contributions. The chronology, geographical distributions, provenance, functions and ornaments of the sinkers will be discussed and their significance for Mesolithic fisheries in western Norway will be explored.

Contexts, shapes and sizes

Soapstone sinkers are found in the cultural layers at residential sites, occasionally also as stray-finds. At some excavated Mesolithic sites, they occur in relatively large quantities, and in the below discussions, the findings at three such sites, *Flatøy* and *Kotedalen* in the district Nordhordland and *17 Havnen* in Nordfjord, will make up the core data (Figures 1 and 2). As many as 106 sinkers were found during the excavations at site complex Flatøy (site I, II, IX, XII, and XIII) (Bjørgo 1981). At the site Kotedalen, 49 were found (Olsen 1992), and 43 soapstone sinkers turned up at the site 17 Havnen (Bergsvik 2002). In addition to these sites, data from two excavated rockshelters *Skipshelleren* (Bøe 1934) and *Olsteinhelleren* (Bergsvik et al. 2016) will be used in the discussions.

The sinkers are sometimes fragmented (20, 25 and 25% at the first three sites, respectively), but most of them are complete and in seemingly good condition (Figures 3–5). It is difficult to evaluate whether they were discarded or just lost at the sites, but they do not seem to be intentionally placed. As is evident from these figures, it is a heterogonous group, but the majority has oval forms. Their lengths exceed their breadth, and they have varying cross-sections in terms of proportions (breadth/thickness). Most sinkers have furrows cut lengthwise on both sides along the sides with thinnest cross-sections. Some of the sinkers have a transverse furrow instead of, or in addition to, the one lengthwise. Some lack furrows and have only notches at the side for attachment of the line. The surfaces of the sinkers have been shaped in different ways. Some of them are only crudely formed and may not have been intentionally modified. Many of the sinkers are, however, smoothed on the surface, and quite a few are also oval-shaped, which has led to the fitting name 'coffee-bean shaped sinkers' of the smallest of these pieces (e.g. Figure 3, no. 1–3 and Figure 5, no. 1–2). The sizes vary mainly between c. 1.5 and 8 cm in length, and most of them weigh between c. 1

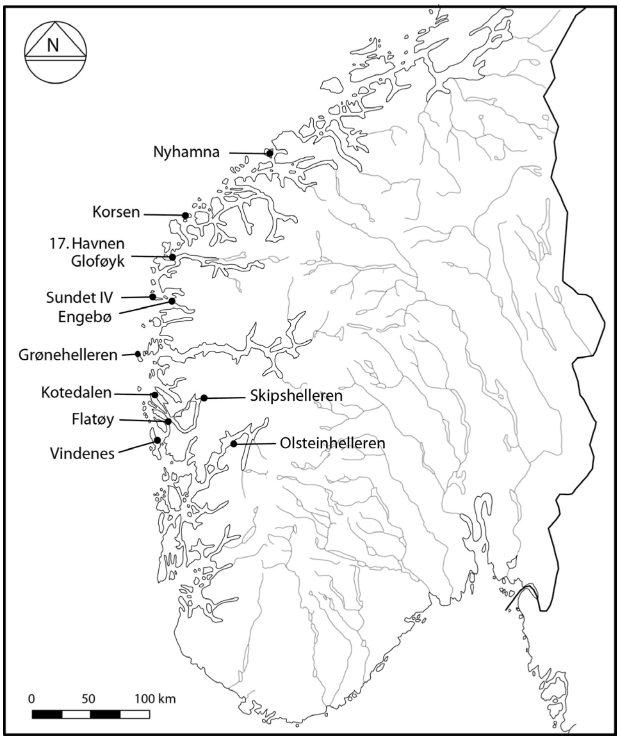


Figure 1. *Southern and central Norway. Archaeological sites referred to in the text.*

and 10 g. Hereafter, the sinkers in this weight-group are termed *small sinkers* (Bjørgo 1981:110). According to the data on weights of the sinkers from Flatøy, Kotedalen and 17 Havnen, very few sinkers weigh between 10 and 50 g. This weight-group is termed *middle sized sinkers*. At 17 Havnen, there is a group of sinkers weighing more than 50 g (e.g. Figure 5, no. 10). This weight-group is hereafter termed *large sinkers*, with most sinkers weighing around 150–200 g. The largest Mesolithic soapstone sinker known weighs 1.096 g (Bang-Andersen 2009). Some of the smaller sinkers have notches on the sides, and these notches occur in varying numbers. A few sinkers also have incisions – often net-shaped or geometrical – which cover most of or all of the surfaces.

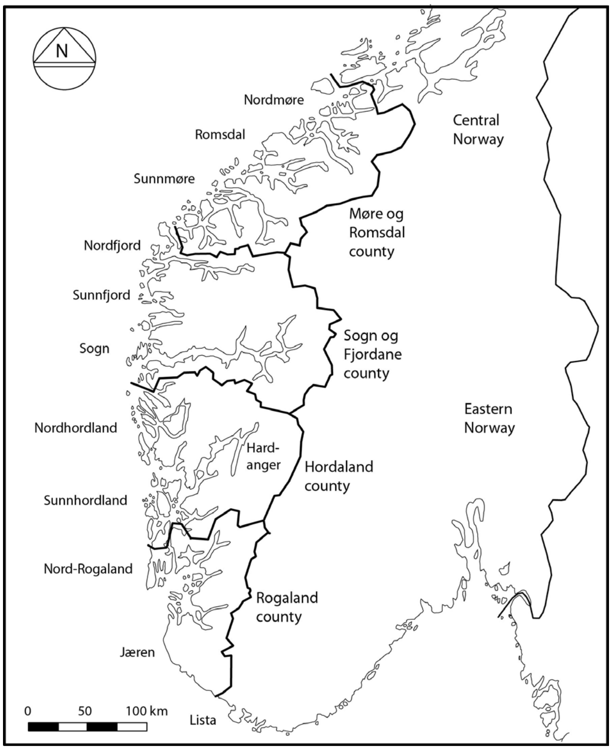


Figure 2. *Counties in western Norway (names to the right) and districts (names to the left) referred to in the text.*

Chronology

Since the sinkers are mainly found at residential sites, they are dated on the basis of radiocarbon determinations from the contexts in which they are found or from chronologically determined (lead) artefacts found in these contexts. With regard to dating, it is necessary to distinguish between small/middle sized and large soapstone sinkers.

The oldest site-contexts (or ^{14}C-dated layers at stratified sites) where small/middle sized sinkers occur are dated to around 5900 cal BC (Bjerck 1986; Olsen 1992:90) and the latest around 4500–4000 cal BC (Skjelstad 2003:91), which means that they were used for 1500 to 2000 years. According to chronological evaluations, they may have been particularly common around 5600–4700 cal BC (Olsen 1992:90, 91; Bergsvik 2002:290), however, this

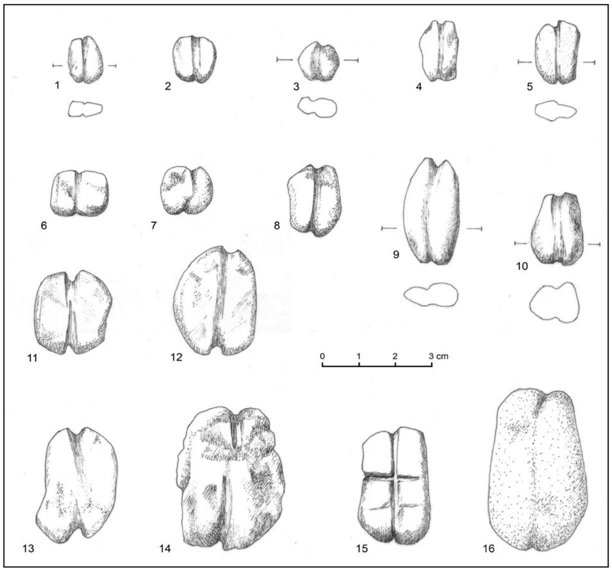


Figure 3. *Small (1–11) and middle sized (12–16) soapstone sinkers from Flatøy XI (1–10) and Flatøy I (11–16). Based on Bjørgo 1981, Figs 34 and 35. (Drawings: L. Gustafson).*

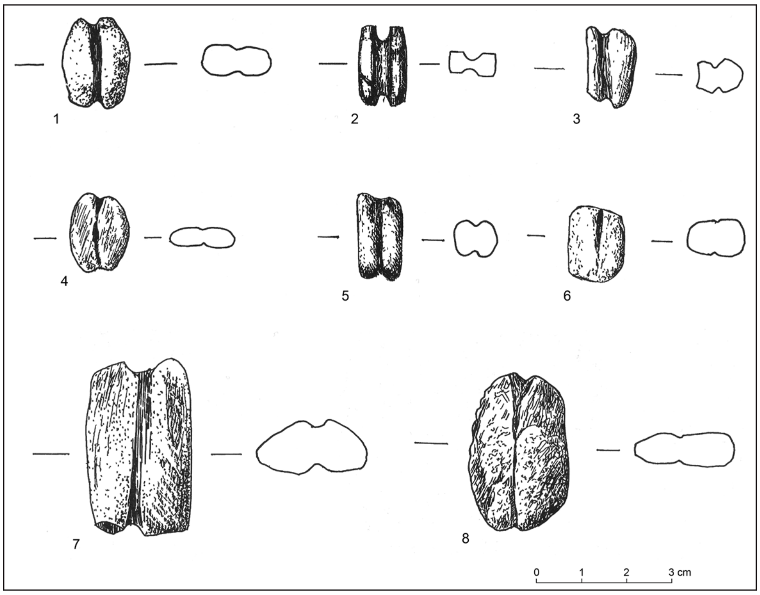


Figure 4. *Small soapstone sinkers from Kotedalen. Based on Olsen 1992, Figs 64 and 65. (Drawings: E. Hoff, University Museum of Bergen).*

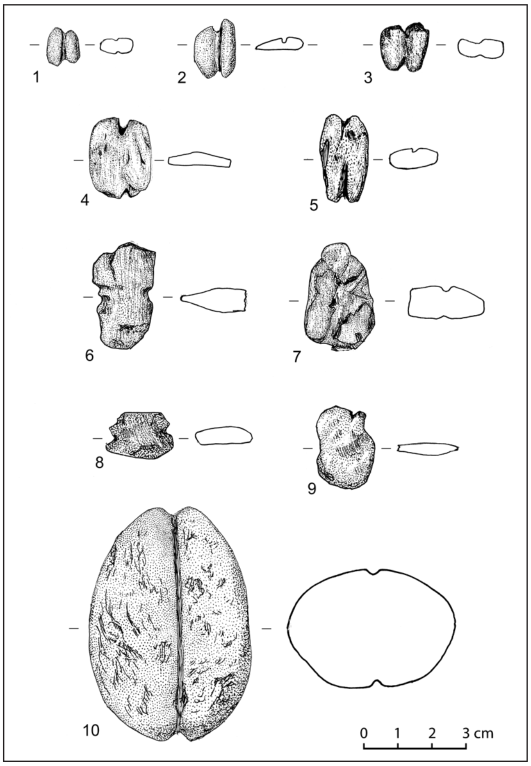


Figure 5. *Soapstone sinkers from 17 Havnen. Small sinkers (1–9) and large sinker (10). Based on Bergsvik 2002, Figs 186, 188 and 190. (Drawings: E. Hoff, University Museum of Bergen).*

needs to be confirmed by a broader set of data, a task which is beyond the scope of this contribution.

Concerning the large soapstone sinkers, there has been some insecurity in terms of dating. One problem is that large sinkers occur infrequently compared to the small specimen, which means that independently dated and reliable contexts are hard to find. Another problem is that most Mesolithic sites in western Norway have been reoccupied during the Neolithic, leading to possible stratigraphic disturbances. On the basis of the presence of large sinkers at the sites Sundet IV, Grønehelleren and Gloføyk in Sogn og Fjordane county, Bjørgo suggests that large sinkers may be dated to the early or middle Neolithic (Bjørgo 1981:82). However, these particular sites are problematic in different ways. In the case of Gloføyk, the sinkers were made of sandstone and gneiss, and are, therefore, not relevant for evaluating the use of soapstone for sinkers. In the two other cases, the sites had also Mesolithic material, which leaves the possibility open that the sinkers are stemming from that phase. Based on her discussion of sinkers at Mesolithic sites in western Norway, Guro Skjelstad concludes that large sinkers cannot be securely related to the Mesolithic phases (Skjelstad 2003:92). A different view is taken here, mainly based on information from the excavations of the stratified site 17 Havnen in Nordfjord. Here, altogether six large soapstone sinkers were found (Bergsvik 2002:290, 291). According to the detailed stratigraphic correlation of the site, three large sinkers were found in layers securely related to the Mesolithic phases 2a/2c (dated to c. 5500–5000 cal BC) and one was insecurely related to these phases. One large sinker was found in the stratigraphic contact zone between the Mesolithic and the Neolithic layers (phase 3); the sixth sinker was from an insecure context. When considering that no large (or small) soapstone sinkers have until now been found in securely dated Neolithic contexts, it is argued here that the data from 17 Havnen provides sufficient evidence for suggesting that the large soapstone sinkers are late Mesolithic, although the basis for this conclusion is admittedly weaker than for the small and middle sized sinkers.

Regional distribution, acquisition and provenance

As a part of her work on regional distribution of lithic raw materials in Mesolithic western Norway, Skjelstad mapped the frequency of soapstone sinkers (and debris) at 35 middle and late Mesolithic sites along the west coast (Skjelstad 2003) (Figure 6). Her analysis showed that small and medium sized soapstone sinkers are most common at sites between Nordfjord in the north to Nordhordland in the south (Skjelstad 2003:93, 109). It appears that they concentrate at coastal sites in these regions, but they have also been found at fjord sites (Bøe 1934; Bergsvik et al. 2016). Soapstone sinkers are less frequent in Sunnhordland and occur only sporadically at sites in Rogaland and Lista (Ballin & Jensen 1995:138, 156, 192; Skjelstad 2003). Occasional sinkers are also found at sites at Sunnmøre (Skjelstad 2003). Recent investigations of Mesolithic sites even further to the north, at Nyhamna in Romsdal, have resulted in a few soapstone sinkers (Åstveit 2008d:401). However, the majority of the sinkers at the site-complex at Nyhamna were made of other raw materials, such as gneiss and sandstone. The non-soapstone sinkers from these sites are also generally large specimen (Åstveit 2008c:271, 2008a:107, 2008b:135). Such large non-soapstone Mesolithic sinkers are also found in eastern Norway, (e.g. Mikkelsen 1975:79; Ballin 1998). As is evident from the above, small and medium sized soapstone sinkers have a relatively wide distribution pattern within western Norway, while large sinkers of this raw material are mainly found at sites in Nordfjord.

It is important to consider how the Mesolithic sinkers have been acquired and distributed in this large region. In principle, there are two main ways in which soapstone may have been procured: by collection at beaches/river beds and by quarrying, both through direct access. In addition, acquisition may have happened by indirect access through exchange networks. We know that stone materials were acquired in all of these ways during the Mesolithic (e.g. Nyland 2015).

Concerning collection, ice-dropped flint and other raw materials were regularly collected at beaches during this period. This alternative is, however, problematic for soapstone. The main reason is that its softness makes it unlikely that it would have survived very long at beach deposits or as transported material during the Ice Age (personal communication with geologist Øystein J. Jansen). Quarrying from bedrock outcrops is more likely to have happened. During this period, it is well attested that quarrying of quartz crystal, quartz, chalcedony and basaltic rocks took place in this region (e.g. Olsen & Alsaker 1984; Nyland 2015). Some of these raw materials, such as quartz and quartz crystal, occur very frequently in the bedrock. Concerning the basalts diabase and greenstone, quarries have been identified and archaeological-geological provenance-studies have been successfully performed, which have connected adzes to specific quarries. These studies show

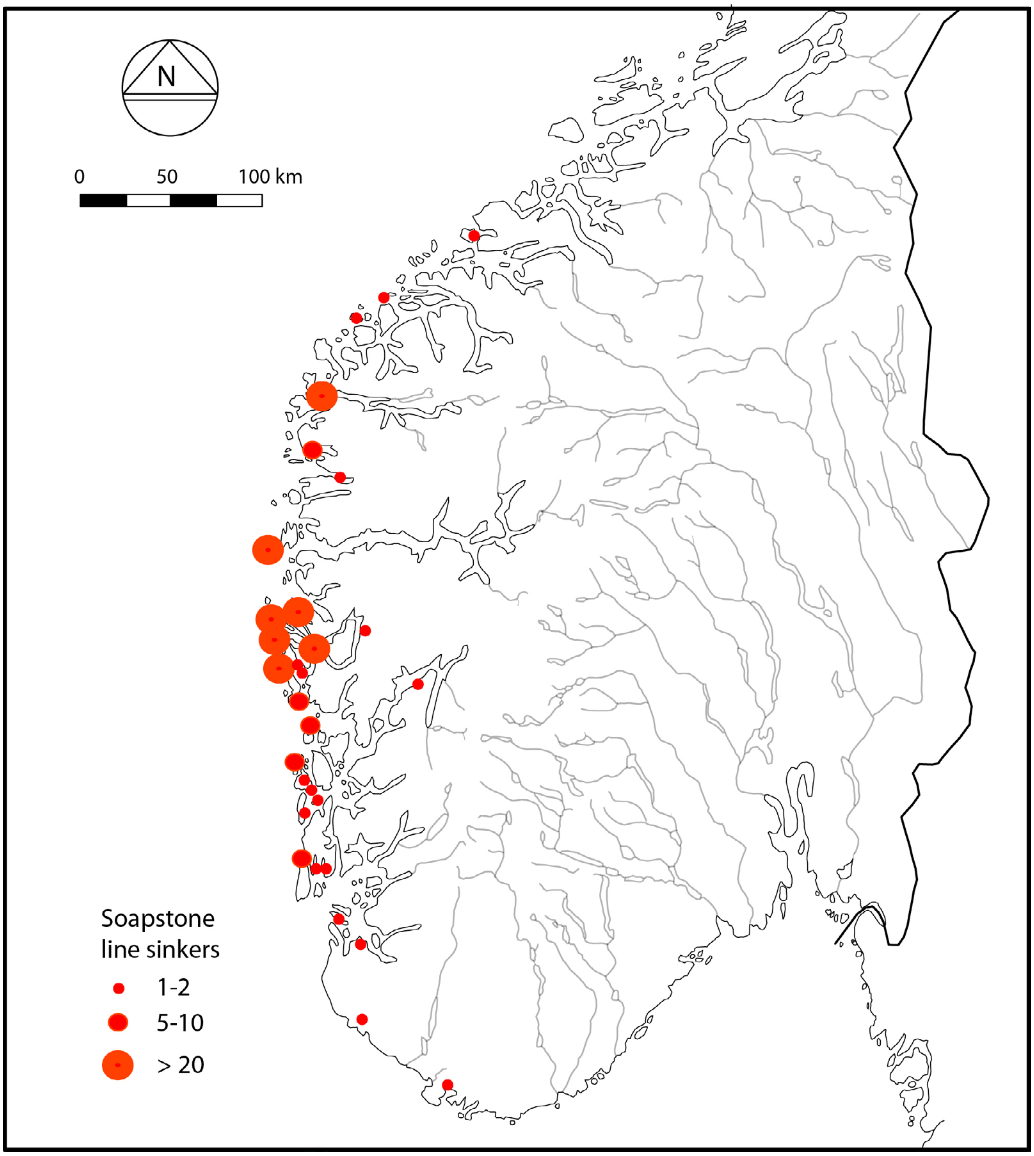


Figure 6. *Distribution of Mesolithic soapstone line sinkers in southern Norway. The map is based on Skjelstad (2003: Fig. 29) and her analyses of data from 35 Mesolithic sites in in western Norway (the counties Sunnmøre, Sogn og Fjordane, Hordaland and Rogaland). Sinkers from three other excavations have been added to Skjelstad's map: Farsund at Lista (Ballin & Jensen 1995), Nyhamna in Romsdal (Åstveit 2008d) and Herand, Hardanger (Bergsvik et al. 2016).*

a marked concentration of adzes around the quarries, interpreted as the result of direct access, and also remarkably long-distance distributions, interpreted as the results of exchange relations (Olsen & Alsaker 1984; Bergsvik & Olsen 2003).

Until now, Mesolithic soapstone in western Norway has not been subject to provenance studies by means of geology, and quarries from this period have not yet been identified. Nevertheless, later soapstone quarries in Norway are relatively well mapped, and one may get a general idea of the type of acquisition by regarding the correlation of the distribution of these quarries with the distribution of soapstone at the residential sites. As shown in the map (Figure 7), soapstone quarries are numerous in Hordaland and Sogn og Fjordane counties. They occur much less frequently in Rogaland and are also rare at the coast of Møre og Romsdal. These quarries are arguably dated back to later ages (Iron Age and Medieval periods), but the frequency of quarries is nevertheless indicative of the frequency of soapstone outcrops in the bedrock. Thus, regarding the distribution patterns of outcrops and sinkers of soapstone (Figures 6 and 7), a reasonable suggestion might be that the marked concentration of sinkers at sites in Hordaland and Sogn og Fjordane counties is connected to the availability of soapstone in the bedrock of that particular region and that the fall-off is explained by a lack of such outcrops. This means that there was a relationship between the frequency of sinkers at the residential sites and the degree of availability in the local bedrock.

The question of provenance may be approached also from the residential sites. According to Skjelstad's study, quite a few soapstone flakes were identified at the sites Engebø in Naustdal, Sunnfjord, and the phases 2a and 2c at site 17 Havnen in Nordfjord (Skjelstad 2003). In addition to Skjelstad's sites, the site Gisøy I at Bømlo, Sunnhordland also yielded a fair amoumt of soapstone flakes from production of sinkers (Kristoffersen 1990:75). This indicates that outcrops were present nearby in these cases. As seen in Figure 7, quarries were surveyed in Sunnfjord and Sunnhordland, and several prehistoric soapstone vessel quarries are known from the area in the vicinity of 17 Havnen (Bergsvik 2002:65). But these three sites are exceptions. In the large majority of Skjelstad's sites – even in the main area of distribution of the sinkers – there is very little soapstone debris; in addition to the sinkers themselves, there are usually just 4–5 pieces of soapstone without traces of cutting or working in the analysed site assemblages.

In contrast, at the same Mesolithic residential sites, other tools such as projectile points and scrapers are usually accompanied by large amounts of debris of raw materials of quartz, quartzite or mylonite (Skjelstad 2003). These raw materials were probably collected or quarried by the users themselves in several different local outcrops (Nyland 2015).

A corollary of the above might therefore be that only a few soapstone outcrops were quarried during the Mesolithic, even if many such outcrops existed in western Norway. As was the case with adzes of diabase and greenstone during this period (cf. Olsen & Alsaker 1984), soapstone blanks may have been brought directly to the residential sites from the workshops close to the quarries or exchanged further as finished or nearly finished products from these workshops. This would leave very little soapstone debris at the sites, even if the objects as such were common. A question, however, is if the production of soapstone can be compared directly with that of flint or quartz. Even if soapstone production was occurring at the residential sites, there may be very little debris left to be identified by archaeologists. Until now, no experimental work has been performed on this topic, but based on ordinary practical insight, one could expect that a large portion of the soapstone roughouts or blanks brought to the sites could actually be transformed into smaller or larger sinkers, and that this would leave very little waste (some of the roughly formed sinkers at 17 Havnen are examples of this). Furthermore, sinker production was probably carried out by a sharp lithic flake or a blade, perhaps in combination with the use of a grinding stone. As a result, only powder and very small pieces of

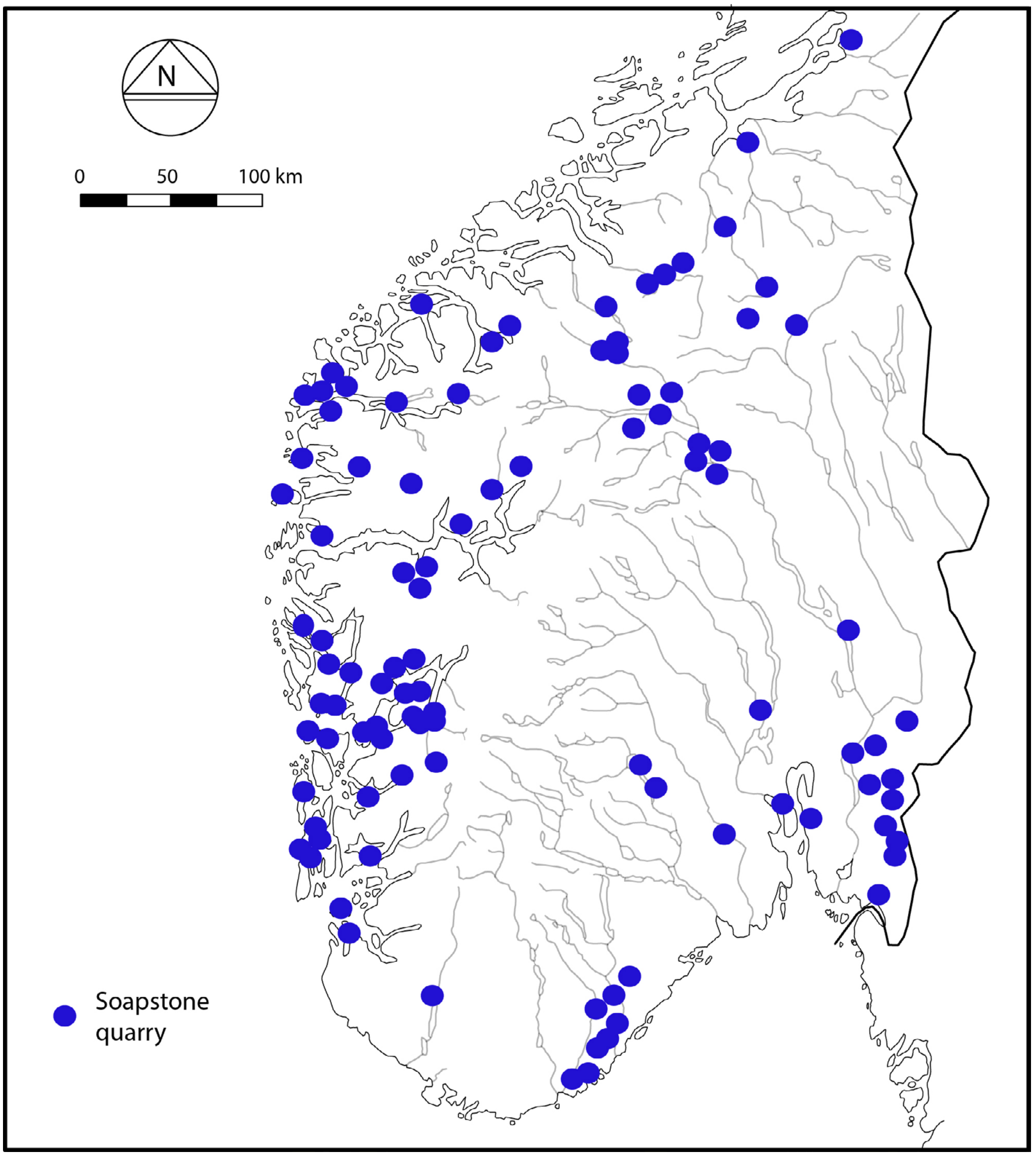


Figure 7. *Distribution of prehistoric and early historic soapstone quarries in southern and central Norway. Based on results of advanced search on the entry 'kleberbrudd' in the database of protected heritage monuments in Norway, 'Askeladden': https://askeladden.ra.no. [accessed 1 December 2016].*

soapstone would be left in the working place. Finally, small as well as larger pieces of soapstone with no furrows or notches are sometimes hard to distinguish from other 'natural' stones, which occur in large quantities at most Stone Age sites. A good portion of waste from the production of soapstone artefacts may, therefore, not have been recognised during fieldwork and was disposed of after sieving. Compared to other lithic waste material such as quartz, quartzite and mylonite, soapstone waste may therefore be somewhat underrepresented at Mesolithic residential sites.

Considering the above, it is likely that soapstone was quarried and acquired by means of direct access to the quarries by the users. This seems at least to be a likely alternative in the main distribution area of soapstone between Nordfjord and Sunnhordland, where the largest number of outcrops is located. To the north and south of these areas, other processes may have been at work: here, soapstone may also have been acquired through exchange networks.

Functions

There has been some disagreement about the functions of the sinkers. Some have suggested that they served as decoration and pendants (Bøe 1925; Bøe 1934; Bakka 1964:40; Åstveit 2008d:402). In support for this interpretation is the fact that several of them have ornaments. Many of the complete specimens are also elegantly shaped. Furthermore, during this period soapstone was also used for animal figures and shafthole hatchets, for which the 'practical' aspects are less evident (Bergsvik 2002:121; Skår 2003). This might mean that the raw material soapstone in itself was considered relevant for other tasks than just practical work. Against this interpretation one may argue that a good portion of the pieces are not elegant at all; some are coarsely made and others are scantily worked beyond a coarse furrow (e.g. Figure 5, no. 6–9), indicating that these artefacts primarily had practical areas of use. Another argument in favour of them being tools is that the artefacts have been found spread on the floor of the excavated sites in the same manner as lithic tools and refuse from the production of such tools. If they mainly served decorative ends, one would perhaps expect that they had been deposited differently than these artefacts, for example as intentionally placed deposits at the residential sites or in ritual contexts. Supporting the theory of the items being used as sinkers is that they only occur at residential sites at the coast. None are found at Mesolithic sites at the mountain plateaux, where one would expect that the need for decoration would be no less than in the lowland. As has been pointed out by Bjørgo (1981:113), the coastal sites where sinkers are found are clearly oriented towards the marine environment, and the specific locations of the sites in areas favourable for fishing suggest that this was an important activity. A few sites with preserved bones from a large variety of fish-species confirm that this was the case (Jansen 1972; Hufthammer 1992; Senneset & Hufthammer 2002; Bergsvik et al. 2016). It seems therefore reasonable to interpret these artefacts mainly as sinkers used for fishing. This is not, however, in conflict with the fact that some of them have ornaments and that such ornaments have had symbolic significance.

A question is if the soapstone sinkers were net-sinkers or line-sinkers. Remains of nets have been found at several Mesolithic sites in Europe (e.g. Gramsch & Kloss 1989; Andersen 2013:217), and contacts towards these areas may suggest that net-fishing was known and practiced also in western Norway. Some of the large non-soapstone sinkers from the sites at Nyhamna have relatively broad furrows for attachment of a rope, and Leif Inge Åstveit argues that they may have been used as parts of nets or fish traps. He suggests that the large soapstone sinkers from 17 Havnen may have been used in the same fashion (Åstveit, 2008a:107). While this may be a likely interpretation, a problem is that, until now, no nets have been found in Norway, so this alternative cannot yet be substantiated.

Line fishing has been, on the other hand, positively identified. The most important evidence for

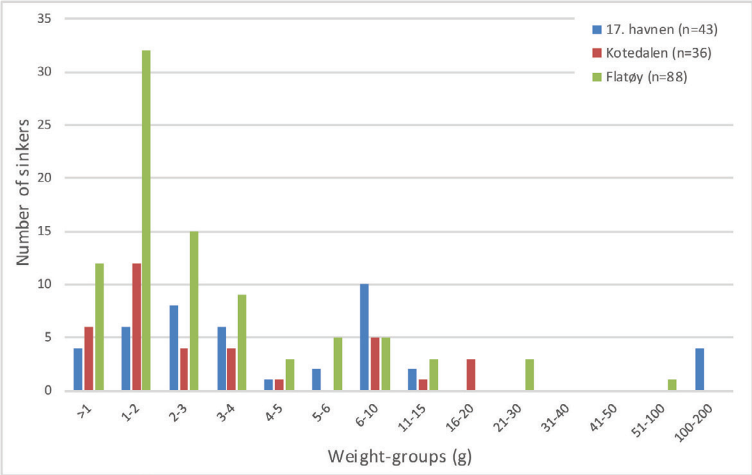


Figure 8. *Weight-groups of soapstone line-sinkers from the sites 17 Havnen, Kotedalen, and Flatøy. Only complete specimens were weighed. Data from Flatøy and Kotedalen are from Bjørgo (1981:110) and Olsen (1992:92). The sinkers from 17 Havnen were weighed for this work.*

Figure 9. *Soapstone line sinker (1) and fishhooks (2–17) from the rockshelter site Olsteinhelleren. (Photo: S. Skare, University Museum of Bergen).*

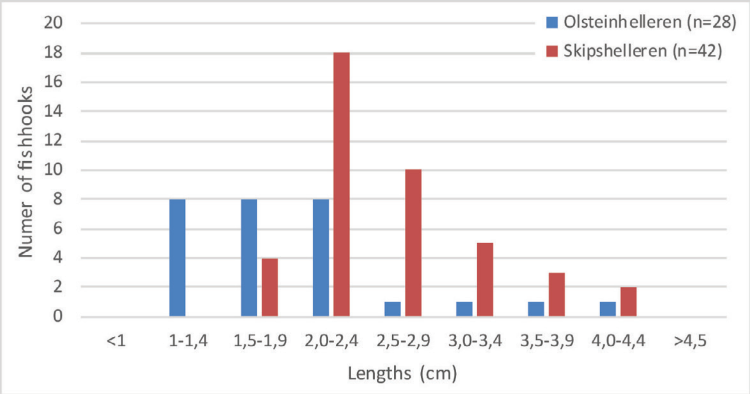


Figure 10. *Lengths of bone fishhooks from the rockshelter sites Olsteinhelleren and Skipshelleren. Many of the hooks found at these two sites had been broken during production or use, often at the bottom of the bow. Only hooks where the stem was preserved from the tip to the bow were measured.*

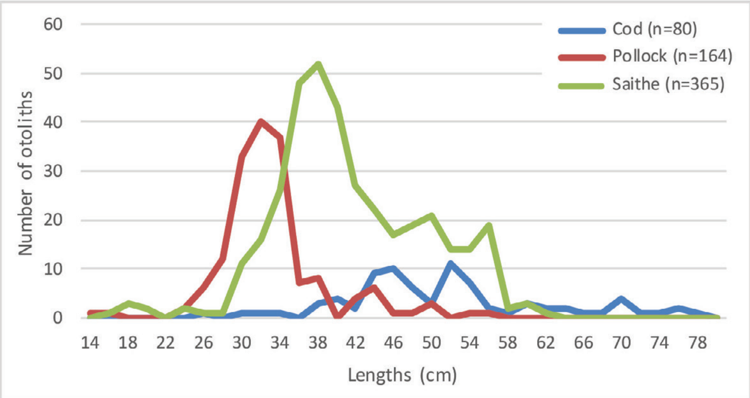


Figure 11. *Lengths of the fish species cod (Gadus morhua), pollock (Pollachius pollachius) and saithe (Pollachius virens) based on measurements of otoliths from the site Olsteinhelleren. (Data extracted from Ritchie et al. 2016).*

this is the large number of bone fishhooks found at the residential sites with preservation conditions for bone material (Brøgger 1908; Bøe 1934; Lund 1951; Jansen 1972; Olsen 1992; Bergsvik et al. 2016). These fishhooks were attached to a line and they would need a weight to bring them down in the water. Bjørgo has argued that the small sinkers found at the Flatøy sites were used for this purpose. The argument is based on weights of the 106 Flatøy sinkers, which correspond fairly well with the lower weight-classes of small modern sinkers made from lead (2.18 g, 3.66 g and 7.20 g), which are today used for fishing with a rod or for trolling (Bjørgo 1981:111). It can be argued that this modern parallel is not entirely relevant, because the degree of updrift of modern nylon lines may be different from that of the Mesolithic lines. This may be the case with iron hooks compared to hooks of bone, and these two factors might influence the overall weight situation. It nevertheless shows that small sinkers are important fishing devices even today. For comparative purposes, weighing has also been performed on the assemblages from the sites Kotedalen (Olsen 1992:92; Warren 1994:178) and 17 Havnen. Sinkers show a marked co-variation with those from Flatøy. Common for the three sites is that the large majority of sinkers weigh between 0.5 and 10 g and that that there is a marked concentration of sinkers weighing around 2–3 g. In the case of 17 Havnen, there is also a concentration around 7–8 g, and at that site there is, as already mentioned, also a group of large sinkers weighing around 150–200 g (Figure 8).

If the sinkers were really used with a hook and a line, one would expect that these dominating weight-classes were reflected in similar concentrations in the size-groups of the fishhooks as well as of the fish itself. For the purpose of this work, measurements were performed of the (unburned) Mesolithic bone fishhooks from two different rockshelter-sites in the Hordaland County: Skipshelleren (Bøe 1934) and Olsteinhelleren (Bergsvik et al. 2016). The measurements show that at both sites, the lengths of the hooks (measured from the point of the stem to the bottom of the bow of the hooks) vary between 1.5 and 4.5 cm (Figures 9 and 10). The hooks from Olsteinhelleren are slightly smaller than the ones from Skipshelleren, however, most of the hooks, from both sites, are less than 3 cm long. At both sites, small soapstone sinkers were retrieved. Admittedly, Skipshelleren and Olsteinhelleren are short-term fjord sites and might not reflect the size variation of hooks that one could expect at the larger coastal open-air sites such as Kotedalen, the Flatøy sites, and 17 Havnen. A problem is that only one of these sites, Kotedalen, has a fair amount of fishhooks. Due to burning, they cannot be measured with the same precision as hooks from the shelter-sites above. However, even considering a larger degree of fragmentation, they clearly fit into the same pattern as the rockshelter sites (see Olsen 1992:162, Fig. 90). This probably means that the small hooks dominate the assemblages at large coastal sites as well as at the fjord sites. Concerning the sizes of the fish, Anne Karin Hufthammer (1992:50) argues that the Mesolithic assemblages from Kotedalen are dominated by young specimen of saithe (*Pollachius virens*). This fish was also the most common catch at the site Olsteinhelleren in the Hardanger Fjord (Ritchie et al. 2016). Here, measurements of otoliths of saithe show lengths varying between 16 and 62 cm. The majority of the saithe caught at this site, however, were between 34 and 42 cm long. These are small sizes of saithe (2–3 years old), which measure up to 120 cm at the maximum. Similar measurements of otoliths from other gadids at the site, cod (*Gadus morhua*) and pollock (*Pollachius pollachius*), mainly confirm this result (Figure 11). A fair amount of labrids were also found. These are also small and they move close to the shore. It may be added that the one soapstone sinker found at the site Olsteinhelleren weighed 1.2 g (Figure 9). On the basis of these data, it seems evident that the main weight groups of the sinkers correspond well with the sizes of the bone fishhooks and the sizes of the main fish species that were consumed at the sites. The close correspondence between the three classes of data strongly indicates that the main function of the soapstone sinkers was to be attached to a line together with bone fishhooks.

An implication of this result is that fishing in western Norway during the late Mesolithic period was dominated by fishing in shallow waters. The main targets were relatively small specimen which could be caught with a line from a boat close to the shore or with a rod from the shore itself. This is in line with the observations made on Mesolithic fisheries in a wider European context (Pickard & Bonsall 2004). Occasionally, however, fishers moved their boats to deeper waters (but not necessarily off the coast), which would demand heavier tools. This is indicated by the presence of bones of a few deep-water species at the sites. At Olsteinhelleren, a bone of a sturgeon (*Acipence*r sp.) was found, in addition to ling (*Molva molva*), haddock (*Melanogrammus aegelfinus*) and tusk (*Brosme brosme*). Ling, haddock, tusk and redfish (*Sebastes marinus*) have also been identified in the Mesolithic faunal assemblages at Kotedalen. In terms of percentage, however, these species make up no more than c. 0.2% of the total amount of bones (NISP) identified to species levels at Olsteinhelleren (Bergsvik et al. 2016:23) and less than 0.1% at Kotedalen (Hufthammer 1992:50). As Hufthammer points out, this means that even if they preferred to fish in shallow waters, they also possessed the technology for deep-water fishing. This seems to be confirmed by the tool-kits which were uncovered at the sites; the occasional large bone-hooks and large soapstone sinkers were probably parts of a repertoire for deep-water line fishing.

Regional adjustments and differences

It is likely that the abundance of 2–3-year-old saithe, cod and pollock to a large degree determined how fishing was practiced. Because of a high expected return rate of these species, a significant share of the fishing technology, such as sinkers, lines, hooks and boats, was probably designed for and targeted towards maximising the catches of this group of fish. This pattern was probably relevant for the entire coast of western Norway. Nevertheless, there were clearly regional differences, even within the main distribution area of the small soapstone sinkers.

As pointed out above, the site 17 Havnen in Nordfjord has a large share of small line-sinkers similar to the sites further south. Bone fishhooks were not preserved at the site, but the few fish bone fragments identified at this site were of gadids (Senneset & Hufthammer 2002:328), which corresponds with the faunal data from Olsteinhelleren and Kotedalen. However, one difference compared to the sites in Hordaland is that large soapstone sinkers make up a fair share (around 14% of the total) at 17 Havnen. In line with the above reasoning, this could indicate that deep-water fishing accounted for a somewhat larger portion of the procurement strategies than at further south at the coast. This may have been related to differences in the local topography. The coastal topography in the outer part of Nordfjord is characterised by large islands, steep cliffs, relatively exposed coastlines and broad as well as deep stretches of water. Here, it may have been necessary to apply a broader variety of techniques, including deep-water kits with large sinkers. In contrast, the topography in Nordhordland is characterised by smaller, low-lying islands along channels and sounds in shallow and protected waters. In this region, it may have been sufficient to use smaller fishing gear in order to secure a reasonable return.

The assemblages in both Nordfjord and Nordhordland may thus be explained as part of the same basic system of procurement and technology for fishing, a result which in accordance with other types of data indicating extensive contact networks within a northern 'social territory' in Mesolithic western Norway (Olsen & Alsaker 1984; Skjelstad 2003). This means that the variations in sinker-use between the two districts are not expressions of cultural differences, but rather results of local adjustments to different circumstances offered by the natural topography.

Why, then, was there such a marked fall-off in the use of soapstone sinkers to the north towards Møre og Romsdal and to the south in Rogaland? And what about the total lack of soapstone line-sinkers at Mesolithic sites in eastern and central Norway? The communities along these coastlines seem to have relied on fishing as heavily as the groups in western Norway (Bjerck 2007, 2008). Being such a practical and convenient raw material, why did they not use soapstone for sinkers? This is particularly odd along the southernmost coast of Norway, where there were many outcrops of soapstone (Figure 7). For Møre og Romsdal and Rogaland, the explanation may be a general absence of soapstone in the local bedrock. This means that, unless people in these latter regions had direct access to the soapstone quarries or participated in exchange networks for soapstone, they had to find other solutions. Other data clearly indicate that long-distance networks covered these particular regions; stone adzes of diabase from a quarry in Sunnfjord are abundant in Møre og Romsdal and greenstone adzes quarried in Sunnhordland are frequent in Rogaland (Olsen & Alsaker 1984). However, considering the low number of soapstone sinkers present at residential sites in Rogaland and Møre og Romsdal sinkers were not particularly common goods in these networks. The reasons for this may be that soapstone sinkers did not possess the same symbolic value as the adzes, and perhaps also that the soapstone as a raw material for sinkers – unlike the diabase and greenstone for the adzes – was easily replaced by other rocks and other raw materials.

As can be seen at some of the Nyhamna sites in Møre and Romsdal, some naturally rounded stones of sandstone and gneiss were modified (grooves were made for the line) and used already during the latter part of the middle Mesolithic (Åstveit 2008a). There are certainly also aspects speaking in favour of using ordinary beach pebbles for sinkers, even in areas where soapstone is present in the local bedrock, such as in parts of northern and eastern Norway. The advantage with pebbles was that they did not need not be quarried; they could be found in large quantities at every beach along the coast in all kinds of sizes and forms. In many cases, there was also no need for modification; a line could easily be tied to hold on a stone with a fitting natural shape (e.g. Rønne 1989). Stones could also be wrapped in bark and connected to wooden rings. Such wheel-shaped (net) sinkers have been found in inland lakes in Norway and are dated to the late Iron Age and early Middle Age (Wammer 2016). However, unless the preservation conditions are good for unburned wooden material (which they almost never are) such sinkers with unmodified stones are not easily identified during excavations of Stone Age sites in Norway and are actually very likely to have been discarded by archaeologists.

The alternative of pebbles as sinkers is relevant also for the early and middle Neolithic in western Norway. In these later periods, fishing also represented a major element of the economy, and line-fishing was also common (Hufthammer 1992; Olsen 1992). However, the use of soapstone sinkers (or any tool of soapstone) came to an end during the transition to the Neolithic in western Norway. If sinkers were used during the Neolithic, they were made from other raw materials.

There may be many different reasons why people did not use soapstone for sinkers outside western Norway during the late Mesolithic. However, the fact remains that no such sinkers are found; the use of sinkers is a characteristic feature of the hunter-fisher groups in the west. Alongside a series of other traits (Bjerck 2008:101–102), this feature distinguishes them culturally from contemporary populations in central and eastern Norway, and should probably be seen as part of the development of regional groups in Scandinavia during this period.

Ornaments

Several of the sinkers also have notches on the sides, most often on both sides, and in varying numbers on each side (Figures 12 and 13). At a few specimens, the notches even continue as incised lines into the surface of the sinkers (Figure 12, no. 3 and 8), and in a few instances, these lines continue all the way to the more marked lengthwise furrow (Figure 12, no. 1). Microscopic studies indicate that the notches were ground by using a grinding stone or cut by using a blade or a flake of quartz, mylonite, or flint.

The other ornamental attribute is the presence of incised lines on the surface, either in the form of parallel lines or a net-pattern (Figures 14 and 15) (e.g. Jansen 1972:29; Bjørgo 1981:78; Ågotnes 1981:38; Olsen 1992:99; Nyland 2016:22). A rare type of surface decoration are parallel zig-zag lines with small perforations/holes between the lines (Åstveit 2008d:401) and at the large sinker found at Jæren, elaborate geometrical patterns occur, one of which is interpreted as a flatfish (Bang-Andersen 2009). The surface ornaments appear at notched sinkers as well as sinkers without notches. Similar to the notches, these thin lines were most likely made with a sharp stone tool.

None of the above ornamental attributes are common. Concerning notches, the following is noted at the three sites: Flatøy: 10/106, Kotedalen: 2/49, and 17 Havnen: 3/43, which means that between 4 and 9% of the sinkers have notches in the main distribution area. An even smaller share of the sinkers (2–3%) have incised lines (Flatøy: 4/106, Kotedalen: 1/49). None of the sinkers from 17 Havnen in Nordfjord had surface incisions.

Notches and incised lines thus seem to have different patterns of regional distribution. Skjelstad (2003:92) observes that while the notched sinkers are found at sites between Nordfjord and Sunnhordland, incised lines/nets have an even more narrow distribution in Sogn and Nordhordland.

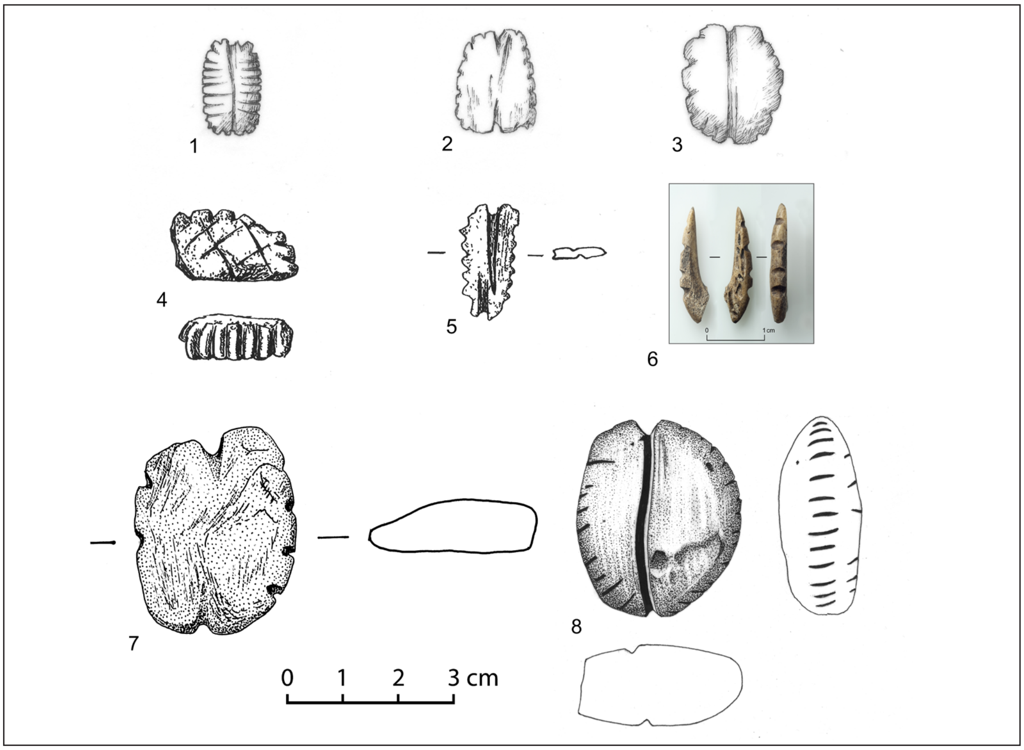


Figure 12. *Soapstone sinkers with notches from the sites Flatøy XII (1, 2), Flatøy II (3), Kotedalen (4, 5), 17 Havnen (7) and Vindenes 101 (8). The fishhook with notches (6) is from the site Olsteinhelleren. Based on Bjørgo (1981, Figs 34 and 36), Olsen (1992, Fig. 64), Bergsvik (2002, Fig. 188) and Ågotnes (1981, Fig. 14). Drawings by L. Gustafsson, E. Hoff, & L. Tangedal. (Photo: S. Skare, University Museum of Bergen).*

The sinker with zig-zag lines and dots is, on the other hand, found in Romsdal, albeit only on one single specimen.

Notches are also found on other Mesolithic artefact-types from this region, for example on pendants/flutters (Lund 1951:pl. IX, 12) or on stone shafthole-hatchets (Skår 2003:67pp).

There is an interesting parallel between the bone fishhooks and the line-sinkers, since these two artefact-types were used together and they both have notches. The fishhooks have notches along the external side of the stem (e.g. Brøgger 1908; Bøe 1934; Lund 1951; Olsen 1992), and their numbers vary between one and eight (e.g. Figure 9), and they are found on 50–70% of the hooks. Microscopic examinations show that these notches have been ground with a thin grinding stone (Bergsvik & David 2015). It is somewhat uncertain whether there is a symbolic connection between this ornamental element at the two different artefact-types and whether they actually were ornaments. In the case of the fishhooks, the notches may have served for attaching the line, although it seems odd that there sometimes were as many as eight notches covering the entire stem of the hook. This indicates that their significance extended beyond the practical. For the sinkers, the notches hardly served practical purposes, considering that all of the sinkers with notches also have furrows which seem to have been made solely for attaching a line to the sinker.

Incised lines are also found at other artefact-types. An interesting parallel in Mesolithic western Norway is an awl made from a split limb bone of a large ungulate from the site Skipshelleren (Figure

Figure 13. *Soapstone sinker with notches from the site Flatøy XII. (Photo: S. Skare, University Museum of Bergen).*

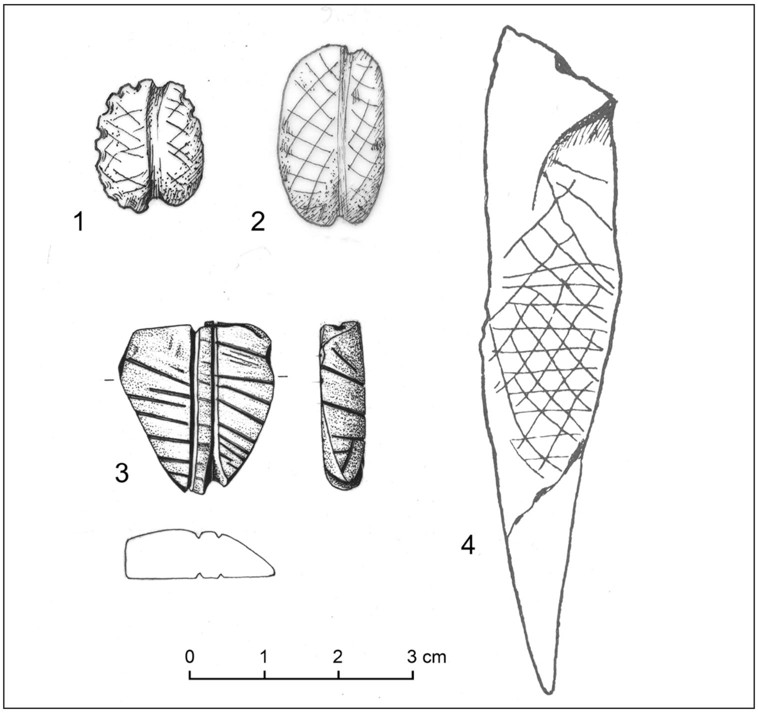


Figure 14. *Soapstone sinkers with incised lines and nets at the surface from the sites Flatøy II (1, 2) and Vindenes 101 (3). The bone awl with net ornaments (4) is from the site Skipshelleren. Based on Bjørgo (1981, Fig. 34), Ågotnes (1981, Fig. 14), and Bøe (1934, plate VII). (Drawings: L. Gustafson & L. Tangedal.).*

Figure 15. *Soapstone sinkers with net ornaments from the sites Flatøy XII (above) and Grønehelleren (below). (Photo: S. Skare, University Museum of Bergen).*

14, 4). As is the case with notches, this decorative pattern is also found at shafthole-hatchets – many made of soapstone – in this region (Skår 2003). However, even if the above patterns were common ornamental features amongst the western populations, these groups were not the only ones that used them, and they were far from the first. Instead, the patterns are widespread traits. Surface incisions are present on a recently published Mesolithic sandstone pendant from eastern Norway (Schülke & Hegdal 2015), and incisions as well as notches occur on a variety of stone/antler/bone artefacts from Mesolithic northern Europe (e.g. Nash 1998; Płonka 2003). Furthermore, the element of incised lines is present on several different Stone Age assemblages throughout the world, for example on artefacts belonging to the Clovis culture in North America (Lemke et al. 2015) and on ochres from middle Stone Age layers in the Blombos cave in South Africa. It is thus one of the earliest examples we have for human symbols (Henshilwood et al. 2009).

This is not the place for discussions of the symbolic significance of the notches and the incised lines on the Mesolithic soapstone artefacts in western Norway. However, on a general level, since the ornaments turn up independently in so many different hunter-gatherer cultures, they should probably be seen as products of common human cognitive structures and as results of the basic need that many humans have for expressing themselves symbolically on material objects. And it is easy to understand why soapstone was chosen for making these particular ornaments. Soapstone possesses some immediate and attractive qualities, such as softness, 'fat' consistency and sometimes plain surfaces. For a Mesolithic man or woman with a stone knife it would surely have been tempting to shape it, to cut it and to decorate it with notches and patterns.

Conclusions

This paper is an attempt to present an overview of the soapstone line sinkers in Mesolithic western Norway in a comparative perspective, and to discuss their role for fishing in this period. Although the artifact-type is well-known and has received much scholarly attention through the years, it has, until now, not been fully treated on its own terms. The above discussions have dealt with five different aspects of the sinkers: chronology, acquisition and provenance, function, regional differences and ornaments. A distinction was made between small sinkers (1–10 g) middle sized sinkers (10–50 g) and large sinkers (50–200 g). It appears that sinkers of all these weight-groups were used during the late Mesolithic in western Norway, between 5900 and 4000 cal BC. However, while large sinkers are mainly present at residential sites in Nordfjord, the main distribution area of the small and middle sized sinkers is between Nordfjord and Nordhordland. In this area, there are numerous bedrock outcrops of soapstone, and it is argued that the raw material was quarried from these outcrops by means of direct access. Soapstone sinkers are only minimally present at sites to the south and north of the main distribution area, which corresponds fairly well with the lower number of outcrops in these regions. Concerning the functions of the sinkers, a comparative analysis was made between measurements of the weights of the sinkers, the lengths of the bone fishhooks and the sizes of the otoliths of the most important fish species caught (gadids). The corresponding results of these measurements strongly indicate that the sinkers were line-sinkers. A similar function may also be the case for the large sinkers, although for them, other functions may have been relevant. A small percentage of the sinkers have ornaments, either as notches along the sides or as incised parallel lines or rhombic patterns on the surfaces.

Acknowledgements

I would like to thank Astrid Nyland for valuable comments on a previous version of the article and Per Viggo Bergsvik for help with the illustrations.

References

Andersen, S. H. 2013. *Tybrind Vig. Submerged Mesolithic settlements in Denmark.* Jutland Archaeological Society, Århus.

Bakka, E. 1964. Steinaldergranskingar i Nordhordland 1960–63. *Frå Fjon til Fusa. Årbok for Nord- og Midthordland Sogelag* 1964, 9–42.

Ballin, T. B. 1998. *Oslofjordsforbindelsen. Arkæologiske undersøgelser ved Drøbaksundet.* Varia 48. Universitetets Oldsaksamling, Oslo.

Ballin, T. B. & Jensen, O. L. 1995. *Farsundprosjektet – steinalderbopladser* på Lista. Varia 29. Universitetets Oldsaksamling, Oslo.

Bang-Andersen, S. 2009. Evig eies kun det tapte – med alle sine hemmeligheter. Refleksjoner rundt en gjenstand av klebestein funnet ved Håelva på Jæren. In Nitter, M., & Pedersen, E. S. (eds) *Tverfaglige perspektiver.* AmS-Varia 49, 75–86. Arkeologisk museum, Universitetet i Stavanger, Stavanger.

Bergsvik, K. A. 2002. *Arkeologiske undersøkelser ved Skatestraumen. Bind 1.* Arkeologiske rapporter og avhandlinger 7. Bergen Museum, University of Bergen. Bergen.

Bergsvik, K. A. & David, É. 2015. Crafting bone tools in Mesolithic Norway, a regional eastern-related knowhow. *European Journal of Archaeology*, 18 (2), 190–221.

Bergsvik, K. A., Hufthammer, A. K. & Ritchie, K. 2016. The emergence of sedentism in Mesolithic Western Norway: a case-study from the rockshelters of Sævarhelleren and Olsteinhelleren by the Hardanger fjord. In Bjerck, H. B., Breivik, H. M., Fretheim, S. E., Piana, E. L., Skar, B., Tivoli, A. M. & Zangrando, A. F. J. (eds) *Marine Ventures – Archaeological Perspectives on Human-Sea Relations*, 15–33. Equinox, Sheffield.

Bergsvik, K. A. & Olsen, A. B. 2003. Traffic in Stone Adzes in Mesolithic Western Norway. In Larsson, L.,

Kindgren, H., Knutsson, K., Loeffler, D. & Åkerlund, A. (ed.) *Mesolithic on the move*, 395–404. Oxbow Books, Oxford.
Bjerck, H. B. 1986. The Fosna-Nøstvedt problem. A consideration of archaeological units and chronozones in the south Norwegian Mesolithic period. *Norwegian Archaeological Review*, 19 (2), 103–21.
Bjerck, H. B. 2007. Mesolithic coastal settlements and shell middens (?) in Norway. In Milner, N., Craig, O. E. & Bailey, G. N. (eds) *Shell Middens in Atlantic Europe*, 5–30. Oxbow Books, Oxford.
Bjerck, H. B. 2008. Norwegian Mesolithic Trends. A review. In Bailey, G.N. & Spikins, P (eds) *Mesolithic Europe*. 60–106. Cambridge University Press, New York.
Bjerck, H. B. 2014. Tidlige fangstsamfunn i stein- og bronsealder. In Kolle, N. (ed.) *Norges fiskeri- og kysthistorie. Bind 1*, 45–117. Fagbokforlaget, Bergen.
Bjørgo, T. 1981. Flatøy. Et eksempel på steinalderens kronologi og livbergingsmåte i Nordhordland. Unpublished mag. art. thesis, University of Bergen, Bergen.
Bjørn, A. 1921. *Træk av Søndmørs stenalder.* Bergens Museums Årbok 1919–20. Historisk-antikvarisk række nr. 4. Bergens Museum, Bergen.
Bøe, J. 1925. *Bergens Museums tilvekst av oldsaker 1924*. Bergens Museums Aarbok 1924–25. Bergens Museum, Bergen.
Bøe, J. 1934. *Boplassen i Skipshelleren på Straume i Nordhordland.* Bergens Museums Skrifter nr. 17. A.S. John Griegs Boktrykkeri, Bergen.
Brøgger, A. W. 1908. *Vistefundet, en* ældre *stenalders kjøkkenmødding fra Jæderen.* Stavanger Museum, Stavanger.
Gramsch, B. & Kloss, K. 1989. Excavations near Friesack: an early Mesolithic marshland site in the northern plain in central Euope. In: Bonsall, C. (ed.) *The Mesolithic in Europe. Proceedings of the 3rd international symposium*, 313–324. John Donald, Edinburgh.
Gustafson, L. & Hofseth, E. H. 1979. Steinalderfangstfolk ved Haglesundet. *Arkeo*, 1979 (1), 15–22.
Henshilwood, C. S., d'Errico, F. & Watts, I. 2009. Engraved ochres from the Middle Stone Age levels at Blombos cave, South Africa. *Journal of Human Evolution*, 57 (1), 27–47.
Hufthammer, A. K. 1992. De osteologiske undersøkelsene fra Kotedalen. In Hjelle, K. L., Hufthammer, A. K., Kaland, P. E., Olsen, A. B. & Soltvedt, E. C. (eds) *Kotedalen – en boplass gjennom 5000 år. Bind 2. Naturvitenskapelige undersøkelser*, 9–64. Historical museum, University of Bergen, Bergen.
Jansen, K. 1972. Grønehelleren, en kystboplass. Unpublished mag. art. thesis, University of Bergen, Bergen.
Kristoffersen, K. & Warren, E. J. 2001. *Kulturminner i trekant-traséen. De arkeologiske undersøkelsene i forbindelse med utbygging av Trekantsambandet i kommunene Bømlo, Sveio og Stord i Sunnhordland.* Arkeologiske rapporter og avhandlinger 6. Bergen Museum, University of Bergen, Bergen.
Kristoffersen, S. 1990. *FV 018 Austvik –Brandasund 1988–1990.* Arkeologiske rapporter 13. Historical museum, University of Bergen, Bergen
Lemke, A. K., Wernecke, D. C. & Collins, M. B. 2015. Early art in North America: Clovis and later Paleoindian incised artifacts from the Gault Site, Texas (41BL323). *American Antiquity,* 80 (1), 113–33.
Lund, H. E. 1951. *Fangstboplassen i Vistehulen.* Stavanger Museum, Stavanger.
Mikkelsen, E. 1975. *Frebergsvik: Et Mesolittisk boplassområde ved Oslofjorden.* Universitetets Oldsaksamlings Skrifter, Ny rekke nr. 1. Universitetets Oldsaksamling, Oslo.
Nash, G. 1998. *Exchange, Status and Mobility: Mesolithic Portable Art of Southern Scandinavia.* BAR International Series 710. Archaeopress, Oxford
Nordgaard, O. 1908. *Træk av fiskeriets utvikling i Norge.* Det Kongelige Norske Videnskabers Selskab, Trondhjem.
Nyland, A. 2015. Humans in motion and places of essence. Variations in rock procurement practices in the Stone, Bronze and Iron Age in Southern Norway. Unpublished Ph.D. thesis, University of Oslo, Oslo.
Nyland, A. 2016. Steinbruk i forhistorien og middelalderen. In Berg, B. I. (ed.) *Bergverk i Norge. Kulturminner og historie*, 15–32. Fagbokforlaget, Bergen.
Nærøy, A. J. 1994. *Troll-prosjektet. Arkeologiske undersøkelser på Kollsnes, Øygarden k., Hordaland, 1989–1992.* Arkeologiske rapporter 19. Historical museum, University of Bergen, Bergen.
Olsen, A. B. 1992. *Kotedalen – en boplass gjennom 5000 år. Bind 1: Fangstbosetning og tidlig jordbruk i vestnorsk steinalder: Nye funn og nye perspektiver.* Historical museum, University of Bergen, Bergen.
Olsen, A. B. & Alsaker, S. 1984. Greenstone and diabase utilization in the stone age of Western Norway: Technological and socio-cultural aspects of axe and adze production and distribution. *Norwegian Archaeological Review* 17 (2), 71–103.

Pickard, C. & Bonsall, C. 2004. Deep-sea fishing in the European Mesolithic: fact or fantasy? *European Journal of Archaeology* 7(3), 273–90.
Płonka, T. 2003. *The portable art of Mesolithic Europe.* Wydawniktwo Uniwersytetu Wrocławskiego, Wrocłav.
Ritchie, K., Hufthammer, A. K. & Bergsvik, K. A. 2016. Fjord Fishing in Mesolithic Western Norway. *Environmental Archaeology: The journal of Human Palaeoecology*, 21(4), 309–316.
Rønne, P. 1989. Sænkesten. *Skalk* 1989 (6), 21–24.
Schülke, A. & Hegdal, H. 2015. Et unikt mesolitisk anheng fra Brunstad i Vestfold. *Viking*, LXVIII, 27–46.
Senneset, K. & Hufthammer, A. K. 2002. Beinmaterialet fra boplassene ved Skatestraumen. In Bergsvik, K. A. (ed.). *Arkeologiske undersøkelser ved Skatestraumen. Bind 1.* Arkeologiske avhandlinger og rapporter fra Universitetet i Bergen 7, 325–331. Bergen Museum, University of Bergen, Bergen.
Skjelstad, G. 2003. Regionalitet i vestnorsk mesolitikum. Råstoffbruk og sosiale grenser på Vestlandskysten i mellom- og senmesolitikum. Unpublished cand. philol. thesis, University of Bergen, Bergen.
Skjelstad, G. 2011. Steinalderboplasser på Fosenhalvøya. AmS Varia 52. Arkeological museum, University of Stavanger, Stavanger.
Skår, Ø. 2003. Rituell kommunikasjon i seinmesolitikum. Unpublished cand. philol. thesis, University of Bergen, Bergen.
Wammer, E. U. 2016. Fjellfiske i grenselandet mellom fangstmark og jordbruksbygd i yngre jernalder og middelalder. In Mjærum, A. & Wammer, E. U. (eds) *Fjellfiske i fortiden.* Årtusener med svømmende rikdom,183–205. Portal, Kristiansand.
Warren, J. E. 1994. Coastal sedentism during the Atlantic period in Nordhordland, Western Norway? The middle and late Mesolithic components at Kotedalen. Unpublished master thesis, Memorial University of Newfoundland.
Ågotnes, A. 1981. Bosetningsmønster og livbergingsform i steinalderen i Vindenesområdet. *Frå Fjon til Fusa. Årbok for Nord og Midthordland sogelag* 1981, 7–63.
Åstveit, L. I. 2008a. Lokalitet 29 Fredly – Mellommesolittisk kulturlagslokalitet med bruksfaser fra MN-BA. In Bjerck, H. B., Åstveit, L. I., Meling, T., Gundersen, J., Jørgensen, G. & Normann, S. (eds) *NTNU Vitenskapsmuseets undersøkelser. Ormen Lange Nyhamna*, 93–118. Tapir akademisk forlag, Trondheim.
Åstveit, L. I. 2008b. Lokalitet 30 Fredly – Boplass med mesolittiske tufter og dyrkningsaktivitet i neolittikum/bronsealder. In Bjerck, H. B., Åstveit, L. I., Meling, T., Gundersen, J., Jørgensen, G. & Normann, S. (eds) *NTNU Vitenskapsmuseets undersøkelser. Ormen Lange Nyhamna*, 119–168. Tapir akademisk forlag, Trondheim.
Åstveit, L. I. 2008c. Lokalitet 50 Søndre Steghaugen. In Bjerck, H. B., Åstveit, L. I., Meling, T., Gundersen, J., Jørgensen, G. & Normann, S. (eds) *NTNU Vitenskapsmuseets undersøkelser. Ormen Lange Nyhamna*, 267–284. Tapir akademisk forlag, Trondheim.
Åstveit, L. I. 2008d. Lokalitet 68 Søndre Stegahaugen. In Bjerck, H. B., Åstveit, L. I., Meling, T., Gundersen, J., Jørgensen, G. & Normann, S. (eds) *NTNU Vitenskapsmuseets undersøkelser. Ormen Lange Nyhamna*, 393–421. Tapir akademisk forlag, Trondheim.

Internet sources

Askeladden: The Norwegian National Cultural Heritage Database: https://askeladden.ra.no/Askeladden/Pages/LoginPage.aspx?ReturnUrl=%2faskeladden

Tor Grenne, Bodil Østerås and Lars F. Stenvik

The Sandbekkdalen Quarry, Kvikne: A Window into Early Iron Age Soapstone Exploitation in Norway

The oldest known example of large-scale soapstone exploitation in Norway is found at Kvikne (south central Norway), where quarrying took place during the pre-Roman Iron Age (5th to 1st century BC). The quarry is located in a remote area at an altitude of nearly 1000 m ASL, and is untouched by Viking Age and medieval exploitation that was so extensive elsewhere in Norway. Excavations in the 1960s suggested a production of several thousand circular vessels. Later studies revealed a separate, large extraction area for angular and irregular blanks that were distinctly different but carved with similar adze-like tools. We speculate that the latter blanks were meant for forge-stones connected to the contemporary, large-scale exploitation and processing of bog iron. Radiocarbon dating results suggest that the circular and angular extractions represent early and late pre-Roman Iron Age phases of quarrying, respectively. The tool marks suggest that iron axes were used for soapstone extraction already from the earliest pre-Roman Iron Age. This nearly 500-year period of quarrying with a bladed tool technique is in marked contrast to the use of pointed tools in the Viking Age and later, in accordance with previous suggestions of a total break in soapstone vessel production during the Roman Iron Age and Migration Period. Similar production must have existed elsewhere in Norway in the pre-Roman Iron Age, but traces of the ancient quarrying were in most cases erased by the very extensive exploitation of soapstone in the Viking Age and later.

Background

In 1952, the Restoration Workshop of Nidaros Cathedral (NDR) started exploitation of soapstone at Sandbekkdalen (Figures 1 and 2) south of Kvikneskogen in the municipality of Tynset. Located 4 km west-southwest of the nearest settlement Bubakken at an altitude of 960 m ASL, well above the tree line in a desolate and barren mountain area, the quarry was worked during the summer season for various restoration purposes at the Cathedral (Storemyr 1997). In 1965, wooden spades found during removal of overburden were delivered to the Antiquarian Collection at the University of Oslo (UO – Universitetets Oldsaksamling). Several similar spades and fragments of soapstone vessels (Figure 3) were found during continued quarrying up until 1967 (Skjølsvold 1969:202−204). An early ^{14}C analysis gave a surprisingly high age of 2350±90 BP (Figure 4). The finds encouraged further investigations by Arne Skjølsvold in 1968−1969 followed by additional radiocarbon dating in 1969 that confirmed the pre-Roman Iron Age activity, including ^{14}C ages of wooden spades (2180±90 and 2310±70 BP), a worked trunk of birch (2440±70 BP), and a large piece of birch bark (2270±70 BP), the latter two items were apparently used to support waste heaps during quarrying (Skjølsvold

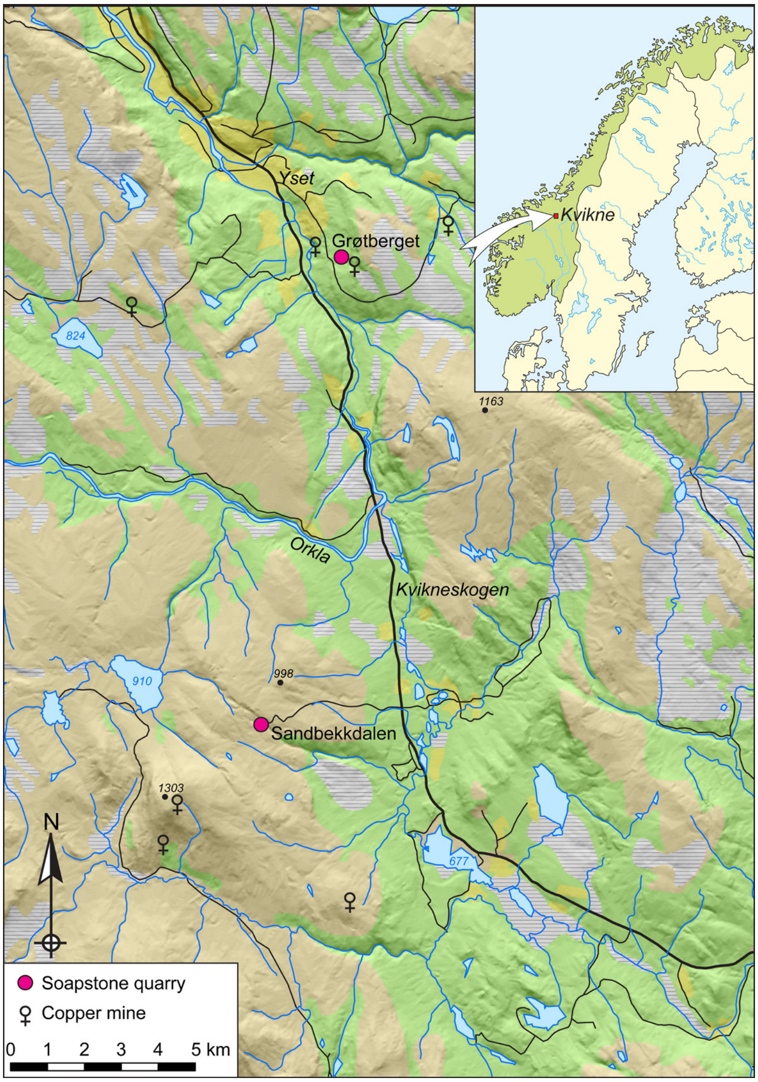


Figure 1. *Map of the Kvikne district with the location of the Sandbekkdalen soapstone quarry and other sites referred to in the text.*

1969:204, 235). Excavations revealed a large number of wooden spades (Figure 5), a low, bowl-shaped wooden vessel, a cup made of birch bark, two stone mauls, and fragments of relatively tall and narrow soapstone vessels with their greatest width well below the middle, the latter referred to as 'low-bellied' vessels (Skjølsvold 1969:206–210). The age estimates, ranging from late Bronze Age to pre-Roman Iron Age, made this the oldest documented example of large-scale soapstone exploitation in Norway.

By the late 1960s NDR quarrying had removed significant parts of the ancient quarry face in the southern and south-eastern parts of the soapstone body (Skjølsvold 1969:Fig. 8). Following the archaeological discoveries, UO demanded a halt to further production in 1969 based on the significance of the site as a unique monument of ancient stone extraction. Later, in the mid-seventies, the northern parts of the body – at that time unexposed and with no obvious sign of ancient quarrying

Figure 2. *Sandbekkdalen, view from the west. The southern quarry area excavated in 1969 is partly exposed on the lower right slope of the serpentinite knoll, while the northern quarry area studied in 2004 forms a flat at lower levels on the left. The irregular surface in the left part of the knoll is from modern block extraction by NDR.*

– were opened to new, limited production by NDR according to provisional permission from the UO. Subsequent discoveries of ancient quarrying also in this area again led to proscription of activity, and block extraction by NDR came to a complete halt in 1996. Limited geological and archaeological mapping was carried out in 2001−2004 (Grenne & Heldal 2002; Østerås 2004a), before most of the quarry faces were covered with soil for future conservation.

The soapstone deposit

Quarrying at Sandbekkdalen took place on a small lensoid body of ultramafic rocks, situated in a major geological unit commonly referred to as the *Gula Group* that otherwise comprises various schists and local amphibolites (Nilsen 1974). The ultramafic body, covering a surface of some 80 by 35 m, originally formed as a magmatic intrusion that crystallized to a relatively coarse grained mass of essentially olivine with some orthopyroxene and plagioclase feldspar. Later, the rocks were subject to deformation and metamorphism during the Caledonian orogeny, leaving the present zonal arrangement of fine-grained metamorphic assemblages (Figure 6).

The central part is a dark greenish serpentinite composed of flake-shaped to fibrous serpentine (antigorite) with minor amounts of intimately intergrown talc, chlorite, magnetite and carbonate

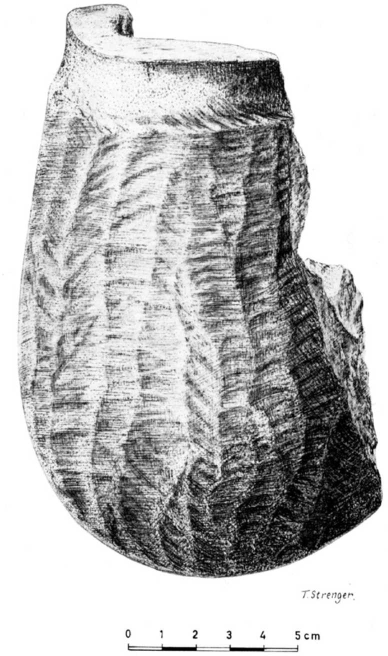


Figure 3. *Fragment of an excavated soapstone vessel. (After Skjølsvold 1969:Fig. 11).*

(Alnæs 1994:332, C7–3). Across a transitional zone of talc-rich serpentinite, this gives way to an outer zone of relatively dark grey soapstone composed essentially of Mg-carbonates (magnesite and subordinate dolomite), pale greenish chlorite, talc and trace amounts of opaque minerals (ilmenite and various sulphides), the talc forming a characteristic microcrystalline network of fibrous crystals. Except for local thin carbonate veins and a thin, peripheral zone of talc schist, the fine grained soapstone is massive, very homogenous and easily workable by fine carving, e.g. as required in ornamental stone for the NDR restoration works (Frigstad 1973:3, 6; Alnæs 1994:337; Storemyr 1997). The grey colour and fine grained texture makes the Sandbekkdalen soapstone rather unique in a Norwegian context (Frigstad 1973:6); most other ancient quarries are located in other geological units with soapstone that is either much lighter grey, coarser and more heterogeneous (e.g. North Gudbrandsdalen and Helgeland) or fine-grained but with a distinct green colour and abundant carbonate veins (e.g. Trondheim area and parts of western Norway) (Helland 1893; Karlsen & Nilsson 2000).

Figure 4. *^{14}C data for artefacts from Sandbekkdalen, Kvikne. Data for the piece of pelt were provided by the National Laboratory for ^{14}C- dating, Norwegian University of Science and Technology (project TUa-7315 DF4130) using the Uppsala accelerator laboratory; all other data are from Skjølsvold (1969). Calibrated ages and probabilities within 1σ and 2σ are calculated using OxCal (Bronk Ramsey 2009) version 4.2.3 with calibration curve from Reimer et al. (2013).*

Sample	^{14}C BP	Calibrated age	Probability	Calibrated age	Probability
		1σ		2 σ	
Worked trunk	2440±70	747 BC – 685 BC	17.9	768 BC – 403 BC	95.4
		666 BC – 642 BC	6.9		
		587 BC – 583 BC	0.94		
		556 BC – 410 BC	42.5		
Wooden spade	2350±90	737 BC – 688 BC	9.0		
		663 BC – 647 BC	2.8		
		548 BC – 357 BC	50.9	766 BC – 346 BC	81.0
		282 BC – 257 BC	4.1	321 BC – 206 BC	14.4
		245 BC – 236 BC	1.3		
Wooden spade	2310±70	481 BC – 441 BC	8.2	745 BC – 687 BC	4.1
		434 BC – 351 BC	34.1	665 BC – 644 BC	1.3
		301 BC – 210 BC	25.9	552 BC – 183 BC	90.1
Birch bark	2270±70	401 BC – 350 BC	25.3	517 BC – 161 BC	94.9
		309 BC – 209 BC	42.9	131 BC – 118 BC	0.5
Wooden spade	2180±90	367 BC – 160 BC	64.5	402 BC – 20 BC	94.7
		132 BC – 117 BC	3.7	12 BC – 1 BC	0.7
Pelt	2045±30	95 BC – AD 2	68.2	165 BC – AD 24	95.4

Figure 5. *Wooden spades excavated in 1969. (After Skjølsvold 1969: Fig. 9).*

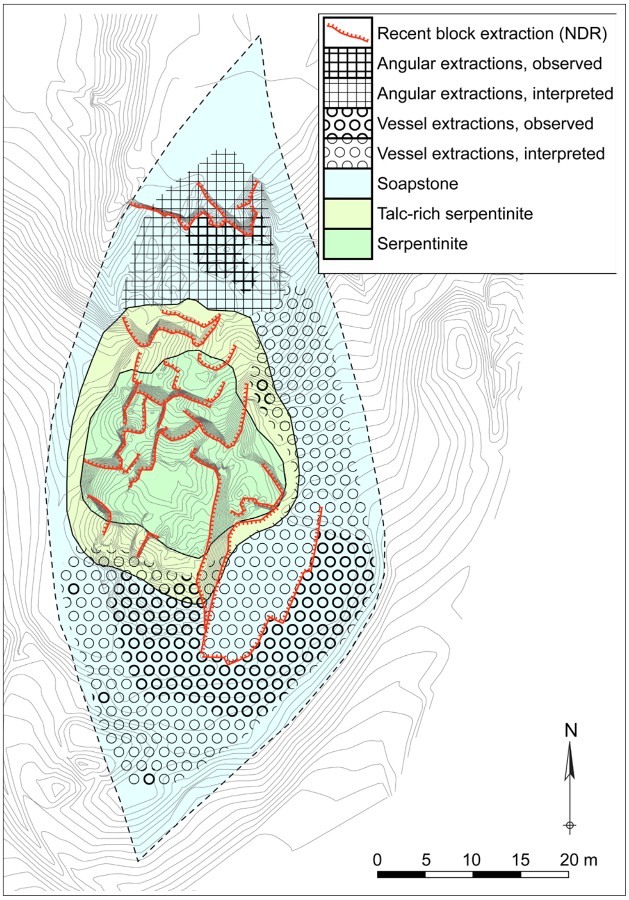


Figure 6. *Map of the Sandbekkdalen soapstone deposit and quarry. Contour line (light grey) intervals 20 cm.*

Figure 7. *View of the southern quarry area southeast of the knoll looking south-southeast. The water-filled pit is from modern quarrying by NDR. (Photo: A. Skjølsvold 1969).*

Figure 8. *Unfinished blanks and traces after extracted circular blanks for vessels in the southern quarry area. (Photo: A. Skjølsvold 1969).*

The central serpentinitic parts of the ultramafic body, covering some 30 by 25 m (Figure 6), is relatively hard and resistant compared to the surrounding soapstone, and forms a conspicuous, 5–6 m high knoll in the landscape (Figure 2). The serpentinitic rocks were exploited to some extent by NDR for block production, while they were apparently untouched by the ancient quarrying except for a few scattered extractions in the more talc-rich transitional zone.

Ancient quarrying at Sandbekkdalen

Southern quarry

Arne Skjøldsvold's excavations in 1969 focused on the area that was affected by recent block production for the NDR restoration works south and south-east of the serpentinite knoll (Figure 6). Traces of ancient extraction were seen covering an area of about 250 m^2, in addition to the 150 m^2 where ancient traces had already been removed by NDR (Figure 7). Moreover, limited trial excavations outside the uncovered area were interpreted to indicate that the total size was perhaps 600–800 m^2 (Skjølsvold 1969:204–205).

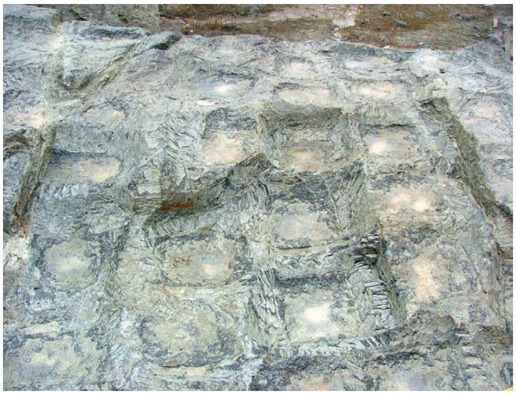
The exposed quarry floor displayed traces of the extraction of hundreds of vessels (Skjølsvold 1969:210–216). Some were left as circular unfinished blanks still attached to the rock surface (Figure 8) at various stages of completion. The average diameter ranges from 22 to 24 cm and heights are up to 28 cm. The majority have a tall and narrow profile, with a rim diameter less than the height. Skjølsvold (1969:212) also observed some blanks that possibly were designed for bowls with an open shape. Observations of exceptionally well preserved tool marks seemed to suggest carving with sharp adze-like tools that had a gently curved, 3.5–5.5 cm wide, transverse edge. The vessels were hewn with bottoms up on the quarry face, and they were loosened by carving a channel that made the blank narrower at the lower edge and future neck of the vessel ('low-bellied vessels'). No traces of wedging were observed. Based on the detailed topography in the quarry and documentation of 2–3 'extraction levels' in the vertical dimension, the number of vessels produced in the exposed parts of the quarry was estimated at 3000–4000, probably on the order of 6000 or more if the unexposed quarry faces were included (Skjølsvold 1969:212–213).

Much of the quarry was buried under three metres of rock waste, mostly fine debris from the ancient activity. Several pieces of birch trunks with one sharpened end were found in this debris together with large pieces of birch bark. Skjølsvold (1969:216) interpreted these finds as remnants of walls raised to protect the local working area at the quarry floor from the large masses of surrounding rock waste. The high number of excavated spades (n=60) also reflects a significant effort required to keep the rock surface clean and accessible for carving. An illustration of this is four wooden spades found together, carefully left in an upright position within a small pit in the soapstone surface before they were inadvertently covered by collapsing waste heaps (Skjølsvold 1969:217). Apparently quarrying was concentrated in a single, restricted area at a time, leaving large amounts of waste that had to be removed intermittently when new working areas were accessed.

Northern quarry

The ancient quarry faces discovered on the northern side of the serpentinite knoll after NDR had resumed block extraction in the mid-1970s were subject to limited excavation and archaeological mapping by Bodil Østerås (2004a). About 61 m^2 of the quarry surface was uncovered and revealed traces of 251 extractions. The average extraction density of 4.1 per m^2 is only slightly higher than that of 3.6 observed in the southern quarry area by Skjølsvold (1979:116). Earlier observations (Grenne & Heldal 2002) indicate that the total extent of the old quarry face was much larger than the excavated area, probably somewhere between 130 and 210 m^2 (Figure 6).

Surprisingly, this quarry area showed no evidence of extraction of the 'low-bellied' vessels with a tall and narrow profile that dominated the southern quarry area previously studied by Skjølsvold (1969:210–216). In contrast, nearly all the extractions (235 of 251) have angular forms, ranging from square and slightly rectangular through to various irregular outlines, commonly placed side by side like a chessboard pattern (Figure 9). Six per cent were classified as circular or oval during the field



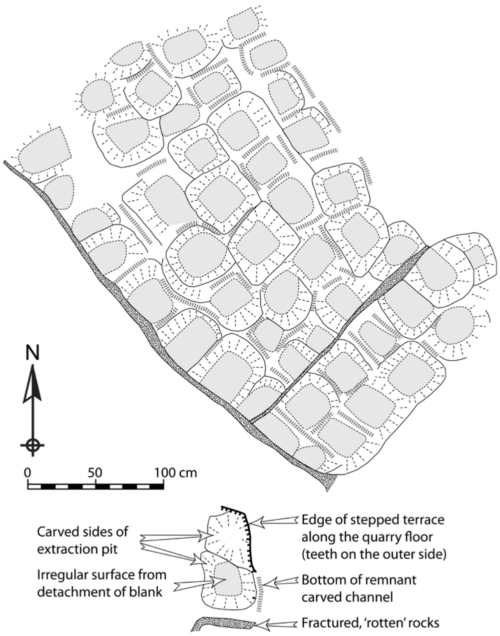


Figure 9. *Angular extractions for blanks in the northern quarry area. (Modified from Østerås 2004a:34).*

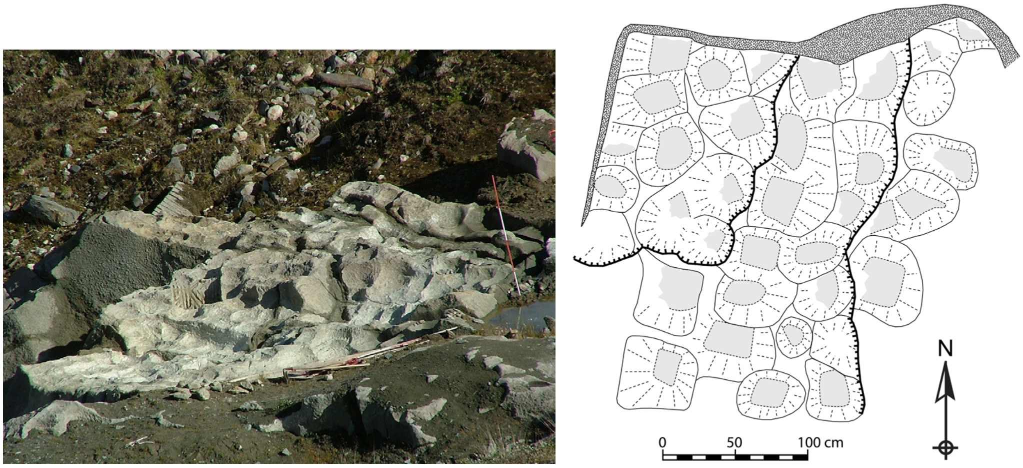


Figure 10. *Part of the northern quarry area showing layer-wise extraction of blanks on terraces that are stepped along the quarry floor. (Modified from Østerås 2004a:31). See Figure 9 for legend.*

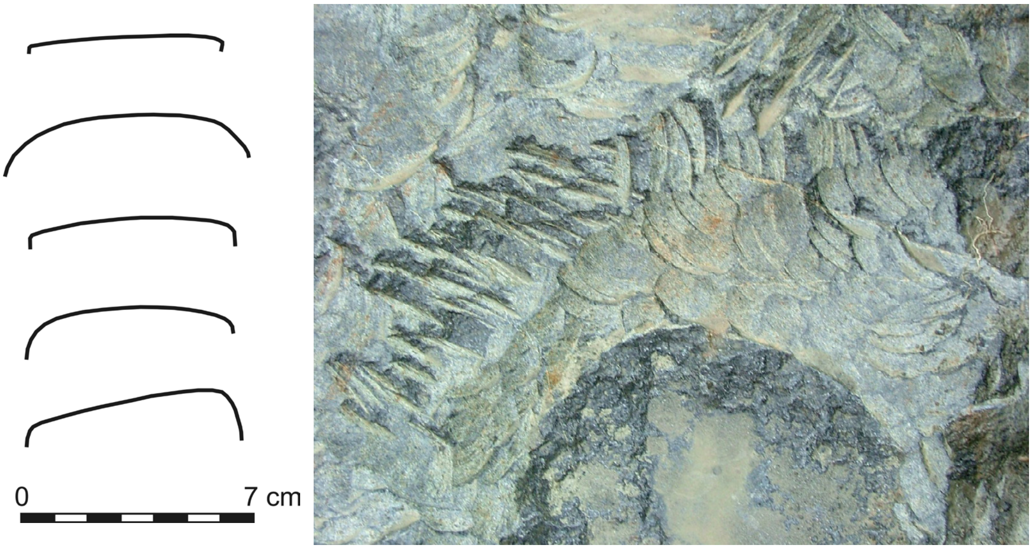


Figure 11. *Close-up photo of angular extraction pit with tool marks in the northern quarry area, Sandbekkdalen. The darker area at the bottom of the photo is the irregular surface where the blank was broken off from the quarry surface. Left: sketch of cutting edge marks from inferred adze-like carving tools.*

investigations, but the classification of these as a different product is questionable in view of the large variation in angular shapes. The extracted blanks are small, with a majority 18–26 cm in length. All of the blanks had been extracted horizontally along 'layers' at different levels, leaving a series of relatively wide stepped terraces along the quarry floor (Figure 10).

Well preserved tool marks denote that carving was done mostly with sharp adze-like tools that had a variably curved transverse edge with rounded sides. The tool marks are comparable to those of the southern quarry area with respect to general shape, but the edge of the tool appears to have been somewhat wider, i.e. 4.8–7.3 cm vs. 3.5–5.5 cm (Figure 11). Wedge holes are absent, and the blanks were apparently released from the bedrock simply by the inward-directed force of the edged tool at the bottom of the surrounding channel, similar to the southern quarry.

A small piece of cut pelt with seam holes, probably from a shoe or clothing that had been reused and wrapped around a tool (Berg-Hansen 2011) was found at the bottom of one of the extraction pits (Østerås 2004a:19). The pelt was from an unidentified species of deer (Cervidae). Radiocarbon dating produced an age of 2045±30 BP (Figure 4). Occurring in undisturbed soapstone debris directly on a surface with exceptionally well preserved tool marks, the pelt must have been buried in the rock waste shortly after carving, before the soapstone was affected by weathering that occurs very rapidly in this particular rock type (Storemyr 1997). The pelt was stained with rust in the otherwise light grey soapstone debris, indicating that it had been in contact with an iron tool (Berg-Hansen 2011).

Discussion

The two quarry areas at Sandbekkdalen were both worked by similar carving and extraction techniques and with comparable adze-like tools, yet they show significant differences with respect to products. Relatively small, narrow and tall vessels were by far the dominant product in the southern quarry. The great majority of blanks, as well as the few vessels apparently carved at the site, fit the typology for pre-Roman Iron Age soapstone vessels (Skjølsvold 1969:221; Pilø 1989). The only possible exceptions are a few low blanks that may have been designed for bowls with an open shape (more akin to late Bronze Age typology; Pilø 1989); however, Skjølsvold (1969:212) stated that this interpretation was ambiguous since the blanks may have been only partly processed. The typical pre-Roman Iron Age soapstone vessels, commonly used as grave urns, were distinctly different from the vast production of soapstone for cooking pots and similar domestic utensils in the Viking Age and Middle Ages (e.g. Pilø 1989:87; Storemyr & Heldal 2002). Lars Pilø (1989:96) notes that vessels of this type are absent in Bronze Age to pre-Roman Iron Age contexts in south-east Norway and that the Sandbekkdalen quarry at Kvikne instead may have served to supply the population of Trøndelag.

In marked contrast, the northern quarry seems to have been worked almost exclusively for the extraction of variably-shaped angular blanks. The practical application of these blanks is unknown, since finished products have not been identified in the quarry. Rectangular soapstone vessels were used in the Viking Age and later (Shetelig 1912:66), but such forms are unknown in older contexts. Extraction of rectangular blocks for building stone are seen in numerous soapstone quarries in Norway, but these blocks were much larger and practically all quarrying was related to the erection of ecclesiastical buildings in medieval times; soapstone is not found as construction or ornamental material in pre-Roman Iron Age buildings.

A preliminary interpretation by Østerås (2004a) suggested the production of rectangular blanks for bronze casting moulds. The size of many blanks, about 25 x 30 cm, is more than sufficient to form a two-piece mould for the casting of, for example, a bronze celt, by splitting the blank in two similar halves that were subsequently carved to form the hollow space inside. Such moulds were particularly common in the Bronze Age, as in Denmark where their great abundance has been taken to reflect large-scale trade with either Norway or Sweden (e.g. Skjølsvold 1961:107). Although scarce, similar moulds are also found in pre-Roman Iron Age contexts in northern Norway (e.g. Wickler et al. this vol.). According to Preben Rønne (1996:17) the Danish moulds were imported as roughly shaped blanks and finished when received by the customer. However, the interpretation is problematic in view of the presumably limited use of bronze casting moulds in this time period (late pre-Roman Iron Age, see below).

Another possible interpretation is that the angular and variably-shaped blanks were intended for the manufacture of heat-resistant products related to the production or processing of iron. This is interesting particularly in view of the extensive utilization of bog iron documented in areas close to the Sandbekkdalen quarry: Central Norway seems to be the most important area for iron production in Norway and perhaps in the whole of Scandinavia from around 500 BC through to the Roman Iron Age (Stenvik 2005), a production apparently organized by persons at a chieftain level in a stratified society (Grønnesby 1999, Sauvage & Mokkelbost 2013). Contemporary smithies have also been identified in the region (Øien 2009). Possible soapstone products in this context are cylindrical forge-stones (*tuyères*) through which air was blown into a furnace, or shield-shaped forge-stones with a hole used to protect bellows from the heat. Both are known from prehistoric iron smelting and smithies elsewhere (Tylecote 1987:118). We do not know contemporary examples that have been identified in Norway; however, in view of the existing, large-scale exploitation and processing of bog iron (Stenvik 2005) and the suitability of soapstone as a heat-resistant and easily carved material, we consider it very likely that both cylindrical and shield-shaped forge-stones were widely used in the region.

The systematic organization of soapstone extraction at Sandbekkdalen suggests that experienced artisans were operating the quarry: The extractions have a comparable size and seem to be standardized both with respect to shape and carving technique. Moreover, the extractions were strategically positioned in order to maximize utilization of the best stone quality and at the same time take advantage of natural fractures to minimize the need for laborious carving.

The question of who these quarry artisans were, however, is still an open issue. Available data for total output and production period (see below), albeit uncertain, suggest a production rate on the order of 5000 to 10,000 vessels over perhaps 200–400 years, i.e. not more than c. 10–50 vessels per year. Similar estimates are valid for the production of angular blanks (see below). Hence, although production was relatively extensive over time, it seems most likely that the quarry was worked only periodically by people who were otherwise occupied elsewhere, e.g. in farming or hunting. The production rates may also suggest that products were traded locally or within the region rather than for a wider export.

At any rate, the quarry workers must have been based in the same district. The nearest settlement with significant farmland is Yset (Figure 1), situated c. 15 km to the north at an altitude of some 550 m ASL. It is noteworthy that another significant soapstone quarry, Grøtberget, is located close to this settlement (Figure 1), on the rim of a protruding knoll of harder ultramafic rock like at Sandbekkdalen and in a similar geological context (Nilsen 1974). Here, exposed traces from the extraction of relatively large pots and trough-shaped vessels are typologically consistent with activity in Viking Age or later periods (Østerås 2004b); however, recent mapping indicates that the larger part of the quarry is presently covered by waste heaps that could be related to earlier activity. Although this remains somewhat speculative in the absence of archaeological studies and radiocarbon dating, it opens the possibility that at least two soapstone quarries were operated near Yset in the early Iron Age. Indeed, it is highly unlikely that the Grøtberget soapstone – standing out as a well exposed and easily accessible resource of good quality near the settlement – was not known and exploited at the same time as the much more remote Sandbekkdalen quarry.

Stone mauls of the type that was found in the quarry often appear in old copper mines on the Continent and in the British Isles, where they seem to be standard equipment for workers in mines and quarries (Stenvik 1988). Anne Lene Melheim (2012:290) pointed to the copper mines of the Kvikne district as a possible connection between mining and soapstone quarrying, although presently visible traces of copper mining evidently relate to modern activity (mid-17th century and later). So far we have no solid proof of copper mining as early as the Bronze Age or pre-Roman Iron Age in

Norway, but it is a possibility that has been raised (Stenvik 1988; Prescott 2006; Melheim 2012). A combination of copper mining and soapstone quarrying would have been an interesting coexistence since there are obvious relations between activities, tools and craftsmanship. It is noteworthy in this regard that the Kvikne district is well known for its many copper mines (Nilsen & Mukherjee 1972). Two of these, Kaltberget and Olkar, are found as close as 100 metres and 1.2 km, respectively, from the Grøtberget soapstone quarry near Yset, while others are about 3 km from the Sandbekkdalen quarry (Figure 1).

Our recalibration of Skjøldsvold's (1969:204, 235) ^{14}C data from the southern quarry area (Figure 12 and Figure 4) indicates that a birch trunk used for support of the waste heaps is most likely from the time interval c. 750–410 BC (at 68% confidence), with the highest probability at c. 560–410 BC. Similarly, the three spades have an age range of c. 740–120 BC, with the highest probability at c. 550–360 BC, 430–350 BC and 370–160 BC, respectively. The piece of birch bark falls within these ranges with a likely age of c. 400–210 BC at 68% confidence. Hence, while it is possible that the birch trunk and one of the spades are from the Bronze Age (i.e. older than 500 BC) as suggested by Joakim Goldhahn (2007:132–133), their similar contexts makes it more likely that all these five artefacts comprise a group that overlap in age within the 4th and 5th century BC. In contrast to these, the piece of pelt found within one of the angular extraction sites in the northern quarry area shows that quarrying at that site most likely took place sometime within the first century BC (Figure 4 and Figure 12).

Coupled with the volume of production, which indicates that quarrying had a relatively long history, the data suggest that the southern part of the Sandbekkdalen quarry was operating at least in the 4th and 5th century BC. Limited ^{14}C data from the northern quarry gives a significantly younger age, suggesting that that there was still activity here in the 1st century BC. Two scenarios seem viable for this development in time and space, from the early production of circular vessels to the south followed by angular blanks to the north: 1) it may reflect a gradual shift from exploitation of the southern to the northern quarry area over time and a concomitant change in products, or 2)

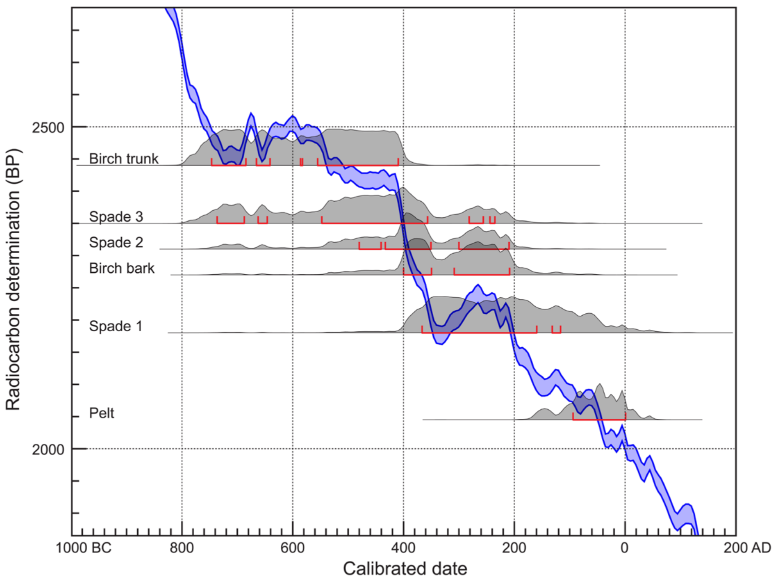


Figure 12. *^{14}C ages, Sandbekkdalen quarry. Probability distributions (grey) and probability intervals at 68.2% confidence (red) calculated by OxCal (Bronk Ramsey 2009) version 4.2.3, with calibration curve (blue) from Reimer et al. (2013).*

quarrying of the two different commodities was temporally discontinuous and only the northern part of the quarry was worked for angular blanks.

Overlap of the two products in time would potentially leave traces of both types on the same quarry surface or, at least, in the same part of the quarry; however, this may not necessarily be the case in a long-lived quarry, where older traces will inevitably be removed as quarrying goes deeper and observed extraction traces on the quarry floor only represent the latest activity at that particular site. The absence of angular extractions to the south, where observed traces obviously represent a late phase of work in that part of the quarry, strongly suggests that this area was abandoned while circular vessels was still the only or predominant product. The northern quarry area is more problematic, since it is impossible to tell if circular vessels had been extracted at a shallower, presently removed, level before the carving of angular blanks as seen on the quarry floor. The sporadic presence of more circular traces may reflect a continued, subordinate, vessel production, but this is highly uncertain in view of the variable shapes of extractions as discussed above. While we know that the Sandbekkdalen quarry had a lifespan of at least four centuries, the ^{14}C data are not conclusive as to whether there was continuous activity during this period. At the 68% confidence level, the data allow for a break in the 2nd century BC, but this is speculative in view of the limited number of dated artefacts.

At any rate, it is unlikely that only the southern part of the knoll was exploited for circular vessels in the early period, especially since glacial drift is very thin in the area and has left protruding knolls more or less uncovered. This implies that the later production of angular blanks in the northern quarry area was most likely established in a soapstone exposure that was previously known and exploited for vessel production. Moreover, it suggests that earlier vessel production may have been significantly more extensive than previous estimates, possibly covering a quarry area of nearly 1000 m^2 (Figure 6). Following Skjølsvold's (1969:212–213) estimate of extraction density and the number of extraction levels, the total output may have been on the order of 10,000 vessels. A similar calculation for the later phase in the north would suggest a total production of angular blanks on the order of 2000. It must be emphasized, however, that the figures are uncertain because we do not know the shape of the original quarry surface and hence how deep the quarries were.

Whether or not extraction of the two different products was continuous and overlapping, the similarity in extraction technique and tool marks points at a unbroken stone craft tradition through the entire lifespan of the ancient quarry, characterized by carving with adze-like tools that had a curved, transverse edge. This was significantly different from that of the mass production of soapstone bowls and other vessels in the late Iron Age and medieval times, when carving with sharp edge tools was replaced by picking with pointed tools (e.g. Østerås 2001). The difference in stone craft traditions lends further support to previous suggestions that soapstone vessel production ceased after the pre-Roman Iron Age, about AD 0, when soapstone vessels were replaced by ceramics, and resumed only after the Migration Period (Pilø 1989).

Tool marks in the quarry demonstrate the use of adzes or axes with a sharp and hard metal edge. The kind of metal is not revealed by direct findings; however, two observations serve as indirect evidence for the use of iron or steel in these tools. Firstly, rust was observed on a piece of pelt that was apparently wrapped around an iron object. The context of this object, lying directly on unweathered extractions, demonstrates that it was related to the quarrying. We do not know whether the metal was removed (and reused?) and just left rust on the pelt prior to disposal, or if the metal rusted away and the pelt was preserved while buried in the rock waste (which is quite possible in view of the exceptional preservation of spades and other organic matter in the quarry debris); at any rate this leaves no doubt that iron or steel was used during quarrying at Sandbekkdalen. Secondly, in spite of fairly extensive excavations with very abundant finds of tools (e.g. 60 wooden spades) lost in the debris, there are no finds of bronze tools, even though the likelihood for preservation of bronze – or at least of copper staining from such tools – is far higher than that of iron. Recent ^{14}C data from iron production sites in neighbouring communities north of Kvikne (Midtre Gauldal, Holtålen and Rennebu) demonstrate that extensive iron production took place at about 300 BC (Stenvik 2005), and a huge site with remains of smithies and forges at Forsetmoen in Midtre Gauldal, about 60 km north of Sandbekkdalen, corroborates iron working as early as 500 BC (Øien 2009). Hence it was obviously possible to produce tools with steel edges at that time (Stenvik 2005).

The documented pre-Roman Iron Age quarrying at Sandbekkdalen is seemingly unique in a Norwegian context in terms of age and products. None of the innumerable soapstone quarries elsewhere in Norway have so far revealed evidence of activity older than the Viking Age. This is an apparent paradox since many soapstone quarries have been worked with resources that are much bigger and logistically far more favourable with respect to proximity to settlements and trade routes than that at Sandbekkdalen. We find it highly unlikely that pre-Roman Iron Age production of items like grave urns and other soapstone objects were restricted to the very remote mountainous area of Kvikne, as long as large and easily accessible soapstone resources occur close to settlements and coastal areas elsewhere, e.g. in Hordaland (western Norway) and Helgeland (northern Norway) where several deposits are well exposed in the immediate vicinity of the intertidal zone (Helland 1893; Karlsen & Nilsson 2000). On the contrary, we suggest that similar production may have been widespread in the pre-Roman Iron Age; however, traces of the ancient quarrying were in most cases erased by the very extensive exploitation of soapstone in the Viking Age and Middle Ages. This is supported by a recent provenance study by one of the authors (TG) based on the geochemical characteristics of soapstone quarries and vessels from archaeological contexts of pre-Roman Iron Age or late Bronze Age in northern Norway (material provided by Stephen Wickler, Tromsø Museum see Wichler et al. this vol.). From just the four vessels studied it is clear that at least two other soapstone quarries – distinctly different from the Sandbekkdalen soapstone – must have been exploited in that period. Future provenance work on a regionally wider selection of pre-Roman soapstone artefacts is likely to increase the number of possible sources considerably. From this perspective, the Sandbekkdalen quarry at Kvikne may be regarded as a fortuitous remnant from the earliest phase of 'industrial-scale' exploitation and utilisation of soapstone resources in Norway, still in existence only by virtue of its remote location and difficult accessibility in later times.

Acknowledgements

We are grateful to Stephen Wickler for valuable discussions and helpful comments on the manuscript, and to two anonymous reviewers for their helpful suggestions which led to improvements in the manuscript. The Workshop of Nidaros Cathedral (NDR) is thanked for logistic support during the field investigations. The Museum of Cultural History, University of Oslo, kindly provided photographs from the excavations undertaken by Skjølsvold (1969).

References

Alnæs, L. -I. 1994. Kvalitet og bestandighet av naturstein. Påvirkningsfaktorer og prøvemetoder. Unpublished Ph.D. dissertation, Norwegian University of Science and Technology, Trondheim.

Berg-Hansen, I. M. 2011. Kort rapport om undersøkelser av pelsbit funnet ved utgravninger i Kvikne, Sandbekkdalen kleberbrudd i 2004. C56497 A2004/193. Universitetet i Oslo, Oslo.

Bronk Ramsey, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51 (1), 337–360.

Frigstad, O. F. 1973. Undersøkelse av klebersteinsforekomst, Bubakk, Tynset kommune, Hedmark fylke.

Geological Survey of Norway, Report 1211.
Grenne, T. & Heldal, T. 2002. Driftsmuligheter og kulturminnevern i Bubakk klebersteinsforekomst, Kvikne. Geological Survey of Norway, Report 2002.113.
Grønnesby, G 1999. Eldre jernalders hus og hall på Hovde i Trøndelag. *Viking* 62, 69−80.
Goldhahn, J. 2007. Dödens hand − en essä om brons− och hällsmed. Rituelle spesialister i bronse- og jernalderen, Vol. 1. Gotarc serie C. *Arkeologiska Skrifter* 65. Göteborg.
Helland, A. 1893. Tagskifere, heller og vekstene. *Norges geologiske undersøkelse* 10, 1−178.
Jordhøy, P. 2007. Gamal jakt- og fangstkultur som indikatorar på trekkmønster hjå rein i Sør-Noreg. Kartlagte fangstanlegg i Rondane, Ottadalen, Jotunheimen og Forollhogna. NINA Report 246.
Karlsen, T. A. & Nilsson, L.P. 2000. Talc deposits in Norway. Geological Survey of Norway, Report 99.135.
Melheim, A. L. 2012. Recycling Ideas. Bronze Age Metal Production in Southern Norway. Unpublished Ph.D. thesis, University of Oslo.
Nilsen, O. 1974. Mafic and ultramafic inclusions from the initial (Cambrian?) volcanism in the central Trondheim region, Norway. *Norsk Geologisk Tidsskrift* 54, 337−359.
Nilsen O. & Mukherjee A. D. 1972. Geology of the Kvikne mines with special reference to the sulphide ore mineralization. *Norsk Geologisk Tidsskrift* 52, 151−192.
Pilø, L. 1989. Early soapstone vessels in Norway from the late Bronze Age to the early Roman Iron Age. *ACTA Archeologica* 60, 87−100.
Prescott, C. 2006. Copper production in Bronze Age Norway? In Glørstad, H., Skar, B. & Skre, D. (eds) *Historien i Forhistorien. Festskrift til Einar Østmo på 60-årsdagen.* Kulturhistorisk Museum, Universitetet i Oslo, Skrifter 4, 183−190, Oslo.
Reimer, P. J., Bard, E., Bayliss, A., Beck, J. W., Blackwell, P. G., Bronk Ramsey, C., Grootes, P. M., Guilderson, T. P., Haflidason, H., Hajdas, I., Hatte, C., Heaton, T. J., Hoffmann, D. L., Hogg, A. G., Hughen, K. A., Kaiser, K. F., Kromer, B., Manning, S. W., Niu, M., Reimer, R. W., Richards, D. A., Scott, E. M., Southon, J. R., Staff, R. A., Turney, C. S. M., & van der Plicht, J. 2013. IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0−50,000 Years cal BP. *Radiocarbon* 55 (4), 1869−1887.
Rønne, P. 1996. Bronse for kleber. *SPOR* 21, 14−17.
Sauvage, R. og Mokkelbost, M. 2013 Høvdinghuset på Hallem. *SPOR 2013* (2).
Shetelig, H. 1912. Kar av kleberstein fra jernalderen. *Oldtiden, tidsskrift for Norsk forhistorie* 2, 49−73.
Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden.* Universitetsforlaget, Oslo.
Skjølsvold, A. 1969. Et keltertids klebersteinsbrudd fra Kvikne. *Viking* XXXIII, 201−238. Hougen & Skjølsvold, A. (eds), Oslo.
Skjølsvold, A. 1979. Gryteindustrien i Kviknefjellene for over 2000 år siden. *Fortiden i Søkelyset. Datering med 14C metoden gjennom 25 år,* 111−119. Nyland, R. et al. (ed.), Trondheim.
Stenvik, L. F. 1988. Steinkøller med skaftfure. *Arkeologiske Skrifter, Historisk Museum Bergen* No.4, 292−300.
Stenvik, L. F. 2005. Jernalderen. *Trøndelags Historie* 1. Bull. I. (ed.), 106−170, Trondheim.
Storemyr, P. 1997. The stones of Nidaros. An applied weathering study of Europe's northernmost medieval cathedral. Unpublished Ph.D. thesis, Norwegian University of Science and Technology, Trondheim.
Storemyr, P. & Heldal, T. 2002. Soapstone Production through Norwegian History: Geology, Properties, Quarrying and Use. In Herrmann, J., Herz, N. & Newman, R. (eds) *ASMOSIA 5, Interdisciplinary Studies on Ancient Stone – Proceedings of the Fifth International Conference of the Association for the Study of Marble and Other Stones in Antiquity, Museum of Fine Arts 1998,* 359−369. Archetype Publications, London.
Tylecote, R. F. 1987. *The early history of Metallurgy in Europe.* Longman, London and New York.
Øien, R. I. 2009. Forsetmoen Gnr/bnr 270/24 Midtre Gauldal kommune. Sør Trøndelag. Rapport fra arkeologiske flateavdekkinger høsten 2008 og sommeren 2009. Unpublished report, Norwegian University of Science and Technology, Trondheim.
Østerås, B. 2001. Klebersteinsbrotet på Sparbu. Kva undersøkingar av eit klebersteinsbrot kan fortelje om gamle steinhoggartradisjonar. Unpublished hovedfag thesis, Norwegian University of Science and Technology, Trondheim.
Østerås, B. 2004a. Forvaltningsplan for klebersteinsbrotet i Sandbekkdalen på Kvikneskogen. Tynset kommune, Hedmark fylke. Unpublished report, Hedmark fylkeskommune.
Østerås, B. 2004b. Grytberget. Unpublished report, Hedmark fylkeskommune.

Per Storemyr and Tom Heldal

Reconstructing a Medieval Underground Soapstone Quarry: Bakkaunet in Trondheim in an International Perspective

Underground medieval quarries are rare, in Norway and elsewhere in Europe. Thus the question: Could a big underground soapstone quarry have been opened at Bakkaunet in Trondheim (central Norway) in the Middle Ages? This question of stone procurement for Nidaros Cathedral – which is Europe's northernmost medieval cathedral and a building heavily influenced by English traditions and fashions – has bothered us for the last 20 years. In this paper we discuss what we think the quarrymen did. It is a biography of the now almost lost Bakkaunet quarry, with a focus on the question about underground operations. But the paper also discusses stone procurement for Nidaros Cathedral in view of contemporary international, especially English, trends. The story is sad, for the open-cast part of this once great quarry, very close to the centre of Trondheim, has been successively destroyed by modern house building over the last century.

Gothic architecture and freestone in Central Norway

Stone from at least 30 individual quarries was used to build Nidaros Cathedral between 1070 and 1350. Gneiss and granitic rubble for various interior walls and masonry cores were provided from local and regional deposits along the Trondheim Fjord, whereas marble was shipped up to 140 km from two regional quarry areas by Sparbu and Allmenningen and used for an array of columns, pillars, floor slabs and gravestones. Slate for floors and (possibly) roofs may, in addition, have been provided from regional deposits by Orkanger and Stjørdal. But the most important stones, chlorite schist and soapstone used for ashlar and decoration, came from two of Norway's largest medieval quarry centres, Øysand at the mouth of River Gaula, some 35 km south of Trondheim (by boat), and – notably – from the town of Trondheim itself (Figure 1). These quarries also provided stone for many other regional churches, monasteries and secular buildings (Storemyr 1997, 2003, 2015a; Storemyr et al. 2010).

The Øysand quarry landscape includes chlorite schist and soapstone extracted from 10–15 interconnected quarries along a one km long valley. The landscape is quite well-preserved and has been subject of several investigations over the last 20 years (Heldal & Storemyr 1997; Storemyr 1997; Lundberg 2007; Storemyr et al. 2010). It has been shown that the evidence of stone extraction nicely correlates with what can be observed at the cathedral and other contemporary stone buildings (Figure 2). Chlorite schist was the principal stone sought after in the Romanesque building period, starting

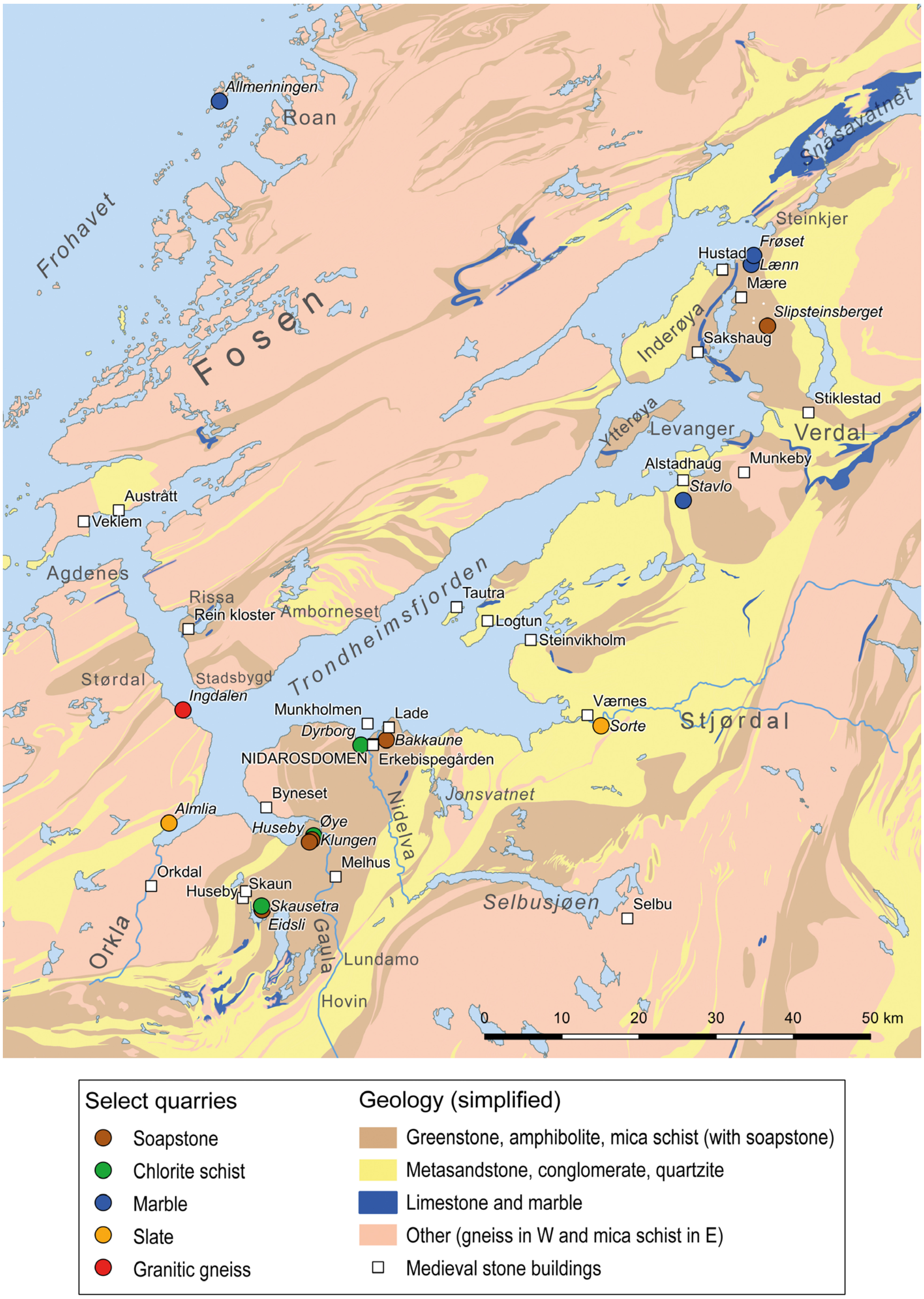


Figure 1. *Simplified geological map of the Trondheim region with the location of secure and probable medieval quarries, as well as select stone buildings in the region. Geology after the online resources at www.ngu.no; location of quarries and buildings based on multiple sources, see Storemyr (2015).*

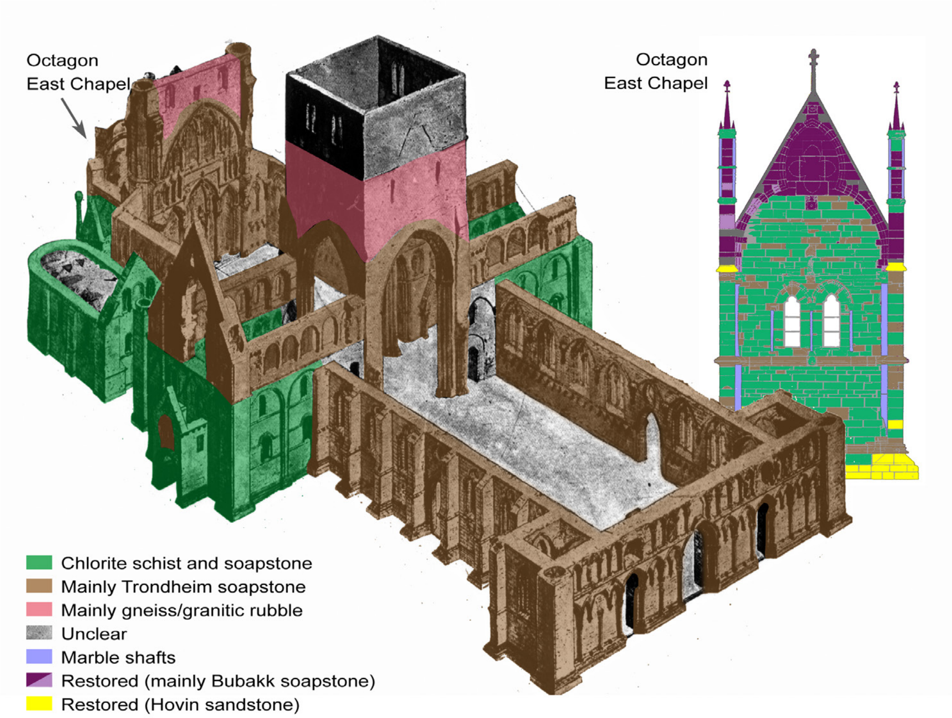


Figure 2. *Rough overview of stone types in preserved medieval masonry at Nidaros Cathedral. Base drawing by Joakim Mathisen (NDR's archive). Base drawing of the octagon's east chapel by NTNU Department of Civil and Transport Engineering (1991). Stone types simplified after extensive mapping by Per Storemyr (Storemyr 1997).*

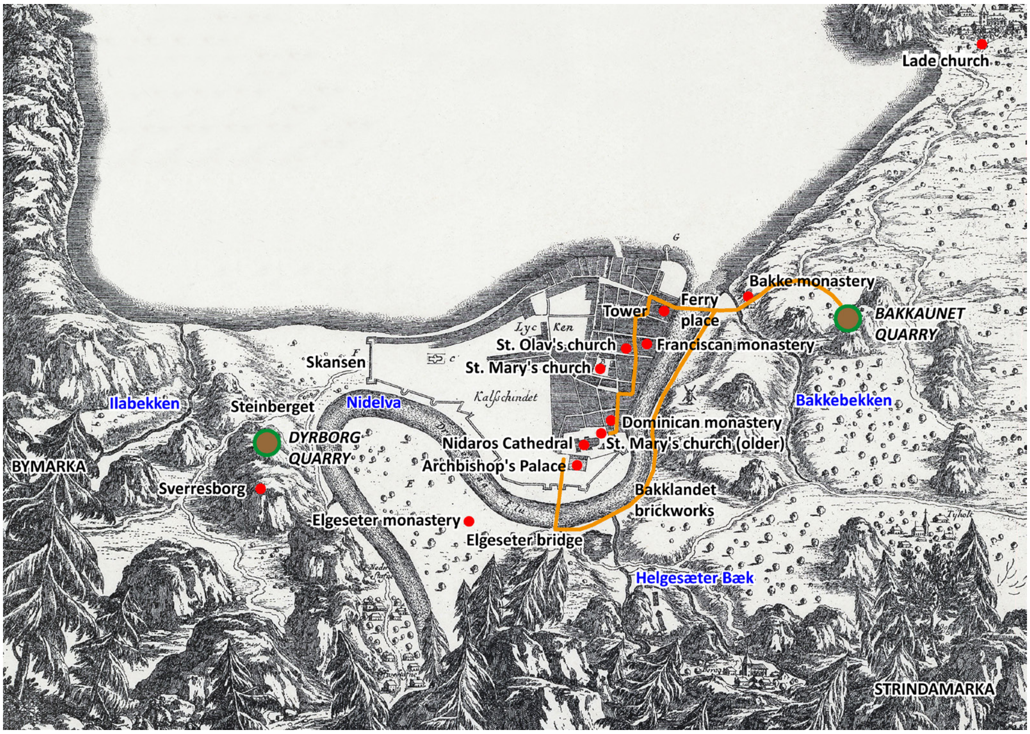
in the late 11th century and continuing until the Gothic style took over towards the 13th century. Although soapstone was also applied in the Romanesque period, both for ashlar and decoration, its use is mainly confined to the Gothic period, when the chlorite schist quarries were completely abandoned.

There may be several reasons why chlorite schist was abandoned as a building and ornamental stone around 1200, the most important of which ought to be its foliated fabric. In order to carve the much more intricate Gothic decoration (moulding, tracery, sculpture; Figure 3), as compared to Romanesque features, there seems to have been a need for a 'true' freestone – a uniform stone that could be carved 'in all directions' without greatly considering foliation and other, from the stone carver's perspective, weaknesses. Another Norwegian example of the same phenomenon is Stavanger Cathedral, which features a range of stones, including chlorite schist, in the Romanesque building phase, but only very good soapstone in the Gothic period (Stige 1997:40–43; Storemyr 2001).

True freestone is *very* scarce in the metamorphic geology of the Trondheim region. In the Middle Ages exploitable resources were, due to transportation restrictions, in practice confined to the soapstone deposits at Øysand and in Trondheim (Storemyr 2015a). Both deposits feature similar bluish-grey soapstone with networks of carbonate veins, a very characteristic type of soapstone rarely found elsewhere in Norway (Figure 3). Their properties are, in fact, so similar – reflecting a common geological origin – that it is still almost impossible to distinguish soapstone from Øysand and Trondheim (optically and geochemically). Hence, 'Trondheim soapstone' is commonly used as a

Figure 3. *Trondheim soapstone used for intricate carving of a central Christian myth; the creation of Eva from Adam's ribs. To be seen at the so-called King's Porch at the south side of the choir, Nidaros Cathedral (first half of the 13th century). The scene was heavily restored in the late 19th century using Trondheim soapstone. (Photo: P. Storemyr).*

Figure 4. *Excerpt of one of the earliest maps of Trondheim town and vicinity, drawn by Pufendorf (ca. 1796) on the basis of Naucler's map from 1658, reprint 1899 (source: kartverket). Though slightly imaginative, the map shows the structure of the medieval town, before it was totally changed after the town fire in 1681. Medieval quarries and select medieval stone buildings, as well as possible transport routes from the Bakkaunet quarry to Nidaros Cathedral.*



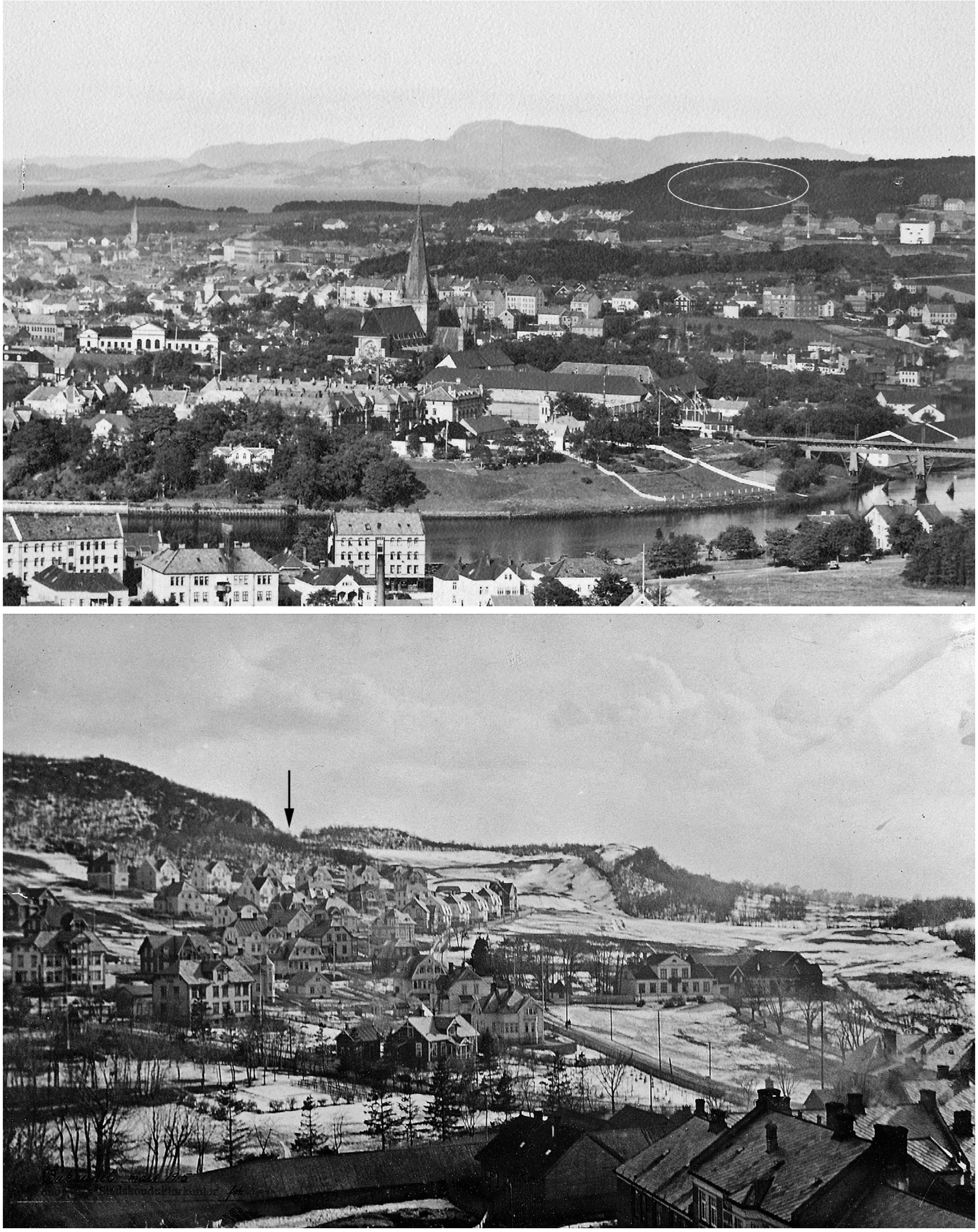


Figure 5. *Location of Bakkaunet soapstone quarry. Above: As seen from the west, across the city with Nidaros cathedral under reconstruction in the centre. (Photo by Schrøder 1937), the quarry is indicated by an oval. Below: As seen from the north (1930), with the quarry indicated by an arrow. (Source: Trondheim byarkiv.)*

Figure 6. *Bakkaunet quarry as seen from above 27. July 2008. The quarry is located below and behind the two large apartment buildings in the middle of the image. The old spoil heaps have been used as building ground. Compare with Figure 13. (Source: Google Earth).*

term encompassing stone from both quarry landscapes. It is likely that both provided soapstone from the late 11th century onward, until the Black Death in 1349–50 (and its aftermath) almost put an end to medieval stone building activities. As indicated by the size of spoil heaps, it seems that Øysand and Bakkaunet provided roughly similar amounts of *soapstone* in the Middle Ages. Øysand was a larger quarry landscape, though, since it also provided vast amounts of chlorite schist.

There is a snag, though. This is because there was a second medieval soapstone and/or chlorite schist quarry close to the Trondheim city centre, at Dyrborg in the hills less than two km west of Nidaros Cathedral (Figure 4) (Schøning 1979a:194; Storemyr 2015a:208–209). Unfortunately, this quarry has been completely destroyed by modern development; the only traces left being fragments of spoil heaps. Since there are hardly any local traditions connected to the quarry, it is presumed that it was relatively small, but its significance remains unknown.

The Bakkaunet quarry is also situated very close to the city centre, about 2.5 km east of the cathedral (Figure 4 and Figure 5). Already in the early 20th century urban development had reached the spoil heaps and the quarry was successively transformed to a residential area. But it was not until the 1980s and again around 2005 that the building of two large housing complexes destroyed the open-cast parts of the quarry (Figure 6).

Prior to the last building phase archaeological excavation was undertaken in a small, open-cast part of the quarry, giving a glimpse of its characteristics (Følstad 2002; Østerås 2008). The question is whether the excavations provided a representative picture of the design and organisation of the quarry as a whole in the Middle Ages. There are indications that the answer is negative, particularly in view of 19th century records hinting at underground operations.

Geology, stone quality – and hints to open-cast and underground exploitation at Bakkaunet

The Bakkaunet quarry is located in a small valley by Kuhaugen, belonging to gentle hills that make up the eastern outskirts of Trondheim. Field survey and observations on old aerial photos (see www.norgeibilder.no) indicate that extraction once took place along a c. 140 m long stretch at the foot of a steep hill more than 30 m high. This hill (now called Skyåsparken) consists of metagabbro overlying the soapstone deposit, which also contains serpentinite, as well as chlorite schist at its periphery, all surrounded by the typical greenstone (metabasalt) of the Trondheim area. These rocks were formed during ordovician sea-floor spreading, and they were later altered during the Caledonian orogeny (c. 490–390 million years ago) (Carstens 1939; Fossen et al. 2008:224–226).

Given this geology, it is likely that the soapstone deposit is part of an ophiolite fragment and that the soapstone was altered from original peridotite. This has also left fragments of serpentinite, an intermediate stage in the geological transformation of peridotite to soapstone. Although the soapstone *outcrop* is restricted to a narrow zone at the foot of the hill, the actual deposit is likely much larger, presumably forming one or several squeezed lenses dipping towards the north, as indicated by the discovery of soapstone just beneath the area during recent construction of a new transport tunnel through Trondheim (Strindheimtunnelen) (Nikolaisen 2011).

The geology is very similar to the Øysand area, which has been mapped in detail (Heldal & Storemyr 1997), and which features quarries as mentioned above. Common both at Øysand and elsewhere in the Trondheim greenstone geology, granitic intrusions have penetrated the Bakkaunet deposit. One of these intrusions are, in fact, marked on the first geological sketch map of Bakkaunet (Figure 7), drawn by the geologist Amund Helland more than a hundred years ago (Helland 1893:145).

More importantly, the sketch also shows three adits (entrances to mines) at the foot of the hill. The adits are located behind the large apartment complexes built in the 1980s and by 2005 (Figure 6), but they are hardly visible today, due to the building activities as well as rock fall. Yet, we have observed two conspicuous places where adits perhaps might be located; both in small re-entrants, covered by scree (see location in Figure 13). Moreover, important traces of open-cast soapstone extraction below the hill were found during archaeological excavation prior to the last construction phase, which commenced in 2005.

These excavations will be described in detail below. However, the excavated areas showed that mainly a soft variety of the soapstone was extracted in the Middle Ages, whereas a harder, serpentine-rich type was, additionally, quarried in the late 19th century (Østerås 2008:93). This is very much

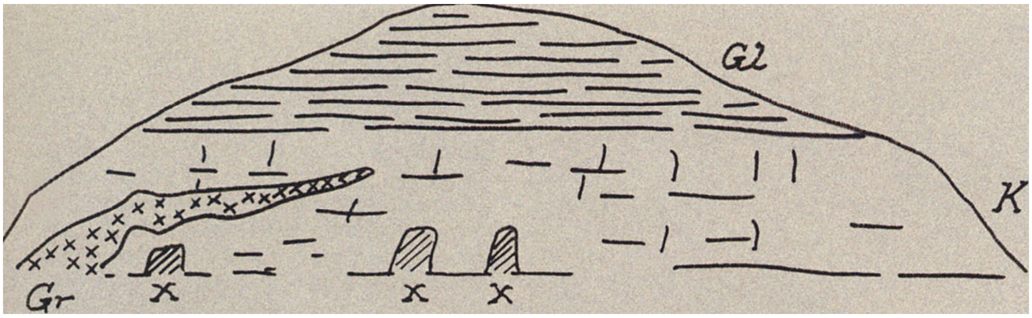


Figure 7. *Sketch map of the geology at Bakkaunet quarry, with three ancient adits (X) indicated. K means soapstone, Gl means micaschist (in reality gabbro), Gr means granite. (Source: Helland 1893:145).*

in line with observations of the use of the stone at Nidaros Cathedral. The soft variety is, thus, of a quality similar to what can be seen on large parts of the cathedral, in particular at the early and high Gothic choir and nave, as well as the west front (Figure 2); all built from the first half of the 13th century on, starting with the choir (Fischer 1965; Ekroll 1997:149–159, 2015). In the bluish-grey, sometimes greenish matrix composed principally of talc and chlorite mainly, is a network of often thick carbonate veins (mainly dolomite), but smaller carbonate clusters are also present (Figure 3). The stone appears as massive, yet slight foliation may be present, as indicated in medieval mouldings that have lost strongly exposed/protruding parts. Such weathering may also be related to thin carbonate and talc veins. Although surfaces usually remain extremely well preserved after 800 years of exposure, despite a certain content of oxidising sulphide minerals (e.g. pyrite), these observations show that the Bakkaune soapstone generally is a good freestone. However, like most building stone, it also has certain weaknesses. For the stone carver it is the harder carbonate veins in particular that represent a challenge during cutting, but this is partially outweighed by the firmness of the talc-chlorite matrix, which makes it possible to cut very sharp lines and edges. In softer soapstone this is often a problem.

History of the quarry and use of the stone: The Middle Ages

Since it is situated very close to the city centre and (Figure 4), in particular, near the Iron Age power centre at Lade (on the history of the Trondheim region, see e.g. Alsaker et al. 2005), it is likely that the Bakkaunet deposit was known prior to the foundation of Trondheim around AD 1000 and the early phases of stone building from the mid-late 11th century. However, it is not established whether the deposit was developed as an early quarry for production of vessels and small items like loom weights, spindle whorls, net sinkers, oil lamps and the like. Still, from the archaeological excavations (2002–2004) we do know that there was limited production of such items parallel to the extraction of building stone at some stage in the Middle Ages (Østerås 2008:87–88). This production has not yet been interpreted; whether it was of an occasional nature or part of more organised activities. Discovery of iron slag during the excavations also showed that there was, as expected, a smithy in the quarry, probably used for sharpening tools. The smithy would imply that a blacksmith worked in the quarry (Østerås 2008:88), similar to what is well known from medieval quarries on the British Isles, for instance in Yorkshire (Moorhouse 2007). In addition, cattle bones were found (Østerås 2008:88), perhaps indicating the sort of food served to hard-working, hungry quarrymen?

The most important results of the excavations were, however, related to quarry design and extraction techniques, which could be studied in-depth because a part of the excavated section at some stage had been rapidly buried under one or more screes from the steep cliff. Although there were many traces of 19th century extraction (boreholes), partially overlapping former extraction marks, it seems that the medieval quarrymen had entered the outcropping deposit at the foot of the hill by extracting blocks along a good vein of soapstone, thus creating a shallow 'ravine'. In this depression, block extraction had been undertaken in a rather chaotic manner, following natural cracks and foliation of the otherwise massive soapstone. An array of blocks nearly ready to be removed from the bedrock (Figure 8) was located at the inclining, north side of the ravine. They showed a pattern of remaining blocks resembling chocolate bar squares, with channels cut perpendicular to one another in a highly regular manner. Studies of tool marks indicate that pickaxes had been used for channeling, and on the underside of each block premade holes for wedging out the blocks had been cut (Østerås 2008) (Figure 9).

Although the rest of the quarry looked chaotic, the chocolate bar-pattern indicates a highly skilled way of cutting stone; we may assume that due to the shifting stone quality it was just not

Figure 8. *Excavated part of the Bakkaunet quarry, the open-cast section, prior to the building of an apartment complex by 2005. Array of soapstone blocks ready to be extracted. (Photo: P. Storemyr 2004).*

possible to use this method in all parts of the quarry. The bar-method reflects a skilled approach to the stone because channels were not carved around each block to be removed from the bedrock one by one, but over longer distances, aiming at removing several blocks in a coordinated operation. A very similar extraction method is known from other contexts, e.g. from Ancient Egypt (c. 2500 BC) onward. In this and similar contexts, however, the method was used for manual extraction of *very* homogeneous, bedded sandstone and limestone – especially from the New Kingdom on, through the Roman period in the Mediterranean and Europe, the Middle Ages and all the way up to the modern period, e.g. in Swiss sandstone quarries. The idea behind the method is to reduce the difficult cutting of corners around each block, thus improving extraction efficiency, especially when flat platforms can be established (as in homogeneous sandstone and limestone), which are then sunk step by step down to the quarry floor. We may call it the 'descending platform' method (Harrell & Storemyr 2015).

This method is not known from pre-medieval extraction of e.g. vessels in Norway, and it is also uncommon in other medieval soapstone quarries across the country. But it was used with success in the Øysand chlorite schist quarries mentioned above (Storemyr 2015a:190–191). Thus, we may speculate that the method was introduced to Norway by English quarrymen, presumably informed about Roman extraction techniques, since we know that the English-style Nidaros Cathedral to a significant extent was built by English master masons and stone carvers. The chlorite schist crops out along a valley slope, as a sub-horizontal, rather homogeneous, thick and soft bed within the greenstone geology. Such deposits are suitable for applying the descending platform method. It is likely that the medieval quarry masters and quarrymen took advantage of the knowledge obtained in the chlorite schist quarry, trying to transfer the technique to Bakkaunet. But due to geological circumstances, it was not possible to establish the desired, regular platforms – at least not in the open-cast part of the quarry. It may, of course, have been different in the presumed underground sections that we will speculate on below. Notably, we know of very similar, regular manual channelling for extracting soapstone blocks in the first half of the 20th century in the Vesleseterberget quarry by Otta in Oppland county, Norway, but also here it seems that the rock was too inhomogeneous for establishing regular platforms – and, notably, too inhomogeneous to be worked efficiently by modern means (drilling, wedging, black powder) (Storemyr 2015a:196–198)

Figure 9. *Close-up of an excavated part of the Bakkaunet quarry, prior to the building of an apartment complex by 2005. Soapstone block with carved-out wedge holes. (Photo: P. Storemyr 2004).*

Unfortunately, the excavated part of the Bakkaunet quarry has not yet been firmly dated, which would have been possible, given the presence of charcoal suitable for radiocarbon analyses. Thus, we do not really know if the stone extraction took place in the high-Gothic period, or rather in late medieval times. After the Black Death (1349–50) and due to political circumstances, as Norway ceased to exist as an independent kingdom, from now on being ruled from Copenhagen, it took more than 150 years before stone building practices again got a foothold. In the beginning of the 16th century, the octagon at Nidaros Cathedral was restored (Ekroll 2015), an operation that presumably involved extraction of Trondheim soapstone. Quarrying must also have taken place when the last medieval construction in the Trondheim region, Steinvikholm Castle, was erected between 1524 and 1532 (Storemyr 2015a 158–159, 245–247). Steinvikholm was the stronghold of the last Norwegian catholic archbishop, Olav Engelbrektsson, who fled the country as the Reformation was formally established in 1537. By then, Nidaros Cathedral and the neighbouring Archbishop's Palace, were also severely damaged, due to fire and warfare, respectively.

All this implies that the most active quarrying at Bakkaunet will have taken place over a 150-year period only, from c. 1200 to the mid-14th century. In addition to Nidaros Cathedral and the Archbishop's Palace, in this period soapstone resembling the one at Bakkaunet (generally called Trondheim soapstone, see above) was mainly used for decoration and to some extent ashlar (squared blocks) in finishing existing local and regional churches (e.g. St. Mary's church in Trondheim itself, Værnes church 30 km to the east of the city, and Sakshaug church 70 to the NE of Trondheim), but also in the original building period at Tautra monastery, 20 km NE of Trondheim. As at the cathedral, Trondheim soapstone can also be found in many of the regional churches and monasteries that were erected already in the 12th century, but to a much lesser extent (Storemyr 2003).

History of the quarry and use of the stone: The post-reformation period

One of the founders of historical research in Norway, Gerhard Schøning, was the first to mention the Bakkaunet quarry, in his detailed 1762-description of Nidaros Cathedral (Schøning 1762:29):

In some of the soapstone at the cathedral there are veins or layers of a harder, white mineral, which looks like flint or quartz. This stone is quarried by a hill just east of Trondheim, from where a huge amount has been transported, which can be seen from the room where the stone has been taken, and from where stone is still extracted. (Our translation)

Schøning's 'flint or quartz' most likely relates to the carbonate veins in the soapstone, but his 'room' in the quarry is more difficult to understand. Does he mean an actual underground gallery, or is the room rather referring to the depression-like, small valley in front of the steep hill? This area was called 'Gryta' (literally the pot or vessel) in modern times (Adresseavisen 4. March 1978; cf. Carstens 1939) (Figure 10), prior to the building of apartment blocks in the quarry. On aerial photos (see www.norgeibilder.no) it can be seen that Gryta was the largest open-cast section of the quarry, covering an area of roughly 70 m x 30 m. This section was probably a main target for quarrying in the latter half of the 19th century, as we shall see below.

Interestingly, Schøning informs us that stone was also extracted in the quarry by 1762. He cannot have meant that it was in regular operation, since there was very little use of the stone by then, as judged by relevant building activities known in the Trondheim area. Rather, he likely implies that occasional, smaller campaigns were carried out, whenever decorative stone was needed. It is, for example, probable that the stone was used to build the finest soapstone portal (around 1740) at the Kristiansten fortress in Trondheim (begun in the 17th century). This work was carried out by master mason Rasmus Banck, who also rebuilt St. Mary's church in the same period, likely with some use of Trondheim soapstone (Lysaker 1998).

And Schøning has more information, this time in his travel notes from the 1770s, when stone was still being extracted in the quarry, now for, among other features, the fine staircase at the royal residence in Trondheim, Stiftsgården (Schøning 1979b:7):

Further up, above the place where stone is now extracted, there has formerly been a large quarry, which now appears to be covered by scree (Our translation).

The 'large quarry' may be the same as 'the room' that Schøning mentions in 1762, but now hardly accessible, so that quarrying had to take place 'below'. It is difficult to understand exactly where this is; it might have been a part of the quarry that later (in the 19th century) would be covered by spoil.

Although we have no sources, it is not unlikely that minor extraction campaigns were also undertaken to provide stone for the King in Copenhagen. The second half of the 18th century was the dawn of the modern Norwegian stone industry, initiated by the Danish king in his appetite for Norwegian marble. But soapstone was also shipped to Denmark, e.g. from the Øysand quarries (Schøning 1979a:201), though it is unknown where the stone was actually used.

Trondheim had seen significant growth in economy and population through the 18th century, and in 1814 Norway obtained independence from Denmark. This initiated discussions about restoring Nidaros Cathedral, now half-ruined, but still the greatest symbol of Norwegian independence and history, with the 'glorious' Middle Ages a reference for new nation-building, art and architecture in the era of Romanticism. Similar trends were seen across Europe. Thus, after 50 years of investigation and heated debate, restoration and reconstruction of the cathedral begun in 1869 (Fischer 1965; Lysaker 1973). It lasted for more than a century, and the workshop established is still active in conservation and maintenance, as one of the largest in Europe. It is known as the Restoration Workshop of Nidaros Cathedral (abbreviated NDR in Norwegian).

Bakkaunet was one of the first quarries that were used for the restoration – a work that has involved deliveries from as much as 70 quarries across the country and to some extent abroad.

Figure 10. *Art historian Brage Irgens Larsen pointing out the Bakkaunet quarry prior to the last modern development in the quarry. (Photo: Adresseavisen, 4. March 1978).*

Helland, as already mentioned above, was very interested in the restoration, and he has given an intriguing description of Bakkaunet in his book on Norwegian slate and soapstone (*Tagskifere, heller og vekstene*) from 1893 (p. 174):

> *The old quarries at Bakkaunet have been reopened for the restoration of the cathedral, but since the stone has to be extracted by mining [NO: gruvedrift] and since economy did not allow for secure operation, work in modern times has been restricted to taking leftover stone and now operations have ceased. The stone is fine and blue and very suitable for decoration.(Our translation).*

Coupled with the previously mentioned sketch in Helland's book (Figure 7), which shows three adits, there can thus be very little doubt that underground quarrying took place in the Middle Ages, indeed. The question is how big such operations really were.

As Helland indicates, stone extraction for the restoration was not very extensive. On the basis of sources in the archives of NDR (account book of accountant Lundemo), we know that 460 m^3 of usable stone was delivered from the quarry, with a first extraction phase between c. 1870 and 1880, and the last one between 1892 and 1897 (cf. Storemyr 1997:appendix 2). Helland, writing around 1890, could, of course, not know that a serious attempt at larger-scale quarrying took place in the mid-1890s, but was abandoned by 1897 (cf. diaries of the architects in charge of the restoration, in NDR's archive; see also Storemyr 2015a:286–289). The ultimate reason for the failure was probably not related to economy, but to quarrying techniques: At the turn of the century, the quarrymen of the restoration workshop used standard contemporary methods (drilling, wedging and blasting with black powder), which, due to the uneven rock properties, were less suitable for quarrying at Bakkaunet. They needed much more homogeneous soapstone deposits for efficient extraction of large blocks, and they found such a deposit at Bjørnå by Mosjøen in Nordland County, 400 km north of Trondheim. This quarry became the key provider for the restoration over the next 60 years (Storemyr 2015a:315–323).

Recalling our interpretation of extraction at Bakkaunet in the Middle Ages, i.e. the trouble in establishing regular platforms for efficient quarrying, it is as if history repeats in the late 19th century. However, in the Middle Ages the quarrymen could not turn to distant deposits; they had no other option than working the Bakkaunet quarry, in addition to the Øysand quarries (where the restoration workshop had exactly the same problems as at Bakkaunet in the late 19th century, cf. Storemyr et al. 2002; Storemyr 2015a:284–287). Thus, we can conclude that the deposit must have been difficult to work, indeed. The question is whether it was like this in the underground parts of the quarry as well. Open-cast operations may have been abandoned both as a result of diminishing 'outdoor' volumes and the quality of the rock.

Spoil heaps and volumes extracted

If the Restoration Workshop had wanted to continue working the quarry beyond 1897 they probably would have had to reopen the underground adits and to resume the medieval method of manual channeling by pickaxes in order to produce suitable blocks for the restoration. This was out of the question back then, but the descision to abandon the quarry may also have been made against a general backdrop of residential areas expanding towards the quarry. According to historic maps, plans and photos (especially historic aerial photos in www.norgeibilder.no, from 1937 on), one of Trondheim's new 'building belts' was approaching the lower spoil heaps already by 1909, with the street Veimester Kroghs Gate winding its way literally within the quarry by 1932 at the latest (Bratberg 1996:68–69) (Figure 11 and Figure 12).

Prior to the 1980s, it was the spoil heaps that were regarded good building ground. By 1930 houses had been built on the two most substantial heaps in front of the quarry (A and B), with another house added a little later on a heap closer to the old extraction areas (C) (Figure 13). The latter house was built in the functionalistic style of the time and was, sadly, demolished when building the last residential block by 2005. Thus, heap C also vanished.

Clearly, road and house building required much levelling of the old spoil heaps, and currently, though also slightly levelled, heap A and B are the only ones relatively intact. They are substantial heaps, each about 40 m across and on average (according to detailed maps) some three m thick at the most. If we assume regularly sloping surfaces around the thickest point, this implies a volume of about 5000 m^3. Heap C adds another 2500 m^3. Then there is all the levelled spoil that presumably will equal the volume of the recognisable heaps. Thus, we end up with a total amount of spoil on the order of 15,000 cubic m^3.

Using this amount of spoil as a basis, it should be possible to roughly estimate the amount of sound stone extracted from the quarry and delivered for building purposes. The spoil will have a density of 1500–2000 kg/m^3, as opposed to bedrock soapstone with a density of about 2900 kg/m^3 (cf. http://www.simetric.co.uk/si_materials.htm).This implies that the volume of the stone heaps corresponds to a volume of soapstone bedrock of about 7–10,000 m^3. Of course, there will also be other stone, earth and whatever in the spoil heaps; thus, for the sake of simplicity, let's use 10,000 m^3 as a measure of the volume of solid bedrock that ended as waste.

Extracting stone with manual methods, as done in the Middle Ages, usually produces less spoil than in modern quarry operations, where the amount of waste regularly exceeds 90%. There are no known studies of the spoil rate in medieval building stone quarries, but if we use impressions from a range of quarries visited and studied, we can speculate that at least 50% of the stone extracted ended up as spoil in the Bakkaunet quarry, but probably not more than 80%. This implies that 3–10,000 m^3 of the extracted volume would have been useful for building purposes; let us use 7000 m^3 as a reasonable approximation. This is about half the volume of usable *freestone* that was delivered from all quarries to Nidaros Cathedral during the restoration period (1869–today). The largest quarry at Bjørnå in Nordland county provided 7500 m^3 alone (Storemyr 1997:appendix 2, based on primary sources in the NDR archive). More than half of the cathedral was reconstructed, which implies that

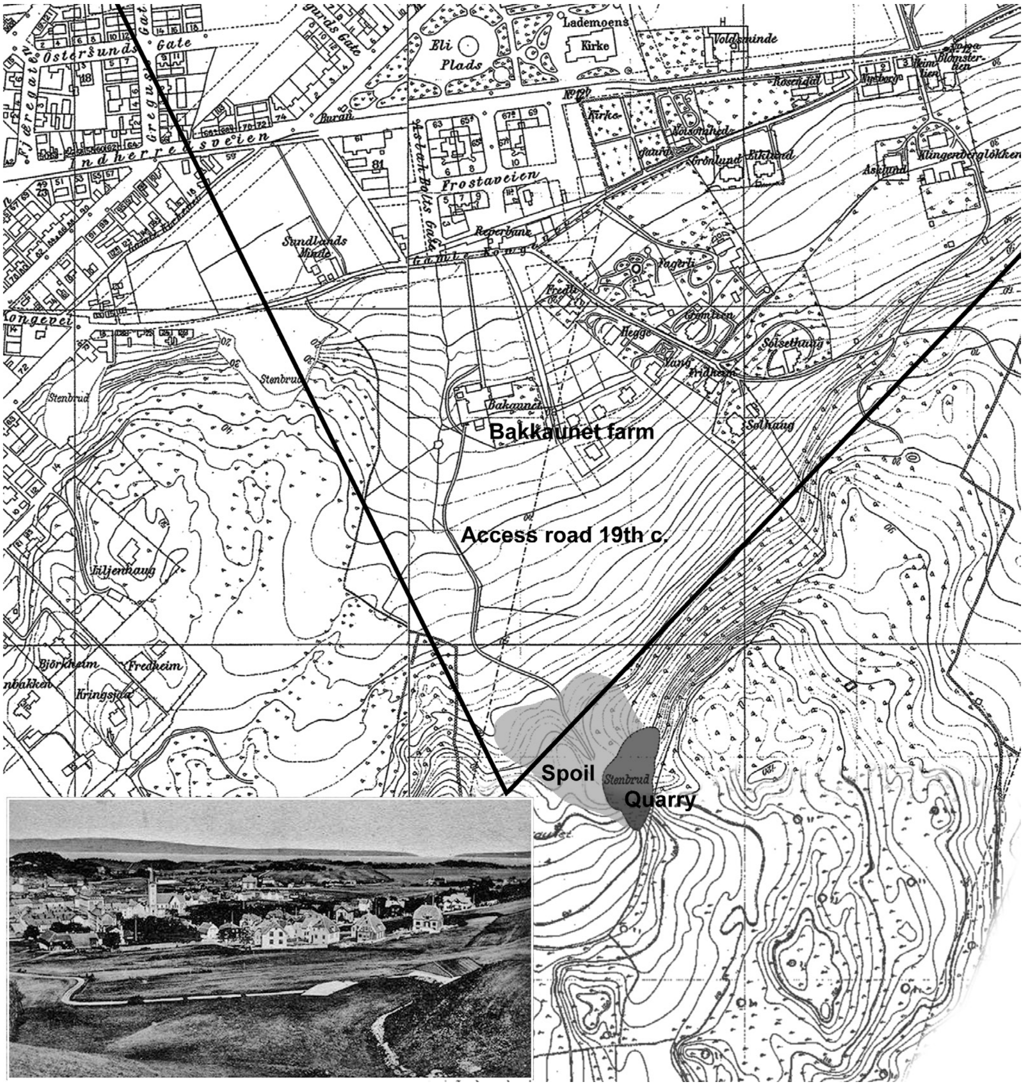


Figure 11. *Map of Bakkaunet quarry prior to the development into a residential area, by 1909, with the extent of the quarry indicated. (Source: www.strindahistorielag.no/Wikibilder/Lademoen%201909-red.pdf). Inserted: Photo of the quarry's spoil heaps and access road, looking north, shortly after 1900. (Source: www.strindahistorielag.no/wiki/index.php?title=Fil:M_Bakkeaunet_mot_Lade.jpg). Black lines indicating the view shown in the photo.*

some 25,000 m^3 of freestone would have been needed to build the whole cathedral in the Middle Ages.

But not all the stone from Bakkaunet ended up at the cathedral in the Middle Ages. We have to substract deliveries to other buildings in the Middle Ages, as well as the minor amount that was extracted in the post-reformation period. Thus, it is likely that a volume in the order of 5–6000 m^3 found its way to the cathedral. This would again imply that Bakkaunet provided about a fourth of the volume of freestone to the cathedral in the Middle Ages. This seems reasonable, given that the Øysand quarries, the other major provider, are bigger than Bakkaunet. In addition, we have to

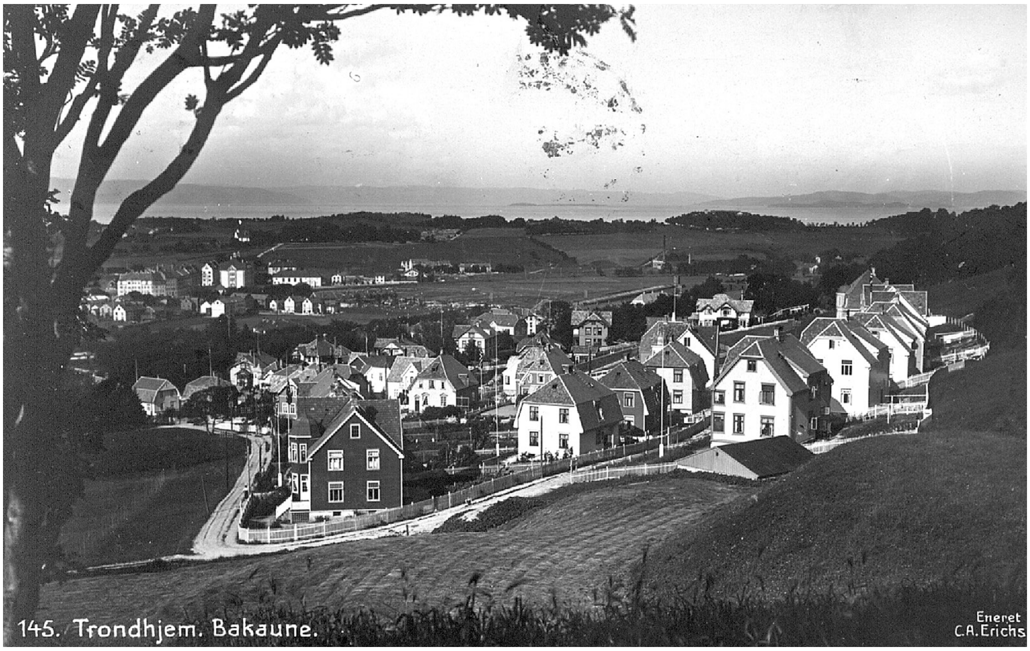


Figure 12. *Early developments into a residential area at Bakkaunet. Note that walls/fences have been constructed below the old spoil heaps of the quarry to protect the new houses (right part of the image). (Post card : C.. A. Erichs 1915).*

consider some deliveries from the lost quarries at Dyrborg in Trondheim (see above).

Turning to the total volume of stone extracted at Bakkaunet in the Middle Ages, i.e. usable stone plus spoil, the estimates above suggest about 15–20,000 m^3. Let us be conservative and assume 15,000 m^3. It is difficult to estimate the proportion extracted in the known open-cast section, which would have measured about 3000 m^2. In theory, it is possible that there was a substantial hill of soapstone in the small valley before quarrying commenced. Such hills or knolls of ice-scoured soapstone deposits are not uncommon in Norway (see e.g. Storemyr 2015a:337–344), but given the general topography and geology it is less likely that a hypothetical knoll of soft soapstone would have survived erosion by the Ice Age glaciers at Bakkaunet. It is more probable that the sopstone deposit cropped out as a narrow band along the foot of the hill and that most of this area was 'peeled off' by open-cast operations. If, on average, the upper one to two m of the area (3000 m^2) was removed, the open-cast quarry operations would have produced, say, 5000 m^3 of usable stone and spoil. Thus, it may very well be that as much as two thirds of the stone volume was extracted in the underground sections of the quarry in the Middle Ages, i.e. up to 10,000 m^3.

All these estimates cannot, of course, be correct. There are way too many uncertainties preventing us from arriving at secure volumes. However, we think they give us *an idea of the order of magnitude*. 10,000 m^3 of stone extracted underground is a very large volume. It is a hall 10 m high, 10 m wide and 100 m long. If it is evenly distributed on the three adits mentioned by Helland (1893), it would mean that more than 3000 m^3 were extracted in each of them. This is a room 10 m high, 10 m wide and 30 m long (or 5 m x 5 m x 120 m, or 2 m x 2 m x 750 m). Even if only half of the stone was extracted underground, the space developed would still be substantial, and probably larger than known underground quarrying operations in Norway in the Middle Ages, with the bakestone quarries at Ølve/Hatlestrand and the soapstone quarries in Hardanger as the most important ones.

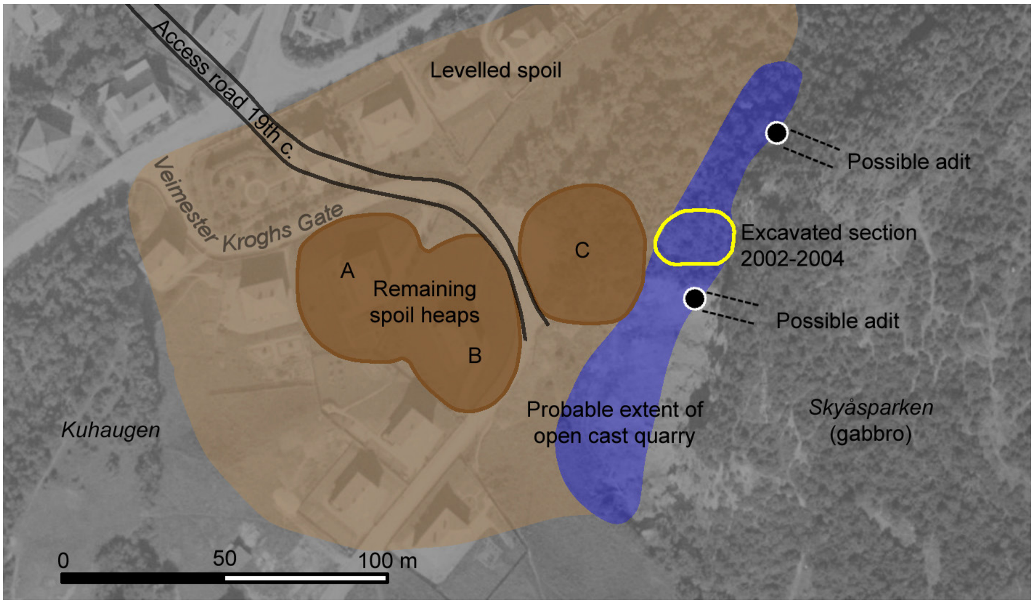


Figure 13. *Reconstruction of the Bakkuanet quarry by the beginning of the 20th century, as the development to a residential area started. Reconstructionby Per Storemyr based on all availaible sources mentioned in the text. Location of adits for underground operations are indicative. Base map: Aerial photo from 1937. (Source: www.norgeibilder.no).*

Underground quarry types

At the moment there is no way that we can find out how the underground operations at Bakkaunet were actually carried out. But we can speculate on the basis of knowledge from other underground quarries. There are few historic underground quarries in Norway. The most substantial ones are located at Ølve and Hatlestrand in Hardanger in Western Norway, where soft chlorite schist bakestone and building stone were extracted from the Middle Ages on (Baug 2015, this vol.; Jansen & Heldal this vol.). This is one of the largest medieval quarry landscapes in Norway, and a substantial part of the stone was quarried in underground galleries several tens of metres long and deep. In each of the largest quarries, e.g. Hedlebergshidlaren and Mannahidlaren, more than 3000 m^3 were extracted. However, it is likely that major parts of the quarrying took place after the Middle Ages; thus the extent of underground activities in the Middle Ages is yet poorly known. These are typical gallery quarries, situated at the bottom of cliffs, where extraction followed thick, sub-horizontal layers of homogeneous soft chlorite schist into the bedrock, implying that there was a need to leave substantial pillars in order to prevent the gallery roofs from caving in (Baug 2015, this vol.). Such quarries are widespread across the Mediterranean and Europe, with particularly fine examples known from Bronze Age Egypt (e.g. at Gebel el-Silsila, cf. Harrell & Storemyr 2015) (Figure 14).

The few known underground soapstone vessel quarries in Norway are of an entirely different nature, with the largest ones located at the Folgefonna penninsula, near Kvitno and Måge in Hardanger (Skjølsvold 1961:70–75). These are adit quarries, up to 40–50 m long, but so narrow that they are often difficult to enter. The idea behind excavating such quarries was apparently to follow a good vein of soapstone and there was no need to leave pillars for securing the quarries, even though they occasionally may widen to minor halls. Clearly, they produced much less stone than the gallery quarries at Ølve and Hatlestrand, often only a few tens of m^3. Smaller adit quarries are also known at

Figure 14. *Typical ancient gallery quarry with pillars supporting the roof from caving in, here from New Kingdom Egypt (Gebel el-Silsila, Upper Egypt, c. 1500 BC). (Photo: T. Heldal).*

Slipsteinsberget in Sparbu (Central Norway) (Østerås 2002, this vol.) and by Piggåsen at Romerike (north of Oslo) (Skjølsvold 1961:71).

The third type of underground soapstone quarries is a variety of the adit quarries, but these are not known in Norway. They are typically developed with an adit for accessing larger volumes of usable stone within the rock, and so the adits widen significantly, often into large halls, with or without pillars. Such quarries are found in Switzerland and North-Italy, where they have a history back to the Roman period (e.g. Rütimeyer 1924; Lhemon & Serneels 2012). But they were typically developed for manual extraction of soapstone for ovens in the early-modern era, for example at Bagnes, close to the famous winter resort Verbier. One of the authors (Storemyr) has visited the quarries at Bagnes, where a narrow adit starts high up in a steep mountain slope for accessing a bigger volume of soapstone within the mountain. The adit widens into irregular and regular, often large halls, several tens of metres from the entrance (Figure 15).

A fourth type of underground quarries is not so relevant in our case; quarries developed in homogeneous limestone and sandstone deposits beneath the ground in flat-lying terrain. In such cases adits or shafts were dug to develop regular halls (with pillars) at a specific level, such as the huge quarries below Paris (Suttel 1993) and Caen (Dungué et al. 2010) in France. However, these quarries were not opened before the late- and post Medieval periods; in the Middle Ages open-cast extraction of building stone was the rule throughout Europe, with quarries typically developed along sloping terrain.

Given that Helland marked three adits on his sketch of Bakkaunet, it is unlikely that this quarry was developed as a gallery quarry. It is also unlikely that only narrow adits were used to carve out stone. If this were the case, the adits would be literally hundreds of metres long – a very inefficient

Figure 15. *Early-modern underground soapstone quarry for production of soapstone ovens at Bagnes by Verbier in the Swiss Alps. One of the halls that can be accessed by a narrow adit, several tens of metres from the surface. (Photo: P. Storemyr).*

way of quarrying large amounts of building stone – and not least of transporting the stone out. Thus, the most likely design is something similar to the quarries at Bagnes in Switzerland: Adits, perhaps also shafts, cut to get access to a larger volume of soapstone, which was extracted in more or less regular halls, with or without pillars.

This, of course, has to remain a hypothesis until future investigations can be carried out. For the underground quarries must still be there, and given that we may possibly have located the wherabouts of two of the openings (see above, Figure 13), future studies ought to first concentrate on these places. If permission is granted, such a project would clearly become extremely expensive due to problems with security (rock fall and the like). Or perhaps it would be possible to explore the underground indirectly by geophysical methods?

Transportation

From old maps (Figure 11) we can see that the 19th century access road entered the quarry in the traditional manner – between spoil heaps. It wound its way down to the Bakkaunet farm and probably took the straight route into the town, along Nedre Bakklandet, across the bridge Gamle Bybro and west to the cathedral workshop (Figure 4). Although this transport route is not mentioned in any sources, we know that a private carriage driver named Vinnan was responsible for transportation through the 1870s and that it was done by horse carriage in summer and sledge in winter, with sledge slightly more expensive than carriage (Storemyr 2015a:288–289). It is not straightforward to suggest that the same 2.5 km long route was taken in the Middle Ages, since the only bridge across river Nidelva at that time was the so-called Elgeseter Bridge, located to the south of the cathedral. This bridge is mentioned for the first time in 1178 and it is not entirely unlikely that its construction was related to transportation of stone from Bakkaunet, in addition to easing general transport from the south into the town, as well as from Elgeseter monastery (Figure 4). The bridge must have been reconstructed in the second half of the 13th century, as indicated by dendrochronological analyses of the preserved timber structures below modern Elgeseter Bridge (Sylvester & Ødegård 2010; cf. Storemyr 2015a:207–208).

If Elgeseter Bridge were used for stone transport in the Middle Ages, the route from the quarry may have been similar, but slightly longer, than in the 19th century. Or it may have followed a more direct route that descended to the bridge slightly south of Kristiansten fortress (built in the 17th and 18th centuries) and today's Singsaker area. But it is also possible that stone was just ferried across the river by today's bridge Bakke Bru (built in the late 19th century), which would have meant a slightly shorter transport route. We know that this was a traditional ferry place before the building of the bridge (http://www.strindahistorielag.no/wiki/index.php?title=Bakke_bru), and – given the key location in the town, just by a (now disappeared) medieval tower/fortress (Ekroll 1995) – it is likely that this tradition goes back to the Middle Ages or beyond. Sledges carrying stone, driven by oxen or horse, may simply have been placed on rafts and taken across the river.

Due to the general lack of roads constructed for carriage, which first appeared in the 17th century, in the beginning related to the transportation of silver from the mines at Kongsberg to Drammen (e.g. Sellæg 2002), we have no indications that carriages were used for stone transport in the Norwegian Middle Ages. Thus, sledges probably was the rule, summer and winter (it is well known that sledges were used to transport heavy stones away from agricultural fields in the summertime, even in the 20th century, see e.g. www.digitaltmuseum.no, query: 'slede stein'). Yet, we cannot entirely rule out that a specific road was constructed for carriage transport from the quarry to the cathedral. After all, it would have eased transport significantly.

Quite a few loads must have been driven from the quarry to the cathedral. If we assume that 6000 m^3 were taken to the cathedral in the 150-year period from c. 1200 to 1350, this implies an annual output of some 40 m^3 (which is about half of the average annual output from Bjørnå, the largest quarry operated during the restoration of the cathedral, cf. above). Assuming activity in the Bakkaunet quarry for some six months each year, and that each load would have weighed about 500 kilos, we end up with about two sledge loads a day (or between 30,000 and 40,000 loads in total).

However, there would have been hectic periods of greatly enhanced activity, both at the building site and in the quarries, and in these periods we have to assume that stone was shuttled to the cathedral much more frequently. We can make comparisons with stone transport during the hectic building and restoration of small stone churches in the late 19th century, such as Orkdal church south of Trondheim, where 6731 loads of stone were needed over a two-year period, i.e. about nine loads per day (Leland 1993:67).

Ownership, funding and income

One of the possible transport routes would have passed Bakke convent (probably of the Benedictine order), one of the five medieval monasteries in Trondheim, about one km from the quarry. The convent is mentioned by 1150 and was probably founded by the king (Bratberg 1996:72). Bakke became a mighty convent and a very big landowner in central Norway. By 1430 it would also have owned Bakkaunet, since the quarry at that time was part of the farm Skyås, which was in the possession of the convent. However, it is important to note that Skyås, according to archbishop Aslak Bolt's list of possessions, seems to have been 'transferred' (sold?) to Bakke monastery at some time prior to 1430 (Jørgensen 1997:51 A, B; cf. Dybdahl 1996). This could imply that the farm – and the quarry – formerly was in the hands of another owner, perhaps the Archbishopric (established by 1152/53). This would agree with our knowledge about the ownership of land on which all other medieval quarries used for Nidaros Cathedral in the Middle Ages were located: The land was firmly in the hands of the Archbishopric. Yet, the quarries may originally have been on private land, later perhaps confiscated by the King, as part of the state formation efforts commencing in the Viking Age and early Middle Ages (Storemyr 2003, 2009, 2015a).

If this is correct, a reasonable explanation is that the King, and later the Archbishopric, were keen on controlling the quarries, especially the freestone quarries, which were very scarce resources, greatly needed for building the cathedral and other churches; as a means for sustaining both Christianity and the State and thus power. In practice, this would mean that the quarries, by the 12th century onward, were owned by the Archbishopric, financed by the cathedral fabrica (the fund usually established for cathedral construction and maintenance, cf. Knoop & Jones 1933; Vroom 2010) and operated, probably, by the cathedral workshop (or lodge). It was similar in many parts of Europe (cf. Salzman 1967:119–139; Binding 1993:312). This, of course, implies that there was nothing to earn from the quarrying for the fabrica as regards stone procurement for the cathedral. There were only expenses (e.g. wages for the quarrymen).

However, there is the possibility that the fabrica could earn money on stone extraction at Bakkaunet (and elsewhere) for *other* purposes than building the cathedral. Ashlar, moulding and decoration, even raw blocks, may have been commissioned by patrons and master builders and sold to build other local and regional churches in the Trondheim region. This is a reasonable interpretation, given that stone from the cathedral quarries were used in many of the local and regional churches (Storemyr 2003, 2015a, cf. above). A testimony to the cathedral's influence is the many, specific masons' marks that can be found not only at the cathedral itself, but also at local and regional churches – and, moreover, that the stylistic traits of the cathedral are repeated in the local and regional stone churches (e.g. Ekroll 1997). Yet, we have to recall that it was very much in the interest of the Archbishopric to get the local and regional churches built, especially in the latter half of the 12th century, and so it is not entirely unlikely that they were given rights to extract stone without other compensation than payment of the workforce. Supporting the latter is a paragraph in the Central Norwegian Law (*Frostatingsloven*) on privileges as to stone extraction (Larson 2011:323 [VII, 26] see also Ekroll 1997:276):

> *And if stone (or the sort) that is needed for a church is found on any man's land, a man may break [quarry] what is needed; but it is more proper to ask (permission), though the owner has no right to refuse.*

Though *Frostatingsloven* was written in the middle of the 13th century, it is likely that it reflects common practice also earlier. The paragraph is probably less democratic than it looks; it may simply have given the elite, i.e. those that were responsible for building costly stone buildings (king, church, monasteries, and aristocracy) access to any useful deposit of stone, wherever it was located. But the question is, of course, whether an already active quarry, such as Bakkaunet, was looked upon in a similar way. We know of no historic sources to inform us in this matter.

As we have seen above, it is, in theory, possible that the nearby Bakke convent owned the Bakkaunet quarry from the 12th century on. If so, it may have increased its wealth by selling stone or, more likely, renting the quarry to the cathedral fabrica. The latter is the more probable option because the local cathedral workshop must have possessed superior skills to extract stone. In other words: it may not have been easy for a nunnery to employ quarrymen to do the same – and then sell off stone to the cathedral. Also, cathedrals renting quarries was a rather common practice on the British Isles (and elsewhere), whether the owner was a monastery or a private landlord (Salzman 1967:119–139). However, monasteries could, in fact, also *sell* stone to building projects, whether to cathedrals or secular constructions (Knoop & Jones 1933:10). Such a situation may, interestingly, have occurred in Norway in the 12th and 13th centuries, at the Cistercian Lysekloster Abbey, which may have sold soapstone from its own quarry to building construction in Bergen (Hommedal this vol.).

Anyway, the procurement of stone to build cathedrals and churches in the Norwegian Middle Ages was in all likelihood not undertaken by private companies, controlled and run by a private quarry master. Even the procurement of utilitarian stone for true commercial markets (like grinding stone and bakestone), was basically controlled by elite institutions, such as bishoprics, monasteries or very rich landowners (see especially Baug 2015, this vol.). The building stone market in Norway probably was too small for private enterprises to get a foothold, which is, presumably, a different situation from large parts of mainland Europe and the British Isles, where commercialisation of building stone procurement started in the high – late Middle Ages. By then, patrons and builders could buy standard moulding and tracery (or other objects) directly from the biggest quarries, like Caen in France and many quarries in England, e.g. Purbeck in Dorset (Salzman 1967:119–139).

Who worked in the Bakkaunet quarry?

There is too little space available to discuss all the possible modes of organisation of the Bakkaunet quarry, drawing e.g. from what we know from English medieval sources. As is very well known, there are hardly any preserved, written sources on stone extraction in the Norwegian Middle Ages. Yet, it seems clear that building in central Norway was heavily influenced by English models – and craftsmen, for instance from York (Syrstad 2001) – and so we have to assume that also stone procurement, at least to some extent, followed English patterns. Bakkaunet and other Norwegian quarries were usually smaller than many of their English counterparts, but, as we have seen, we can use the organised way that open-cast operations in this quarry (and at Øysand) was carried out as an indication of skills that went far beyond traditional stone procurement in the region – and also the fact that underground operations were initiated.

Much of what has been written on stone delivery to church building in Norway has focused on a paragraph in the Frostatingsloven, which imposed free farmers and farmers that rented land (*leilendinger*) to deliver stone to the building of county churches (*fylkeskirker*). There is, in other words, an element of forced labour in the paragraph, but it is not unlikely that this relates to the delivery of simple rubble stone (not freestone), from which many of the county churches are built (cf. Storemyr 2015a:19–23). But there is also another intriguing note, often overlooked, in King Sverri's Saga on quarry work, from the civil war period, about 1189–1190. King Sverri talks to Archbishop Eirik Ivarsson, his enemy (Sephton 1899:145 [chapter 117]):

> *I should think it more righteous before God if the Archbishop had no Guardsmen beyond what is lawful, for no one will plunder him or the church property, and if he used the cost to set men to the quarries, to transport stone, to do masons' work, so as to advance the building of the minster, for which preparations have already been made.*

A reasonable interpretation of this statement, which refers to one or several quarries in the Trondheim region, is that quarry and transportation work aimed at providing freestone for the cathedral was indeed paid work. We can compare this with the famous York Fabric Rolls, related to the building of York Minster, from the 14th century on, with their detailed accounts of all elements of quarry operations; from rent of quarries, payment of quarrymen to repair of stone transport routes (for a overview, see Moorhouse 2007). From other English sources we get the impression that quarrymen could have a diverse background, sometimes unskilled (but surely with often great experience), sometimes expert stone masons temporarily extracting stone, sometimes specialist quarriers, the latter of which implies that they were regarded as craftsmen, albeit at the lower end of the scale, and thus they were free to climb the career-ladder (Salzman 1967:126; Knoop & Jones 1933:75–78; see also Binding 1993:312–313 for the situation in Central Europe, where specialist quarriers were often called *Steinbrecher*).

Importantly, many quarries became nurseries (places of recruitment) for stone masons that finally ended up as stone carvers at cathedrals and other stone building works (Knoop & Jones 1933:75–78).

This is, in fact, a very similar situation to what happened in central Norway when many old and new quarries were (re)opened as the major restoration and reconstruction works at Nidaros Cathedral took place from the late 19th century on: Local guys looking for work often started their careers to become specialist stone masons and stone carvers as unskilled quarry workers. They eventually had to finish more or less formal education as masons (Storemyr 2015a:259ff).

Surely, we cannot directly transfer such accounts to the Bakkaunet quarry in the Middle Ages. In particular, it is often difficult to interpret who were really involved in medieval quarry work since there were so many different types of quarries that provided diverse types of stone (from rubble and rag to freestone) – all of which required different types of craftsmanship and skill. Also, many quarries in England and elsewhere in Europe provided finished and half-finished products, like standard mouldings and tracery, from the high – late Middle Ages onward, as we have seen above. This implies that highly specialised stone carvers were active in the quarries themselves, and not just at the building sites. We have found half-finished ashlars at Øysand, (Storemyr et al. 2010), but never finished moulding or tracery in Norwegian freestone quarries. Given the limited archaeological excavations that have been carried out, this certainly does not mean that finishing never happened.

In conclusion, given that Bakkaunet was a valuable freestone quarry, we believe that a range of workers with different skills were active in the quarry in the Middle Ages; from specialist (perhaps also foreign) quarriers and perhaps a few stone masons, to local lads looking for employment, some of whom may eventually have ended up at the cathedral workshop as specialist stone carvers. In addition, the operations must have involved a range of workers responsible for everything from carrying stone to preparing food, as well as an expert smith to operate the smithy.

This said, we understand that running a big quarry was not very different from running the complex construction of a major building, like Nidaros Cathedral. Many types of skills were needed – and the workforce had to be supervised in one way or another. Supervision, including anything from planning stone extraction to paying the workforce, is in itself a field of study, but in substantial English and European quarries it was done by a quarry master, just as it had been done in the Roman world – and thousands of years ago in Ancient Egypt (Storemyr 2015a).

Concluding remarks

Building Nidaros Cathedral was based on very scarce freestone resources, as opposed to England and much of Europe with their big, homogeneous limestone and sandstone deposits. But, as we have seen, there are strong indications that the medieval quarry masters and quarrymen were experienced enough to embark on underground quarrying in order to solve the stone delivery problems. This, suggested, development at Bakkaunet to become a key provider of soapstone for a full-fledged Gothic cathedral in the 13th century can be better understood when also including other stone resources that were needed, in particular marble.

Roughly at the same time as Bakkaunet may have developed to the largest contemporary Norwegian underground quarry, delivery of marble for columns commenced – from a quarry on the small island of Allmenningen, off the coast at Fosen, some 140 km north of Trondheim (Figure 1 and 16). The use of marble for free-standing columns started in the late 12th century and was in all likelihood directly inspired by the contemporary English developments, which resulted in most English cathedrals being equipped with columns of Purbeck marble or its substitutes, such as Frosterly marble (Storemyr 2015b:90–101; Blair 1991). As far as we know, Nidaros Cathedral is the only other building in Europe that became part of the same fashion or tradition. One the one hand, this shows how English developments influenced building in Trondheim, on the other hand it underpins the

Figure 16. *Part of the substantial medieval marble quarry at the island of Allmenningen off the coast of Central Norway, some 140 km north of Trondheim. This quarry produced about 10.000 marble shafts in the Middle Ages. Wedge holes for splitting blocks can be seen on the picture. (Photo: P. Storemyr).*

will, knowledge – and economy – for exploration and engineering.

For the Allmenningen quarry did not provide a couple of columns only, but on the order of 10,000 shafts, up to six m long, mainly in the 13th century. Situated close to the coastal shipping route, it would not have been awfully difficult to develop the quarry, yet a costly infrastructure would have been needed for extraction and shipping, as well as for carving and polishing (Storemyr 2015a:219–223; Storemyr 2015b).

Development of a major underground soapstone quarry in the same period fits, we believe, very well with the marble exploitation. Though both rather short-lived, these were major industries that developed in a crucial period in Norwegian history. They were, after all, meant for the largest cathedral in the North, comparable to many of its sisters in England and on the Continent. On this backdrop, it is very sad that the open-cast parts of Bakkaunet quarry has been successively destroyed, the last phase of which happened just a decade ago – with the blessing of the cultural heritage authorities. Thus, we hope that this paper may also be a contribution to future preservation of medieval and other old quarries throughout Norway. Old quarries are key resources for understanding building practices in the Middle Ages.

Acknowledgements

This paper is based on fieldwork and various studies relating to the Bakkaunet quarry over a period spanning more than 20 years. The authors wish to thank Bodil Østerås and Nina Lundberg for discussions on the archaeology of the quarry, as well as The Restoration Workshop of Nidaros Cathedral and The Geological Survey of Norway for support. Many thanks also to reviewers Gitte Hansen and Stephen Wickler for comments and suggestions that significantly improved the manuscript.

References

Alsaker, S., Sognnes, K., Stenvik, Skevik, O. & Røskaft, M. 2005. *Trøndelags historie. Landskapet blir landsdel. Fram til 1350*, vol. 1. Tapir Akademisk Forlag, Trondheim.

Baug, I. 2015. *Quarrying in Western Norway. An archaeological study of production and distribution in the Viking period and Middle Ages*. Archaeopress, Oxford.

Binding, G. 1993. *Baubetrieb im Mittelalter*. WBG, Darmstadt.

Blair, J. 1991. Purbeck marble. In Blair, J. & Ramsay, N. (eds) *English medieval industries: craftsmen, techniques, products*. The Hambledon Press, London, 41–56.

Bratberg, T. 1996. *Trondheim byleksikon*. Kunnskapsforlaget, Oslo.

Carstens, C. W. 1939. Det faste fjell. *Strinda Bygdebok*. Trondheim 1, 1–18.

Dugué, O., Dujardin, L., Leroux, P. & Savary, X. 2010. *La Pierre de Caen. Des dinosaures aux cathédrales*. Charles Corlet Eds, Caen.

Dybdahl, A. 1996. *Matrikkel over sentraleid jordegods i Trøndelag på reformasjonstiden*. Skrifter, Senter for Middelalderstudier 3. Norwegian University for Science and Technology, Trondheim.

Ekroll, Ø. 1995. To kastell i Jämtland – og eitt i Trondheim. *Spor*, 1–1995, 36–39.

Ekroll, Ø. 1997. *Med Kleber og kalk. Norsk steinbygging i mellomalderen 1050–1550*. Samlaget, Oslo.

Ekroll, Ø. 2015. The Octagonal Shrine Chapel of St Olav at Nidaros Cathedral. An Investigation of its Fabric, Architecture and International Context. Ph.D.-thesis 2015:295. Norwegian University of Science and Technology, Trondheim.

Fischer, G. 1965. *Domkirken i Trondheim*, vol. 1 & 2, Forlaget Land og kirke, Oslo.

Følstad, E. 2002. Kleberbruddet i byen. *Spor*, 2002–2, 30–32.

Fossen, H., Pedersen, R. -B., Bergh, S. & Andresen, A. 2008. Creation of a mountain chain. In Ramberg, I. B., Bryhni, I., Nøttvedt, A. & Rangnes, K. (eds) *The Making of a Land – Geology of Norway*. Norsk geologisk forening, Trondheim, 178–231.

Harrell, J. A. and Storemyr, P. 2015 [2013]. Limestone and sandstone quarrying in Ancient Egypt: tools, methods and analogues. *Marmora – an international journal for archaeology, history and archaeometry of marbles and stones*, 9, 19–43.

Heldal, T. & Storemyr, P. 1997. Geologisk undersøkelse og arkeologisk registrering av de middelalderske bruddene ved Øye, Klungen og Huseby i Sør-Trøndelag. Report 97.149, *The Geological Survey of Norway*, Trondheim.

Helland, A. 1893. *Takskifre, heller og vekstene*, NGU, 10.

Jørgensen, J. G. 1997. *Aslak Bolts Jordebok*. Riksarkivet, Oslo.

Knoop, D. & Jones, G. P. 1967 [1933]. *The Medieval Mason*. Manchester University Press, Manchester.

Larson, L. M. 2011. *The Earliest Norwegian Laws*. Columbia University Press, New York [originally published 1935].

Leland, E. *Orkdalskyrkja* på Grøtte i 900 år. Orkdal menighetsråd, Orkdal.

Lhemon, M. & Serneels, V. (eds) 2012. Les récipients en pierre ollaire dans l'Antiquité. *Minaria Helvetica*, 30.

Lundberg, N. 2007. Øye – en arkeologisk undersøkelse av et klorittskiferbrudd. Unpublished MA-thesis, Norwegian University of Science and Technology, Trondheim.

Lysaker, T. 1973. *Domkirken i Trondheim*, vol. 3. Forlaget Land og Kirke, Oslo.

Lysaker, T. 1998. Vår Frue kirke i Trondheim. Fra brannen i 1681 til det definitive tårn i 1742. *Trondhjemske samlinger*, 7–50.

Moorhouse, S. 2007. The quarrying of building stone and stone artefacts in medieval Yorkshire: a multi-disciplinary approach. *Ruralia*, VI, 295–319.

Nikolaisen, R. U. 2011. Analyse av ingeniørgeologiske problemstillinger for Strindheimtunnelen. Unpublished

MSc-thesis, Norwegian University of Science and Technology, Trondheim.
Rütimeyer, L. 1924. Gefässe aus Topfstein und Geschichte der Topfsteinindustrie. In Rütimeyer, L. (ed.) Urethnographie der Schweiz*, Schweiz. Gesellschaft für Volkskunde*, 16, 94–143.
Salzman, L. F. 1967 [1952]. *Building in England down to 1540*. Oxford University Press, London.
Schøning, G. 1762. *Beskrivelse over den tilforn meget prægtige og vidtberømte Dom-Kirke i Throndhjem, egentligen kaldet Krist-Kirken*, Trondheim.
Schøning, G. 1979a [1778]. *Reise, som gjennem en Deel af Norge i de Aar 1773, 1774 og 1775 paa H. M. Kongens Bekostning er gjort og beskreven*, vol. 1. Tapir, Trondheim.
Schøning, G. 1979b [1778]. *Reise, som gjennem en Deel af Norge i de Aar 1773, 1774 og 1775 paa H. M. Kongens Bekostning er gjort og beskreven*, vol. 2. Tapir, Trondheim.
Sellæg, J. 2002. *Sølvveien: landets første kjørevei*. Statens vegvesen, Buskerud
Sephton, J. 1899. *Sverrissaga – The Saga of King Sverri of Norway*. David Nutt, London.
Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden*. Universitetsforlaget, Oslo.
Stige, M. 1997. Stavangerkorets utvidelse og innflydelse. Unpublished master thesis, University of Oslo.
Storemyr, P. 1997. The Stones of Nidaros: An Applied Weathering Study of Europe's Northernmost Medieval Cathedral. Ph.D.-thesis 1997:92. Norwegian University of Science and Technology, Trondheim.
Storemyr, P. 2001. Restaurering av koret i Stavanger domkirke. De ytre fasadene 1997–1999. *Fortidsminneforeningens årbok*, 63–74.
Storemyr, P. 2003. Stein til kvader og dekor i Trøndelags middelalderkirker. Geologi, europeisk innflytelse og tradisjoner. In Imsen, S. (ed.) *Ecclesia Nidrosiensis* 1153–1537. *Søkelys på Nidaroskirkens og Nidarosprovinsens historie. Tapir,* Trondheim, 445–463.
Storemyr, P. 2015a. *Nidarosdomens grunnfjell. En reise i steinbryternes fotspor fra Det gamle Egypt til Europas nordligste katedral*. Nidaros Domkirkes Restaureringsarbeiders forlag, Trondheim.
Storemyr, P. 2015b. The medieval quarries at Sparbu: A Central Norwegian 'little sister' of the Purbeck quarry landscape in England. In Indrelid, S., Hjelle, K. L. & Stene, K. (eds) *Exploitation of Outfield resources – Joint research at the University Museums of Norway*, *Universitetsmuseet i Bergen Skrifter*, 32, 141–154.
Storemyr, P., Berg, A. & Heldal, T. 2002. Problems in reopening medieval stone quarries: A study of Norwegian failures. In Lazzarini, L. (ed.) *ASMOSIA 6, Interdisciplinary Studies on Ancient Stone*. A. Ausilio, Padova, 63–72.
Storemyr, P., Lundberg, N., Østerås, B. & Heldal, T. 2010. Arkeologien til Nidarosdomens middelaldersteinbrudd. In Bjørlykke, K., Ekroll, Ø. & Syrstad Gran, B. (eds) *Nidarosdomen – ny forskning på gammel kirke*. Nidaros Domkirkes Restaureringsarbeiders forlag, Trondheim, 238–267.
Suttel, R. 1993. *Catacombes et carrieres de Paris*. Éditions du Treuil, Chatillon
Sylvester, M. og Ødegård, Ø. 2010. Broen over elven. *Spor*, 1–2010, 8–11.
Syrstad, M. 2001. Smekre vannliljekapiteler og rike chevroner: Spor av Yorkbygghyttens folk i Trondheims- og Bergensområdet 1160–80. *Fortidsminneforeningens årbok*, 75–89.
Vroom, W. 2010. *Financing Cathedral Building in the Middle Ages*. Amsterdam University Press, Amsterdam.
Østerås, B 2002: Klebersteinsbrotet på Sparbu. Kva undersøkingar av eit klebersteinsbrot kan fortelje om gamle steinhoggartradisjonar. Unpublished master thesis, Norwegian University of Science and Technology, Trondheim.
Østerås, B. 2008. Rapport arkeologisk utgraving. Klebersteinsbrotet på Bakkaune, Veimester Krohgs gate 2B, Trondheim, Sør-Trøndelag. Report, University Museum, Norwegian University of Science and Technology, Trondheim.

Internet sources

DigitaltMuseum: http://www.digitaltmuseum.no
Norge i bilder: https://www.norgeibilder.no/
Kartverket: http://kartverket.no/Kart/Historiske-kart/Historiske-kart-galleri/#16/28/4).
Simetric: http://www.simetric.co.uk/si_materials.htm
Strinda historielag: http://www.strindahistorielag.no/
Trondheim byarkiv: www.flickr.com/photos/trondheim_byarkiv, licence CC BY 2.0

Torbjørn Preus Schou

Trade and Hierarchy: The Viking Age Soapstone Vessel Production and Trade of Agder, Norway

The Viking Age soapstone vessel production and trade in Norway was a spatially allocated enterprise due to limited access to raw materials and the logistically confining topography of the country's rugged landscapes. In the southernmost Norwegian region of Agder, vessel production was concentrated along the waterways of the river Nidelva, which empties into Skagerrak near the agriculturally and archaeologically rich farms on the moraine soil of the Fjære parish. The research presented here looks into a number of aspects related to the soapstone industry of the Agder region, from the quarries and production sites, via distributional and topographical patterns, to the trade and consumption of the products. The implications of the soapstone industry for power structures and hierarchical developments of Agder during the Viking Period are addressed on a local scale as well as within a larger chronological and spatial context.

Introduction

Norwegian Viking Age sites (c. AD 800–1030) are commonly characterised by almost total absence of ceramic vessel fragments, apart from rare occurrences of imported ware in central settlements, such as Kaupang (cf. Skre 2007a). Instead, soapstone vessels seem to have completely replaced local pottery production around the beginning of the Viking Age, and judging from the archaeological assemblages of the period, these constituted the main domestic equipment for storage and cooking – in addition to iron pots and wooden vessels (Petersen 1951:380; Lossius 1977:13). Significant for archaeological studies, soapstone vessels do not appear in contexts dated to the period between the pre-Roman Iron Age and the Viking Age (c. AD 0–800) (Skjølsvold 1961:12; Pilø 1990). Pots of soapstone continued to be produced into the Medieval period (c. AD 1030–1537), but these later vessels seem to have been typologically different from those of the preceding period (Lossius 1977:50). The character of production and distribution of soapstone vessels seems to increase in magnitude during the Viking Age, from a rather limited nature in the first half of the 9th century, to widespread distribution networks and large quantities of affordable commodities in the 10th century. The main topic here is that this increase coincided with a general expansion in production and trade of such goods in Scandinavia as a whole (e.g. Christoffersen 1991; Näsman 1991; Sindbæk 2005), as well as changes in associated aspects, like means of transportation (Näsman 1991:37) and modes of payment (Hårdh 1996; 2007). In the following pages, I intend to discuss the Viking Age soapstone vessel production and trade of Agder in the southernmost part of Norway, and more specifically the area around the old parish of Fjære, and link this process up with the general economic development of the period.

Based on the research of my master thesis (Schou 2007), I would argue this production could be characterised as an industry, directed toward a large number of consumers living across southern Scandinavia, with close parallels to trade in other types of commodities (e.g. iron, quernstones etc.), which were increasingly mass produced specifically for trade purposes.

Geographical context

Regional description

Agder is today divided into two counties, Aust-Agder and Vest-Agder, with several towns along the coast. However, town settlements as a concept is in general a recent phenomenon in Norway, and the vast majority of the pre-industrial population lived in clustered or isolated farms and farmsteads scattered throughout the country. This is particularly true for the Agder region, with its long, roughly southward-flowing rivers moving through valleys, each more or less completely separated by characteristic steep, densely forested hills dotted with small lakes and bogs. Thus, due to topographical hindrances, the coast has traditionally provided the most practical communication route when moving in an east-west direction, while river valleys have been the preferable choice for travel and transport between north and south. The best agricultural land is situated along the coast,

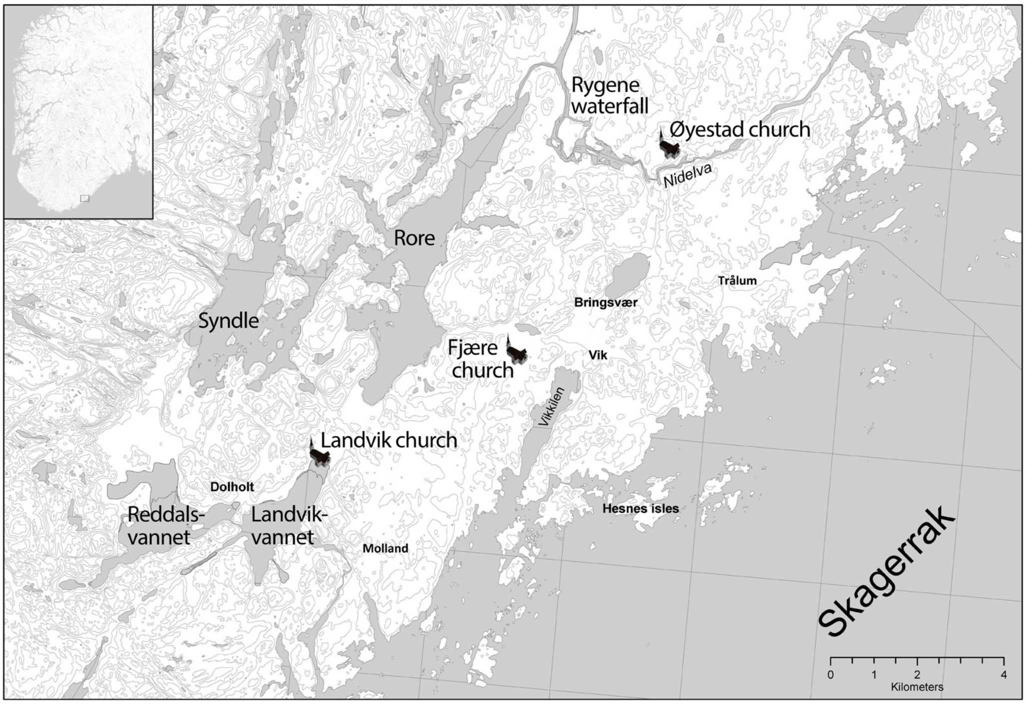


Figure 1. *The parishes of Fjære and Landvik, today mainly the modern town of Grimstad. Some of the central farms mentioned in the text and topographical features are also shown here. Additionally, minor modifications of the Viking Age water level in the area are indicated, most notably in the two lakes Reddalsvannet and Landviksvannet.*

and the mainland coast itself from Lindesnes and eastward (see e.g. Figure 2) is incised by numerous inlets, bays, and coves, in many places sheltered from the open sea of Skagerrak by islands and skerries (cf. Schou 2007:3–4).

The topography of Fjære

The Agder coast has provided traditional shipping with excellent anchorages, and one of the best is Vikkilen in Aust-Agder (Wikander 1985). During the Viking Age, this was the boat landing (Norse *stóð*) for several large farms lying along a fertile moraine ridge between the sea and the steep hills behind (Figure 1). Today, Vikkilen is the harbour of the town of Grimstad (pop. 20,000), but during the Middle Ages the area was divided into two agricultural parishes, Fjære and Landvik, which will be the geographical focus here and collectively termed *the Fjære area* (cf. Schou 2007). I have for the sake of simplicity adopted *the Fjære complex* as a term for the farms lying next to and just east of the Fjære medieval church, i.e. Fjære, Sæveli, Bringsvær, and Vik. The river emptying into the sea near the Fjære area is called Nidelva, stretching 210 km inland northward and crucially providing a potential transportation route for a multitude of commodities produced in the forested hills and mountains of Aust-Agder up until the early 20th century. Although a large and relatively violent waterfall called Rygene hinders unbroken travel from the interior to the coast, a viable traditional option has been to sail or row into the large lake Rore, just short of the Rygene falls, a choice preferred and used by the timber floating industry of the 18th and 19th centuries. From the shores of Rore, the Fjære area, the Vikkilen harbour, and the coast were easily accessed (Schou 2007:73–74). As will be argued below, the Fjære area is central to the understanding of the soapstone vessel trade in Agder and the regions bordering onto Skagerrak, as well as tentatively also contributing to the understanding of economic developments during the Viking Age.

Theoretical considerations

Structures

Søren M. Sindbæk (2005) showed how the *duality of structure* framework (cf. Giddens 1984:25) could fruitfully be applied to the study of the development of complex networks of production and trade during the southern Scandinavian Viking Age and early Medieval period. Groups of individuals constitute immaterial structures, which through repetitive practice create patterns of behaviour which are contextually limited by biology and technology, and their actions are both a medium for and a result of the practice they structure. In other words, social and economic patterns and relations emerge, develop and are maintained through (unconscious or subconscious) practice. Sindbæk argued that in a given context, relational interplay of individuals create networks bound together by central areas (nodes), wherein powerful individuals or groups emerge, capable of wielding more social and economic power than others located in more peripheral parts of the system (Sindbæk 2005:25). The main reason for this is their advantage of access to other and more extensive parts of the network, due to locational centrality, as well as potential monopoly on the connection between certain parts of the system. Associated with Viking Age social and economic structures is also the concept of routes and routinised practice, as routes are not only physical structures based on topography, but also social structures, which are realised as social institutions through the repeated and structured practice of routinised communication (Sindbæk 2005:30–32). This has great potential to alter associated socio-economic systems, or strengthen those already in place, hence lead to accumulation or dissolution of power connected to certain key individuals or groups in a given society (Sindbæk 2005:42–43).

Regionalisation and institutionalisation

Various regions and areas are directly or indirectly pulled into a trading network, as nodes situated along routes of communication add more and more links to the system (Sindbæk, 2005:38). This centripetal force crystallises these areas into relative and defined hierarchies within the network, a process called *regionalisation*, while growth of structural principles and social systems which spatially and temporally bind individuals together through the abovementioned repetitive practice is termed *institutionalisation* (cf. Giddens 1984:130). Communication and trade are in this way two very powerful institutionalising conceptual agents. Structural principles can be *authoritative resources* (organisational aspects which crystallise individuals into e.g. specialists, leaders etc.), *allocative resources* (economical institutions which provide control over e.g. raw materials and land), and *rules* (e.g. regulations and standardisations) (cf. Giddens 1984:181–185; also cf. Sindbæk 2005:39–41). These structure social patterns, but an essential aspect is that they do not constitute structural principles until the preconditions for them to emerge are present in a given context, and structural processes transform them (Giddens 1984:33–34). Set in a context of Viking Age socio-economic developments, the soapstone vessel production could not provide more than very limited economic or political advantages until it was connected to the larger systemic network of southern Scandinavian production, trade, and consumption. This is the backdrop within which the archaeological material of the Fjære area and its social, economic and geographical contexts must be interpreted.

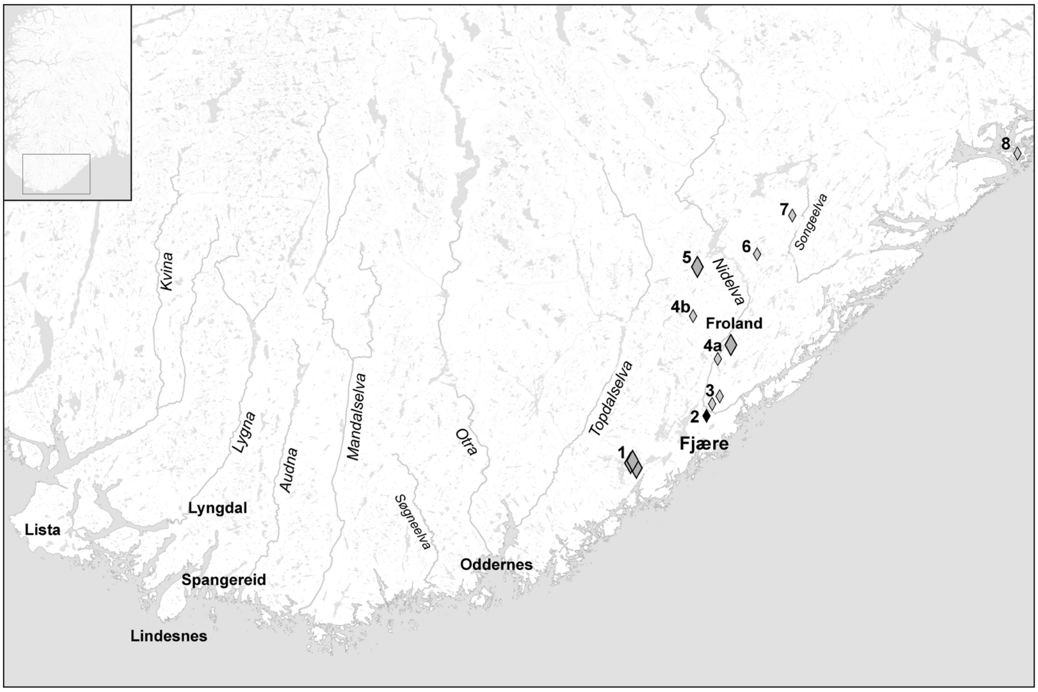


Figure 2. *Map of the Agder region, showing main river valleys and central areas of the Viking Age. All the soapstone quarries known here are situated along the river Nidelva or near the Fjære area. The larger diamonds denote two quarries, while the smaller indicate one quarry. The black diamond denotes an approximately placed quarry. The quarries are: 1. Hisåsen, 2. Tøra, 3. Øyestad, 4a. Blakstad, 4b. Brattelandsåsen, 5. Sparsås, 6. Austre Vimme, 7. Østre Myre, 8. Skåtøy.*

The soapstone vessels

The quarries of Agder

The central element of this article is that the allocative resources necessary for structuring the soapstone vessel trade are all found in a very limited area of Agder. Virtually all of the known quarries in the region are located in the wooded hills on either side of Nidelva, or near its tributary waterways (Figure 2). Except for the quarry at Tøra (Figure 2, no. 2), which contains poor quality soapstone and little or no traces of exploitation, production at these quarries seems to have been characterised by large-scale extraction, some places arguably bordering on industrial scale. Particularly Sparsås (Figure 2, no. 5), Austre Vimme (Figure 2, no. 6), and the cluster of quarries at Hisåsen (Figure 2, no. 1) were reported by Arne Skjølsvold in his influential studies of the Viking Age soapstone industry in Norway to be associated with massive waste heaps (Skjølsvold 1961:59–64; 1979). At Austre Vimme, he measured a waste heap to be 50 x 20 m and noted that it originally must have towered as high as 8 m. Its profile showed three separate phases of activity, although associated stray finds have generally consisted of Viking Age vessels and equipment (Skjølsvold 1979). It is uncertain when mass production of soapstone products ended at this quarry, but Skjølsvold himself argued against any post-medieval production there. Such dimensions are in any case suggestive of large-scale operations, and the fact that the waterway linking this quarry with Nidelva is called *Grytebekken* – from Norse *grjót* meaning stone as a raw material, and more often than not associated with soapstone vessels (cf. Skjølsvold 1961:5; Nymoen 2009:112) – is indeed striking. Following the Viking Age, some of the Nidelva quarries evidently also provided material for medieval church building in Aust-Agder, with e.g. baptismal fonts in central churches having been made of local soapstone (Solhaug 2013:30).

In addition to large heaps of waste, several quarries have numerous unfinished or broken vessels

Figure 3. *Set of soapstone vessels from Hafstad which have not yet been polished, probably originating from the Hisåsen quarries. A mark had been carved into the third pot, which is interpreted as some sort of stone cutter's mark (see Figure 4). (Photo: Museum of Cultural History, University of Oslo).*

lying about in their hundreds, as well as showing chisel marks and vessels still attached to the rock faces up to a height of 6–7 m. Tools of the trade have also been found, such as wooden ladders, clubs, and iron chisels (Skjølsvold 1961:57–60), and wooden scaffoldings were presumably used at e.g. Hisåsen to be able to reach all areas of the rock face and maximise the extraction from the soapstone vein (Skjølsvold 1961:74). Another indication of economical use of a limited resource is the fact that vessels were both hewn with the opening inward and outward of the rock face (cf. Skjølsvold 1961:84; Schou 2007:62). Generally, vessels were seemingly finished and polished further down the transport line, as both unfinished objects in the quarries and unfinished sets of vessels have been found near points where transfer from local to regional transport would have been necessary. One can argue that the pots were more resistant to breakage when transported through rugged and hilly terrain in an only roughly finished state, and it has been suggested that they were soaked in rivers, lakes, or bogs to ease the finer internal polishing nearer to their intentional markets or close to systemic nodal points (Skjølsvold 1961:83–92; Lossius 1977:62; Baug 2011:315).

Production and transport

One important stray find from the Fjære area illustrates the point where further treatment of the vessels was carried out. At the Hafstad farm on the isthmus between the lakes Reddalsvannet and Landvikvannet, a set of five soapstone vessels of decreasing size was found (Figure 3) (Skjølsvold 1961:89–90). These probably came from the Hisåsen quarries, and were still unpolished and perhaps put to soak, but subsequently forgotten. At Froland, c. 7 km upriver from the Fjære area, down the transport line from the quarry at Brattelandsåsen, another set of three pots was found in 1878 (Skjølsvold 1961:90–92). These examples indicate that the production included a practical aspect for both transportation and storage, as well as a spatial separation of various stages in the production line and standardisation of the process. On one of the five pots shown in Figure 3, a groove had been cut into the rim, very similar to stone masons' marks known from the Middle Ages (Figure 4). This practice has as far as I know *only* been documented on soapstone vessels from the southernmost coast of Norway. The other two examples were found at Flekkefjord in the westernmost part of Agder, and at the quarry of Skåtøy near the border between Telemark and Agder (Figure 2, no. 8) (Skjølsvold 1961:101–103). All these aspects of the Agder production with typological standardisation, practicality of transport and storage, massive waste heaps, and cutters' marks come together to suggest that the soapstone trade in the region was a lively and institutionalised activity (Skjølsvold 1961:120–122; Schou 2007:62). Some scholars (e.g. Grieg 1990) have argued that the

Figure 4. *Carvings found on the rim of three soapstone vessels from Agder. The pots are from left to right from Flekkefjord, Fjære (see Figure 3), and Skåtøy (see Figure 2, no. 8) and the carvings are unique from Norwegian contexts. They have been interpreted as some sort of stone cutter's marks. (Photo modified after Skjølsvold 1961:101–103).*

resources belonged to the nearest farms or farmsteads, while others (e.g. Skjølsvold 1961) thought for the reasons mentioned above that the soapstone vessels were mainly carved and fashioned by specialised craftsmen working for powerful individuals, perhaps chieftains or petty kings, who owned special resource rights. Skjølsvold referred to these craftsmen as 'pot smiths' (Norwegian *grytesmeder*) (Skjølsvold 1961:99–100). Based upon the same material, I have also argued that the latter of these theories seems to be the most plausible one (Schou 2007). I will now turn to relevant aspects of Viking Age soapstone vessel chronology and typology, as well as focusing on a short description of the archaeological material associated with the Fjære area.

Soapstone vessels and the archeological material of Fjære

Material and chronology

Viking Age soapstone vessels largely seem to be typologically standardised and usually divided into three main types, R728–730 (cf. Rygh 1999 [1885]). The bowl-shaped R729 (see Figure 3) is by far the most common type, with over 500 examples known from Norwegian Viking Age contexts (Risbøl 1994:122). Although both R728–729 are found throughout the Viking Age, there are far more examples known from datable 10th century contexts than there are from the preceding century, with over six times more (157 vs. 25 examples) of R729 (cf. Skjølsvold 1961:29), and the last type (R730) is *only* known from the 10th century (Petersen 1951:362; Risbøl 1994:122). A study of soapstone vessels known from datable Viking Age grave contexts, but with chronology divided into the early (800–875), middle (875–925) and the late (925–1050) Viking Age, has provided a somewhat finer chronological division (cf. Risbøl 1994:130–131). While the 75 years of early Viking Age graves included 34 vessels (less than 0.5 per year), the middle and late Viking Age had 29 (about 0.6 per year) and 130 vessels (over one per year) respectively, i.e. a development in annual average from a slight increase from c. 875 to more than a doubling from c. 925 compared with the early Viking Age. For the sake of argument it can be included that the three soapstone vessels from grave contexts in the Fjære-area, which allowed for a more detailed chronology *within* the Viking Age, all dated to the 10th century (Schou 2007:55). It is thus quite possible that the *majority* of Viking Age soapstone vessels can be dated to the late 9th and the 10th century, although perhaps not exclusively.

An object well-represented in the archaeological material from the Fjære area is the foldable bronze balance, often found with weights of various sizes and occasionally a birch bark case, which is characteristic for its foldable quality. This balance type is reckoned to be an import from the British Isles and dated to the period c. 880–1000 (Jondell 1974:33). Intriguingly, no less than *three* of these have been found in the Fjære area, and all of them in the mound clusters of the Fjære complex (Figure 5). This is a high number, as is evident from the distribution map of southeastern Norwegian weights and balances presented by Pedersen (2007:136), where the Fjære area clearly stands out. One particular aspect of the coastal Agder region, which is important to note in the case of chronology, is that the heathen practice of mound burials generally seems to have gone out of use by the mid-10th century and replaced by burial according to Christian practice (e.g. Larsen 1986:48; Skre 2007a:469). From this it follows that except in special cases, Viking Age grave goods in Fjære typologically dated to the 10th century most likely should be placed in the first half of this period.

Graves and status

No settlement excavations have been carried out in the Fjære area, and most of the archaeologically excavated material originates from grave mound investigations. The large majority of these graves

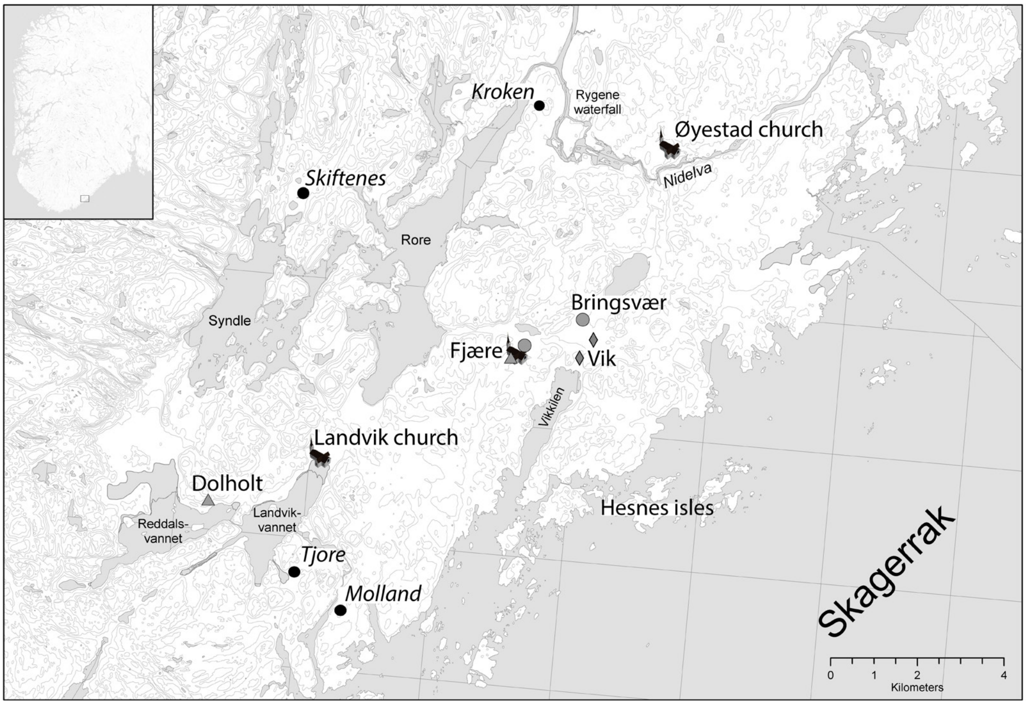


Figure 5. *Map of the distribution of balances (triangle), weights (diamond), and combination of balances and weights (grey circle) from Viking Age graves in the Fjære area. The Dolholt equipment is from a 9th century context, while the rest date to the 10th century. There is a clear cluster around the Fjære farm and medieval church. The map also shows precious metal depots (black circle), which mostly seem to be associated with peripheral farms in the area, apart from the large Slemmedal depot found at Molland in 1982.*

were excavated in the 1870s by Nicolaysen (1876; 1877; 1878) and then in 1880 by Winther (1881), while later investigations have been scattered throughout the following century. Even though these early archaeologists have later been criticised for having excavated perhaps too large a number of grave mounds in too short a period of time (e.g. Grieg 1990:124), they were both quite meticulous in their contextual documentation. For my study of the Viking Age material I have found that they produced reliable records (cf. Schou 2007). In addition to excavations, we also have available a number of finds discovered by farmers and other laymen since the 19th century and up to this date, with various degrees of contextual certainty (cf. Schou 2007:27–45 for detailed descriptions and discussion of contexts and material).

My study of the grave material in the Fjære area has provided some interesting, albeit tentative results. The material itself can be said to cluster in four separate areas, where individual objects or combinations of material indicate the burial of high-status individuals. The associated farms are from southwest to northeast Dolholt, Molland, the Fjære complex, and Trålum. Although it is difficult to be certain of the property boundaries of Viking Age farms, there are reasons for incorporating some neighbouring farms into one large property (cf. Schou 2007:37–39). All these central farms have large grave mounds from the early Iron Age as well as the Viking Age within their boundaries, but regarding the latter period, Trålum and Dolholt can only be said to conclusively have indications of the highest status burials from the early 9th century, while in the later Viking Age, they show more modest material. Although the richest grave at Dolholt did contain a balance, it is not clear that this should be defined as a foldable type, and thus weapon typology still form the basis for a date c. 800–850. In contrast, the Fjære complex and Molland exhibit richly furnished graves from the late 9th to 10th century. However, it must be pointed out that the numbers on which this specific indication is based cannot be said to be statistically significant, and thus should only be seen as a tentative pattern.

Precious metal depots

Burying precious metal in the ground for various reasons is a well-known Viking Age practice. From the Fjære-area, four separate Viking Age precious metal deposits have been found and reported (see Figure 5), all mostly containing silver, a general trend of the period. Three of these come from peripheral farms in the region, namely Kroken, Skiftenes, and Tjore. The Kroken depot consisted of a silver cross, an Insular silver buckle, hundreds of various beads, and an Arabian coin dated 782–783, as well as supposedly a silver arm ring which was not sent to the Museum of Cultural History at the University of Oslo. This depot is commonly dated to the 9th century, and its clerical content makes it seem rather likely to be booty from Viking raids (Wamers 1997:10). The latter two depots consisted of two and one silver arm ring respectively, and possibly date to the 10th century (Grieg 1929:238).
However, by far the largest precious metal depot from the Fjære area was discovered in 1982 at the Molland farm, which as mentioned above also exhibits richly furnished 10th century burials. This depot consisted of silver objects which weighed over 2100 g, as well as close to 300 g of gold, making it the second largest Viking Age silver depot in Norway. It included several gold and silver rings of various sizes, some smaller objects of silver and gold, as well as five coins, providing a terminus post quem of c. 920 for the depot (Skaare 1982:39). Interestingly, this secure 10th century depot can tell us something about the economic structure of the period in the Fjære area, as one of the arm rings had been cut down and presumably used as hack silver (Blindheim 1982:8). It provides an intriguing link with the many instances of balances and weights in the Fjære-complex graves, and can be integrated into the larger economic context of the Viking Age (see below).

The potential for communication and trade

Centrality and Viking Age spatial hierarchy

Even though an area contains archaeological material associated with status and economy, it is not given that it acted as a regional centre with nodal function within a network, which here is a seen as a prerequisite for structuring distribution and organisation of mass-produced commodities. Features associated with such areas must be actively studied in relation to their regional context to establish whether or not this was the case. To do this, I have adopted the terms *central area* and *central place*. The first refers to a spatially limited area within a region, containing advantageously structuring features within the contexts of communication and network compared to other parts of the region (relative periphery). Central places on the other hand, are conceptual complexes containing centralising and centripetal elements – e.g. ritual focus and administrative institutions – *within* a central area (Myhre 1987:184, fig. 13), usually also representing the most important political, religious, social, and economic functions within a region (Fabech 1999:455; Hedeager 2002:7). These aspects occur on varying scales of magnitude and size, both structuring a hierarchy on a vertical and horizontal level, influencing social and economic practice. Several criteria should be met to increase the likelihood of an area being a regional centre with a central place. These are generally related to natural conditions structuring communication and allocation of resources, as well as archaeological material associated with status and wealth (Fabech & Ringtved 1995:19; Skre 2007a:49).

Communication and nodal function

The potential nodal function of the Fjære area in relation to its region and the communicative network is possible to approach in three different ways – land routes along the coast, sea routes, and routes from upland or inland areas. Norwegian topography is highly structuring when it comes to traditional land travel, and consequently the main routes have a high degree of structural continuity (Engesveen 2006:16). Medieval laws also indicate that this continuity could stretch back into the Iron Age (Steen 1934:217). By spatially mapping the distribution of Iron Age grave mound clusters and 18th century roads in the Fjære area (Figure 6), a picture suggesting clear visual associations between routes and grave monuments becomes apparent. The central nexus within the area is the Fjære complex, which, due to topographical hindrances of hills and sea, is where all these routes meet. Thus, the complex must be traversed when travelling by land in the area, with the principal node probably being the site of the Fjære medieval church. Traditional regional land routes to neighbouring areas are also known to have passed this way, making the Fjære complex both a local and a regional node for Viking Age and medieval land travel (Schou 2007:70–71).

Sea travel would have been the preferred method to get around on a regional and intraregional level in the Viking Age and along the parts of coastal Agder the safest sea lane was the sounds and basins situated between the mainland and an outer line of skerries and islands. Certain medieval itineraries list four main harbours between the main Norwegian Viking Age town of Kaupang and the cape of Lindesnes (see Figure 9), and the one which served the Fjære area is called Hesnessund (or alternatively the Hesnes isles) (Steen 1934:220). One noticeable element with these medieval harbours is that the link between the sea lane and the harbour itself would be the topographical feature of islands lying outside them poking into or across the sea lane, providing ships sailing along an otherwise rather monotonous coast with a navigable waypoint. Although several alternatives for anchorage or landing were most likely known and available for Viking Age and medieval sea travellers (Nymoen 2009), a socio-economic centripetality associated with the Fjære area probably made it an important destination for the repeated practice of communication. Intriguingly, one day's traditional travel by sea, c. 130 km (Crumlin-Pedersen 1983), from either Kaupang or Skien, an important medieval node for inland iron products and whetstones of Telemark (Christophersen 1989), would actually have ended up more or less exactly in the Fjære area, a spatio-temporal aspect of regional position which again suggests that it was advantageously located within the network of communication. This is also the distance from Fjære across Skagerrak to the northernmost parts of Denmark (Figure 9). Additionally, the protected bay of Vikkilen was in later times renowned for providing a good and safe harbour (Wikander 1985). Onward sailing into the night when travelling from the northeast, e.g. toward Ulvøysund (40 km further sailing) or Randesund (50 km further sailing), could potentially have jeopardised both crew and cargo. In fact, several Viking Age or early medieval shipwrecks have been discovered along this stretch of water – e.g. at Håøya just south of Vikkilen and in Kvåsefjorden between Ulvøysund and Randesund (Nymoen 2010; 2011). The recovered cargo associated with these wrecks represents more or less the full assortment of stone-based mass-produced commodities of the Viking Age – quernstones, whetstones, and soapstone vessels (specifically R729, cf. Nymoen 2010:135).

The third line of communication considered here is highly associated with the soapstone trade – transport of raw materials and goods from the upland/inland of Agder toward the coast. The main route was Nidelva, which meets the sea at Nedenes just northeast of Fjære. However, the waterfall obstacle of Rygene and subsequent narrowing of the river channel has traditionally structured large-

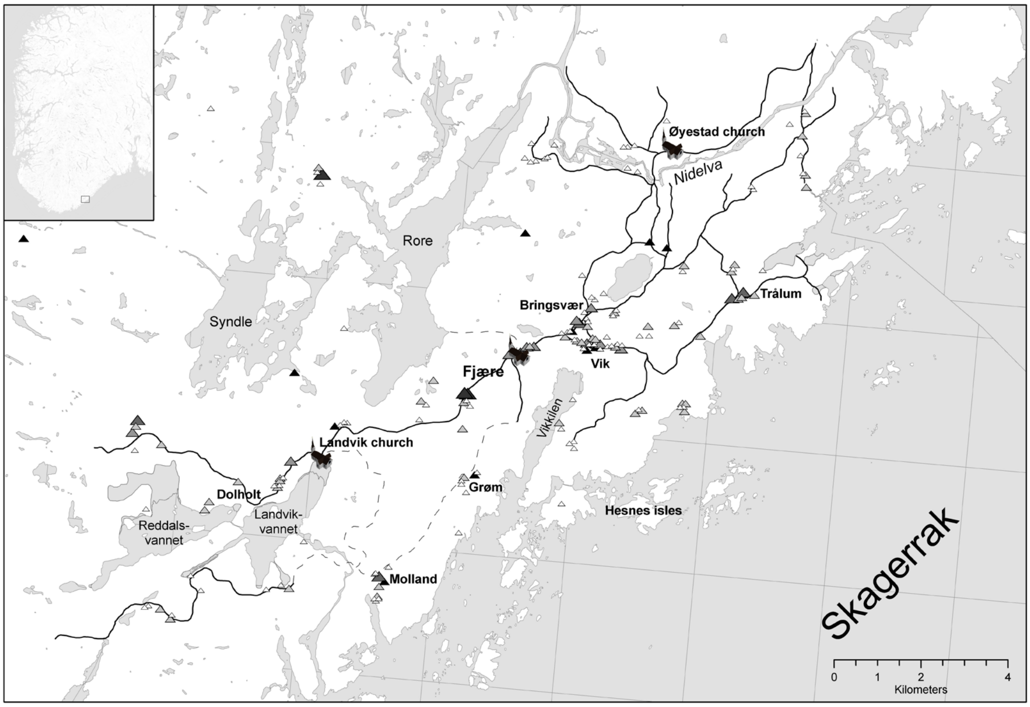


Figure 6. *Map showing the relation between grave mounds and roads in Fjære. The black solid line indicates routes known from 18th century maps, while the dotted line indicates probable routes now vanished due to the growth of the modern town of Grimstad. The increasingly larger triangles denote increasingly larger clusters of grave mounds, respectively 1 (small white triangle), 2–5, 6–10, 11–15, 16–25, and over 25 separate grave mounds (large dark triangle). The small black triangles indicate grave mounds approximately located.*

scale transport into the Rore lake, just upriver from Rygene. Apart from this, the river would probably have been quite navigable all the way from the inland lake of Nelaug in pre-industrial times (Schou 2007:73–74). Thus, it seems highly likely that all three types of regional and intraregional travel and transport would have ended up in the Fjære area in the Viking Age, with routes coming from inland regions, going along the coast, and following sea lanes all joining up there, probably providing the communicative advantage and nodal function necessary for regional centrality and centripetality.

Archaeological material

The specific archaeological material from the Fjære area has been touched upon above, but it will here be elaborated upon in the context of regional central areas and central places. One method put forward to indicate the presence of high-status individuals is the combination of weapons in Viking Age graves, where contexts with three types are seen as indications of the burial of a powerful figure (Solberg 1985). Clusters of these can indicate a central place, as can import or precious objects (Fabech & Ringtved 1995). Figure 7 shows the distribution of Viking Age graves containing two or more weapon types in southeastern Agder. The Fjære area clearly stands out as a cluster in an otherwise sparsely furnished region, suggesting that it was the main *locus* and central area for political, religious, and economic activity in the region.

Clusters of Iron Age grave mounds indicate routes and grave goods are related to status, but the character of the mounds themselves could arguably also indicate which farms or local areas were the most central in a landscape (see Figure 6 above). In the Fjære area, the farms with the highest numbers and largest sizes of grave mounds are again Trålum, Molland, and to a lesser degree the area around the Landvik medieval church. However, the Fjære complex is undoubtedly special in this respect, as it harbours several dozens of mounds of all sizes, even today. These lie clustered in large groups where all communication lines meet, i.e. around the Fjære medieval church above the Vikkilen bay. Additionally, it is also here that nearly all the weights and balances have been found, although not too much deposited precious metal. However, there are indications of widespread use of silver. One grave situated at the modern farm of Vik (cf. Schou 2007:35–36) contained a sword with a silver-gilded hilt, equipment for smithing, and a mould for silver ingots, implying that the person had regular access to precious metal. According to Fabech and Ringtved (1995:19), this is a particularly characteristic feature which suggests association with a central place, as is the occurrence of balances.

To conclude, it seems that the evidence, albeit tentative, supports the notion that the Fjære area acted as a regional central place toward which much of the communication and transport was channeled, both as a consequence of topography, but probably also due to its nodal function as an integrated part of the larger intraregional network (also cf. Stylegar 2009:88, 91). The central place within the area was located on the moraine just above Vikkilen, where the medieval church of Fjære was built around the turn of the first millennium AD, and where the farms of the Fjære complex lay and its inhabitants were buried. These people probably acquired more and more socio-economic regional power on an intra- and interregional scale as the Viking Age unfolded. My suggestion is that some form of control over the organisation of the soapstone vessel trade was a catalyst which caused these powerful figures in Fjære to accumulate increasing symbolic and real capital, which then could be converted to prestige and power, providing a political and economic advantage over other potential local and regional contenders for power positions.

The wider socio-economic context

Viking Age trade as an economic transition

In order to synthesise the soapstone vessel production and trade and the economic development of Agder into a diachronic perspective, it is necessary to describe some associated Viking Age aspects. A forcing factor for the development toward market economies is technological expansion in the fields of transportation and communication (Giddens 1984:192). The Viking Age can be characterised as a transitional period in many areas, including economy. In the 8th to early 9th century, the economy seems to have been largely based upon reciprocity and redistribution in Norway, like it was in the preceding Migration Period. However, by the mid-10th century, the economic system had integrated traits associated with medieval market economies (Skre 2000:169; 2007b:343). This development coincided with an expansion of trade in affordable commodities, but mass production would not have occurred without the incentive of a market consisting of an anonymous mass of consumers. Thus, the activity in the quarries along Nidelva and at Hisåsen was dependent on the network of contacts and nodal structure provided by the central area of Fjære (Schou 2007:80), and the specialised trade network itself was probably also dependent on cooperation with local powerful actors (Callmer 2002:155).

Transport technology in the Viking Age

Trade networks of a systemic character were also dependent on technology and institutionalisation of associated aspects of the trade. The system that emerged in the late 8th century, expanded during the 9th century to include broader and broader parts of the northern European society, characterised by commodities like soapstone vessels, iron, whetstones, and quernstones (Christophersen 1991:160; Baug 2006:6). It developed to become a complex hierarchical network of regions, nodes, and routes, connected to central political and economic regions in Western Europe and the Near East (Hårdh 2003:49; Sindbæk 2007:119), and attained full bloom in the 10th century. Developments within the transport sector were unavoidable products of an increasing focus upon heavy, affordable commodities (Näsman 1991:37), as well as a progressive factor feeding back into the system which again re-expanded. This led to a development tentatively traceable in the archaeological material of Southern Scandinavia, where ship types known from the 9th century constitute mostly warships, such as the *skeið*, while ships dated to the 10th century onward show a greater focus on carrying capacity, and

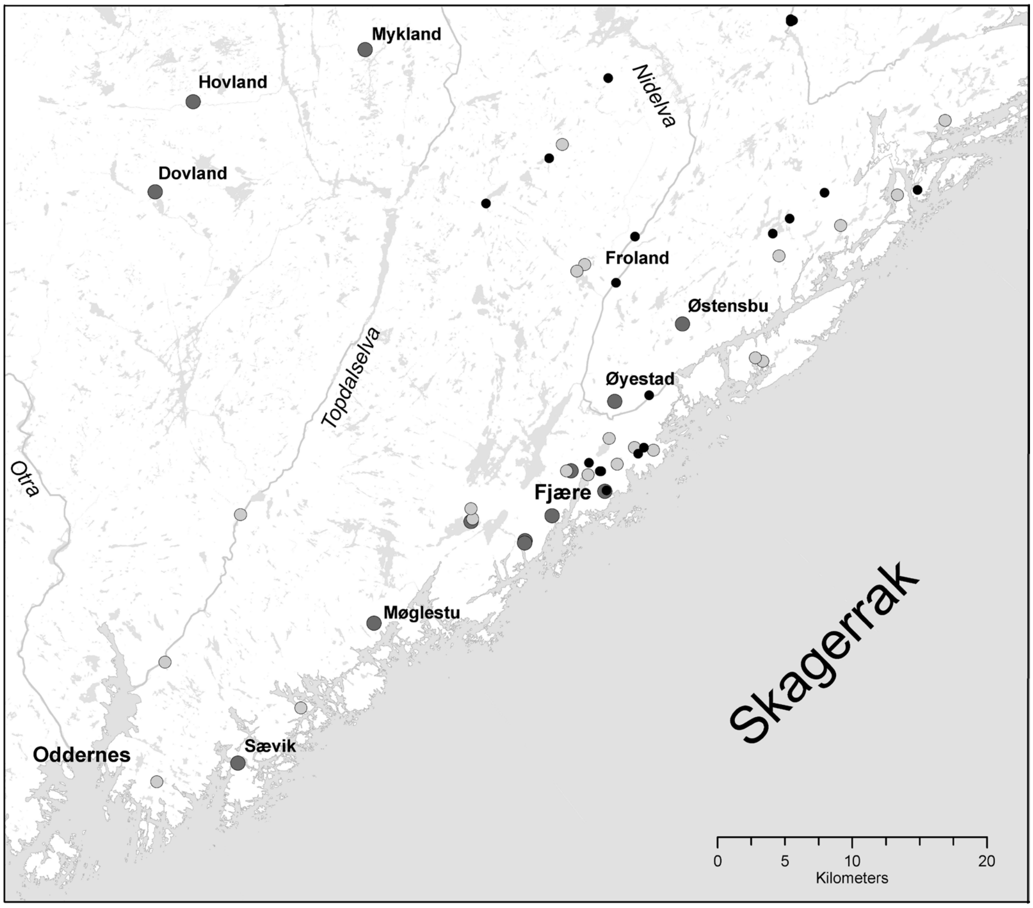


Figure 7. *Map of south-eastern Aust-Agder showing the distribution of so-called status graves in the region. Small black dot indicates one weapon type, medium grey dot indicates two weapon types, and three weapon types in a burial is indicated by a large, dark grey dot. The cluster of graves in Fjære is striking.*

include the specialised trading ship *knarr* (Crumlin-Pedersen 1991:75; 1999:12). Indeed, it is possible that trading activities supplanted the practice of raiding and plundering as chieftains and petty kings realised the economic potential of emerging mass consumption (Schou 2007:89). The characteristic Viking raids of the early 9th century gradually ceased through the period, while the trading system grew and was consolidated through institutionalisation and routinisation. This development seems to have continued into the next millennium, as suggested by the increasing number of known ship wrecks dating to the last part of the Viking Age (i.e. after c. 1000 AD) (Ulriksen 1998:223; also cf. Schou 2007:83).

Economic developments during the Viking Age

Integration of the hypothesised central place in Fjære into such a system would also act as a catalyst for economic changes there, moving it into a proto-monetary economy with standardised means of payment, which in turn fits well with the presence of balances, weights, and hack silver in the area. The system of weighing silver for payment grew up in parts of Scandinavia after c. 850 (Hårdh 1996:25–26). However, as Pedersen (2000; 2007) has pointed out, the mere presence of such objects need not necessitate the burial of a specialised trader or merchant so to speak, as they could also be associated with other activities, such as administrative functions. On the other hand, trade and administration are not mutually exclusive activities, and their association with the same area or even the same person is in fact not an unlikely scenario. Closer to the turn of the century, larger parts of southern Scandinavia started using the same standardised measurement system, so the system itself may have functioned as a guarantee in transactions, similar to the function currency would take later on (Hårdh 1996:60; Sindbæk 2005:46–48). This also coincided with the culmination of newly re-established import of Arabian silver c. 890–950 (Skaare 1976:52), indicating that the system was sufficiently institutionalised to become generalised practice. Thus, there are a lot of aspects associated with mass-produced commodity trade suggesting that the system acquired the prerequisites necessary to reach its full potential from c. 900, and progressively developed during the 10th century. Hårdh (1996) proposed that the content and character of precious metal depots could indicate how silver was used in a regional economic system, as well as economic changes within given Scandinavian regions. She argued that the difference between depots containing large ornamental rings and those with hack silver is an indication of different perspectives on silver in the society, i.e. prestige objects vs. more neutral characteristics and practicality. If one applies this to the material from Fjære (see Figure 5), there seems to be a focus on prestige in the more peripheral farms while the large depot from Molland incorporates both features (whole rings *and* hack silver) and could have acted within both spheres. However, silver and weighing equipment together is particularly associated with farms in the Fjære complex, which could indicate that these central farms were more attracted to a southern Scandinavian pragmatic view of silver and trade, although this would be speculation.

The regional soapstone vessel trade

The quarries shown on Figure 2 are the only ones known in Agder, but soapstone sherds and vessels have been found throughout the region in settlement and burial contexts (Figure 8). The soapstone veins other than those on Figure 2 closest to western parts of Agder are found in north-western Rogaland (Skjølsvold 1961:136–140), so it seems likely that most of the Viking Age households in Agder acquired their pots and vessels from the Fjære area. Based on the presumption that each household had two to three pots for cooking and storage and that the regional number of farmsteads in the Middle Ages were c. 3000 (Låg 1999:56), I have previously argued that a conservative estimate of vessels in Agder would have amounted to *at least* a total of five thousand for the period c. 800–950

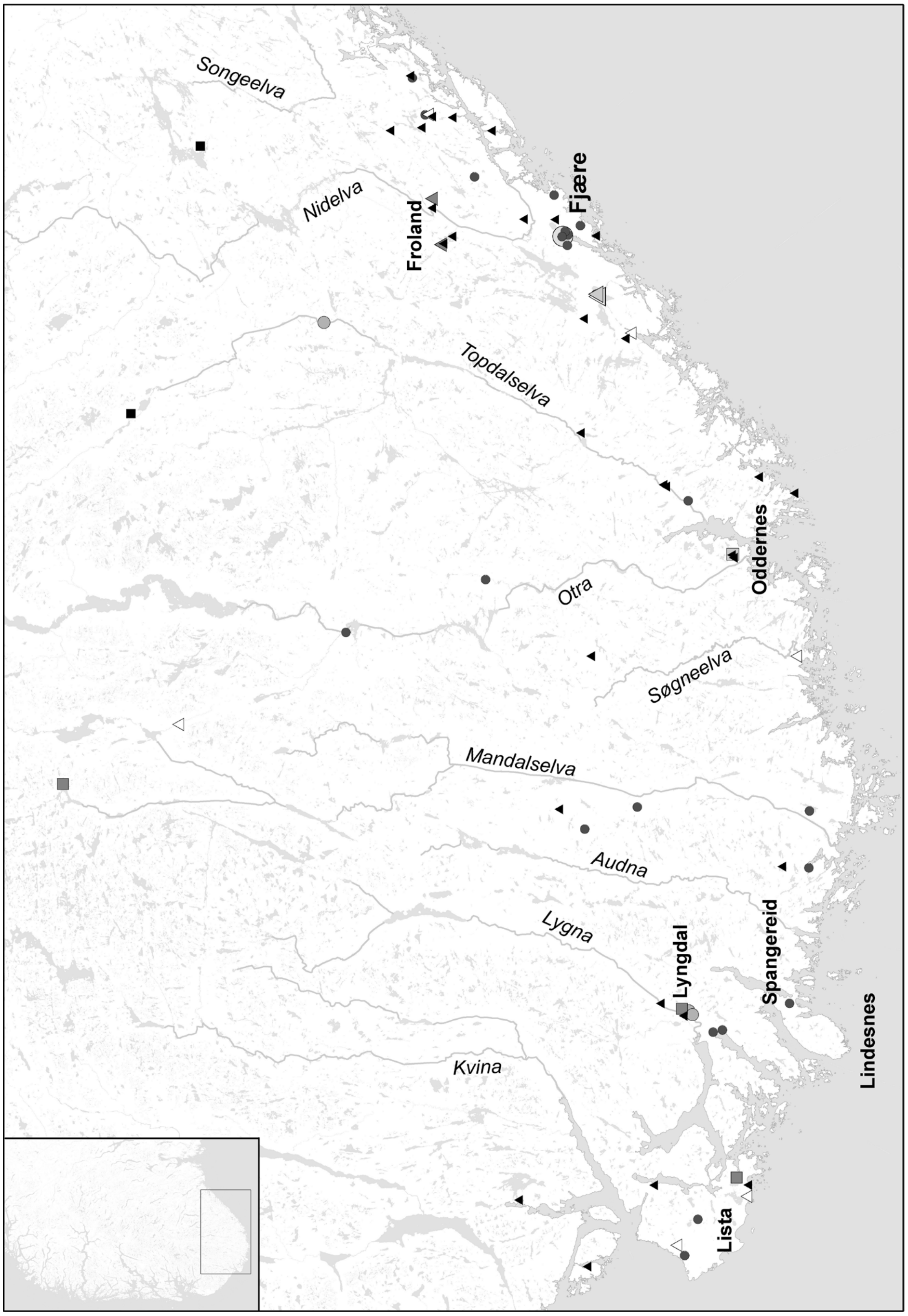


Figure 8. *Map of Agder, showing Viking Age soapstone finds in the region as a whole. Triangles indicate stray finds of sherds or vessels, circles indicate vessels as grave goods, and squares indicate sherds found in settlement contexts. Sizes of geometrical figures indicate increasing amounts of material, from one to five and more.*

(Schou 2007:66), of which the large majority probably came from the quarries along Nidelva and were distributed via a central place in the Fjære area. As shown on Figure 8, the finds are clustered in particular spots along the coast. These places, such as Lyngdal, Lista, Spangereid, and Oddernes, are generally thought to have constituted central areas during the Viking Age, as well as being associated with early medieval church buildings (e.g. cf. maps in Stylegar 2009). Thus, the distribution network was seemingly linked to powerful individuals or institutions on the consumption end, as well as on the production/organisation end of the process. The distribution pattern also suggests that peripheral inland parts of the region were dependently connected to the network via these central areas, as finds are found along the rivers toward the interior, as well as along the coastline.

The main Norwegian town and market bordering onto Skagerrak in the Viking Age was Kaupang in the county of Vestfold (e.g. Skre 2000; 2007a). However, even though there have been found numerous soapstone vessels and sherds from Viking Age settlement and burial contexts here, no quarries are known in this county. The nearest quarry lies on the island of Skåtøy on the coast of Telemark (Figure 2, nr. 8), which is the only quarry between the Fjære area and Kaupang. Apart from this, quarries are only known far inland in Telemark (c. 170 km away), in Akershus (c. 150–180 km away depending on the quarry), or across the Oslo fjord in Østfold (c. 120–140 km away), with respective distances approximately measured along waterways to Kaupang (Skjølsvold 1961:136–140). Provenience analyses have recently been carried out on soapstone material from this site (cf. Baug 2011:329–331). Intriguingly, the vessel sherds all seem to have originated from one quarry site, although among the quarries sampled for comparison, none proved a definite match. As the analysed samples came from quarries in Akershus and Østfold, there is still a possibility that Fjære supplied Kaupang with soapstone vessels in the Viking Age. However, further investigation would be necessary to answer this question (Baug 2011:331). Like Vestfold, soapstone vessels and sherds have also been found throughout Denmark, although the country does not have any naturally occurring soapstone. By far the largest quantity has been found in Hedeby (or Haithabu), the largest town in Viking Age Scandinavia, but unlike in Norway, pottery is ubiquitous in Denmark. The soapstone fragments found at Hedeby have tentatively been traced by mass spectrometry to geological regions in western Sweden or possibly Østfold (cf. Alfsen & Christie 1979:171–172), but this method is relatively old and not entirely certain. However, sherds and vessels found in northern Denmark and around Limfjorden (cf. Sindbæk 2005:141, fig. 6.6) may just as likely have originated in Fjære. Its geographical position on the coast probably strengthened its role as a nodal point associated with the network of communication and trade. The spatio-temporal relation with Kaupang and Skien, as well as Denmark, may suggest that the Fjære area retained a more prominent position in the trading network than other harbours along this coastline (Figure 9).

Possible modes of distribution

How did these soapstone vessels find their way from the Fjære area to their consumers? As implied above, they seem to have been transported from Fjære to other regional nodes or central places and from there distributed to respective hinterlands and inland settlements along the river valleys. It is difficult to establish which distribution scenario would be the most likely one, or indeed if several modes of distribution could have been in action at the same time. However, there is one indication that someone came *to* Fjære to acquire its mass-produced commodities, either as direct consumers or as independent middlemen, thus perhaps making it less likely that the people in Fjære themselves transported the wares out to consumers. The medieval harbour of Hesnessund is referring to the safe harbour of Vikkilen. The name 'Hesnes' is derived from Norse *Esjunes*, where the first part *esja* in fact is Norse for soapstone (Rygh 1905:119; Skjølsvold 1961:120). This means that Hesnessund

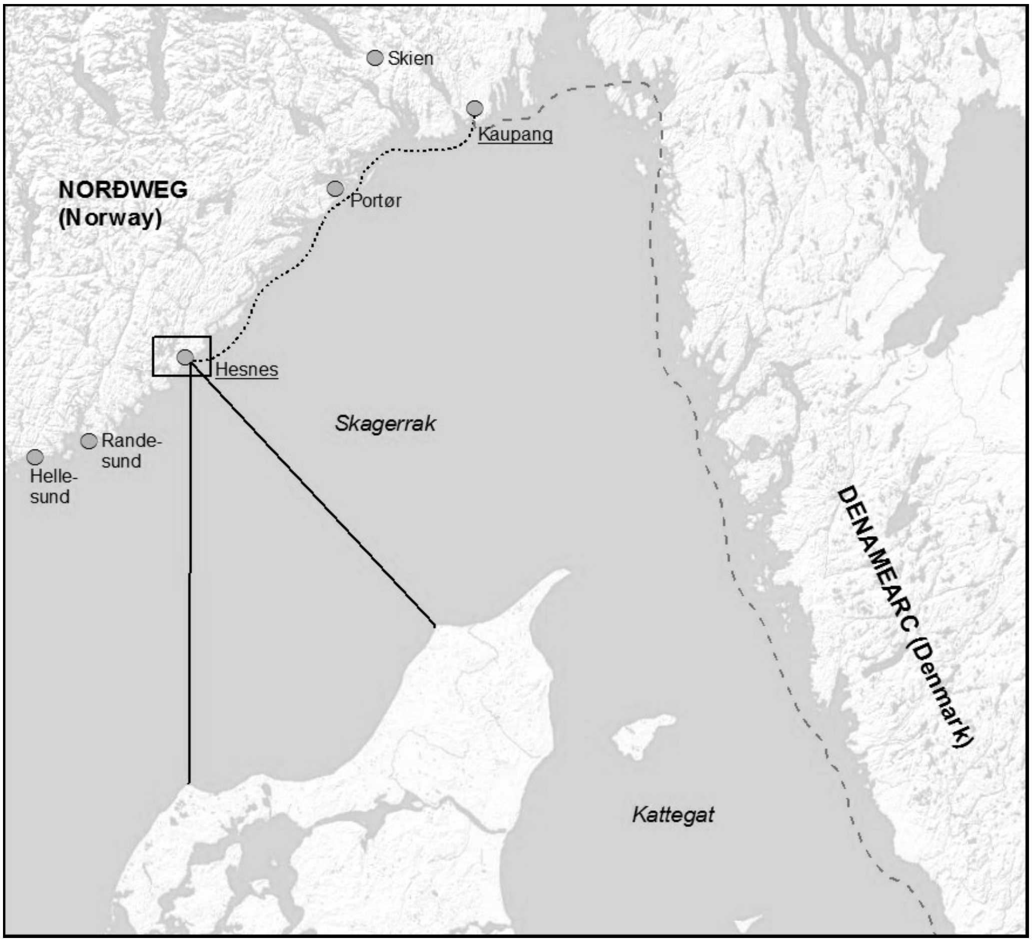


Figure 9. *Map of probable routes along the rim of Skagerrak in the Viking Age, showing some of the main harbours along the Agder coast known from medieval sources, as well as the Viking Age town of Kaupang and the medieval town of Skien. (Reconstruction and modification of map in Crumlin-Pedersen 1983:36).*

(cf. Figure 1), a topographical point by which a traveller would have navigated and identified as a way point on the route, actually means 'soapstone promontory sound'. The peninsula itself does not contain any naturally occurring soapstone at all, and thus it seems unlikely that the name was given to this natural feature by locals in Fjære. Instead, a valid explanation could be that it was named in this manner by people travelling along the sea lanes, denoting a point and haven along the route where soapstone products were available and could be acquired. This is in my view one of the strongest arguments for the hypothesis that the soapstone trade in Agder was channeled via – and probably also organised by – powerful actors in the Fjære area. Remains of this active trading network of travelling *knarr* are discernable on the map in Nymoen (cf. 2011:69), showing Viking Age and medieval shipwrecks along the Norwegian coast from the Sognefjord to Østfold. The Agder coastline from Lindesnes to Arendal, and particularly the stretch between Randesund and Fjære, is littered with wrecks, most of which seem to have carried quernstones, but also with evidence for soapstone vessels and whetstones, indicating a lively, but also hazardous regional trade in mass-produced commodities.

Conclusion

The soapstone trade in Norway was an industry providing an increasingly larger consumer market with affordable, mass-produced household wares, necessary for all Viking Age homes. The Agder region in the southernmost part of Norway was probably supplied with soapstone vessels mostly originating in the forested hills along the river Nidelva. The vessels were channeled through the central area at Fjære on the coast, and organised by powerful regional figures inhabiting a potential central place focused on the large farms around Fjære medieval church, which indeed increased their economic and social status through this trade. The activity included various actors on several levels during the process from quarry to consumers, i.e. in production, transport, organisation, control, and distribution. All these aspects were structured by a limited trading network probably emerging in the late 8th century, and expanding via institutionalising and regionalising processes to become a wide systemic hierarchical network of political and economic contact points, nodes, and communication lines in 10th century Scandinavia, in which Agder and Fjære played but a part. After initial contact with the system, both regionalisation and institutionalisation of the soapstone vessel trade progressively expanded within the structure of mass produced commodities trade, both stimulating to and being stimulated by the general expansion of the whole economic system.

References

Alfsen, B. E. & Christie, O. H. J. 1979. Massenspektrometrische Analysen von Specksteinfunden aus Haithabu und wikingerzeitlichen Specksteinbrüchen in Skandinavien. *Berichte über die Ausgrabungen in Haithabu, Bericht* 14, 170–184, Neumünster.

Baug, I. 2006. Stein som handelsvare. In Førsund, F.B. (ed.) *Hyllestadseminaret. Rapport fra fagseminar,* 6–15, Hyllestad kommune.

Baug, I. 2011. Soapstone Finds. In Skre, D. (ed.) *Things from the Town. Artefacts and Inhabitants in Viking-age Kaupang*, Kaupang Excavation Project Publication Series, Vol. 3, Norske Oldfunn XXIV, 311–337, Aarhus.

Blindheim, C. 1982. Slemmedal-skatten. En liten orientering om et stort funn. *Viking* XLV, 5–31.

Callmer, J. 2002. North-European Trading Centres and the Early Medieval Craftsman. Craftsmen at Åhus, north-eastern Scania, Sweden ca. AD 750–850. In Larsson, L. & Hårdh, B. (eds) *Central Places in the Migration and Merovingian Periods.* Uppåkrastudier 6. Acta Archaeologica Lundensia, Series in 8°, No. 39, 133–157, Lund.

Christoffersen, A. 1991. Ports and Trade in Norway during the transition to historical time. In Crumlin-Pedersen, O. (ed.) *Aspects of Maritime Scandinavia AD 200–1200,* 159–170, Roskilde.

Crumlin-Pedersen, O. 1983. Skibe, sejlads og ruter hos Ottar og Wulfstan. In Lund, N. (ed.) *Ottar og Wulfstan – to rejsebeskrivelser fra vikingetiden*, 32–44, Roskilde.

Crumlin-Pedersen, O. 1991. Ship Types and Sizes AD 800–1400. In Crumlin-Pedersen, O. (ed.) *Aspects of Maritime Scandinavia AD 200–1200,* 69–82, Roskilde.

Crumlin-Pedersen, O. 1999. Ships as indicators of trade in Northern Europe 600–1200. In Bill, J. & Clausen, B. L. (eds) *Maritime Topography and the Medieval Town*, 11–20, København .

Engesveen, A. 2005. På vei mellom levende og døde: en analyse av forholdet mellom veier og graver i Vestfold. Unpublished master thesis, University of Oslo.

Fabech, C. 1999. Centrality in sites and landscapes. In Fabech, C. & Ringtvedt, J. (eds) *Settlement and Landscape*, 455–473, Århus.

Fabech, C. & Ringtvedt, J. 1995. Magtens geografi i Sydskandinavien – om kulturlandskab, produktion og bebyggelsesmønster. In Resi, H.G. (ed.) *Varia* 30, 11–37, Oslo.

Giddens, A. 1984. *The constitution of society*, Cambridge.

Grieg, S. 1929. *Vikingetidens Skattefund*. Universitetets Oldsaksamling Skrifter. Bind II, Oslo.

Grieg, S. 1990 [1939]. Fjære i oldtiden. In Frogner, K. T. (ed.) *Fjære – som engang var,* Arendal.

Hedeager, L. 2002. Scandinavian 'Central Places' in a Cosmological Setting. In Larsson, L. & Hårdh, B. (eds) *Central Places in the Migration and Merovingian Periods.* Uppåkrastudier 6. Acta Archaeologica Lundensia, Series in 8°, No. 39, 3–18, Lund.

Hårdh, B. 1996. *Silver in the Viking Age. A Regional-Economic Study.* Acta Archaeologica Lundensia, Series in 8°, No. 25, Lund.

Hårdh, B. 2003. The Contacts of the Central Place. In Larsson, L. & Hårdh, B. (eds) *Centrality – Regionality. The Social Structure of Southern Sweden during the Iron Age.* Uppåkrastudier 7. Acta Archaeologica Lundensia, Series in 8°, No. 40, 27–66, Lund.

Hårdh, B. 2007. Hacksilver and Ingots. In Skre, D. (ed.) *Means of Exchange. Dealing with Silver in the Viking Age*, Kaupang Excavation Project Publication Series, Volume 2, Norske Oldfunn XXIII, 95–118, Aarhus.

Jondell, E. 1974. *Vikingatidens balansvågar i Norge*, C 1-uppsats i arkeologi, särskilt nordeuropeisk, Uppsala.

Larsen, J. H. 1986. En mulig handelsplass i Grimstadsområdet i vikingtiden. *Universitetets Oldsakssamling Årbok 1984/1985*, 111–120, Oslo.

Lossius, S. M. 1977. *Kleberkarmaterialet fra Borgund.* Arkeologiske avhandlinger fra Historisk Museum, Universitetet i Bergen, No. 1, Bergen.

Låg, T. 1999. *Agders Historie 800–1350,* Kristiansand.

Myhre, B. 1987. Chieftain's graves and chiefdom territories in South Norway in the Migration Period. In Häßler, H.-J. (ed.) *Studien zur Sachsenforschung* 6, 169–187, Hildesheim.

Nicolaysen, N. 1876. Udgravninger i Fjære 1875. *Foreningen til Norske Fortidsmindesmerkers bevaring. Aarsberetning 1875*, 203–215.

Nicolaysen, N. 1877. Udgravninger i Fjære 1876. *Foreningen til Norske Fortidsmindesmerkers bevaring. Aarsberetning 1876*, 117–139.

Nicolaysen, N. 1878. Udgravninger i Fjære 1877. *Foreningen til Norske Fortidsmindesmerkers bevaring. Aarsberetning 1877*, 241–261.

Nymoen, P. 2009. Marginale steder eller marginale kilder? Undervannsarkeologisk blikk på små handelshavner. In Brendalsmo, J., Eliassen, F.-E. & Gansum, T. (eds) *Den urbane underskog. Strandsteder, utvekslingssteder og småbyer i vikingtid, middelalder og tidlig nytid*, 93–131, Oslo.

Nymoen, P. 2010. Fatal feilnavigering med tung last? Om en samling brynesteinsemner i Kvåsefjorden, Kristiansand. In Stylegar, F.-A. (ed.) *Mangesysleren. En vennebok til Svein Mjaatvedt*, 128–157, Kristiansand.

Nymoen, P. 2011. Kun for den smarte skippers regning? Skipsvrak med omsettelig ballast: på sporet av kvernstein, kleber og brynehandelen fra Norge ca. 800–1800. *Nicolay* 114, 2–2011*,* 65–75.

Näsman, U. 1991. Sea trade during the Scandinavian Iron Age: Its character, commodities, and routes. In Crumlin-Pedersen, O. (ed.) *Aspects of Maritime Scandinavia AD 200–1200,* 23–40, Roskilde.

Pedersen, U. 2000. Vektlodd – sikre vitnesbyrd om handelsvirksomhet?: vektloddenes funksjoner i vikingtid: en analyse av vektloddmaterialet fra Kaupang og sørøst-Norge, Unpublished hovedfag thesis, University of Oslo, Oslo.

Pedersen, U. 2007. Weights and Balances. In Skre, D. (ed.) *Means of Exchange. Dealing with Silver in the Viking Age*, Kaupang Excavation Project Publication Series, vol. 2, Norske Oldfunn XXIII, 119–196, Aarhus.

Petersen, J. 1951. *Vikingetidens redskaper.* Skrifter utgitt av Det Norske Videnskaps-Akademi i Oslo II. Hist.-filos. Klasse. 1951. No. 4, Oslo.

Pilø, L. 1990. Early Soapstone Vessels in Norway, from the late Bronze Age to the Early Roman Iron Age. *Acta Archaeologica*, vol. 60, 87–100.

Risbøl, O. 1994. Socialøkonomiske aspekter ved vikingetidens klæberstenshandel i Sydskandinavien. *LAG* vol. 5, 115–161.

Rygh, O. 1968 [1905]. *Norske gaardnavne. Ottende bind: Nedenes Amt,* Kristiania.

Rygh, O. 1999 [1885]. *Norske Oldsager*, Christiania.

Schou, T. P. 2007. Handel, produksjon og kommunikasjon – en undersøkelse av klebersteinsvirksomheten i Aust-Agders vikingtid med fokus på Fjære og Landvik. Unpublished hovedfag thesis, University of Bergen, Bergen.

Sindbæk, S. M. 2005. *Ruter og rutinisering – Vikingetidens fjernhandel i Nordeuropa*, København.

Sindbæk, S. M. 2007. Networks and nodal points: the emergence of towns in early Viking Age Scandinavia. *Antiquity,* vol. 81, no. 311, 119–132.

Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden*. Universitetsforlaget, Oslo.

Skjølsvold, A. 1979. Redskaper fra forhistorisk klebersteinsindustri. *Universitetets Oldsaksamling Årbok 1979*, 165–172.

Skre, D. 2000. Kaupang – et handelssted? Om handel og annen vareutveksling i vikingtid. *Collegium Medievale. Tverrfaglig tidsskrift for middelalderforskning,* vol. 13, 165–176.

Skre, D. (ed.) 2007a. *Kaupang in Skiringssal.* Kaupang Excavation Project Publication Series, vol. 1, Norske Oldfunn XXII, Aarhus.

Skre, D. (ed.) 2007b. *Means of Exchange. Dealing with Silver in the Viking Age.* Kaupang Excavation Project Publication Series, vol. 2, Norske Oldfunn XXIII, Aarhus.

Skaare, K. 1976. *Coins and Coinage in Viking Age Norway. The establishment of a national coinage in Norway in the XI century, with a survey of the preceeding current history,* Oslo

Skaare, K. 1982. Myntene i Slemmedal-skatten. *Viking XLV,* 32–43.

Solberg, B. 1985. Social status in the Merovingian and Viking periods in Norway from archaeological and historical sources. *Norwegian Archaeological Review 18, 1–2*, 61–76.

Solhaug, M. B. 2013. Stavangerinspirerte døpefonter på Sørlandet. *Collegium Medievale. Tverrfaglig tidsskrift for middelalderforskning*, vol. 26, 27–59.

Steen, S. 1934. Veiene og leden i Norge. In Brøndum-Nielsen, J., van Friesen, O. & Olsen, M. (eds) *Nordisk Kultur – Handel og samferdsel. Nordisk Kultur XVI.* B. *Handel och samfærdsel under medeltiden*, 217–228, Oslo.

Stylegar, F.-A. 2009. Kaupangs omland og urbaniseringstendenser i norsk vikingtid. In Brendalsmo, J., Eliassen, F.-E. & Gansum, T. (eds) *Den urbane underskog. Strandsteder, utvekslingssteder og småbyer i vikingtid, middelalder og tidlig nytid*, 67–92, Oslo.

Ulriksen, J. 1998. *Anløbsplasser. Besejling og bebyggelse i Danmark mellem 200 og 1100 e.Kr. En studie av søfartens pladser* på baggrund *af undersøgelser i Roskilde Fjord,* Roskilde.

Wamers, E. 1997. Insulære importfunn i vikingtidens Skandinavia og spekulasjoner om Norges samling. *Rikssamling – Høvdingmakt og kongemakt. Karmøyseminaret 1996,* 8–21, Karmøy kommune.

Wikander, J. A. 1985. *Gamle havner ved Grimstad*, Selskapet for Grimstad Bys Vel.

Winther, T. 1881. Undersøgelser i Nedenæs amt i 1880. *Foreningen til Norske Fortidsmindesmerkers bevaring. Aarsberetning 1880*, 88–112.

Bodil Østerås

Slipsteinberget Soapstone Vessel Quarry. Home Production or Professional Craft?

A case study of the large Slipsteinsberget soapstone quarry at Sparbu in Nord-Trøndelag County (central Norway) is presented. The archaeological evidence indicates that professional craftspeople worked at the soapstone quarry, producing vessels for larger markets, over a period of at least 400 years, from the early 11th to the 15th century. Discovery of finished vessels, two house ruins attached to the production, the large volume of the production and the exploitation methods all bear witness of a large-scale industry with distinct structures and methods.

Introduction

Stone quarries are sites where traces of what was once a production area can help us gain an insight into working methods, techniques, extents and aspects of the social life of those who had their place of work there. Through archaeological studies of human-induced traces in and around the Slipsteinsberget soapstone quarry in Sparbu, central Norway, attempts have been made to get nearer to the stonecutters. Were they local craftsmen who made vessels for use in their own households or specialists who made their products for sale on a larger market?

Slipsteinsberget in Sparbu

The Slipsteinsberget quarry in Sparbu is situated in the Steinkjer municipality, about 15 km south of the town Steinkjer in Nord-Trøndelag County (Figure 1). The small hill covers an area of 20,000 m^2 and rises 20–30 m above a surrounding landscape characterised by amphibolite and various schists. The hill is a serpentinite 'dome' with a marginal zone of talc and soapstone along its steep periphery (Mortenson 1973; Storemyr & Heldal 2002:365–366)

The top of the hill lies at an elevation of 188 m ASL and today, the area is covered by full-grown spruce and deciduous forest. There are spoil heaps as a result of quarrying almost around the entire hill, and the site is not easily accessible, with steep slopes and a wet bog on the eastern side. In the soapstone zone, there are distinct traces of the use of sharp-pointed tools and the extraction of soapstone vessels. Vessel production mostly took place as open-cast operations, but there are also five small underground quarries.

Stone and minerals have been quarried and mined at Slipsteinsberget in recent history. There is reason to believe that attempts were made at quarrying decorative stone for the restoration of the Nidaros Cathedral in the late 19th century, albeit probably unsuccessfully. Later, between 1930 and 1960, talc was produced and during the Second World War, the Germans took charge over the manufacturing plant, which produced powder for salves (cf. Mortenson 1973). The quarry is still in

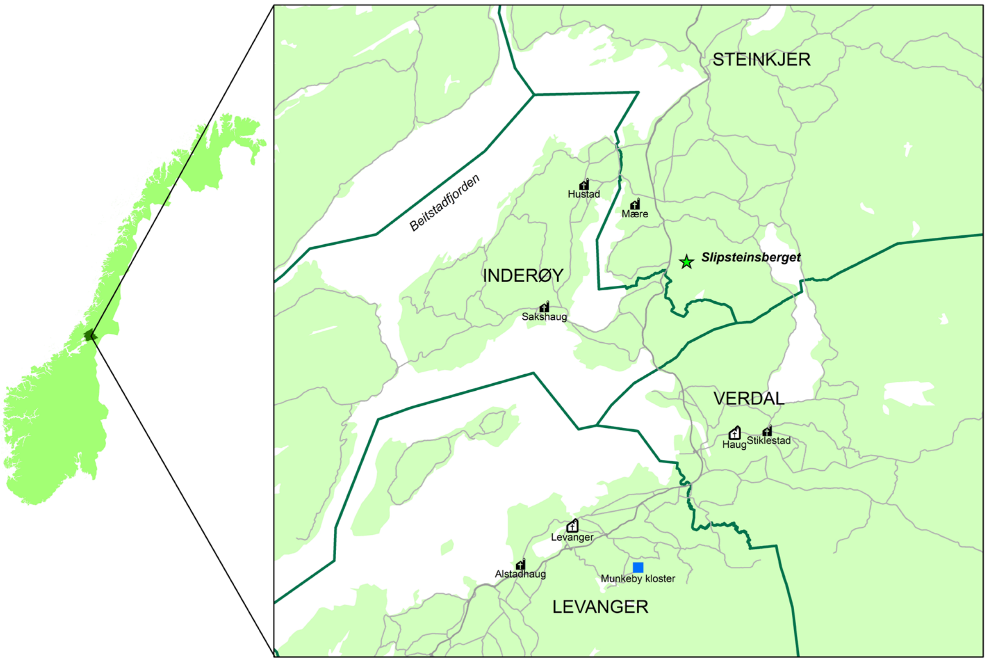


Figure 1. *Slipsteinsberget quarry is situated in Steinkjer municipality. There are seven churches and one monastery, all built from stone in the 12th century, near the quarry. (Map: Nord-Trøndelag County Administration).*

operation and today, serpentinite is being produced. Along the entire southern side, blocks from the inner parts of the hill are being extracted. The green stone, resembling Italian *verde antico*, is sawn and polished and mainly used for floor tiles.

Slipsteinsberget is part of a much larger quarry landscape in the Sparbu area, including nearby soapstone and marble quarries that have been exploited for decorative stone and as sources for lime production since the early Middle Ages (Storemyr 2015a, 2015b:173–180).

The problem at discussion

Karin Gjøl Hagen (1994:29–30) uses the word *professional* for a craft specialist who works with the aim of selling his products as opposed to production for use within the household of the craftsperson. As early as in 1869, Anders Lorange wrote that a soapstone industry must have existed in the Viking Age and that the products were objects of trade (Lorange 1869:47). Haakon Schetelig was of the same opinion in 1912 and thought that the production of soapstone pots in the Viking Age was on such a large scale that it could not only have been intended for local needs, but also for export to other parts of Norway and abroad. Schetelig refers to the soapstone vessels in the Viking Age as an industrial commodity of considerable importance (Schetelig 1912:73). In Sigurd Grieg's work *Det norske håndverks historie* (The History of Norwegian Crafts) from 1936, the soapstone industry was listed under the name 'home industry'. Grieg believed that it is highly unlikely that soapstone vessels were made by professional craftsmen, but rather by people from the farms situated near the old quarries. He found it natural that farmers produced vessels when they had a moment to spare between the work seasons on the farms and that half-finished vessels were transported down to the farms for finishing. Arne Skjølsvold, on the other hand, reached the conclusion that the smallest

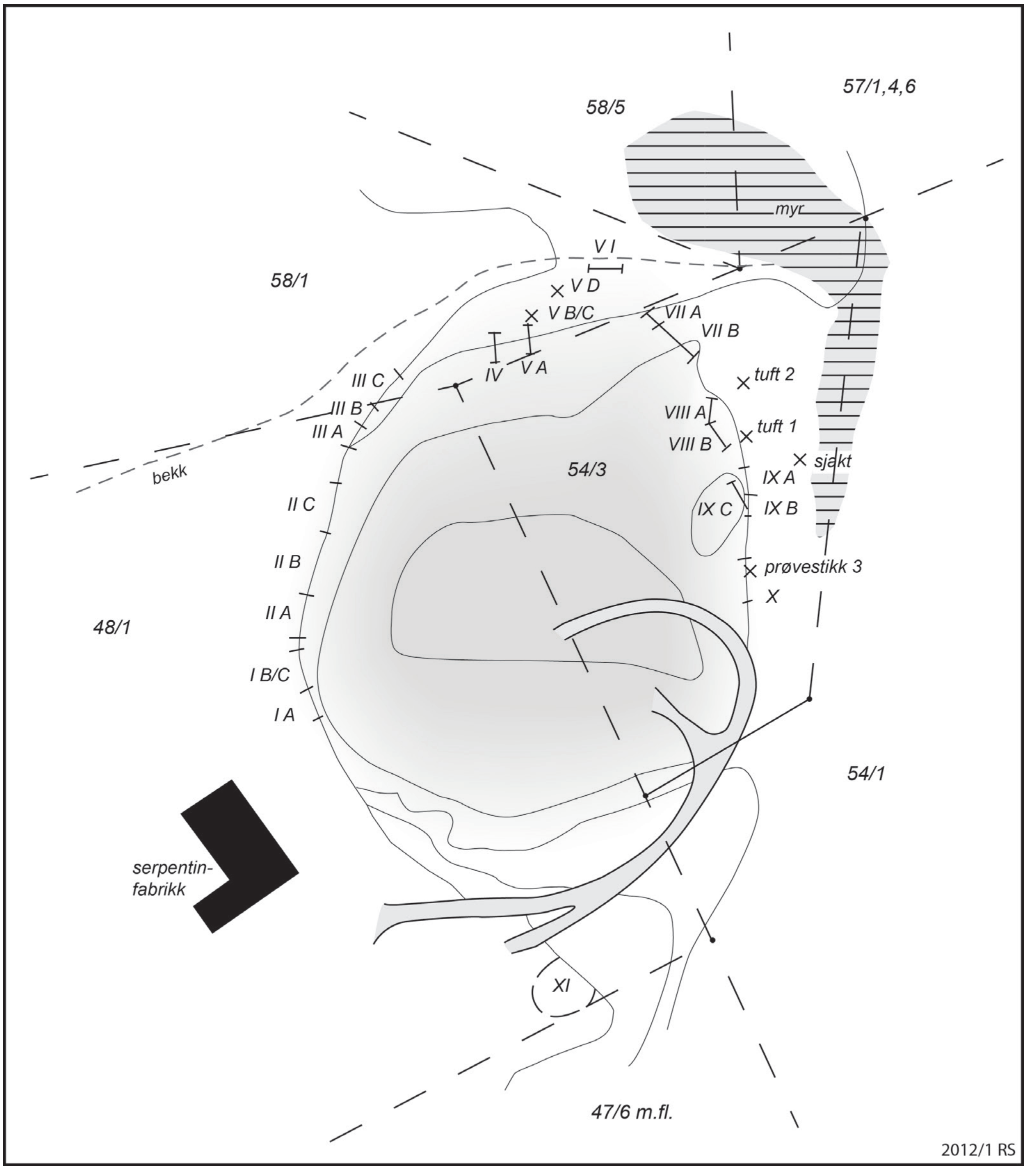


Figure 2. *Sketch map of Slipsteinsberget. The Roman numerals show surfaces that have traces of vessel extraction. The hill is c. 200 m Long N—S. (Illustration: R. Sauvage).*

soapstone quarries were operated by individual consumers, but argues that there were professional stone cutters at work in the majority of the larger quarries (Skjølsvold 1961:104pp). Large spoil heaps, pots with stonecutter marks on the rim and the use of scaffolding are some of the arguments he uses for characterising the craft as a professional one.

The question is whether, by means of the archaeological material in one specific stone quarry, it could be possible to get closer to the old stonecutter tradition by analysing the traces that are left behind there. The remnants are diverse, and it will be up to us to find them, interpret them and establish connections.

In 1999 and 2000, archaeological surveys and excavations of the Slipsteinsberget quarry were carried out. Quarry faces covering more than 1000 m^2 were studied, both in underground and open-cast quarries. On the eastern side of the hill, two house ruins that are believed to relate to the production were found (Figure 2). Both houses seem to have fallen into disuse in the 1400s. Parts of a spoil heap were also recovered half a metre down in a bog. The dates from the bog indicate that the quarry was used for vessel production from at least the early 11th century and up until approximately 1400 (Østerås 2002).

Local needs or larger markets?

In the following, I will bring up four elements concerning the investigations of Slipsteinsberget that will be central in the discussions on whether this was a quarry meant for local needs or for specialised production aimed at larger markets. We have to presume that the same operations and the same tools were used whether the pots were made for personal use or mass-produced for a market. But are there differences to be traced using other means than tool marks?

The scale of production

The first question that naturally arises is the scale of production. How many soapstone vessels were made at Slipsteinsberget? Traces from stonecutting activities were found all around the hill in five underground quarries and nine opencast quarries. On the 1032 m^2 of rock face that have been investigated, traces of 910 extractions of vessels or attempts at extraction were recorded. Of these, 330 were left hanging as rough vessel chunks on the rock wall, while 580 were negative impressions, that is, extraction marks where the vessel preform had been removed. Without doubt, the majority of what was extracted are circular, bowl-shaped vessels, and all of them were carved out with the base projecting from the rock surface. In addition, a few rectangular, unfinished chunks are still left; they may have been intended for vessels with a long handle, a so-called *skaftkar* (saucepan). From the form of the quarry faces one can assume that, generally, vessel preforms were extracted in three layers, thus it is possible to multiply the visible extraction marks by three, obtaining a total production of 2730 pots.

At the early Iron Age soapstone vessel quarry at Kvikne in Hedmark County, Arne Skjølsvold (1979:116) used a 'vessel density' of 3,6/m^2 and assumed 3–4 layers of extraction. If we assume an average of three layers in Slipsteinberget, this way of calculation will imply a production of more than 11,000 pots, that is, a quadrupling of the first calculation. Now, it should be pointed out that the vessels from Kvikne had a different form and were 1000–1500 years older than those at Slipsteinsberget.

Previously, it has been estimated that 3000 to 6000 m^3 of soapstone were quarried in Slipsteinsberget (Mortensen 1973:4). Each vessel may have required c. 1/3 m^3 of rock, and the total production would therefore range between 9000 and 18,000 pots.

But if we, instead of using the quarry faces as a point of departure to work out the amount, rather look at the spoil heaps, then the situation changes. The spoil heaps are consistently situated in close proximity to the quarry faces around Slipsteinsberget, and in most places, the lowermost traces of vessel extraction are covered by spoil. The recorded vessel traces are therefore only a fraction of what actually exists on the rock face.

We may use the quarrying area XI (Figure 2) as an example. This is a surface measuring c. 30 m^2, with traces of vessel extraction. The rock overhang indicates that vessel preforms were extracted in three layers, which corresponds to an extraction area of 90 m^2. At the rear edge of the extraction area, there are three clearly delimited spoil heaps that can be directly connected to vessel production. The volume of the heaps is c. 244 m^3, which would give about 3 m^3 of debris per m^2 *recorded* rock face. If we presume that this calculation can be transferred to the rest of Slipsteinsberget, where a total of 1032 m^2 of vessel extraction has been documented, we will have to multiply by three to obtain the total quarried area not covered by spoil, thus in the order of 3100 m^2. By again multiplying by three to obtain the total amount of spoil, we end up with more than 9000 m^3. We must then multiply by three to get a rough estimate of the number of pots produced, which thus will be in the order of 25–30,000.

Clearly, such calculations have many pitfalls and can never be accurate. As a form of qualified guesswork, they nevertheless give an indication of the *order of magnitude* of the production: a few tens of thousands of vessels over a period of at least 400 years. Using a total of 30,000 vessels, this implies an average production of 75 vessels/year, which is probably way beyond local needs.

Exploitation of the raw material

The extraction marks can be divided into two types. The first is found on near-vertical quarry faces and represents the most common extraction method at Slipsteinsberget, with many preforms still attached to the bedrock. The extraction spots seem to be rather randomly placed, but this is probably a misconception and rather a result of varying properties of the bedrock (hardness, serpentine content, crack pattern etc.). The stonecutters understood the practicalities of varying rock properties and thus concentrated on extracting vessels at places where the rock was both soft and firm enough for a good end-result.

The second way of extraction is connected to often steeply sloping rock faces, with negative extraction marks now forming 'stairs' along the slopes (Figure 3). This form of extraction seems well organised, and the raw material has been used to the maximum, indicating sound knowledge of extraction techniques and rock quality. With quarry faces sometimes situated more than six metres above the current ground level, it is likely that the workers used scaffolding, ropes and ladders to reach the highest areas

The stonecutters were also skilled in making adits for underground mining (Figure 4). The reason why the mines do not extend further than 8–9 m into the bedrock is because the core of Slipsteinsberget contains hard serpentinite, as mentioned above.

In summary, vessel quarrying at Slipsteinsberget, especially connected to the second type of extraction, gives the impression of organised activity. In my judgement, there must have been sound plans behind much of the work, including the collaboration of several persons.

Figure 3. *The second way of extraction with removal scars looking like stairs in the hill slope. (Photo: B. Østerås).*

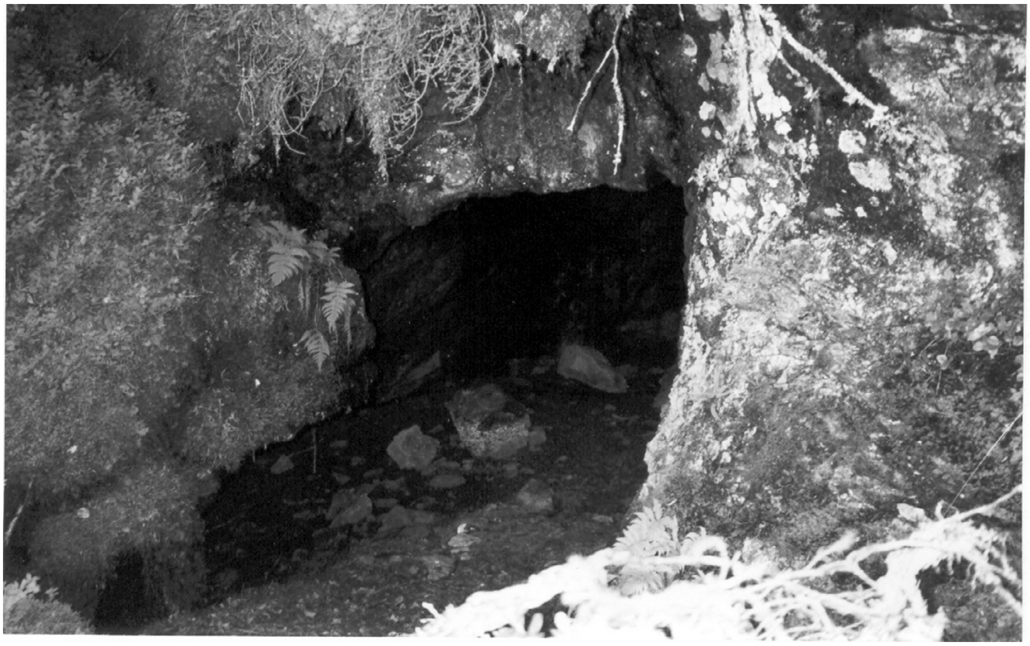


Figure 4. *The entrance area to one of the mines at Slipsteinsberget. (Photo: B. Østerås).*

Vessel production

The majority of the tool marks in Slipsteinsberget are narrow and demonstrate the use of pointed tools, either pointed chisels or pick axes. The pointed chisel leaves a long, semi-continuous track in the rock, and there are small depressions along the track, created by each blow with the mallet. It may be hard to distinguish these from the marks of a pick axe, but if a pick is used, it is difficult to hit the same track at the same angle several times successively. Thus, the marks are straight, but shorter and less connected. In addition, the point of the pick axe is often a bit broader than that of the chisel, and the marks are thus blunter.

To produce the shape of the vessel and to obtain enough room to split the preform loose, a fair amount of stone needed to be removed along the periphery of the blank. This was relatively rough work and probably carried out by using a pick. When the form of the vessel had been completed, the blanks were split off using a tool resembling a small wedge, probably a flat chisel (Figure 5).

What happened to the preform once it had been split from the rock? Thirty-two soapstone fragments were collected from the spoil heaps and brought to the NTNU University Museum in Trondheim (T22500). Twenty of these clearly were fragments of soapstone vessels, whereas the rest was identified as soapstone with cut marks, presumably spoil. Investigations showed that the finishing operations of the vessels took place in the quarry itself. Not only had the hollowing out been started, but several of the vessels were nearly finished when they cracked and were left in the spoil heaps. Both T22500:17 and T22500:25 are parts of vessels. Both are bowl-shaped with a 15 cm mouth rim; T22500:25 has a 12 cm long handle with a triangular section right on top of the mouth rim. The wall of the vessel is less than 1.5 cm thick, but the base is missing. On the inside, the hollowing out had been carried out using a groove technique with a fairly small, pointed tool. The exterior, the rim and the handle were polished with a tool with a slightly curved edge, c. 1.2 cm wide (Figure 6).

The vessel with the handle was deposited in a stratigraphic layer that included a few pieces of charcoal. They were ^{14}C dated to 775 ±50 BP (cal AD 1225–1285), thus in the high Middle Ages. Regarding style, the vessel bears a resemblance to Myrvoll Lossius' type A pot, known to date very broadly from the early Middle Ages and up to the 1300s (Myrvoll Lossius 1977:50; Vangstad this vol.), which is in accordance with the ^{14}C date.

In regards to T22500:17, the hollowing-out process had not come that far. The vessel wall is 3 cm thick and the marks from a pointed chisel criss-cross on the inside. The exterior, on the contrary, is so smooth that it is natural to assume that some sort of polishing (with sand?) was carried out.

Several pieces of vessels with exterior polishing were found, but only one piece was polished on both the inside and the outside (T22500:20). The wall is less than 2 cm thick (Figure 7). This implies that at least some of the vessels were completely finished at the quarry site. Myrvoll Lossius (1977:71) arrived at an opposite conclusion in her examination of the vessels from Borgund, where she states that the last finishing touch was made by specialist craftsmen or private individuals in the town. Also, Irene Baug (2008:333) arrived at the same conclusion as Myrvoll Lossius in her study of the soapstone material from the Viking Age Kaupang in eastern Norway. Thus, it seems that there was not just one tradition in regards to the location of finishing soapstone vessels.

Figure 5. *Experimentation with extraction of preforms (Eva Stavsøien). A pickaxe is used to produce the shape of the vessel and a flat chisel to separate the preform from the bedrock. (Photo: B. Østerås).*

The investigations at Slipsteinsberget also included a collaboration with stonemason Eva Stavsøien at the Restoration Workshop of the Nidaros Cathedral (NDR), Trondheim. Based on experience and knowledge about soapstone craft in the Middle Ages, Stavsøien concluded that the extraction of preforms was by far the simplest part of the vessel production. An expert stonecutter would probably extract several preforms on an ordinary workday. If there were any doubts as to whether the preform would detach where it was supposed to, or if the quality of the stone was sufficiently satisfactory, it did not take long to start carving out a new preform at a more suitable place. The challenge started with the hollowing-out of the vessel (Eva Stavsøien, pers. comm., see also Stavsøien this vol.).

If the soapstone at Slipsteinsberget was used in the household of the craftsperson only, we would hardly find finished, polished vessels at the quarrying site itself. For a mere household production, including only one or a few vessels at a time, it would be natural that as little work as possible was carried out at the quarry site and that it was considered more convenient to bring unworked preforms back to the farm for finishing.

Figure 6. *Part of handled vessel found in Slipsteinsberget (T22500:25). The vessel is dated to AD 1225-1285. (Photo: B. Østerås).*

Figure 7. *Part of vessel wall where both the inside and the outside have a smooth finish (T22500:20). (Photo: NTNU University Museum).*

The house ruins

Very few prehistoric house ruins have been found in ancient stone quarries in Norway. Skjølsvold (1969:235) mentions one of them, a stone-built construction measuring 12–15 m², about 80 m northwest of the soapstone quarry at Kvikne in Hedmark, which dates back to 500–200 BC. Skjølsvold suggests that the hut may have functioned as a shed or temporary dwelling for the stonecutters.

Only a few metres apart from each other, there are two house ruins at the eastern side of Slipsteinsberget; they were built on the spoil heaps of the quarry (Figure 2). The base of ruin 1 is c. 2.5 x 4.5 m, with a distinct entrance area measuring 1.25 x 1.25 m. From here, a 7.5 m long path leads to the quarry face. Thus, the connection between the house and the extraction area seems to have been important. The floor is covered with slabs of soapstone, but there are also remains of a wooden floor in between the slabs. The wood has been ^{14}C dated to 690 ±70 BP (cal AD 1280–1390) and 470 + 50 BP (cal AD 1420–1450). Therefore, the house seems to have been in use from the 13th to the 15th century.

Our excavation showed no signs of hearths in ruin 1, but on the floor, there were many fragments of finished soapstone vessels. Thus, it is reasonable to in-

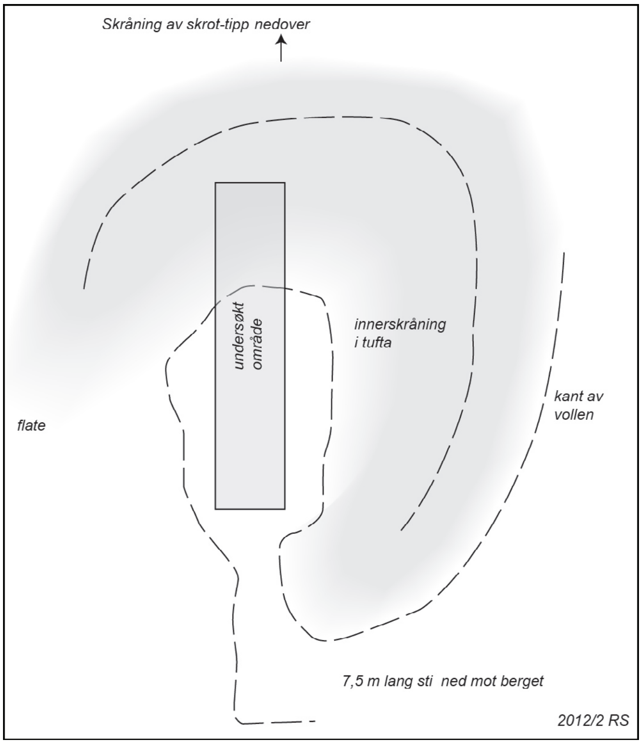


Figure 8. *Plan drawing of house ruin 1 with excavated area (marked in gray) and the path leading down to the rock hill. (Illustration: R. Sauvage).*

terpret the house as a stone workshop (Østerås 2002:53ff). Here, the vessel makers could sit sheltered from wind and weather and work the vessels into finished products (Figure 8).

Ruin 2 was also placed on the spoil heap, but measuring 6 x 6 m, the ground plan is bigger than that of ruin 1. The exit is not facing the extraction area, but a nearby bog. It is possible that the bog on the eastern side of Slipsteinsberget once was a small lake and that this was the water supply of the people who worked here. Moreover, the lake may also have been a place to soak the vessel preforms. We know of several instances where both finished and unfinished soapstone artefacts have been found in bogs and lakes, like, for example, the 25 cm tall soapstone vessel with a rounded base that was found more than 1 m down in a bog at Vikstrøm on Hitra island (central Norway) (Figure 9).

Figure 9. *Soapstone vessel from the early Iron Age found in a bog at Vikstrøm on Hitra (T3767). (Photo: P. Fredriksen, NTNU University Museum).*

The explanation may be that moist soapstone is, indeed, easier to work than a dry and brittle one which has been left to dry out for some time. The bog at Slipsteinsberget was not investigated further with a view to possible depot finds, but the associated spoil heap was dug to a depth below the current surface of the bog. The organic material in the bog could be dated back to the 11th century AD (^{14}C-dating).

In ruin 2, there was a hearth located in the north-eastern corner and a test pit provided a charcoal sample dating to 695 ±45 BP (cal AD 1285–1375). Thus, it seems that the houses may have been in use simultaneously and were abandoned at some stage in the early 1400s.

The discovery of house ruins, one of them clearly a workshop for producing vessels, indicates that professional craftsmen were indeed working at Slipsteinsberget. It is unlikely that local people, in need of a vessel or two every now and then, would have gone to the troubles of setting up a workshop for finishing vessels as well as housing in the quarry. Local people would presumably, as argued above, have brought preforms back home to the farm for finishing.

Household production or export?

There are no provenance studies currently available to indicate vessel sale from Slipsteinsberget to larger markets such as the medieval towns in central Norway, especially Trondheim, and beyond. Yet, the archaeological evidence, including the scale of production, certainly hints at export to markets beyond the local one in Steinkjer/Sparbu.

Over a 400-year-period, from the 11th century to the 1400s, on average, some 75 vessels may have been produced annually. There were probably many ups and downs, and years of intensive production followed periods with no production at all.

There were 75 farms in Sparbu county in the late Middle Ages, in the 1430s according to Aslak Bolt's jordebok (Jørgensen 1997:18A–23B). Thus, the question arises: did these farms need a new soapstone cooking vessel every year? Probably not, since a soapstone vessel was rather durable and would most likely last for many years.

How many of these farms may have had access to Slipsteinsberget as a source of raw material? Today, there are no less than seven property boundaries meeting at the quarry. Two of the farms, Andstad and Landstad, are named farms that (according to the ending *-staðir*) probably were cleared already in the Viking Age. Could the boundaries be an indication of a strong interest in the deposit far back in time? Was it important to claim a piece of the deposit because soapstone was considered a key resource?

Few archaeological finds of soapstone vessels have been made in north-Trøndelag, and only five have been localised to the old Sparbu parish. With one exception, they are finds connected to the quarry. The last one is from a grave not far from Slipsteinsberget. There may be a number of explanations for this; the production of vessels in Slipsteinsberget may not have reached its peak before the custom of grave gifts died out with the introduction of the Christian faith in the Middle Ages. But the lack of finds may also be an argument in favour of the assumption that the vessels were produced for export rather than ending up as kitchen utensils on the local farms.

In the same way as there were blacksmiths in the rural districts or shoemakers and other types of craftspeople, one could imagine that there were stonecutters. Maybe a few specialists on some of the farms in Sparbu gathered every year and met at Slipsteinsberget to act as part-time specialists?

It is highly likely that the intensity of the production increased towards the end of the 12th century and onwards to the Black Death. At that time, we know that there was a high quarrying activity in Trøndelag in connection with the building of stone churches and monasteries. In Innherad, in the neighbouring municipalities Levanger, Verdal, Steinkjer and Inderøy alone, seven churches and one monastery were built during the 12th century (Ekroll 1997). There was a strong medieval stonemason tradition, with one centre in Trondheim and another in Sparbu (Storemyr 2015a, 2015b:173–180), and it may have been the same people who worked both building and decorative stone and vessels.

There was a strong population growth in the period under study, and the Norwegian medieval towns were established. As a consequence, the demand for refined products also increased. In connection with archaeological excavations around Nidaros Cathedral in Trondheim, several remains of finished and half-finished soapstone pots have been found (Domkirkegården TA 2001/05. Shaft 13). The stonemasons here probably made use of the left-overs from the building sites to produce other soapstone objects.

Concluding remarks

The archaeological sources at Slipsteinsberget in Sparbu indicate that professional craftspeople worked at the soapstone quarry over a period of at least 400 years. The discovery of finished pots, two house ruins, the volume of the production and the exploitation of the raw material bear witness of a large-scale industry with distinct structures and methods.

We may find the people behind the production in the stonemason traditions that developed in the Middle Ages in connection with the building of churches and monasteries, and a growing market for finished vessels in the towns. I suggest that among the stone builders, there may have been travelling specialists who made their living as stonecutters, also producing vessels during parts of the year. Part-time specialists could as well be local craftspeople from the rural district. In any case, the production of soapstone vessels in Slipsteinsberget must by far have exceeded the local needs and the vessels must have been transported as finished products out of the quarry to new markets.

Acknowledgements

I want to thank Vedis Bjørndal (University Museum of Bergen) for translating the Norwegian manuscript into English. Also thanks to Per Storemyr for correcting and adapting the English translation.

References

Baug, I. 2011. Soapstone Finds. In Skre, D. (ed.) *Things from the Town. Artefacts and Inhabitants in Viking-age Kaupang,* 311–337. Kaupang Excavation Project. Publication Series, 3. (Norske Oldfunn XXIV, Aarhus).

Domkirkegården TA 2001/05, 2001. Unpublished archaeological report, Norwegian Institute for Cultural Heritage Research (NIKU), Trondheim.

Ekroll, Ø. 1997. *Med kleber og kalk. Norsk steinbygging i mellomalderen 1050–1550*, Oslo.

Grieg, S. 1936. *Det norske håndverks historie*, 1, Oslo.

Hagen, K. G. 1994. Profesjonalisme og urbanisering. *Universitetets Oldsaksamlings Skrifter*. *Ny rekke*, 16, Oslo.

Jørgensen, J. G. 1997. *Aslak Bolts Jordebok*. Riksarkivet, Oslo.

Lorange, A. 1869. Student A. Loranges udsigt over hans antikvariske virksomhed i 1868. *Foreningen til norske fortidsmindesmerkers bevaring*. *Aarsberetning for 1868*, 40–84. Kristiania.

Lossius, S. Myrvoll. 1977. *Kleberkarmaterialet fra Borgund, Sunnmøre.* Arkeologiske avhandlinger fra Historisk museum, no.1. Universitetet i Bergen, Bergen.

Møllerop, O. 1960. Kleberkar fra keltertid. *Stavanger Museum.* Årbok 1959, 21–40.

Mortensen, M. 1973. Talk og serpentinforekomster i Sparbu, Nord-Trøndelag. *NGU Norges geologiske undersøkelse*, 290, 1–16.

Petersen, J. 1934. De eldste norske kleberstenskar fra Jernalderen. *Finska Fornminneföreningens Tidsskrift,* XL, Helsingfors.

Pilø, L. 1990. Early soapstone vessels in Norway from the Late Bronze Age to the Early Roman Iron Age. *ACTA Archeologica*, 60, 87–100.

Schetelig, H. 1912. Kar av kleberstein fra jernalderen. In Brøgger, A.W (ed.) *Olditden, tidsskrift for Norsk forhistorie,* 49–73.

Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden*, Oslo.

Skjølsvold, A. 1969. Et keltertids klebersteinsbrudd fra Kvikne. *Viking*, 33, 201–236.

Skjølsvold, A. 1979. Gryteindustrien i Kviknefjellene for over 2000 år siden. In Nyland, R. (ed.) *Fortiden i Søkelyset. Datering med* ^{14}C *metoden gjennom 25 år,* 111–119, Trondheim.

Storemyr, P. & Heldal, T. 2002. Soapstone Production through Norwegian History: Geology, Properties, Quarrying and Use. In Herrmann, J., Herz, N. & Newman, R. (eds): *ASMOSIA 5, Interdisciplinary Studies on Ancient Stone – Proceedings of the Fifth International Conference of the Association for the Study of Marble and Other Stones in Antiquity,* 359–369. Museum of Fine Arts, Boston, June 11–15, 1998, London.

Storemyr, P. 2015a. The medieval quarries at Sparbu: A Central Norwegian 'little sister' of the Purbeck quarry landscape in England. In Indrelid, S., Hjelle, K. L. & Stene, K. (eds) *Exploitation of Outfield resources – Joint research at the University Museums of Norway*, *Universitetsmuseet i Bergen Skrifter* no. 32, 141–154, Bergen.

Storemyr, P. 2015b. *Nidarosdomens grunnfjell. En reise i steinbryternes fotspor fra Det gamle Egypt til Europas nordligste katedral*. Nidaros Domkirkes Restaureringsarbeiders forlag, Trondheim.

Østerås, B. 2002: Klebersteinsbrotet på Sparbu. Kva undersøkingar av eit klebersteinsbrot kan fortelje om gamle steinhoggartradisjonar. Unpublished hovedfag thesis, Norwegian University of Science and Technology, Trondheim.

Østerås, B. 1999. Eit klebersteinbrot fortel si historie. *Spor*, 14, 2, 23–25.

Østerås, B. 2001. Rapport frå Slipsteinsberget i Sparbu. Top-Ark, dok.nr 20253, Unpublished report at NTNU University Museum, Trondheim.

Østerås, B. 2005. Rapport. Arkeologisk utgraving av klebersteinsbrotet på Kvikne. Kvikne klebersteinsbrudd – fjellsameige Kvikneskogen vest gbnr 140/12 – Bubakk/ Sandbekkdalen, Tynset kommune, Hedmark. Saksnummer 2008/20486. Unpublished report, University of Oslo.

Irene Baug

Bakestones – Production and Trade in the Middle Ages

During the Middle Ages, bakestones, or stone griddles, were an important part of Norwegian households, representing everyday products required for the preparation of food over the hearth. Demand for these tools formed the basis for large-scale production, which is the subject of this paper. The study is based on analyses of an extended quarry landscape in Ølve and Hatlestrand in the County of Hordaland, representing the largest and most important production centre for bakestones in Norway. The griddles were produced from chlorite-rich talc-amphibole schist, a material able to withstand repeated heating and cooling without an imminent risk of fracturing. The range of products from the quarries also included tiles, building stones, and stone crosses. Small scale archaeological excavations in some of the quarries, and at a workplace where the finishing of bakestones took place, date the production to between the early Middle Ages (c. 11th or early 12th centuries) and the early modern period. The character and scale of production indicate an intense and well-organised activity, a specialisation where the quarries were exploited for profit. Most evidence points to a so-called semi-professional craft where people working and living at the surrounding farms also worked in the quarries. Some of the largest quarry sites may, however, have demanded different organisation and larger workforces. The bakestones were distributed all over Norway from the 1100s and into the early modern period. Outside Norway, they are mainly to be found within the North Atlantic region, whereas in Sweden and Denmark they are only found in small numbers, indicating random export.

Introduction

Throughout the Middle Ages, widespread use of a variety of stone objects can be traced. Many of these objects were needed in the daily household. This is the case for bakestones: flat stones, often circular or oval in shape, approximately 25–50 cm in diameter, and normally c. 1 cm thick, used for baking bread or heating other foodstuffs over the hearth. Characteristic of the bakestones are incised grooves or furrows in different patterns, on one or both of the sides (Figure 1). For centuries, stone griddles were important in Norwegian households, as everyday products for food preparation and demand for them was high. This formed the basis for large-scale production, which is the subject of this paper. The study is based on analyses of an extended quarry landscape in Ølve and Hatlestrand in the county of Hordaland in western Norway, carried out in connection with my doctoral project (Baug 2013, published 2015). I will present the archaeological investigations conducted in the quarries, and the results thereof. What was produced and when? Important questions to be included are: Was this production largely based on a local, and perhaps regional, need? Or was it large-scale production meant for widespread distribution and sale?

Geology of the bakestones

Bakestones had to be able to withstand repeated heating and cooling without an imminent risk of fracturing. Geological studies show they were made of two types of rock: soapstone and chlorite-rich talc-amphibole schist (Weber 1989; Tengesdal 2010:20–22, 31). The latter rock type has previously been referred to as *chlorite-rich talc-bearing green schist* (Baug 2015b). So far three production sites for chlorite-rich talc-amphibole schist are known of in Norway: one at Øye in Sør-Trøndelag, one at Ertenstein in Rogaland, and one in Ølve and Hatlestrand in Sunnhordland (Heldal & Storemyr 1997:9–12; Storemyr 2001:67; 2015:189–191; Lundberg 2007; Storemyr et al. 2010:189–192; Jansen 2013:78; Baug 2015b). The rock type at the latter production site has in some places been referred to as schistose soapstone (Naterstad 1984), but from a geological point of view the talc content of the stone is not considered large enough to use the term soapstone (Jansen pers. comm. 2009). A more precise term for this material would be chlorite-rich talc-amphibole schist, which in the following will be shortened to *chlorite schist.*

Figure 1. *Bakestone fragment from Bryggen in Bergen (Inventory no. BRM0/50119, University Museum of Bergen). (Photo: M. Gladki, Museumssenteret i Hordaland).*

Ølve and Hatlestrand was, by far, the largest and most important production centre for bakestones in Norway (Baug 2015b). The chlorite schist is located along a 5–6 m thick layer in a greenstone complex, situated on the southern and eastern sides of Lake Kvitebergsvatnet, as well as on the western side of Kvinnherad Fjorden, which is a part of Hardanger Fjorden. During extraction, the layer of chlorite schist was followed into the rock. This resulted in overhangs and underground quarries (Baug 2015b:4).

In the quarries at Øye in Sør-Trøndelag, building stones for Nidaros Cathedral were the main items extracted, but small-scale extraction of bakestones was also carried out (Heldal & Storemyr 1997:5, 9–12, 18; Lundberg 2007; Storemyr et al. 2010:189–190). A similar situation is to be found in the medieval quarry site at Ertenstein farm in Rennesøy, in Rogaland, where building stones for the Romanesque part of Stavanger Cathedral were extracted (Storemyr 2001:67). The quarries at Ertenstein contain more mica and carbonate, and are thus easy to distinguish from Ølve/Hatlestrand and Øye (Jansen pers. comm., 2012). In medieval Norway, local, small-scale production of bakestones also occurred in a number of soapstone quarries used for vessel production and, at times, building stone extraction. This is evident from bakestone finds of soapstone in medieval towns, such as Bergen and Trondheim (Weber 1989; Tengesdal 2010).

Outside Norway, Shetland is the only place where production of bakestones has been documented. Here, bakestones were produced in soapstone quarries, along with soapstone vessels. The griddles extracted in Shetland were rectangular or sub-rectangular in shape (Weber 1999:134), and hence differ somewhat from the circular or oval Norwegian ones. Locally produced bakestones in Shetland are found in early Viking deposits, for instance at Old Scatness Broch, and are thus older than those from Norway. As bakestones are not known prior to the early Middle Ages in Norway (Petersen 1951:417-421; Granlund 1956:307; Baug 2015b), the Shetland bakestones have been suggested as an innovation which led to Norwegian production (Forster 2009:65).

The quarries in Ølve and Hatlestrand

The communities of Ølve and Hatlestrand are located in Kvinnherad municipality on the western side of Hardanger Fjorden, around 100 km southeast of Bergen. So far 71 quarries have been identified in this area, located within the borders of nine historical farms; the majority located in Ølve (Figure 2) (Baug 2015b:7). Production was carried out in both underground and open-cast quarries.

Underground exploitation has left both overhangs and caves, ranging from a few metres to around 30 m deep (Figure 3). The entrances to the caves are located in hillsides along the sub-horizontal layer of chlorite schist. A few of the largest underground quarries comprise several caves. Some have entrances from the surface, while others can only be accessed through another cave. Several caves have collapsed, leaving large stone blocks inside, and in front of, the quarries, in some cases blocking access. Most quarries are located in the mountainous outer fields of the farms, whereas a few are to be found in the inner fields. Together, they have strongly altered the natural landscape.

In Ølve, the quarries are situated in a closely-spaced row along Fuglebergåsen hill, stretching along a north-south axis c. 60–145 m ASL. Many of the quarries overlap each other, and it is difficult to determine their individual layout. Each quarry site may thus comprise several quarries, probably used in different periods. In the middle of this area underneath the Kvitafjell rockshelter, a workplace is located. In Hatlestrand, most quarries are located closer to the sea and possible harbours. However, the production sites in Hatlestrand are generally fewer and more scattered, and many of them are smaller than those in Ølve (Baug 2015b:75–76).

The products were carved directly from the bedrock, generally by cutting the shape of the objects

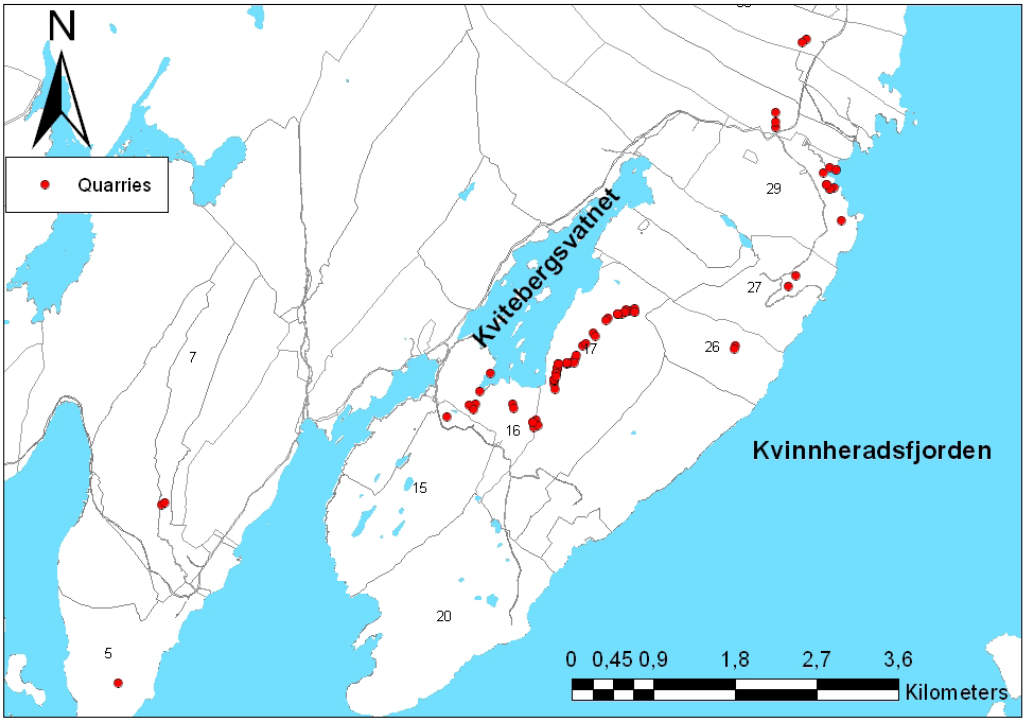


Figure 2. *Identified quarries in Ølve and Hatlestrand. Farm numbers are specified for farms with quarries within their boundaries. (Source: Baug 2015b: Fig. 1.7).*

Figure 3: *Underground quarry at Fugleberg Farm in Ølve. Production marks of bakestone extraction are visible on the wall to the right (Photo: A. O. Martinussen, 2012).*

into the rock and then splitting them individually loose along the cleavage. Extraction of large slabs, probably used for building stones, was carried out using a form of channelling with pick axes (or similar tools), and wedging with chisel-like tools. This technique is typical for cutting building stones out of soft rock, but is also known from ancient and medieval production of soapstone vessels and garnet micaschist quernstones (cf. Storemyr et al. 2010:191, 204; Harrell & Storemyr 2013 [2015]). The same technique was used in bakestone production. Here, however, only a small furrow was cut around the base of the bakestone before splitting it from the rock. As bakestone blanks are approximately 3 cm thick, wider channels were not needed. Imprints of bakestone extraction are also generally rounder or more oval compared to production marks from building stones. The production method left tall, carved walls in the quarries. Extraction of bakestones often left semi-circular marks resembling the negative imprint of a stack of coins, often with a sharp edge between individual stacks (cf. the carved wall to the right on Figure 3). Extraction of larger slabs generally left straighter, step-like walls, often with rectangular marks with straight or rounded corners. However, in several quarries it is difficult to identify the products extracted based solely on the cutting marks.

The range of products

The best known product type from the quarries in Ølve and Hatlestrand is bakestones (cf. Naterstad 1984; 1989; Weber 1984; 1989; 1990; 1999). Yet, traces of cutting in the quarries, as well as written sources, testify to a wide range of products. From the 16th century onwards, written sources provide information on the production of bakestones and roofing tiles (NRJ IV:474; Friis 1632:71-74; Hoff & Lidén 2000:156). According to the priest and writer Peder Clausson Friis, in the late 16th century thin stones used for baking flatbread were produced – the bakestones – but thin oblong slabs were also extracted for the purpose of drying corn and oats (Friis 1632:72). In the late 19th century, the quarries allegedly also delivered building stones for castles in Denmark, as well as stones for window and doorframes, and cornerstones for the Skåla church in Kvinnherad, and for the main house at the Rosendal Barony (Haukenæs 1888:68, 135). In the 20th century, it was believed that vessels were also extracted from the quarries (Vaage 1972:125-128), but this kind of production has not been verified.

Grave crosses have been extracted from some of the quarries, allegedly in the 1900s (Hoff & Lidén 2000:166). Geochemical analyses of grave crosses at the Skåla church in Kvinnherad indicate that they were produced in Ølve or Hatlestrand (Jansen pers. comm. 2009). They are shaped like Celtic crosses where the intersection is encircled. Quite similar crosses are found in eastern Norway, where several are considered to stem from the early 1100s and 1200s (Nordeide 2009:164–165; 2011:129, 133). Whether or not the production of crosses in Ølve and Hatlestrand also dates to the Middle Ages is not known. No remains have been documented in the quarries.

In several of the quarries, different products may have been extracted during different periods, while some quarries may have produced a range of different objects contemporaneously. In fact, extraction marks of tiles, slabs, and building stones dominate in most quarries, whereas production marks from bakestones are often difficult to identify. It is possible that later production of other objects has removed traces of bakestone production. Yet, finds of bakestone fragments in spoil heaps indicate that this extraction was carried out along with the production of other objects in all of the investigated quarries. Identification of the products extracted in different quarries is, however, difficult based only on production marks in the bedrock and from surface recovery. In most cases, the cutting traces do not give any clear indication of what objects were produced.

Archaeological investigations in the bakestone quarries

In connection with my doctoral project, archaeological research at selected locations within the quarry landscape in Ølve and Hatlestrand was carried out. The aim was to reach a better understanding of the quarries regarding scale of the production, production techniques, product types, and chronology. The main goal was to identify the objects produced and date the extraction in different quarries within the extensive production area. The considerable size of the quarry landscape only allowed investigation of selected sites, and it was important to obtain a representative sample through archaeological surveys. Quarries that differed with regard to products, size, technology, and geological conditions were studied. I also wanted to investigate quarries within different distances from possible harbours and transport routes. Changes in production methods and product

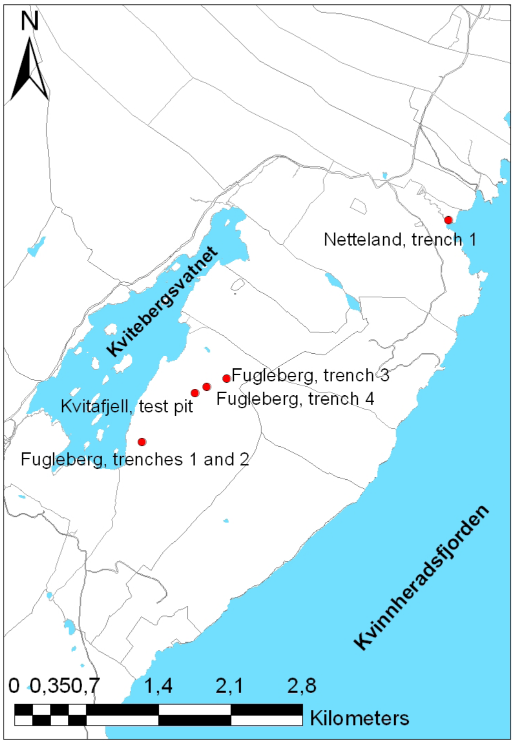


Figure 4. *Map of excavation locations. (Source: Baug 2015: Fig. 6.1).*

types also formed central issues. Four quarries and one workplace were selected and altogether five trenches and one test pit were dug, all of them in spoil heaps. They were excavated in order to analyse stratigraphical relationships and to collect material for ^{14}C-dating. The sites are all located in the outer fields of two historical farms, Fugleberg (farm no. 17) in Ølve, and Netteland (farm no. 29) in Hatlestrand (Figure 4) (Baug 2015b:75–104).

Investigated quarries at Fugleberg farm

The quarries investigated at Fugleberg are located on the hillside of Fuglebergåsen hill, c. 60–145 m ASL, a long distance from the fjord and possible harbours. Altogether, ten production sites have been identified, located both in the inner and outer fields of the farm (Baug 2015b:76–78). The farm does not border the sea, but had a mooring place, Støo (farm no. 19) on Kvinnheradsfjorden. In the Middle Ages Støo may have belonged to Skarvatun Farm (no. 18) (Nysæter 2013:148). Products from the quarries furthest east at Fugleberg may have been brought to Støo for further distribution, but the stones were probably also transported across steep terrain down to Kvitebergsvatnet lake. Here, they may have been transported to the southern end of the lake, where a distance of c. 350 m separates the lake from the fjord. Three quarry sites of different scales were chosen for the survey at the farm. Additionally, a workplace where bakestones were finished was investigated.

Fugleberg, Trenches 1-2

Bakkhidlaren, one of the largest production areas in Ølve, is a coherent production area covering a distance of roughly 82 m, on a northeast-southwest axis, and was chosen as an investigation area. Extractions in both open-cast and underground quarries are documented, and altogether five underground quarries of different size have been identified. Inside the largest underground quarry

Figure 5. *Carving traces in the underground quarry at Bakkhidlaren indicating extraction of tiles and slabs, possibly for building stones. (Photo: A. O. Martinussen).*

in Bakkhidlaren, a small scrape (Inventory no. BRM652/1, University Museum of Bergen) and a wooden wedge (24 x 4 cm) were found, most likely representing tools used during extraction (Baug 2015b:79–80, 82). Similar wooden wedges have been found in several of the quarries in Ølve. Their exact function is not known, but they may have been used in connection with wedging the products loose along the cleavage plane. Wooden wedges are also known from the millstone quarries in Selbu in Sør-Trøndelag County (Rollseth 1947:152).The scrape was probably used in order to move the spoil away and clean up the quarry.

The production traces in Bakkhidlaren, both inside and outside the quarries, indicate extraction of several products, but without clear traces of bakestones in the underground quarries. Here, extraction of larger slabs, probably for building stones or tiles, seems to have dominated (Figure 5). A carved rockface to the north-east, resembling the negative imprint of a stack of coins, is the only area with clear traces of the extraction of bakestones.

Two large spoil heaps are located at the southwestern end of the production site, just outside the underground quarries. Here, a search trench was established in each of the heaps. The content in Trench 1 concurred with the production marks on the rock and indicates only small-scale extraction of bakestones. Large slabs were the most common element in the trench, perhaps originating from

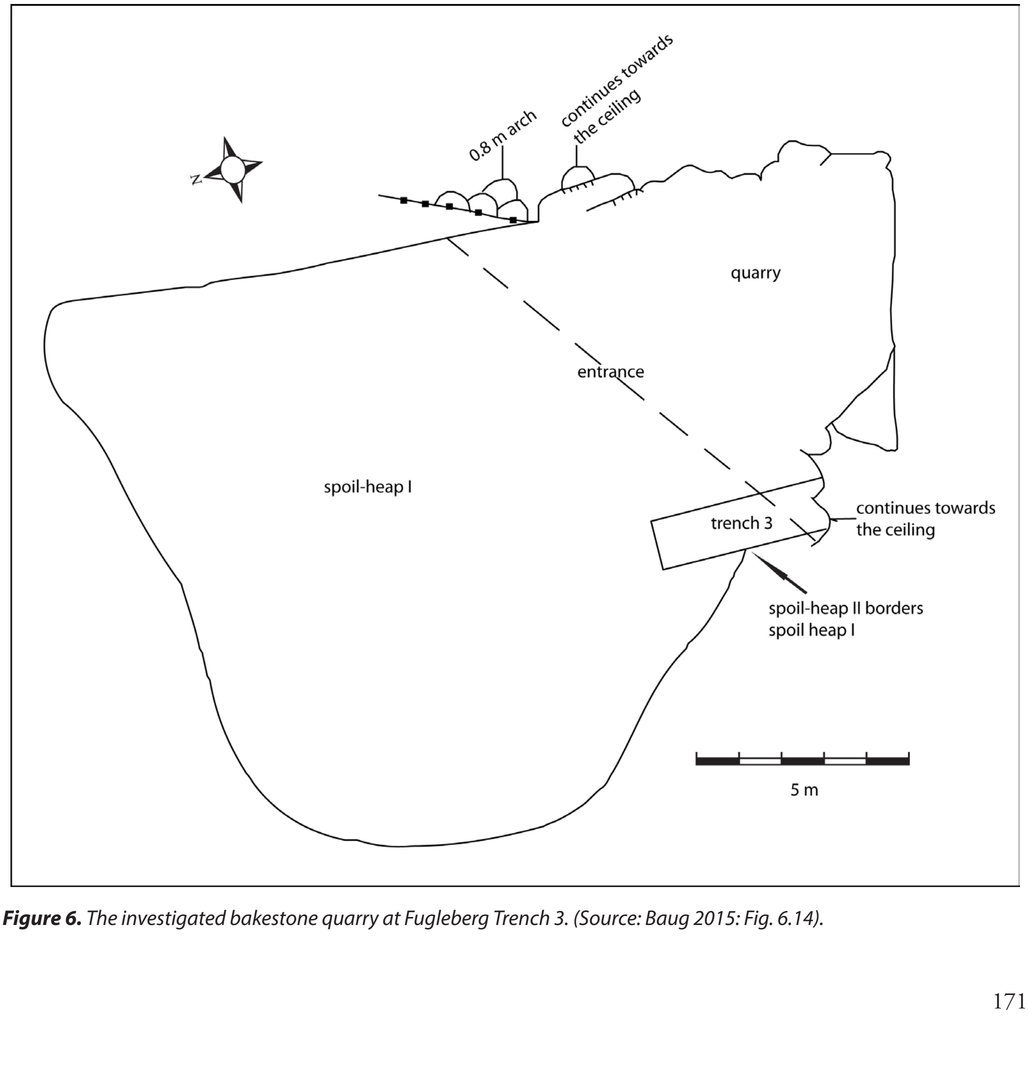


Figure 6. *The investigated bakestone quarry at Fugleberg Trench 3. (Source: Baug 2015: Fig. 6.14).*

production of tiles and slabs for building stones. No building stones were identified in the trench, but prodution cannot be excluded. In Trench 2, smaller flakes (spoil from the extraction) from 1 to 20 cm in length were the dominant items, but there were only a few fragments of bakestones. No datable material was found in either of the two trenches, thus the period of production remains unknown (Baug 2015b:81–86).

Fugleberg Trench 3

The second site excavated is located at the northern end of Fuglebergåsen hill, at a cliff where three small quarries were identified. The site selected for the investigation is an underground quarry, 1.6–2.5 m high, 9 m wide, and 10 m deep (approximately 80 m^3). Production was mainly carried out inside the quarry. The spoil heap is located in front of the entrance, but large amounts of waste were also dumped inside the quarry. Here, most of the production marks have concave curves of a semi-circular shape with a diameter ranging between 55 and 65 cm, most likely originating from the extraction of bakestones. Some production marks, though, are more rectangular in shape, some with straight and others with rounded corners. Remains of channelling are also evident on the rock, indicating products other than bakestones.

Two different spoil heaps were identified (Figure 6). The main heap (Heap I) is located in front of the underground quarry, and is a result of production within the quarry. This heap is bordered by another heap (Heap II) in front of the southwestern end of the quarry opening. Heap II is, however, most likely a result of extraction in this part of the quarry

Figure 7. *Fugleberg Trench 3 during excavation. (Photo: I. Baug).*

Figure 8. *^{14}C-analyses from Fugleberg Trench 3.*

Lab. Ref.	Context	The age BP	Calibrated Age	Material
TUa-6697	Fugleberg Trench 3, layer 2	720 ± 35	AD1280—1295	Pine charcoal
TUa-6699	Fugleberg Trench 3, layer 4	800 ± 35	AD1225—1280	Birch charcoal
T-19070	Fugleberg Trench 3, layer 4	370 ± 45	AD1445—1635	Birch and pine charcoal
T-19071	Fugleberg Trench 3, layer 4	190 ± 45	Younger than AD1660	Birch and pine charcoal
TUa-6696	Fugleberg Trench 3, layer 6	960 ± 35	AD1025—1155	Pine charcoal
TUa-6698	Fugleberg Trench 3, layer 6	905 ± 35	AD1045—1190	Pine charcoal
TUa-6700	Fugleberg Trench 3, layer 7	2605 ± 35	805—790 BC	Deciduous trees charcoal
TUa-6701	Fugleberg Trench 3, layer 7	4440 ± 45	3260—2930 BC	Sallow, willow/aspen charcoal

site, both at the exterior rockface and from the southernmost quarry, which forms an overhang in the cliff. Trench 3 was laid out towards the rockface at the southern end of the quarry, covering parts of Heap II and, to the north, goes into Heap I (Baug 2015b:84–91).

Compared with the other investigated quarries, more fragments of bakestones were identified in Trench 3, indicating that they were the main product here (Figure 7). The diameter of the measurable bakestones found ranged from 27 to 55 cm in diameter, and they were made in different shapes – circular, oval, and drop shaped. Some of the production marks in the rock are about 60–70 cm in diameter, indicating that there was no standard size of the bakestones. They also vary in thickness; unfinished blanks are about 3–4 cm thick, while more finished bakestones with furrows on each side are about 1 cm thick (Baug 2015b:90).

Altogether eight samples for ^{14}C-dating were taken from the trench. Dating indicates that the production of bakestones goes back to the early Middle Ages, to the 11th or early 12th centuries. A second production phase is documented from the high Middle Ages (from the 13th century), continuing up until early modern period (c. the 15th to 17th centuries). There were also indications of products other than bakestones, most likely from the high Middle Ages onwards (Figure 8; Baug 2015b:86–92).

Fugleberg Trench 4

Located further south on Fuglebergåsen Hill, c. 200 m north of Kvitafjell, is the last investigated quarry at Fugleberg Farm, with remains of manufacture both in an underground and an open-cast quarry. The underground quarry is about 11 m wide, 7 m deep, and c. 2.2 m high (approximately 170 m^3), with traces of a variety of production marks, both on the walls and in the roof. The spoil from the quarry is deposited beside the rockface, and formed into a heap (c. 20 m x 9 m). The production marks in the quarry vary in shape and size, indicating that there was not a standard measure for the objects made. Traces of bakestone production are few, and totally absent inside the underground quarry.

Trench 4 was laid out east of the quarry entrance, with the rockface at the southern end and the production heap at the northwestern end, and against the rock in order to investigate its height and also trying to reach the bottom of the quarry. Trench 4 was 4 m long and 1.1–1.4 m wide, and 1–1.4 m deep. The base of the heap was reached where carved rock appeared. This clearly demonstrates that the spoil heap covers an older worked out part of the quarry. The carved rockface at the bottom of the trench continues into the heap to the northeast (Figure 9).

Figure 9. *The carved rockface at the base of Fugleberg Trench 4, seen from the north. (Photo: I. Baug).*

All layers in the trench contained large slabs, many over 1 m in diameter, but also a few unfinished and fragmented bakestones, varying in size from 43 to 65 cm in diameter, with no indications of a standard size. Fragments of bakestones were few compared to the larger slabs, which indicates that the griddles may not have been the main product in the quarry. This also fits with the production marks in the carved rock. For instance, the carved rock at the bottom of the trench seems to indicate the production of building stones. Unfortunately no organic material suitable for ^{14}C-dating was found (Baug 2015b:91–93).

The workplace at Kvitafjell

The last location chosen at Fugleberg farm was the workplace underneath Kvitafjell, a natural rock shelter stretching along a north-south axis. The rock type here is green schist without talc, and therefore no extraction has taken place. The site represents a workplace where the bakestones were finished. The workplace was discovered in the 1980s, when a fireplace, a tuyére, and 20 kg of iron slag was recovered (Weber 1984; Top. Ark). Spoil from the cutting of bakestones is located in large amounts underneath the overhang, extending 2 m out from the rock wall, following the length of the overhang for c. 30 m. A test pit was excavated underneath the overhang, in order to date the activity at the site. The test pit contained silt and flakes of c. 0.5–30 cm in size. There were more fragments from bakestones here than was the case for the investigated quarries. Most were small fragments, a few centimetres in length/width, but there were also some more or less complete bakestones of various sizes found: 42–55 cm in diameter and about 1 cm thick (Baug 2015b:90). After being extracted from the bedrock in the quarries as more or less round or oval, thin blanks, bakestones were transported to the workplace at Kvitafjell. Here, they were made thinner and received the characteristic furrows known from stone griddles found in consumer contexts (cf. Weber 1984; Tengesdal 2010).

To make the bakestones thinner, coarse furrows were carved into the stone, probably using pickaxes, and the area between the furrows seems then to have been peeled off. A second phase of furrowing was then carried out, with thinner furrows closer together, in patterns, running in different directions, and obviously made by a finer tool than was used in the initial furrowing. On some griddles, furrows are carved only on one side, while others have them on both sides (Baug 2015b:96). It has been suggested that the furrows were vital for frying or baking. In medieval Bergen food remains on bakestones are only found on the furrowed side and not on the unfurrowed side of the bakestones (Tengesdal 2010:70), which supports this assumption.

The deposit at Kvitafjell is 1.5 m thick, indicating an intensively used workplace. The activity dates to the 11th and early 13th centuries (Figure 10) (Baug 2015b:93–98). Investigations show that the rock shelter was mainly used for cutting bakestones. Remains of slag and the tuyére (Weber 1984; Top.ark. University Museum of Bergen) indicate that smithing also took place at the site, perhaps in order to sharpen the tools used in bakestone production. A few other workplaces have been identified in the quarry landscape in Ølve: one south-west of Kvitafjell and another at the neighbouring Tufta farm (Baug 2015b:93). The presence of workplaces indicates that blanks for bakestones were commonly transported from the quarries to suitable places for finishing. This may

Figure 10. *^{14}C-analyses from the workplace underneath Kvitafjell.*

Lab. Ref.	Context	The age BP	Calibrated Age	Material
TUa-6702	Kvitafjell layer 2	875 ± 35	AD1160–1220	Pine charcoal
TUa-6703	Kvitafjell layer 4	845 ± 35	AD1170–1245	Birch charcoal
TUa-6704	Kvitafjell layer 4	950 ± 35	AD1030–1165	Pine charcoal
TUa-6705	Kvitafjell layer 4	840 ± 35	AD1170–1245	Pine charcoal

also explain the relatively low number of bakestone fragments found at the investigated quarry sites. Kvitafjell and the other identified workplaces may have operated as workplaces for several of the quarries nearby. However, unfinished bakestones in a different stage of the finishing process at the quarry sites indicate that such work was also occasionally carried out in the quarries. For instance, in the quarry at Fugleberg, in Trench 3, at least some of the products had been finished.

Investigated quarries at Netteland farm

Seventeen identified quarries are located in the community of Hatlestrand on the western side of Kvinnherad Fjorden. The largest concentration of quarries has been identified at Netteland farm (no. 29), which was selected as a research area. One quarry, Båtahidlaren, only 4 m ASL, was chosen for excavation. The quarry is located by Netlandsvågen only 14 m north of the main fjord. It is an underground quarry, 5.7 m wide, 9.5 m deep, and c. 2 m high at the entrance, becoming lower further inside, and where a minimum of 108 cubic metres of rock have been extracted. Semi-circular production marks on the rock wall have been identified inside the quarry; some of them from bakestone production. Above the underground quarry, c. 2.25 m in from its entrance, open-cast extraction is documented with a 1.4–1.8 m high carved rock wall (Baug 2015b:79, 97).

East and west of the underground quarry, the production site continues as an open-cast quarry and stretches over roughly 100 metres, reflecting intensive extraction. Part of the carved rockface west of the underground quarry appears as rather straight without the concave traces typical of bakestone production and most likely reflects extraction of building stones. At Båtahidlaren, bakestones, then, seem to represent a minor product, while building stones, and possibly tiles and slabs, seem to dominate. This was also substantiated by the content in the excavated trench.

A search trench was established north of the entrance into the underground quarry, along a partly covered rockface with production marks stretching along a north-south axis, with the underground quarry to the south. The area in front of the quarry thus seems to represent a previously worked out part of the quarry that has been covered with spoil from later activities, making it difficult to date the beginning of production. The spoil may possibly stem from both the extraction in the underground quarry and that from the rockface just above this. The trench was 3.8 m in length, 1.5 m wide, and 1.4–1.9 m deep. The combination of large, heavy stones and slabs and the depth of the trench made it difficult to continue excavating. As a result, the bottom level of the spoil heap was not reached, and its depth could not be estimated. Activity in the quarry was dated broadly from the 13th and 14th centuries to the modern period (Figure 11). The three ^{14}C-samples show a reverse chronology with the oldest dates from the uppermost layer (layer 2). This indicates that the spoil has been disturbed by later activities, probably caused by moving of spoil to allow later extraction. Production may have been carried out in both the high and late Middle Ages but also later. The oldest production was, however, not uncovered (Baug 2015b:98–101).

Figure 11. *C14-analyses from Netteland Trench 1.*

Lab. Ref.	Context	The age BP	Calibrated Age	Material
TUa-6706	Netteland Trench 1, layer 2	750 ± 35	AD1265–1290	Oak charcoal
TUa-6707	NettelandTtrench 1, layer 3	595 ± 35	AD1310–1405	Birch, bird cherry/rowan charcoal
TUa-6708	Netteland Trench 1, layer 3	140 ± 35	AD1680–1940	Hazel nut

Organisation of production

Was the quarrying carried out by full-time specialists or was it a seasonal activity conducted by local farmers? The character and scale of the production indicate an intense and well-organised activity, where large-scale production took place from the early Middle Ages onwards. Specialisation is defined by Cathy Costin as production where people produce for profit or commercial returns, as distinguished from a domestic mode of production where people primarily produce for their own subsistence (Costin 1991:3–4). The scale of production and the widespread distribution (see below) certainly indicate specialisation, whereby the quarries were exploited for profit. Who controlled the quarries and who were the stonecutters? In order to answer this, quarrying and the people involved need to be understood in relation to the societies of which they were part, and an important precondition for doing so is to date the activity. It is difficult to reach conclusions for the entire production landscape regarding chronological development because few quarries can be dated. The small scale investigation and the small number of datable sites can only suggest certain trends. The investigations indicate that production of bakestones began in the early Middle Ages, in the 11th or early 12th centuries (cf. Figures 8–10) and continued throughout the Middle Ages and into the early modern period. It is, however, only at the bakestone quarry at Fugleberg farm (Trench 3) that the initial production phase could be dated.

I have earlier shown that all farms located within the quarry landscape in Ølve and Hatlestrand belonged to different estates and not to the peasants themselves during the Middle Ages and after the Reformation. Several of the farms with quarries within their boundaries were owned by ecclesiastical institutions from the middle of the 12th century onwards. These included Halsnøy Abbey, Archbishop Olav Engelbrektson, Munkeliv Abbey in Bergen, the Bishop in Bergen, and, possibly, the local churches of Kvinnherad and Ølve (Baug 2015a; Baug 2015b:135–141). These landowners may have organised production and distribution, while the activities were carried out on a daily basis by local tenants. Possibly, at an early phase, the quarries may have formed an element of a *veitsle*-system, where bakestones were produced as tributes to the landowners. Later during the Middle Ages tenancy was increasingly based on fixed rents, where land rent was normally paid in products manufactured at the tenant farms. The quarried stones may have formed part of the land rent (Baug 2015a; Baug 2015b:142–143).

The quarries may thus represent a situation termed 'proto-industrialisation' by the historian Franklin Mendels (1972). According to Mendels, this kind of semi-professional craft existed before industrialisation, in rural societies where agriculture constituted the main activity. The quarrying documented in Ølve and Hatlestrand seems to have been labour intensive, and know-how with regard to stone quality and extraction techniques were undoubtedly important. Yet, the stonecutters need not have been working full-time in that role. The work in the quarries may well have been conducted on a seasonal or part-time basis, in combination with other tasks they had to perform at the farms they worked and lived on. It is probable that an experienced person would be able to make the objects without being a full-time specialist. In the millstone quarries in Selbu in Sør-Trøndelag County, intensive exploitation aimed at larger markets took place in the early modern period. Yet year-round production or a hired work force was not necessary, and extraction was carried out during the winter season by local farmers from the Selbu district (Rollseth 1947). A similar situation may have existed in Ølve and Hatlestrand, where people working and living at the different farms, as farmers, tenants, or semi-free workers, were the ones working in the quarries. Quarrying may have been carried out during the winter season: the off-season for agricultural work (Baug 2015b:146).

However, within the central production areas, such as Fugleberg farm and perhaps also Netland farm, extraction was on a larger scale and may have demanded different organisation and a larger workforce. Knowledge of quarrying operations (i.e. how to organise quarry work) must have been important. Although annual production volumes cannot be estimated, the numbers of quarries and size of the quarry areas indicate that the households may have included hired workers. A hierarchy based on specialisation of workers may have developed. It is also possible that quarries where large-scale production occurred were rented out to agencies other than tenants, a situation known from, for instance, Germany in the Middle Ages (Pohl 2012:77–78).

Bakestones as commodities – where were they distributed?

The quarry landscapes in Ølve and Hatlestrand indicate large-scale and long-lasting production aimed at large markets. Thus, an interesting question is: Are the products found in contexts outside the areas near the quarries? What markets were central for the bakestones? Archaeological finds of griddles outside the quarries indicate their distribution as commodities on a regional and international level.

Bakestones are found in large quantities within Norwegian towns, such as Oslo, Bergen, Trondheim, and Stavanger. Many of the fragments found in medieval urban contexts have traces of extensive use. Even though it is difficult to detect using archaeological material, redistribution from the towns should also be expected, as indicated by finds in several places in the rural areas of western and northern Norway (http://www.unimus.no/arkeologi/forskning/index.php; Reiersen 1999:47–48).

As Bergen was the closest town to the production areas in Ølve and Hatlestrand, it may have been the main distribution centre. This is indicated in the archaeological assemblage from Bergen. At the medieval settlement site of Bryggen in Bergen (BRM 0, inventory no. University Museum of Bergen), nearly 1600 bakestone fragments have been found within the five northernmost house rows, later denoted as Gullskogården, dating from c. 1120–1702. About 90 per cent of this material is made of chlorite schist (Tengesdal 2010), with Ølve and Hatlestrand as the most probable production area. The earliest fragments of bakestones found in Bergen are dated to c. 1100–1120s (15 fragments), even though one fragment may stem from the period c. 1070–c. 1100. This latter date is considered uncertain (Hansen 2005:178–179), but is not contradicted by the dating of the production in Ølve. From the period c. 1120–1170/71, more than 250 fragments have been found at Bryggen, most of them of chlorite schist, but nearly as many were of soapstone (Tengesdal 2010:36, 46–47). At Bryggen, chlorite schist dominates as a raw material throughout the Middle Ages. However, bakestones of soapstone are quite common during the period 1120–1198, but decrease during the period 1248–1413. In the latter period, bakestones of chlorite schist superseded those of soapstone (Tengesdal 2010:31–36). This may have to do with the large-scale, well organised production that developed in Ølve and Hatlestrand, as well as the quality of the products from these quarries. This may have led to an increase in distribution during the high and late Middle Ages.

In Oslo, some 300 bakestones were identified in the excavations at the sites of *Mindets tomt* and the *Søndre felt* in the medieval part of the town, and c. 49 per cent of these (132 fragments) are of chlorite schist considered to stem from Ølve and Hatlestrand. In Trondheim, from the large site Folkebibliotekstomten, nearly 400 bakestones were found. About 35 per cent of these (141 fragments) are considered to stem from Ølve and Hatlestrand, whereas the rest are described as *local stone* (Weber 1989:18), most likely stemming from various soapstone quarries. The bakestones found in Gamlebyen in Oslo and in Trondheim have been dated from c. 1050–1100 onwards (Weber 1984:159). As is the case in Bergen, in Oslo and Trondheim an increase in the number of chlorite schist bakestones relative to those made of soapstone seems to have taken place during the high and late Middle Ages, from c. 1300–1400. However, griddles of soapstone are still present in the assemblages, and thus reflect a situation somewhat different to Bergen (Weber 1989:18). Even though production in Ølve and Hatlestrand starts in the early Middle Ages, it is not until the high and late Middle Ages that the chlorite schist starts to dominate, suggesting a specialisation in bakestone production. The large numbers of bakestones that have been found in the towns signifies a more or less regular trade. The chlorite schist seems, however, to have been far more dominant in Bergen compared to the other medieval towns. This may have to do with its proximity to the quarries in Ølve and Hatlestrand.

As stated above, the quarries in Ølve and Hatlestrand were not the only possible production sites of chlorite schist bakestones. The quarries at Øye, in the community of Melhus, in the county of Sør-Trøndelag, are also a possible provenance, especially with regard to the finds from Trondheim, which is closer to Øye than Ølve/Hatlestrand. However, it seems unlikely that bakestones from Øye were traded over long distances, as the extraction traces are few and do not indicate large-scale production. It is, however, possible that later extraction of building stones may have removed traces of bakestone production (Storemyr et al. 2010:192; Storemyr 2015:191). In the medieval town Stavanger too, the geology of bakestones varies, and also here provenances other than Ølve and Hatlestrand are possible. Some bakestones were of soapstone, whereas others have a different composition. Some of these stones may come from the chlorite schist quarry site at Ertenstein in Rennesøy, in the northern part of the county of Rogaland, where building stones were also extracted during the Middle Ages (Storemyr 2001:67; Baug 2015b:4, 116).

In northern Norway, bakestones are found at farmsteads and farm mounds and are more frequent in coastal areas compared to the inland (Reiersen 1999:47–48), but bakestones were not commonly used in northern Norway. It has been suggested that their distribution in these rural sites indicates an export limited to central places, or so called hubs, along the sea route. That is, sites located within the catchment areas of medieval towns, or connected to the towns' trade networks (Øye 2009:232). The towns' involvement in distribution may, in this way, have influenced the area within which the bakestones were used. Bakestones of both soapstone and schist have been identified (Reiersen 1999:47), but whether or not any stem from the quarries in Ølve and Hatlestrand is not known. The limited number of bakestones in northern Norway may be connected with differing food traditions. According to written sources from the late Middle Ages, bread was normally baked in the ashes in northern Norway. It was also more common for people to eat dried fish rather than bread (Grøn 1927:53; Granlund 1956:309). Most likely, regional differences existed with regard to the role of bread in the daily diet, and in some areas foodstuffs other than bread may have been preferred. It was thus not just a question of geography and proximity to the sea that were decisive for the distribution of bakestones (Baug 2015c:38).

Outside Norway, bakestones are principally found within the North Atlantic region. Iceland, Shetland, and the Faroe Islands are the only areas where bakestones, most likely from Norway, have been found in large quantities (Hamilton 1956:183; Arge 1989:119; Smith 1999:127; Weber 1999:134–139; Forster 2004). In Shetland, Norwegian stones have been found dating from the 1100s onwards (Weber 1999), and were thus transported to the North Atlantic islands at more or less the same time as they appeared in Norwegian towns.

Archaeological finds of bakestones indicate that these implements were also known in Sweden and Denmark (Campbell 1950:14; Larsen 2005a:377; Bergström 2007:134). Bakestones are found in towns and areas with close trading contacts to Norway in the Middle Ages, such as Lund in Sweden, and Århus and Tårnby in Denmark (Andersen et al. 1971:108–109; Larsen 2005a:377; Baug 2015b:116). Only small numbers of bakestones have been documented, and they seem to have rarely been used in Sweden and Denmark. However, a thorough investigation of these finds is lacking.

Direct distribution between the quarries and consumers outside Norway most likely did not take place, and redistribution from the towns is expected. In medieval Norway foreign trade was mainly organised through Bergen. The landowners need not have been central agents in the trade, but they would most likely have ensured that their surplus production was taken to market (Skre 2008, 353). They would normally have their land rent products brought into the towns where they were sold on (Helle 1982, 330-337, 346, 354). Producers and landowners may have organised the transport of stone products to the towns, and the ecclesiastical institutions owning land within the quarry areas may thus have been directly or indirectly involved in the distribution of the products. Both Norwegian and foreign merchants were probably involved in exporting the bakestones further afield. From about 1180–90 at the latest, Bergen had direct contact with areas around the North Sea (Helle 1982:323; Nedkvitne 1983), which might explain the presence of Norwegian bakestones on the North Atlantic islands. Even though people from these islands travelled to Bergen from the 1100s onwards in order to buy and sell, trade was mainly organised by Norwegian traders and ecclesiastical institutions in Bergen, which annually sent several ships westwards with Norwegian commodities (Helle 1982:165, 360–365), most likely including bakestones. In a charter issued by King Håkon Håkonsson dated to 1217–1219, Halsnøy Abbey was to have the same rights as canons in the Bergen diocese to send their land rent commodities to Iceland for sale (RN I, 430). This may have included products from the bakestone quarries in Ølve belonging to the monastery. Thorough geological investigation of the North Atlantic bakestones is lacking, and their provenance cannot be established with certainty. Spectrographic analyses of bakestones found in the Faroes indicate that they stem from Ølve (Arge 1989:119), but it is difficult to separate Ølve and Hatlestrand from the quarries in Øye, in the county of Sør-Trøndelag, using this method (Jansen pers. comm. 2011). However, based on the close contact between Bergen and the North Atlantic region, combined with the relatively few traces of bakestone extraction in Øye, it is perhaps more likely that the bakestones stem from Ølve and Hatlestrand. Trading ships from Bergen may possibly, at times, have transported bakestones to Sweden and Denmark. It is also possible that bakestones were brought there by merchants and other travellers as personal belongings. There is, however, no evidence to indicate a large and regular export of these products to southern and eastern Scandinavia.

The distribution of bakestones, then, seems mainly to be connected to the Norwegian cultural sphere, including the islands in the North Atlantic. Different food traditions and alternative ways of cooking may have limited the market for bakestones, and they never managed to gain a foothold in foreign markets (Baug 2015c). Food processing represents a conservative aspect of culture, where not only traditions and availability, but also strategic decisions and social roles, are important factors (Øye 2009:225; Baug 2015c). This may have made it difficult for bakestones to gain importance outside of the Norwegian cultural sphere.

Building stones – commissioned work from the quarries?

As noted, bakestones were not the only type of product extracted from the quarries in Ølve and Hatlestrand. Stone crosses and building stones represent different product categories with a far more limited distribution than bakestones, both in time and space, and there is no evidence to indicate that they were distributed via market places and towns as the bakestones were. Building stones seem to represent items aimed at, and commissioned by, the upper strata of society. The production of building stones, and perhaps also crosses, may have been initiated by specific orders and instructions from customers (Baug 2015b). Grave crosses were produced in the 1900s (Hoff & Lidén 2000:166), and have been identified in the churchyard of the Skåla church in Kvinnherad. How far back this production goes is, as previously mentioned, not known. Crosses were, in all likelihood, commissioned products and their production took place on a small-scale.

Using stone as a building material was a new technique in Norway at the very beginning of the Middle Ages which was introduced from abroad. Most buildings built of stone were churches and castles, with the Church or the King as owner and builder. Thus, the production of building stones was connected to the elite (Baug 2015b:158). Plans for the buildings may have been worked out in detail before construction was started, and measurements and patterns needed may have been sent to the quarry before production, a situation known from medieval quarries in England. Trimming the building stones as far as possible at the quarry site would also reduce weight before transport (Salzman 1967:123). Building stones should thus be regarded as a commissioned product with a much more limited distribution than bakestones.

Building stones from the quarries have so far only been identified in Onarheim church in Tysnes, Hordaland. The church is mentioned in written sources from 1327 (DN X, 25), but construction most likely started in the latter half of the 1100s (Hoff & Lidén 2000:267–268). Geochemical analysis confirms that the building stones stem from the quarries in Ølve/Hatlestrand (Jansen & Heldal 2009; Jansen & Heldal this vol.), indicating extraction of building stones in the early Middle Ages. Onarheim farm belonged to elite members of society in the Middle Ages, and was settled by magnates with close connections to the King (Håkon Håkonssons saga, chapter. 23 and 87). The church was most likely built as a private church, but was in use as a parish church from at least 1347 when it is mentioned as such in written evidence. There was also a guild at Onarheim farm in the Middle Ages (DN IV, 316; Hoff & Lidén 2000:267). This emphasises Onarheim's function as a religious, judicial, and cultural centre in western Norway, and also links products from Ølve and Hatlestrand to the societal elite in the Middle Ages.

Different types of products from the quarries may thus have been subject to different forms of production and transaction. While bakestones testify to serial production aimed at large markets, building stones indicate production of commissioned items for agents or institutions belonging to the upper strata of society.

Concluding remarks

The quarries in Ølve and Hatlestrand represent a long-abandoned proto-industrial landscape where large-scale production of several product-types took place over a period of hundreds of years. Two types of production can be documented from the Middle Ages: large-scale, serial production of a household product aimed at large markets – the bakestones; and commissioned production of building stones for more limited groups belonging to the societal elite. Intensive activity through the centuries has led to profound changes in the landscape.

The production of bakestones may be regarded as a commercial activity and, from the 1100s onwards, bakestones became a common household utensil in both urban and rural areas of Norway. The Ølve-Hatlestrand area evidently played a major, but not unrivalled, role in the production of bakestones. An increase in griddles of chlorite schist is documented fairly late, in the period between the 1200s and 1400s, and in some areas, such as Bergen, they superseded bakestones of soapstone.

Most evidence points towards a semi-professional craft carried out by people living and working on the surrounding farms. Such part-time or seasonal production most likely reflects the situation at most production sites. Yet, the largest quarry sites may have demanded larger workforces and management, where full-time stonecutters may have been engaged. As the earliest dating from the quarries largely corresponds with finds of bakestones in urban contexts in the 12th century, the bakestones may have been produced for a large market at an early stage. The occurrence of bakestones decreases with distance, and the distribution seems to be closely linked to towns' trade networks, but also to food traditions. The quarries in Ølve and Hatlestrand, then, bear witness to an activity important for people over large areas. Yet, the bakestones never managed to get a foothold outside Norway and the North Atlantic region, and only random export can yet be documented outside this area.

References

Andersen, H. H., Crabb, P. J. & Madsen, H. J. 1971. Århus Søndervold en byarkæologisk undersøgelse. Jysk Arkæologisk selskabs skrifter – bind IX – 1971, København.

Arge, S. V. 1989. Om landnåmet på Færøerne. *Hikuin* 15, 103–128.

Baug, I. 2013. Quarrying in Western Norway. An archaeological study of production and distribution in the Viking period and the Middle Ages. Unpublished doctoral thesis in archaeology, University of Bergen,

Baug, I. 2015a. Actors in quarrying. Production and distribution of quernstones and bakestones during the Viking Age and the Middle Ages. In Hansen, G., Ashby, S. & Baug, I (eds). *Everyday Products in the Middle Ages. Crafts, Consumption and the Individual in Northern Europe c. AD 800–1600,* 229–250. Oxbow, Oxford & Philedelphia.

Baug I. 2015b. Quarrying in Western Norway. An archaeological study of production and distribution in the Viking period and Middle Ages. Archaeopress Archaeology, Oxford.

Baug, I. 2015c. Stones for bread. Regional differences and changes in Scandinavian food traditions based on the use of quernstones, bakestones and soapstone vessels c. AD 800-1500. In Baug, I. Larsen, J. & Mygland, S. S. (eds) *Nordic Middle Ages – Artefacts, Landscapes and Society. Essays in Honour of Ingvild Øye on her 70th Birthday.* UBAS, University of Bergen Archaeological Series, vol. 8, Bergen.

Bergström, L. 2007. Gräddat. Brödkultur under järnålderen i östra Mälardalen. Doctoral Thesis in Archaeological Science at Stockholm University. Stockholm.

Campbell, Å. 1950. Det svenska brödet. En jämförande etnologisk-historisk undersökning, Stockholm.

Costin, C. L. 1991. Craft Specialization: Issues in Defining, Documenting and Explaining the Organization of Production. *Archaeological Method and Theory,* vol. 3, 1–56. Tucson.

DN = *Diplomatarium Norvegicum,* published by Lange, C. C. A., Unger, C. R. & Huitfeldt, H. J. 1847–1990, Christiania/Oslo.

Forster A. K. 2004. Shetland and the Trade of Steatite Goods in The North Atlantic Region during the Viking and Early Medieval Period. Unpublished doctoral thesis at Department of Archaeological Sciences, University of Bradford, Bradford.

Forster, A. K. 2009. Viking and Norse Steatite Use in Shetland. In Forster, A. K. & Turner, V. E. (eds) *Kleber: Shetland's Oldest Industry. Shetland Soapstone Since Prehistory,* 58–69, Lerwick.

Friis, P. C. 1632. Norriges oc omliggende Øers sandfærdige Bescriffuelse : indholdendis huis vært er at vide, baade om Landsens oc Indbyggernis Leilighed oc Vilkor, saa vel i fordum Tid, som nu i vore Dage / korteligen tilsammen fattit aff Peder Claussøn, Kiøbenhaffn.

Granlund, J. 1956: Bakning. In Danstrup, J. (ed.) *Kulturhistorisk leksikon for nordisk middelalder KLNM ,* vol. 1, 307–311.

Grøn, F. 1927. *Om kostholdet i Norge indtil aar 1500*. Kildeforlaget, Oslo.

Hamilton, J. R. C. 1956. *Excavations at Jarlshof, Shetland.* Ministry of works, Archaeological reports No. 1, Edinburgh.

Hansen, G. 2005. *Bergen c 800–c 1170. The emergence of a town.* The Bryggen Papers. Main Series No. 6, Bergen.

Harrell, J. A. & Storemyr, P. (2013) [2015]: Limestone and sandstone quarrying in Ancient Egypt: tools, methods and analogues. *Marmora – an international journal for archaeology, history and archaeometry of marbles and stones,* 9, 19-43.

Haukenæs, T. S. 1888. Natur; Folkeliv og Folketro i Sønhordland. Natur- og Folkelivsskildringer, Eventyr, Fortællinger o.s.v. fra ældre og nyere Tid. Sjette Del: Kvinherred, Bergen.

Heldal, T. & Storemyr, P. 1997. Geologisk undersøkelse og arkeologisk registrering av de middelalderske bruddene ved Øye, Klungen og Huseby i Sør-Trøndelag. *The Geological Survey of Norway,* report, no. 97.149.

Helle, K. 1982. Bergen bys historie, I, Kongssete og kjøpstad. Fra opphavet til 1536, Bergen-Oslo-Tromsø.
Hoff, A. M. & Lidén, H. E. 2000. Norske minnesmerker. Norges kirker. Hordaland. Bind II, Oslo.
Håkon Håkonssóns Saga. *Norges Kongesagaer IV. 1914-utgaven* (translated by Alexander Bugge).
Jansen, Ø. J. & Heldal, T. 2009: Medieval greenschist quarries near Bergen, western Norway. '*The 9th International Converence of ASMOSIA*. Tarragona 8–13th June 2009. Interdisciplinary studies of ancient stone': Book of abstracts 54.
Jansen, Ø. 2013. Stein til klostermurane. In Økland, B. G., Jünger, J. C. S. & Øye, I. (eds) *Halsnøy kloster. Til kongen og Augustins ære*, 69—83, Oslo.
Larsen, J. L. 2005. Andet inventar. In Kristiansen, M. S. (ed.) *Tårnby. Gård og landsby gennem 1000 år,* 374–383, Århus.
Lundberg, N. 2007. Øye – en arkeologisk undersøkelse av et klorittskiferbrudd. Unpublished master thesis in archaeology at NTNU, Trondheim.
Mendels, F. F. 1972. The First Phase of the Industrialization Process. *The Journal of Economic History, Vol. 32, No. 1, The Tasks of Economic History:* 241–261, Cambridge.
Naterstad, J. 1984. Den geologiske bakgrunn for bakstehelleindustrien ved Kvitebergvatnet i Hardanger. *Viking Bind XLVII – 1983,* 161–164.
Nedkvitne, A. 1983. Utenrikshandelen fra det vestafjelske Norge 1100–1600, Bergen.
Nordeide, S. W. 2009. Cross Monuments in North-Western Europe. *ZAM Zeitschrift für Archäologie des Mittelalters, Jahrgang 37,* 163–178, Bonn.
Nordeide, S. W. 2011. Steinkors og korssteiner i nordvestre Europa. *Collegium Medievale, colum 24, 2011,* 127–148, Oslo.
Nysæter, E. 2013. Jordegods og andre verdslege gode i klostertida. In Økland, B. G., Jünger, J. C. S. & Øye, I. *Halsnøy kloster. Til kongen og Augustins ære*, 144–171, Oslo.
NRJ = *Norske Regnskaber og Jordebøger fra det 16. de Aarhundrede 1–4,* utgitt for Det Norske historiske kildeskriftfond ved H. J. Huitfeldt-Kaas (1887–1906), Christiania.
Petersen, J. 1951. *Vikingtidens redskaper.* Skrifter (Det Norske videnskaps-akademi i Oslo) / 2 Historisk-filosofisk klasse. Bind/hefte nr. 1951:4, Oslo.
Pohl, M. 2012. *Steinreich - Mühlsteine, Tuff und Trass aus der östlichen Vulkaneifel und ihr Markt. Eine vergleichende Analyse vorindustrieller Produktions- und Handelsstrukturen,* Bochum.
Reiersen, M. 1999. Mat i yngre jernalder og middelalder. Mattilberedning og måltid langs kysten av nordre Nordland og Troms. Unpublished master's thesis in archaeology at the University of Trømsø.
RN = Regesta Norvegica: Kronologisk Fortegnelse over Dokumenter vedkommende Norge, Nordmænd og den norske Kirkeprovins, bind I 991–1263. 1989. Storm, G. (ed.).
Rollseth, P. O. 1947: *Kvernfjellet,* Oslo.
Salzman, L. F. 1967. Building in England down to 1540, Oxford.
Skre, D. 2008. Dealing with Silver: Economic Agency in South-Western Scandinavia AD 600–1000. In Skre, D. (ed.) *Means of exchange.* Kaupang Excavation Project Publication Series, Vol. 2. Norske Oldfunn XXIII, 343–355, Aarhus.
Smith, A. N. 1999. Steatite: vessels, bakestones and other objects. In Crawford, B. E. & Ballin-Smith, B. (eds) *The Biggings, Papa Stour, Shetland; the history and archaeology of a royal Norwegian farm.* Society and Antiquaries of Scotland and Det Norske Videnskaps-Akademi, Society of Antiguaries of Scotland Monograph Series Number 15, 129–143, Edinburgh.
Storemyr, P. 2001: Restaurering av koret i Stavanger domkirke. De ytre fasadene 1997-1999. *Foreningen til norske fortidsminnesmerkers bevaring, årbok,* 63-74.
Storemyr, P. 2015: *Nidarosdomens grunnfjell. En reise i steinbryternes fotspor fra Det gamle Egypt til Europas nordligste katedral*. Nidaros Domkirkes Restaureringsarbeiders Forlag, Trondheim.
Storemyr, P., Lundberg, N. Østerås, B. & Heldal, T. 2010: Arkeologien til Nidarosdomens middelaldersteinbrudd. In Bjørlykke, K., Ekroll, Ø. & Syrstad Gran, B. (eds) *Nidarosdomen – ny forskning på gammel kirke*. Nidaros Domkirkes Restaureringsarbeiders forlag, 238-267, Trondheim.
Top. Ark: Topographical archive, University Museum of Bergen.
Tengesdal, S. S. 2010. Å steike! En kontekstuell materialanalyse av steikeheller funnet i et bygårdskompleks i middelalderens Bergen. Unpublished master thesis in archaeology at the University of Bergen.
Vaage, E. 1972. *Kvinnherad. Bygdesoga I,* Bergen.
Weber, B. 1984. 'I Hardanger er Qvernberg og Helleberg… og Hellerne, det er tyndhugne Steene, bruger man til at bage det tynde Brød Fladbrød på…› *Viking Bind XLVII – 1983,* 149–160, Oslo.

Weber, B. 1989. Fortiden i Trondheims bygrunn: Folkebibliotekstomten. Meddelelser nr. 15. Baksteheller – en handelsvare, Trondheim.

Weber, B. 1990. Tregjenstander. In Molaug, E. & Molaug, P. B. (eds) *De arkeologiske utgravninger i Gamlebyen, Oslo*. Bind 7. Dagliglivets gjenstander, del I, 11–180, Oslo.

Weber, B. 1999. Bakestones. In Crawford, B. E. & Beverley, B. S. (eds) The Biggings, Papa Stour, Shetland. The history and excavation of a royal Norwegian farm. Society of antiquaries of Scotland monograph series number 15, 134–139, Edinburgh.

Øye, I. 2009. Food and technology – Cooking utensils and food processing in medieval Norway. In Klápštê, J. & Sommer, P. (eds) Processing, Storage, Distribution of Food. Food in the Medieval Rural Environment. Ruralia VIII. 7th–12th September 2009. Lorca, Spain, 225–234, Turnhout.

Internet sources

Gjenstandsbasen: The five Norwegian University Museums' Collection Database: http://www.unimus.no/arkeologi/forskning/index.php

Hilde Vangstad

From Numeric Data to Cultural History – A Typological and Chronological Analysis of Soapstone Vessels from the Medieval Bryggen Wharf in Bergen, Norway

This paper's task is to establish a typology and a finer chronology of medieval Norwegian soapstone vessels used primarily as cooking pots. The case study includes 806 soapstone vessels from BRM 0 the Bryggen site located at Bryggen, the medieval wharf in Bergen, western Norway. The vessels stem from contexts dated from the 11th century to the 18th century. The assemblage is classified into six different vessel types: A–F. Soapstone vessels are frequent at Bryggen through to the end of the 15th century after which consumption drops off. A change from the relatively uniform western Norwegian A vessel type to a more diverse vessel design happens after the mid-1200s. It is suggested that the new diversity in shape points to a shift in the mode of production from a well-organised large production scale to a smaller one. Corresponding changes in the vessel assemblage points to an alteration in the way the vessels were used; the vessels cease to be produced in all sizes and generally get smaller and more homogenous in size in the later periods at Bryggen. As the vessels get smaller they are also more likely to have a flat or flattened bottom better suited to standing on a table to accommodate the new late medieval eating habits. German Hansa merchants occupied the Bryggen wharf from the 1360s, but the use of the indigenous soapstone cooking pots seems to continue to a certain degree.

Introduction

Norwegian soapstone vessels are simple household products manufactured in rural contexts and rooted far back in prehistory. They are often common finds in urban and rural medieval contexts all over Norway, yet a detailed typology and understanding of the chronological development of this important Norwegian artefact group is still lacking. The soapstone vessels studied for the present paper derive from the Bryggen site in Bergen excavated between 1955 and 1979 under the direction of Asbjørn E. Herteig (University Museum of Bergen inventory no. BRM 0). The site (5700 m²) covered the western parts of *Bryggen*, the local name for the medieval town's wharf area. Waterfront, storehouses and living quarters of the settlement at Bryggen dating back to the 11th century were uncovered during the excavations (Herteig 1990, 1991; Hansen 2005). The soapstone assemblage found during the Bryggen excavations comprises shards from more than 800 vessels. Since the assemblage is large and relatively well dated, it is well suited for the development of a more precise typology and chronology of medieval soapstone vessels; the Bryggen material is the most extensive

Norwegian medieval soapstone assemblage to undergo an archaeological analysis with these aims.

The main task of this paper is thus to present the Bryggen soapstone vessels' morphology, and thereby establish a more precise typology as well as a narrower chronology of medieval Norwegian soapstone vessels. I will also discuss if, how, and why this household item changed in quantity and quality over many centuries of Bergen's history. The paper is based on the main results from my unpublished master thesis at the University of Bergen 2003 (Vangstad 2003).

It is also of interest to see how such a traditional and functional object developed and was used during the centuries from the early phase of the town's history to the late medieval dynamic and sophisticated urban environment. Furthermore, interplay between tradition and innovation is an important issue. Which morphological features of the vessels were static and which changed during the many centuries of usage at Bryggen? What conservative elements made the vessels stay in use over the relatively long time span, and what led to changes and finally decline? Answers to these questions are sought with respect to the demographic changes of the Bryggen wharf area during the Middle Ages, the development of the urban community in general, and changes in the exploitation of soapstone resources and production during high and late medieval times.

The Bryggen area and the archaeological excavations

Bergen was founded in the 11th century, and in the course of the 12th century a living urban community emerged here (Hansen 2005). Before 1350, the population is estimated to have reached approximately 7000 (Helle 1982:492), making Bergen Scandinavia's largest town. The medieval town was located around the Vågen bay, with Bryggen on the northern shore. The Bryggen area witnessed significant demographic changes through medieval times. In the first centuries of the town's history, Norwegians owned and occupied the housing area, while foreign traders were not allowed to stay during the winter season. From about 1360, the expanding German Hanseatic traders established their Kontor at Bryggen and the population of the area came to be made up of males of non-Norwegian ethnicity. These demographic changes are important for the interpretation of the development of the use of soapstone vessels in the Bryggen area during the Middle Ages.

Norwegian soapstone vessels

The earliest known Norwegian soapstone household vessels date back to the late Bronze Age (Pilø 1989). Soapstone vessels continued to be made in Norway throughout the pre-Roman Iron Age (Shetelig 1912; Møllerop 1959:21–40; Skjølsvold 1969) and into the Roman Iron Age. Lars Pilø (Pilø 1989) points to a break in the production and use of soapstone vessels in Norway after this period until it was re-established during the Viking Age at the latest.

In the Viking Age (c. 800–1030), production of soapstone vessels increased in importance and was carried out on large, even industrial, scale (Skjølsvold 1961). Soapstone vessels from the Viking Age are found over a large area of northern Europe and must have been trade goods at that time (Resi 1979; Forster 2004; Nymoen 2011). In the Middle Ages (c. 1030–1537), the production of vessels continued (Lossius 1977; Berglund 1999), but to what extent and for how long is not well documented yet. However, some small-scale production of vessels is known even through the 18th and 19th centuries (Helland 1893:121–123).

Norwegian medieval soapstone vessel typology

During the Viking Age the most common vessel shape was the 'bowl shaped' R729 (Rygh 1885). R729 is circular with a curved base and a smooth outer and inner surface, and the vessels often show traces of an iron handle (Skjølsvold 1961:20). In her analysis of soapstone vessels, with a presumed

Norwegian provenance, found in Hedeby in North Germany Heid Gjøstein Resi observed some variations in the surface treatment of the vessels in addition to the well-known curved bottomed type with smooth surfaces (Resi 1979). Resi suggests these variations could be regional.

Whereas a significant number of the Viking Age vessels are complete and often found in well-preserved burial contexts (Petersen 1951:363; Schou 2007:54), the majority of the medieval material is comprised of shards thrown away as waste at urban dwelling sites. Thus while the Viking Age vessels' size and shape are well known from preserved vessels, determining the size and shape of the fragmented medieval vessels requires extensive reconstruction.

For a long time, it had been assumed that opposed to the earlier types, the dominant medieval vessel shape was primarily 'bucket shaped', that is with high, straight sides, a flat bottom and a sharp angled junction between the side and bottom (Grieg 1933). The first study that really shed light on the morphology of Norwegian medieval soapstone vessels was Siri Myrvoll Lossius' work on the soapstone vessels from the Borgund kaupang, a medieval urban centre close to Ålesund in Sunnmøre, on the west coast of Norway. In her analysis of more than 600 vessel fragments from the kaupang area (broadly dated from the 11th to 14th century), she was able to single out two main groups – 'bowl shaped' and 'bucket shaped' specimens – based on the shape of the vessels' walls, base and the junction between them. The vessels were divided into four different types named A–D based on a combination of the two main shapes and the treatment of the outer surface (Lossius 1979:65). The study described recurrent variations in the morphology of the medieval vessels, pointing out two of these varieties as most likely to be regional differences (vessel types A and C).

Figure 1. *Bryggen fire interval chronology. Compilation of dates from Herteig 1990:Fig. 3, Herteig 1991:Fig. 5, and Hansen 1998, 2005:58-67. (Drawing: G. Hansen).*

Fire	Date		Period	Building phase	
0	1955				
			9	9.2	
I.a Prev. Unknown				9.1	9.1.1
I	1702				
			8	8.3	
I.b Prev. Unknown				8.2	
Local fire 1527				8.1	8.1.1
II	1476				
			7	7	
III	1413				
			6	6.3	
III.b	1339				
				6.2	6.2.1
				6.1	6.1.1
IV	1332				
			5	5.2	5.2.1
				5.1	
V	1248				
			4	4.2	
				4.1	
VI	1198				
			3	3.2	3.2.1
				3.1	3.1.1
VII	1170/71				
			2	2.2	
				2.1	
VIII	c. 1120				
			1	1.2	
				1.1	
Oldest documented structures at the Bryggen site (BRM 0): 2nd quarter of 11th century (c. 1020/30)					

Methods of dating and classification

Dating

Fire layers dated through a combination of archaeological materials, dendrochronology and historically known fires in the Bryggen area serve as a method of dating settlement layers and buildings at the Bryggen site. The Bryggen fire chronology comprises nine periods, period 1 to

9, which ended after nine fires. The earliest fire, which ended period 1 at the site, is dated to c. 1120 and the last fire took place in 1955 (Herteig 1990:12; Hansen 1998, 2005) (Figure 1). Period 1 comprises materials dated broadly from between the second quarter of the 11th century (c. 1020/30) and c. 1120 (Hansen 2005), and each period to which the vessels in this study are contextually dated, consists of one or several 'building phases'. Only 46 vessels (6%) have been found in actual fire layers or in situ layers dating to the time of a fire; so most vessels were found in inter-fire layers, some of which are fill layers redeposited from a previous period. In the present study vessels from all types of contexts are included. This may cause a certain 'delay', or extension of the time span during which the vessel types appear in the archaeological records, and this should be kept in mind when assessing the chronological patterns in the material. The analyses of the material were originally undertaken during the early 2000s, but since then the chronology of the Bryggen site has been re-vised and improved (Hansen et al. 2017). In the present paper new dates provided by Hansen et al. 2017 have been applied. Only the temporal overview of rim diameter, rim shapes and the design of knobs and handles is still based on dates from 2003, since the raw data on these details are no longer available. The new dates have resulted in a larger set of dated vessels, as well as more precise dates for some vessels. A fuller set of dated vessels has been especially important for the vessel types which are not so numerous in the assemblage. It is unlikely that the new dates significantly affect trends in the temporal overview of rims, knobs and handles. In periods with few vessels, or when vessel types consist of few specimens, the numbers must, however, be read with a degree of caution.

Classification

The Bryggen material is classified with a point of outset from Lossius' typology, classifying vessels into types by a combination of the overall shape (wall and bottom, and the junction between them), and the outer surface treatment of the pots (Lossius 1977). Vessel size and morphological variations in handle and rim shapes are considered to be less typologically significant for the primary classification. Using the described criteria Lossius' typology has been supplemented with two new types–'type-E' and 'type-F' (Figures 2–4). The soapstone vessels from Bryggen consist of 1171 shards from 806 vessels. Of these vessels, 656 could be classified according to type based on the two elements of shape and surface treatment. The rest are too fragmented, or have a non-characteristic or non-distinguishable morphology. Figures 23 and 24 give an overview of the chronological distribution of types.

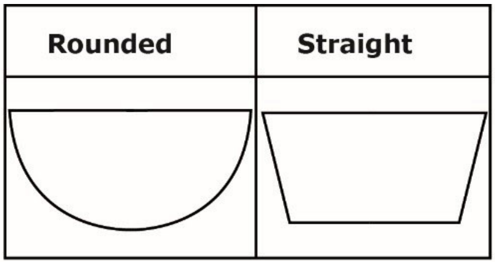


Figure 2. *The two basic wall and wall-base junction shapes of the soapstone vessels from Bryggen.*

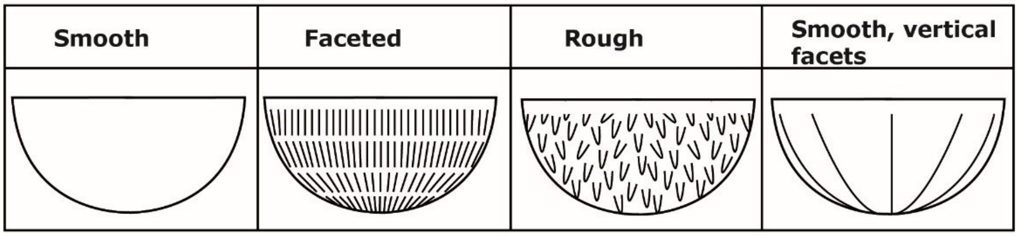


Figure 3. *The four different surface treatments of the Bryggen soapstone assemblage.*

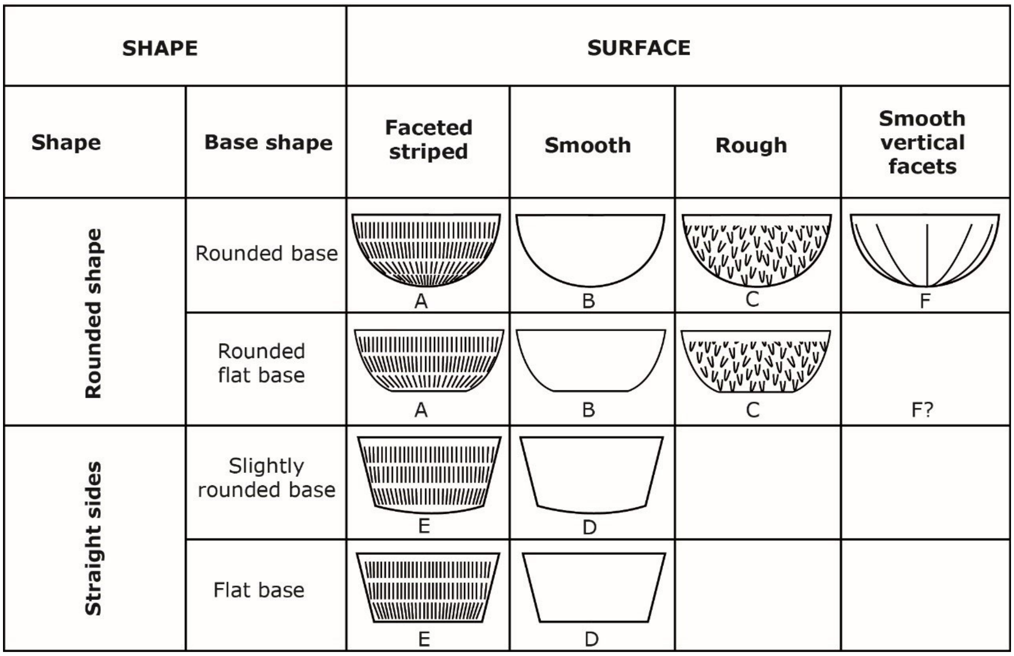


Figure 4. *The criteria of classification of the Bryggen soapstone assemblage based on the combination of wall and base shape and surface treatment.*

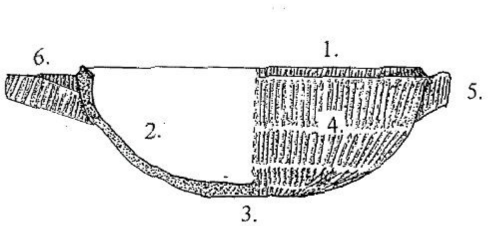


Figure 5. *The basic elements of a medieval soapstone vessel, exemplified by a type-A vessel. 1) Rim, 2) wall, 3) base, 4) surface (outer), 5) knob and 6) shaft.*

Six categories of size have been established based on the vessel's diameter of the rim. Very small vessels have a rim diameter of less than 10 cm, small have a diameter between 10–19 cm, medium between 20 and 29 cm, large between 30 and 39 cm and very large have a rim diameter of 40 cm or more.

Figures 6–8 show the diversity in rim designs (4 forms) and handles (6 varieties of shafts and 9 of knobs). Figure 9 sums up the variety of rims, knobs and handles. While certain designs, like the pointed rim R1 and the flat shaft S6, seem to be diagnostic for type-A and type-C vessels respectively, most designs are present in two or more vessel types.

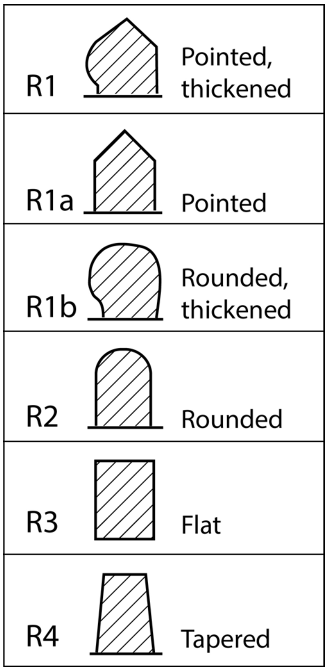


Figure 6. *Variety in rim shapes R1–4.*

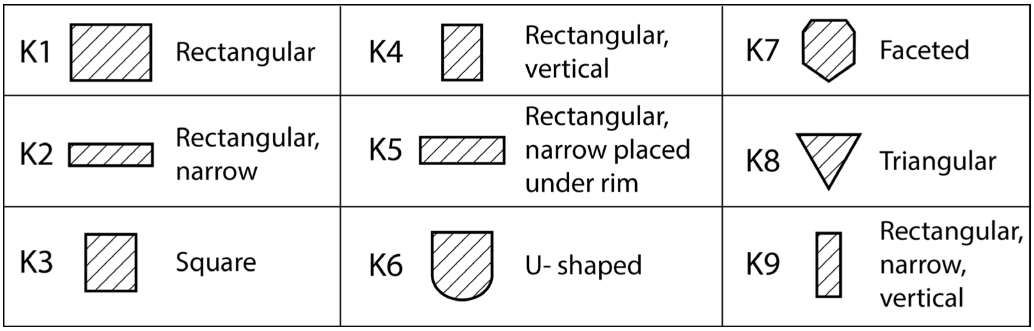


Figure 7. *Variety in knob shapes K1–K9.*

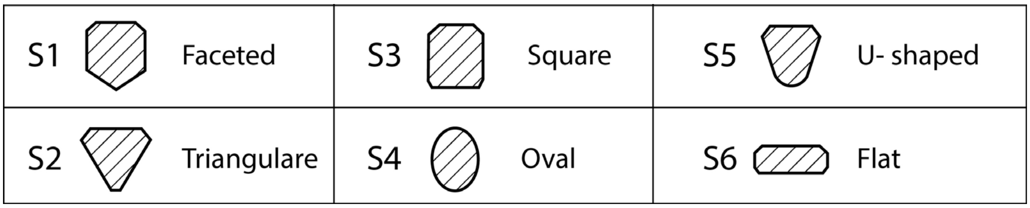


Figure 8. *Variety of shaft shapes S1–S6.*

Figure 9. *The diversity of design in rim shapes and handles, all vessel types.*

	Rim shapes Measurements n=370				Knobs Measurements n=105									Shafts Measurements n=56					
Vessel types	R1	R2	R3	R4	K1	K2	K3	K4	K5	K6	K7	K8	K9	S1	S2	S3	S4	S5	S6
A	165	18	7	1	14	1	12	3	-	-	1	1	-	20	7	2	2	1	-
B	-	29	55	31	5	5	26	11	3	2	1	1	-	1	2	1	6	5	-
C	-	-	6	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	5
D	-	5	22	7	2	5	2	-	2	2	-	-	2	-	-	-	-	-	-
E	-	-	14	-	-	1	-	-	-	-	-	-	-	1	-	2	-	-	-
F	-	7	-	-	1	-	-	1	-	-	-	-	-	1	-	-	-	-	-
Total	**165**	**59**	**104**	**42**	**22**	**13**	**40**	**15**	**5**	**4**	**2**	**2**	**2**	**23**	**9**	**5**	**8**	**6**	**5**

Type-A vessels

The type-A group from Bryggen consists of 419 shards from 311 vessels. Type-A vessels are characterised by curved walls and a rounded or semi-flattened base and facetted tooling of the outer vessel walls. Most of the vessels have a very distinct pointed rim (R1) and two or three handles; both knobs and shafts are equally common (Figure 10).

The type-A vessels are found in size categories ranging from very large to small. As Figure 11 shows, the medium size is the most abundant. Compared to the other vessel types, the A vessel is both the largest and most diversely sized. The wall thickness relates to vessel size, and in half of the vessels (50%), it seems to be between 1 to 1.4 cm. The height-width ratio varies significantly from

Figure 10. *Type-A vessels from Bryggen. Inv. no. BRM 0/54219, BRM 0/54530, BRM 0/75669. (Photo: S. Skare University Museum of Bergen).*

Figure 11. *Type-A vessels, wall thickness, rim diameter.*

A vessels wall thickness/ rim diam	**Small 10–19 cm**	**Medium 20–29 cm**	**Large 30–39 cm**	**Very large 40+ cm**	**Total**
0.5–0.9 cm	12 = 39%	11 = 16%	0	0	23 = 18%
1–1.4 cm	18 = 58%	36 = 53%	10 = 43.5%	1 = 12.5%	65 = 50%
1.5–2 cm	1 = 3%	16 = 24%	10 = 43.5%	4 = 50%	31 = 24%
2+ cm	0	5 = 7%	3 = 13%	3 = 37.5%	11 = 8%
Total	31 = 100%	68 = 100%	23 = 100%	8 = 100%	130 = 100%

Figure 12. *Type-A vessels, chronological distribution of rim shapes, knob and shafts designs.*

Design of dated A vessels	**Rim shapes Measurements n=174**				**Knobs Measurements n=31**							**Shafts Measurements n=36**				
	R1	**R2**	**R3**	**R4**	**K1**	**K2**	**K3**	**K4**	**K5**	**K8**	**K9**	**S1**	**S2**	**S3**	**S4**	**S5**
P1c. 1020/30–c. 1120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P2 1120s–1170/71	36	1	1	4	2	-	3	-	1	-	1	6	2	-	--	-
P3 1170/71–1198	51	-	3	7	4	-	3	2	-	1	-	10	2	1	2	-
P4 1198–1248	43	-	2	2	5	1	3	-	1	-	-	7	1	-	-	-
P5 1248–1332	9	-	3	6	1	-	2	-	1	-	-	2	1	1	-	1
P6 1332–1413	4	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
P7 1413–1476	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P8 1476–1702	-	-	-	-	-	-	-	--	-	-	-	-	-	-	-	-
P9 1702–1955	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	144	1	9	20	12	1	11	2	3	1	1	25	6	2	2	1

1:1.9 to 1:4.8. The proportions of the vessels change during the medieval times as discussed below. None of the type-A vessels at Bryggen are ornamented, with the exception of one of the handles, that has an incised line.

Type-A vessels are the dominant vessel type at Bryggen until about 1248; i.e. in periods 1 to 4, the early vessels are relatively large and all sizes are present. In the later periods, the size of the vessels decreases. Figure 12 gives a picture of the trends in the chronological development of rim shapes and the design of knobs and shafts. Before 1248 the vessel type is uniform, mainly with R1 rims, and the facetted shaft as the dominant handle type. From period 5, after 1248, the manufacture seems to get more diverse and random and both rims and handles seem to have a more inconsistent design. After the mid-13th century this vessel type is clearly in decline not only in numbers, but also in quality.

Type-B vessels

The type-B group from Bryggen consists of 299 shards from 229 vessels. Type-B vessels have a curved or sometimes semi-flattened base, the sides' surfaces are smoothed and straight or slightly curved and junction between the bottom and walls is smooth (Figure 13). The form is, similar to the Viking Age type Rygh 729 (Rygh 1885), but the proportions seem to differ. B vessels of size small are the most common, and walls are quite thin, most commonly less than 1 cm (51%). Compared to type-A vessels, type-B vessels are smaller, with thinner walls and are generally of more homogenous size (Figure 14). The height-width ratio varies from 1:1.9 to 1:3.6. The size of the vessel type decreases over time, and the percentage of semi-flattened bases, the prevailing base shape from period 6 (1332), increases.

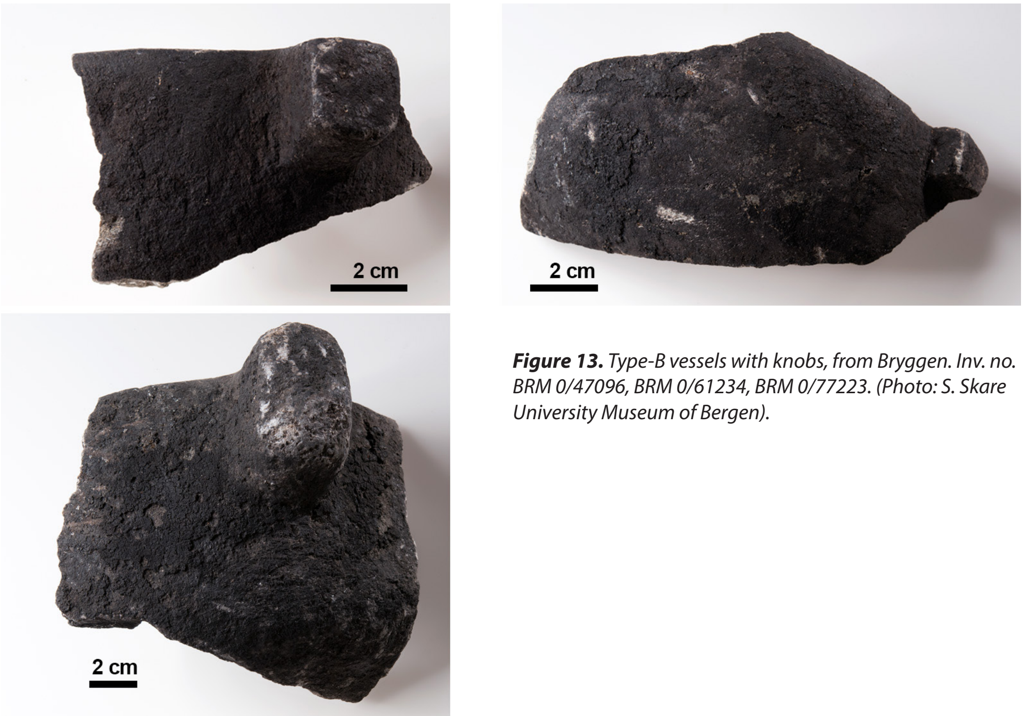


Figure 13. *Type-B vessels with knobs, from Bryggen. Inv. no. BRM 0/47096, BRM 0/61234, BRM 0/77223. (Photo: S. Skare University Museum of Bergen).*

Figure 14. *Type-B vessels, wall thickness, rim diameter.*

B vessels wall thickness/ rim diam	**Very small <10 cm**	**Small 10–19 cm**	**Medium 20–29 cm**	**Large 30–39 cm**	**Very large 40+ cm**	**Total**
0.5–0.9 cm	4 = 100%	34 = 55%	12 = 41.5%	0	0	50 = 51%
1–1.4 cm	0	24 = 39%	14 = 48%	3 = 100%	0	41 = 41%
1.5–1.9 cm	0	4 = 6%	2 = 7%	0	1 = 100%	7 = 7%
2+ cm	0	0	1 = 3.5%	0	0	1 = 1%
Total:	4 = 100%	62 = 100%	29 = 100%	3 = 100%	1 = 100%	99 = 100%

Figure 15. *Type-B vessels, chronological distribution of rim shapes, knob and shafts designs.*

Design of dated B vessels	**Rimshapes Measurements n=108**				**Knobs Measurements n=52**								**Shafts Measurements n=12**				
	R2	R3	R4	R5	K1	K2	K3	K4	K5	K6	K7	K8	S1	S2	S3	S4	S5
P1 c. 1020/30–c. 1120	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-
P2 1120s–1170/71	-	1	-	-	-	-	-	-	-	-	-		-	-	-	1	-
P3 1170/71–1198	-	-	1	-	-	-	-	-	-	-	-		-	-	-	-	-
P4 1198–1248	3	5	5	1	-	-	1	1	-	-	-		1	1	-	1	1
P5 1248–1332	3	21	9	-	2	-	3	4	6	1	2		-	-	1	-	2
P6 1332–1413	13	23	11	-	3	5	14	-	3	-	-	1	-	-	-	-	1
P7 1413–1476	6	2	3	-	1	2	-	-	2	-	-	1	1	-	-	1	-
P8 1476–1702	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P9 1702–1955	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Total	25	53	29	1	6	7	18	5	11	1	2	2	2	1	1	4	4

Viking Age vessels often have an iron handle whereas medieval vessels have cut-out knobs or shafts. Knobs are more than four times more common than shafts on B vessels. Figure 15 shows some trends in the chronological changes in vessel design; the rim type R3 – the flat rim – becomes more frequent from the mid-13th century and R2 the rounded rim – becomes more frequent in the 14th century, i.e. from period 6 on (1332–1413). In period 6, K3 – the square knob design – dominates the handles, which are more diverse in design in the periods before and after. Although the number of shaft measurements is small, it seems like shafts are present in higher numbers proportionally in the early settlement phases compared to after 1248, when the majority of B vessels seems to have knobs only. The Bryggen B vessels are in a few cases (n=8) ornamented with one or two incised grooves under or on top of the rim and on top of the shafts.

B vessels are found at Bryggen from period 2 on. B vessels peak during periods 5 and 6 and are the dominant vessel type during these periods. Only a few vessels are found in contexts dating to after the late 15th century.

Type-C vessels

The C-type group, which has curved walls and a rounded base like A and B vessels, consists of 19 shards from 18 vessels. The walls' outer surface is easily distinguished by its rough tooling using a pointed tool, except for a smooth band below the rim (Figure 16). The rim diameter of C vessels in the Bryggen material varies between 15 and 31 cm, but could only be measured on seven vessels: two fall within the size category small, three within the medium category, and one is large. The average

Figure 16. *Type-C vessels from Bryggen. Inv. no. BRM 0/44706, BRM 0/80455. (Photo: S. Skare University Museum of Bergen) .*

wall thickness is about 1–1.4 cm (n=9), with seven being thinner and one vessel being thicker. It was not possible to measure the height ratio on any of the artefacts. Too few of the vessels are preserved to describe the proportions of the vessel type as a whole, or the chronological development of the type. Some type-C vessels have a characteristic long, flat handle (S6) at Bryggen and they are not decorated.

The C vessel is present in the Bryggen assemblage from periods 2 to 6. The number of C vessels is altogether small so it is hard to determine if, or when, the type has a peak at Bryggen. The poor preservation of the vessels, as well as the low number of shards, does not all for us to detect any chronological development in shape or size.

Figure 17. *Type-D vessel from Bryggen. Inv. no. BRM 0/49636. (Photo: S. Skare University Museum of Bergen).*

Figure 18. *Type-D vessels, wall thickness, rim diameter.Bergen) .*

D vessels wall thickness/ rim diam	Very small <10 cm	Small 10–19 cm	Medium 20–29 cm	Large 30–39 cm	Total
0.5–0.9 cm	2 = 100%	15 = 68%	3 = 33%	0	20
1–1.4 cm	0	5 = 23%	6 = 67%	1 = 100%	12
1.5–1.9 cm	0	1 = 5%	0	0	1
2+ cm	0	1 = 5%	0	0	1
Total	2 = 100%	22 = 100%	9 = 100%	1 = 100%	34

Figure 19. *Type-D vessels, chronological distribution of rim shapes, knob and shafts designs.*

Design of dated D vessels	Rim shapes Measurements n=32			Knobs Measurements n = 11							
	R 2	**R 3**	**R4**	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**K8**	**K9**
P1 c. 1020/30–c. 1120	-	-	-	-	-	-	-	-	-	-	-
P2 1120s–1170/71	-	-	-	-	-	-	-	-	-	-	-
P3 1170/71–1198	-	1	-	-	-	-	-	-	1	-	-
P4 1198–1248	-	-	1	-	-	-	-	-	-	-	-
P5 1248–1332	-	-	1	-	-	-	-	-	-	-	-
P6 1332–1413	4	10	3	1	2	-	-	1	1	-	1
P7 1413–1476	1	7	2	1	1	1	1	-	-	1	-
P8 1476–1702	-	2	-	-	-	-	-	-	-	-	-
P9 1702–1955	-	-	-	-	-	-	-	-	-	-	-
Total	**5**	**20**	**7**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**1**

Type-D vessels

The type-D group, defined as flat bottomed vessels with straight, smoothed walls with an angled junction between the bottom and wall (Figure 17), consists of 71 shards from 61 vessels. The vessel type's most common size category is small with a rim diameter between 10–19 cm. The walls are generally thin – less than 1 cm (Figure 18). The height ratio varies from 1:2 to 1:3.6. Figure 19 shows trends in the chronological development of rim and knob design. The flat rim shape R3 is the most common. No shafts are present in the Bryggen assemblage, and the 11 measured knobs are very varied with 8 different design groups represented. Traces of holes for metal handles are observed on one vessel. In four cases type-D vessels were ornamented like the B vessels with one or two incised grooves close to the rim (2) or on the knobs (2).

D vessels at Bryggen are found from period 3 throughout period 9. The type has its peak with respect to numbers during periods 6 and 7. During periods 7 and 8, that is, from the late 15th century and throughout the early modern period, it is proportionally the most common vessel type. It is not possible to detect a distinct chronological development in the design of the type from the Bryggen material.

Figure 20. *Type-E vessel from Bryggen, seen towards the facetted bottom, angled junction between bottom and straight, facetted sides. Inv. no. BRM 0/49509, BRM 0/69125. (Photo: S. Skare University Museum of Bergen).*

Type-E vessels

The type-E group consists of 30 shards from 28 vessels. This type has the same form as D vessels, and are thus flat bottomed with straight walls and a sharp angled junction between the bottom and the sides. Type-E vessels have a distinct facetted surface treatment similar to that seen on A vessels (Figure 20). The E vessels are generally small with thin walls, less than 1 cm thick (Figure 21). As opposed to the D- type vessels, E vessels not only have knobs but also shafts with which to lift the vessel. One knob and three shafts have been found.

The vessels date from period 6 to period 9 with a peak in periods 6 and 7 (1332–1476). The vessels are too few to determine any chronological development of the type.

Figure 21. *Type-E vessels, wall thickness, rim diameter.*

E vessels wall thickness/ rim diam	Small 10–19 cm	Medium 20–29 cm	Total
0.5–0.9 cm	9 = 75%	0	9
1–1.4 cm	3 = 25%	4 = 100%	7
Total	12 =100%	4 = 100%	16

Figure 22. *Type-F vessels from Bryggen. Inv. no. BRM 0/56949, BRM 0/76447 (Photo: S. Skare University Museum of Bergen).)*

Type-F vessels

The type-F group consists of only nine shards from nine vessels and is the least numerous type at Bryggen. Type-F vessels are characterised by being bowl shaped with a curved bottom and sides divided into vertical panels. The upper part near the rim is kept smooth like the rim of type-C vessels (Figure 22). The vessels are small (43%) and middle sized (57%), the walls are quite thin – 78% are less than 1 cm thick and the wall thickness is not directly connected to the vessel size. F vessels are only known to have knobs, not shafts. The representativity of these observations for the type-F as a whole must be taken with some reservation since the number of vessels in the study is small.

At Bryggen, type-F vessels are found during periods 5 to 7 (1248–1476) with a peak in period 6. Type-F vessels are too few to determine any chronological development of the type.

A summary of the typological and quantitative development over time

The distribution over time shows the use of soapstone vessels in the Bryggen area during all settlement phases from the earliest period dating from the 11th century to the last period after the fire in 1702 (Figures 23 and 24). The Bryggen soapstone vessel assemblage shows a marked morphological and quantitative variation over time. During the oldest period dating from c. 1020/30 to 1120, only A vessels are found. The number of vessels from this extended period of time is, however, small (3) and one should be careful not to place too much trust in this early material (see Hansen 2005:58–67 for details on the dates of the oldest material at Bryggen BRM 0). During period 2, from the 1120s to 1170/71, two more types of vessels (B and C) are present in the material, but type-A vessels dominated for another hundred years throughout period 4 (1198–1248). From period 5 throughout period 6 (1248–1413), that is, for almost 200 years, type-B vessels were the most common soapstone pot in the wharf area. Type-C is present in small numbers from periods 2 to 6. Towards the end of the middle ages and throughout the early modern period, the straight-walled, flat-based types E and D

Figure 23. *Chronological distribution of all soapstone vessels from the Bryggen site BRM 0 in Bergen from periods 1 to 9. Vessels n= 806.*

Vessel type	A	B	C	D	E	F	Classified	Un classified	Total
P1 c. 1020/30– c. 1120	3	-	-	-	-	-	3	-	3
P2 1120s –1170/71	76	1	1	-	-	-	78	17	95
P3 1170/71–1198	81	3	2	1	-	-	87	21	108
P4 1198–1248	83	26	4	2	-	-	115	15	130
P5 1248–1332	39	70	3	2	-	1	115	27	142
P6 1332–1413	12	95	4	27	11	5	154	40	194
P7 1413–1476	1	18	-	21	8	2	50	7	57
P8 1476–1702	-	4	-	6	5	-	15	6	21
P9 1702–1955	1	3	-	2	2	-	7	2	10
P?	15	9	4	0	2	1	31	15	46
Total	**311**	**229**	**18**	**61**	**28**	**9**	**656**	**150**	**806**

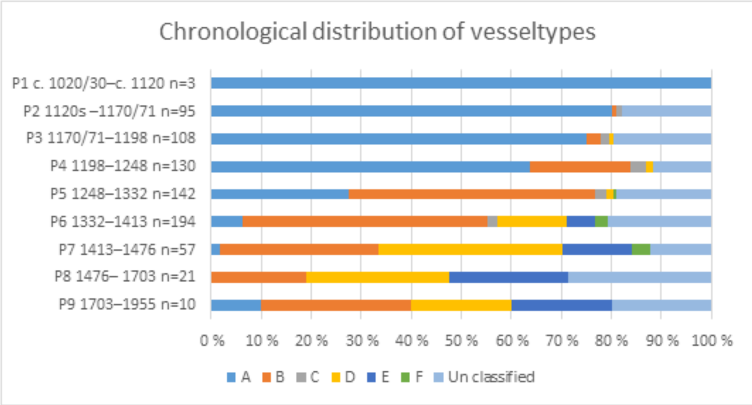


***Figure 24.** The chronological distribution of soapstone vessels from the Bryggen site BRM 0 in Bergen as % of all vessels from periods 1 to 9.*

became more popular. For a timespan of about 150 years during periods 6 and 7 (1332–1476), all six vessel types A–F were in use at Bryggen. From period 7 on, i.e. from the 15th century and throughout the period under study, we have no clear evidence of A and C vessels being present here; the single A vessel found in period 9 has so many archaic attributes that I find it hard not to think it must have been redeposited and from a far older primary context. Type-F vessels went out of use after 1476 while types B, D and E were present during the latest settlement periods of the wharf.

The dating of the Bryggen assemblage in relation to comparative material

Compared to the other published Norwegian medieval soapstone assemblages, the Bryggen material shows that the A–D types were in use over a longer timespan than has been previously recognised. Type-A vessels have been found at Borgund in contexts dated very broadly from 1100 to 1300 (Lossius 1977:52–53), and at Borg in Lofoten in northern Norway in ^{14}C dated strata from c.1000 to early c. 1300 (Brodshaug 2005; Brodshaug & Solli 2006:296). The Bryggen A vessels date from the late 11th century throughout period 6 (1332–1413). The decline in the number of type-A vessels during period 6, between 1332–1413 at Bryggen, corresponds with the chronological pattern indicated at Borgund and Borg, thereby giving an overall picture of the type as a possibly early, but primarily high medieval vessel type (Norwegian high Medieval period c. 1130–1350). The A vessel assumedly has its primary provenance in the western part of Norway, but evidence of production is also found on the coast of Helgeland in the southern part of the Nordland County in northern Norway (Berglund 1999).

Type-B vessels can be found in the Viking period and are present at Borgund in contexts dated very broadly from c. 1100 to the post-medieval time (Lossius 1977:52–53). The Bryggen assemblage dates the B vessels from period 2 (1120s–1170) to post medieval times, and parallels the results from Borgund. It has not been possible to identify a specific area of production for this vessel type so far, and its general shape makes it likely to have been produced independently over a larger area.

Type-C vessels are mainly found in the eastern part of Norway (Oslo, Tønsberg), in contexts dated from 1000/1100 to post-medieval times in Tønsberg and from c. 1150 to post-medieval times in Oslo (Lossius 1979:64–71), while the vessel type disappears at Bryggen after or by the 15th century.

C vessels are believed to be of eastern Norwegian provenance due to the type's overall distribution pattern (Lossius 1977:51).

According to Lossius, a small number of type-D specimens are known from the Viking Age. The few vessels of this type from Borgund date to around 1300. In addition, type-D vessels have been found in contexts dating to the late medieval/post-Medieval periods, i.e., mainly dating to the 16th century and later (Lossius 1977:51). In the Bryggen assemblage, type-D vessels appear in period 3, the late 12th century, but seem to be increasingly common during the 14th century. The Bryggen assemblage shows an earlier use of the D-type vessel than the hitherto published medieval material (Lossius 1977:51), and confirms the primary distribution of the vessel type during the late medieval and post-Medieval periods. The provenance of the type-D vessels is unknown (Lossius 1977:63), but it might be possible to establish regional variations if vessel assemblages from several regions are compared.

Until now, no finds of type-E and F vessels have been published from sites other than the Bryggen site in Bergen. However, in connection with my master study, I observed several specimens in the University Museum of Bergen's collection of medieval archaeological finds from western Norway. This confirms the two types' existence at other western Norwegian medieval sites. Still, a closer study of these artefacts' contexts is necessary to give further indications of the types' dating in contexts beyond Bryggen and Bergen. The types' provenance is unknown and awaits further study.

Discussion – the use of soapstone vessels at Bryggen through time

The results of the typological analysis of the medieval soapstone vessels from Bryggen in Bergen has led to several questions concerning the mechanisms and events leading to the quantitative and qualitative development of soapstone pots during the medieval and early modern period.

A gradual overall decrease in the use of soapstone pots at Bryggen

Upon looking at the chronological development of soapstone vessel consumption, an estimate of the number of vessels consumed per decade throughout the period under study proves interesting. During the Bryggen excavations, some parts of the area had the upper strata, younger than 1248, removed by hydraulic excavators (Herteig 1990; Hansen 1998). To ensure a correct understanding of the quantitative chronological development, it is useful to compare the figures from the total excavated area at the Bryggen site with figures from a selected area excavated using the same method from the top to the bottom strata. In Figure 25 the number of vessels found per decade at the whole Bryggen site as well as figures based on a selected area are seen. The numbers from the whole site show that during period 3, the largest amount of soapstone vessels were consumed per decade, with 36 vessels per decade. The most significant quantitative decline in consumption happened sometime during period 7, in which the number of vessels per decade drops from 24 to 9.5, with a further drop during period 8 when a number of only 0.9 vessels is found per decade. The equivalent figures for the selected site coincide well with this development (the actual numbers per decade are lower since the number of vessels from the selected area is lower). In the selected area there is also a peak in period 3 and a marked decline in periods 7 and 8. From the 15th century onwards, soapstone cooking pots could not have been a common sight at the wharf.

The town's population increased rapidly from the mid-12th century onwards, and international trade flourished throughout the Medieval period. Judging by the amount of pottery found (e.g. Lüdtke 1989), the availability of ceramic cooking pots must have been good and stable in Bergen. Metal cooking pots were manufactured in Bergen from the last quarter of the 13th century at the

Figure 25. *The number of dated soapstone vessels per decade in periods 1 to 9 from the whole Bryggen BRM 0 site and from selected archaeological contexts at the site.*

	Total all contexts n=760	Number per decade	Total comparable contexts n=554	Number per decade
P1 c. 1020/30–c. 1120	3	?	3	?
P2 1120s –1170/71	95	19	47	9.4
P3 1170/71–1198	108	36	98	33
P4 1198–1248	130	26	84	17
P5 1248–1332	142	18	91	11
P6 1332–1413	194	24	161	20
P7 1413–1476	57	9.5	45	7.5
P8 1476–1702	21	0.9	18	0.8
P9 1702–1955	10	0.4	7	0.3

latest (Helle 1995:433). On this basis, a gradual decrease in the use of soapstone pots through the Medieval period should be expected. It is therefore surprising to notice that the decrease in the number of soapstone vessels discarded annually does not drop off until sometime in the 15th century, a good while after the establishment of the Hanse kontor at Bryggen around 1360. After the establishment of the kontor, the area became inhabited more or less exclusively by Hanseatic merchants. The late drop-off may to some extent, as noted in the introduction to this paper, be explained by the chronological 'delay'/extension of the time span during which the vessel types appear in the archaeological record due to the presence of a certain amount of redeposited material in some of the contexts at the Bryggen site. The trend that the final drop in consumption does not occur till period 8, however, should probably be considered trustworthy.

The decline of the type-A vessels – a change in the mode of production

The western Norwegian type-A vessels of widely differing sizes dominate during the earliest periods at Bryggen. I suggest that the decline in the quantity of type-A vessels in the 13th century may be connected to changes in the regional production and/or distribution of soapstone vessels. I suggest that such a decline may be caused by the depletion of the best soapstone quarries for building stone in the 12th and 13th centuries when approximately 20 stone churches were erected in Bergen (Ekroll 1997; Storemyr & Heldal 2002:363). Eleven stone churches and three monasteries were built in Bergen during the 12th century alone (Helle 1995:149), and the pressure on the regional soapstone resources and workforce must have been substantial. This quite rapid change in the utilisation of the quarries/soapstone resources must have affected the mode of production of soapstone vessels. It is not known if the same workers that had (seasonally?) extracted pots from the quarries continued to work with building stone, or if new specialists took over. The scale of production in the Viking Age indicates good organisation (Skjølsvold 1961; Østerås 2002), and I find it likely that the well-organised production continued for a while into the medieval age (but see Hansen et al. this volume). The decline in urban consumption of the type-A vessels about c. 1300 might reflect a decline in the production of these vessels and a shift in the way the quarries were organised, and/or the depletion of the resources followed by the termination of a several hundred-year old western Norwegian vessel-manufacturing tradition. This interpretation of the decline is strengthened by the fact that the design of the A vessels becomes less uniform and stringent from period 5 on (1248–1332). The suggested late medieval development from large-scale to small-scale local production in western Norway may find some support in a description in a letter from the royal chancery (Norwegian: kongebrev) from 1577 mentioning how local farmers extracted soapstone pots from a quarry at Lysekloster south of Bergen: '*… af et stenbrud ved Lysekloster hvoraf bønderne gjøre gryder og potter…*' (Helland 1893:177).

From overall important household vessel to special purpose item

In the earliest settlement periods, soapstone vessels with a diverse array of sizes have been in use for a variety of cooking purposes (Figure 26). The large and heavy vessels disappear from the assemblage first; perhaps they are substituted with more expensive but durable metal cooking pots? Metal vessels were imported into Bergen, and as already mentioned, manufactured locally in Øvregaten no later than the end of the 13th century (Helle 1995:433).

In Viking Age and medieval Norway no indigenous pottery tradition existed and soapstone pots are considered the main cooking vessel in Norwegian households during this time (e.g. Schou 2015:204, this vol.). The relation between the absence of a Norwegian medieval pottery production and the presence of a strong soapstone industry has been much debated (e.g. Molaug 1982:211). Likewise, evidence for an increase in the importation of pottery, leading to a decrease in the production of soapstone vessels, has been sought in several Norwegian medieval towns. At the medieval Mindets tomt site in Oslo, Petter Molaug sees a parallel decline in the use of both soapstone and ceramic cooking pots in favour of metal vessels during the 13th century (Molaug 1982:208). Siri Myrvoll did not find any clear connection between an increase or decrease in the quantity of ceramics compared to soapstone cooking pots in her study of material from medieval Oslo and Skien (Myrvoll 1983:22). For Bryggen, however, the pattern is so far not clear. One might expect that soapstone vessels were also the most common household container, relatively speaking, during the earliest period at the Bryggen wharf. However, it is difficult to assess the actual frequency of soapstone vessels versus pottery during period 1 at this particular site. This is due to both methodological problems inherent in the documentation system at the site, and the circumstance that actual settlement and activity in

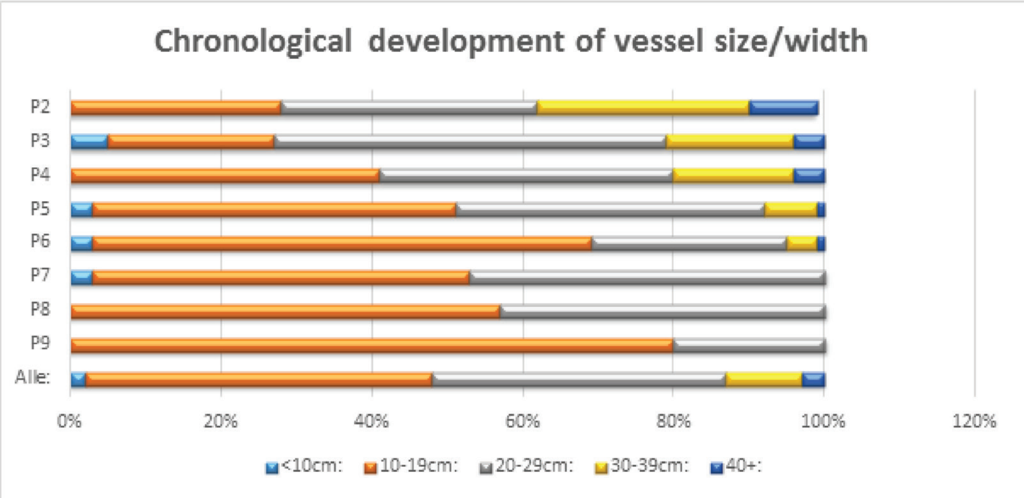


Figure 26. *The chronological development of soapstone vessel rim diameter.*

this area of the town was sparse until some decades into the 12th century (Hansen 2005). One of the published ceramic wares from Bryggen is the English Shelly-Sandy Ware (Blackmore & Vince 1994). This pottery type was typically used as cooking ware, and may thus have filled the same main function as soapstone vessels. It is suitable as a comparative material to the soapstone vessels. The quantity of this ceramic type had its peak at Bryggen in period 3 – identical to soapstone vessels. Based on figures in Lyn Blackmore and Allen Vince's studies, almost 5 times as many Shelly-Sandy shards as soapstone shards were deposited in period 3 (1170/71–1198), and seven times as many were deposited in the following period 4 (1198–1248). With the reservation that pottery is less durable than soapstone, and thus may fragment into more pieces when broken – and that pottery is not so often repaired and reused compared to soapstone vessels – the trends are clear. They show an increase in the use of ceramic cooking pots compared to soapstone pots. An interesting observation is that Shelly-Sandy cooking pots are most often (62%) medium sized (20–29 cm) while the rest (38%) are small vessels (10–19 cm) (Blackmore & Vince, 1994:57). They thus seem to fill the same need for small and medium sized pots as the soapstone vessels.

Changes in medieval meal and cooking customs

The size of the vessels is, together with the shape of the base, an important functional feature. Combined with traces of use, like soot, it can help us understand how these vessels were used. In Figure 27 we see that traces of soot are found on the outer surface of 72% of vessels. This shows that soapstone vessels were mainly used as cooking pots. D vessels are an exception to this general picture. Only 61% of the D vessels are sooted, making it probable that the vessels had been used for other purposes as well. It is also interesting to observe that in several cases the largest vessels are burned on the outside but have no traces of food residue on the inside. It might point to the use of the largest vessels for heating fluids that do not adhere to the surface, such as water. Some of the D vessels could have been used for serving purposes only. It is a clear tendency that the bottom part of the type-B vessels get a more semi-flattened design during the 13th century; this facilitated the pots standing flat on the table. Furthermore, the long handles or shafts became less frequent during this period. The long handles were most likely used to drag the pots around in the hearth, and were not necessarily used to lift the pots.

During the second third of the 14th century (period 6), straight-walled vessels with flat bottoms (D and E-types) became more frequent. This could be a consequence of changes in the kitchen and meal customs. We know that earthenware, the German three-legged pipkin, was used for heating food and then serving it on the table in the late Medieval period (Molaug 1982:210; Demuth 2015). The

Figure 27. *Traces of soot and residue on the Bryggen soapstone vessels.*

	A	B	C	D	E	F	Un classified	Total
External soot only	105 = 34%	38 = 17%	6 = 33%	12 = 20%	7 = 24%	3 = 33%	40 = 27%	211 26%
Ext.+ internal soot/residue	138 44%	134 59%	12 67%	25 41%	15 55%	5 56%	44 = 29%	373 46%
Total soot traces	243 78%	172 = 75%	18 100%	37 61%	22 79%	8 89%	84 = 56%	584 72%
Number of vessels	311	229	18	61	28	9	150	806

smaller, flat-bottomed soapstone vessels from the later periods can probably be seen as an adaption to a more 'urbanised' identity, expressed by imported ceramics (cf. Christophersen 1999:144). The Pingsdorf ceramic jugs and beakers from Bryggen (dated to periods 2–4) likewise indicate a familiarity with contemporary European drinking customs in medieval Bergen (Lüdtke1989:67).

Analysis of food residues from soapstone vessels at the high medieval dwelling Borg III in Lofoten, northern Norway (dated to c. 1100–1300) shows that the same pots were used for a wide variety of medieval food – meat, fish, rye, peas and milk products (Brodshaug 2005:105–110). It is however uncertain if there are similarities to the use of soapstone pots in the more urban environment at Bryggen. Nevertheless, it is obvious that some use of soapstone cooking pots still took place even after the introduction of more 'sophisticated' vessels available in what became a gradually internationalised and urbanised environment.

Concluding remarks

The soapstone vessel assemblage from Bryggen in Bergen confirms the use of soapstone vessels as cooking pots through all the wharf's settlement periods, roughly from the 11th century throughout the medieval and early modern period up to 1702. The use of soapstone pots seems to significantly decline in 15th century. Evidently, the use of soapstone vessels also continues at the wharf after the German Hanseatic merchants took over the area in the 1360s. The assemblage shows a wide range of form and size categories. All four previously published medieval Norwegian vessel types and two 'new' types are present. The material suggests a distinct change in vessel manufacturing in the late 13th or early 14th century (Bryggen period 5) when the type-A vessels ceased to be produced. This coincides with the results of Bård Økland's study of waste management at Bryggen where he suggests that a turn towards a more urbanised society in Bergen happened during the 15th century (Økland 1998:122–123). The more limited range of sizes, which characterises the late Medieval period, points to a gradually marginalised use of soapstone pots towards the end of the Middle Ages. While cooking pots in ceramic and metal were available all through the settlement periods, technological developments leading to more reasonably priced metal pots and lead glazed pottery may more or less have ended the demand for soapstone vessels in Bergen by the end of the Medieval period.

The preference for smaller pots with a flat bottom and knobs instead of long handles may reflect the change from cooking a meal at the fireplace/hearth and serving the food on the table in other vessels, to serving the meal directly from the cooking pot placed on the table. The development from larger to smaller cooking pots during the late Medieval period might indicate that meals became more elaborate with several small dishes replacing the earlier 'one big pot dish'.

Based on the quantitative analysis of the extensive assemblage of soapstone vessels from Bryggen, changes in the use of soapstone vessels in medieval Bergen are indicated. There are most likely several explanations for the changes seen. Important reasons for change pinpointed here are the decreasing availability of good soapstone resources combined with an increased importation and production of cooking pots out of other materials. Furthermore, mentality changes towards a late medieval urbanised society with an international, European identity must have contributed to changes in, and eventually the decline of, the usage of soapstone vessels as cooking pots at the Bryggen wharf in the late Medieval period.

References

Berglund, B. 1999. Middelaldersk kleberindustri på Helgelandskysten. *Ottar 2/1999.*
Blackmore, L. & Vince, A. 1994. *Medieval pottery from south east England found in the Bryggen excavations 1955–68.* The Bryggen Papers Supplementary Series No. 5. University of Bergen, Bergen.
Brodshaug, E. 2005. Det anonyme dagliglivet. Klebersteinsmaterialet fra de arkeologiske utgravningene av Borg III, Vestvågøy, Lofoten. Unpublished master thesis, University of Tromsø.
Brodshaug, E. & Solli, B. 2006. Kleber, mat og rom på Borg i middelalderen. *Viking* 69, 289–306.
Christophersen, A. 1999. Norm, handling og identitet. Om boligkultur og social romliggjøring i urbane miljøer i norsk middelalder. In Mundal, E & Øye, I (eds) Norm og praksis i middelaldersamfunnet. 116–148. Senter for europeiske kulturstudier, Bergen.
Demuth, V. 2015. If sherds could tell. Imported ceramics from the Hanseatic hinterland in Bergen, Norway. Producers, traders and consumers: who were they, and how were they connected? In Hansen, G., Ashby, S. P. & Baug, I. (eds) *Everyday Products in the Middle Ages. Crafts Consumption and the Individual in Northern Europe c. AD 800–1600*, 339–359. Oxbow, Oxford & Philadelphia.
Ekroll, Ø. 1997. *Med kleber og kalk. Norsk steinbygging i mellomalderen 1050–1550.* Samlaget, Oslo.
Forster, A. K. 2004. Shetland and the trade of steatite goods in the North Atlantic region during the Viking and Early Medieval period. Unpublished Ph.D thesis, University of Bradford.
Grieg, S. 1933. *Middelalderens Byfund.* Akademiet, Oslo.
Hansen, G. 1998. The Bryggen chronology. New light upon the dating of the periods before fire V. In Ingvild Øye (ed) *Medieval Fires in Bergen – Revisited*, 81–127. Bryggen Papers Supplementary Series, No. 6. Fagbokforlaget. Bergen.
Hansen, G. 2005. *Bergen c 800–c. 1170. The Emergence of a Town*. Bryggen Papers Main Series, No. 6. Fagbokforlaget, Bergen.
Hansen, G. Hope, B. & Mygland, S. S. 2017. Migreringsprosjektet 2015-2017. Rapport om migrering av Middelaldersamlingens digitale BRM-funnprotokoller til de norske Universitetsmuseenes felles databaseløsning, MUSITbasen for arkeologi. Archive report. Topografisk arkiv for middelalderarkeologi, The Medieval Collections, Department of Cultural History, University Museum of Bergen, University of Bergen, Norway.
Helland, A. 1893. *Tagskifere, heller og vekstene*. N. G. U. No. 10. H. Aschehoug & Co., Kristiania.
Helle, K. 1982. *Kongssete og kjøpstad, fra opphavet til 1536. Bergen bys historie I*. Universitetsforlaget, Bergen, Oslo, Tromsø.
Helle, K. 1995. Under kirke og kongemakt 1130–1350. *Aschehougs Norgeshistorie,* bd.3. Aschehoug, Oslo.
Herteig, A. E. 1990. *The Buildings at Bryggen, Their Topographical and Chronological Development*. Part 1. The Bryggen Papers Main Series, vol. 3, part 1. Norwegian University Press, Bergen.
Herteig, A. E. 1991. *The Buildings at Bryggen, their Topographical and Chronological Development.* The Bryggen Papers Main Series, vol. 3, part 2. Norwegian University Press, Bergen.
Lossius, S. Myrvoll. 1977. *Kleberkarmaterialet fra Borgund, Sunnmøre.* Arkeologiske avhandlinger fra Historisk museum, no.1. Universitetet i Bergen, Bergen.
Lossius, S. Myrvoll. 1979. Skien, vår ‚nyeste' middelalderby. *Nicolay* 30, 14–23.
Lüdtke, H. 1989. *The Bryggen Pottery I. Introduction and Pingsdorf Ware.* The Bryggen Papers Supplementary Series No. 4. Norwegian University Press, Bergen.
Molaug, P. B. 1982. Om bruken av leirkar i Norge i middelalderen. *Hikuin* 8, 201–212.
Myrvoll, S. 1983. In Magnus, B. & Myrvoll, S. (eds) Mångahanda slags kärl finnas hos nordborna. Bruk av keramikk i middelalderen. *Riksantikvarens rapporter* 8, 17–24. Øvre Ervik, Oslo.
Møllerop, O. 1959. Kleberkar fra keltertid. *Stavanger Museum Årbok* årg. 61, 21–40.
Nymoen, P. 2011. Kun for den smarte skippers regning? Skipsvrak med omsettelig ballast: på sporet av kvernstein, kleber og brynehandelen fra Norge ca. 800–1800. *Nicolay* 114, 65–75.
Petersen, J. 1951. *Vikingetidens redskaper.* Dybwad, Oslo.
Pilø, L. 1989. Early soapstone vessels in Norway from the Late Bronze Age to the Early Roman Iron Age. *Acta Archaeologica* 60, 87–100.
Resi, H. G. 1979. *Die Specksteinfunde aus Haithabu.* Wachholtz, Neumünster.
Rygh, O. 1885. *Norske Oldsager.* Forlaget of Alb. Cammermeyer, Christiania.
Schou, T. P. 2007. Handel, produksjon og kommunikasjon – en undersøkelse av klebersteinsvirksomheten i Aust-Agders vikingtid med fokus på Fjære og Landvik. Unpublished master thesis, University of Bergen.
Schou, T. P. 2015. The soapstone vessel production and trade of Agder and its actors. In Hansen, G., Ashby, S.

P. & Baug, I. (eds) *Everyday Products in the Middle Ages. Crafts Consumption and the Individual in Northern Europe c. AD 800–1600*. 204–228. Oxbow, Oxford & Philadelphia.
Shetelig, H. 1912. Kleberstenskar fra jernalderen. *Oldtiden II.*
Skjølsvold, A. 1961. *Kleberindustrien i vikingetiden*. Universitetetsforlaget, Oslo and Bergen.
Skjølsvold, A. 1969. Et keltertids klebersteinbrudd i Kvikne. *Viking* 33, 201–238.
Storemyr, P. & Heldal, T. 2002. Soapstone production through Norwegian history: Geology, properties, quarrying and use. In Herrmann, J., Herz, N. & Newman, R. (eds) *ASMOSIA 5, Interdisciplinary Studies on Ancient Stone – Proceedings of the Fifth International Conference of the Association for the Study of Marble and Other Stones in Antiquity,* Museum of Fine Arts, Boston, June 11–15, 1998. 359–369. Archetype Publications, London.
Vangstad, H. 2003. Kleberkarene fra Bryggen i Bergen. En arkeologisk analyse av kleberkarene funnet på Bryggen i Bergen fra middelalder og etterreformatorisk tid. Unpublished hovedfagsoppgave i arkeologi med vekt på Norden, University of Bergen.
Økland, B. G. 1998. Det ureine avfallet? Ein arkeologisk analyse av avfallshandtering i Bergen 1150–1700. Unpublished hovedfagsoppgave i arkeologi med vekt på Norden, Universitetet i Bergen.
Østerås, B. 2002. Slipsteinsberget i Sparbu. Kva undersøkingar av eit klebersteinsbrot kan fortelje om gamle steinhoggartradisjonar. Unpublished hovedfagsoppgave i arkeologi. Vitenskapsmuseet NTNU.

Mogens Skaaning Høegsberg

The Soapstone of Norse Greenland

The article presents an overview of Norse Greenlandic portable objects of soapstone, based on the author's Ph.D. dissertation (2009). An analysis of 1168 artefacts from six Norse sites and their comparison with soapstone artefacts from other parts of the Norse world is presented. The majority of the artefacts were vessel sherds and the analysis suggests that most vessel types of Norse Greenland have parallels in known types from Norway, Shetland and Hedeby. Two vessel types, one with straight vertical sides and one trapezoid, as well as one rim shape appear to be unique to Greenland. The analysed material also comprises e.g. spindle whorls, loom weights, mending patches, architectural details and even moulds for casting. Most of these artefact types are also paralleled in soapstone finds elsewhere in the Norse world. One area in which the Greenlandic material stands out is in the high frequency of various types of ornamentation on all types of soapstone artefacts. It is suggested that the Norse Greenlanders may have reproduced traditional motives in order to stress continuity with the past and the cultural connection with Scandinavia.

Introduction

When settlers from Iceland made landfall in Greenland towards the end of the 10th century, they arrived in a country that not only lacked suitable clay for the production of ceramics, but also had sparse vegetation resources for the firing of pottery. In Iceland, ceramics as well as soapstone had been imported, but in Greenland, the settlers found and exploited outcroppings of soapstone. Particularly in the northernmost of the two Norse settlement areas, the Western Settlement in the present day Nuuk region, numerous soapstone quarries have been recorded (Appelt et al. 2005:14). Throughout the period of Norse settlement in Greenland, from c. AD 985 to c. AD 1450, soapstone was the dominant material in use for household cooking utensils as well as lamps, loom weights, spindle whorls and a number of other artefact types. Import of ceramic vessels did take place, but apparently on a very limited scale; only about ten ceramic sherds have been recorded from Norse contexts (Christiansen 2004:33). Pottery had to be imported from Europe and was not a vital import such as for instance iron. As such it is likely that pottery was considered an exclusive type of goods, reserved for those with the means to acquire it.

Large quantities of artefacts have been recovered from Norse sites in Greenland since the 1880s, and soapstone objects makes up the majority of portable finds recovered in any excavation of a Norse farm site in Greenland. The thousands of Norse artefacts in the National Museum in Copenhagen and in the Greenland National Museum and Archives have been subject of some interest over the years. But the soapstone, the numerically dominant group of artefacts, has been given little attention apart from in a few studies and in the chapters on finds in the publications of archaeological excavations of Norse farms. While the publications of the excavations in Greenland in the 1920s and 1930s were of a high quality for their time, the finds chapters are relatively superficial and mostly concerned with a presentation of major finds groups and particularly interesting or well-preserved artefacts. They do not contain detailed analysis of artefacts and often do not contain a complete list of finds.

There are a number of reasons for the lack of interest in soapstone from Norse Greenland. One is that the majority of all artefacts from Norse Greenland in the museums today were recovered in excavations which were not conducted stratigraphically. Most artefacts come from excavations that took place in the 1880s and 1890s and during the Danish National Museum's large campaigns in the 1920s and 1930s. Although the publications rarely, if ever, mention the excavation methods, it is clear that the excavators followed a method whereby the wall-lines of buildings were identified after which each identified room was emptied down to the natural. During the process only features such as fireplaces, benches etc. were recorded, not individual strata. (For an example of this method, see Vebæk 1992:33). Although the artefacts from C. L. Vebæk's post war-excavations of the late 1940s and the 1950s are generally better documented, they are still not assigned to specific stratigraphic contexts. Properly stratified excavations of Norse sites in Greenland did thus not take place until the 1960s and onwards. Consequently, it is difficult to study the development of Norse Greenland material culture over time, and many conclusions cannot be drawn until a larger body of evidence from stratigraphic excavations becomes available. This obviously also applies to the large body of soapstone artefacts.

The aim of this paper is to give an overview of portable objects of soapstone in Norse Greenland, including a discussion of major soapstone artefact types, vessel typology and ornamentation. The paper is, to a large degree, based on my Ph.D. thesis from 2009 (Høegsberg 2009) and deals primarily with soapstone artefacts from six selected Norse sites. This notwithstanding, the soapstone from these six sites are in all likelihood representative of Norse Greenlandic soapstone as a whole (although see below) and the paper aims to characterize Norse Greenlandic soapstone use in a broader sense and to demonstrate the breadth of the material. After a brief presentation of Greenlandic soapstone studies and of the six sites, a broad overview is given of soapstone vessels, other artefact types and of ornamentation on soapstone artefacts; the latter is one of the areas where the Greenlandic material seems to stand out compared to finds from other parts of the Norse world.

The study of Greenlandic soapstone

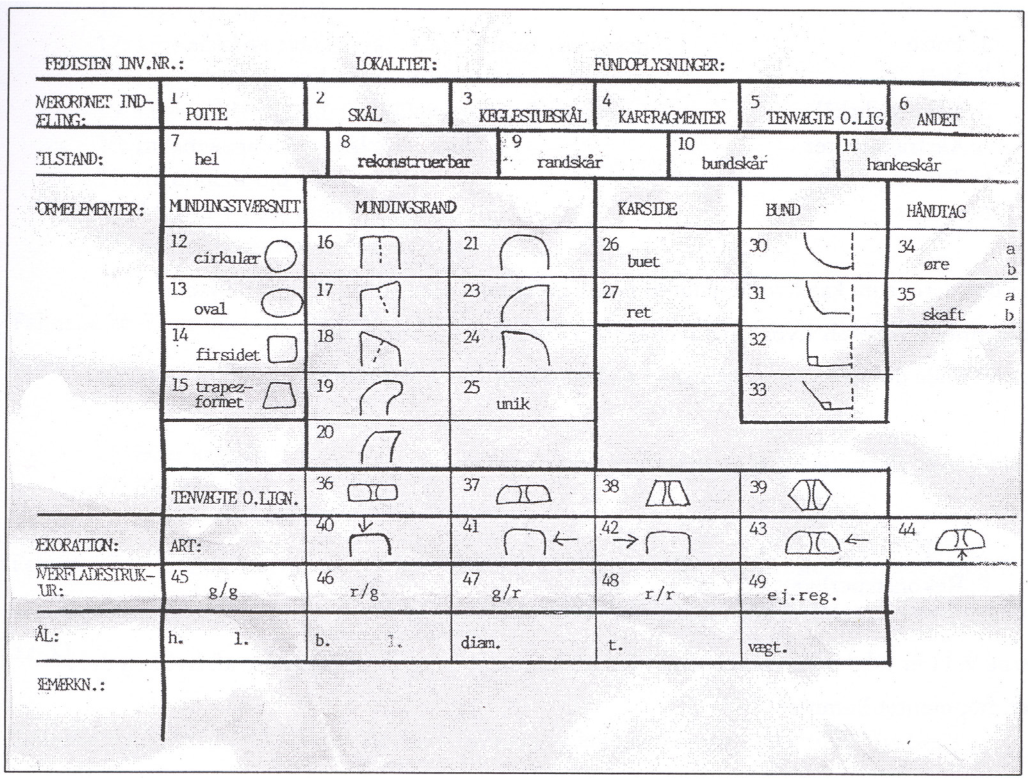
Among the few studies that have been made of soapstone from Norse Greenland is Arneborg's 1984 thesis from Aarhus University in which, among other artefacts, she studied some 150 vessel sherds from stratified excavations at the two Western Settlement sites W48 and W51 (Arneborg 1984). In her Ph.D. thesis from 2004, Amanda Forster also discusses Norse Greenlandic soapstone (Forster 2004). But apart from these studies, Norse Greenlandic soapstone artefacts have not been subject to closer scrutiny. In the publications of the large scale excavations of the 1920s and 1930s, Poul Nørlund and Aage Roussell must be commended for devoting separate chapters to the recovered artefacts – by no means a given fact at the time – but there was no attempt at a systematic approach to the large material and generally only the most well preserved or curious finds were devoted much interest (e.g. Nørlund 1924:221–227; Nørlund 1930:150–163; Nørlund & Stenberger 1934:122–131; Roussell 1936:133, 143–144, 151–152).

The aim of my thesis was to examine if the material culture of Norse Greenland reflected the existence of a specifically Norse Greenlandic cultural identity. The study included a total of 2663 artefacts from six sites. Of the 2663 artefacts, 1469 were of soapstone while the remainder was made up of a variety of other materials, predominantly wood and iron. Of the 1469 soapstone artefacts, 1168 were recorded; the remaining artefacts were not available for study and hence left out of the detailed analyses. The 1168 recorded soapstone artefacts were distributed on artefact types as seen in Figure 1.

All soapstone artefacts were recorded using a recording sheet, drawn up by Arneborg and slightly adjusted by myself (Figure 2). The sheet could be used for both vessels and other artefacts. For vessels it contained, among others, fields for vessel type, rim shape, side shape, bottom shape, decoration. All data was then entered into a database to allow for easier analysis, particularly of the various components of the vessels. The choice to record the material in this way was brought on by a major methodological concern; having no stratified collections to work from, I could not hope to extract any information about the development of vessel types or overall artefact

Figure 1. *Soapstone artefacts distributed by types*

Type	Quantity	Percentage
Vessels	764	65.4
Spindle whorls	158	13.5
Loom weights and other weight stones	96	8.2
Unknown function	80	6.9
Mending patches	38	3.3
Architectural details	19	1.6
Moulds	11	0.9
Other	2	0.3
Total	1168	100



FEDISTEN INV.NR.:			LOKALITET:		FUNDOPLYSNINGER:	
NERORDNET IND-ELING:	1 POTTE	2 SKÅL	3 KEGLESTUBSKÅL	4 KARFRAGMENTER	5 TENVÆGTE O.LIG	6 ANDET
:ILSTAND:	7 hel	8 rekonstruerbar	9 randskår	10 bundskår	11 hankeskår	
ORMELEMENTER:	MUNDINGSTVÆRSNIT	MUNDINGSRAND		KARSIDE	BUND	HÅNDTAG
	12 cirkulær	16	21	26 buet	30	34 øre a b
	13 oval	17	23	27 ret	31	35 skaft a b
	14 firsidet	18	24		32	
	15 trapez-formet	19	25 unik		33	
		20				
	TENVÆGTE O.LIGN.	36	37	38	39	
EKORATION:	ART:	40	41	42	43	44
NERFLADESTRUK-UR:	45 g/g	46 r/g	47 g/r	48 r/r	49 ej.reg.	
ÅL:	h. l.	b. l.	diam.	t.	vægt.	
EMÆRKN.:						

Figure 2. *The soapstone recording sheet developed by Arneborg (1984). For my analysis, I expanded the sheet with further categories, particularly regarding decoration. My data was entered directly into a Microsoft Access database.*

types. Thus taking a point of outset in Arneborg's recording system gave me the advantage of being able to compare many of my findings directly with an assemblage of already classified objects. Out of the 1168 soapstone artefacts, 764 (65%) were vessels and vessel fragments in various sizes and state of preservation. The remaining 404 (35%) consisted of artefact types, ranging from spindle whorls and loom weights to architectural details, moulds and artefacts whose function could not be determined.

Six Norse sites

When the Norse settlers arrived in Greenland, they established settlements in two areas on the west coast of Greenland. The Eastern Settlement was located in the southernmost part of the country, from Cape Farewell in the south to the area around Ivittuut in the north. The Western Settlement was located some 500 km further north, in the fjords of the present-day Nuuk region. Norse sites, traditionally referred to as 'ruin groups', are designated with a number, preceded by E (for Eastern Settlement) or W (for Western Settlement). Of the six sites that provided the material, one is located in the Western Settlement W51, which is traditionally identified with the farm Sandnes and which is mentioned in some of the written sources concerning Greenland. Sandnes was a prosperous farm, favourably located and with a church on the site (Roussell 1936). The remaining five sites are all from the Eastern Settlement: E29, E29a, E47, E111 and E167. Of these, E29a is traditionally identified as the farm Brattahlið, which is also known from written sources and which is believed to be the farm established by Eric the Red upon his arrival in Greenland. E29a is also a church site. E29 is located directly to the south of Brattahlið and may originally have formed part of the land taken by Eric the Red (Nørlund & Stenberger 1934). Ruin group E47 is the single largest Norse ruin group in Greenland and has been positively identified as the site of the farm Garðar, which is known from written sources as the site of the Norse bishop's seat from c. 1125 onwards (Nørlund 1930; Høegsberg 2007). Ruin group E111 is traditionally identified as Herjolfsnes, also known from written sources. The site is best known for the spectacular find of well-preserved pieces of Norse clothing during the excavation of the churchyard there in 1921 (Nørlund 1924). The last site, E167, is less well known and represents the only non-high status site of my examination, although it does not appear to be low-status either. It was located in the inland area called Vatnahverfi (all the other sites are coastal sites) and is not a church site (Vebæk 1992:45–64).

The nature and location of the six sites give rise to questions about representativity. First of all, there is only one Western Settlement farm and secondly all but one farm appears to be definite high status sites. I have not performed an in-depth analysis of any other collections of soapstone, but based on knowledge of soapstone from other sites my distinct impression is that there are no general problems concerning the representativity of the material. One possible exception relates to the assemblage from the Western Settlement, which is only represented by artefacts from W51/Sandnes. It cannot be ruled out that the spectrum of artefact types, vessel types and/or rim shapes could be broadened if a larger body of Western Settlement soapstone was brought to bear. The Eastern and the Western settlements were geographically quite far apart from each other and as such the precondition for the development of regional differences is certainly present. However, as described in the section about soapstone vessels below, there seems to be a good overall correspondence between the vessel types found in both areas and no vessel type can thus far be said to be unique to either of the two settlements.

Regarding the social status of the sites, this does not seem to have a bearing on the types of soapstone vessels found. At least, there does not seem to be any significant differences between the types of soapstone vessels that were found on the definite high status sites E29a/Brattahlið and E47/

Garðar and the ones that were found on e.g. E167. This suggests that soapstone was not a medium for the expression of social status in Norse Greenlandic society. However there are certain other artefact types which as seen below were either more common or which were only found on high status sites, e.g. architectural details and moulds.

A final methodological problem relates to the size of the soapstone artefact collections from each of the six sites. Some collections were very small and some were very large (Figure 3). In some cases this simply reflects the fact that fewer soapstone artefacts were recovered from the excavations or a difference in artefact retrieval policy during the excavations. Bear in mind that the excavations which produced the collections were mostly carried out in the 1920s and 1930s where the logistics of transportation were even more complicated than they are today, and soapstone is a heavy and cumbersome material to transport. In one case, that of E29/Brattalið, there were also problems with finding the artefact collection in the museum storerooms, so that only 12 artefacts were available for study. Given the small number of artefacts, one could ask if it makes sense to include this site in the study, but among the 12 artefacts are some highly decorated ones that merit mention.

Figure 3. *The distribution of soapstone artefacts from the six sites.*

Site	Recorded during analysis	Total number of known recovered artefacts
W51 (Sandnes)	285	292
E29	12	186
E29a (Brattahlið)	114	130
E47 (Garðar)	348	439
E111 (Herjolfsnes)	37	45
E167	372	377
Total	1168	1469

Soapstone vessels

In accordance with the methodology followed, the most important criteria for the analysis of vessel sherds are the main types of vessels – pots, bowls and cone-stump bowls. In addition, a number of other elements are recorded, such as the vessel mouth shape (as seen from above), rim shapes, side shapes, bottom shapes, handle shapes and surface structure. The main vessel types are defined as follows: Pots are vessels where the height of the side is equal to or larger than the diameter of the bottom. Bowls are vessels where the height of the side is smaller than the diameter of the bottom. And cone-stump bowls are bowls with a small, centrally placed 'platform' in the shape of cone-stump. Pots are considered to be cooking and/or storage vessels, while bowls are considered to be vessels for the serving of food. Cone-stump bowls (Figure 4) could conceivably also be used for the serving of food, but the reason for the existence of the cone-stub is unknown.

Arneborg's 1984 study was based on c. 150 vessel sherds from the two Western Settlement sites of W48 and W54. Her methodology was based on three fixed elements which could be analysed in conjunction with a number of variables. The fixed elements were vessel shapes (as seen from above), side shapes and bottom shapes. The variable elements were rim shapes, handle shapes and a number of forms of decoration. The combination of fixed and variable criteria resulted in a total number of 42 possible vessel types. However, there was a marked difference between the statistically possible number of types and the number of types actually encountered in the material; 12 of the 42 possible types were thus found: three types of bowls, eight types of pots and one type of cone-stump bowl. Arneborg's main conclusion was that, in terms of vessel types and rim shapes, the Greenlandic material seemed to follow the development in the Norwegian area. One unparalleled vessel type and one rim shape, however, seemed unique to Greenland: A vessel type with a trapezoidal mouth shape and a rim shape with flat top and a thick lip towards the inside of the vessel (Arneborg 1984:59).

That Arneborg could compare the development in her material with the development of soapstone vessels in Norway was due to the fact that her material came from stratified contexts. My material did not, so I did not have the possibility of evaluating the chronological development of types, but had to settle for the presence or absence of specific vessel types and other elements compared to available parallel material. One caveat with Arneborg's classification system is that it demands that the vessel sherds are rather well preserved; rim, side and bottom thus need to be preserved in one and the same sherd for the method to be applicable. In the current study only 70 out of 764 vessels/shards lived up to these criteria and merely 9 of Arneborg's 12 types were recognised. On the other hand, six types of bowls and one type of pot, which do not occur in Arneborg's material, were identified. The vessel types found in my study expand the spectrum of Greenlandic types somewhat, but all in all there is great correlation with those identified by Arneborg at W48 and W54. With the considerably larger amount of sherds in the present assemblage one might expect all Arneborg's types to be identified, However, with merely 70 sherds which fulfilled the criteria for a meaningful analysis it is possible, that all of Arneborg's types may hide in the assemblage and would have been found if more sherds had fulfilled the criteria. On the other hand, the types I discovered which were absent in Arneborg's study could equally be related to the difference in sample sizes. More generally, it probably speaks to the limited use of a classification system which emphasizes the preservation of rim, side and bottom in order to be applicable.

Looking at comparative material, there is generally a good correlation with vessel types known from Norway, Shetland and Hedeby. Siri Myrvoll Lossius (1977) divided the vessels from the Borgund kaupang, close to Ålesund, Sunnmøre, in western Norway, into four types, A–D, and two main groups: bowl shaped (*bolleformete*) and bucket shaped (*spannformete*). The two main groups are based on the transition from bottom to side. Lossius' bowl shaped types correspond to Greenlandic vessels with curved sides and both rounded and flat bottoms, while the bucket shaped types correspond to Greenlandic vessels with straight sides and flat bottoms. Lossius' four types were distributed on three types of bowl shaped vessels and one type of bucket shaped vessels (Lossius 1977:19). Lossius does not distinguish between pots and bowls, but both types must be assumed to exist in her material. The shape of the mouth does not play any role in Lossius' analyses, however, the Borgund assemblage generally represents circular vessels (Lossius 1977). Four sided vessels are indeed known from Norway, e.g. lamps from Oslo and Bergen, but I have been unable to find actual four sided pots and bowls in published material from Norway. According to Forster four sided vessels were not common in Norway (Forster 2004:196).

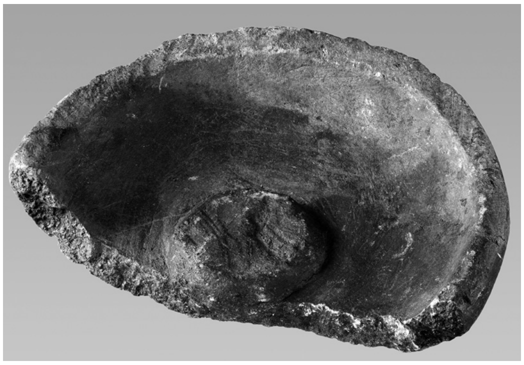


Figure 4. *A cone-stump bowl from W51/Sandnes. Apart from the centrally placed cone-stump, nothing sets these vessels apart from regular bowls. Diameter c. 20 cm. (Photo: J. Lee, National Museum of Denmark).*

The Hedeby material, too, is dominated by circular vessels. No four sided vessels were recorded although it must be noted that a third of the rimsherds were too small to allow for any secure inferences about the vessel mouth shape (Resi 1979:19). In the Hedeby assemblage there are both pots and bowls which all seem to have had curved sides. The bottoms are both rounded and flat. It should be noted that the Hedeby material may not be the best material to use as the basis of comparison with

Greenlandic material due to the time difference. The Hedeby material is strictly Viking Age, while most of the Greenlandic material must be assumed to be medieval and in many cases probably from the later stages of the settlement period (most excavations of Norse farms in Greenland have only touched the later phases of the farms and left the earlier phases more or less untouched).

The soapstone material from Shetland covers a greater variety of types, including oval and four sided vessels, but otherwise the Shetland material is generally comparable with the Norwegian (Forster 2004:165). The four sided vessels from Shetland all appear to have had outward slanting sides, meaning that the four sided Greenlandic vessel type with straight, vertical sides still appears to be unique to Greenland.

I have been unable to find examples of trapezoid vessels outside Greenland and it should be noted that even in Greenland the type is rare. From the six farms included in the study only one example was found. According to Arneborg the cone-stump bowl is paralleled in the Faroes and a possible ceramic example is found at Farum Lillevang, Denmark (Arneborg 1984:58). The Danish bowl is reminiscent of the Greenlandic examples, but with the important difference that in the Danish example the cone-stump is perforated and resembles a candle holder. This is not the case in the Greenlandic examples. The Greenlandic rim shapes resemble the rim shapes seen in Norway, Shetland and Hedeby and with one exception, the Greenlandic rim shapes can be found outside Greenland. The exception has a flat top and has either a thick lip towards the inside of the vessel or is heavily inwardly curved. Out of a total number of 517 recorded rimsherds, 59 sherds represent just over 11% and the type must thus be considered quite common, though not dominant.

Altogether an evaluation of the Greenlandic soapstone vessels shows a marked tendency to correlate with known types from outside Greenland. The only unique element which is significantly represented is the inwardly thick rim type, but even with an occurrence of about 11% it does not seem to have been dominant in any way. Looking at the soapstone vessels from the point of view of shape, the Norse Greenlanders seem to have continued to use well-known types from the rest of the Scandinavian world.

Other soapstone artefacts

About 400 soapstone artefacts are distributed on several groups of objects: spindle whorls, loom weights and other weight stones, mending patches, architectural details and moulds as well as a number of artefacts with unknown functions. In the following these artefacts are presented very briefly.

Spindle whorls

A large group of artefacts is spindle whorls (Figure 5) of which there are 158 from the six sites. The spindle whorls are distributed on four types, with the plano-convex as the most common, followed by the disc shaped (i.e. flat) and conical, and with the double-conical as the least frequent. In addition there are two examples of special and uncommon types. Most of the spindle whorls represent types which are also known from e.g. medieval Bergen in western Norway, where the plano-convex shape is also dominant, although not quite as dominant as in the Greenlandic material. Generally speaking, the types of spindle whorls in the Greenlandic material correspond well to the types that are found in Bergen and this also extends to the relative occurrence of the types (For comparison see Øye 1988:39).

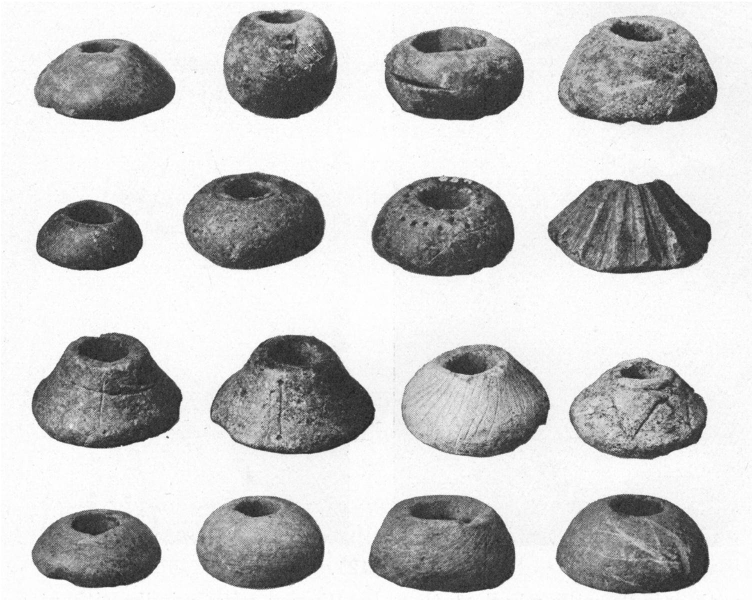


Figure 5. *A selection of spindle whorls from W51/Sandnes. Note that not all the four occurring types of spindle whorl are shown in the photo. (After Roussell 1936:133).*

Loom weights and other weight stones

Loom weights and other weight stones comprise the third largest group. It is hardly the case that every perforated piece of soapstone was necessarily a loom weight and some of the specimens may have been used for other purposes, e.g. as net sinkers. The majority of artefacts in this group are pieces of soapstone which are either unworked or very slightly worked. All are perforated at least once. There are 91 artefacts in this group and very little can be said about them because of the very slight degree of working. Indeed, it is not certain that all were ever used as weight stones, since not all of them bear evidence of wear in the perforated hole(s).

Mending patches

There are 38 mending patches in the assemblage. All have a slightly convex upper side while the other side is flat and has a protruding stub which was meant to be placed in the hole of the broken vessel (Figure 6). In addition there are usually several perforations, either in the stub or on either side of it. The perforations were used for securing the mending patch to the defect vessel with a piece of string. The mending patches come in various sizes; from very small (c. 2.5 cm) and finely wrought, to large (up to c. 17 cm) and more roughly made pieces.

Figure 6. *Mending patches from E167. The largest patch is c. 12 cm wide. (After Vebæk 1992:88).*

Architectural details

Soapstone artefacts interpreted as architectural details are rare and only represented at one of the sites studied here, namely the farm E47/Garðar, site of the Norse bishop's seat. There are a total of 22 artefacts in this group, which comprises both small and large pieces carved with various mouldings, which indicate that the interpretation as architectural details is correct. The interpretation is also supported by the context of the artefacts which is known for all but one piece; they were all found in or near the ruin of the cathedral. It seems, then, that certain building elements of the cathedral at Garðar had details of soapstone. This is a well known phenomenon from Norway where soapstone is used in this way from as early as the 11th century (Ekroll 1997:63).

Moulds

From the sites, there are a total of 11 moulds, eight from Garðar and three from Sandnes. An additional specimen, from E29, was not available for study. The best known moulds are the six found by Poul Nørlund at Garðar in 1926. They appear to have been meant for the production of spindle whorls and carry inscriptions (Figure 7). They are interpreted as moulds not only because of their

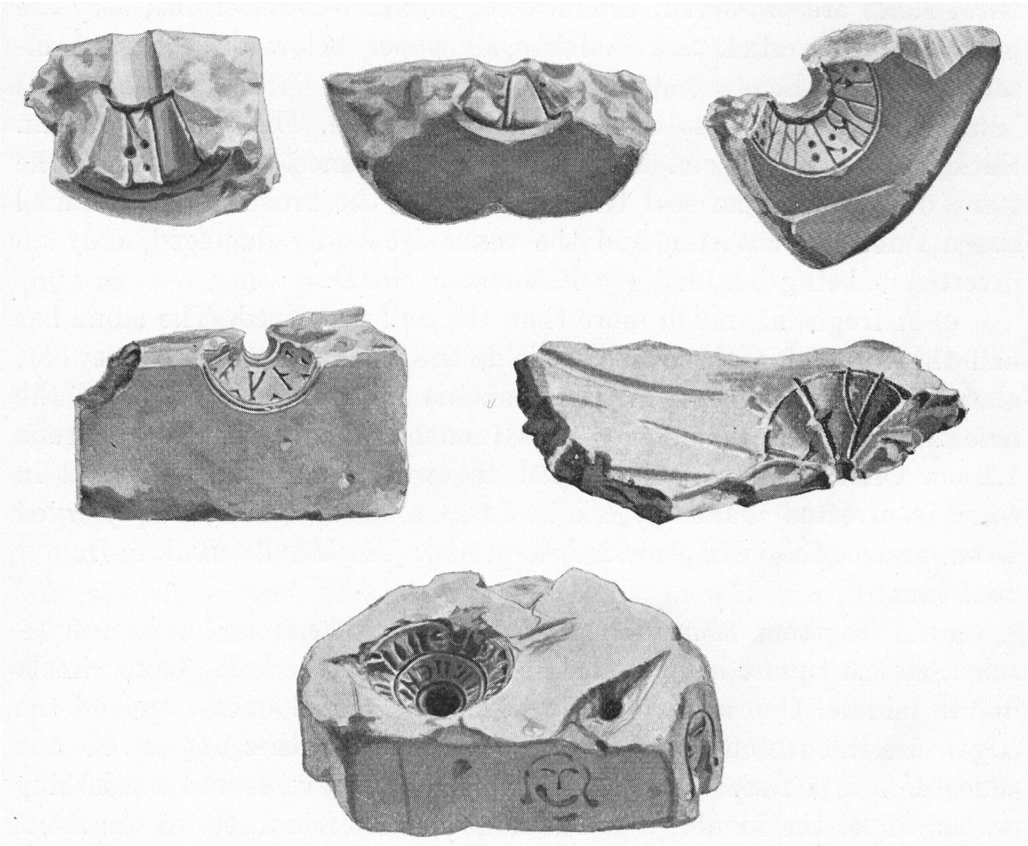


Figure 7. *Moulds for the casting of spindle whorls from E47/Garðar. Note the inscriptions in the moulds. They are runic, except the bottom one which is in Gothic minuscules. All inscriptions are in the negative. The bottom one is c. 10 cm long. (After Nørlund 1930:147).*

shape, but also because the inscriptions are in the negative. Five of the inscriptions are runic; the sixth is in Latin letters (and in the Latin language). Only some of the inscriptions are legible, they contain either names or express ownership (Jónsson 1930:173–174). Moulds of soapstone are known from elsewhere in the Scandinavian world, e.g. for casting metal bars or Thor's hammers (Gräslund 1992:191; Hansen 2005:166). As such there is nothing unique about the existence of moulds in Greenland, but it does beg the question of what kind of metal was meant to be used and indeed if the moulds were ever used to cast spindle whorls. No examples of cast spindle whorls have been found in Greenland so far, but of course any cast spindle whorl may have been reused due to the scarcity of metal as a raw material.

Artefacts with unknown functions

Lastly, there are 80 artefacts of which we do not know the function and of which several are decorated. The artefacts in this group cover a wide variety of shapes. Some are small, perforated pieces that seem to have been too small to function as weight stones. Others are pieces which have clearly been worked, but where the function cannot be determined. The latter can be divided into three main groups: 1) Slabs of soapstone from E47/Garðar of which most appear to have been square while some may have been either triangular or trapezoid (Nørlund 1930:159). Several of these slabs have a carved groove along the edges and several seem to have been decorated with carved concentric circles. It is likely that the combination of the overall shape and the decoration which prompted the excavator Poul Nørlund

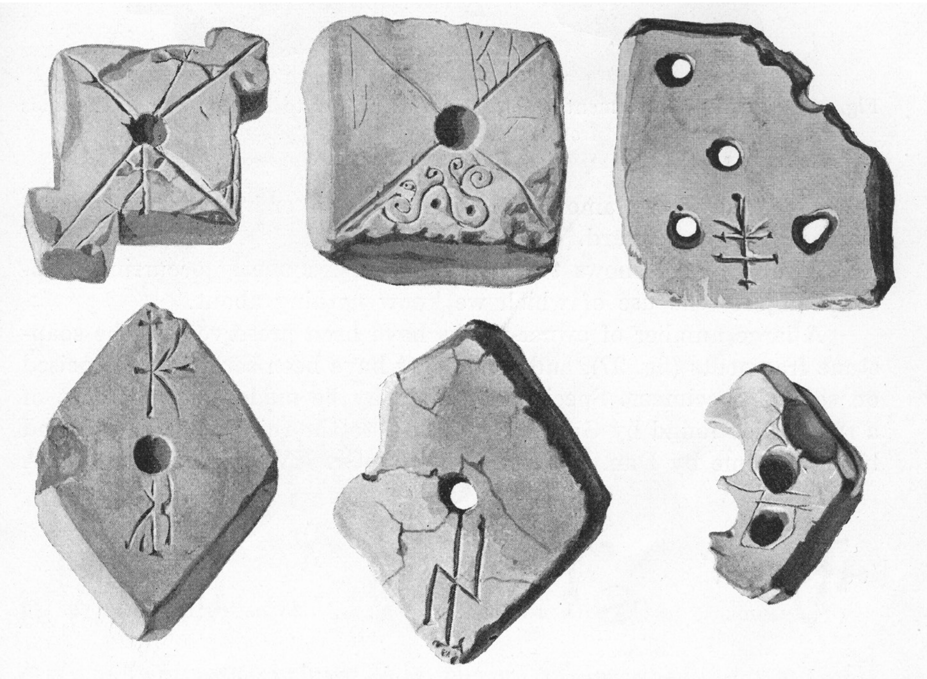


Figure 8. *Unidentified soapstone artefacts from E47/Garðar with various kinds of decoration and/or runic inscriptions. The leftmost slab measures about 6 x 6 cm, the middle one is c. 9 cm along the lengthwise axis and the straight sides of the slab to the right are about 5 cm long. The runic inscription on the slab in the top middle probably reads 'gri', perhaps the male name Grimr. (After Nørlund 1930:159).*

to interpret these artefacts as plates to eat from. 2) Smaller square or rhombic slabs with one or more perforations (Figure 8). One of these slabs has smaller knobs on two of the corners and most of the specimens are decorated in various ways. The majority of these artefacts are from the bishop's seat at E47/Garðar, but one example comes from the Western Settlement farm W51/Sandnes. 3) A group of artefacts of about the same size as the above, only disc shaped, but otherwise also decorated and/or with one or more perforations.

Perhaps many of these artefacts should be interpreted as some sort of weight stones, but the shapes and decorations deviate strongly from the group of simpler loom weights and weight stones; the decoration thus ranges from very simple carved grooves to quite complex motifs. The specimen from Sandnes is decorated with a compass-drawn figure related to the tetragram (known in Scandinavia as the St. Hans's Cross) which in religious contexts is used to symbolize either the name of God or the human nature of Christ (Lexicon des Mittelalters vol. 8:575; Gotfredsen & Frederiksen 2003:57). The context of the artefacts provides no hints to their functions. The specimen from W51/Sandnes was found in the dwelling and the excavator Aage Roussell interpreted it as a loom weight (Roussell 1936:152). We do not know the context of the artefacts from E47/Garðar. Regarding the specimen from W51/Sandnes, it is tempting to see it as a parallel to the consecration crosses of soapstone which can be found in the cathedral Muren in Kirkjubø on the Faroes, although the Faroese examples are considerably larger (Eliasen 1995:23, 25). In this connection, it is important to keep in mind that Sandnes was a large farm with a church. These soapstone slabs and discs appear to be almost unique to Greenland. Apart from the similar soapstone slabs from the Faroes, the only other parallels I have been able to find were uncovered at the Danish Viking Age ring fortress Fyrkat (Roesdahl 1977:69). The specimens from Fyrkat were small perforated discs without decoration, and the functions of these are also unknown.

The other artefact types described in this section, spindle whorls, loom weights/weight stones, mending patches, architectural details and moulds are all found elsewhere in the Scandinavian world and do not reflect anything uniquely Greenlandic. Indeed, the spindle whorls are not only found in shapes, but also in relative quantities that are comparable to e.g. the body of spindle whorls found at Bryggen in Bergen.

Decoration and graffiti

A very interesting aspect of the Greenlandic soapstone that seems to set it apart from contemporary collections elsewhere in the North is the frequency of various types of decoration on soapstone artefacts in Greenland. Here, decoration is meant in the broadest possible sense, including both loosely scratched 'graffiti' (e.g. simple crosses) and more formal decoration (e.g. concentric lines on the body of vessels). Since it has not been employed analytically in the following, I will not enter into a more thorough discussion of this distinction. Incised symbols that may be interpreted as ownership marks are excluded from the present discussion since several of them may in fact be runes (pers. com. Lisbeth Imer). Two-dimensional decoration is found on 377 of the 1168 artefacts studied here. Out of these 259 are vessels and vessel fragments. Finally there is one artefact with decoration that approximates plasticity.

I distinguish between geometric and figurative decoration. (For a similar approach see Fuglesang 1991). As well as 'indefinable decoration' which is clearly intentional, but neither geometrical nor figurative. Geometric decoration can be divided into four sub-groups and figurative into six.

Figure 9. *Distribution of decoration on artefact types.*

Geometric decoration	**Type 1**	**Type 2**	**Type 3**	**Type 4**
Vessels	209	19	20	3
Spindle whorls	20	20	12	4
Mending patches	-	-	-	-
Moulds	-	-	-	-
Loom weights/weight stones	8	5	26	2
Architectural details	-	-	-	-
Other	-	-	-	-
Unknown function	12	3	7	1

Figurative decoration	**Type 1**	**Type 2**	**Type 3**	**Type 4**	**Type 5**	**Type 6**
Vessel fragments	2	-	5	-	-	1
Spindle whorls	-	-	-	-	-	-
Mending patches	-	-	-	-	-	-
Moulds	1	-	-	-	-	-
Loom weights/weight stones	1	-	-	1	-	-
Architectural details	-	-	-	-	-	-
Other	1	-	-	-	-	-
Unknown function	-	-	-	-	-	-

Two dimensional décor and graffiti

In the recorded material, all four geometric sub-groups are represented as well as four of the figurative (nos. 1, 3, 4 and 6, see below). The remaining two types of figurative decoration (animals and mythological creatures) are known from other Norse Greenlandic farms. The types and frequency of the decoration on the various soapstone artefact types are seen in Figure 9. In the following, I will provide a brief description and some examples of the various types of decoration.

Geometric decoration, type 1: Carved grooves

This decoration represents carved grooves which are usually placed on the top of rims or on the body of soapstone vessels. There may be one or more grooves which run the circumference of the vessel and the grooves may be deep or shallow, narrow or broad (Figure 10). This type of decoration is also seen on the slabs and discs of soapstone mentioned above. On the discs there may be one or more carved grooves. On the slabs there is usually one along the edges of the artefact. This is by far the most strict and formalistic of the decoration types seen on the Greenlandic material and it is also by far the most common. Because of their frequency, one might ask if these carved grooves may have had a function in addition the decorative-. However, I fail to see what function they could have performed. Had the grooves only occurred on the bodies of the vessels, below the rim, they might have accommodated a length of string keeping a piece of animal hide secured to the vessel as a sort of lid. However, this is not the case. The vast majority of the grooves are found on the tops of the rims and as mentioned they appear in all widths, depths and numbers. I am inclined to interpret them as a formalistic type of decoration, perhaps inspired by similar ornamentation on the lids of coopered vessels which is often seen in Scandinavia and also in Greenland (e.g. Fuglesang 1991:186).

Geometric decoration, type 2: Other geometric shapes

This sub-group consists of a variety of different geometric shapes, carved into the soapstone: circles, triangles, squares, rectangles, parallelograms and ovals, even simple straight lines used to create a decorative effect. The latter is especially seen on spindle whorls but is also found on vessels. The sub-group accounts for the finest of the decorated soapstone artefacts. For instance it is seen as finely executed zigzagging lines in low relief carved into the top of vessel rims. It also occurs as bands of parallelograms on the body of vessels or as compass drawn, concentric circles on the body of vessels. On spindle whorls we find carved lines, radiating from the central perforation or as zigzagging lines which create a series of triangles. This type of decoration is also seen on loom weights and weight stones in the shape of ovals, semi-circles and squares. While some of the decoration is roughly made and may be considered as a type of graffiti, other examples are very delicately executed, for instance some of the zigzagging reliefs in the tops of vessel rims. The latter decoration must represent a significant investment of time and as such, it may not come as a surprise that this decoration was only found on the definite high status sites of W51/Sandnes, E29a/Brattahlið and E47/Garðar.

Figure 10. *A large soapstone pot from E47/Garðar with concentric lines on top of the rim and on the body of the vessel. Diameter by the rim c. 50 cm. (After Nørlund 1930:151).*

Geometric decoration, type 3: Symbols

This sub-group is dominated almost completely by crosses, although there are other symbols, e.g. the previously mentioned tetragram. The majority of the recorded crosses are extremely simple, being composed by two crossing straight lines. A few are more carefully made, e.g. a cross inscribed in a circle.

Geometric decoration, type 4: Small circular indentations

This is a very rare sub-group of decoration, consisting of very small indentations into the surface of soapstone artefacts, e.g. on a handle from W51/Sandnes. They were probably made simply with the tip of a knife.

Figurative decoration, type 1: Humans

This sub-group of figurative decoration is found on only five artefacts. Two artefacts have extremely simple 'stick figures' carved in such as way that a perforation of the artefact constitutes the head of the human figure. One piece of soapstone has a slightly more detailed human figure with a hint of facial features (Figure 11). On one of the moulds from Garðar there are small circular human faces. And finally there is a very small fragment of an object from Garðar with a human hand in low relief. The latter must come from a larger piece which unfortunately has never been found.

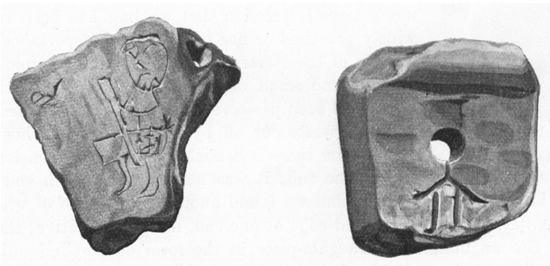


Figure 11. *Soapstone pieces with human figures. The artefacts are c. 6 cm wide. (After Nørlund 1930:161).*

Figure 12. *Slab of soapstone with carvings on both sides, found at E167. On one side there is a depiction of Christ on the cross. The figure of Christ can just be made out. Also note the perforation in the corner which appears to be original. On the other side there is a leaf ornament and a band of diamonds, created by a number of crossing lines. Length of the top rim 6,2 cm. (After Vebæk 1992:77).*

Figurative decoration, type 3: Plants, vines, ribbons and interlacing motifs

This sub-group is the largest in the category of figurative decoration. One example is a rimsherd from E29a/Brattahlið with a very carefully carved rope motif where two ropes weave in and out of each other. Another example is a handle from a soapstone vessel, found at E29, with a ribbon motif. The rope motif from the rimsherd has a very close parallel on a wooden artefact from Oslo (Nørlund & Stenberger 1934:123; Fuglesang 1991:204).

Figurative decoration, type 4: Artefacts

This sub-group is only represented by one artefact from E47/Garðar which, in addition to a human figure, also has a carving which resembles a hammer (Nørlund 1930:161). Any further interpretation, e.g. as a Thor's hammer, should probably be avoided, as the hammer does not have the characteristic shape of the Thor's hammer.

Figurative decoration, type 6: Religious scenes

This sub-group, too, is only represented by one artefact, also from E47/Garðar. It is a very simple Golgotha image, where a carved cross stands on a small hill, set on a straight line which represents the flat ground.

In addition to the 12 recorded items with figurative decoration, there are a further three which were not available for analysis and of which only one has previously been published: A loom weight/weight stone from E29a/Brattahlið with what is definitely a Thor's hammer. The other two are both supposedly from E47/Garðar and are said to carry a plant motif and a bird, respectively. While the number of soapstone artefacts with figurative decoration in the material studied here is very small, various types of figurative decoration do occur on the Greenlandic soapstone judged by my survey of artefact collections from other Norse Greenlandic sites. Still, there is no doubt that various types of geometric decoration dominate. Also, contrary to the geometric decoration, particularly geometric decoration of type 1, many of the figurative decorations give the distinct impression of being graffiti rather than being decoration in the formal understanding of the word. Before discussing the reason for the profusion of decoration on Greenlandic soapstone, a final group of soapstone artefacts must be presented.

Plastic carvings

Although some of the geometric decoration mentioned above was executed in low relief, it was still, essentially, two-dimensional. However, there are a few examples of scenes which are executed in high relief and even one carving which achieve real plasticity.

Only one of the four artefacts presented in the following was available for analysis, the three other objects have been studied using illustrations in publications. The available object stems from E167. It is a fragmented, but probably originally square, slab of soapstone with a carving of the crucifixion on one side. On the other side it carries a leaf decoration as well as a band of crossing lines which create diamond shapes. The artefact is perforated in the one preserved corner as if it was meant for hanging (Figure 12). A second and very similar slab of soapstone was also found at E167 (Vebæk 1992:77). It, too, has a crucifixion scene in high relief on one side and a leaf motif on the other. This specimen is perforated twice, but here the perforations appear to be secondary as one of the holes has been bored straight through the figure of St. John. Both carvings must have been some sort of devotional images, although exactly how they were used and even if they were ever meant to hang, remains an open question. A third enigmatic artefact is a fragmented disc of soapstone from E47/Garðar (Nørlund 1930:161) (Figure 13). It is richly decorated with a deeply carved leaf motif and appears to have been originally perforated in the middle. A presumably secondary perforation has been made in the preserved part of the disc. The use of this artefact is also unknown. Finally, a small, very finely carved bird's head, with a preserved length of c. 5 cm, also found at E47/Garðar, should be mentioned (Nørlund 1930:162). It is clearly broken at the neck and must have come from a larger figure. The bird's head is unique among soapstone from Norse Greenland and even more so because it is a very realistic representation of an actual arctic bird species, the ptarmigan.

Figure 13. *Fragment and reconstruction of a soapstone disc with a deeply and finely carved leaf decoration. The diameter would originally have been c. 18 cm. Found at E47/Garðar. Function unknown. (After Nørlund 1930:161).*

Discussion

Overall, the Greenlandic soapstone presents a somewhat fragmented picture. The majority of the artefacts were vessels, spindle whorls and other types of artefacts which are well known from other parts of the Scandinavian world. The vessel types appear to correspond well to the vessel types known from e.g. Norway, and although one rim shape and one vessel type appears to be unique to Greenland, neither dominated the material in any way. The other well-known artefact types, spindle whorls as well as mending patches, are also shaped just as they were elsewhere. The various discs and slabs of soapstone, many of which were also decorated, do not appear to be frequent outside of Greenland, and their exact function also remains unknown. As such they make the Greenlandic material stand out as something special, compared to soapstone artefacts from other parts of Scandinavia. But they make up less than 7% of the complete body of material and as such we should perhaps be careful not to let their 'strangeness' overshadow the fact that looking at the overall artefact types and shapes, the

Greenlandic material is very well in line with what is known from elsewhere. What really makes the Greenlandic material stand out is the frequency of decoration and graffiti. Just over 32% of the total number of recorded artefacts from the six sites was in some way decorated or carried graffiti.

Some of the figurative decoration should undoubtedly be understood as graffiti, made because of a simple joy of pictures or to pass time. Others probably had a so far unknown function to perform. But no matter how one may look at the figurative decoration, that still leaves the large group of objects with geometric decoration, particularly the carved grooves of type 1, which was intentionally put on the artefacts, particularly vessels, and which was obviously viewed as an appropriate type of decoration for those particular types of artefacts. Even if we only look at the group of vessels with carved grooves, it still represents 27% of the 764 artefacts belonging to the group of vessels. Thus between one fourth and one third of all soapstone vessels were in some way decorated with the formalistic decoration design of type 1.

I have been unable to find numbers for the frequency of decoration on Norwegian soapstone vessels. The same decoration existed in Scandinavia, but the only numbers I have been able to find were for the Hedeby material. Here the same type of decoration appears at a markedly lower frequency; just 10% of the vessels were decorated. So why the large amount of decoration and graffiti on the Greenlandic soapstone compared with the Norwegian material or the Viking Age material from Hedeby?

The focus of my Ph.D. thesis was cultural identity and I focused on this topic in relation to the decorative elements of the Greenlandic soapstone. I also had the advantage of looking at artefact types of other materials than soapstone and to bring those into the discussion. One important thing to note here is the general frequency of both formal decoration and graffiti-like pictures on all sorts of artefacts in Norse Greenland, not just the soapstone. There is simply an abundance of decoration of all sorts and sizes on the Greenlandic artefacts which not only tells us of a people with a basic love of images, but may also reflect aspects of the identity of the Norse Greenlanders. An important point here is that while the frequency of decoration and graffiti may set the Greenlandic material aside as something unique, the motifs are very familiar. The vast majority of motifs could just as easily have been found in a Norwegian town as in Greenland. Frequency of decoration and graffiti aside, the motifs are solidly Scandinavian. And this also goes for the geometric decoration on the soapstone vessels.

My interpretation of the apparent tendency to use known motifs but with a high frequency leads me to suggest that it was employed by the Norse Greenlanders as a part of their identity construction and maintenance. I do not believe that the Norse Greenlanders were trying to establish a special Greenlandic type of identity for themselves through the expression of decoration on their artefacts, but rather the direct opposite. The Norse Greenlanders probably used well known motifs in such profusion exactly because they were well known motifs which stressed continuity with their cultural past. As such, the decoration on the soapstone artefacts may have been used to reinforce their overall Scandinavian identity in that faraway land in the North Atlantic. Such an interpretation fits well with the observation that the majority of overall artefact types and even vessel types correspond to types that were well known in Norway. Soapstone was by far the most common material for household vessels in Norse Greenland. At least in this domain, it does not appear that the Norsemen had any need whatsoever of trying to demonstrate a Greenlandic identity of their own.

Because of the general lack of soapstone artefacts from stratified contexts, it is impossible to say anything about any developments in the choice and prevalence of particular motifs over time. Many of the motifs may already have been known at the time of settlement. Other motifs the Norsemen may have learned through contact with Norwegian merchants or through travels of their own. As such, it is quite likely that the motifs could be used as an indicator of contact with the rest of the Norse world, but in order to work with the Norse Greenlandic soapstone in this way, more artefacts from stratified contexts need to be procured and analysed.

Conclusion

Soapstone objects are the most frequently found group of portable finds on any Norse Greenlandic site. The body of soapstone material is fascinating because the Norse Greenlanders had the raw material in common with their ancestors in Norway. Soapstone artefacts were also in use in the Faroes and in Iceland, although it was imported into both of those lands of the North Atlantic. Indeed, soapstone appears in many ways to have been a 'carrier of culture'. In most ways, the soapstone of Norse Greenland appears to correspond well with soapstone from other parts of the Scandinavian world, both with regards to overall artefact types and specific vessel types and shapes. There are some artefact types, a vessel type and a vessel rim shape which appear to be unique to Greenland, but these special types are very clearly in the minority. The only place the Greenlandic soapstone really stands out is in the very high frequency of decoration and graffiti. While other explanations may be given, I find that it very likely may be linked to the maintenance of an essentially Scandinavian identity on the part of the Norse Greenlanders.

This presentation of the soapstone of Norse Greenland has only scratched the surface of the very large body of material which sits in the Danish National Museum and in the Greenland National Museum and Archives. Much of it comes from unstratified contexts, but still information can be extracted from it, as I hope this paper has demonstrated. For the exact same reasons it is important that more work be carried out on the Greenlandic soapstone and that particular attention be paid to soapstone from future stratified excavations which could allow the creation of an actual soapstone typology. Much more information may be obtained from the Norse Greenlandic soapstone collections than has been gained so far.

References

Appelt, M., Myrup, M., Pasda, C. & Grønnow, B. 2005. *The Soapstone Objects Analyses Report (S.O.A.P.) 2005–2007: Travel and Project – Report 2005.* (Sila Feltrapport 21). Retrieved from: http://natmus.dk/fileadmin/user_upload/natmus/forskning/dokumenter/SILA/Feltrapport_21_SOAP.pdf (accessed January 2015).

Arneborg, J. 1984. De norrøne bebyggelser i Nipaitsoq og Niaquusat: Materiel kultur, udlandsforbindelser, kulturelt særpræg, kronologi og ophør. Unpublished speciale thesis, Aarhus University. Quoted by permission.

Christiansen, D. V. 2004. Fra Europa til Verdens Ende: De grønlandske nordboers kulturelle kontakter over Nordatlanten. *Nationalmuseets Arbejdsmark*: 27–39.

Ekroll, Ø. 1997. *Med kleber og kalk: norsk steinbygging i mellomalderen*. Norske samlaget, Oslo.

Eliasen, K. 1995. 'MÚRURIN' - den middelalderlige domkirke i Kirkjubøur på Færøerne. *Bygningsarkæologiske Studier*: 7–44.

Forster, A. 2004. Shetland and the trade of soapstone goods in the North Atlantic region during the Viking and early Medieval period. Unpublished Ph.D. thesis, University of Bradford. Quoted by permission.

Fuglesang, S. H. 1991. Ornament. In Schia, E. & Molaug, P.B. (eds) *De arkeologiske utgravninger I Gamlebyen, Oslo bind 8: Dagliglivets gjenstander – Del II*, 159–221. Akademisk Forlag, Øvre Ervik.

Gotfredsen, L. & Frederiksen, H. J. 2003. *Troens billeder: Romansk kunst i Danmark*. G.E.C. Gad, Copenhagen.

Gräslund, A. -S. 1992. Thor's hammers, pendant crosses and other amulets. In: Roesdahl, E. & Wilson, D.M. (eds.) *From Viking to Crusader: The Scandinavians and Europe 800–1200*, 190–191. Nordic Council of Ministers, Copenhagen.

Hansen, G. 2005. *Bergen c 800–c 1170: The Emergence of a Town,* The Bryggen Papers: Main Series No. 6. Fagbokforlaget, Bergen.

Høegsberg, M. S. 2007. A reassessment of the development of the cathedral at Garðar, Greenland. *Archaeologia Islandica* 6: 74–96.
Høegsberg, M. S. 2009. Materiel kultur og kulturel identitet i det norrøne Grønland. Unpublished Ph.D. thesis, Aarhus University.
Jónsson, F. 1930. *Rune Inscriptions from Gardar,* Meddelelser om Grønland LXXVI, II. C. A. Reitzel, Copenhagen.
Lexicon des Mittelalters volume 8. 1997. Artemis Verlag, Munich & Zurich.
Lossius, S. M. 1977. *Kleberkarmaterialet fra Borgund, Sunnmøre*. Historisk museum, Universitetet i Bergen, Bergen.
Nørlund, P. 1924. *Buried Norsemen at Herjolfsnes. An archæological and historical study,* Meddelelser om Grønland LXVII. C. A. Reitzel, Copenhagen.
Nørlund, P. 1930. *Norse ruins at Gardar. The Episcopal Seat of Medieval Greenland,* Meddelelser om Grønland LXXVI. C. A. Reitzel, Copenhagen.
Nørlund, P. & Stenberger, M. 1934. *Brattahlid,* Meddelelser om Grønland 88:1. Kommissionen for Videnskabelige Undersøgelser i Grønland, Copenhagen.
Resi, H. G. 1979. *Die Specksteinfunde aus Haithabu,* Berichte über die Ausgrabungen in Haithabu - Bericht 14. Karl Wachholtz, Neumünster.
Roesdahl, E. 1977. *Fyrkat: En jysk vikingeborg II: Oldsagerne og gravpladsen*. Det kongelige nordiske Oldskriftselskab, Copenhagen.
Roussell, Aa. 1936. *Sandnes and the Neighbouring Farms,* Meddelelser om Grønland 88:2. C.A. Reitzel, Copenhagen.
Vebæk, C. L. 1992. *Vatnahverfi: An inland district of the Eastern Settlement in Greenland,* Meddelelser om Grønland - Man & Society 17. Dansk Polarcenter, Copenhagen.
Øye, I. 1988. *Textile equipment and its Working Environment, Bryggen in Bergen c 1150–1500,* The Bryggen Papers, Main Series Vol. 2. Fagbokforlaget, Bergen.

Informant

Lisbeth Imer, Danish National Museum

Amanda Forster and Richard Jones

From Homeland to Home; Using Soapstone to Map Migration and Settlement in the North Atlantic

One of the most characteristic features of Viking material culture is the use of soapstone (steatite) to make vessels, lamps and other artefacts. As soapstone was a readily available material in the Viking homelands, the inclusion of these characteristic objects with items transported by pioneer Norwegian migrants to the North Atlantic is likely. As settlements were established across the North Atlantic region during the Viking period other sources of this stone would have become available, for example in Shetland and Greenland. In this context a central question arises about the identification of those sources during the different phases of the Viking period. This paper presents some of the findings from two independent studies which have combined into a single project, Homeland to home, one concerning the morphology/typology of soapstone artefacts, the other applying analytical techniques to determine the origin of such artefacts. Based particularly on displaced artefacts found at Viking period sites in northern Britain (York to Orkney), Ireland, Faroe and Iceland, the main attributes of seven typological classes have been identified, allowing hypotheses to be proposed about the likely source and chronological floruit of each class. Some of these hypotheses have been tested by ICP-MS analysis (for rare earth elements) and to a lesser extent by portable XRF for semiquantitative analysis of major, minor and trace elements. Results are presented for a number of quarries on Shetland and south east Norway and artefacts from Shetland (Sandwick, Unst), York, Orkney (Quoygrew, Westray), Norway (Kaupang) and the Faroes. For several reasons including the still limited size of the quarry chemical database, positive assignments of origin to individual artefacts remain difficult to propose on the basis of chemical composition. On the other hand, more progress is made in a process of association: identifying groups of artefacts that are likely to have similar origin owing to their similarity of composition and then correlating those groups with their typological membership.

Introduction

Across the North Atlantic region (see Figure 1) archaeologists are acutely aware of the homelands of early Viking settlers who colonised the region from the ninth to the mid-eleventh century. The cultural blueprint of artefacts, building forms and economic base introduced by Viking period migration created a Scandinavian sphere of influence which is striking across the region – from Orkney to Greenland. This paper looks at one aspect of material culture, soapstone (also called steatite) vessels, in order to shed light on the movement of peoples – and their belongings – from the Norwegian homeland and into the North Atlantic. The premise is simple; Norwegian migrants to the North Atlantic region brought with them soapstone vessels, included with their belongings. These imported

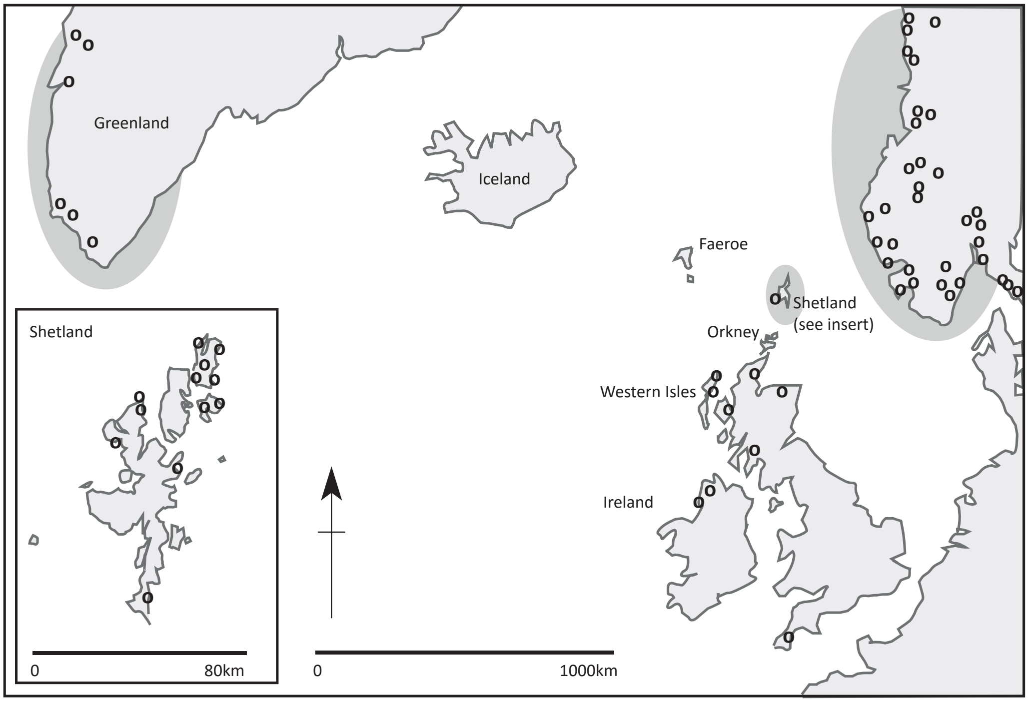


Figure 1. *The North Atlantic region, showing locations of known soapstone outcrops. Shaded areas are regions known to have been utilised during the Viking and Medieval periods; Norway, Shetland and Greenland.*

goods contain clues which have the potential to pinpoint the starting point of pioneer settlers using science-based provenance of the artefacts themselves. In addition, provenance studies can help shed light on the development of these island societies as pioneers settled and subsequently adapted to the opportunities and limitations apparent in their new homes.

The Homeland to home project brings together two independent studies, one on the morphology of North Atlantic soapstone artefacts (Forster 2004a) and the other on the science-based provenance determination of soapstone from Scotland (see Clelland et al. 2009). The breadth of understanding provided from both cultural and scientific study of the material has provided an excellent platform for more in-depth analysis. This paper presents preliminary results of targeted provenance studies of soapstone artefacts and samples from the North Atlantic region against a background of hypothetical origins based on typological classification.

Vikings in the North Atlantic region

During 9th and 10th centuries, the North Atlantic region was transformed from a barrier dividing remote and often uninhabited island groups, to an inland sea within a predominantly Norwegian sphere of interest (Larsen & Stummann Hansen 2001:115). The western expansions of the Norse linked Scandinavian homelands to a wider world, developing a medieval cultural identity across the maritime landscape. This common Norse ancestry diverged as settlers adapted to their new homes, separated by sea and variable access to resources. James Barrett (2012:6) describes the island settlements as insular societies, 'physically removed from centres of consumption yet potentially interconnected by the sea'. Rather than being isolated and marginal, these island societies were embedded within the wider political and economic landscape of northern and western Europe; 'The reality is that the 'chiefly' societies of the north – Orkney, Iceland, the Isle of Man and elsewhere – were interdigitated with contemporary chiefdoms, states and empires…' (Barrett 2012:7).

The nature of those migrations and the development of each island society in the North Atlantic is a study in itself – and not one to rehearse here (see Barrett 2008 for discussion). The provenance of soapstone has an important part to play in researching the nature of that society and how each of those insular societies developed and interacted. In the North Atlantic region, soapstone outcrops can be found in Norway, Shetland and Greenland (see Figure 1). Soapstone artefacts have a wide distribution during the Viking period which correlates with areas of Norse settlement across the region (see Forster 2005:55). Limited availability and wide distribution implies some movement of raw material and/or finished goods, and has often been taken to indicate presence of long-distance trade networks across the North Atlantic (e.g. Crawford 1987:152). However, morphological study of soapstone artefacts concluded that the distribution and nature of *displaced* artefacts (e.g. artefacts which have been transported, Needham 1993:162) suggested a more complex story of migration, adaptation, resource control and contact through the Viking and later Norse periods (Forster 2005; 2009). The authors believed that evidence provided by morphological analysis warranted further investigation, and that a more detailed investigation of provenance of artefacts could provide the level of detail needed to understand the complexities of this medieval commodity.

Typological reference series of soapstone vessels in the North Atlantic

By amalgamating regional type series developed through morphological study, Forster has developed a series of reference sheets for the assessment of displaced soapstone artefacts (Forster 2004a:Figs 5.1, 5.2). The original study (Forster 2004a) highlighted the chronological and regional sensitivity of particular types (not all), enabling some differentiation between the date and possible provenance of artefacts recovered from North Atlantic sites. The types identified remain relevant and, with some minor updates, are presented below (Figures 2, 3 and 4). The broad chronological and geographical sensitivity provides a useful mode of comparing assemblages from across the region. Within the remit of this paper, finds from sites in Greenland have been omitted. Whilst the Norse inhabitants of Greenland did utilise local sources (Arneborg 1984; Forster 2004a:197ff), morphological study highlights a number of distinctive traits which have not been recorded elsewhere. As such, there is no evidence to date of Greenland vessels being exported to other areas (see Forster 2004a for discussion of morphology) and, therefore, the material is not a core part of this phase of the Homeland to home project.

The main aim of the original morphological study was to evaluate displaced soapstone artefacts from the North Atlantic region. The study included finds from Ireland, York, the Western Isles, Caithness, Orkney, Faroe and Iceland (see Forster 2004a; 2004b; 2005; 2009). Research aimed to characterise soapstone assemblages, highlighting the role that source regions played in the manufacture and distribution of soapstone vessels through Viking and Medieval periods. Reference types illustrated here (Figures 2, 3 and 4) highlight vessel morphologies which feature most highly across the region, noting the main characteristics of those types and the assumed provenance region and date. These forms do not provide a comprehensive typological series for each source region, but should be seen as reference types for the North Atlantic. Primary analysis and discussion of typological series for each region can be found in Forster 2004a.

Five vessels types are highlighted as regionally sensitive and two could be manufactured in either source region. *Type 1* (hemispherical circular vessel) is the most common type within Scandinavia

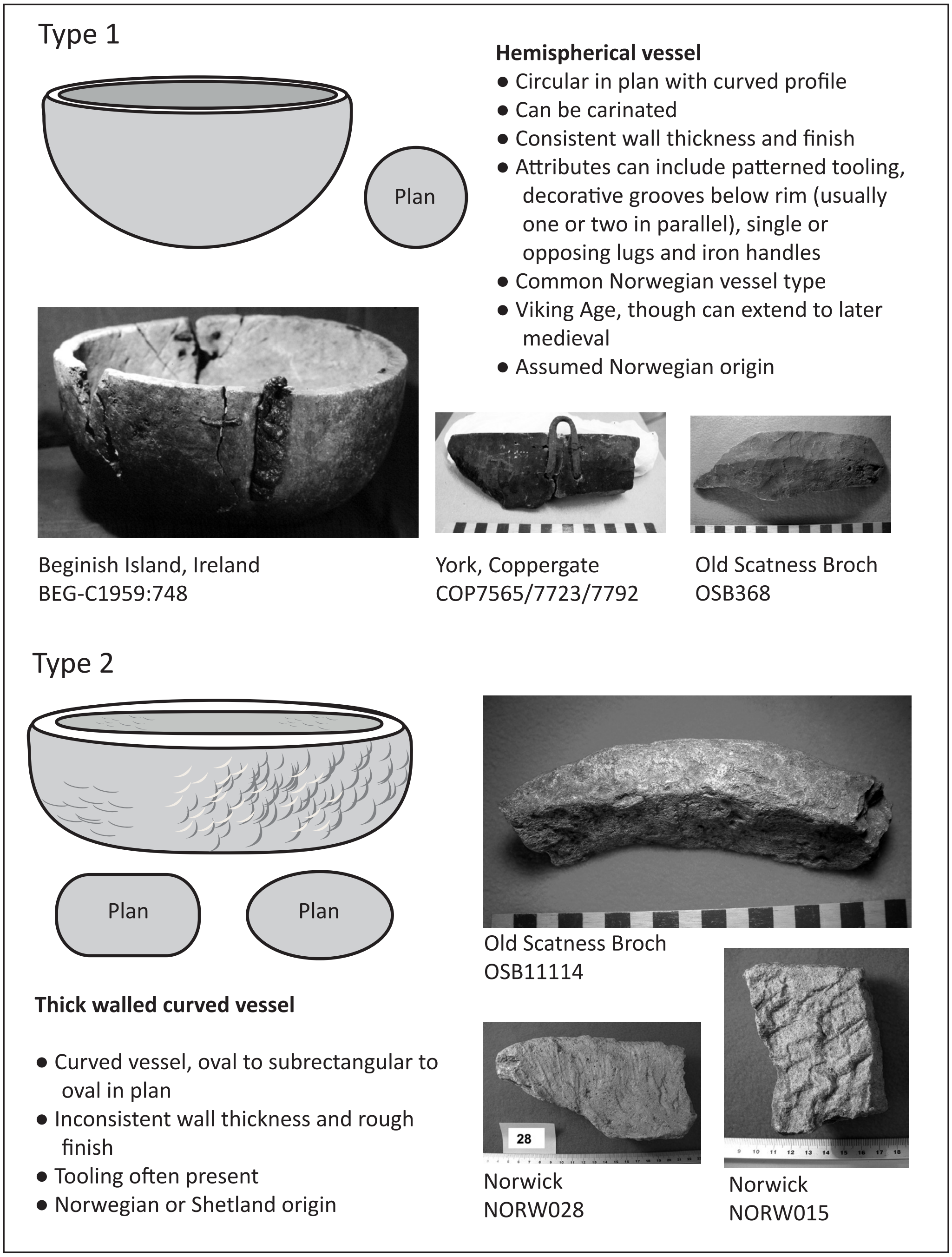


Figure 2. *Reference sheet for soapstone vessels of the North Atlantic region; Types 1 and 2 © Forster.*

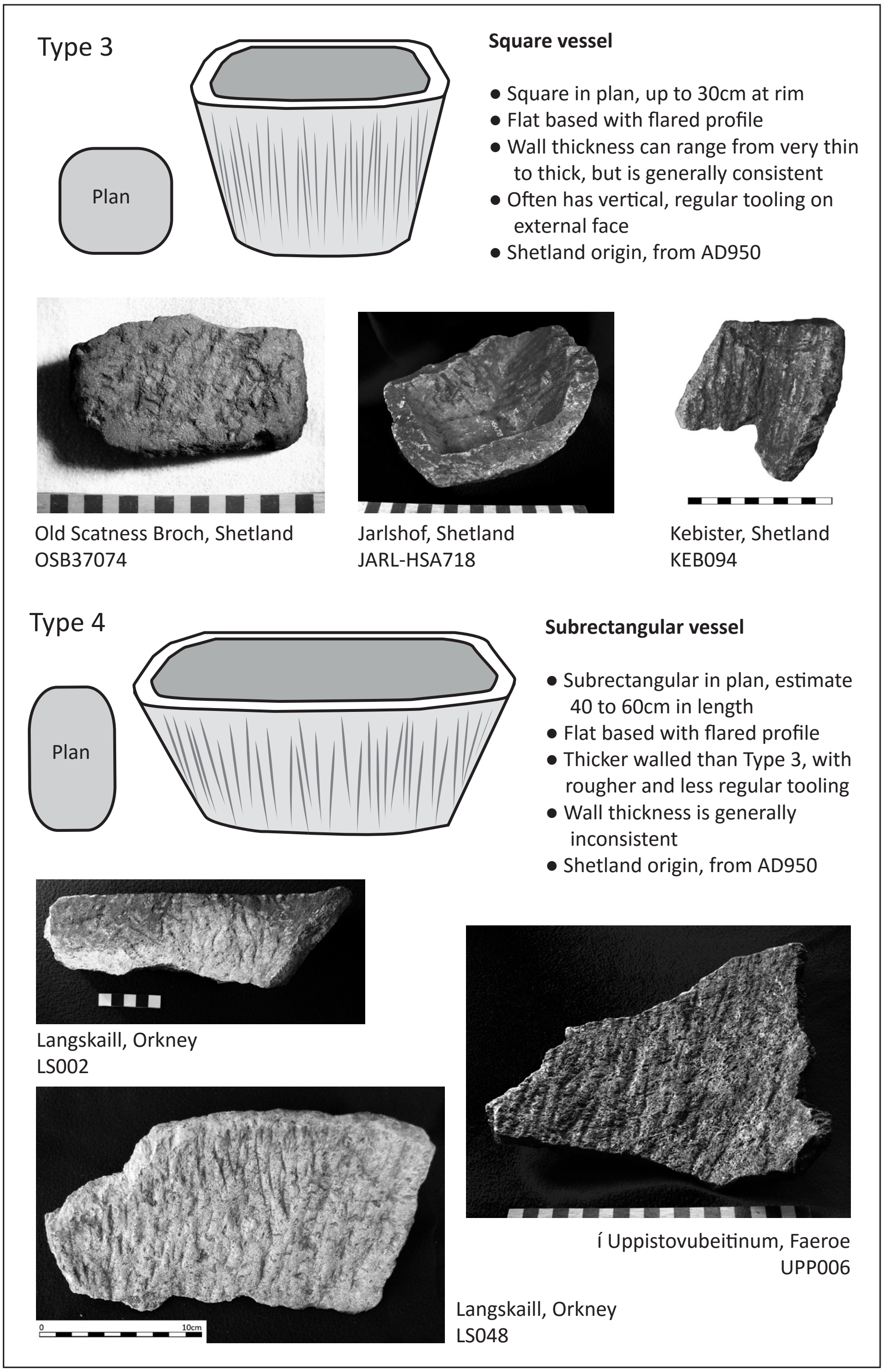


Figure 3. *Reference sheet for soapstone vessels of the North Atlantic region; Types 3 and 4 © Forster.*

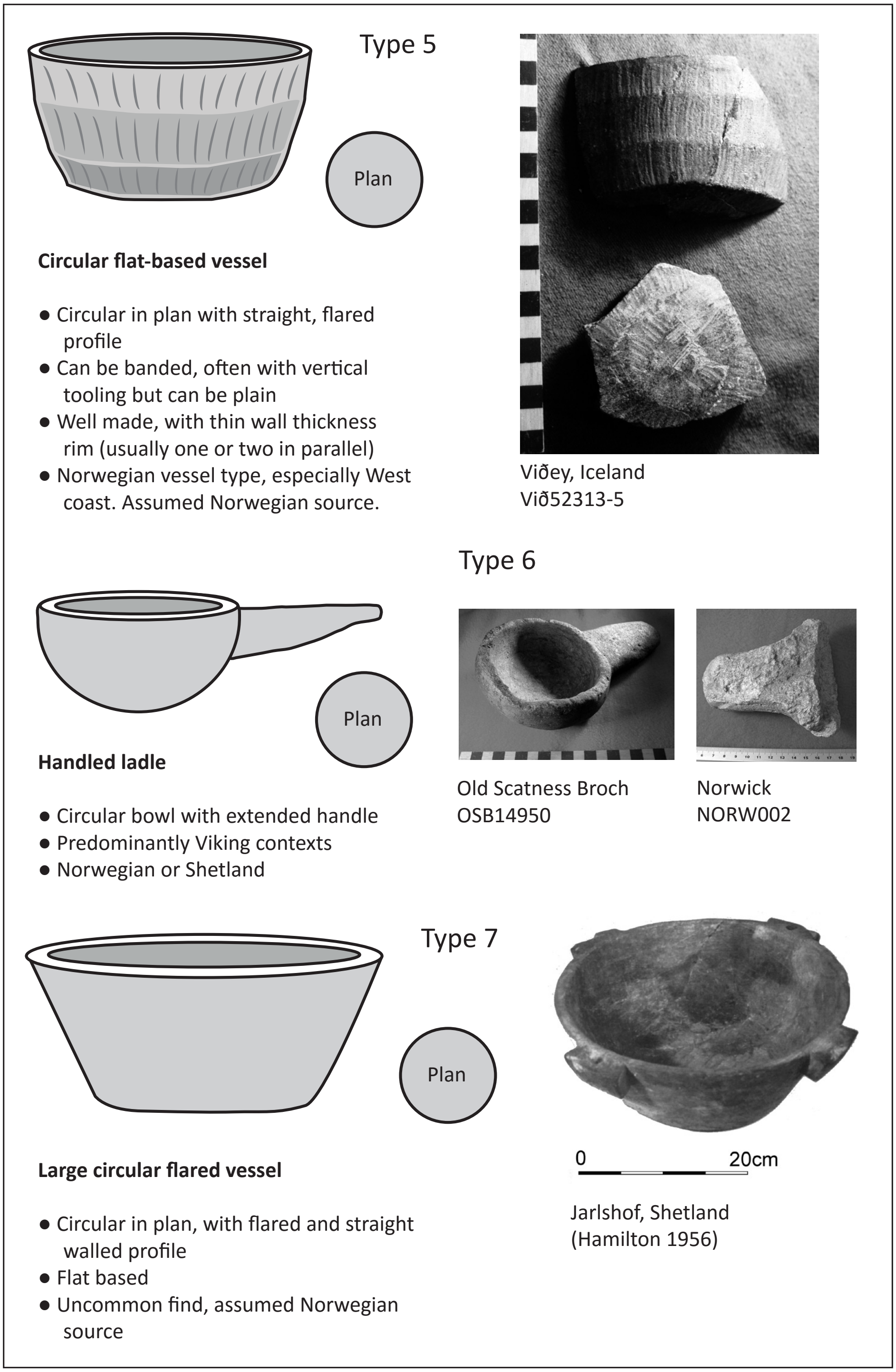


Figure 4. *Reference sheet for soapstone vessels of the North Atlantic region; Types 5, 6 and 7 © Forster.*

and provides a standard morphology to which a number of attributes can be added. Within the North Atlantic region, Type 1 vessels have been recorded at sites in every area (for examples see Old Scatness, Shetland, Forster 2010:258; Pool, Orkney, Smith and Forster 2007:412). The common factor is quality; a consistent wall thickness, reasonably symmetric shape and curved profile. *Type 2* is a less accomplished curved vessel, with thicker walls, a flatter base and rougher finish. This vessel is not strongly recognisable as either Norwegian or Shetland in origin, although in Shetland it may be a stepping stone towards a more developed morphological type (see Forster 2009:67).

The large assemblage recovered from the Viking age settlement at Norwick (Shetland) provides an insight into early Viking period use of Shetland soapstone, where a number of Type 2 vessels are recorded (Forster 2006). Rather than being the aim of the maker, Type 2 vessels could represent early attempts to recreate Norwegian Type 1 vessels which failed when using Shetland stone. This may result from a lack of experience; skilled artisans familiar with producing soapstone vessels may not have been among those who settled in that area, or perhaps local inhabitants emulating exotic Norse imported vessels were simply not skilled in working soapstone in this way. It is interesting to note that early prehistoric vessels from Shetland are also subrectangular in form and are striking in their similarity to those which developed centuries later in the Viking period (see Forster and Sharman 2009). There is no obvious explanation for this, although it seems unlikely to be the result of a coincidence. The relict quarry faces and spoil tips of Shetland's prehistoric workings would have been visible to those producing vessels in the Viking and Norse periods – and perhaps those then ancient workings simply provided inspiration. Another possibility is that soapstone sources differ in their working qualities according to the geological environment at each source, and that those in Shetland may more easily be worked into square and rectangular vessel forms, e.g. *Types 3* and *4*. Perhaps some experimental production of soapstone vessels could shed some light on the puzzle.

Types 5, 6 and *7* are less common, but are distinctive and have been included as types for that reason. *Type 5* is the most regionally sensitive. Various styles of flat-based circular vessel are widely found in Norway, but it is the banded form which is most apparent in the North Atlantic region. This type has been recorded at a small number of sites in Iceland (Viðey and Storaborg, Forster 2004b) which date to the later Medieval period and appear to demonstrate a strong link with west Norway and possibly Bergen. *Type 6* has a wider distribution and appears to be a feature of Viking period assemblages. The type has been recorded in Orkney, Shetland, Faroe and Iceland, but has not been strongly linked to a specific source region. Finally, *Type 7* is a larger vessel type which is circular in plan and has straight, flared walls. This is not a common type and is represented by only a handful of single examples in Orkney (Quoygrew 61989, Batey et al.:215) and Shetland (Jarlshof, Hamilton 1956; and possibly The Biggings 1503a; Smith 1999:133) from Medieval period sites. It is assumed to be a Norwegian vessel type, mainly due to its rarity within Shetland assemblages.

Mapping morphologies; interpreting distribution maps

Using the reference types outlined above, assemblages recovered from sites across the region can be compared as a group. This has allowed more informed interpretation of the distribution of soapstone vessels, and consideration of the mechanisms behind those distribution maps. In addition, comparison has highlighted the main questions which can be addressed with targeted science-based analysis.

AD 800–950: Landnám phase, original imports

The displaced soapstone artefacts of the North Atlantic region from the Landnám phase can be interpreted largely as original imports, based on their types (Stummann Hansen 1991:51). Stummann

Hansen used the term original imports to refer to materials introduced by the pioneering Norwegian settlers to Faroe, rather than being goods imported as items of trade. Large numbers of well-preserved Type 1 vessels were recorded at Toftanes (Faroe), Pool (Orkney), Old Scatness (Shetland), Jarlshof (Shetland) and, to a lesser extent, Reykjavík (Suðurgata 3–5, Iceland). Vessel fragments tended to be of medium to large size (e.g. at Old Scatness the average weight of 112 vessel fragments was 190 g), with a reasonable level of conservation and repair where vessels had broken. Re-working of larger fragments for the manufacture of small portable objects such as whorls and weights is common. The discard of numerous large fragments (e.g. over 100 g in weight) is taken to be an indication that artefacts were relatively common and could be replaced when broken beyond reasonable repair.

Vessels are mostly of Type 1, believed to be of Norwegian origin, although morphologies are diverse within individual sites, contrasting with the uniform assemblages recorded at contemporary proto-urban Scandinavian sites such as Kaupang (Baug 2011:313) and Hedeby (Resi 1979). This diversity has been interpreted as indicating domestic-level manufacture (e.g. uniformity of vessel form indicating more organised production), the variation resulting from occasional production by individuals when needed. The existence of both forms of production in Norway has previously been suggested by Skjølsvold (1961:155)

A different type of assemblage is found at York and Dublin; soapstone objects have been interpreted as possessions but representing individuals rather than groups. Vessels are exclusively Type 1, believed to be of Norwegian origin. Scandinavians resident in York and Dublin are likely to have been traders and craftsmen, and the few soapstone vessels and moulds recovered probably represent the personal possessions of individuals. Richards (2000:67) questioned the number of Scandinavians actually resident at York, and the level of migration and intensity of Scandinavians settling was certainly greater in Scotland than in England (Barrett 2003:82). Although this paper is concerned with vessels, it is worth mentioning one find from York, a four-sided bar mould, which is undoubtedly part of a toolkit. Such a find indicates craft specialisation consistent with the proto-urban nature of Viking York, an interpretation reiterated by presence of a similar find at Hedeby (Resi 1979:58), and a possible example from Kaupang (Baug 2011:329). Only one mould of this type has been recovered from the Northern Isles, and it seems no coincidence that this example was recovered from Brough of Birsay (Curle 1982:SF577, Ill 28:45), a site considered to be a high status settlement (see Crawford 2005 for discussion of Birsay's relationship with the Orkney Earldom).

The origin of soapstone goods across the North Atlantic region during this phase is almost exclusively believed to be Norwegian, although utilisation of local sources appears within the Norwick assemblage (see Type 2 above). The distribution of soapstone finds recovered from the landnám phase strongly reflects areas of Norwegian settlement during the 9th century AD. The dominance of Type 1 vessel forms suggest that, despite use of sources within Shetland, the majority of finds across the North Atlantic region are imported from Norway, probably transported by settlers. A key question that is considered in the next section is whether science-based techniques of analysis can identify the sources of those assumed Norwegian artefacts found abroad. The premise that these imports derive from the belongings of settlers (rather than from a trade in goods) implies that the identification of their sources could pinpoint the regions within Norway or neighbouring regions from which pioneer settlers started their journey. This pivots on the assumption that Type 1 vessels are indeed a Norwegian import.

A broad-based approach to the analysis of samples has been taken, targeting Type 1 examples from across the region and including material from York. In addition, the analysis of material from sites such as Norwick, where Type 2 vessels have been identified as early Shetland examples, will provide some understanding of the development of the Shetland vessel types. Source material from

Shetland quarries and early prehistoric sites in the Northern Isles will provide further refinement of the identification of Shetland quarries, building on previous analytical work (see below). The examination of both archaeological and geological samples from Norway is necessary to provide comparison to material from Shetland.

AD 950–1200: Utilising local resources and developing an industry

This phase of soapstone use is characterised by the adaptation of Norse communities throughout the North Atlantic region to the local environment. Use of soapstone throughout the region is variable and determined by local access to materials. Soapstone goods are no longer assumed to be transported from Norway in large numbers as original imports, and in areas devoid of local sources vessels are few and preservation is very poor due to the degree of secondary working. In extreme cases, extensive re-working results in the preservation of only very small flakes, such as at Sveigakot, Iceland (Forster 2004b) and í Søltuvík, Faroe (see Forster 2004a). Low numbers of fragmented soapstone are an indication that access to replacement vessels was limited. Although reworking of material is recorded in all areas, regions where soapstone is accessible consistently discard larger and more numerous vessel fragments.

The proximity of Orkney to Shetland meant that vessels continued to be accessible despite no local source being present on the Orkney Islands. High numbers of Type 3 and 4 vessels are clearly seen at Pool from the mid-10th century onwards, suggesting Shetland goods were attainable and provided an accessible replacement for diminishing original imports (Smith & Forster 2007:412). Examples of Shetland vessels are noted at Brough of Birsay (see SF5000, 5001 and 5027, Hunter 1986) and Quoygrew (Batey et al. 2012:214), where material was used to a similar extent as in Shetland. The uniformity and wide distribution of Shetland types suggest some level of resource control and perhaps provides the first suggestion of an organised Shetland soapstone industry. Evidence from Faroe and the Western Isles suggests that a limited number of soapstone Type 4 vessels were imported from Shetland (Forster 2009:67).

Within Shetland and Orkney, imported soapstone vessels believed to be of Norwegian origin are present in low numbers, certainly by comparison with vessels thought to be produced in Shetland (see Forster 2005). Such low numbers could indicate that Norwegian vessels were not transported in great numbers to the North Atlantic islands, resulting in occasional examples such as the Type 7 vessels recorded at Jarlshof and Quoygrew. In Iceland, the numbers of soapstone artefacts remain extremely low (with the exception of Viðey) and are exclusively assumed to be Norwegian. Finds from Viðey are comparatively numerous and well preserved, and include both Type 1 and Type 6 vessels. The objects are of high quality, adorned with copper alloy accoutrements, decorative tooling or of exceptional size. The number and quality of the soapstone goods must reflect the high status of this monastic site (Hallgrímsdóttir 1989).

Science-based analysis for this phase aims to shed light on the development of the Shetland industry, with analysis of well-dated archaeological samples from Orkney. Analysis of archaeological samples from Shetland from recently excavated sites aims to identify the source quarry for a possible organised industry by including archaeological and geological samples from quarry sites. In addition, a key question for this phase is the export of Shetland goods beyond the Northern Isles. Archaeological examples from Faroe and the Western Isles will be analysed, and samples thought to be from Shetland will be targeted alongside assumed Norwegian examples.

Science-based analysis of North Atlantic soapstone vessels

The previous section has explained the desirability of acquiring objective information on the sources of Viking soapstone artefacts and has set out the broad sampling strategy of the Homeland to home project. This information derived from science-based analysis is now accumulating for those regions of the Viking world where soapstone occurs naturally (Bray et al. 2009:Fig. 2.1), for example Norway (several papers in this volume), northern Britain and Greenland (Appelt et al. 2005). In the case of Norway Storemyr and Heldal (2002) have outlined the geological basis of the main soapstone outcrops on the one hand in the Trondheim and Gudbrandsdalen areas and between Bergen and Stavanger, all of which belong to Caledonian formations, and on the other in the Precambrian deposits lying east and south east of Oslo (Storemyr & Heldal 2002:Fig. 1); notable is the variety of geological settings of all these deposits (Storemyr & Heldal 2002:Fig. 2). Of the Viking Age quarries, Storemyr and Heldal (2002:365–6) describe the serpentinite and soapstone deposit at Slipsteinberget.

Regarding the sources in northern Britain, those in Shetland have received the most attention (Forster & Turner 2009). The outcrops of soapstone and talc have been well documented geologically, initially by Wilson and Phemister (1946), and in a broader context by Mykura (1976). Bray et al. (2009) have provided a convenient overview of this topic as well as valuable field descriptions of 23 sources on the Islands. Some of the archaeologically relevant sources (which are illustrated in several contributing chapters in Forster and Turner (2009) have been characterised in terms of elemental, mineralogical, magnetic and isotopic composition, as reported by Clelland et al. (2009). These authors implicitly emphasise that the complex nature of soapstone demands a multi-technique approach for provenance determination, a view that features strongly in Ritchie's (1984:77–82) review of early characterisation work on material from Norway and Shetland. While endorsing the desirability of applying such an approach, the present report is based on the *elemental* characterisation, more specifically the determination of soapstone's rare earth element (REE) composition by ICP-MS, coupled in a more limited, exploratory manner of the major (Fe, Mg), minor (K, Ti, Ca) and trace (Cr, Mn, Sc, V) element contents with portable XRF (X-ray fluorescence spectrometry, abbreviated here pXRF). This is the same technique that Smith et al. (2013) used to establish that a jasper fire-starter found at L'Anse aux Meadows was neither Icelandic nor Greenlandic; that it was tentatively linked to Newfoundland's Notre Dame Bay area is interesting for the fact that another jasper fire-starter from the same site analysed by INAA was linked to a source on Greenland (Smith 2000). Analysis by pXRF of the major, minor and trace elements, which proved useful in Magee et al.'s (2005) study of Arabian softstone, has the additional benefit of providing a rapid assessment of the relative heterogeneity of the archaeological/geological soapstone's composition.

The purpose of this section is to consider some of the results of analysis of soapstone carried out over the last ten years and more recently as part of the on-going Homeland to home project. This enables us to assess the extent to which these results can indeed shed light on the archaeological questions that were posed in the previous section. An essential methodological element of the project has been to consider *concurrently* geological soapstone, worked soapstone found at sources as well as soapstone artefacts. Furthermore, as indicated in Figure 5, the project's sampling strategy has deliberately been broad-based geographically. On the one hand, there are assemblages comprising more than ten samples at individual archaeological sites, such as Bayanne, Sandwick and Fetlar on Shetland, and with relevant quarry material, for example at Kaupang. On the other, more recent selection has been more targeted to include, on the basis of morphology and/or fabric appearance, likely imports from Shetland as well as Norway; examples here are York, Quoygrew and Faroe. Raw data that has not previously been published appears in Appendix, Tables 1 and 2. The pXRF data set is as yet incomplete as analyses are still in progress.

Methods

The REE analyses were carried out by inductively-coupled plasma-mass spectrometry (ICP-MS) at the Scottish Universities Environmental Research Centre, East Kilbride, using Varian VG PQ II quadrupole and more recently Agilent 7500ce instruments. Jones et al. (2007) describe the sampling of geological material, the analytical procedure and the method of acid dissolution in HF and aqua regia. For artefacts, sampling usually involved drilling into the wall of the artefacts with an electric drill with a 2.5 mm diameter head; up to 1 g of powder was collected from four holes drilled into the cross-sectional wall of artefacts, having discarded any surface residue or weathering. In the case of large artefacts it was often possible to drill in well separated locations to provide a larger, more representative sample, and in a few cases two separate samples were taken, one by drilling, the other by crushing a small cleaned fragment to powder in an agate mortar. The latter method was used more frequently on geological soapstone: fragments were crushed in a mortar to *c*. 50µm, yielding

Figure 5. *Soapstone analysed by ICP-MS (and pXRF).*

Reference material	Number of samples	Publication
Shetland: Cunningsburgh/Catpund Shetland: Catpund	12 10	Jones et al. 2007 This volume
Shetland: Clibberswick	8	Jones et al. 2007
Shetland: Fethaland (Cleberswick)	10	Jones et al. 2007
Shetland: Dammins, Clemmil Geo (Houbie) on Fetlar	10	Unpublished; Bray 1994
Norway, Oslofjord region: Solerudberget and Fluetjern (Østfold), Piggåsen and Folvelseter (Akershus)	5 from each quarry	Baug 2011:330 (see also http://www.ngu.no/en-gb/hm/Resources/prospecting/)
Norway: numerous locations including Slipsteinsberget (Nord-Trøndelag)	1 from each quarry	Baug 2011:330; Batey et al. 2012:209–10. For Slipsteinsberget see Storemyr & Heldal 2002:365–366
Archaeological material found on Shetland		
Bayanne, Yell	18 early prehistoric artefacts (all vessel fragments) and three unworked pieces	See text; Forster & Sharman 2009; Forster & Jones 2014
Sandwick, Unst	15 prehistoric artefacts and miscellaneous material	See text; Jones 2009
Houbie and Giant's Grave, Fetlar, (http://www.fetlar.com/time_team_index.htm)	13 Viking period artefacts	Jones internal report 2007a
Archaeological material found elsewhere		
Quoygrew, Orkney	31 Viking and Norse period artefacts	See text; Batey et al. 2012
York, Coppergate	7 Viking period artefacts	See text; Jones 2007b
Faroe Islands: Inni á Tvørgarði, Toftanes, Uppistovubeitið	6 Viking period artefacts	See text
Kaupang, Norway	24 Viking period artefacts	See text; Baug 2011:329–31; Jones et al. 2006

up to 2 g and 10 g artefact and geological samples respectively) of homogenised powder. Having obtained the concentrations (in ppm) of fourteen REE, their *pattern* and *concentration range* of the data in chondrite-normalised form offer the best means of visual examination. This may sometimes be followed with bivariate plots of elements (chondrite-corrected, normalised to La) and multivariate treatment with principal components and discriminant analyses (Batey et al. 2012:Figs. 12.2–12.4).

For analysis of the major, minor and trace elements by non-destructive pXRF, a portable Thermo-Scientific Niton XL3t energy-dispersive instrument with a 50 kV silver X-ray tube and a Geometrically Optimized Large Drift Detector pXRF analysis was employed. The nature of the surface selected for analysis required attention. Experiments on geological soapstone showed significant variation in certain element contents according to the nature of the surface: naturally flat, sawn, and sawn and polished. But because the preparation of a fresh surface on *artefacts* with a cutting saw was not normally permissible it was decided to analyse surfaces of both geological and artefactual soapstone that were naturally as flat as possible: we exploited the often smooth laminated surface in the former and the interior surface or flat rim top of vessels. Weathered or carbonised material was removed, where necessary, prior to analysis. The artefact or fragment was placed on a stand allowing reasonably constant distance and geometry between the X-ray beam and the selected location on the fragment. At least three locations on each artefact or fragment were analysed, the count time of each analysis being 75 seconds and the analysis area *c.* 10 mm^2. The instrument's calibration algorithms TestallGeo and Mining were employed. No great claims of accuracy can be made: most element determinations of USGS BCR, DNC, AGV and GSP (powdered) standards were found to be up to 20% lower than the certified compositions, and for chromium at low concentration (<200 ppm) the discrepancy was much larger. Since the analysis was of a surface rather than a bulk sample, the element determinations should be regarded as *semi-quantitative*. Of the approximately twenty detectable elements, the concentrations of nine – Fe, Mg, Ca, K, Mn, Ti, Ni, Cr and V – were retained for processing and presented as element to Mg ratios.

Results

Quarries

The geological environment and hand specimen description of the soapstone at the main quarry sources on *Shetland* are set out in Figure 6. The inter-quarry distinctions can be made from the respective elemental, magnetic, isotopic and mineralogical compositions appear to be limited and yet they reflect the contrasting tectonic environments given in Figure 6 (Clelland et al. 2009:113). Thus, as discussed further below, the REE compositions at Cunningsburgh (including the Viking quarry at Catpund located at the southern end of the Cunningsburgh outcrop (Turner et al. 2009), can be differentiated from those at Fethaland (previously called Cleberswick), but only with difficulty from those at Clibberswick. In terms of mass specific magnetic susceptibility there are two distinct groups separating Fethaland and Clibberswick from Houbie and Cunningsburgh. The strontium isotope ratios – $^{87}Sr/^{86}Sr$ – are lower in samples from the Ophiolite zone than in those from the Dalradian zone; Shetland Basement samples have the highest values (Jones et al. 2007:Tab. 6). While talc and magnesite are the dominant minerals in soapstone from Cunningsburgh and Clibberswick, talc and Mg-hornblende are present in soapstone from Fethaland. But encouraging though this picture may appear at a general level, there are two observations which, confirming previous views, have marked implications for provenance determination purposes: no single technique can decisively discriminate between these sources, a situation that would worsen as further sources on Shetland are introduced, and intra-source variation in composition is significant at several quarries.

Both these observations are relevant to the present purpose of reviewing the currently available REE patterns at four quarries – Catpund-Cunningsburgh, Fethaland, Dammins and a neighbouring quarry on Fetlar, and Clibberswick (Unst) – expressed in Figure 7a as indicative ranges. Fethaland stands well apart in terms of shape; the Clibberswick ranges are narrow but are encompassed by those on Fetlar and are very close to those at Catpund. The corresponding pXRF-derived data, albeit incomplete but including new samples of worked soapstone from excavations at Catpund (Turner et al. 2009), reveals that the ranges in several elements overlap at the three quarries considered, however it is encouraging to find relatively narrow ranges in most elements at Catpund. Here the Fe, Ni and Mn ranges are higher than at Clibberswick. At Fethaland, the Ca range is notably higher than elsewhere but the Cr range is wide (Figure 7b).

Turning to the corresponding situation in *Scandinavia*, the chemical and other characterisations of soapstone quarries are still in progress (see papers in this volume) and for present purposes a comparison is made of ICP-MS and pXRF compositions of soapstone sources/quarries in Norway of Viking age relevance: Slipsteinsberget (Nord-Trøndelag) in central Norway and four quarries in the south east of the country which Baug (2011:330–31; Fig. 12.20) has argued were probably known to the settlement at Kaupang; they are Pigåssen and Folvelseter in Akerhus County and Solerudberget and Fluetjern in Østfold County (Figure 5). Inspection of Figure 8a, b indicates that, although there are wide *intra*-quarry ranges of Ca and K, Folvelseter stands apart from the others with respect to those two elements; Solerudberget seems to differ in Mn and Slipsteinsberget perhaps in Ti. In terms of REE composition (Figure 8c), the quarries of SE Norway are rather similar to each other and at the same time offer resemblance with the range found among the vessels found at Kaupang which this author proposed formed a single composition group (Baug 2011:Tab. 12.11, Group 1). Other artefacts at Kaupang such as spindle whorls, loomweights and sinkers were found to have patterns different from that of the vessels; for example, a tuyere at Kaupang – F1025599 – shows a measure of similarity with Slipsteinsberget (Figure 8d). This finding is unexpected since Baug (2011:334) has proposed that such artefacts – classed as secondary products – were probably derived from vessels, representing primary production, which had broken.

It is encouraging to find that the SE Norwegian quarries offer an indication of differentiation from Clibberswick and Fethaland in terms of both REE pattern and higher concentration ranges

Figure 6. *Geological environment of the main steatite quarries on Shetland, including hand specimen description (Bray et al. 2009).*

Quarry	Geological environment	Hand specimen description
Catpund-Cunningsburgh	Dalradian (*metamorphosed marine sediments of late Precambrian age*)	Much variation, but coarse grained >2 mm, weathering brownish yellow and containing large cream-coloured carbonates
Fethaland	Shetland basement (*acid banded orthogneiss with accessory hornblende/ banded schistose hornblende gneiss*)	Dark grey and fine grained, made up of talc with few grains of carbonate
Fetlar (Dammins)	Ophiolite (*peridotite, dunite, pyroxenite, gabbro, sheeted dyke complex, basic metavolcanics*)	Coarse, platy, grey green talc surrounded by pale brown carbonates in patches and clusters
Clibberswick, Unst	Ophiolite	Cream to pale greenish grey, fairly homogeneous; equigranular; 0.5 mm grains of carbonate surrounded by finer talc with small opaques.

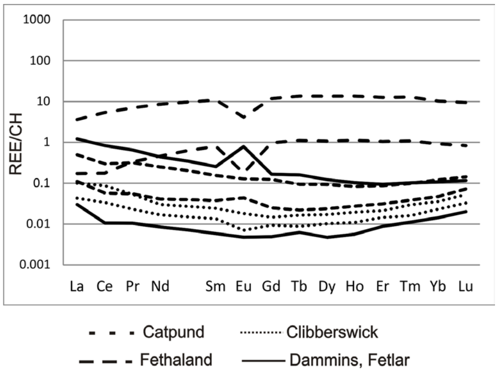


Figure 7a. *Ranges of REE patterns at Shetland quarries; Catpund (Jones et al. 2007 samples), Clibberswick, Fethaland and Dammins Fetlar.*

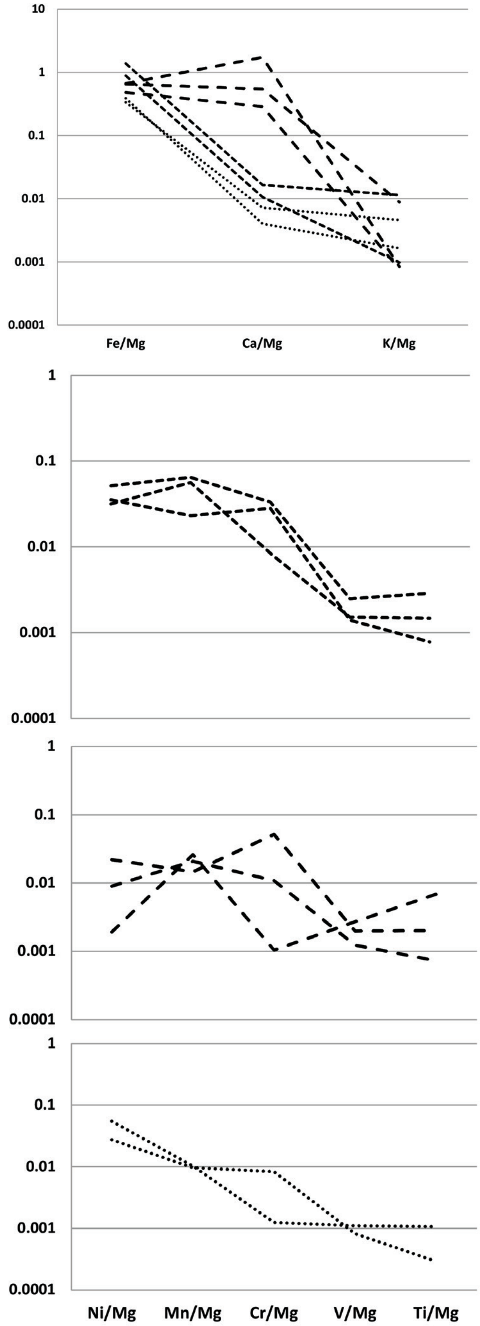


Fig. 7b. *Indicative ranges of element patterns at Shetland quarries: (top) Fe/Mg, Ca/Mg, K/Mg ratios and (bottom) trace element/Mg ratios at Catpund (new samples), Clibberswick and, Fethaland. Same site symbol style as in Figure 7a; pXRF data.*

than on Shetland; Catpund and Fetlar also have lower concentration ranges but their REE patterns seem to be less significantly different. However, this picture, presently based on limited results, may become more complex as the database expands. Anticipating the findings obtained below on artefacts, it looks likely that positive assignments of origin will remain very difficult to make, although it should be possible to exclude sources. Working with associations rather than assignments of origin is a sensible way forward, thus artefacts having similar compositions may be regarded as having a similar origin. On the methodological front, current evidence suggests that intra-source and, for large artefacts, even intra-artefact variation in composition is significantly more marked than variation introduced through vessel use or burial conditions.

Artefacts

The soapstone artefacts found within prehistoric deposits at Bayanne and Sandwick, and Viking period phases at Fetlar on Shetland were analysed on the premise that the majority of artefacts at each site would represent exploitation of local source(s). Analysis confirmed this; in all three cases, although the concentration ranges were wide, the REE patterns with few exceptions conformed to those represented at Clibberswick, Fetlar and even Cunningsburgh as demonstrated for Sandwick (Figure 9; cf. Figure 7a). The exceptions were interesting as they often combined a marked Eu anomaly (which need have no significance in terms of origin) with an atypical appearance in hand specimen. For example at Sandwick 2322, notwithstanding its Eu anomaly, may be regarded as different from the rest owing to the combination of its REE pattern (Figure 9) and atypical macroscopic appearance.

For the seven vessel fragments from Coppergate site at York there are the results of macroscopic examination (by G.D. Gaunt in Mainman & Rogers 2000:2541, 2547*)* which pointed to a strong connection with the Dalradian Supergroup in Shetland for all but 7256 (Type 1) and 15699 (Type 1) (see Figures 2–4). But the REE analyses (Figure 10) seem to indicate otherwise: 9682 (Type 1) stands well outside the Shetland concentration ranges. The pattern of 15699 (Type 1) is notable for its higher concentrations of the heavy REEs, a feature which is found, but to a significantly lesser extent, at Fetlar on Shetland. That leaves 7256 (Type 1), 9689 (Type 2), 9672 (Type 2), 9692 (Type 1) and 9677 (Type 1) which all share a similar pattern; on the grounds of both pattern and concentration ranges they show more resemblance with the vessels found at Kaupang (Figure 8d) than any of the Shetland quarries. The two separate samples taken from 9672 have gratifyingly similar compositions, but less so in the case of 9677.

In the writer's classification (in Batey et al. 2012) of the data for 31 subrectangular, hemispherical and uncertain vessel forms at Quoygrew, a large group of artefacts was found to have compositions that were an order of magnitude lower in concentration than those of a group of four vessels. In

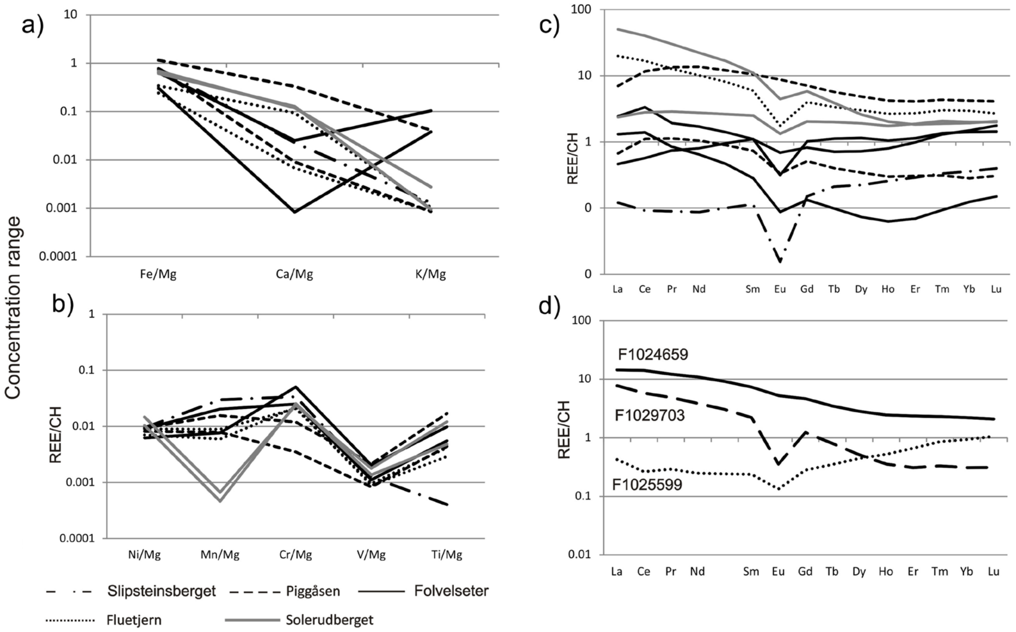


Figure 8. *(a) Fe/Mg, Ca/Mg and K /Mg ratios and (b) trace element/Mg ratios at quarries in SE Norway (Piggåsen, Folvelseter, Fluetjern and Solerudberget) and at Slipsteinsberget (Nord-Trøndelag); pXRF data. (c) The corresponding REE patterns and (d) the range of REE patterns among soapstone vessels at Kaupang represented by F1024659 and F1029703 (Baug 2011:Tab. 12.11, Group 1), and the REE pattern of tuyere F1025599 at Kaupang.*

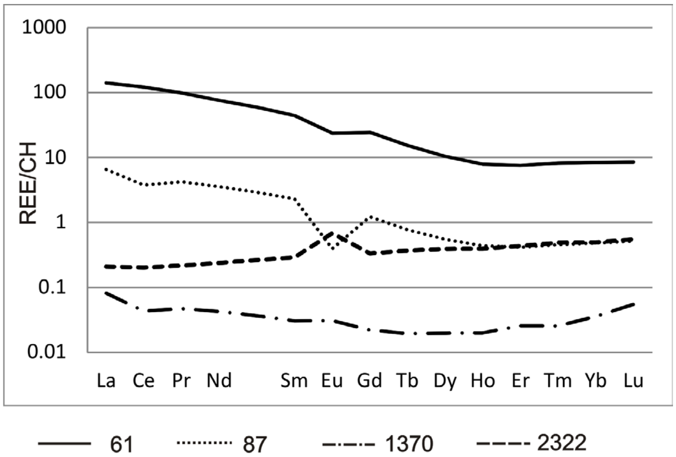


Figure 9. *REE patterns of vessel fragments 61, 87, 1370 and 2322 at Sandwick, Unst.*

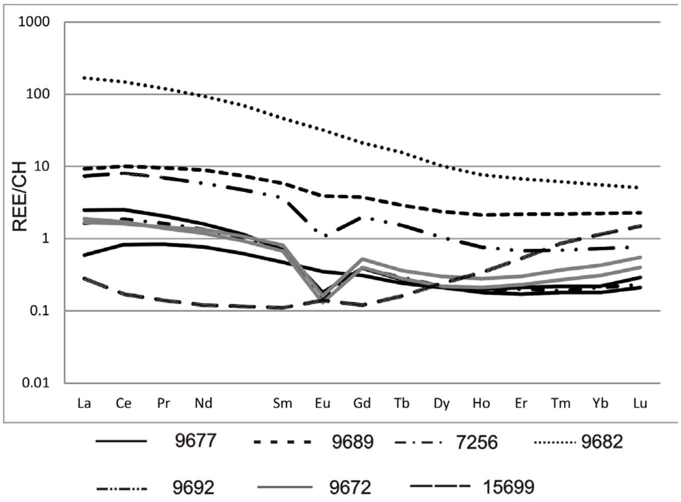


Figure 10. *REE patterns of vessel fragments at Coppergate, York. They are identified by their catalogue number (Mainman & Rogers 2000: 2627) except for small find 15699. The two samples of 9672 are indicated in grey.*

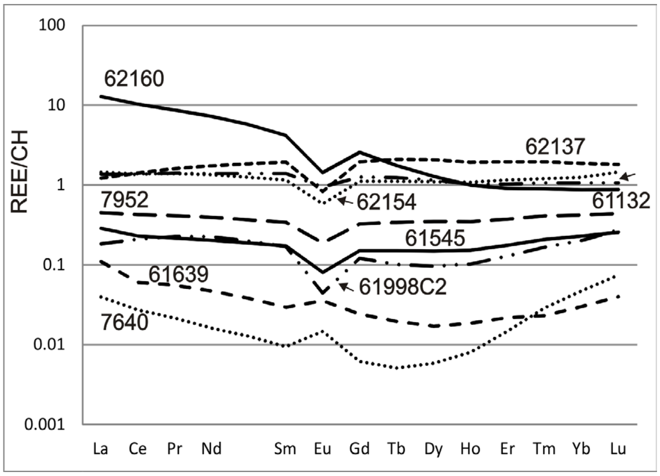
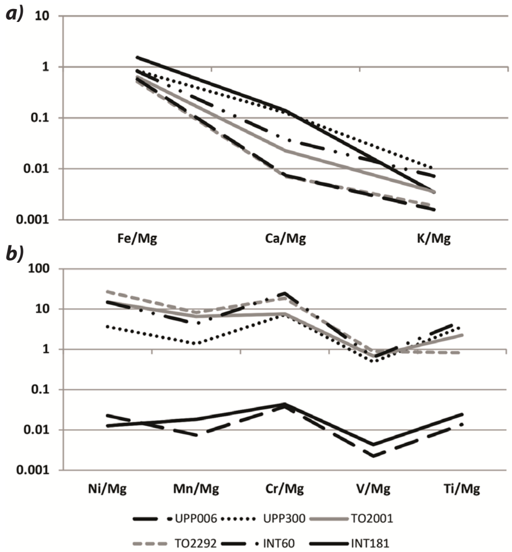


Figure 11. *REE patterns of vessel fragments at Quoygrew. 62160, 62154, 61545 and 61998 are hemispherical; 62137, 61639, 7640 and 7952 are of uncertain shape.*



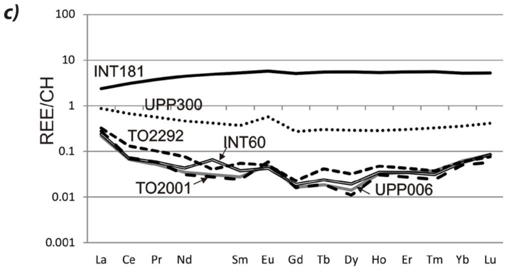


Figure 12. *(a) Fe/Mg, Ca/Mg and K/Mg ratios, (b) trace element/Mg ratios (pXRF data) and (c) REE patterns of vessels from Inni á Tvørgarði (INT), Uppistovubeitið (UPP) and Toftanes (TO), Faroe.*

the multivariate data treatment, discriminant analysis assigned, albeit with varying confidence, the members of the main group to either Catpund or Clibberswick with just one sample to Fethaland. However, examination of the corresponding REE patterns of examples of this Shetland group (Figure 11) indicates considerable variability, for instance the contrast between on the one hand 61545 (Type 1), 7952 (unknown), 61998C2 (Type 1) and on the other 61639 and 7640 (both unknown forms). Regarding the group of four, the least that can be said is that 62160 (Type 1 hemispherical), 62137 (uncertain), 62154 (Type 1 hemispherical) and 61132 (uncertain) (Figure 11) are not from Shetland but rather from probably more than one source in Norway.

Finally, of the six vessels from Faroe analysed so far, INT181 (Type 1 carinated circular vessel with lipped rim from Inni á Tvørgarði) has a hard dark grey fabric, UPP300 (Type 2 large oval dish from Uppistovubeitið) with a soft almost white fabric, contrasting with TO2292 (Type 1 hemispherical bowl from Toftanes) with a notably fibrous looking fabric and the remaining three – INT60 (Type 4) large subrectangular vessel, TO2001 (Type 2) large hemispherical vessel, and UPP006 (Type 4) large 4-sided vessel – which have a greyish more crystalline fabric. The pXRF data (Figure 12a, b) shows that INT181 and UP006 have much lower trace element contents than the rest but only the former stands somewhat apart in terms of pattern. As regards REE pattern (Figure 12c), INT60, TO2001, UPP006 together with TO2292 lie within the Shetland ranges, albeit with lower concentrations than at Catpund. Sharing a similar pattern is UPP300 which may therefore also belong to Shetland; its concentration ranges lie at the upper limit of the Fetlar group. That leaves INT181 which is unlikely to be from Shetland.

Discussion

The second part of this paper has explored the extent to which hypotheses based on traditional criteria can be usefully tested by elemental analysis. The outcome has been reasonably positive: similarity of REE signature may be used to associate artefacts, whether or not from the same findspots, to a common origin, but defining that origin is much more likely to be in the form of a negative than

Figure 13. *Comparison between origin assignments of individual artefacts found at Sandwick, York, Quoygrew and Faroe based on morphology and chemical analysis.*

Site	Period	ID	Morphology	Chemical analysis	Comment
Sandwick		2322	Unknown	Atypical Shetland	
York	Viking	7256	Type 1	More likely Norway (possibly Kaupang area?) than Shetland	Ok
York	Viking	9672	Unknown	More likely Norway (possibly Kaupang area?) than Shetland	
York	Viking	9677	Type 1	More likely Norway (possibly Kaupang area?) than Shetland	Ok
York	Viking	9682	Type 1	Not Shetland	Ok
York	Viking	9689	Unknown	More likely Norway (possibly Kaupang area?) than Shetland	
York	Viking	9692	Type 1	More likely Norway (possibly Kaupang area?) than Shetland	Ok
York	Viking	15699	Type 1	More likely Norway (possibly Kaupang area?) than Shetland	Ok
Quoygrew	Norse	61545	Type 1	Shetland	Disagreement
Quoygrew	Norse	62154	Type 1	Not Shetland	Ok
Quoygrew	Norse	62160	Type 1	Not Shetland	Ok
Quoygrew	Norse	61998C2	Type 1	Shetland, same source as 61545	Disagreement
Inni á Tvørgarði	Norse	IAT060	Type 4	Catpund; Clibberswick	Agreement
Uppistovubeitið	Norse	UPP060	Type 4	Uncertain Shetland	Agreement
Inni á Tvørgarði	Norse	IAT181	Type 1	Not Shetland	Agreement
Toftanes	Viking	TO2001	Type 1	Catpund; Clibberswick	Disagreement; morphologically this sample is consistent with a Norwegian provenance
Toftanes	Viking	TO2292	Type 1	Catpund; Clibberswick	Disagreement; morphologically this sample is consistent with a Norwegian provenance

a positive statement. Although much remains to be done to expand the reference data for quarries throughout the North Atlantic region as well as to integrate the corresponding data from other techniques of analysis, it is already apparent that the combination of relatively small inter-source composition differences and sometimes significant variations within a quarry and even within a (large) artefact will always limit the quality of assignment of origin to individual soapstone artefacts. For the moment at least, the way forward is to formulate modest aims for the science-based effort. On the basis of the semi-quantitative pXRF data accumulated so far, it certainly provides a valuable, broad characterisation, but the REE composition probably remains the more informative.

From the perspective of assigning origin to reference Types presented in the first section of this paper, we are far from drawing firm conclusions but results are reasonably encouraging (Figure 13). Types 1 and 2 samples of Viking period artefacts from York could be Norwegian, and are a poor match to Shetland samples. From the later Norse site of Quoygrew, Type 1 vessels are also consistent with possible Norwegian sources, despite the slight prevalence of Shetland vessel Types 3 and 4 at the site. Artefacts from Faroe demonstrate that Type 1 samples are unlikely to be from Shetland, and that Type 2 and Type 4 examples are within Shetland ranges. Where regions are more confidently assigned, the provenance assignments suggested by analysis and by morphology (e.g. Type 1, Norwegian, Type 2, Norwegian or Shetland and Types 3 and 4, Shetland) are in broad agreement. While links to individual quarry sites may well be beyond the capability of currently used techniques as a result of intra-source (and even intra-artefact) variation in composition, associations between artefacts from across the region can provide tangible results. These results will have implications for the original distribution of soapstone vessels throughout the region in the Viking period and for the potential control of the resource in the later Norse period. By increasing the number of analyses and concentrating on targeted samples (with regards to sites studied and types of vessel fragments sampled), the nature of the manufacture and distribution of soapstone vessels should be better understood. To this end, the next phase of the Homeland to home project includes analysis of further material from the Faroe Islands, Shetland (Norwick, Scatness) and Orkney (Pool, Snusgar), as well as a greater emphasis on integrating fabric description (as in Figure 6 for the main Shetland quarries) with vessel morphology and chemistry (ICP-MS and pXRF).

Acknowledgements

R. J. thanks Valerie Olive for discussion of the ICP-MS results and the Viking Society for Northern Research for funding some of the analyses. A. F. would like to thank all those who facilitated her original research into the archaeological artefacts from North Atlantic contexts. R. J. and A. F. also thank York Archaeological Trust for providing access to samples from Coppergate, York, Tom Heldal (Geological Survey of Norway) for soapstone quarry specimens in Norway and Símun Arge (Føroya Fornminnisavn) for allowing us to include samples from Faroe.

The Homeland to home project forms Stage 1 of a NABO project, *Comparative Island Ecodynamics in the North Atlantic Project* funded by the US National Science Foundation. We are grateful to Thomas McGovern and his project team for inviting us to be part of this project. Finally, we thank the reviewers for their comments.

References

Appelt, M., Myrup, M. & Pasda, C. 2005. *The steatite objects analyses project 2005–2007*. SILA National museums centre for research on Greenland, Copenhagen.

Arneborg, J. 1984. De Norrøne bebyggelser i Nipaitsoq og Niaquusat: materiel Kultur, udenlandsforbindelser, kulturelt særpræg, kronologi og ophør belyst især ud fra oldsagerne udgravet 1976–1977, med en vurdering af, hvad en samlet undersøgelse af oldsagerne fra også de øvrige bebyggelser i Vestbygden vil kunne sige om de nævnte spørgsmål for vesterbygden som helhed. Ph. D. thesis. University of Aarhus, Aarhus.

Barrett, J. H. 2003. Contact, Continuity and Collapse: the Norse Colonization of the North Atlantic In Barrett, J.H. (ed.) *Studies in the Early Middle Ages*. Turnhout: Brepols, 73–111.

Barrett, J. H. 2008.The Norse in Scotland. In S. Brink and N. Price (eds), *The Viking World*, 411–427. Routledge, London.

Barrett, J. H. (ed.) 2012. *Being an Islander; production and identity at Quoygrew, Orkney AD 900–1600.* MacDonald Institute Monographs, Cambridge.

Batey, C. E., Forster, A., Jones, R., Gaunt, G., Breckenridge, F., Bunbury, J. & Barrett, J.H. 2012. Local

Availability and Long-range Trade: the Worked Stone Assemblage. In Barrett, J. H. (ed.) *Being an Islander: Production and Identity at Quoygrew, Orkney, AD 900–1600*, 207–27. McDonald Institute for Archaeological Research, Cambridge.

Baug, I. 2011. Soapstone finds. In Skre, D. (ed.) *Things from the Town: artefacts and inhabitants in Viking-age Kaupang,* 311–37. Aarhus University Press, Oslo.

Bray, I. 1994. Geochemical methods for provenance studies of steatite. Unpublished Ph.D. thesis, University of Glasgow, Glasgow.

Bray, I., Forster, A. K. & Clelland, S. J. 2009. Steatite and Shetland: a geological introduction and gazetteer of sites. In Forster, A. K. & Turner, V. E. (eds) *Kleber: Shetland's oldest industry: Shetland soapstone since prehistory*, 4–17. Shetland Amenity Trust, Lerwick.

Clelland, S. J., Batt, C. M., Stern, B. & Jones, R. E. 2009. Scientific analysis of steatite: recent results. In Forster, A. K. & Turner, V. E. (eds) *Kleber: Shetland's oldest industry: Shetland soapstone since* prehistory, 106–17. Shetland Amenity Trust, Lerwick.

Crawford, B. E. 1987. *Scandinavian Scotland*. Scotland in the Early Middle Ages 2. Leicester University Press, Leicester.

Crawford, B. E. 2005. Thorfinn, Christianity and Birsay: what the Saga tells us and archaeology reveals. In O. Owen (ed.) *The World of Orkneyinga Saga. The Broad-Cloth Viking Trip.* 88–110. The Orcadian Limited, Kirkwall.

Curle, C. L. 1982. *Pictish and Norse Finds form the Brough of Birsay 1934–74*. Society of Antiquaries of Scotland, Monograph Series Number 1, Edinburgh.

Forster, A. K. 2004a. Shetland and the trade of steatite goods in the North Atlantic region during the Viking and Early Medieval period: an investigation into trade and exchange networks in the Norse North Atlantic and the extent to which steatite goods manufactured in Shetland were included in such networks. Unpublished Ph.D. thesis, University of Bradford, Bradford.

Forster, A. K. 2004b. The soapstone trade in the North Atlantic: preliminary research of Viking and Norse period soapstone imports in Iceland. In Guðmundsson, G. (ed.) *Current Issues in Nordic Archaeology*, 17–21. Society of Icelandic Archaeologists, Reykjavik.

Forster, A. K. 2005. Steatite, Resource Control and the Orkney Earldom. In Owen, O. (ed.) *The World of Orkneyinga Saga: The Broad-Cloth Viking Trip*, 55–74. Kirkwall, Orkney.

Forster, A. K. 2009. Viking and Norse steatite use in Shetland, in Forster, A. K. & Turner, V. E. (eds), *Kleber; Shetland's first industry. Shetland soapstone since prehistory*, 58–69. Shetland Amenity Trust, Lerwick.

Forster, A. K. 2010. Steatite. In Dockrill, S. J. Bond, J. M. Turner, V. E. Brown, L. D. Bashford, D. J. Cussans, J. E. & Nicholson, R. A. (eds) *Excavations at Old Scatness, Shetland. Vol.1: the Pictish Village and Viking Settlement*, 258–303, Shetland.

Forster, A. K. & Sharman P. 2009. Use in Early Prehistoric Shetland: from the Neolithic to the Early Iron Age. In Forster, A. K. & Turner, V. E. (eds). *Kleber: Shetland's oldest industry: Shetland soapstone since prehistory*, 27–36. Shetland Amenity Trust, Lerwick.

Forster, A. K. & Turner, V. E. (eds). 2009. *Kleber: Shetland's oldest industry: Shetland soapstone since prehistory.* Shetland Amenity Trust, Lerwick

Forster, A. K. & Jones, R. E. 2014. Rare earth element analysis of steatite artefacts found at Bayanne. In Moore, H. & Wilson, G. (eds), *Ebbing Shores: survey and excavation of coastal archaeology in Shetland 1995–2008*, Historic Scotland Archaeology Report 8, 144–162.

Hallgrímsdóttir, M. 1989. *Viðey: Fornleifarannsóknir 1988–1989*, Reykjavík.

Hamilton, J. R. 1956. *Excavations at Jarlshof, Shetland*. Ministry of Works Archaeological Reports 1, HMSO, Edinburgh.

Jones, R. E. 2007a. Rare earth element analysis of steatite artefacts found at the 'Time Team' site – FG02 – on Fetlar, Shetland. Unpublished preliminary report.

Jones, R. E. 2007b. Rare earth element analysis of steatite artefacts found at York. Unpublished preliminary report.

Jones, R. E. 2009. Rare earth element analysis of steatite artefacts found at Sandwick, Unst. Unpublished preliminary report.

Jones, R. E., Olive, V. & Ellam, R. 2006. *Chemical (rare earth element) analysis of Viking steatite artefacts from Kaupang*. Unpublished preliminary report.

Jones, R. E., Olive, V., Kilikoglou, V., Ellam, R., Bassiakos, Y., Bray, I. & Sanderson, D. 2007. A new protocol for the chemical characterisation of steatite: two case studies in Europe: the Shetland Isles and Crete.

Journal of Archaeological Science 34, 626–641.
Larsen, A. C. & Stummann Hansen, S. 2001. Viking Ireland and the Scandinavian Communitites in the North Atlantic. In Larsen, A.C. (ed.) *The Vikings in Ireland*, 115–126. The Viking Ship Museum, Roskilde.
Mainman, A. & Rogers, N. S. H. 2000. *Craft, industry and everyday life, The Archaeology of York: The Small Finds,* vol. 17 fasc. 14, York.
Magee, P., Barber, D., Sobur, M. & Jasim, S. 2005. Sourcing Iron Age softstone artefacts in southeastern Arabia: results from a programme of analysis using Inductively Coupled Plasma-Mass Spectrometry/Optical Emission Spectrometry (ICP-MS/OES). *Arabian Archaeology and Epigraphy* 16, 129–143.
Mykura, W. 1976. *British Regional Geology: Orkney and Shetland*. HMSO, Edinburgh.
Needham, S. 1993. Displacement and exchange in archaeological methodology. In Scarre, C. & Healy, F. (eds). *Trade and Exchange in Prehistoric Europe* (Oxbow Monograph 33), 161–169, Oxford.
Resi, H. G. 1979. *Die specksteinfunde aus Haithabu, Ausgrabungen in Haithabu*, Berichte 14. Karl Wachholtz Verlag, Neumunster.
Richards, J. D. 2000. *Viking Age England*. Second Edition. Stroud, Tempus.
Ritchie, P. R. 1984. Soapstone quarrying in Viking Lands, in Fention, A. & Palsson, H. (eds) *The Northern and Western Isles in the Viking World: survival, continuity and change*, 59–84, Edinburgh.
Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden*, Oslo-Bergen.
Smith, A. N. with Buttler, S. & Weber, B. 1999. Steatite: vessels, bakestones and other objects. In Crawford, B. E. and Ballin-Smith, B. *The Biggings, Papa Stour, Shetland; the history and archaeology of a royal Norwegian farm*, 129–143. Society and Antiquaries of Scotland & Det Norske Videnskaps-Akademi, Society of Antiquaries of Scotland Monograph Series Number 15, Edinburgh.
Smith, A. N. & Forster, A. K. 2007. Steatite. In Hunter, J. R. *Investigations in Sanday. Vol.1: Excavations at Pool, Sanday. A multi period settlement site from Neolithic to Late Norse times*, 412–432. Historic Scotland and the Orcadian, Orkney.
Smith, K. P. 2000. Who lived at L'Anse aux Meadows? In Wallace, B.L. The Vikings at L'Anse aux Meadows, in Fitzhugh, W.W. and Ward, E. I. (eds) *Vikings: the North Atlantic Saga*, Smithsonian Press, Washington
Smith, K. P., Urban, M. A. & Herringer, S. 2013. Geochemically Tracking the Earliest European Explorers in North America: Investigations of a New Jasper Fire-Starter from L'Anse aux Meadows, Newfoundland, Abstract, Society for American Archaeology Meeting, Hawaii.
Storemyr, P. & Heldal, T. 2002. Soapstone production through Norwegian history: Geology, properties, quarrying and use, in Hermann, J. J. Herz, N. and Newman, R. (eds*) Interdisciplinary studies on ancient stone,* 359–369, Archetype Publications, London,.
Stummann Hansen, S. 1991. Toftanes: A Faroese Viking Age Farmstead from the 9–10th Centuries AD. In Bigelow, G. F. (ed.) *The Norse of the North Atlantic*, 44–53. Acta Archaeologica, 61, Copenhagen.
Turner, V., Sharman, P. & Carter, S. 2009. Excavations at Catpund, Cunningsburgh, in Forster, A. K. & Turner, V. E. (eds), *Kleber; Shetland's first industry. Shetland soapstone since prehistory*, 70–84, Shetland Amenity Trust, Lerwick.
Wilson, G. V. & Phemister, J. 1946. *Talc, other magnesium mineral and chromite associated with British serpentines*. Geology Survey of Great Britain, Wartime Pamphlet 9. 3rd. ed. Geological Survey and Museum, London.

Appendix

Table 1. *pXRF compositions expressed as % element (Mg, Fe, Ca, K) or ppm element (Mn, Ti, Ni, Cr and V) of soapstone quarry samples in Shetland and Norway and artefacts from Faroe.*

	Mg	Fe	Ca	K	Mn	Ti	Ni	Cr	V
Shetland									
Catpund	1,9	3,4	0,08	0,03	5572	158	891	804	90
	5,1	4,5	0,05	lod	1176	40	1805	1431	71
	4,2	4,3	0,04	0,01	1213	53	1277	1096	77
	3,1	3,6	0,05	lod	1110	38	1203	1214	64
	3,9	5,6	0,06	0,02	2038	94	1605	1285	102
	3,8	5,2	0,06	0,04	2450	110	1962	1264	95
	3,7	2,2	0,06	0,01	2089	55	1178	314	57
	4,7	3,6	0,06	0,05	1294	106	1757	1383	74
	5,1	4,0	0,05	0,05	1106	108	2187	879	75
Fethaland	5,1	3,3	2,8	0,04	741	102	1114	2619	101
	6,5	3,1	1,9	lod	633	84	414	1984	115
	7,2	3,9	2,3	lod	811	46	677	2250	137
	7,2	4,1	4,9	lod	1311	71	718	3693	152
	6,0	4,0	10,3	lod	1302	753	539	101	155
	6,3	3,0	7,8	lod	1314	46	568	683	78
	4,3	3,3	7,2	lod	1123	295	83	45	117
	7,6	4,1	5,9	lod	967	108	198	4807	163
Clibberswick	8,4	3,3	0,03	0,01	811	24	2294	698	69
	9,3	3,4	0,05	0,04	824	59	2319	1061	77
	6,2	2,1	0,04	0,03	639	66	3392	77	68
Norway									
Piggåsen	11,1	7,4	0,6	lod	1173	501	1012	687	95
	11,4	8,7	2,0	lod	1758	554	957	1357	140
	11,7	8,5	0,1	lod	940	582	1068	1139	98
	10,2	6,5	0,2	0,02	797	446	949	738	84
	9,1	10,4	3,0	0,40	1417	1538	741	318	195
Folvelseter	9,6	6,2	0,2	1,00	1960	944	872	4846	196
	13,8	7,3	0,0	0,02	1057	762	860	3443	153
	12,4	5,8	0,1	1,20	1722	917	1016	4020	172
	11,5	4,7	0,0	1,40	1203	778	889	3187	158
	12,1	3,7	0,0	0,50	1150	531	761	3629	95
Fluetjern	11,5	6,2	0,3	lod	940	387	921	3635	141
	11,5	2,8	0,1	lod	680	333	810	2494	101
	10,8	4,5	0,6	lod	798	572	680	1884	101
	12,3	3,5	0,9	lod	826	515	1282	1839	83
	9,6	3,3	0,9	lod	852	397	863	1986	92
Faroes									
INT181	6,5	9,9	0,9	0,020	1197	1589	829	2029	283
TO2001	4,7	3,0	0,1	0,020	663	227	1499	1042	69
UPP300	3,8	3,2	0,5	0,040	389	1029	1029	502	137
TO2292	5,3	2,7	0,04	lod	569	57	1842	1142	62
INT60	4,0	3,3	0,2	0,030	595	689	2040	2331	87
UPP006	6,3	3,6	0,1	lod	470	864	1426	2380	141

Table 2. *Rare earth element concentrations (expressed in ppm) of soapstone artefacts and quarry samples.*

Sandwick, Shetland	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
61	43,6407	97,8784	12,0463	45,0961	8,5775	1,7403	6,3275	0,7226	3,3372	0,5663	1,5878	0,2648	1,7485	0,2742
61a	0,1908	0,6790	0,1331	0,7734	0,3138	0,0614	0,3633	0,0750	0,4784	0,0891	0,2342	0,0326	0,1722	0,0208
87	2,0132	3,0305	0,5142	2,1230	0,4463	0,0289	0,3150	0,0365	0,1773	0,0314	0,0868	0,0147	0,1004	0,0167
600	24,8807	53,5314	6,7825	28,6778	6,5386	1,9666	6,6586	1,0539	6,4044	1,2661	3,6835	0,5624	3,4040	0,5179
629	0,0577	0,0835	0,0119	0,0442	0,0085	0,0024	0,0085	0,0014	0,0082	0,0018	0,0066	0,0012	0,0092	0,0016
630	24,4596	57,2641	6,7712	24,3059	5,3544	1,2881	5,4724	0,9680	6,2172	1,2432	3,4884	0,5435	3,2347	0,4689
665	0,0353	0,0749	0,0087	0,0342	0,0078	0,0028	0,0083	0,0015	0,0084	0,0017	0,0052	0,0008	0,0054	0,0008
715	0,0398	0,0764	0,0090	0,0352	0,0067	0,0019	0,0069	0,0011	0,0061	0,0013	0,0042	0,0007	0,0061	0,0009
907	0,0918	0,2576	0,0554	0,3561	0,1627	0,0193	0,2132	0,0421	0,2770	0,0577	0,1691	0,0252	0,1497	0,0193
907a	0,0887	0,2104	0,0497	0,3142	0,1411	0,0157	0,1797	0,0362	0,2430	0,0502	0,1436	0,0219	0,1296	0,0171
1370	0,0252	0,0349	0,0057	0,0255	0,0060	0,0023	0,0057	0,0009	0,0064	0,0014	0,0054	0,0008	0,0074	0,0018
1473	16,6035	36,1597	4,4615	17,7157	3,4334	0,6748	2,2758	0,2735	1,4435	0,2848	0,8528	0,1532	1,0132	0,1691
1505	0,1263	0,2536	0,0373	0,1670	0,0507	0,0036	0,0630	0,0112	0,0732	0,0156	0,0471	0,0074	0,0486	0,0079
2233	27,1124	66,6625	7,3446	26,6013	5,6085	1,2696	4,7652	0,6742	3,7281	0,7060	2,0827	0,3422	2,1724	0,3350
2322	0,0650	0,1628	0,0265	0,1430	0,0566	0,0502	0,0863	0,0174	0,1260	0,0284	0,0913	0,0158	0,1030	0,0177
2338	0,0859	0,1676	0,0211	0,0881	0,0202	0,0071	0,0221	0,0038	0,0223	0,0048	0,0145	0,0023	0,0149	0,0021
Tuyere	0,1291	0,2321	0,0284	0,1129	0,0215	0,0069	0,0208	0,0030	0,0166	0,0032	0,0093	0,0016	0,0114	0,0019
Faroe	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
INT60	0,075	0,056	0,0071	0,026	0,007	0,0031	0,0049	0,0011	0,0062	0,0025	0,0073	0,0010	0,0120	0,0028
INT181	0,740	2,483	0,4595	2,676	1,034	0,4248	1,3277	0,2612	1,7945	0,3872	1,1695	0,1809	1,0938	0,1690
UPP006	0,067	0,054	0,0062	0,021	0,005	0,0036	0,0043	0,0009	0,0046	0,0023	0,0073	0,0012	0,0130	0,0028
UPP300	0,269	0,544	0,0691	0,278	0,072	0,0423	0,0706	0,0144	0,0934	0,0205	0,0636	0,0106	0,0747	0,0132
TO2001	0,086	0,059	0,0071	0,019	0,005	0,0044	0,0042	0,0009	0,0035	0,0022	0,0058	0,0008	0,0105	0,0019
TO2292	0,101	0,107	0,0124	0,046	0,011	0,0037	0,0059	0,0020	0,0103	0,0034	0,0089	0,0012	0,0126	0,0025
York	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
9677	0,7701	2,0388	0,2516	0,9625	0,1357	0,0136	0,1012	0,0127	0,0670	0,0129	0,0367	0,0059	0,0384	0,0066
9677	0,1832	0,6681	0,1029	0,4606	0,0921	0,0258	0,0805	0,0116	0,0682	0,0147	0,0435	0,0071	0,0468	0,0095
9689	2,8733	8,0824	1,1668	5,3581	1,1327	0,2849	0,9701	0,1371	0,7636	0,1529	0,4558	0,0709	0,4656	0,0737
7256	0,5050	1,5037	0,1994	0,8040	0,1329	0,0113	0,0999	0,0137	0,0718	0,0137	0,0410	0,0063	0,0430	0,0074
9682	52,1895	119,9332	14,6132	56,3462	8,9910	2,3413	5,9948	0,7367	3,2647	0,5485	1,4150	0,1989	1,1571	0,1633
9672	0,5199	1,3015	0,1763	0,8067	0,1577	0,0116	0,1335	0,0168	0,0963	0,0200	0,0638	0,0120	0,0907	0,0176
9672	0,5829	1,3805	0,1711	0,7155	0,1302	0,0095	0,1035	0,0133	0,0709	0,0147	0,0487	0,0088	0,0652	0,0129
15699	0,0881	0,1387	0,0168	0,0712	0,0211	0,0100	0,0304	0,0074	0,0783	0,0245	0,1113	0,0277	0,2395	0,0480
9692	2,2867	6,5158	0,8493	3,4858	0,7139	0,0773	0,5150	0,0719	0,3350	0,0548	0,1432	0,0224	0,1518	0,0247

Tabel 2 *(continued).*

Norway /Piggåsen	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
P1	1,6136	5,2403	0,7808	3,6300	0,9049	0,1650	0,8426	0,1287	0,7869	0,1604	0,4780	0,0756	0,4776	0,0726
P2	1,1445	3,6975	0,5749	2,7351	0,7374	0,1300	0,6924	0,1070	0,6584	0,1340	0,3953	0,0628	0,3889	0,0586
P3	0,2075	0,8946	0,1373	0,6290	0,1427	0,0243	0,1325	0,0190	0,1107	0,0214	0,0642	0,0101	0,0588	0,0098
P4	0,4192	1,3528	0,1987	0,9244	0,2411	0,0318	0,2259	0,0347	0,2054	0,0408	0,1286	0,0191	0,1209	0,0212
P5	2,1701	9,4051	1,6289	8,1351	2,0456	0,6413	1,8257	0,2688	1,5581	0,3013	0,8576	0,1398	0,8793	0,1320
Folvelseter														
FO1	0,7529	2,6982	0,2336	1,0196	0,2139	0,0505	0,2119	0,0336	0,2316	0,0573	0,2068	0,0420	0,3115	0,0567
FO2	0,4046	1,1215	0,1027	0,3864	0,0551	0,0064	0,0343	0,0047	0,0236	0,0045	0,0145	0,0030	0,0258	0,0048
FO3	0,5027	1,5187	0,2343	1,1941	0,3145	0,0305	0,2865	0,0406	0,2342	0,0455	0,1392	0,0254	0,1817	0,0303
FO4	0,3393	0,9256	0,1283	0,5674	0,1094	0,0223	0,0900	0,0125	0,0727	0,0162	0,0552	0,0104	0,0875	0,0163
FO5	0,3125	0,7166	0,0944	0,4497	0,0987	0,0158	0,0918	0,0124	0,0709	0,0139	0,0443	0,0075	0,0531	0,0101
Fluetjern														
FL1	1,0248	2,3615	0,2882	1,1733	0,2775	0,0268	0,2718	0,0440	0,2944	0,0646	0,2117	0,0398	0,2829	0,0485
FL2	1,6539	5,4156	0,6041	2,4853	0,5870	0,0597	0,5899	0,0932	0,5816	0,1219	0,3832	0,0627	0,4026	0,0652
FL3	0,1432	0,4594	0,0904	0,4809	0,2147	0,0232	0,2631	0,0530	0,3685	0,0755	0,2391	0,0438	0,2948	0,0461
FL4	0,3684	1,4723	0,2806	1,5231	0,5575	0,0645	0,5836	0,0940	0,5865	0,1170	0,3550	0,0580	0,3691	0,0586
FL5	6,1272	13,5261	1,5485	6,0655	1,1578	0,1291	1,0337	0,1586	0,9639	0,1897	0,5669	0,0973	0,6140	0,0859
Solerudberget														
S1	2,8295	7,4966	1,1120	5,3633	1,5315	0,2491	1,4881	0,2395	1,3838	0,2505	0,6681	0,1061	0,6437	0,0907
S2	3,2179	8,8798	1,3208	6,0896	1,5144	0,3097	1,2679	0,1838	1,0112	0,1819	0,5015	0,0829	0,5297	0,0813
S3	15,4674	32,4223	3,6565	13,3308	2,1583	0,3256	1,5003	0,1833	0,8332	0,1450	0,3842	0,0611	0,4033	0,0662
S4	10,7449	22,9671	2,6687	10,0607	1,7947	0,2061	1,3109	0,1624	0,7388	0,1221	0,3113	0,0463	0,2869	0,0457
S5	0,7319	2,2507	0,3501	1,6520	0,4865	0,0972	0,5269	0,0945	0,6161	0,1252	0,3935	0,0671	0,4173	0,0641
Slipsteinsberget	0,0373	0,0738	0,0109	0,0520	0,0222	0,0011	0,0390	0,0100	0,0715	0,0184	0,0609	0,0107	0,0750	0,0128
Kaupang	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
F66871	1,4187	3,3249	0,4584	1,9627	0,5083	0,1270	0,5443	0,0887	0,5435	0,1057	0,3034	0,0467	0,2966	0,0474
F1028137	1,9592	4,8140	0,5201	2,1003	0,5016	0,1162	0,5027	0,0858	0,5180	0,0968	0,2706	0,0417	0,2335	0,0343
F1024659	4,4728	11,3822	1,4854	6,5273	1,4306	0,3856	1,2041	0,1652	0,9096	0,1763	0,4959	0,0749	0,4606	0,0673
F1031790	0,7975	1,4019	0,2143	0,9290	0,2020	0,0216	0,1864	0,0284	0,1477	0,0265	0,0735	0,0112	0,0723	0,0121
F1031628	0,7681	0,7186	0,1919	0,9216	0,1965	0,0449	0,2169	0,0316	0,2014	0,0469	0,1561	0,0279	0,1956	0,0353
F10229961	0,2857	0,5542	0,0732	0,2924	0,0643	0,0340	0,0596	0,0097	0,0488	0,0118	0,0356	0,0061	0,0396	0,0065
F1024436	0,4293	0,9546	0,1116	0,4706	0,1159	0,0398	0,1335	0,0234	0,1586	0,0362	0,1194	0,0213	0,1497	0,0262
F1029703	2,3921	4,6813	0,5936	2,3171	0,4298	0,0260	0,3190	0,0379	0,1645	0,0256	0,0647	0,0107	0,0647	0,0100
F1031227/A	0,7211	1,9636	0,2425	0,9609	0,1765	0,0345	0,1456	0,0208	0,1216	0,0253	0,0770	0,0142	0,0998	0,0174
F1031227/B	1,7598	2,7028	0,3730	1,3853	0,2605	0,0904	0,2321	0,0352	0,1999	0,0410	0,1219	0,0192	0,1306	0,0222
F1027483	1,0974	2,2129	0,2796	1,1433	0,1941	0,0132	0,1390	0,0168	0,0740	0,0120	0,0324	0,0051	0,0309	0,0047
F1033599	0,5070	1,1155	0,1073	0,4323	0,0779	0,0227	0,0688	0,0098	0,0544	0,0104	0,0333	0,0063	0,0427	0,0071
F1025599	0,1318	0,2123	0,0354	0,1482	0,0462	0,0098	0,0727	0,0165	0,1432	0,0374	0,1394	0,0278	0,1949	0,0341
F1024559/A	0,1079	0,1690	0,0224	0,0932	0,0233	0,0170	0,0237	0,0046	0,0310	0,0064	0,0200	0,0034	0,0217	0,0030
F1024559/B	0,2935	0,5981	0,0832	0,3727	0,0925	0,0251	0,1126	0,0192	0,1330	0,0279	0,0951	0,0158	0,1139	0,0197
F1024559/C	0,1776	0,4199	0,0566	0,2522	0,0706	0,0235	0,0866	0,0157	0,1072	0,0247	0,0752	0,0130	0,0862	0,0148
F1026902	1,3008	3,0728	0,3690	1,3905	0,2224	0,0325	0,1893	0,0258	0,1395	0,0298	0,0923	0,0162	0,1119	0,0189
F1024899	1,9480	5,6334	0,8583	3,8831	0,8677	0,1889	0,7444	0,1140	0,6974	0,1397	0,4252	0,0664	0,4317	0,0640
F1001958	0,8745	2,0970	0,2786	1,2014	0,2913	0,0934	0,3032	0,0491	0,3021	0,0639	0,1929	0,0307	0,2028	0,0319
F1002641	1,2035	2,0827	0,3128	1,1579	0,2539	0,0778	0,2309	0,0383	0,1992	0,0387	0,1136	0,0176	0,1185	0,0188
F1004043	0,8059	1,2340	0,1706	0,6236	0,1084	0,0212	0,1091	0,0186	0,1398	0,0362	0,1375	0,0307	0,2433	0,0452
F1022980	0,6269	1,8593	0,2502	1,0721	0,2486	0,0227	0,2351	0,0349	0,1959	0,0349	0,1008	0,0165	0,1018	0,0178
F1016134	0,8077	1,3423	0,1938	1,0580	0,4263	0,0422	0,5939	0,1163	0,7583	0,1552	0,5119	0,0978	0,7448	0,1262
F1007403	0,2737	0,3695	0,0400	0,1287	0,0224	0,0056	0,0213	0,0034	0,0184	0,0034	0,0107	0,0018	0,0130	0,0021

Gitte Hansen, Øystein J. Jansen and Tom Heldal

Soapstone Vessels from Town and Country in Viking Age and Early Medieval Western Norway. A Study of Provenance

In this study geological and archaeological data and analytic methods are combined and explored to find the geological source for 146 late Iron Age/Viking Age and early medieval soapstone vessels from the Hordaland region and the town of Bergen in western Norway. The dataset comprises archaeological and geological data relating to the vessels and to 38 soapstone quarries in the Hordaland region. The geological datasets are major and trace element and rare earth element data, as well as the geological setting of the Hordaland region. The archaeological datasets comprise information on the temporal and spatial contexts of the vessels and the quarries. The geochemical datasets are studied and categories established of geochemically based matches made between vessels and quarries. The reliability of these categories of match is then critically assessed through the application of other datasets. Subsequently, the match between individual vessels and regional quarries is given a provenance point-score that reflects the reliability of the provenance result. Through the interdisciplinary efforts provenancing results are obtained for 131 vessels. The success rate is thus high. The immediate social and historical implications of the provenancing results are briefly elaborated upon: previously undated quarries are now tentatively dated through vessel match; distinct quarry-districts that were in use during the late Iron Age/Viking Age and the early Medieval period have been discerned, and the contours of the organisation of the regional production of and trade in soapstone vessels during the Viking Age and the early Middle Ages are recognised. Finally, it is shown that late Iron Age/Viking Age rural households received vessels from areas from outside the Hordaland region to a much lesser degree than their early medieval urban counterparts.

Introduction

Soapstone, as used for vessels and building stone, was an important Norwegian resource in prehistory and the Middle Ages. Some 60 of Norway's c. 200 known soapstone quarries are located in the Hordaland region and soapstone quarrying is considered an important industry here during the Viking Age and the Middle Ages (Petersen 1951:349–369; Skjølsvold 1961:124–125; Bakka 1963:185–190; Lossius 1977). Abundant finds from archaeological excavations, as well as stray finds from rural sites and the medieval town of Bergen in western Norway, show that soapstone vessels were widely used in rural and urban households for cooking and storage. Still, in spite of the abundance of archaeological sources, the stone vessels, as well as the quarries, remain rather under-exploited assets in the study of the Viking Age and early medieval life. This is due not least to the lack of reliable and proper information on provenance. The present study combines and explores geological and archaeological data to find the geological source for 146 late Iron Age/Viking Age and early medieval soapstone vessels from the Hordaland region and the town of Bergen. At our disposal we have archaeological and geological data relating to the vessels and to 38 quarries in the Hordaland region, i.e., Hordaland County and Sogn and Fjordane County, south of Sognefjorden (one sampled quarry: Svanøy is located north of Sognefjorden). The geological datasets include major and trace element (MTE) measurements obtained by conventional X-ray fluorescence analyses (XRF), rare earth element (REE) data measured by inductively coupled plasma mass spectrometry (ICP-MS), and the geological setting of the Hordaland region. The archaeological datasets comprise information on the temporal and spatial context of the vessels and the quarries. Vessels and quarries are first matched through geochemistry and a number of categories of match are established based on the degree of resemblance between vessel and quarries. Next, the reliability of these match categories is evaluated through the application of archaeological data. Finally, based on this assessment, the individual vessels are given a score and divided into groups that express the reliability of the provenance suggested for the individual vessels. The immediate social and historical implications of the provenancing results and perspectives for further studies are briefly elaborated upon.

The problem of provenancing soapstone vessels

The provenancing of Viking Age and medieval soapstone vessels to large geographical regions by means of object typology has been carried out in earlier research. In her comprehensive study of soapstone products found in Viking Age Haithabu, Heid Gjøstein Resi concluded that the Haithabu vessels may stem from eastern Norway or south western Sweden (1979:131). With reference to Resi's observations on décor-elements on vessels, Irene Baug, in a recent study, suggested a provenance to eastern Norway for Viking Age vessels from the Kaupang site by the Oslo fjord in Norway (2011:329–331). Furthermore, in pioneering work on the typology of medieval vessels, Siri Myrvoll Lossius established that the medieval vessel type A is of western Norwegian origin and that the medieval vessel type C is derived from eastern Norway (1977:62–67; 1979:67–69). Also, Amanda Forster has provenanced vessels to large geographical regions in the Norse world through typological studies (2004). Still, due to the rather broadly defined vessel types, typology has been of limited use in high-resolution provenancing efforts. Studies based on the frequency of Viking Age vessel finds and the density of quarries have pointed to the Hordaland region as an important area for vessel production during the Viking Age (Petersen 1951:349–369; Skjølsvold 1961:124–125). With reference to examples of unfinished medieval type A vessels found close to quarry areas, Lossius has suggested that the Sørfjorden area in the Hordaland region was also an especially important production center in the Middle Ages. Furthermore, quarries in the Oslo area (Akershus County) have been pointed out as possible suppliers of medieval type C vessels, due to the frequency of these vessels in consumer contexts by the Oslo fjord (1977:62–67; 1979:67–69).

Applying visual geological approaches in provenancing efforts has proven difficult due to the inherent qualities of soapstone. For some types of soapstone, macroscopic features, such as the mineral composition or structural features may be useful indicators of provenance. Talc is the most important mineral in soapstone. Carbonate (predominantly magnesium rich- varieties such as magnesite) also occurs in most deposits as a major component, and chlorite and magnetite are also common. Amphibole, biotite and serpentine may occur in some deposits. However, due to the non-homogeneous nature of soapstone deposits, mineral composition can be an unreliable criterion for provenance, unless it is possible to find diagnostic minerals unique to a particular quarry or group of quarries.

Soapstone can be characterised by typical structural features: it may, for example, be brecciated (heavily veined), schistose or massive. Colour and grain size also have broad ranges of variability.

However, although specific typical features may predominate within a quarry, rapid changes occur, such as intercalating schistose and massive types. Thus, macroscopic features may be less useful for distinguishing quarries from each other. Furthermore, even in the cases where macroscopic features can clearly be linked to specific quarries, the small sizes of the vessels and vessel fragments recovered archaeologically makes macroscopic identification difficult or impossible. This means that, although a few deposits may be identified from their mineral composition or visual appearance, combinations of geochemical analyses and other datasets are needed in most cases for establishing reliable provenance.

Most soapstone deposits were formed by metamorphic alteration of ultramafic igneous rocks (Sturt et al. 2002). Ultramafic rocks, such as dunite and peridotite, can be transformed into serpentinite and soapstone, with the latter being the ultimate product of such an alteration process. A single deposit may comprise a variety of rocks at different stages of alteration, ranging from serpentinite to nearly pure talc schist. Soapstone may also form from mafic igneous rocks, such as gabbro. A problem with the geochemistry on soapstone is the mobility of elements in this type of alteration process. During the transport of ultramafic igneous bodies from the lower part of the earth's crust to the upper crust, steatisation involves reactions in the rock induced by hot aqueous fluids and carbon dioxide. Thus, the content of various elements in the rocks may not only reflect the composition of the ultramafic bodies themselves but also the geochemical influence from the wall rocks. In addition, local variations connected to fluids in shear zones and fractures may occur.

Geochemical studies of soapstone artefacts using MTE have been applied in some provenance studies. The first case in a Scandinavian context was made in connection with Resi's (1979) study of artefacts from Haithabu in northern Germany. Cluster analyses based on nine trace elements indicated a possibility that the 40 sampled artefacts might come from five different populations, all with a proposed/possible geological provenance to the Precambrian rocks of southern Scandinavia. Two of the populations could possibly be assigned to quarries in the Precambrian of eastern Norway and western Sweden respectively, while some quarries in Precambrian rocks were ruled out. Trace element data from two Swedish and seven Norwegian quarries made up the reference material (Alfsen & Christie 1979). In more recent years Santi and colleges (Santi et al. 2005; Santi et al. 2009) employed major and trace elements (Al, Mg, Fe, Cr, Si, Co, Ca and V) in a provenance study of medieval artefacts from Italy. Altogether, 28 vessels made of soapstone were analysed by inductively coupled plasma optical emission spectrometry (ICP-OES) (major elements) and ICP-MS (trace elements) and the values compared with corresponding measurements from two quarry areas in the Alps. The purpose of these studies was to link the vessels to quarry areas, not to specific quarries. The studies contributed to establishing the area by the ancient Valchiavenna quarries of the central Alps as a probable source of the artefacts.

REE data have also been applied in several studies. Richard Jones and colleagues (2007) assessed REE studies employed in the 1970s and 1980s, pointing out the limited success of some studies and several projects that had failed, mainly due to large intra-source variation and minor inter-source range of composition. In their paper, they presented a method for the chemical characterisation of soapstone (steatite) based on analyses of REE and some transition elements (Jones et al. 2007). This study demonstrated the ability to discriminate chemically between three of the known Viking Age sources in Shetland. Jones et al. (2006) applied REE analysis to 24 artefacts from the Kaupang site in Vestfold County, with reference material sampled from four large quarries in eastern Norway. It was possible to match three of the artefacts to the sampled quarries with some confidence, and through bivariate and multivariate analyses, it was possible to divide the artefacts into four groups that may represent different quarry areas (Jones et al. 2006; Baug 2011:329–331). It was thus considered possible to group and exclude sources through the REE data.

These previous studies, based on MTE and REE data, respectively, have been able to discriminate between source areas on rather large geographical scales, such as 'Precambrian of eastern Norway and western Sweden'. In areas where relatively few optional quarries have been relevant, it has also been possible to exclude resource areas, which is, in itself, very useful. The size of the reference material, the database for quarries sampled for comparison, varies in these studies but, generally, the analysed reference material must be characterised as relatively sparse.

In this study, our aim is to find the origin of 146 vessels that have been found in a geographical area with a high density of quarries, with our reference material derived from 38 out of c. 60 known quarries in this region. Altogether, our data must be characterised as relatively extensive. MTE data are available from all quarries and objects, whereas REE data are available to a more limited extent. As a result, this study takes its point of outset on MTE data with subsequent applications of REE data for finer discrimination where such data is available. The combination of MTE and REE has, to the best of our knowledge, not been tested before on a similarly large scale (but see Forster & Jones this vol.) As an additional, and also to the best of our knowledge a new approach, we will assess the geochemically based matching results through the application of independent sets of archaeological and geographical data, considered within the context of the geological setting of the Hordaland region.

Sources and data

Figure 1 and Figure 2 show the datasets available for vessels and quarries. One hundred and forty-six objects from two archaeological assemblages are included in the study. The urban Bergen assemblage comprises 95 objects: 94 vessels and one piece of raw material waste (hereafter, the objects or the vessels). The urban vessels are confidently dated to between the late 11th century and c. 1170 (hereafter, the early Middle Ages) and stem from well-defined contexts in the secular parts of Bergen (for details on the dating methods and selection of archaeological sources from early Bergen, see Hansen 2005). The assemblage is considered representative of the vessels consumed in the secular parts of Bergen during the period at hand. They are denoted by the University Museum of Bergen's inventory numbers with the prefix BRM (e.g., BRM 110/5651). The urban vessels have been classified in connection with the current study, in accordance with principles outlined by Vangstad (2003, this vol.).

The rural assemblage comprises 51 vessels from rural sites in the Hordaland region. The vessels are grave and stray finds dated to the late Iron Age/Viking Age through grave-context or by typology. Information on the spatial and temporal contexts and descriptions of the vessels comes from the University Museum of Bergen's inventory (Gjenstandsbasen). The finds stem from sites across the whole Hordaland region and it is thus likely that they make up a fairly representative sample of vessels consumed in the region during the late Iron Age/Viking Age. The rural finds are denoted by inventory numbers with the prefix B (e.g., B6982/b). Compared to the urban objects, the rural counterparts are more roughly dated, and dating stray finds by typology certainly has its weaknesses, yet, for the level of detail employed here, we believe that a broad dating to the late Iron Age/Viking Age (hereafter, Viking Age) suffices. The rural vessels have not been reclassified in connection with the present study.

The quarry assemblage comprises data from 38 of c. 60 known soapstone quarries in the Hordaland region. Six quarries (Bergsholmen, Juadal, Klovsteinsjuvet, Russøy, Urda, and Vassenden) have been studied in some detail and the results documented in archive reports (Heldal et al. 2003). The remaining quarries have not been documented or studied in any detail. A systematic overview of important information such as for instance the quarries' size or date is thus not available at the present. In connection with a previous project, samples from spoil heaps were collected from the 38 quarries.

Vessel extraction marks were registered in several of the quarries. A collection of stone samples was available from that previous project (Jansen et al. 2009). Many samples from the quarries had been analysed by different geochemical methods, among others, conventional XRF measurements of MTE and ICP-MS measurements of REE; they thus constitute a useful starting point as reference material for the present study.

The 146 vessels have been sampled and the quarry samples have been analysed further to supplement the reference material. The geochemical data at our disposal has thus been supplied at different periods of time and by different laboratories, for the most part it has not been previously published. MTE data was already available from the Department of Earth Sciences, University of Bergen (GEO/UIB) for many of the quarries. In 2007, the Geological Survey of Norway (NGU) supplied MTE data for all the 146 vessels and additional analyses from the quarries. For vessels, sampling was done by cutting a piece (minimum 11 g) of each vessel fragment to be analysed. Contaminated surfaces (soil/rust/carbon) were removed by rubbing with an iron file. Geological samples (about 50 g) from the quarry waste were cleaned mechanically by cutting saw and hammer to obtain fresh surfaces. All samples of vessels and the majority of the geological samples were crushed to powder at NGU and used for both XRF and ICP-MS analyses. MTE were mostly analysed using XRF at the laboratories of the NGU, but a minor amount of geological samples was analysed at GEO/UIB, at an early stage of the project. Powder tablets were made for the major element analyses, glass tablets for trace element analyses. We generally have one MTE sample for each vessel, from each quarry between one and 11 samples are available, with five to six samples as the most common number. Data can be found in Table 1 of the Appendix.

Similarly, REE data for 19 of the quarries was already available from GEO/UIB at the outset of our study. For the urban vessels, REE was supplied from GEO/UIB in 2010, and in 2014 REE was supplied for 27 rural vessels and for 11 additional quarries. The REE analyses were carried out by ICP-MS at GEO/UIB using Element 2/Element XR (Thermo). Altogether, REE data is now available for all of the vessels from urban contexts, 27 rural vessels, and 30 quarries. We have one REE sample from each of the 122 vessels while, for the quarries, the number of samples varies from one to nine. Data can be found in Table 2 of the Appendix.

The geographical locations of the sampled quarries and the find spots for rural vessels are also datasets to be included. In the University Museum of Bergen's inventory (see *Gjenstandsbasen*), information on the Universal Transverse Mercator (UTM) coordinates and address of the find spots of the vessels are linked to the geographical centre of the so-called named farm (Navnegård) (for explanation of this term see Øye 2004:96) where the vessel is found. In the present study, the named farm thus serves as a general spatial context/address for the rural vessels. For the majority of the quarries, the UTM coordinates of the location are derived from *Askeladden*, the Norwegian National Cultural Heritage Database, while UTM coordinates for the rest of the quarries were measured by a Global Positioning System (GPS) device.

The 38 sampled quarries are located within four main geological units (Figure 2). In *Unit 1/ Melange*, 16 quarries were sampled: Unit 1 is located in the area between Sognefjorden and Hardangerfjorden and consists of a late Proterozoic to Palaeozoic melange occurring near the base of a sequence of crystalline nappes emplaced during the Caledonian orogeny that occurred from the Ordovician to Early Devonian eras, about 490 to 390 million years ago. The unit consists mainly of phyllite and mica schist with minor greenschist and metagabbro, containing a large number of lenses of ultramafic rocks (serpentinite, soapstone and talc-schist), many of which were quarried for soapstone (Andersen et al. 2012). The melange has traditionally been interpreted as a tectonic

Figure 1. *Quarries and objects, available datasets. 1) Alternative quarry names found in the literature and in Askeladden are in (brackets). 2) Number of samples and readings for major and trace element (MTE) data supplied by Geological survey of Norway (NGU) or Department of earth Sciences (GEO/UIB). 3) Number of samples and readings for rare earth element (REE) data supplied by GEO/UIB. 4) Some coordinates are from Askeladden, other from our GPS measures. 5) Svanøy is located north of Sognefjorden. 6) Two samples were cut from one object.*

Quarry no.	Quarries[1] and objects	Geological Unit	MTE[2] NGU or GEO/UIB	REE[3] GEO/UIB	Askeladden Id./ UTM X and Y[4] coordinates 33N or projection in (brackets)
1	Arnafjord (Framfjord)	1	5/1	2	37014X 6793343Y
2	Baldersheim (Sørtveit)	1	5/2	5	Id:64089/ 12582X 6703150Y
3	Bergsholmen	1	5/1	5	Id:35539/ 30309X 6699274Y
4	Bergspytt (Nes – Bergspytt)	4	5/1	3	Id:97652/ 1965X 6684954Y
5	Bru	2	5/0	1	Id:105678/ 3634X 6714998Y
6	Digranes (Tussaholo)	3	5/0		Id:101837/ 31397X 6699614Y
7	Drebrekke	3	2/1		Id:112827/ 22253X 6712948Y
8	Flatabø (Øvre, Storemyr) Flatabø (Nedre)	3	3/1	1	Id:112521/ 23907X 6712893Y Id:112522/ 23784X 6713345Y
9	Froastad	2	4/0	1	18308X 6729057Y
10	Ingahogget	4	5/0	4	1202X 6667160Y
11	Juadal	1	6/5	4	17896X 6717640Y
12	Katlaberg (Katlabrotet)	1	1/0		Id:66433/ 28725X 6707537Y
13	Klauvsteinsberg (Klauvberg)	1	0/3	2	Id:159301/ 19049X 6764527Y
14	Klovsteinsjuvet (Osvåg)	4	4/2	4	Id:143976/ 10931X 6645177Y
15	Kvernes	1	6/3	6	338526X 6791592Y
16	Kvitno	3	5/1	1	Id:101838/ 31700X 6700798Y
17	Lysekloster	2	0/6	6	31700X 6700798Y
18	Melstveit	2	2/0		Id:97434/ 18359X 6726866Y
19	Munkahogget	1	1/0		Id:97619/ 11399X 6732348Y
20	Nygård	1	4/1	1	5874.9X 6732787Y
21	Rauberg (Gryteberget)	1	6/0	1	Id:141992/ 28578X 6785882Y
22	Raudesteinane	3	2/0	2	31288 X 6701868Y
23	Russøy	1	6/3	6	Id:66527/ 30848X/6698991Y
24	Sele	2	5/0		52425 X 6657881Y
25	Sjusete	2	4/0	1	Id:97497/ 4207X 6717907Y
26	Skare	4	4/0	1	Id:101886/ 31206X 6674184Y
27	Svanøy[5]	2	4/0		Id:64080/ 25409X 6858128Y
28	Sævråsvåg (Sæverås)	1	0/8	5	Id:99976/ 29103X 6772079Y
29	Tysse (Tøsse, Blautesteinberget)	4	3/0	3	Id:90157/ 11888X 6666332Y
30	Tyssedal (Værmålen 2)	3	1/0	1	35934X 6698813Y
31	Tyssøy (Skjervika)	2	7/0	6	Id:171674/ 43103X 6724518Y
32	Urda (Urdo)	2	4/4	6	Id:66742/ 51394X 6659423Y
33	Vargahola (Vargholet) (in-complete MTE dataset)	1	1/0		Id:45493/ (33V) 28968X 6707270Y
34	Vargavåg, north (Ferstad) Vargavåg, south (Halhjem)	1	6/0	9	Id:55238/ (33V) 29286X 6706695Y Id:25533/ (33V) 29428X 6706388Y
35	Vargavåg, gryte (Os, Halhjem)	1	0/3	4	Id:60558/ 29460X 6706504Y
36	Vassenden (Handegard)	3	5/0	2	Id:112001/ 23740X 6715735Y
37	Ådland (in-complete MTE dataset)	1	2/	3	11564X 6731639Y
38	Åkra	4	4/0	4	1691X 6662950Y
	Early Medieval: 95 urban vessels		96[6]	95	79 shards could be classified to vessel type A, B or C
	Viking Age: 51 rural vessels		51/0	27	None are classified to type

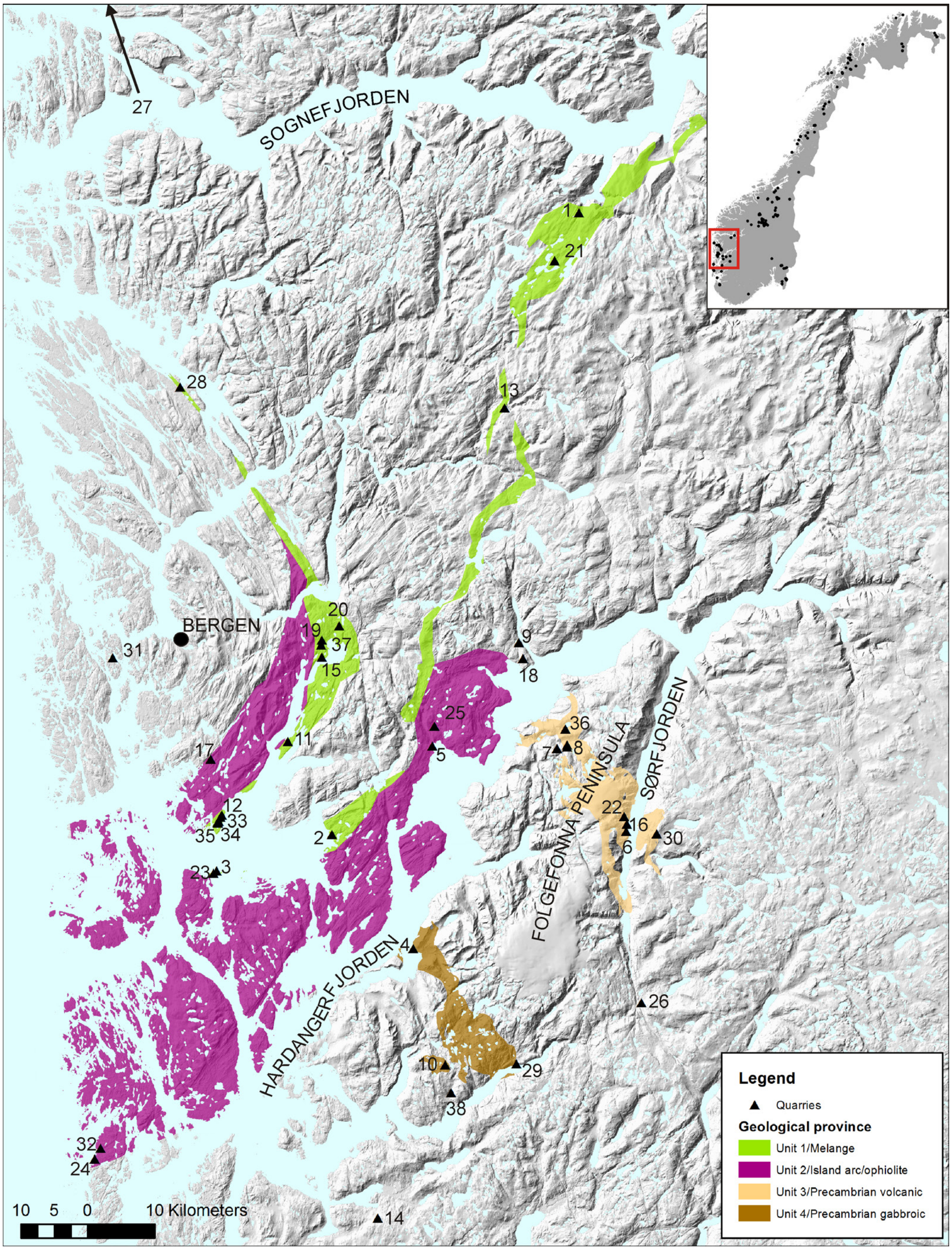


Figure 2. *The Hordaland region, 38 sampled quarries and the approximate location of the four geological units. For quarry names see Figure 1. (Geologic map partly based on Andersen et al. 2012).*

mixture of ophiolitic rocks and metasediments assembled during the Caledonian orogeny (Færseth et al. 1979; Thon 1985; Pedersen 1997). Andersen et al. (2012) later proposed the ultramafics of Unit 1 to be derived from the mantle by pre-Caledonian hyperextension of the Baltic shield. A Caledonian origin was, however, recently supported by Pedersen et al. (2015), thus indicating a common/similar origin of Unit 1 and Unit 2.

In *Unit 2 Island arc/ophiolite*, nine quarries have been sampled. Unit 2 is situated northwest of Hardangerfjorden and is characterised by dismembered ophiolites and island arc units. The two largest quarries in Unit 2, Urda and Lysekloster (Figure 2: 17, 32), are located in ultramafic bodies of the Lykling and Gulfjellet Ophiolites. Some minor quarries, mostly situated along the northwestern shores of Hardangerfjorden, are found in ultramafic lenses located within greenschists of island arc origin (Ragnhildstveit & Helliksen 1997; Ragnhildstveit et al. 1998; Andersen et al. 2012).

In *Unit 3/Precambrian* volcanic sequence, seven quarries have been sampled. Unit 3 is located southeast of Hardangerfjorden and consists of a volcanic sequence of metabasalts and metadacites called the Kinsarvik formation, dated to about 1540 (Sigmond 1998). The soapstone deposits are confined to ultramafic bodies occurring within the sequence. Most of these bodies have been transformed into serpentinite and soapstone and in some quarries a remnant core of serpentinite is found.

In *Unit 4/Precambrian gabbroic*, six quarries have been sampled. Unit 4 is located southeast of Hardangerfjorden and consists of gabbroic rocks embedded in gneisses and granites of Proterozoic age (Sigmond 1998). The soapstone deposits occur as steatised pods in the main bodies shown on the map (Figure 2) but are also found associated with small bodies not shown on the map.

The 38 sampled quarries make up about 63% of the known soapstone quarries in the Hordaland region. The 'missing' quarries are of varying size, including a few larger ones, but the four different soapstone-bearing geological units that make up the region are well represented among the 38 sampled ones. We expect that the four units display unique geochemical patterns to a certain extent, and that they collectively are representative of the Hordaland region. With the high share of sampled quarries we expect the sampled quarries to be representative for quarries in the Hordaland region on some level. We shall return to this below.

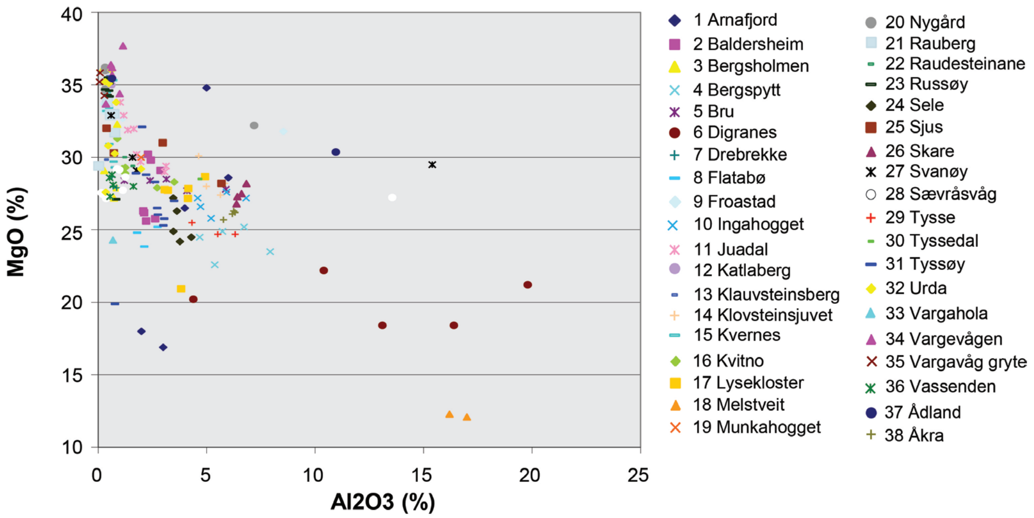
The way forward: methods and procedures

The analysis is carried out in several steps and for each step introductory tests have been performed to develop adequate procedures. In this respect the study has been a hermeneutic venture with a interdisciplinary approach at its core. Interpretation of the MTE data is, as already mentioned, the starting point. The first step is thus to match vessels and quarries through MTE; the vessels are divided into four match categories depending on the degree of MTE resemblance between vessel and quarries. The *method* behind the MTE based matches is then evaluated by testing results against the geological setting of the Hordaland region. Next, as step two, REE data is applied to the MTE based results, and new match categories are established. As the third step, the reliability of the MTE and MTE/REE based vessel match categories is then addressed and the MTE/REE based matches are evaluated through independent archaeological datasets. With these efforts, the general reliability of the various categories of geochemical vessel match is assessed. As a fourth and final step the individual vessels are given a point score and divided into six provenance groups that express the level of reliability of the individual provenancing result.

The analysis

Step 1: matching vessels and quarries through main and trace elements

An introductory test was run to find the combinations of MTE that worked best in distinguishing between the quarries. Some elements seemed more applicable than others and when combining ratios between eight elements (Al_2O_3/MgO, Co/Ni, Cr/Ni, Fe_2O_3/Ni and Zn/V) in bivariate plots, it was possible to see clusters of points that, to some degree, separated the quarries from each other (Heldal



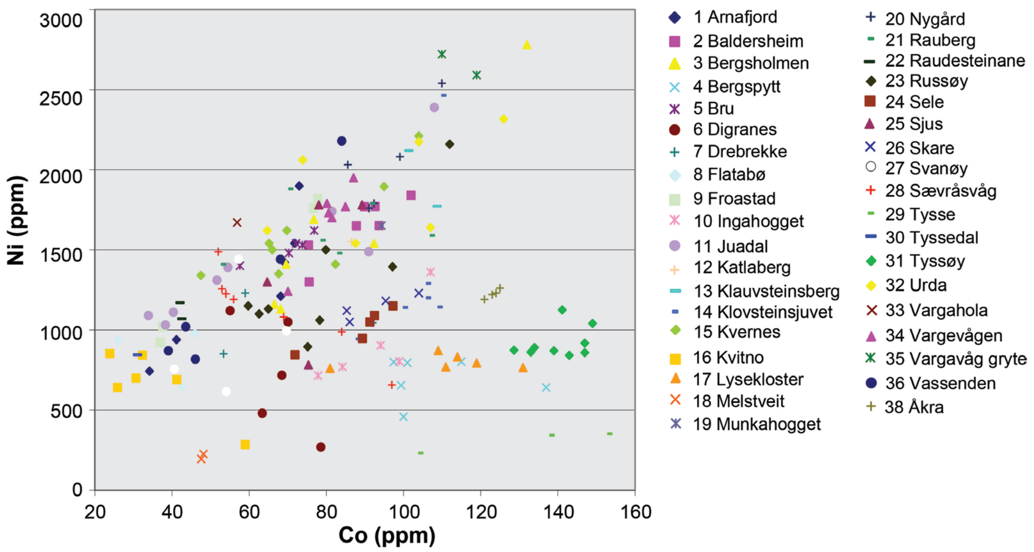
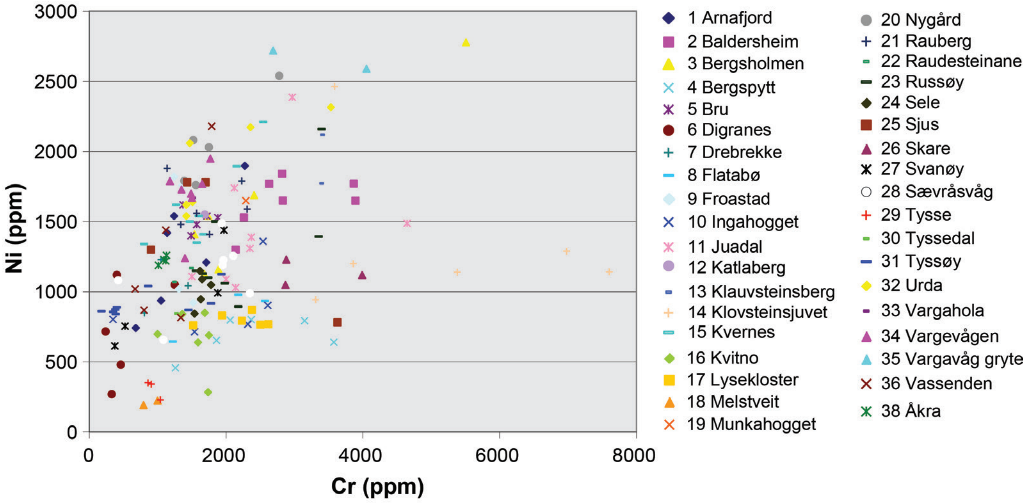


Figure 3a. *Al2O3/MgO ratios for the 38 sampled quarries.*
Figure 3b. *Co/Ni ratios for 37 sampled quarries (Ådland is not included due to incomplete Ni values).*



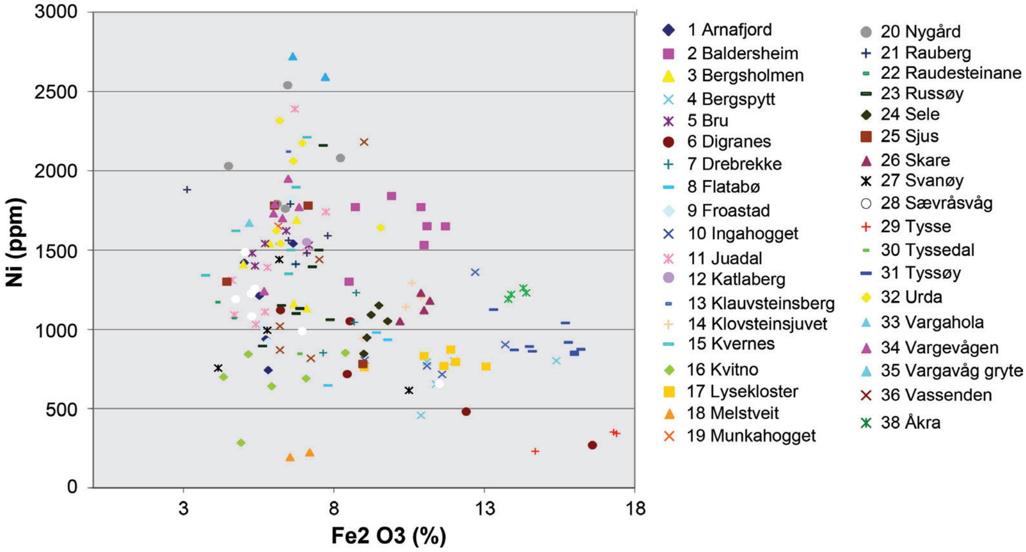


Figure 3c. *Cr/Ni ratios for 37 sampled quarries (Ådland is not included due to incomplete Ni values).*
Figure 3d. *Fe/Ni ratios for 37 sampled quarries (Ådland is not included due to incomplete Ni values).*

et al. 2008) (Figure 3a-e). Tests were also run to see if additional trace elements, especially As, Ba, and Sr, that occur in rather high and varying concentrations both in some vessels and quarries, were suitable for discrimination. The test results were, however, too inconsistent, perhaps due to the mobility of these elements in fluids at different stages in the steatisation process, and it was decided to disregard the elements.

There are some specific challenges when interpreting the MTE data. In particular, these relate to the lack of conformity regarding the measured values from each quarry, sometimes resulting in poorly defined clusters. Some clusters display an oval shape, some define a line (e.g., Åkra), or are

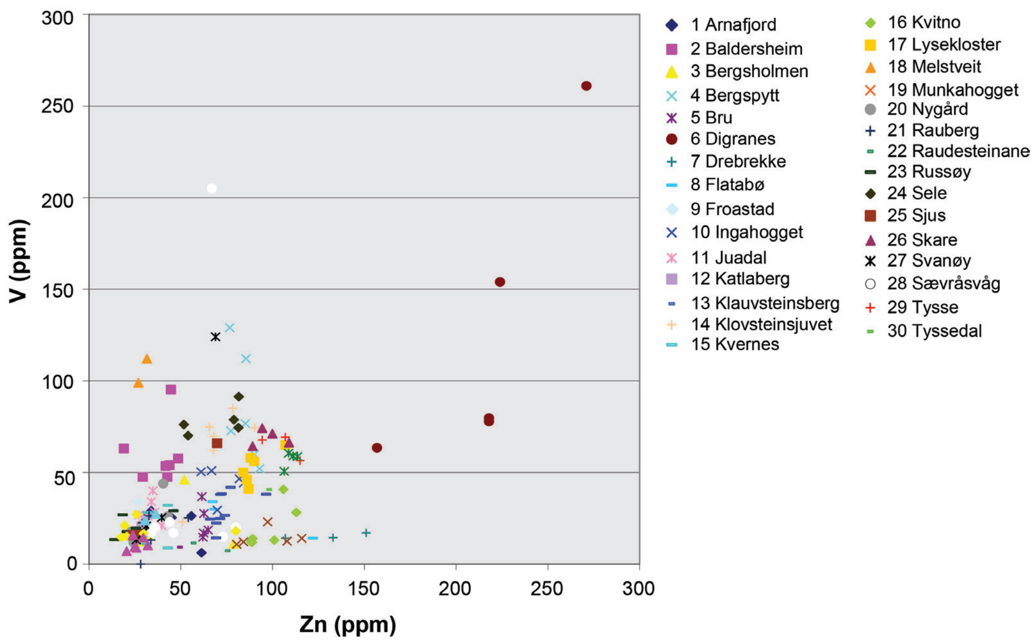


Figure 3e. *Zn/V ratios for the 38 sampled quarries.*

bimodal (two clusters from the same quarry, e.g., Froastad) while others show an irregular shape. Furthermore, some quarries with a generally well-defined cluster may contain one or two anomalous measurements plotting far from the cluster. For example, the Co/Ni values of Klovsteinsjuvet include a single anomalous value plotting far away from the rest, a result that makes us less confident in the 'cluster' (Figure 3b).

As a consequence we have, for the level of detail aimed at here, deemed the application of standard multi-component or statistical analysis on the MTE data unfruitful; in such analyses, anomalies/outliers are often disregarded. We wanted to keep the anomalies in our analyses; they could make a difference when distinguishing between many quarries in a small geographical area. Matches between the 146 vessels and the 38 quarries on the five element combinations have thus been made manually. This has been a time-consuming effort and, evidently, the decision of promising/poor match between vessels and quarries may have elements of subjectivity. Out of concern for this subjective element, the manually performed MTE matchmaking was carried out as a blind test; we neither took into consideration the temporal and spatial context of the vessels, nor the location of the quarries in relation to geological units during matchmaking.

Matches between vessels and quarries were considered valid on the specific element combination when the vessel plotted within or close to the cluster field of a quarry. An introductory test showed that, with matches on eight elements, it was often possible to single out quarries. There seems to be a breaking point around four elements, so that matches made on four or fewer elements exhibit inconsequential, or no, resemblance to the sampled quarries. With this insight, a match on eight elements is considered promising, whereas a match made on four or fewer elements is considered to be poor. By this procedure vessels were divided into categories according to the degree of match with the sampled quarries (see Figure 8 for the procedure):

- Vessels come out with a one-quarry match (1Q/MTE match) when only one quarry matches the vessel on the entire suite of eight MTE.
- When a vessel matches more than one quarry on the eight elements this results in the multiple-choice category (MC/MTE). Here, as we will see, the individual vessels match between two and eight quarries (MC2–8/MTE).
- Vessels that plot within the ratio of five to seven of the eight elements for one or more quarries are assigned to the category some regional match. These vessels match between one and four quarries (SRM1–4/MTE).
- Vessels that match the regional quarries on four or less of the eight elements are labelled poor regional match (PRM).

Figure 4. *Results of match based on MTE data.*

Four categories of **MTE** *based match*	*Number of vessels n=146*
One quarry match (1Q/MTE)	38 = 26%
Multiple choice (MC2–8/MTE)	67 = 46%
Some regional match (SRM1–4/MTE)	24 = 16%
Poor regional match (PRM/MTE)	17 = 12%

As seen in Figure 4 it is possible to give a 1Q/MTE match for 38 (26%) of the 146 vessels. Sixty-seven (46%) are matched as an MC to between two and eight quarries (MC2–MC8/MTE). Twenty-four (16%) of the vessels have SRM with one to four quarries as candidates (SRM1–4/MTE) and 17 (16%) have PRM (PRM/MTE).

Evaluation of the methodological consistency of the manual MTE matching: The location of MC2–8 and SRM2–4 quarries within geological units

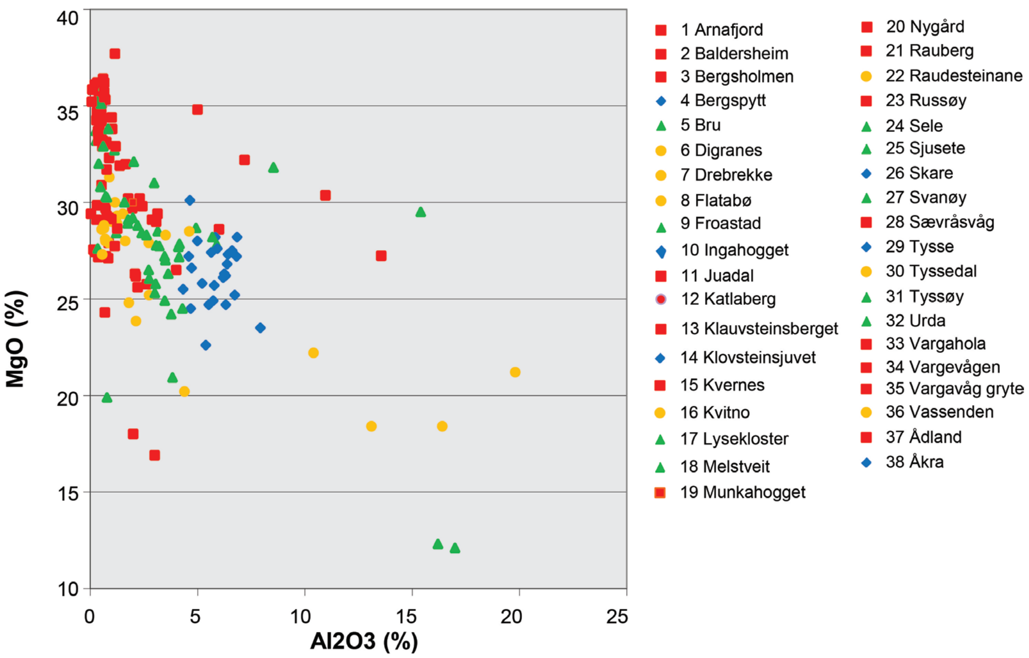
As a test of the methodological consistency the location of alternative quarry candidates for MC2–8 and SRM2–4 vessels in relation to the Hordaland region's four geological units was addressed. Behind the test is the assumption that quarries within the individual units may, at some level, have MTE compositions in common due to a shared geological history (see Alfsen & Christie 1979). If we have been able to differentiate between the units through the MTE match-making in the cases where several quarries came up as alternatives, this would be a barometer for the level of methodological consistency – and objectivity – in our manual blind-testing efforts. As a background for the test we first looked at the general MTE composition of quarries in the four geological units, to see if the quarries within each unit actually have geochemical traits in common.

MTE element composition of quarries in the four geological units

Unit 1: The majority of the ultramafic bodies in Unit 1 are described as low-Al, high-Mg mantle peridotites (Andersen et al. 2012). A similar Al/Mg ratio is recognised in most of the 16 sampled Unit 1 quarries (Figure 5a). This pattern of a high-clustering area is repeated for most of the quarries in the other discrimination diagrams, reflecting a common geochemical identity. A few Unit 1 quarries, however, form unique clusters while others do not display any clustering at all. Furthermore, some quarries with a generally well-defined cluster may contain one or two anomalies plotting far from the cluster.

Unit 2: Most of the nine sampled quarries display low-Al, high-Mg compositions similar to the Unit 1 quarries; they also cluster in similar areas as the majority of Unit 1 quarries in the other diagrams. The values of the Lysekloster and Tyssøy quarries appear in the outskirts of the high-cluster areas of Unit 1, while the values of Melstveit (see Figure 3 for cross reference to individual quarries), deviate markedly from the other quarries in Unit 2.

Unit 3 and *Unit 4*: The MTE values of the seven sampled quarries in Unit 3, as well as the six in Unit 4, have a tendency to cluster in the outskirts of the main cluster areas of Unit 1 and Unit 2



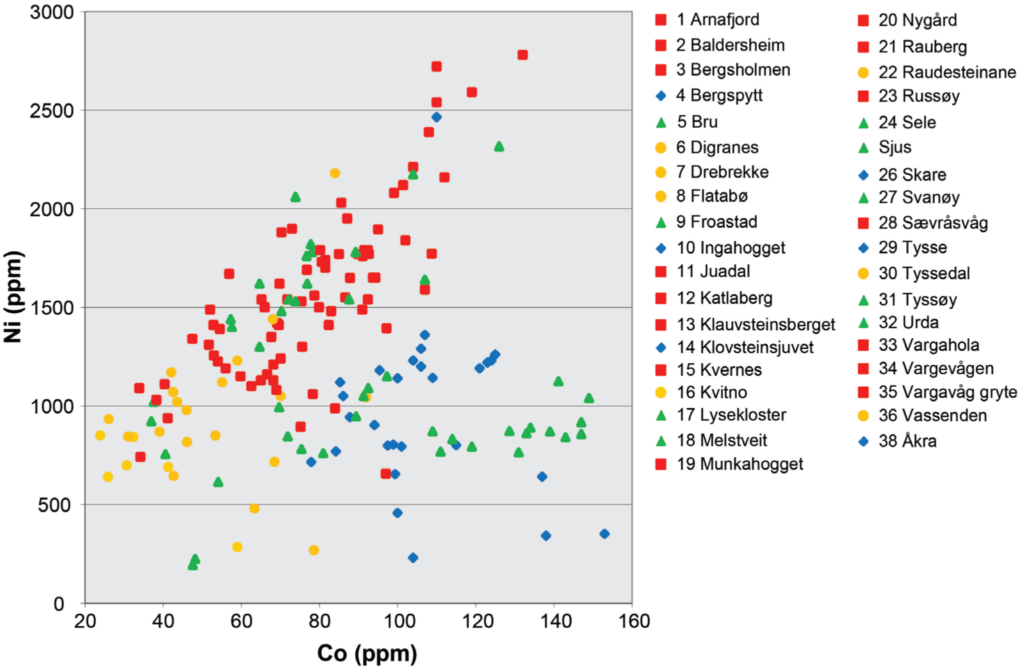
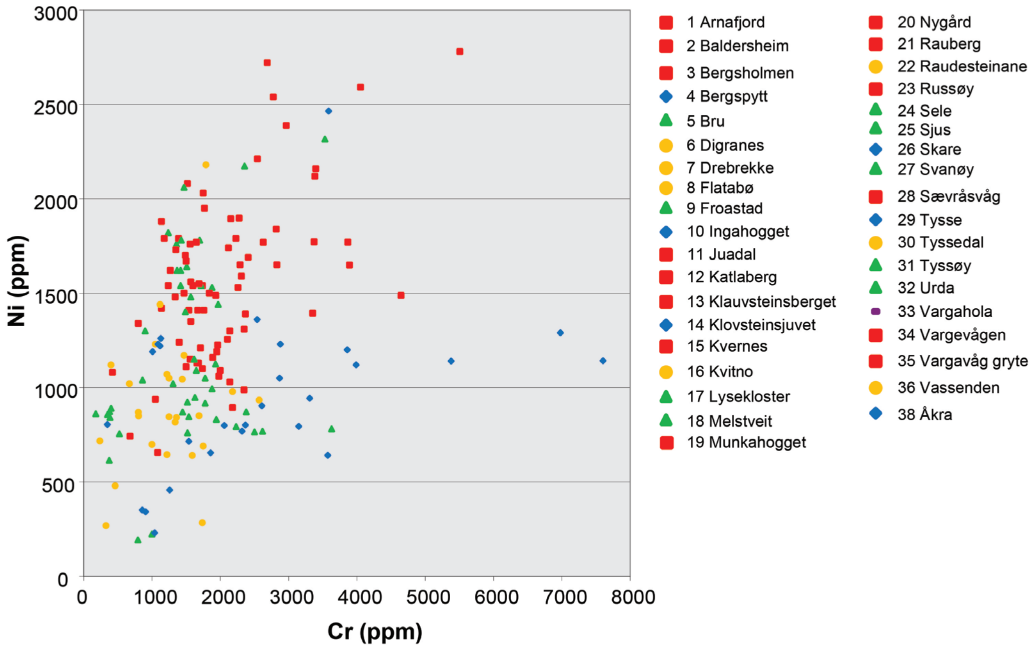
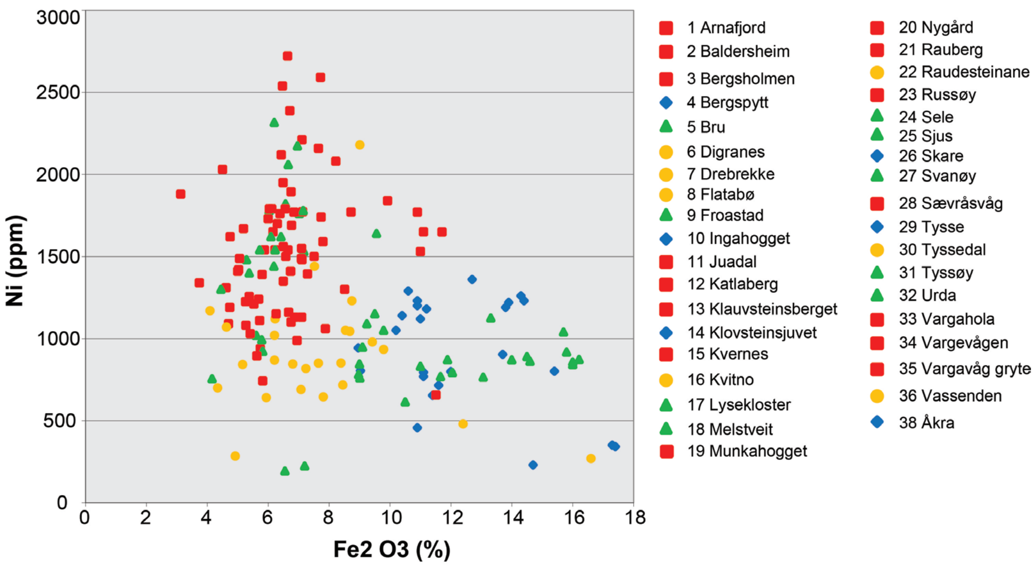


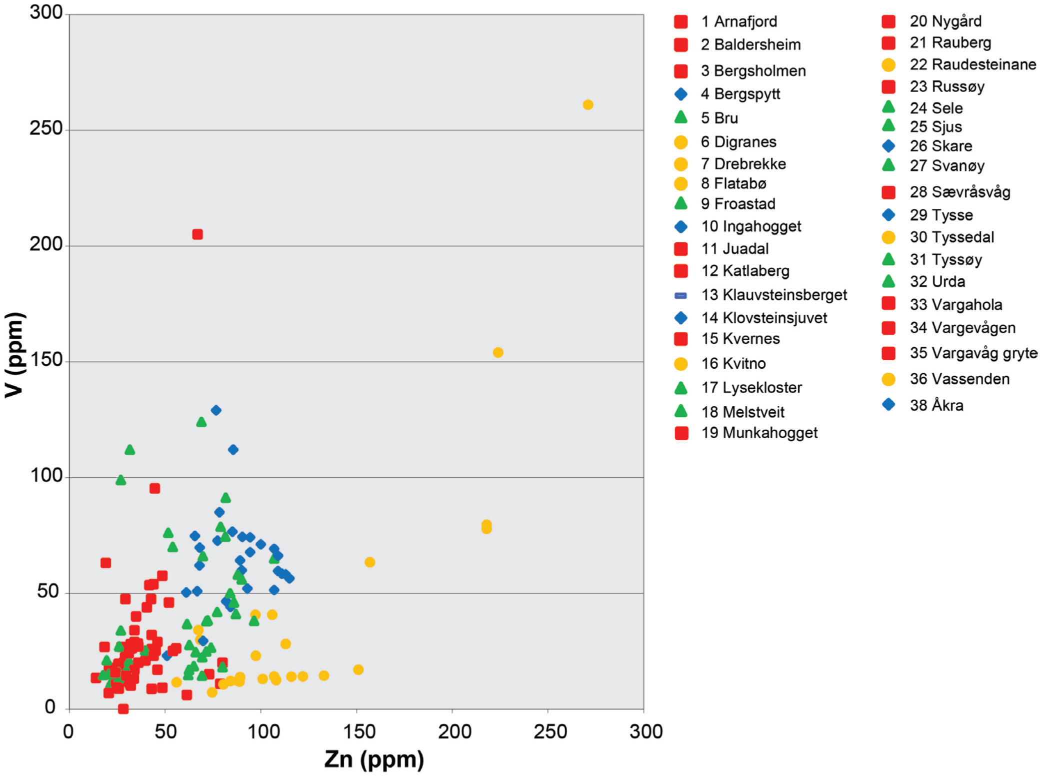
Figure 5a-e. *Al2O3/MgO, Co/Ni, Cr/Ni, Fe/Ni and Zn/V ratios for the sampled quarries. The quarries are divided in geological units: Unit 1/Melange (rectangular, red), Unit 2/Island/ophiolite (Triangle, green), Unit 3/Precambrian volcanic (Circle, orange), Unit 4/Precambrian gabbroic (Diamond, blue).*





quarries (Figure 5a–e) and Unit 4 quarries have a notable higher Al value than most others. Some quarries display a remarkably well-defined cluster (Åkra, Unit 4) for all discrimination diagrams, while others (e.g., Digranes, Unit 3 and Klovsteinsjuvet, Unit 4) are typically scattered over a large area in the plots.

To sum up, the majority of the Unit 1 quarries meet in a high cluster area on several bivariate plots. The Unit 2 quarries define some unique cluster areas, but the majority of the clusters overlap



with the Unit 1 quarries. This may be explained by the proposed Caledonian origin of the melange that makes up Unit 1 (Færseth et al. 1979; Thon 1985; Pedersen 1997; Pedersen et al. 2015), resulting in a common geological origin of Unit 1 and 2. The high degree of overlap between the MTE clusters of the quarries in Unit 1 and Unit 2 may make it difficult to distinguish between quarries in these two geological units and will thus not serve as good indicators of methodological consistency in the manually performed blind test matches. Unit 1 and Unit 2 are thus treated as one (Unit 1&2) in the test below. The tendency of the Unit 3 and the Unit 4 quarries to cluster in the outskirts or in separate areas of the main cluster areas of the Unit 1 and Unit 2 main cluster areas, is convenient when evaluating the methodological consistency in the manually performed MTE matchmaking.

The test

We now have a look at the location of alternative quarry candidates in the cases where vessels are matched with several quarries (MC2–8 and SRM2–4). We want to see if the vessels' alternative quarries are located within one or within several geological units. This will, to reiterate, be a barometer for the methodological consistency of the blind-test matchmaking efforts.

For 54 of the 67 MC/MTE vessels (80%) the alternative quarries are located within one geological unit or Unit 1&2 (Figure 6). This shows that we have been able to discriminate consistently between the geological units in these cases of manual blind test matching. The systematic correspondence between the location of alternative quarries and geological units shows that the blind test match based on eight elements has been carried out with a large degree of consistency.

The spatial patterns made up by the quarries that were associated with the 15 SRM2–5/MTE

Figure 6. *The location of the MC2–8/MTE and SRM2–4/MTE vessels' quarries in the geological units.*

MTE based vessel match category/quarries in different geological units	***'One unit' and Unit 1&2***	***Unit 1 and Unit 3***	***Unit 2 and Unit 4***	***Unit 3 and Unit 4***	***Unit1,Unit 2 and Unit 3***
Multiple choice (MC2–8/MTE) n=67	54 = 80%	9 = 13%	2 = 30%	-	2 = 83
Some regional match (SRM2–4/MTE) n=15	8 = 53%	3 = 20%	2 = 13%	2= 13%	-

vessels show that the alternative quarries associated with each of the vessels in eight of 15 cases (53%) are located within one geological unit or in Unit 1&2. There are thus less consistent spatial patterns discerned in the SRM/MTE matches than within the MC/MTE vessel matches. While this could suggest that the SRM matches were carried out in a less consistent way than the MC matches, this would be strange, since all categories of matches were identified through the same procedures. A more likely explanation is that, since the SRM match is made between vessels and quarries on fewer elements (between five and seven elements), the common denominator is less complex, permitting a vessel's geochemistry to fit in with more units. This is an interesting observation to which we are going to return below in the evaluation of the geochemically based matches.

Another interesting observation is the very fact that such a large share of the MC vessels systematically match quarries confined to individual units. This may convincingly suggest that, even if we are not able to make a match to an individual quarry, a match to a geological unit seems feasible. This is yet another observation to bear in mind in the further analyses.

Altogether then, the test shows that a very large share of the MC/MTE vessels matched quarries that are located within one geological unit; the same goes for a fair share of the quarries matched with SRM/MTE vessels. These trends lend general confidence to the methodological execution of the manually performed MTE matching between vessels and quarries. With this insight we will go on to step two in the analysis: the application of REE data to the MTE based matches.

Step two: application of REE data to the MTE based matches

We have REE data from 122 vessels and 30 quarries. In this part of the analysis, the vessels' REE patterns are compared with those of the relevant quarries suggested by the MTE analysis. Before doing so, a look at the available REE data from the quarries in the four geological units is necessary. We want to assess the degree of intra-source variation in REE contents within quarries where several samples have been analysed, as well as the degree of inter-source variation between the quarries within the respective geological units. This leads to an assessment of the weight with which REE can be applied to the MTE matches.

REE: a background

REE data are plotted in so-called normalised diagrams, where concentration in the sample divided by concentration in a chosen standard (Chondrite, Boynton 1984) is plotted on the Y axis and different elements are plotted on the X axis by increasing atomic number and thus forming profiles, a standard method in geochemistry. The REE profiles of the sampled quarries display a range of patterns varying from symmetrical or asymmetrical, convex downwards or convex upwards, or flat, and with more or less significant Europium (Eu) anomalies that range from positive to negative.

Unit 1: Eleven of the 16 Unit 1 quarries were matched with vessels through MTE. REE data is available from all of these 11 quarries, although for two of the quarries, REE data are rather

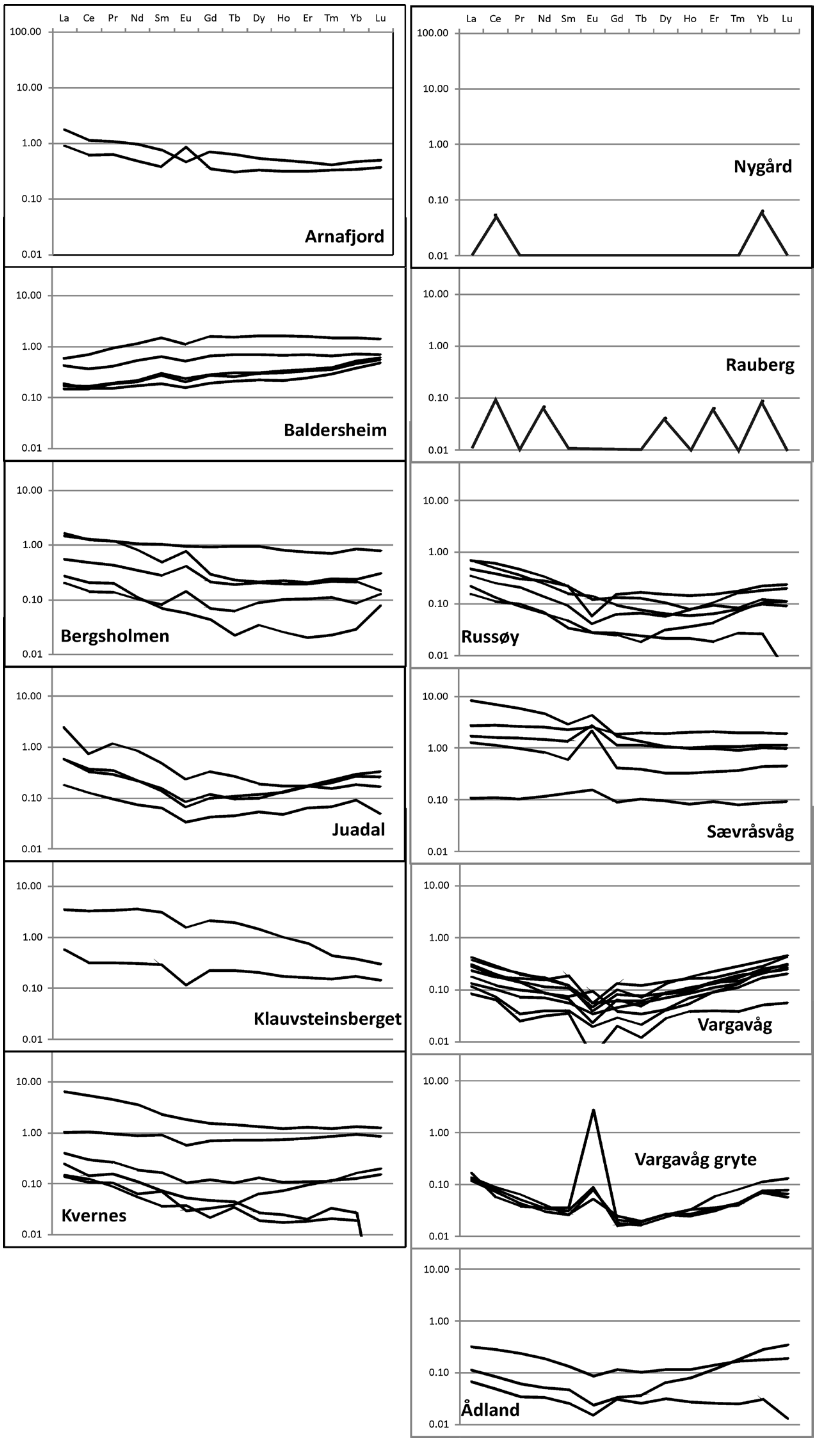


Figure 7a. *REE profiles of quarries in Unit 1.*

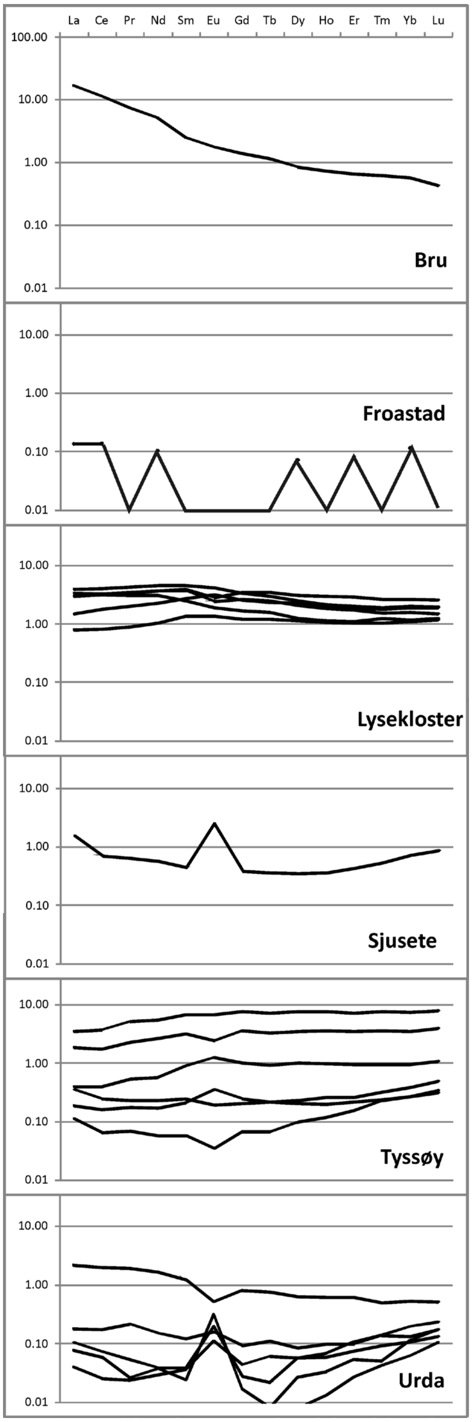


Figure 7b. *REE profiles of quarries in Unit 2.*

incomplete due to concentration below analytical detection limit (Nygård and Rauberg) (Figure 7a). The Bergsholmen, Kvernes, and Russøy quarries display a high degree of intra-source variation with a diverse range of profiles reflecting the internally inhomogeneous composition of the deposits. The remaining quarries display less intra-source variation, however; only the convex upwards profiles of Baldersheim and the U-shaped profiles of the Vargavåg quarries can be said to display little internal variation. Eu anomalies are common, both depleted (low values) and enriched (high values), and in some quarries both types are present. An example of highly contrasting Eu anomalies in nearby deposits is found in two of the neighbouring quarries, Vargavåg and Vargavåg gryte, situated about 100 metres from each other. At Baldersheim, the profiles display distinct REE profiles with a relative enrichment of the heavy REE elements (HREE) (right side of the diagram) quite different from all other Unit 1 quarries. Altogether, there are examples both of intra-source variation and of relatively little variation within the quarries in Unit 1. The REE profiles of the soapstone deposits in Unit 1 seem to reflect a varied and complex geological development with a range of different patterns present.

Unit 2: Eight of the nine Unit 2 quarries were matched with vessels through MTE. REE is available for six of these (Figure 7b). The Urda quarry shows an intra-source variation ranging from U-shaped profiles with marked positive Eu anomalies, to nearly flat or slightly light REE (LREE) enriched patterns with a small negative Eu anomaly. The characteristic REE pattern of the Lysekloster quarry displays little intra-source variation. Also the Tyssøy quarry's profiles show relatively little internal variation in REE patterns, but with a large range of concentrations and both small negative and positive Eu anomalies. Tyssøy shows a general enrichment of HREE, a rare trend among the sampled quarries, but still present in some quarries in all the units (e.g., Baldersheim in Unit 1, Flatabø and Raudesteinane in Unit 3 and Klovsteinsjuvet in Unit 4). From the quarries along Hardangerfjorden, only one REE sample is available for each (Bru, Froastad and Sjusete) and the degree of intra-source variation cannot be determined. Some REE were not detected in the Froastad quarry sample, but the available REE data may indicate a REE profile with similarities to Sjusete, although there are major differences in the concentrations. The profiles of the soapstone deposits in Unit 2 seem to reflect a complex geological situation, with both high and low intra-source variation. There also seems to be some degree of inter-source variation, although the sparse number of samples for some quarries requires that this observation be made with some reservations.

Unit 3: Five of the seven sampled quarries in Unit 3 matched vessels on MTE. REE data is available for four of these, and for one additional quarry that did not match any vessels (Figure 7c). Only one or two profiles are available for each quarry, making it hard to judge the degrees of intra-source variation. Three of the quarries display rather similar sub-horizontal profiles, including a large vessel quarry at Raudesteinane. Flatabø displays increased values of the HREE, a trend that is not shared with any other Unit 3 quarry. Eu anomalies are negative for all Unit 3 quarries. U-shaped REE profiles are not found in Unit 3. Apart from Flatabø, there is relatively little inter-source variation among the sampled Unit 3 quarries.

Unit 4: The six sampled quarries in Unit 4 matched vessels on MTE, and REE data is available for all of these (Figure 7d). Five of the quarries have more than one profile available and, with the exception of some variation in the profiles of Ingahogget and Klovsteinsjuvet, they display relatively little intra-source variation. Apart from the Åkra quarry and partly Klovsteinsjuvet, the REE profiles consistently show negative Eu anomalies. The content of REE is notably high in Unit 4, between 10 and 1 ppm. U-shaped REE profiles are not found in Unit 4. There is relatively little inter-source variation among the sampled Unit 4 quarries.

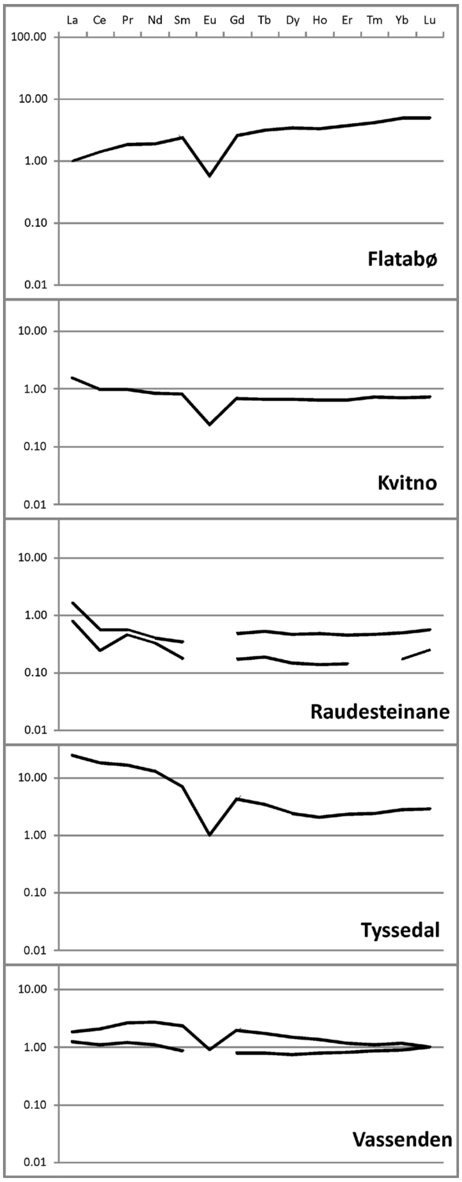


Figure 7c. *REE profiles of quarries in Unit 3.*

The limitations of the REE data for discrimination between quarries become clear from the above.

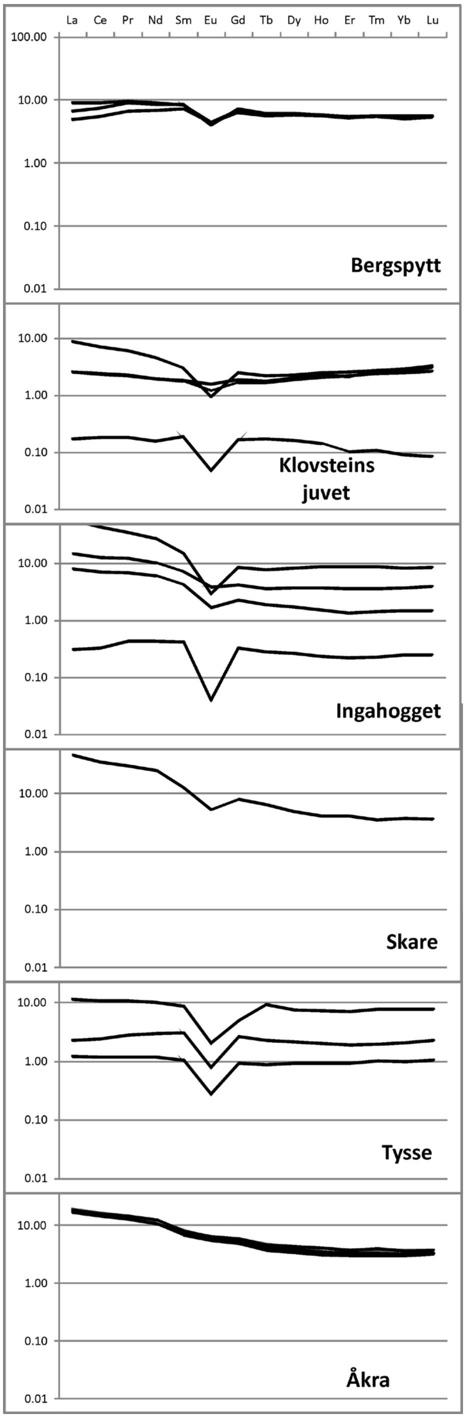


Figure 7d. *REE profiles of quarries in Unit 4.*

Intra-source profile variations prevail within all of the geological units, but to a lesser degree in Units 3 and 4. Some quarries with several REE profiles available display little internal variation, whereas many show internal profile variations reflecting the inhomogeneous composition of the rocks. With this variety in internal pattern displayed both on the level of geological units and on the level of individual quarries we do not find it feasible to make a positive match between a vessel and a quarry based on REE alone. Instead, however, quarries that have been matched with vessels through MTE can be rendered improbable/implausible through REE when vessel and quarry REE patterns do not show acceptable correspondence (for similar observations see Forster & Jones this vol.). With this procedure, the REE pattern of the vessels will be compared to that of their MTE matched quarries and the vessels are divided into categories according to their degree of match based on both MTE and REE. We hold as a premise that, if the REE patterns show acceptable correspondence, the reliability of the MTE match between vessel and quarry is strengthened. This premise is, as we will show, supported below.

The application of REE to the MTE matches

REE data is available for 122 vessels (Table 2 in the Appendix); however, since REE is not available for all quarries, REE is practically only available for 112 vessels and all their matching quarries. In 34 cases, then, REE data are not available for either vessels or all the relevant quarries. For these 34 cases, we consider the REE data to be inconclusive. When comparing the vessel's REE pattern with that/those of MTE matched quarries, the results are given as 1Q, MC2–8 or SRM1–4. The procedure and terminology is described below and shown in Figure 8:

- If the REE pattern of a quarry suggested in a 1Q/MTE match shows an acceptable degree of correspondence with that of the vessel, the match now qualifies as a 1Q match based on MTE&REE (1Q/MTE&REE).

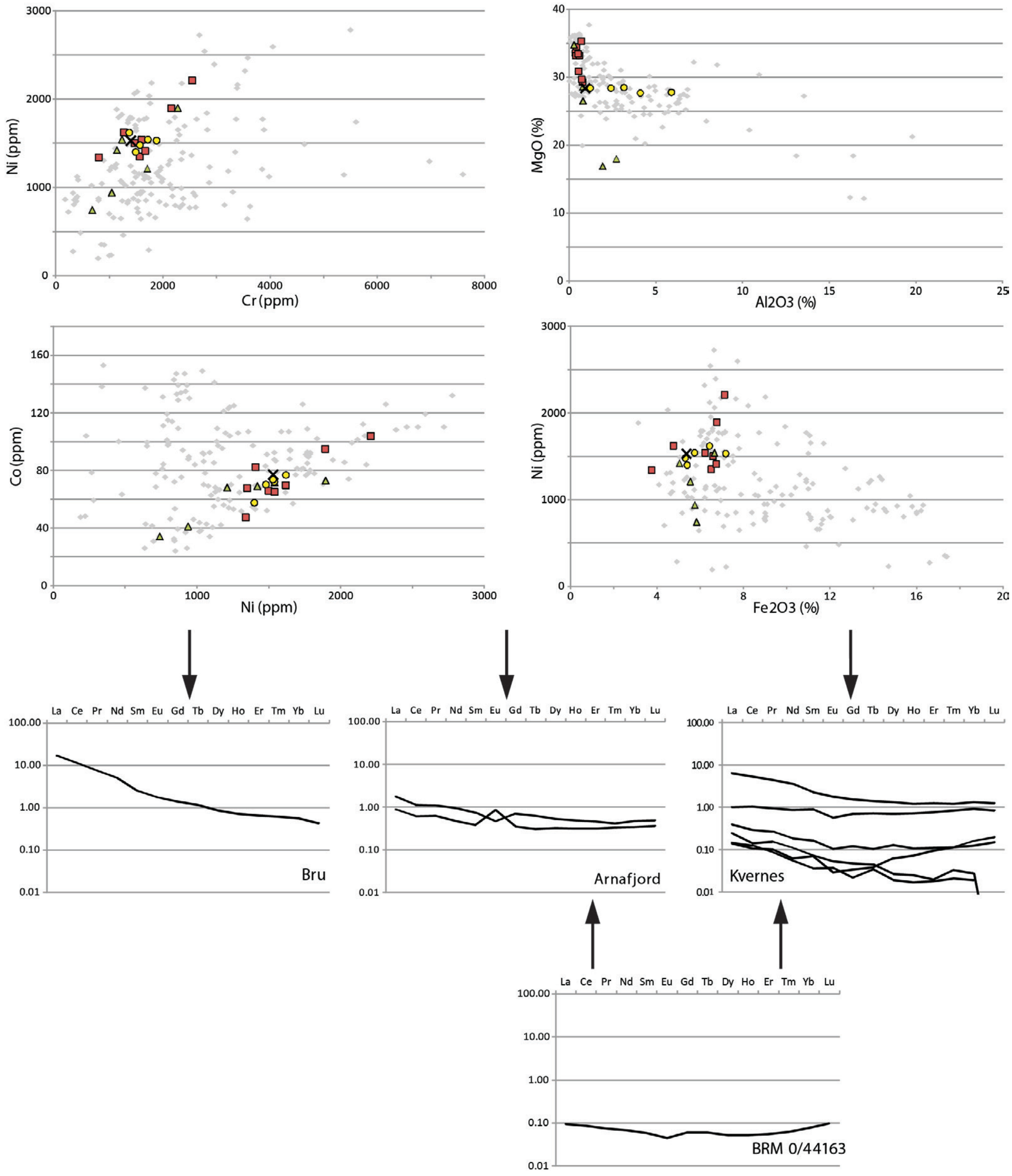


Figure 8. *The matchmaking history of the urban vessel (cross) BRM 0/44163. Three quarries came out as relevant during the MTE analysis: The MC3/MTE choice of quarries are Bru (square), Arnafjord (triangles) and Kvernes (circles). The vessel's REE pattern shows an acceptable degree of correspondence with profiles of the Arnafjord and Kvernes quarries, whereas Bru's profile differs considerably. Bru is thus rendered improbable, the number of eligible quarries is reduced to two, and BRM 0/44163 is now a vessel in the MC2/MTE&REE match category.*

- If the REE pattern of one or several alternative quarries suggested in an MC/MTE or an SRM/MTE match shows an acceptable degree of correspondence with that of the vessel, the match now qualifies as a 1Q match based on MTE&REE (1Q/MTE&REE) or an MC match based on MTE&REE (MC/MTE&REE), or an SRM match based on MTE&REE (SRM/MTE&REE).
- If one or all quarries suggested in a 1Q/MTE or MC/MTE match are rendered improbable by REE, quarries that have matched the vessel on between five and seven elements are tested if such have been identified during the MTE analysis. If any of these quarries have REE patterns with an acceptable degree of correspondence with that of the vessel, the match now qualifies as SRM based on MTE&REE (SRM/MTE&REE).
- If all quarries suggested by MTE as 1Q, MC or SRM are rendered improbable by REE, the vessel goes into the category PRM based on MTE and REE (PRM/MTE&REE).

Through these procedures it is possible to give a 1Q/MTE&REE-match for 43 (38%) of the 112 vessels/objects (Figure 9). Nineteen (17%) have an MC match with between two and five quarries (MC2–5/MTE&REE) and the number of relevant quarries is thus reduced in many cases. Eleven (10%) of the vessels have SRM with one or two quarries as candidates (SRM1–2/MTE&REE) and 37 (33%) now have a PRM.

Compared to the results based on MTE alone, we see that, when applying REE, a larger share of the vessels are now matched with only one quarry, and a larger share seem to have a poor match with the Hordaland region's quarries.

Figure 9. *Results of match based on MTE&REE data for 112 vessels.*

Five categories of match based on MTE&REE, where REE is available for vessels and all quarry alternatives	***MTE&REE n=112***
One quarry match (1Q/MTE&REE)	43 = 38%
Multiple choice (MC2–5/MTE&REE)	19 = 17%
Some regional match (SRM1/MTE&REE)	11 = 10%
Some regional match (SRM2/MTE&REE)	2 = 2%
Poor regional match (PRM)	37 = 33%

Step three: evaluating the reliability of the geochemically based match categories

The reliability of the categories of MTE and MTE/REE based matches is now assessed through five approaches. First, we will see how the categories of MTE based matches 'responded' to the application of REE. Then, independent sets of data will be drawn upon, while applying, among other, spatial analyses and Visual Impact Analysis (VIA). The aim of applying a VIA is to see if regular or random patterns are visible when independent sets of data are studied spatially (Emmelin 1984; Hansen 2008). In these analyses, vessel dates and find contexts, as well as the geological unit of quarries, are parameters drawn upon. The details are elaborated upon below. If regular patterns or trends in the spatial distribution of independent sets of data are discerned and these patterns coincide with patterns in the geochemically based matches, this may offer insight into the reliability of these matches between vessels and quarries. The typology of the urban vessels is also included in the evaluation.

Evaluation of the MTE based matches using REE

With the premise that REE profiles with an acceptable degree of correspondence strengthen the MTE based matches and that quarries can be rendered improbable through REE, an overview of how the categories of MTE based match 'responded' to the application of REE data gives an indication of the reliability of the categories of MTE based matches. This in turn provides guidance on how much trust to place in the 34 cases where REE are not available.

For the 38 1Q/MTE vessels (Figure 4), REE data was available for both vessel and relevant quarries in only 29 cases (Figure 10). For 16 of these (55%) there was an acceptable degree of correspondence between the REE pattern of the vessel and that of the quarry. In six cases (21%), quarries with five to seven elements in common with the vessels (SRM) had acceptable REE patterns, whereas for the remaining seven vessels (24%), no quarries were relevant and they were 'sent' to the PRM group. Altogether, then, 76% of the 1Q vessels had a REE profile that had an acceptable degree of correspondence with the quarries in the Hordaland region selected through matches on five to eight MTE, but 24% ended up as PRM.

For the 67 MC/MTE vessels, REE was available for vessel and all quarries in 52 cases. In six (12%) of these 52 cases, there was an acceptable degree of correspondence between the REE pattern of the vessel and those of each of the alternative quarry candidates. For 40 (77%) of the 52 MC vessels, one or more of the quarries were rendered improbable and the number of eligible quarries was reduced to between one and five. For two vessels, SRM/MTE quarries became eligible and had REE patterns with an acceptable degree of correspondence. Only four cases (8%) became PRM. Thus, 88% of the MC vessels had a REE profile that had an acceptable correspondence with that of one or more of the regional quarries selected through matches on eight MTE, while only 8% ended up as PRM.

Fifteen of the 24 SRM/MTE vessels had REE data as well as REE available for all quarry alternatives suggested through MTE match. For the six cases where only one quarry was a candidate (SRM1), REE rendered the quarry improbable in four cases. In three of the nine cases with alternative quarries (SRM2–5), the number of quarries was reduced. In the last six cases, the alternative quarries were considered improbable through REE. Altogether then, in five (33%) of the 15 SRM cases where REE data were available for both vessels and all involved quarries, there was acceptable correspondence

Figure 10. *Correspondence between match made through MTE and REE for 112 vessels.*

Correspondence between match made through MTE and REE	***Correspondence REE pattern all quarries involved = none rendered improbable through REE***	***Correspondence, for some quarries, some rendered improbable = number of quarries reduced through REE***	***Correspondence, with 5–7 element (SRM) quarries***	***No correspondence = all quarries rendered improbable through REE***
One quarry match (1Q) REE available for the vessel and quarry n=29	16 = 55%	0 = 0%	6 = 21%	7 = 24%
'Multiple choice' (MC2–9) REE available for all vessels and quarries n=52	6 = 12%	40 = 77%	2 = 4%	4 = 8%
'Some regional match' (SRM1) REE available for the vessel and quarry n=6	2 = 33%	0 = 0%	–	4= 66%
'Some regional match' (SRM2–5) REE available for the vessel and all quarries n=9	–	3 = 33%	–	6 = 66%

between the REE pattern of the vessel and that of one or more of the alternative quarries suggested through MTE.

If we can trust these numbers to be relevant for all the MTE matches, there is an 88% chance that one or more quarries in the MC/MTE match category would have had acceptable REE patterns and that only 8% of these matches would have ended up in the PRM/MTE&REE category. This implies that the MC/MTE matches are generally quite trustworthy. Regarding the 1Q/MTE vessels, it seems that matching a single quarry is difficult through MTE alone; as many as 45% of the matches to single quarries were dismissed through REE. Even if a large share of these vessels became SRM vessels, altogether one quarter of the 1Q matches ended up as PRM/MTE&REE. This suggests that 1Q/MTE matches should be considered less trustworthy on a general basis than the MC/MTE matches, and should be considered carefully with this in mind. This also applies to the SRM/MTE vessels, where 66% of the matches to the suggested quarries were rendered improbable by REE.

These results and insights are taken into consideration when giving individual vessels a provenance point score below. We will proceed to further evaluate the geochemically based matches through other datasets.

The distribution of match categories in rural versus urban assemblages

The rural vessels are, as we recall, from Viking Age contexts in the Hordaland region, whereas the urban vessels stem from early medieval Bergen. If there are systematic differences in the distribution of vessel match categories within the two vessel assemblages, and if these have 'independent' social and historical explanations, this may lend confidence to the geochemistry based match categories.

Figure 11 shows the distribution of the MTE and MTE&REE based match categories in the rural and urban assemblages. It is interesting to note that the rural assemblage has a notably smaller share of PRM match vessels than the urban counterpart. If we first look at numbers based on MTE alone, only one (2%) of the rural vessels does not find a matching quarry in the region, while in the urban assemblage the share is 16 vessels (17%). As a result of a chi square test (X2-test) (Siegel 1956:174-179, 249), the null-hypothesis of a random distribution of the match categories can be rejected on a highly significant level i.e. the probability of a random distribution causing the pattern is lower than 1%.

In the 11th and 12th centuries, Bergen was certainly connected to inter-regional networks of trade and exchange (Hansen 2005). It is not unlikely that households in Bergen would have had access to soapstone vessels through interregional networks to a higher degree than households in rural Viking Age Hordaland. If we accept this assumption, it would plausibly explain the differing distribution of the match categories, and lend support to the credibility of the PRM/MTE category in particular, and suggests that the poor match with the region's quarries is real. It also lends support to MTE based matches on a general level.

Turning to the distribution of PRM categories based on MTE&REE, the pattern with a higher

Figure 11. *Categories of MTE and MTE&REE matches for the rural and urban vessels.*

Four categories of match based on MTE (n=146 vessels) and on MTE&REE (n=112 vessels)	***MTE rural vessels n=51***	***MTE urban vessels n=95***	***MTE&REE rural vessels n=21***	***MTE&REE urban vessels n=91***
One quarry match (1Q)	19 = 37%	19 = 20%	13 = 61%	30 = 33%
Multiple choice (MC)	20 = 39%	47 = 49%	1 = 5%	18 = 20%
Some regional match (SRM)	11 = 22%	13 = 14%	5 = 24%	8 = 9%
Poor regional match (PRM)	1 = 2%	16 = 17%	2 = 10%	35 = 38%

share of PRM in the urban versus the rural vessel assemblage is strengthened; the urban share has increased to 38%, whereas only one more rural vessel is added to the PRM category (10%). Why has the urban share increased so much more than the rural? One factor may be that the number/share of rural vessels with available REE is small and statistics on small numbers can be hazardous. Again, however, the null-hypothesis of a random distribution of the match categories can be rejected on a highly significant level (1%). So the trend seems clear: hardly any of the rural 1Q, MC or SRM were considered improbable and sent to the PRM category by REE. And since the same methodological procedures have been followed on the two vessel assemblages, the trend should not be explained as a problem inherent in the analytic methods or data. Rather, the increased share of urban PRM matches may be given independent social and historical explanations; we would actually consider it very likely that there are more 'strangers' among the urban vessels than among the rural. If we accept this, the increased share of PRM among the urban vessels suggests that the ability of REE to render quarries improbable/implausible is real. It also lends support to the PRM/MTE&REE as trustworthy, in the sense that poor matches with the region's quarries are real. Furthermore, it lends strong general confidence to matches made on both MTE&REE. This insight is taken into consideration when giving individual vessels a provenance point score below.

The geographical location of quarries with matches to the rural versus the urban vessel assemblages

The geographical location of quarries that were matched with, respectively, rural Viking Age vessels and early medieval urban vessels as 1Q/MTE&REE or MC/MTE&REE matches is the next dataset to be addressed.

The spatial distribution of quarries that gave 1Q/MTE&REE-match to 43 rural and urban vessels shows clear trends. Regarding the quarries that match the 13 rural vessels, all quarries except one (that has matched three vessels) are located in the area southeast of Hardangerfjorden. Quarries that match the 30 urban vessels are all, except three (that have matched altogether four vessels), located northwest of this fjord.

A similar analysis of the 19 vessels with an MC2–5/MTE&REE match and their alternative quarries produced these patterns: for the single rural vessel that was matched with multiple quarries, all alternative quarries are located southeast of Hardangerfjorden. For 16 of the 18 urban MC vessels the alternative quarries are all located northwest of this fjord. The remaining two urban MC/MTE&REE vessels have matched quarries that are located on either side of the fjord. The trends in the spatial patterns formed by the MC/MTE&REE matches are accordingly similar to those formed by the 1Q MTE/REE matches: the majority of quarries matched with the urban vessels are located northwest of Hardangerfjorden and the majority of quarries that were matched with the rural vessels are located southeast of Hardangerfjorden.

The quarries have, with few exceptions, not been studied archaeologically; their social and historical context is thus not well established. The separate dates and contexts of the two object assemblages, however, coincide so well with the trends in the spatial pattern provided by the quarries that it is unlikely that the patterns are a product of methodological errors or qualities inherent the geochemical data. So we will argue that the coinciding patterns imply that the 1Q/MTE&REE and MC/MTE&REE matches are not random. They must have – so far unexplored – social and historical explanations, and this lends general support to the validity of 1Q/MTE&REE and MC/MTE&REE matches made between vessels and quarries. This insight is taken into consideration when giving individual vessels a provenance score below.

An important point is that the geographical area northwest of Hardangerfjorden corresponds to geological Unit 1&2, and the area southeast of the fjord corresponds to geological Unit 3 (the northern part of the Folgefonna peninsula) and Unit 4 (the southern part of the Folgefonna peninsula). If all quarries had been located within one unit/geological setting, the pattern would probably not be so clear. Thus, the geological setting is very favourable for the clear patterns discerned here.

The find location of 1Q and SRM/1 rural vessels versus the location of their quarry candidate

The transport distances between the find spot of 1Q and SRM1 rural vessels and their quarry candidate are addressed as yet another spatial approach to evaluate the geochemically based matches. Valleys probably constituted natural passageways over land, however, given the weight of soapstone, waterways (in particular, the fjords) must have been preferred (cf. Resi 1979:125). Topographic maps and tools in ArcGIS have been used to estimate the approximate transport distance along waterways or valleys between quarries and vessel find spots. Vessels that are found within a transport distance of 0–10 km from the quarry are, according to our definition, found *in the vicinity* of this quarry. If found within a transport distance of 11–30 km from the quarry, we consider the vessel as *local*. Vessels that are found beyond 30 km, but along a natural transport route between the quarry and the find spot of the vessel are considered *regional with favourable accessibility*. Vessels that are found further than 30 km away from the quarry candidate but not along a convenient transport route are labelled *regional*. When vessels are found in the vicinity or in the local area of their quarry candidate, we consider such a spatial circumstance as a strong indication that the match between vessel and quarry is trustworthy. If vessels are found further than 30 km from a quarry candidate, whether or not along a convenient transport route in relation to 'their' quarry this is, however, *not* considered to be an indication of a mismatch.

Three of the 13 rural 1Q/MTE&REE-vessels were found in the vicinity and two were found within the local area of their quarry (Figure 12). For five of these 13 1Q rural vessels, the find location of the vessels versus the location of their matching quarry thus lends strong support to the particular matches made and confidence to the 1Q/MTE&REE match category as a whole. Concerning the nine 1Q/MTE vessels where REE was not available for analysis, two vessels were found in the local area of their quarry. This lends strong support to these two 1Q/MTE matches in particular.

Addressing the five SRM1/MTE&REE vessels, three were found in the vicinity of their matching quarries, lending strong support to these three particular matches. Of the two SRM/MTE vessels, one was found in the vicinity of its matching quarry. This lends strong support to this particular match, and this spatial analysis suggests that some of the matches made on less than eight MTE may be reliable. This insight is taken into consideration when giving individual vessels a provenance score below.

Figure 12. *Distance between find spot for 1Q and SRM1 rural vessels and their quarry candidate.*

Transport distance between the find spot for 1Q and SRM/1 rural vessels and 'their' quarry	*Number of rural 1Q vessels n=13 MTE&REE*	*Number of rural 1Q vessels n=9 MTE*	*Number of SRM/1 rural vessels n=5 MTE&REE*	*Number of SRM/1 rural vessels n=2 MTE*
Vicinity of quarry (0–10 km)	3	0	3	1
Local area of the quarry (11–30 km)	2	2	0	0
Regional, (more than 30 km) but with *favourable accessibility* along transport route from quarry to vessel find spot	4	2	0	0
Regional (more than 30 km), but not along any natural transport route from quarry to vessel find spot	4	5	2	1

The typology of the urban vessels

Vessel typology may also provide interesting insights into the reliability of the geochemically based matches. The urban vessels, as already mentioned, have been classified in connection with the study. Vessels of the medieval types A and B were most likely produced in western Norway (Lossius 1977). It is not known whether differences among these types had functional or chronological significance, or whether both types were produced in the same quarries. We thus expected to find both types A and B within an assemblage of vessels quarried in the Hordaland region. Type C is, however, held to be of eastern Norwegian origin (Lossius 1977: 63–67) and if such vessels are among the urban vessels, their 'matching history' will be interesting for an assessment of the general reliability of the geochemically based matches (for an illustration of the vessel types see Vangstad this vol.).

Among the urban vessels, 79 could be classified according to type. Seventy were of type A, seven of type B and two were of the eastern Norwegian type C. Based on typology, there are thus only two obvious strangers in the urban assemblage. The inventory numbers of the type C vessels are shard (1) BRM 0/80455 and shard (2) BRM 110/5651. We shall have a look at their match history.

Shard 1 was assigned to the MC3/MTE category. Three different quarries, i.e., Ingahogget and Klovsteinsjuvet (in geological Unit 4) and Lysekloster (in Unit 2) all came out with a match on eight elements, while a fourth quarry (Sele in Unit 2) came in with a five element match. The three quarries that matched on eight elements did not have REE patterns with any acceptable degrees of correspondence to the vessel's REE pattern, so they were discarded in accordance with the principles outlined above. The fourth quarry, Sele, came up as an SRM1 alternative that was up for testing. Since we do not have REE data for Sele, the shard was classified as inconclusive during the REE analysis. Accordingly, it remained in the category MC3/MTE with the three eight-element quarries as alternatives, even if they quite likely should have been ruled out.

Shard 2 was assigned to the SRM2/MTE group by matches on six elements with the Ingahogget quarry (Unit 4) and with the Sele quarry (Unit 2) on five elements. The REE profile of Ingahogget had an acceptable degree of correspondence with the vessel's REE pattern; however, since Sele did not have REE data, this shard was also classified as inconclusive during the REE analysis and it remained in the SRM/MTE group. Had we not known the typology of the two shards they would not have been recognised as strangers through the analyses of geochemical data.

These two type C shards both have MTE compositions showing traits in common with two different geological units in the Hordaland region. These examples may imply that the geochemical composition of vessels that match quarries in more than one unit may find better or similar parallels in other parts of Norway as well. Geological knowledge (see Sturt et al. 2002) tells us that some of the Hordaland units may have equivalents in other parts of Norway, so we should probably not be too surprised. This calls for some attention and some scepticism regarding vessels matched with quarries in several geological units. One of the shards has an REE profile that is acceptable within a Hordaland regional context that may also call for attention and supports our supposition that discriminating between quarries cannot be based on REE alone. This insight is taken into consideration when giving individual vessels a provenance point score below.

Conclusion on step three: the evaluation of the general reliability of the geochemically based matches

The analyses of the distribution of, respectively, PRM/MTE and PRM/MTE&REE, match categories in the rural versus the urban assemblages lend support to the validity of REE in rendering quarries improbable/implausible. Our premise, that the application of REE data strengthens the MTE based matches, thus finds support.

The analyses have resulted in several categories of geochemically based matches between vessels and regional quarries. These categories may, if no other evidence supports the match, be used with varying degrees of confidence:

- 1Q/MTE: vessels that matched one quarry on eight MTE. The application of REE to these matches rendered many improbable, and showed that one must use the individual 1Q/MTE matches with caution if no additional data, such as the co-location of the find spot of the vessel and its matching quarry, can support the match.
- MC/MTE: vessels that matched several regional quarries on eight MTE. The application of REE to this category of matches showed that a high degree of trust can be placed in trends in the MC/MTE matches. It is thus quite likely that one of the quarries that matches the vessel's geochemistry may actually have delivered the vessel. If the vessel's matching quarries are all located within one geological unit it is considered likely that the vessel stems from this unit. As a contrast, the matching history of a MC/MTE type C vessel indicated that the geochemical composition of MC/MTE vessels with a match to quarries located in more than one geological unit may be so general that it fits with geological units outside the Hordaland region as well. Taking this observation into consideration, MC/MTE matches to quarries in more than one geological unit are regarded as less trustworthy.
- SRM/MTE: vessels that are matched with the regional quarries on between five and seven MTE. The application of REE to these matches deemed two thirds improbable, so the individual SRM/MTE matches must be perceived as uncertain if no additional data, such as the co-location of the find spot of the vessel and its matching quarry, can support the specific match. The matching history of a SRM/MTE type C vessel indicated that the geochemical composition of vessels with a match to quarries located in more than one geological unit may be so general that it fits into geological units outside the Hordaland region. Taking this observation into consideration, SRM/MTE matches to quarries in more than one geological unit are treated as untrustworthy.
- PRM/MTE: vessels that are matched with the regional quarries on four or fewer MTE. The over-representation of PRM/MTE among the urban vessels, compared to the rural, implies that the trends in the MTE based PRM matches may have some validity, making it likely that these vessels do not stem from regional quarries.
- 1Q/MTE&REE and MC/MTE&REE: vessels that matched one quarry or multiple quarries on eight MTE and that have an REE profile that has an acceptable degree of correspondence with the profile(s) of its matching quarry. The increased difference in the representation of 1Q/MTE&REE and PRM/MTE&REE among the urban vessels versus the rural assemblages, and the coinciding patterns in the geographical locations of quarries that matched respectively the rural and medieval 1Q/MTE&REE and MC/MTE&REE vessels all lend strong support to the validity in the trends of these two categories of geochemically based matches. Furthermore, the close distances between the find spots of some 1Q/MTE&REE rural vessels and their quarry candidates lend support to the validity of the match category on a general level and strong support to the concrete matches in particular. Matches with a single quarry are considered relatively well established, whereas provenance to the geological unit of the quarry is considered reliable.
- SRM/MTE&REE: vessels that match regional quarries on five to seven MTE. The close distances between some SRM/MTE&REE vessels and their matching quarries give strong support to these concrete matches in particular, and show that some matches made on less

than eight elements may be trustworthy when combined with REE.

- PRM/MTE&REE: vessels that matched regional quarries on four or less MTE, or had an REE profile without an acceptable correspondence to those of the quarries matched on five to eight elements. The fact that all the 1Q/MTE vessels that ended up as PRM/MTE&REE after the application of REE were urban vessels lends support to the geochemically based methods applied and thus suggests that the MTE&REE classification of these vessels as PRM is trustworthy on a general level.

Altogether, in spite of favourable evaluations of most of the geochemically based match categories, the matching history of two 'strangers', both type C vessels, showed that the geochemically based methods used here are not watertight. These two cases implied that the geochemical composition of vessels that match quarries in more than one geological unit may be so common or general that it finds parallels in other parts of Norway as well. One of the shards had a REE profile that would be acceptable in a Hordaland regional context, which also calls for attention and supports our supposition that discriminating between quarries cannot be based on REE alone. In any one case there will be the possibility of a false match.

Step four: the individual vessels are scored and divided into provenance groups

Based on the assessments above, the individual vessels are now given a point score to quantitatively express the reliability of their match/mismatch with the sampled quarries/the Hordaland region. The vessels can gain or lose points depending on their stepwise performance through steps one to three in the analysis above. For the score this principle has been followed (Figure 13): vessels that came out with a one 1Q result on eight MTE are given three points, vessels that came out with multiple quarries on eight MTE are given four points, vessels that came out with a score on five to seven MTE are given two points and PRM vessels (four or less elements) are given zero points. Vessels with a REE profile that shows an acceptable degree of correspondence with that of the matching quarry(ies) gain two points, whereas profiles without any acceptable degree of correspondence lose two points. If a vessel's find spot is in the vicinity of the matched quarry, this results in three added points; if in the local area two points are added. If vessels matched more than one quarry that are located in different geological units (treating Unit 1&2 as one) one point is deducted from the score. Finally, if the vessel is of type C, all points are lost.

All in all, the sum of points expresses the degree of reliability of the match between the vessel and the sampled quarries in the Hordaland region, based on geochemical and archaeological data and analytic methods. Thus, for the PRM vessels, a low score is an indication that it is trustworthy that the vessel is not from the sampled quarries in the region.

Provenance groups and provenancing results

Through use of the provenance points and an eye to the evaluation of the general reliability of the geochemically based match categories, the vessels can now be divided into six provenance groups, where the reliability of provenance is characterised as reliable, quite reliable or tentative (Figure 14).

- Group 1 comprises vessels from the category 1Q/MTE&REE, as well as SRM1/MTE&REE vessels that are found in the vicinity or local area of their matching quarry. These 49 vessels each have six to nine points. Within this group, provenance to a single quarry is considered quite reliable, whereas provenance to the geological unit of the quarry is considered reliable.
- Group 2 comprises 15 vessels from the categories 1Q/MTE and SRM1/MTE&REE. These vessels have three to four points. Within this group, provenance to the single quarry is considered to be tentative, whereas provenance to the geological unit of the quarry is considered quite reliable.

Figure 13. *Individual vessel's points, gained and lost.*

Vessel	*Points gained*	*Points lost*
1Q MTE (8 MTE in common with one quarry)	3	
MC MTE(8 MTE in common with several quarries)	4	
SRM MTE (5–7 MTE in common with one or more quarries)	2	
PRM MTE (4 or less MTE in common with the sampled quarries)		0
REE profile acceptable for quarries selected through 5–8 MTE	2	
1Q & MC & SRM: REE not in accordance with any quarry alternatives selected through 5–8 MTE		2
Quarry in the *vicinity* of 1Q and SRM1vessel's find spot	3	
Quarry *local* in relation to 1Q and SRM1vessel's find spot	2	
MC/MTE and SRM/MTE quarries in various geological units (treating Unit 1&2 as one)		1
MC/MTE&REE and SRM/MTE&REE quarries in various geological units (treating Unit 1&2 as one)		1
Typology, C vessel		All

- Group 3 comprises 17 vessels that have matched several quarries in the category MC/MTE&REE. The matching quarries are all located within the same geological unit or within Unit 1&2. The vessels have six points. Within this group, provenance to one of the quarries is considered quite reliable and provenance to the geological unit of the quarries is considered reliable.
- Group 4 comprises 10 vessels in the MC/MTE category where all alternative quarries are located within a single geological unit or within Unit 1&2. The vessels have three to four points. Within this group, provenance to one of the specific alternative quarries is considered to be tentative, whereas provenance to the geological unit of the quarry is considered quite reliable.
- Group 5 comprises 15 vessels that, for various reasons, have not passed the matching procedures without problems. The vessels have a point score of one to four, so some score quite well. However, for 14 of the 16 vessels in this group, REE data are not available for vessel or quarry, so they have not been able to go through the matching procedures with a robust set of data. Many of the vessels are matched to more than one quarry (MC/MTE&REE, MC/MTE, SRM/MTE and SRM/MTE&REE) and in many cases these quarries are located in different geological units. The reliability of the matches between vessels and the region's quarries can neither be established nor dismissed with any certainty.
- Group 6 comprises vessels in the PRM/MTE and PRM/MTE&REE vessel categories. These 40 vessels have zero or one point scores and it is considered quite reliable that they are not from the Hordaland region.

The aim of the study was to assess the provenance of 146 vessels from Viking Age rural Hordaland and early medieval Bergen. For 131 vessels, a reliable, quite reliable, or tentative provenancing result has been found. The list of provenancing results for the individual vessels, with provenance point score, group assignment and their origin/quarry(ies) is given in Figure 15, see Table 3 in the Appendix for full overview of provenancing result.

Figure 14. *Six provenance groups established by use of the provenance 'point-sum' and an eye to the evaluation of the general reliability of the geochemically based match categories.*

Six provenance groups (n=146 vessels)	*Point sum*	*Provenance to the selected quarry*	*Provenance to one selected quarries*	*Provenance to geological unit*	*Not from the Hordaland region*
Group 1 (n=49)	6–9	Quite reliable		Reliable	
Group 2 (n=15)	3–4	Tentative		Quite reliable	
Group 3 (n=17)	6		Quite reliable	Reliable	
Group 4 (n=10)	3–4		Tentative	Quite reliable	
Group 5 (n=15)	1–4	Reliability neither established or dismissed	Reliability neither established or dismissed	Reliability neither established or dismissed	Reliability neither established or dismissed
Group 6 (n=40)	0–1				Quite reliable

Figure 15. *Provenancing result for the 146 vessels, with provenance point score, group assignment and their origin/ quarry(s). Rural vessels with a B-prefix, urban vessels with a BRM-prefix.*

Object no.	MTE	MTE & REE	Group 1–6	Quarry selected Group 1–6	Score
BRM 0/42937	1Q	1Q	1	Kvernes	5
BRM 0/43530	NRM	NRM	6		0
BRM 0/43549	NRM	NRM	6		0
BRM 0/44163	MC3	MC2	3	Arnafjord/Kvernes	6
BRM 0/44650	SRM1	Quarry no REE	5	Digranes	2
BRM 0/44931	MC4	1Q	1	Urda	6
BRM 0/44934	MC7	MC5	3	Arnafjord/Bergsholmen/Juadal/Kvernes/Urda	6
BRM 0/44998	NRM	NRM	6		0
BRM 0/45373	1Q	NRM	6		1
BRM 0/45465	MC3	MC2	3	Bergsholmen/Kvernes	6
BRM 0/45548	MC2	1Q	1	Kvernes	6
BRM 0/45695	1Q	NRM	6		1
BRM 0/45792	MC3	1Q	1	Bergsholmen	6
BRM 0/45810	NRM	NRM	6		0
BRM 0/45843	NRM	NRM	6		0
BRM 0/45857	NRM	NRM	6		0
BRM 0/45938	NRM	NRM	6		0
BRM 0/46144	SRM1	SRM1	2	Baldersheim	4
BRM 0/54177	MC5	1Q	1	Kvernes	6
BRM 0/54478	MC2	1Q	1	Kvernes	6
BRM 0/54795	MC3	MC3	3	Kvernes/Urda/Bergsholmen	6
BRM 0/55200	SRM2	NRM	6		0
BRM 0/63018	1Q	NRM	6		1
BRM 0/63600	MC2	1Q	1	Bergsholmen	6
BRM 0/63801	1Q	1Q	1	Urda	5
BRM 0/63998	MC3	1Q	1	Urda	6
BRM 0/64002	MC3	1Q	1	Bergsholmen	5
BRM 0/64060	1Q	NRM	6		1

Object no.	MTE	MTE & REE	Group 1–6	Quarry selected Group 1–6	Score
BRM 0/64141	NRM	NRM	6		0
BRM 0/64255	NRM	NRM	6		0
BRM 0/64272	NRM	NRM	6		0
BRM 0/64393	MC2	1Q	1	Kvernes	6
BRM 0/64422	MC3	MC2	5	Bergsholmen/Vassenden	4
BRM 0/64487	MC3	1Q	1	Kvernes	6
BRM 0/64621	1Q	1Q	1	Baldersheim	5
BRM 0/64638	MC2	1Q	1	Kvernes	6
BRM 0/64641	MC3	1Q	1	Urda	6
BRM 0/64657	SRM1	NRM	6		0
BRM 0/64742	MC2	1Q	1	Russøy	6
BRM 0/64786	MC2	MC2	3	Sjusete/Urda	6
BRM 0/64803	SRM1	NRM	6		0
BRM 0/64828	MC2	MC2	3	Bergsholmen/Kvernes	6
BRM 0/64984	MC3	1Q	1	Kvernes	6
BRM 0/64994	MC3	1Q	1	Bergsholmen	6
BRM 0/65004	SRM2	NRM	6		0
BRM 0/65007	MC2	1Q	1	Bergsholmen	6
BRM 0/73087	NRM	NRM	6		0
BRM 0/73155	SRM3	SRM2	5	Arnafjord/Vassenden	2
BRM 0/73346	NRM	NRM	6		0
BRM 0/73353	NRM	NRM	6		0
BRM 0/73441	MC4	SRM1	2	Bru	4
BRM 0/75316	SRM3	NRM	6		0
BRM 0/75671	1Q	SRM1	2	Juadal	3
BRM 0/75767	MC3	MC3	5	Bergsholmen/Sævråsvåg/Vassenden	5
BRM 0/77526	1Q	1Q	1	Ingahogget	5
BRM 0/77531	MC4	1Q	1	Sævråsvåg	5
BRM 0/77564	SRM4	SRM1	2	Kvernes	4
BRM 0/77576	1Q	1Q	1	Sævråsvåg	5
BRM 0/79750	1Q	SRM1	2	Russøy	3
BRM 0/80155	MC3	1Q	1	Kvernes	6
BRM 0/80210	MC4	1Q	1	Sævråsvåg	6
BRM 0/80253	SRM1	NRM	6		0
BRM 0/80455	MC3	Quarry no REE	6	Ingahogget/Klovsteinsjuvet/Lysekloster/Sele	0
BRM 0/80803	MC6	MC4	3	Bergsholmen/Kvernes/Russøy/Sævråsvåg	6
BRM 0/80852	MC4	MC3	3	Kvernes/Rauberg/Vargavåg	6
BRM 0/80871	1Q	1Q	1	Bergspytt	5
BRM 0/81128	1Q	SRM1	2	Rauberg	3
BRM 0/81366	MC3	MC3	3	Bergsholmen/Kvernes/Rauberg	6
BRM 0/81374	MC3	NRM	6		2
BRM 0/85416	MC8	MC2	3	Rauberg/Vargavåg	6
BRM 0/85447	MC6	MC3	3	Bergsholmen/ Kvernes/ Russøy	6

Object no.	MTE	MTE & REE	Group 1–6	Quarry selected Group 1–6	Score
BRM 0/85448	MC8	MC4	3	Bergsholmen/Froastad/Kvernes/Russøy	6
BRM 0/85465	1Q	1Q	1	Sævråsvåg	5
BRM 0/85502	MC7	1Q	1	Urda	6
BRM 0/85503	MC8	MC5	3	Bergsholmen/Juadal/Kvernes/Russøy/Urda	6
BRM 0/85556	NRM	NRM	6		0
BRM 0/85580	SRM2	NRM	6		0
BRM 0/85591	MC8	MC4	3	Bergsholmen/Kvernes/Russøy/Sjusete	6
BRM 0/85635	1Q	NRM	6		1
BRM 0/86150	MC3	NRM	6		2
BRM 0/86199	MC2	1Q	1	Urda	6
BRM 0/86220	MC6	MC2	3	Bergsholmen/Sjusete	6
BRM 0/86878	NRM	NRM	6		0
BRM 3/697	1Q	1Q	1	Kvitno	6
BRM 3/702	1Q	SRM2	4	Kvitno/Vassenden	3
BRM 76/11041	MC4	NRM	6		2
BRM 76/11048 # 2	Same as #1	Same as #1			
BRM 76/11048 # 1	1Q	NRM	6		1
BRM 104/2180	MC3	1Q	1	Ingahogget	5
BRM 104/2299	MC2	MC2	3	Bergsholmen/Sævråsvåg	6
BRM 104/2356	NRM	NRM	6		0
BRM 110/5518	MC4	NRM	6		2
BRM 110/5651	SRM2	Quarry no REE	6		0
BRM 110/5959	1Q	NRM	6		1
BRM 110/6463	MC2	Quarry no REE	4	Urda/Vargehola	4
BRM 237/1277	SRM2	NRM	6		0
B4253	1Q	1Q	1	Kvitno	5
B4369	SRM2	Quarry no REE	5	Bergspytt/Digranes	1
B4432	1Q	Vessel no REE	2	Sævråsvåg	3
B4719	MC6	Vessel no REE	4	Bergsholmen/Kvernes/Rauberg/Russøy/Urda/Vargavåg	4
B4836	1Q	1Q	1	Tysse	5
B6204	MC2	1Q	1	Bergspytt	9
B6982/b	MC3	Vessel no REE	4	Froastad/Juadal/Russøy	4
B7018	1Q	Vessel no REE	2	Sævråsvåg	3
B7019	1Q	Vessel no REE	2	Kvitno	3
B7105	SRM3	Vessel no REE	5	Nygård/Vargavåg gryte/Vassenden	1
B7829	1Q	1Q	1	Sævråsvåg	7
B7888	1Q	1Q	1	Klovsteinsjuvet	8
B7925	1Q	1Q	1	Kvitno	5
B7960	1Q	1Q	1	Kvitno	5
B8300	MC4	Vessel no REE	4	Drebrekke/Flatabø/Kvitno/Vassenden	4
B8308	MC4	1Q	1	Sævråsvåg	8
B8321	MC6	Vessel no REE	4	Bergsholmen/Katlaberg/Kvernes/Nygård/Rauberg/Vargavåg	4

Object no.	MTE	MTE & REE	Group 1–6	Quarry selected Group 1–6	Score
B8995	SRM3	Vessel no REE	5	Bergsholmen/Juadal/Kvernes	2
B9976	SRM2	Quarry no REE	5	Digranes/Kvitno	2
B10270	1Q	Vessel no REE	2	Svanøy	3
B10454	SRM1	SRM1	2	Bergspytt	4
B10457	MC4	Quarry no REE	5	Drebrekke/Kvitno/Sævråsvåg/Vassenden	3
B10462/a	MC2	1Q	1	Vassenden	5
B10462/b	SRM1	Vessel no REE	1	Bergspytt	5
B10462/c	MC2	Vessel no REE	5	Sævråsvåg/Vassenden	3
B10462/d	SRM2	NRM	6		0
B10481	1Q	SRM1	1	Flatabø	5
B10655	1Q	SRM1	1	Kvitno	5
B10680/a	1Q	Vessel no REE	1	Åkra	5
B10680/b	1Q	Vessel no REE	2	Skare	3
B10697	1Q	Vessel no REE	2	Raudesteinarne	3
B10980	MC2	Vessel no REE	4	Kvernes/Rauberg	4
B11115	SRM2	Quarry no REE	5	Bergspytt/Digranes	1
B11116	MC2	Vessel no REE	5	Arnafjord/Kvitno	3
B11422	SRM1	Vessel no REE	5	Bergspytt	2
B11551/a	MC5	Quarry no REE	4	Juadal/Kvernes/Nygård/Urda/Vargavåg	4
B11564/g	MC3	Vessel no REE	5	Sævråsvågen/Raudesteinane/Vassenden	3
B11630	1Q	Vessel no REE	1	Sævråsvåg	5
B11636	MC5	Vessel no REE	5	Juadal/Kvernes/Nygård/Urda/ Vassenden	3
B11686	MC5	Vessel no REE	4	Bergsholmen/Juadalen/Rauberg/Russøy/Urda	4
B11797	1Q	1Q	1	Skare	5
B11815/b	1Q	1Q	1	Åkra	8
B11835	MC3	Quarry no REE	4	Arnafjord/Kvernes/Svanøy	4
B11867/a	SRM3	SRM1	1	Bergsholmen	6
B11868/b	SRM1	NRM	6		2
B11869/c	1Q	Vessel no REE	2	Sævråsvåg	3
B11878/a	MC2	1Q	1	Sævråsvåg	5
B12025/b	MC2	1Q	1	Vassenden	6
B12050/a	MC4	MC3	3	Bergspytt/Ingahogget/Klovsteinsjuvet	6
B12314	MC2	SRM1	2	Juadal	4
B12372	NRM	Vessel no REE	6		0

Immediate social and historical implications of the provenancing results, suggestions for further studies

Using the six provenance groups defined above, we want to pursue some of the provenancing results' immediate implications in social and historical terms. We also comment on directions for further studies. We hold as a premise that the provenancing results for individual vessels in Group 1 and Group 3 are quite reliable and that trends in the results (i.e., that more than one 'result' points in the same direction) in these groups are reliable. Furthermore, the provenancing results of individual vessels in Group 2 and Group 4 are held to be tentative, and, as such, cannot carry an argument alone. Whereas trends formed by vessels in these groups can support an argument. As mentioned initially, the urban assemblage is reliably dated and considered representative for vessel consumption among ordinary people in Bergen during the early Middle Ages. Being aware that the rural counterpart, with fewer and less well dated objects, may not be quite as representative for vessels consumed in the Hordaland region during the Viking Age, we nevertheless assume heuristically in the discussions below, that the rural assemblage is quite representative for vessels consumed in the area during the Viking Age.

Interesting spatial patterns emerged when coupling information on the contexts and dates of vessels versus their matching quarries. We want to pursue four areas of implications regarding the dating of activities in the quarries, the identification of distinct quarry-districts, the character of soapstone vessel production in the Hordaland region, and the existence of PRM vessels.

Dating production in the quarries

Previous research has pointed to the Hordaland region as an important area for vessel production during the Viking Age (Petersen 1951:349–369; Skjølsvold 1961:124–125) and it has been suggested that the Sørfjorden area in the Hordaland region was an especially important production center in the Middle Ages (Lossius 1977:62-67, 1979:67-69). Soapstone quarrying has thus been considered an important industry in the Hordaland region during prehistory and the Middle Ages, yet activity in the regional quarries has, with few exceptions, not been dated hitherto. Matches between a quarry and Viking Age or early medieval vessels may now allow us to date production in the quarry indirectly to at least these respective periods. In Figure 16, quarries that match rural and urban vessels in Group 1 and Group 2 are listed.

Twenty quarries are linked to vessels that were matched with only one eligible quarry. The quarries Bru, Juadal, Rauberg, Raudesteinane, Svanøy, and Tysse have only matched Group 2 vessels, so dates for activity in these quarries established indirectly through the vessels' dates are tentative and cannot stand alone. Activities in the remaining quarries with matches to Group 1 vessels may be dated with more confidence; the more matches to each quarry, the stronger the confidence in dating activities here. At Bergsholmen, Bergspytt, Kvitno, and Sævråsvåg, activity is dated indirectly to both the Viking Age and the early Middle Ages. At Flatabø, Klovsteinsjuvet Skare, Vassenden and Åkra, activity is dated at least to the Viking Age; while at Baldersheim, Ingahogget, Kvernes, Russøy, and Urda, matches with urban vessels date activity to at least the early Middle Ages.

The indirect dating of activity in individual quarries through vessel matches is interesting, even if some dates are tentative. The datasets alone cannot be used to determine when activity began or ended in the quarries. A better understanding of the time frame for the onset and end of production at the individual quarry sites may be obtained through future archaeological investigations in the quarries.

Figure 16. *Quarries that match vessels from the Viking Age and the Early Middle Age. Group 1 comprises vessels with a quite reliable provenance, Group 2 is tentatively provenanced.*

Quarries	***Rural vessels Group 1/Group 2. The Viking Age***	***Urban vessels Group 1/Group 2. The early Middle Ages***
Baldersheim		1/1
Bergsholmen	1/0	5/0
Bergspytt	2/1	1/0
Bru		0/1
Flatabø	1/0	
Ingahogget		2/0
Juadal	0/1	0/1
Klovsteinsjuvet	1/0	
Kvernes		9/1
Kvitno	4/1	1/0
Rauberg		0/1
Raudesteinane	0/1	
Russøy		1/1
Skare	1/1	
Svanøy	0/1	
Sævråsvåg	4/3	4/0
Tysse	1/0	
Urda		6/0
Vassenden (Handegård)	2/0	
Åkra	2/0	

Identifying quarry districts

Clear patterns were discerned in our assessments of the locations of quarries that had matches with Viking Age rural and early medieval urban vessels respectively. The map in Figure 17 shows the geographical locations of quarries across the Hordaland region and the frequencies of matches between rural or urban vessels at the quarries. Vessels in Groups 1, 2, 3, and 4 are included; thus, both single-quarry (Group1&2) and multiple-quarry (Group 3&4) matches with varying levels of reliability are drawn upon. Note that vessels that matched multiple quarries have a 'hit'-signature at every one of these quarries, so the Group 3&4 signatures do not represent individual vessels. The frequency of hits reflects degrees of geochemical similarity between the rural/urban vessel assemblages and quarries in case. One must recall that, in numbers, the rural vessels are only about half as many as their urban counterparts, so the number of 'rural hits' are understandably fewer than the urban hits. Furthermore, more trust can be placed in Group 1 and Group 3 hits than in Group 2 and Group 4 hits. Nevertheless, the map provides a good visual impression of the locations of quarries/quarry-areas with rural versus urban hits so that *general trends in the spatial and temporal patterns formed by the hits* can be identified.

The map shows that the hits for rural vessels fall primarily southeast of Hardangerfjorden in the northern part of the Folgefonna peninsula and by Sørfjorden (i.e., within geological Unit 3, for a cross reference to quarry names and units, see Figure 1 and Figure 2), and in the southern part of the Folgefonna peninsula, which is equivalent to geological Unit 4. As most of the hits here are from Group 1 vessels, this trend is considered reliable. Some Group 3&4 vessel-hits are also found southeast of Hardangerfjorden and lend additional support to the trend formed by Group 1&2 hits here. Northwest of Hardangerfjorden (the area covered by geological Unit 1&2) the rural hits are fewer, however, since some stem from Group 1 vessels, it is considered reliable that rural vessels were quarried northwest of the fjord. In addition, rural Group 3&4 hits are documented northwest of Hardangerfjorden and these hits lend additional support to the trend based on Group 1&2 hits. In particular, Group 1&2 hits are frequent in the Sævråsvåg quarry (no. 28) in the most northwestern part of the Hordaland region.

The patterns suggest that, in the Viking Age, the quarries southeast of Hardangerfjorden on the Folgefonna peninsula and by the Sørfjorden area were the most important suppliers of vessels to rural households in the Hordaland region. Some quarries in the area northwest of Hardangerfjorden, however, also produced rural vessels and among these the Sævråsvåg quarry stands out. The Folgefonna peninsula/Sørfjorden area producers were thus not alone in producing vessels for rural Viking Age Hordaland households.

The early medieval urban vessel hits also form a very distinct spatial pattern, with the vast majority being located in areas northwest of Hardangerfjorden, (geological Unit 1&2). Only a few hits are linked to quarries southeast of this fjord. One Group 1 vessel is matched with the Kvitno quarry (no. 16) by Sørfjorden at the Folgefonna peninsula and, while it is the only hit to a quarry in geological Unit 3, it should not be ignored. The others are Group 1 hits to the Ingahogget (no. 10) and Bergspytt (no. 4) quarries in the southern part of the Folgefonna peninsula (geological Unit 4). The spatial pattern of hits formed by urban vessels from Groups 1 to 4, coupled with the well-substantiated dates of the urban vessel assemblage, strongly suggests that quarries in the area northwest of Hardangerfjorden became Bergen's main suppliers of soapstone vessels during the early Middle Ages. It seems that some quarries at the Folgefonna Peninsula and by Sørfjorden were still active and made some few deliveries to Bergen in this period.

The implications of these patterns are that quarries in the general Sørfjorden area seem to have been important producers of vessels for rural Viking Age households in the Hordaland region, while quarries in the area northwest of Hardangerfjorden, with the exception of the Sævråsvåg quarry, delivered vessels to a lesser extent at this time. In the early Middle Ages, quarries in areas northwest of Hardangerfjorden became the main suppliers of vessels to Bergen, while quarries southeast of this fjord made relatively few deliveries to Bergen. This stands in stark contrast to previous perceptions that the Sørfjorden area continued to be an important production centre from the Viking Age into the Middle Ages (Lossius 1977:62–67).

Rural/Viking Age and urban/early medieval households thus got their vessels, generally, from quarries located in two different geographic areas. In fact, one may suggest that distinct quarry districts existed in the Viking Age and the early Middle Ages: one of these quarry districts (hereafter Quarry District A) comprised the Folgefonna peninsula and the Sørfjorden area, while the second district (hereafter Quarry District B) was found in the area northwest of Hardangerfjorden. These observations add a whole new level of detail to the picture of the regions' production of soapstone vessels in the Viking Age and the early Middle Ages

Based on the available evidence, it cannot be established whether the production of vessels in District A declined dramatically by the end of the Viking Age and the transition to the Middle Ages, or whether this area simply did not deliver vessels in any quantity to the early medieval urban community at Bergen. Did production decline or did the district's producers not engage in exchange-networks involving town/Bergen-connected actors? These are interesting questions that must be pursued on a broader canvas in future research. Refined dating of the quarries obtained through further archaeological investigations, factors such as restraints and possibilities offered by the natural topography, the size of the quarries/soapstone outcrops, the demand for new types of products such as stone for monumental buildings in the early Middle Ages, as well as land-ownership, should all be considered in seeking answers to these new questions.

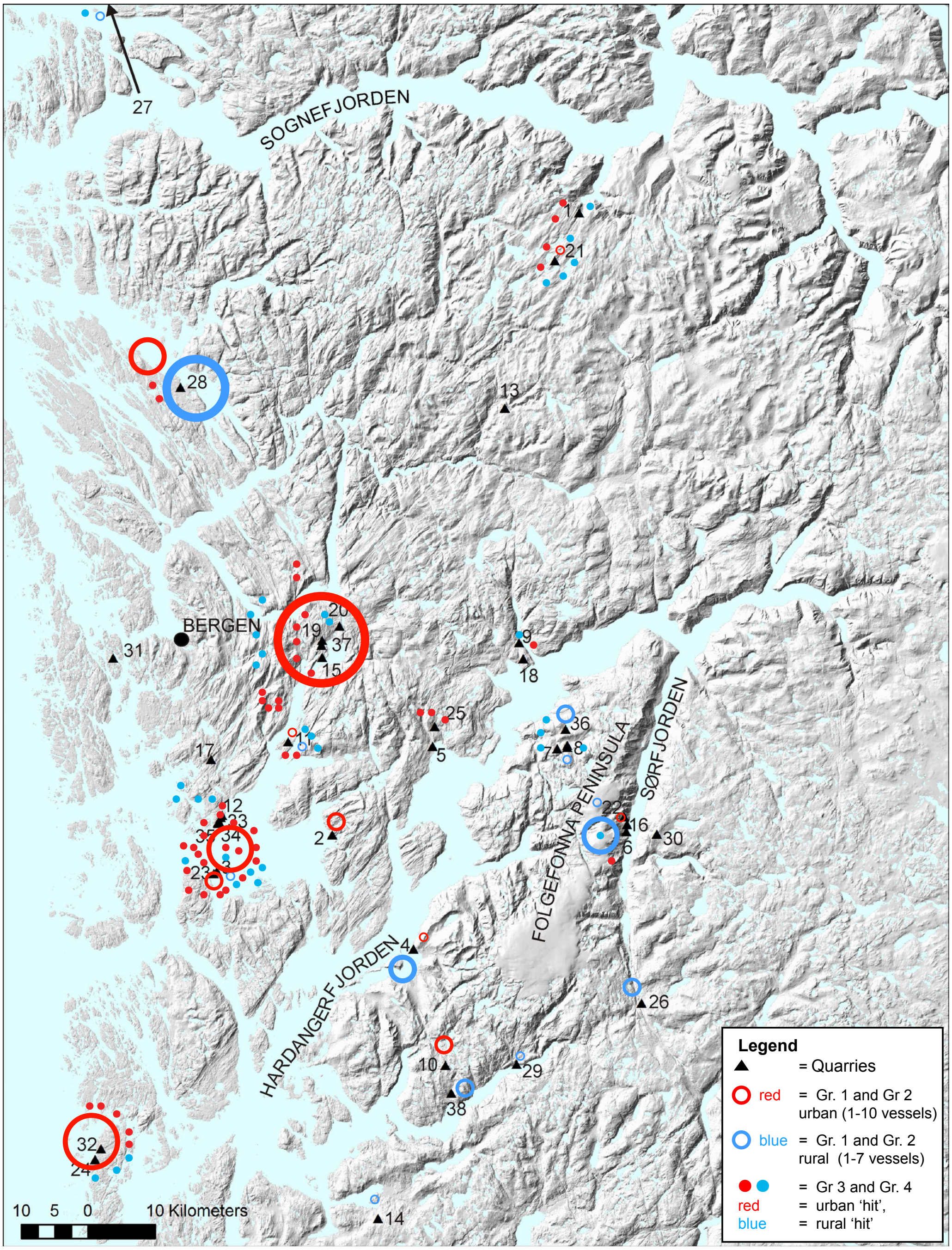


Figure 17. *Map with rural and urban vessel match and 'hits' on quarries in the Hordaland region. The map provides a visual impression of the locations of quarries/quarry-districts with rural versus urban 'hits'. Cross reference for quarry names and geological units see Figure 1 and Figure 2. Red = Urban, blue = rural. O= vessel Group 1 and 2. A 'solid dot' represents one 'hit' on the quarry for Group 3 and 4 vessels with a multiple choice of quarries.*

The character of vessel production during the Viking Age and the early Medieval period

Assessing transport distances between quarries and rural vessel find spots produced some interesting insights by which we believe that we are starting to discern patterns in the regional organisation of production and trade in soapstone vessels during the Viking Age. Furthermore, the general find spot of early medieval vessels (i.e., Bergen) can also be included in the discussion, adding time depth to the analysis. The question asked here is, thus, what was the character of vessel production: did the quarries produce vessels for consumers in their immediate vicinity, in the local area, in the wider rural parts of the Hordaland region, or did they produce for consumers in Bergen? The criteria for distance categories, or one might rephrase and say *consumer* categories, are those used in the assessment above: if vessels were found within 0–10 km of the quarry, the consumers are considered to be from a household in the *vicinity* of this quarry. If a vessel is found within a distance of 11–30 km from the quarry, the consumers are considered *local*. If vessels are found more than 30 km from the quarry or in Bergen, the consumers are considered *regional*. We are aware of the hazards of circular reasoning when including, in this analysis, rural vessels for which the distance between the vessel's find spot and a quarry location was also used as a dataset for provenancing. However, with awareness of the uncertainties inherent in making individual matches to individual quarries, we have nonetheless looked for trends in the material. To explore those trends with the least uncertainty, we only discuss quarries with one or more Group 1 vessel-matches, using quarries with only Group 2 vessels merely to support trends identified through stronger sets of vessel-to-quarry matches. Figure 18 shows the different categories of consumers that quarries in the Hordaland region serviced. The categories are related to transport distances between quarries and the find spots of matching rural and urban Group 1 and Group 2 vessels. The quarries are now listed within their geographical location in Quarry Districts A (geological Units 3 or 4) or B (Unit 1&2).

During the Viking Age, evidence suggests that three quarries delivered vessels to households in their vicinities. These quarries are found in District A, and include Bergspytt, Klovsteinsjuvet and Åkra. We also have several examples of quarries that probably delivered vessels to households in the local area. These quarries are located in both District A (Flatabø, Kvitno and Åkra) and District B (Bergsholmen and Sævråsvåg). Some quarries, such as Kvitno, Vassenden, Skare, and Tysse in District A and Sævråsvåg in District B, seem to have delivered vessels to households throughout the broader region in addition to those located nearby. During the early Middle Ages, Bergspytt, Ingahogget and Kvitno in District A and Baldersheim, Bergsholmen, Kvernes, Russøy, Sævråsvåg, and Urda in District B may have delivered vessels to Bergen consumers.

It seems to have been common for quarries to deliver vessels to households in the vicinity or in the local area during the Viking Age. However, some quarries appear to have produced for households in the wider region as well. At Sævråsvåg, Kvitno, and perhaps also Bergspytt (where Viking Age regional distribution is shown through a Group 2 vessel only) there may be a continuation in the production for regional consumers from the Viking Age into the early Medieval period.

Skjølsvold suggested that the Viking Age production of soapstone vessels was organized both as household production and as production for sale (Skjølsvold 1961:96–107). With a definition of household production as production of goods to be consumed by one's own household and professional production as production of goods for consumption outside one's own household (see Hagen 1994; Hansen 2005), it may tentatively be suggested that stoneworkers in the quarries that delivered vessels to households in the vicinity of the quarry were producing for their own household needs, perhaps as part of a self-subsistence economy. In contrast, stoneworkers in quarries that produced for local and regional consumers, must have been professional craftspeople that produced for a wide market.

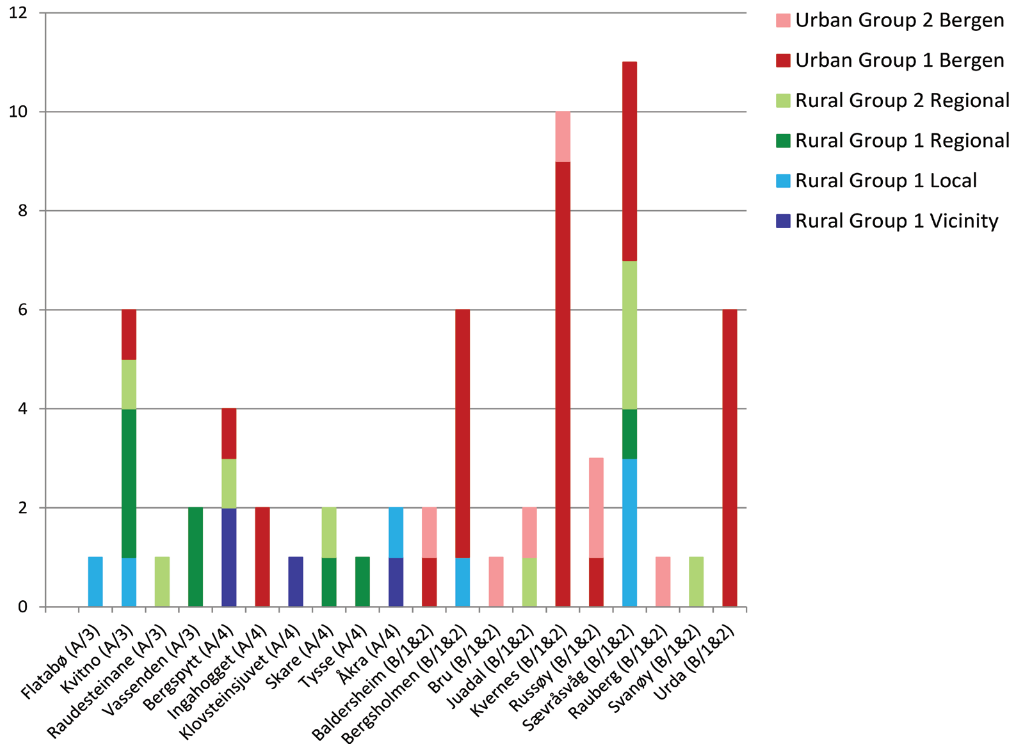


Figure 18. *Consumer categories for quarries of that delivered vessels during the Viking Age and the early Middle Ages. Ordered by quarry district (A/3/4) = District A/Geological unit 3 or 4. (B) = District A/Geological unit 1&2. The Y-axis denotes the number of vessels assigned to the quarry.*

Following this model, we suggest that, during the Viking Age, in addition to household production, professional production of vessels was carried out to a wide extent in District A, and to a lesser extent in District B, with the Sævråsvåg quarry as a distinct exception to the general picture. This lends empirical support to Skjølsvolds model for Viking Age soapstone production.

During the early Middle Ages, professional production was carried out in District B. At the same time some professional production was still taking place in District A but- it may seem to a much lesser extent, and mainly in quarries that already had traditions for professional production and regional distribution during the previous period of time.

Perhaps this is too simple a model, and the realities of Viking Age, as well as of early medieval quarry activities, were more complex. However, the contours of the organisation of regional production and trade in soapstone vessels during the Viking Age and the early Middle Ages can now to be discerned, refined and debated. In future research, they should be discussed on a broad background. Relevant information, such as quarry sizes and the amount of extraction undertaken through the centuries would add valuable data and insights, if investigated through new archaeological field work.

Interesting questions to be addressed may also concern the distribution of vessels from quarry to consumer: how, exactly, did products wind up in rural Hordaland, or in urban Bergen's households? Who owned the quarries? Who were involved in the extraction, sale and distribution of vessels? Were vessels sold/exchanged directly between producers and consumers or were there middle men/ middle-institutions? Where and how did distribution take place? Was it organised at the quarries, at the farmsteads of the quarriers, or in local or regional markets? In Bergen? Did this change over time?

Poor regional match: rural versus urban vessels

Finally, we briefly address the PRM vessels. Figure 19 shows the distribution of the six groups defined by vessel provenance within the rural and the urban assemblages. As a result of a X2-test (Siegel 1956:174-179, 249), the null-hypothesis of a random distribution of the match categories can be rejected on a highly significant level i.e. the probability of a random distribution causing the pattern is lower than 1%. It is especially Group 6, the vessels that have poor matches with the sampled regional quarries, that calls for immediate attention.

There may be an unknown number of vessels with poor regional match hiding in the rural Group 5, due to the high share of Group 5 vessels in this assemblage. Consequently, the share of rural vessels with poor regional match may be somewhat higher than the 6% figure suggested in Figure 19. Within the urban assemblage, however, the share of vessels with poor regional match is considered quite realistic and it seems safe to conclude that about one-third of the soapstone vessels used or discarded in early medieval Bergen may have come to the town from quarries beyond the Hordaland region. It also feels quite safe to conclude that even if we do not have particularly exact numbers for establishing the proportion of non-regional vessels that came to Hordaland's rural households during the Viking Age, they were relatively speaking much less numerous than were seen in Bergen during the following centuries.

The cross disciplinary approach of our study not only has the ability to, with some certainty, rule out regional quarries as the origin of vessels consumed in the Hordaland region and Bergen, the approach also indirectly helps identify soapstone vessels that must have come through trade or other means of exchange from distant quarries, even if those vessels' origin cannot yet be identified. It would be interesting, in future research, to extend the reference material to include quarries from other regions beyond Hordaland.

Identifying anomalies that need explanation, where trade or other exchange mechanisms may be the answer, is in itself an important result that in future research may have a bearing on our understanding of not only domestic interregional relations, but also of international relations between Norway and the rest of Scandinavia and the North Atlantic Isles in the Viking Age and early Middle Ages.

Final remarks

The aim of the present study was to provenance 146 late Iron Age/Viking Age and early medieval soapstone vessels from the Hordaland region and from the town of Bergen. At our disposal we had archaeological and geological data relating to the vessels and to 38 quarries from the Hordaland region. Through interdisciplinary efforts we have been able to obtain provenancing results that are considered to be reliable, quite reliable, or tentative for 131 vessels. The success rate is thus high. There

Figure 19. *Provenance groups within the rural and urban vessel assemblages.*

Six provenance groups based on MTE, REE, typology, transport distance and Geological unit-coherence	***Rural vessels n=51***	***Urban vessels n=95***
Group 1	19 = 37%	30 = 32%
Group 2	9 = 18%	6 = 6%
Group 3	1 = 2%	16 = 17%
Group 4	8 = 17%	2 = 2%
Group 5	11 = 22%	4 = 4%
Group 6	3 = 6%	37 = 39%

is no doubt that the combination of several sets of geological and archaeological data and analytic methods have been essential to achieving these results. The provenancing results are fresh datasets, they have provided immediate insights that have social and historical implications and should be pursued on a wide scale in future research: previously undated quarries are now tentatively dated through vessel matching; distinct quarry-districts that were in use during the Viking Age and the early Medieval period have been discerned; contours of the organisation of regional production and trade in soapstone vessels during the Viking Age and the early Middle Ages are now substantiated, and it is seen that Viking Age rural households received fewer vessels from areas beyond the Hordaland region than their early medieval urban counterparts. The study has been an interdisciplinary venture all the way. Geology and archaeology are two disciplines that have much in common; we interpret patterns in complex and rarely 'complete' datasets. As interpretations are always up for discussion, the disciplines are dynamic: what may be perceived as solid today may be challenged tomorrow.

Acknowledgements

The processing of samples and field work was partially supported by the Meltzer foundation. We would like to thank Jens-Bjørn Riis Andresen (CAS Aarhus University, Denmark), Lars Forsberg (AHKR, UIB), Sonja Innselset and Sigrid H. H. Kaland (Dep. of Cultural History, University Museum of Bergen, UIB), Tor Grenne (Geological Survey of Norway), Rolf Birger Pedersen (Dep. of Earth Sciences, UIB), and Elisabeth Warren (Hordaland county administration) for helpful discussions during the different stages of the research.

References

Alfsen, B. E. & Christie, O. H. J. 1979. Massenspektrometrische Analysen von Specksteinfunden aus Haithabu und wikingerzeitlichen Specksteinbrüchen i Skandinavien. In Schietzel, K. (ed) Berichte über die Ausgrabungen in Haithabu, Bericht 14, 170–184. Karl Wachholtz Verlag, Neumünster.

Andersen, T., Corfu, F., Labrousse, L. & Osmundsen, P-T. 2012. Evidence for hyperextension along the pre-Caledonian margin of Baltica. Journal of the Geological Society 169, 601–612.

Bakka, E. 1963. Forntida i Odda, Ullensvang og Kinsarvik. In Kolltveit, O. (ed) Odda, Ullensvang og Kinsarvik i gamal og ny tid. Bygdesoga, volume 1, 47–208. Ullensvang og Kinsarvik Bygdeboknemnd, Odda.

Baug, I. 2011. Soapstone finds. In Skre, D. (ed) Things from the Town. Artefacts and Inhabitants in Viking-age Kaupang, Norske Oldfunn, volume 3, Aarhus University Press & The Kaupang Excavation Project, Aarhus.

Boynton, W. V. 1984. Cosmochemistry of the rare earth elements; meteorite studies. In Henderson, P. (ed) Rare Earth Element Geochemistry, 63–114. Elsevier Scientific Publication Co., Amsterdam.

Emmelin, L. 1984. Visuell konsekvensanalys – En metod för att beskriva och analysera förändringar i kulturlandskap och samhällsplanering. In Emmelin, L. (ed) Kulturlandskap och samhällsplanering, 213–242. Nordisk ministerråd, Trondheim.

Forster, A. K. 2004. Shetland and the trade of steatite goods in the North Atlantic region during the Viking and Early Medieval Period. Unpublished doctoral thesis, Department of Archaeological Sciences, University of Bradford.

Færseth, R. B., Thon, A., Larsen, S. G., Sivertsen, A. & Elvestad, L. 1979. Geology of the lower Palaeozoic rocks in the Samnanger–Osterøy area, Major Bergen Arc, western Norway. Bulletin Norges Geologiske Undersøkelse, 334, 19–58.

Hagen, K. G. 1994 [1988]. Profesjonalisme og urbanisering. Universitetets Oldsaksamling Skrifter. Ny rekke, volume 16. Universitetets Olsaksamling, Oslo.

Hansen, G. 2005. Bergen c 800 – c 1170, The emergence of a town. Bryggen Papers Main Series, volume 6. Fagbokforlaget, Bergen.

Hansen, G. 2008. Arkæologiske kort – fra arbejdet med middelalderbyer i Skandinavien. Byerne og den byhistoriske kartografi. Byplanhistoriske noter, volume 5, 71–94. Dansk Byplanlaboratorium.

Heldal, T., Jansen, Ø. J., Grenne, T., Hansen, G. & Kaland, S. H. H. 2008. Where do they all come from? Towards a methodology for soapstone provenance. Oral paper presented at SMIA The 9th Nordic Conference on the Application of Scientific Methods in Archaeology. Museum of Natural History and Archaeology, NTNU Trondheim.

Heldal, T., Jansen, Ø. J. & Kaland, S. H. H. 2003. Geologiske og arkeologiske undersøkelser av klebersteinsbrudd på Russøy og Bergsholmen, Tysnes og ved Urda, Bømlo. Universitetsmuseet i Bergen. Archive report Topografisk arkiv.

Jansen, Ø. J., Heldal, T., Pedersen, R. B., Ronen Y. & Kaland, S. H. H. 2009. Provenance of soapstone used in medieval buildings in the Bergen region, Western Norway. In Maniatis, Y. (ed.) Asmosia VII, Proceedings of the 7th International Conference of Association for the Study of Marble and Other Stones in Antiquity. Thassos 15th–20th September 2003. Bulletin de Correspondance Hellénique, 581–595. École Francaise d'Athénes, Athens.

Jones, R., Kilikoglou, V. Olive, V. Bassiakos, Y., Ellam, R., Bray, I. S. J. & Sanderson, D. C. W. 2007. A new protocol for the chemical characterisation of steatite – two case studies in Europe: the Shetland Islands and Crete. Journal of Archaeological Science 34, 626–641.

Jones, R., Olive, V. & Ellam R. 2006. Chemical (Rare Earth Element) Analysis of Viking Steatite Artefacts from Kaupang: A Preliminary Report. Museum of Culture History, University of Oslo.

Lossius, S. M. 1977. Klebermaterialet fra Borgund. Arkeologiske avhandlinger fra Historisk museum, volume 1. Historisk museum, Universitetet i Bergen, Bergen.

Lossius, S. M. 1979. Klebermaterialet. In Schia, E. (ed) De arkeologiske utgravninger i Gamlebyen, Oslo. 'Oslogate 3 og 7' Bebyggelsesrester og funngrupper. De arkeologiske utgravninger i Gamlebyen, Oslo, volume 2, 64–71. Akademisk Forlag. Øvre Ervik.

Pedersen, R. B. 1997. The Voss-Lom melange: age, geochemistry and significance for the acretionary history of the Caledonides. NGF Vintermøte. Geonytt 23, 77.

Pedersen, R. B., Slama, J. & Jansen, Ø. J. 2015. The accretionary history of the Caledonides: new provenance data from continental margin sediments, melanges and outboard terrains in S. Norway. In Nakrem, H. A. & Husås, A. M. (eds) NGF Abstracts and Proceedings of the Geological Society of Norway. Vinterkonferansen 2015. Stavanger, 12th–14th January, 2015, volume 1, 2015.

Petersen, J. 1951. Vikingtidens redskaper. Skrifter utgitt av det norske vitenskaps-akademi i Oslo. Historisk filosofisk klasse, volume 2, Oslo.

Ragnhildstveit, J. & Helliksen, D. 1997. Geologisk kart over Norge. Berggrunnskart Bergen, M 1:250 000. Norges geologiske undersøkelse.

Ragnhildstveit, J., Naterstad, J., Jorde, K. & Egeland, B. 1998. Geologisk kart over Norge. Berggrunnskart Haugesund, M 1:250 000. Norges geologiske undersøkelse.

Resi, H. G. 1979. Die Specksteinfunde aus Haithabu. In Schietzel, K. (ed) Berichte über die Ausgrabungen in Haithabu, Bericht 14, 9–167. Karl Wachholtz Verlag, Neumünster.

Santi, P., Antonelli, F. & Renzulli, A. 2005. Provenance of medieval pietra ollare artefacts found in archaeological sites of central-eastern Italy: insights into the Alpine soapstone trade. Archaeometry 47(2), 253–264.

Santi, P., Renzulli, A., Antonelli, F. & Alberti, A. 2009. Classification and provenance of soapstone and garnet chlorite schist artifacts from medieval sites of Tuscany (Central Italy): insights into the Tyrrhenian and Adriatic trade. Journal of Archaeological Science 36(11), 2493–2501.

Siegel, S. 1956. Nonparametric Statistics for the Behavioral Sciences. International Student Edition. McGraw-Hill Kogakusha, Ltd, Tokyo.

Sigmond, E. M. O. 1998. Geologisk kart over Norge. Berggrunnskart ODDA, M 1:250 000. Norges geologiske undersøkelse.

Skjølsvold, A. 1961. Klebersteinsindustrien i vikingetiden. Universitetsforlaget, Oslo-Bergen.

Sturt, B. A., Gautneb, H., Heldal, T. & Nilsson, L. P. 2002. Industrial minerals associated with ultramafic rocks in Norway. In Scott, P. W. & Bristow, C. M. (eds) Industrial Minerals and Extractive Industry Geology, 43–58. Geological Society of London, London.

Thon, A. 1985. The Gulfjellet ophiolite complex and the structural evolution of the Major Bergen Arc, West Norwegian Caledonides. In Gee, D. G. & Sturt, B. A. (eds) The Caledonide Orogen – Scandinavia and Related Areas, 671–677. Wiley, Chichester.

Vangstad, H. 2003. Kleberkarene fra Bryggen i Bergen. En arkeologisk analyse av kleberkarene funnet på Bryggen i Bergen fra middelalder og etterreformatorisk tid. Hovedfagsoppgave. Arkeologisk institutt. Universitetet i Bergen, Bergen.
Øye, I. 2004. Farming systems and rural societies c. 800–1350. In Almås, R. (ed) Norwegian Agricultural History, 80–143. Tapir Academic Press, Trondheim.

Internet sources

Gjenstandsbasen, the Five Norwegian University Museums' Collection Database. Retrieved from: http://www.unimus.no/arkeologi/forskning/index.php (accessed June 2016).
Askeladden, the Norwegian National Cultural Heritage Database. Retrieved from: https://askeladden.ra.no/Askeladden/Pages/LoginPage.aspx?ReturnUrl=%2faskeladden (accessed June 2016).

Appendix

Table 1a. *Major element data for quarries and vessels expressed as % element.*

Quarry	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
1 Arnafjord # 1															12	UIB
1 Arnafjord # 12	47,2	2,72	5,74	0,017	18,0	9,86	0,23	0,047	0,168	-0.01	16,4	100	-1	-1	-1	99
1 Arnafjord # 16	45,8	1,93	5,82	0,028	16,9	11	-0.1	0,098	0,231	-0.01	18,2	99,9	-1	-1	3,6	100
1 Arnafjord # 2	45,5	0,798	5,53	-0.01	26,5	6,08	-0.1	-0.01	0,078	-0.01	12,7	97	-1	-1	-1	96
1 Arnafjord # 3	32,9	0,282	6,65	-0.01	34,8	0,153	-0.1	-0.01	0,111	-0.01	24,3	99,3	-1	-1	-1	97
1 Arnafjord # 9	59,2	0,783	5,03	-0.01	28,6	-0.01	-0.1	-0.01	0,031	-0.01	4,57	98,2	-1	-1	-1	98
2 Baldersheim # 1	39,3	2,3	9,92	0,086	30,2	1,09	-0.1	-0.01	0,115	-0.01	15,2	98,2	-1	-1	-1	101
2 Baldersheim # 2	33,7	2,21	8,51	0,075	25,6	10	-0.1	-0.01	0,144	-0.01	19	99,2	-1	-1	-1	102
2 Baldersheim # 3	35,8	2,43	11,1	0,089	29,8	1,87	-0.1	-0.01	0,164	-0.01	17,2	98,5	-1	-1	-1	103
2 Baldersheim # 4	42,6	2,08	11	0,076	26,3	5,2	-0.1	-0.01	0,089	-0.01	11,8	99,1	-1	-1	-1	104
2 Baldersheim # 5	41,3	2,88	10,9	0,139	29,1	1,15	-0.1	-0.01	0,106	-0.01	12,5	98,1	-1	-1	-1	105
2 Baldersheim # 21	44,5	2,12	11,71	0,08	26,2	4,13	0,04	0,02	0,07	0,01	10,36	54,71			10,894	UIB
2 Baldersheim # 19	49,4	2,63	8,72	0,11	25,8	1,03	ND	ND	0,11	0,01	12,05	50,42			9,152	UIB
3 Bergsholmen # 2	55,0	0,733	5,88	-0.01	27,2	1,91	-0.1	-0.01	0,062	-0.01	7,08	98	-1	-1	-1	106
3 Bergsholmen # 3	54,9	0,854	5	-0.01	27,9	1,9	-0.1	-0.01	0,039	-0.01	7,19	97,8	-1	-1	-1	107
3 Bergsholmen # 4	27,3	0,209	6,77	-0.01	36,1	0,211	-0.1	-0.01	0,115	-0.01	28,4	99,1	-1	-1	-1	108
3 Bergsholmen # 5	37,8	0,877	6,67	-0.01	32,3	1,06	-0.1	-0.01	0,05	-0.01	20,3	99	-1	-1	-1	109
3 Bergsholmen # 7	27,2	0,286	7,1	-0.01	29,1	7,97	-0.1	-0.01	0,246	-0.01	26,2	98,1	-1	-1	-1	110
3 Bergsholmen # 1															15	UIB
4 Bergspytt # 10	44,9	5,73	11,1	0,547	24,9	4	0,25	0,037	0,126	0,032	7,21	98,9	-1	2,4	17,6	114
4 Bergspytt # 13	45,3	4,68	12	0,425	24,5	4,61	0,23	0,031	0,142	0,035	6,74	98,7	-1	1,2	17,5	115
4 Bergspytt # 2	44,8	5,38	15,4	0,651	22,6	4,58	0,42	0,052	0,13	0,052	4,5	98,6	-1	1,5	17	111
4 Bergspytt # 4	41,3	7,93	10,9	0,298	23,5	5,63	0,17	0,019	0,21	0,04	8,04	98,1	-1	1	32,8	112
4 Bergspytt # 5	45,4	6,73	11,4	0,3	25,2	3,79	0,1	0,024	0,14	0,056	6,3	99,3	-1	1,1	32,5	113
4 Bergspytt # 1															25	UIB
5 Bru # 1	55,5	3,15	5,72	0,03	28,5	0,078	-0.1	-0.01	0,061	0,012	5,46	98,5	-1	2	8,1	116
5 Bru # 2	53,0	4,1	6,42	0,069	27,7	0,533	-0.1	-0.01	0,073	0,046	5,69	97,7	-1	5,5	73	117
5 Bru # 3	57,9	1,21	5,38	-0.01	28,4	0,011	-0.1	-0.01	0,034	-0.01	4,87	97,9	-1	-1	5,8	118
5 Bru # 4	56,4	2,4	5,29	0,012	28,4	0,022	-0.1	-0.01	0,047	0,013	5,21	97,9	-1	-1	1,4	119
5 Bru # 5	49,6	5,89	7,17	0,037	27,8	0,193	-0.1	0,01	0,078	0,01	6,6	97,5	-1	-1	11,7	120
6 Digranes # 1	41,1	16,4	12,4	0,911	18,4	1,15	-0.1	0,023	0,128	0,288	8,23	99	1,1	11,3	88,3	120
6 Digranes # 10	28,2	19,8	16,6	1,18	21,2	1,17	-0.1	0,017	0,176	0,222	9,79	98,4	4,1	16,4	168	123
6 Digranes # 11	54,7	4,39	6,23	0,358	20,2	10,4	0,12	0,211	0,14	-0.01	3,03	99,6	1,8	4,9	252	124
6 Digranes # 12	49,0	13,1	8,45	0,607	18,4	2,49	-0.1	0,031	0,117	0,105	6,93	99,3	-1	9,5	126	125
6 Digranes # 2	44,7	10,4	8,54	0,48	22,2	6,87	-0.1	0,036	0,146	0,03	5,83	99,3	-1	8,2	105	122
7 Drebrekke # 2	54,6	0,855	8,75	0,062	27,9	1,04	-0.1	0,083	0,179	0,016	4,96	98,5	-1	-1	-1	297
7 Drebrekke # 3	55,5	0,699	7,65	0,046	28,0	1,82	-0.1	0,04	0,141	-0.01	4,85	98,8	-1	-1	-1	298
7 Drebrekke # 1	57,9	0,64	8,68	0,05	28,7	0,89	n.d	0,05	0,17	0,03	4,92	101,73			13	UIB

Table 1a. *(Continued)*

Quarry	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
8 Flatabø # 1	55,1	1,8	9,42	0,044	24,8	3,46	-0.1	0,016	0,276	0,014	3,14	98,1	-1	2,2	-1	130
8 Flatabø # 2	53,5	2,74	9,79	0,059	25,2	2,37	-0.1	0,012	0,262	-0.01	4,06	98,1	-1	2,8	-1	131
8 Flatabø # 3	57,8	1,01	7,81	0,026	29,0	0,528	-0.1	0,166	0,164	0,015	3,1	99,7	-1	-1	-1	132
8 Flatabø # 29	56,1	2,13	8,44	0,05	23,9	4,44	ND	0,01	0,22	0,02	3,6	42,76				UIB
9 Froastad # 1	43,1	8,54	5,61	0,012	31,8	-0.01	-0.1	-0.01	0,037	-0.01	9,09	98,2	-1	-1	-1	133
9 Froastad # 2	46,0	1,13	5,82	-0.01	32,7	0,102	-0.1	-0.01	0,078	-0.01	13,6	99,5	-1	-1	-1	134
9 Froastad # 3	35,7	0,251	7,02	-0.01	33,7	0,496	-0.1	-0.01	0,105	-0.01	22	99,4	-1	-1	-1	135
9 Froastad # 4	39,3	0,271	6,57	-0.01	33,2	0,509	-0.1	-0.01	0,089	-0.01	19,7	99,7	-1	-1	-1	136
10 Ingahogget # 1	49,2	5,92	9,03	0,209	27,6	0,047	-0.1	0,012	0,054	0,024	6,59	98,9	-1	-1	25,4	140
10 Ingahogget # 2	38,8	4,59	12,7	0,179	27,2	2,29	-0.1	0,012	0,173	0,051	12,9	98,8	-1	-1	15,9	141
10 Ingahogget # 4	49,4	4,72	11,1	0,15	26,6	0,27	-0.1	-0.01	0,035	-0.01	6,51	98,8	-1	-1	7,9	142
10 Ingahogget # 5	44,3	6,82	13,7	0,154	27,2	-0.01	-0.1	-0.01	0,049	0,016	6,94	99,2	-1	-1	15	143
10 Ingahogget # 6	47,5	5,21	11,6	0,252	25,8	1,42	-0.1	-0.01	0,068	-0.01	7,18	99,1	-1	-1	15,9	144
11 Juadal # 1	34,5	1,02	7,74	-0.01	33,8	0,137	-0.1	-0.01	0,054	-0.01	22,4	99,8	-1	-1	-1	145
11 Juadal # 10	42,8	1,18	5,8	-0.01	32,9	0,231	-0.1	-0.01	0,058	-0.01	16,5	99,4	-1	-1	-1	147
11 Juadal # 11	53,5	3,13	5,41	-0.01	29,4	0,531	-0.1	0,011	0,02	-0.01	6,79	98,7	-1	-1	-1	148
11 Juadal # 12	47,8	3,07	4,7	0,028	29,0	2,7	-0.1	0,114	0,053	0,029	11,3	98,8	-1	-1	4,3	149
11 Juadal # 13	48,3	1,37	5,72	-0.01	31,9	0,067	-0.1	-0.01	0,034	-0.01	12,6	100	-1	-1	-1	150
11 Juadal # 2	57,2	1,77	4,62	-0.01	30,2	-0.01	-0.1	-0.01	-0.01	-0.01	5,72	99,5	-1	-1	-1	146
11 Juadal # 1/UIB	56,0	1,96	4,78	0,01	29,7	0,87	n.d	n.d	0,02	0,01	6,53	99,619				UIB
11 Juadal # 2/UIB	40,9	0,75	6,71	0,01	33,1	0,1	n.d	n.d	0,06	0,01	19,46	100,811			15	UIB
11 Juadal # 3/UIB	43,8	1,64	7,09	0,01	32,0	0,14	0,13	0,02	0,09	n.d	15,89	100,8			15	UIB
11 Juadal # 2/2/UIB															15	UIB
11 Juadal # 3/3/UIB															15	UIB
12 Katlaberg # 1	28,4	0,617	7,1	-0.01	35,0	1,66	-0.1	-0.01	0,127	-0.01	25,9	98,8	-1	-1	-1	UIB
13 Klauvsteinsberg # 2	49,2	0,31	6,28	0,01	29,8	0,56	ND	ND	0,08	0,01	14,68	51,77				UIB
13 Klauvsteinsberg # 3	38,0	0,4	7,13	0,01	35,6	0,47	ND	0	0,07	0,27	17,98	61,92			7,644	UIB
13 Klauvsteinsberg # 1	39,3	0,32	6,43	0,01	35,9	0,04	ND	ND	0,08	0,01	18,24	61,03			8,058	UIB
14 Klovsteinsjuvet # 3	40,5	5,83	10,6	0,105	28,2	1,84	-0.1	-0.01	0,099	0,011	9,92	97,1	-1	-1	3,7	152
14 Klovsteinsjuvet # 5	40,7	5,64	8,96	0,084	27,4	3,73	-0.1	-0.01	0,142	-0.01	11,3	98	-1	-1	4,4	153
14 Klovsteinsjuvet # 6	39,2	4,99	10,4	0,094	28,0	2,66	-0.1	0,011	0,141	0,012	12,2	97,8	-1	-1	4,2	154
14 Klovsteinsjuvet # 8	42,3	4,64	10,9	0,059	30,1	0,844	-0.1	-0.01	0,09	-0.01	9,04	98	-1	-1	4,1	155
14 Klovsteinsjuvet # 3															11	UIB
14 Klovsteinsjuvet # 4															15	UIB
15 Kvernes # 10	60,0	0,761	4,75	-0.01	29,3	0,01	-0.1	-0.01	0,022	-0.01	4,67	99,5	-1	-1	-1	156
15 Kvernes # 11	60,2	0,713	3,74	-0.01	29,7	-0.01	-0.1	-0.01	-0.01	-0.01	4,77	99,1	-1	-1	-1	157
15 Kvernes # 20	37,8	0,368	6,58	-0.01	33,6	0,128	-0.1	-0.01	0,069	-0.01	20,3	98,8	-1	-1	-1	158
15 Kvernes # 21	34,4	0,378	6,5	-0.01	33,2	1,83	-0.1	-0.01	0,111	-0.01	22,8	99,2	-1	-1	-1	159

Table 1a. *(Continued)*

Quarry	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
15 Kvernes # 22	35,6	0,405	6,22	-0.01	34,5	0,121	-0.1	-0.01	0,055	-0.01	22,2	99,2	-1	-1	-1	160
15 Kvernes # 23	44,5	0,527	6,73	-0.01	30,9	1,91	-0.1	-0.01	0,135	-0.01	14,9	99,7	-1	-1	-1	161
15 Kvernes # 1	40,0	0,58	7,89	0,02	33,2	2,29	n.d	n.d	0,11	0,01	17,09	100,829				UIB
15 Kvernes # 2	40,8	0,7	7,11	0,01	35,3	0,83	n.d	n.d	0,08	0,01	15,67	100,205			14	UIB
15 Kvernes # 3	42,7	0,51	6,75	0,01	33,4	1,62	n.d	n.d	0,12	n.d	16,49	101,336			14	UIB
16 Kvitno # 1	58,6	1,26	4,34	0,071	29,3	0,042	-0.1	-0.01	0,023	0,01	4,77	98,5	-1	1,1	-1	162
16 Kvitno # 10	51,5	0,885	5,94	0,016	31,3	0,78	-0.1	0,011	0,084	-0.01	7,32	98	-1	-1	-1	166
16 Kvitno # 5	55,6	2,72	7,08	0,087	27,9	0,983	-0.1	0,015	0,132	-0.01	4,55	99	-1	-1	7	163
16 Kvitno # 6	53,4	3,51	8,39	0,223	28,3	0,75	-0.1	0,013	0,164	-0.01	4,69	99,4	-1	1,2	26,5	164
16 Kvitno # 7	58,3	1,25	5,16	0,038	28,9	1,2	-0.1	-0.01	0,078	-0.01	4,33	99,3	3,2	-1	-1	165
16 Kvitno # 1/UIB	60,4	1,12	4,92	0,06	29,2	0,21	n.d	n.d	0,05	0,01	4,57	100,231			11	UIB
17 Lysekloster # 1	41,2	4,93	13,06	0,25	28,7	1,47	n.d	n.d	0,18	0,04	11,53	101,097			19	UIB
17 Lysekloster # 10	37,4	3,07	11	0,26	27,8	4,93	n.d	n.d	0,2	0,03	16,17	100,585			23	UIB
17 Lysekloster # 11	38,1	3,22	11,89	0,19	27,7	4,69	n.d	n.d	0,16	0,03	14,69	100,352			21	UIB
17 Lysekloster # 12	47,4	4,16	11,66	0,46	27,8	1,96	n.d	n.d	0,14	0,03	8,02	101,386			21	UIB
17 Lysekloster # 13	40,9	4,14	12,05	0,24	27,2	3,04	n.d	n.d	0,17	0,04	11,95	99,536			16	UIB
17 Lysekloster # 14	39,0	3,83	9,01	0,19	20,9	12,8	n.d	0,01	0,21	0,02	14,41	100,115			20	UIB
18 Melstveit # 1	44,6	16,2	6,55	0,086	12,3	14,5	1,2	0,091	0,103	-0.01	4,26	99,8	-1	-1	-1	167
18 Melstveit # 2	45,3	17	7,2	0,114	12,1	12,4	1,56	0,068	0,096	-0.01	3,41	99,1	-1	-1	-1	168
19 Munkahogget # 1	52,5	1,98	6,16	-0.01	30,0	1,41	-0.1	-0.01	0,041	-0.01	7,54	99,6	-1	-1	-1	169
20 Nygård # 1	33,6	0,364	6,39	-0.01	35,2	0,073	-0.1	-0.01	0,087	-0.01	22,7	98,5	-1	-1	-1	172
20 Nygård # 2	45,4	7,19	4,5	-0.01	32,2	-0.01	-0.1	-0.01	0,015	-0.01	8,74	98,2	-1	-1	-1	173
20 Nygård # 3	31,7	0,322	6,12	-0.01	36,0	0,109	-0.1	-0.01	0,108	-0.01	24,3	98,7	-1	-1	-1	174
20 Nygård # 4	29,7	0,323	8,22	-0.01	36,2	0,105	-0.1	-0.01	0,108	-0.01	25,3	100	-1	-1	-1	175
20 Nygård # 1/UIB	35,8	0,31	6,47	0,01	34,7	0,23	n.d	n.d	0,1	0,01	22,91	100,156			15	UIB
21 Rauberg # 1	41,9	0,593	6,5	-0.01	33,0	0,169	-0.1	-0.01	0,042	-0.01	17,4	99,8	-1	-1	-1	182
21 Rauberg # 1/UIB	38,8	0,564	6,74	<0.01	32,9	0,246	<0.1	<0.01	0,095	<0.01	20	99,4	<1	<1		UIB
21 Rauberg # 2/UIB	60,5	0,031	3,13	<0.01	29,4	<0.01	<0.1	<0.01	0,017	<0.01	4,58	97,7	<1	<1		UIB
21 Rauberg # 3/UIB	43,5	0,768	6,56	<0.01	31,7	0,076	<0.1	<0.01	0,037	<0.01	15,9	98,6	<1	<1		UIB
21 Rauberg # 5/UIB	42,6	0,729	7,8	<0.01	33,0	0,045	<0.1	0,01	0,159	<0.01	13,9	98,2	<1	<1		UIB
22 Rauberg # 4/UIB	34,2	0,429	7,11	<0.01	33,8	0,395	<0.1	0,012	0,108	<0.01	23,5	99,6	1,1	<1		UIB
22 Raudesteinane # 1	57,8	1,52	4,63	0,012	29,4	0,022	-0.1	-0.01	0,02	-0.01	5,1	98,5	-1	-1	-1	183
22 Raudesteinane # 2	58,8	1,15	4,09	0,015	30,0	0,012	-0.1	-0.01	0,015	-0.01	5	99,1	-1	-1	-1	184
23 Russøy # 12	31,8	0,454	6,87	-0.01	35,5	0,391	-0.1	-0.01	0,174	-0.01	24,4	99,6	-1	-1	-1	291
23 Russøy # 1	34,4	0,507	6,75	-0.01	34,6	0,961	-0.1	-0.01	0,111	-0.01	21,2	98,5	-1	-1	-1	185
23 Russøy # 10	33,0	0,494	7,88	-0.01	35,4	0,1	-0.1	-0.01	0,11	-0.01	21,2	98,3	-1	-1	-1	188
23 Russøy # 13	35,0	0,534	6,26	-0.01	34,2	0,099	-0.1	-0.01	0,123	-0.01	22,4	98,6	-1	-1	-1	189
23 Russøy # 2	34,0	0,526	7,51	-0.01	35,1	0,318	-0.1	-0.01	0,122	-0.01	21,2	98,8	-1	-1	-1	186

Table 1a. *(Continued)*

Quarry	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
23 Russøy # 4	42,2	0,835	5,63	-0.01	27,1	7,83	-0.1	-0.01	0,114	-0.01	15,9	99,7	-1	-1	-1	187
23 Russøy # 1/UIB	41,3	0,44	6,58	n.d	34,3	1,29	n.d	n.d	0,07	0,01	17,11	101,032				UIB
23 Russøy # 2/UIB	34,0	0,45	7,65	0,01	35,2	0,34	n.d	n.d	0,13	n.d	21,91	99,395			15	UIB
23 Russøy # 10/UIB	38,5	0,33	7,29	0,01	34,7	0,07	ND	ND	0,09	0,01	18,92	61,4			7,043	UIB
24 Sele # 1	46,5	3,63	9,24	0,289	26,3	3,71	-0.1	0,014	0,083	0,122	10,3	100	-1	2	25,6	190
24 Sele # 2	49,7	3,46	9,5	0,279	27,2	1,9	-0.1	0,018	0,052	0,127	7,76	100	-1	1,8	24,4	191
24 Sele # 3	45,1	3,77	9	0,26	24,2	6,6	-0.1	0,013	0,11	0,125	9,98	99,2	-1	2	23,8	192
24 Sele # 4	36,1	3,47	9,1	0,296	24,9	8,01	-0.1	0,012	0,164	0,134	16,5	98,7	-1	1,7	23,9	193
24 Sele # 5	42,3	4,3	9,79	0,37	24,5	5,16	-0.1	-0.01	0,091	0,171	11,8	98,5	-1	2,4	30,7	194
25 Sjusete # 1	28,7	0,395	7,15	0,013	32,0	4,96	-0.1	-0.01	0,24	-0.01	25,8	99,3	-1	1,4	-1	195
25 Sjusete # 2	48,0	5,69	8,97	0,075	28,2	0,087	-0.1	-0.01	0,102	-0.01	6,7	97,8	-1	-1	3,7	196
25 Sjusete # 3	43,7	0,722	6,03	-0.01	30,3	3,72	-0.1	-0.01	0,107	-0.01	14,4	99,1	-1	-1	-1	197
25 Sjusete # 4	54,5	2,98	4,45	0,014	31,0	0,018	-0.1	-0.01	0,032	-0.01	5,86	98,8	-1	-1	-1	198
26 Skare # 3	37,7	6,38	11	0,478	26,8	4,44	-0.1	0,046	0,151	0,114	11,8	99	-1	-1	33,3	199
26 Skare # 4	38,0	6,61	10,9	0,393	27,5	3,51	-0.1	0,022	0,144	0,093	11,8	99,1	-1	-1	27,9	200
26 Skare # 5	36,4	6,42	10,2	0,41	27,3	4,08	-0.1	0,084	0,155	0,099	12,4	97,6	-1	-1	30,3	201
26 Skare # 6	39,4	6,84	11,2	0,445	28,2	2,59	-0.1	0,029	0,135	0,103	10,9	99,7	-1	-1	30,1	202
27 Svanøy # 1	58,0	1,59	4,16	-0.01	30,0	0,011	-0.1	-0.01	-0.01	-0.01	5,26	99,1	-1	-1	-1	206
27 Svanøy # 2	43,5	0,604	6,19	-0.01	32,9	0,107	-0.1	-0.01	0,035	-0.01	16,4	99,8	-1	-1	-1	207
27 Svanøy # 3	32,8	15,4	10,5	0,049	29,5	-0.01	-0.1	-0.01	0,071	-0.01	10,7	99,1	-1	-1	-1	208
27 Svanøy # 4	55,0	1,77	5,79	-0.01	29,1	0,867	-0.1	-0.01	0,058	-0.01	6,59	99,3	-1	-1	-1	209
28 Sævråsvåg # 10	42,4	1,14	5,26	0,02	27,7	8,41	n.d	n.d	0,13	n.d	16,05	100,777			11	UIB
28 Sævråsvåg # 11	59,3	0,98	6,95	0,01	29,1	0,16	n.d	n.d	0,03	0,01	4,7	100,986			11	UIB
28 Sævråsvåg # 12	46,5	1,26	4,74	0,02	28,6	6,65	n.d	n.d	0,09	n.d	14,21	101,834			8	UIB
28 Sævråsvåg # 13	34,4	13,56	11,51	1,64	27,2	2,33	n.d	n.d	0,17	0,22	9,6	100,38			143	UIB
28 Sævråsvåg # 14	43,6	0,22	5,38	0,01	27,4	8,15	n.d	n.d	0,12	0,01	15,85	100,713			10	UIB
28 Sævråsvåg # 2	39,7	0,37	5,06	0,01	27,2	10,36	n.d	n.d	0,13	n.d	18,8	101,298			10	UIB
28 Sævråsvåg # 3	60,7	0,15	5,27	0,01	27,6	3,25	n.d	n.d	0,08	0,01	3,94	100,699			11	UIB
28 Sævråsvåg	42,6	0,87	5,23	0,02	29,2	6,39	n.d	0,01	0,13	0,01	16,77	101,173				UIB
29 Tysse # 1	44,8	4,33	17,3	0,205	25,5	0,505	-0.1	-0.01	0,206	0,063	5,52	98,4	-1	-1	8,4	210
29 Tysse # 2	39,1	6,32	17,4	0,214	24,7	2,31	-0.1	0,017	0,233	0,027	7,04	97,5	-1	-1	43,8	211
29 Tysse # 3	45,5	5,52	14,7	0,252	24,7	3,33	0,24	0,035	0,219	0,081	5,19	99,8	-1	-1	32,4	212
30 Tyssedal # 6	52,5	4,61	6,81	0,202	28,5	0,05	-0.1	-0.01	0,056	0,022	5,91	98,7	-1	2,6	52,4	213
31 Tyssøy # 1	37,9	2,72	14	0,034	26,5	4,59	-0.1	-0.01	0,152	-0.01	13,1	99	-1	-1	-1	214
31 Tyssøy # 10	29,0	2,62	16	0,042	28,3	4,35	-0.1	0,015	0,258	-0.01	20	101	-1	-1	-1	220
31 Tyssøy # 2	45,9	3,5	14,6	0,059	27,0	0,559	-0.1	-0.01	0,022	-0.01	7,04	98,7	-1	-1	-1	215
31 Tyssøy # 3	35,1	1,74	14,5	0,024	28,9	3,54	-0.1	-0.01	0,19	-0.01	15,6	99,6	-1	-1	-1	216
31 Tyssøy # 6	30,8	3,01	16	0,04	25,3	6,95	-0.1	-0.01	0,171	-0.01	17,6	99,9	-1	-1	-1	217

Table 1a. *(Continued)*

Quarry	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
31 Tyssøy # 8	38,4	2,03	15,7	0,101	32,1	0,603	-0.1	-0.01	0,165	-0.01	10,1	99,2	-1	-1	-1	218
31 Tyssøy # 9	28,5	2,21	15,8	0,059	28,8	4,65	-0.1	-0.01	0,299	-0.01	19,5	99,9	-1	-1	-1	219
31 Tyssøy # 27	49,3	0,78	13,23	0,05	19,9	3,54	ND	0	0,2	ND	13,06	50,75				UIB
31 Tyssøy # 14	36,9	2,75	13,31	0,03	26,0	5,38	ND	ND	0,16	0	14,42	62,09			10,664	UIB
31 Tyssøy # 10/UIB	41,4	3,05	16,21	0,05	25,8	2,47	ND	ND	0,07	0,01	10,06	57,69			9,471	UIB
32 Urda # 17	34,4	0,472	6,23	-0.01	30,8	6,5	-0.1	-0.01	0,123	-0.01	20,9	99,5	-1	-1	-1	221
32 Urda # 18	22,1	0,615	9,56	0,013	36,0	0,368	-0.1	-0.01	0,337	-0.01	30,2	99,2	-1	-1	-1	222
32 Urda # 19	36,9	0,5	6,66	-0.01	35,1	0,05	-0.1	-0.01	0,061	-0.01	20,5	99,9	-1	-1	-1	223
32 Urda # 20	41,5	0,834	6,09	-0.01	33,8	0,205	-0.1	-0.01	0,025	-0.01	16,6	99,1	-1	-1	-1	224
32 Urda # 5	33,4	0,32	6,96	n.d	35,2	0,85	n.d	n.d	0,12	0,01	24,39	101,075			14	UIB
32 Urda # 1	57,9	0,77	4,04	0,03	30,3	1,25	n.d	n.d	0,04	0,01	6,89	100,859				UIB
32 Urda # 14	61,8	0,35	6,2	0,01	27,6	0,03	n.d	n.d	0,03	0,01	4,33	100,094			11	UIB
32 Urda # 2	57,5	1,98	5,61	0,01	29,2	0,19	n.d	n.d	0,04	0,01	5,48	99,714				UIB
33 Vargahola # 1	28,7	0,683	5,19	-0.01	24,3	15,5	-0.1	0,013	0,25	-0.01	25,8	101	5	-1	-1	231
34 Vargavågen # 1	32,7	0,65	6,3	-0.01	36,2	0,08	-0.1	-0.01	0,077	-0.01	24,2	100	-1	-1	-1	225
34 Vargavågen # 2	26,9	1,15	5,69	-0.01	37,7	0,104	-0.1	-0.01	0,134	-0.01	28,5	100	-1	-1	-1	226
34 Vargavågen # 3	35,9	0,995	6	-0.01	34,4	0,064	-0.1	-0.01	0,046	-0.01	21	98,6	-1	-1	-1	227
34 Vargavågen # 4	32,9	0,649	6,85	-0.01	35,7	0,071	-0.1	-0.01	0,075	-0.01	23,8	100	-1	-1	-1	228
34 Vargavågen # 5	32,7	0,594	6,49	-0.01	36,4	0,063	-0.1	-0.01	0,093	-0.01	22,2	98,6	-1	-1	-1	229
34 Vargavågen # 6	38,0	0,361	6,04	-0.01	33,7	0,636	-0.1	-0.01	0,152	-0.01	20,6	99,4	-1	-1	-1	230
35 Vargavåg Gryte # 1	31,8	0,09	7,67	0,01	35,8	0,33	n.d	n.d	0,11	0,02	25,91	101,429				UIB
35 Vargavåg Gryte # 3	31,8	0,07	7,72	0,01	35,2	0,27	n.d	n.d	0,11	0,02	25,38	100,297			14	UIB
35 Vargavåg Gryte # 4	34,6	0,29	6,64	n.d	34,3	0,89	n.d	n.d	0,11	n.d	24,17	100,661			15	UIB
36 Vassenden # 1	57,2	0,528	7,24	0,031	28,6	0,715	-0.1	-0.01	0,118	-0.01	4,83	99,3	-1	-1	-1	292
36 Vassenden # 2	54,8	0,553	6,21	0,031	27,3	3,56	-0.1	-0.01	0,117	0,102	5,05	97,8	-1	-1	-1	293
36 Vassenden # 3	54,4	0,642	7,52	0,036	28,8	0,401	-0.1	-0.01	0,126	-0.01	5,55	97,4	-1	-1	-1	294
36 Vassenden # 4	56,5	0,695	6,21	0,031	28,1	2,71	-0.1	-0.01	0,109	0,057	4,75	99,1	-1	-1	-1	295
36 Vassenden # 5	52,5	1,63	9,01	0,053	28,0	1,27	-0.1	-0.01	0,118	-0.01	6,05	98,7	-1	-1	-1	296
37 Ådland # 1	30,6	0,64	7,96	0,01	35,4	0,13	n.d	n.d	0,2	n.d	26,61	101,356				UIB
37 Ådland # 2	42,2	10,96	8,49	0,02	30,4	n.d	n.d	n.d	0,06	0,01	9,17	100,935				UIB
38 Åkra # 1	41,5	6,31	13,9	0,391	26,2	2,48	-0.1	0,018	0,16	0,089	9,12	100	-1	1,2	35,7	232
38 Åkra # 2	40,5	6,19	14,4	0,351	26,1	2,34	-0.1	0,018	0,167	0,09	9,14	99,3	-1	1,1	33,8	233
38 Åkra # 3	39,6	5,78	13,8	0,319	25,7	3,29	-0.1	0,022	0,181	0,086	10,4	99,3	-1	1,1	30	234
38 Åkra # 4	41,7	6,25	14,3	0,357	26,3	1,91	-0.1	0,018	0,172	0,088	8,82	99,8	-1	1,3	32,4	235
Vessels, urban																
BRM 0/42937	54,5	0,958	4,56	0,011	28,0	0,018	-0.1	-0.01	-0.01	0,02	5,13	97,9	-1	-1	-1	1
BRM 0/43530	45,7	3,43	12,2	0,16	24,5	3,07	-0.1	-0.01	0,199	0,015	8,17	97,5	-1	-1	13,3	2

Table 1a. *(Continued)*

Vessels, urban	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
BRM 0/43549	44,3	6,24	12	0,213	17,2	0,572	-0.1	0,145	0,129	0,343	15,9	97,1	-1	-1	11,8	3
BRM 0/44163	58,6	0,926	5,36	-0.01	28,4	0,034	-0.1	-0.01	0,036	0,017	5,2	98,6	-1	-1	-1	4
BRM 0/44650	40,2	7,59	15,1	0,105	23,4	4,95	-0.1	0,028	0,199	0,395	7,02	99	-1	-1	12	5
BRM 0/44931	59,3	0,714	5,45	-0.01	28,0	0,14	-0.1	0,02	0,032	0,022	5,08	98,8	-1	-1	-1	6
BRM 0/44934	40,5	0,539	6,21	-0.01	32,2	0,524	-0.1	-0.01	0,06	-0.01	17,6	97,7	-1	-1	-1	7
BRM 0/44998	37,1	1,62	13	0,096	28,0	3,57	-0.1	-0.01	0,18	0,051	15	98,7	-1	-1	3,8	8
BRM 0/45373	49,3	0,673	5,54	-0.01	27,0	5,04	-0.1	-0.01	0,123	-0.01	11,6	99,4	-1	-1	-1	9
BRM 0/45465	58,1	0,966	4,75	-0.01	29,3	0,035	-0.1	-0.01	0,015	0,019	5,16	98,4	-1	-1	-1	10
BRM 0/45548	59,5	0,722	5,01	-0.01	28,1	0,079	-0.1	0,015	0,029	0,175	5,36	99	-1	-1	-1	11
BRM 0/45695	38,8	5,56	7,97	0,082	28,3	4,56	-0.1	-0.01	0,121	0,015	13,2	98,7	-1	-1	1,2	12
BRM 0/45792	57,5	1,2	5,61	-0.01	28,2	0,042	-0.1	-0.01	0,048	-0.01	5,14	97,8	-1	-1	-1	13
BRM 0/45810	36,6	6,13	11	0,356	26,0	4,72	-0.1	-0.01	0,179	0,046	14,1	99,2	-1	-1	-1	14
BRM 0/45843	46,1	5,73	9,1	0,271	25,3	4,17	0,11	0,028	0,155	0,068	7,36	98,4	-1	-1	21,3	15
BRM 0/45857	52,9	5,21	7,95	0,447	24,8	0,25	-0.1	3,09	0,071	-0.01	3,62	98,4	-1	4,8	11,5	16
BRM 0/45938	32,3	1,96	8,56	0,021	23,2	10,5	-0.1	0,015	0,152	0,094	18	94,9	-1	-1	-1	17
BRM 0/46144	51,9	3,49	10,3	0,191	25,9	1,58	-0.1	0,027	0,298	-0.01	5,04	98,8	-1	1,9	23,2	18
BRM 0/54177	36,2	0,266	7,32	-0.01	31,9	0,96	-0.1	-0.01	0,193	0,01	21,6	98,5	-1	-1	-1	19
BRM 0/54478	59,4	0,718	4,92	-0.01	28,9	0,033	-0.1	-0.01	0,028	-0.01	5	99,1	-1	-1	-1	20
BRM 0/54795	59,4	0,534	5,1	-0.01	28,6	0,013	-0.1	-0.01	0,045	-0.01	4,72	98,5	-1	-1	-1	21
BRM 0/55200	55,2	0,974	6,96	0,044	26,4	0,242	-0.1	0,085	0,114	0,099	7,87	98,1	1,6	-1	2,3	22
BRM 0/63018	57,9	1,01	4,45	-0.01	27,2	2,46	-0.1	0,032	0,062	1,14	4,02	98,3	-1	-1	-1	23
BRM 0/63600	59,3	0,957	4,89	-0.01	28,3	0,108	-0.1	0,033	0,054	0,217	4,13	98	-1	-1	1,4	24
BRM 0/63801	58,8	0,897	5,18	-0.01	27,6	1,2	-0.1	0,038	0,044	0,42	4,12	98,3	15,9	-1	-1	25
BRM 0/63998	57,0	1,18	5,04	0,012	28,7	1,03	-0.1	-0.01	0,08	-0.01	6,18	99,3	-1	-1	-1	26
BRM 0/64002	58,1	0,806	5,28	-0.01	28,1	0,244	-0.1	-0.01	0,034	0,025	5,02	97,7	-1	-1	-1	27
BRM 0/64060	58,8	0,633	5	0,023	26,7	3,33	-0.1	-0.01	0,102	-0.01	4,07	98,7	-1	-1	-1	28
BRM 0/64141	43,9	4,48	10,2	0,197	25,9	3,31	-0.1	-0.01	0,14	0,083	9,59	97,8	-1	-1	18,9	29
BRM 0/64255	54,1	4,17	8,17	0,325	24,9	0,448	-0.1	2,87	0,075	0,016	3,26	98,4	3,3	4,8	99,3	30
BRM 0/64272	54,8	1,99	14,5	0,114	24,5	0,973	-0.1	0,058	0,277	0,323	2,35	99,9	-1	-1	5,4	31
BRM 0/64393	58,9	0,456	3,95	0,019	29,5	0,028	-0.1	-0.01	0,06	0,012	5,22	98,2	-1	-1	-1	32
BRM 0/64422	56,9	0,89	5,93	-0.01	28,0	1,05	-0.1	-0.01	0,051	-0.01	5,57	98,4	-1	-1	-1	33
BRM 0/64487	59,2	0,424	4,54	0,016	28,6	0,047	-0.1	0,038	0,04	0,057	5,18	98,2	-1	-1	-1	34
BRM 0/64621	36,4	3,29	8,34	0,036	26,4	7,75	-0.1	-0.01	0,126	0,036	16,3	98,7	-1	-1	-1	35
BRM 0/64638	57,6	1,34	5,09	0,014	28,4	0,111	-0.1	0,011	0,034	0,019	5,04	97,7	-1	-1	-1	36
BRM 0/64641	54,1	3,15	4,64	0,012	27,7	1,13	-0.1	0,037	0,071	0,923	6,44	98,3	-1	-1	-1	37
BRM 0/64657	41,5	8,92	10,2	0,551	26,8	1,27	-0.1	-0.01	0,085	0,235	7,94	97,4	4,6	3,4	76,5	38
BRM 0/64742	27,5	0,548	8,64	-0.01	34,8	0,187	-0.1	-0.01	0,047	-0.01	28,2	100	-1	-1	-1	39
BRM 0/64786	55,6	2,29	5,6	0,014	27,7	0,916	-0.1	0,016	0,073	0,089	5,97	98,3	-1	-1	-1	40

Table 1a. *(Continued)*

Vessels, urban	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
BRM 0/64803	39,9	3,88	7,98	0,127	25,3	6,73	-0.1	0,031	0,124	0,016	13,6	97,8	-1	-1	-1	41
BRM 0/64828	37,7	0,354	6,82	-0.01	32,8	0,724	-0.1	-0.01	0,138	0,012	20,6	99,1	-1	-1	-1	42
BRM 0/64984	42,3	0,392	4,77	-0.01	26,7	8,68	-0.1	-0.01	0,105	-0.01	16,8	99,7	-1	-1	-1	43
BRM 0/64994	57,4	1,63	4,4	0,015	28,9	0,491	-0.1	-0.01	0,061	-0.01	5,25	98,2	-1	-1	-1	44
BRM 0/65004	41,6	1,14	6,43	0,029	25,7	7,55	-0.1	-0.01	0,172	0,024	13,8	96,5	-1	-1	-1	45
BRM 0/65007	57,7	0,975	5,65	-0.01	28,3	0,501	-0.1	-0.01	0,036	-0.01	5,36	98,5	-1	-1	-1	46
BRM 0/73087	39,5	1,89	10,9	0,133	30,0	0,579	-0.1	-0.01	0,108	0,441	14,9	98,5	-1	-1	2,1	47
BRM 0/73155	50,5	1,53	5,71	0,02	27,6	3,21	-0.1	0,011	0,08	-0.01	9,1	97,8	-1	-1	2,2	48
BRM 0/73346	49,7	1,57	6,66	0,025	28,0	2,7	-0.1	-0.01	0,056	-0.01	8,49	97,3	-1	-1	-1	49
BRM 0/73353	35,3	0,56	5,12	-0.01	24,7	11,4	-0.1	-0.01	0,277	-0.01	21,2	98,6	-1	-1	-1	50
BRM 0/73441	57,7	0,988	5,61	0,012	28,4	0,362	-0.1	-0.01	0,061	-0.01	5,03	98,3	-1	-1	4,8	51
BRM 0/75316	53,7	0,586	6,52	-0.01	26,3	0,788	-0.1	0,031	0,123	2,95	6,78	97,9	-1	-1	-1	52
BRM 0/75671	54,1	2,85	5,13	0,029	28,6	0,948	-0.1	0,08	0,041	0,029	7,03	99	-1	-1	1,4	53
BRM 0/75767	58,2	0,702	5,2	-0.01	28,2	0,528	-0.1	-0.01	0,04	-0.01	5,17	98	-1	-1	-1	54
BRM 0/77526	39,8	4,16	8,34	0,136	25,7	6,13	-0.1	-0.01	0,116	-0.01	12,8	97,2	-1	-1	-1	55
BRM 0/77531	36,2	0,489	6,1	-0.01	31,4	3,22	-0.1	-0.01	0,091	0,033	21,2	98,9	-1	-1	2,7	56
BRM 0/77564	56,2	0,979	5,16	-0.01	28,9	1,12	-0.1	-0.01	0,035	0,012	6,74	99,3	-1	-1	-1	57
BRM 0/77576	32,5	0,381	4,77	-0.01	27,6	10,2	-0.1	-0.01	0,194	0,015	23,5	99,2	-1	-1	-1	58
BRM 0/79750	35,6	7,48	8,03	0,114	31,9	0,22	-0.1	-0.01	0,067	0,011	15,4	98,8	-1	-1	3	59
BRM 0/80155	35,9	0,471	5,86	-0.01	34,1	0,13	-0.1	-0.01	0,076	-0.01	21,9	98,5	-1	-1	1,4	60
BRM 0/80210	21,6	0,518	6,66	-0.01	30,3	7,91	-0.1	-0.01	0,364	-0.01	31,8	99,2	-1	-1	1,6	61
BRM 0/80253	32,8	1,6	8,68	0,076	23,5	10,4	-0.1	-0.01	0,198	0,085	18,1	95,5	-1	-1	3,6	62
BRM 0/80455	41,2	4,61	9,24	0,174	26,5	3,85	-0.1	0,196	0,131	0,07	11,2	97,2	-1	2,1	57,1	63
BRM 0/80803	40,0	0,57	6,06	-0.01	31,7	2,65	-0.1	-0.01	0,106	-0.01	18,6	99,8	-1	-1	-1	64
BRM 0/80852	31,6	0,741	6,7	-0.01	32,5	2,18	-0.1	-0.01	0,11	-0.01	24,5	98,3	-1	-1	-1	65
BRM 0/80871	40,0	6,1	11,5	0,325	26,2	3,69	-0.1	0,011	0,13	0,039	11,8	99,8	-1	-1	12,9	66
BRM 0/81128	50,4	0,774	5,49	-0.01	27,4	4,58	-0.1	-0.01	0,11	0,012	10,9	99,6	-1	-1	-1	67
BRM 0/81366	57,5	0,793	5,63	-0.01	29,2	0,04	-0.1	-0.01	0,033	-0.01	5,09	98,3	-1	-1	-1	68
BRM 0/81374	48,6	0,575	5,35	-0.01	26,9	4,46	-0.1	-0.01	0,106	-0.01	10,9	97	-1	-1	-1	69
BRM 0/85416	28,8	0,175	7,54	-0.01	34,3	0,147	-0.1	-0.01	0,113	-0.01	26,8	98	-1	-1	-1	70
BRM 0/85447	31,3	0,352	6,79	-0.01	35,0	0,118	-0.1	-0.01	0,097	-0.01	25,5	99,2	-1	-1	-1	71
BRM 0/85448	33,8	0,452	6,36	-0.01	34,6	0,15	-0.1	-0.01	0,109	-0.01	23,7	99,2	-1	-1	-1	72
BRM 0/85465	42,9	0,622	4,85	-0.01	26,2	8,37	-0.1	-0.01	0,146	-0.01	16,3	99,4	1,2	-1	-1	73
BRM 0/85502	35,5	0,398	6,42	0,011	32,5	0,286	-0.1	-0.01	0,097	-0.01	22,6	97,9	-1	-1	-1	74
BRM 0/85503	35,8	0,437	6,29	-0.01	34,1	0,081	-0.1	-0.01	0,08	-0.01	22,4	99,2	-1	-1	-1	75
BRM 0/85556	41,7	9,56	9,74	0,291	28,2	0,5	-0.1	0,012	0,056	0,064	8,96	99,2	-1	4,6	128	76
BRM 0/85580	53,7	0,359	5,22	-0.01	27,3	0,883	0,39	0,159	0,093	0,056	10,4	98,5	-1	-1	-1	77
BRM 0/85591	35,1	0,337	6,35	-0.01	34,0	0,152	-0.1	-0.01	0,086	-0.01	22,7	98,8	-1	-1	-1	78

Table 1a. *(Continued)*

Vessels, urban	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
BRM 0/85635	43,0	0,574	5,73	-0.01	29,1	2,88	-0.1	0,014	0,068	0,012	15,4	96,8	-1	-1	-1	79
BRM 0/86150	57,7	1,64	5,24	0,01	28,9	0,031	-0.1	-0.01	0,03	-0.01	5,23	98,9	-1	-1	-1	80
BRM 0/86199	57,7	1,57	5,81	0,015	28,2	0,021	-0.1	0,012	0,038	-0.01	5,14	98,5	-1	-1	-1	81
BRM 0/86220	34,8	0,316	6,32	-0.01	31,6	2,88	-0.1	-0.01	0,112	0,011	23,4	99,4	-1	-1	-1	82
BRM 0/86878	37,6	3,79	11,6	0,264	29,7	1,42	-0.1	-0.01	0,17	0,02	15	99,4	-1	-1	14	83
BRM 3/697	58,9	0,555	3,43	0,014	29,2	0,637	-0.1	0,013	0,044	0,269	6,02	99,2	-1	-1	-1	84
BRM 3/702	47,7	1,32	5,7	0,036	27,1	4,94	-0.1	-0.01	0,09	0,011	10,7	97,6	-1	-1	-1	85
BRM 76/11041	44,4	0,932	5,2	-0.01	26,8	6,87	-0.1	-0.01	0,131	-0.01	14,5	98,8	-1	-1	-1	86
BRM 76/11048 # 1	58,1	1,67	3,27	0,012	30,4	0,121	-0.1	-0.01	0,012	-0.01	5,54	99,1	-1	-1	-1	87
BRM 76/11048 # 2	30,4	14,8	10	1,42	30,4	0,055	-0.1	-0.01	0,076	-0.01	11,4	98,5	-1	-1	6	300
BRM 104/2180	43,0	4,48	11,6	0,214	26,4	2,94	-0.1	-0.01	0,151	0,03	9,86	98,7	-1	-1	10,3	88
BRM 104/2299	43,2	0,637	5,12	-0.01	26,3	7,69	-0.1	-0.01	0,138	-0.01	15,3	98,4	-1	-1	2,7	89
BRM 104/2356	43,0	3,71	7,75	0,173	26,6	4,99	-0.1	-0.01	0,12	0,081	10,6	97,1	-1	-1	14,8	90
BRM 110/5518	32,8	0,622	7,32	-0.01	33,0	0,987	-0.1	-0.01	0,156	-0.01	24,1	99,1	-1	-1	-1	91
BRM 110/5651	39,8	4,51	9,66	0,282	25,6	5,39	-0.1	0,023	0,157	0,138	13	98,6	-1	-1	33,6	92
BRM 110/5959	58,7	1,12	5,19	-0.01	28,3	0,043	-0.1	-0.01	0,058	-0.01	4,9	98,4	-1	-1	1,5	93
BRM 110/6463	45,2	0,426	5,66	-0.01	26,2	5,62	-0.1	-0.01	0,173	0,02	12,7	96	-1	-1	-1	94
BRM 237/1277	53,3	1,34	5,71	0,017	26,8	0,343	-0.1	0,06	0,026	1,12	10,5	99,2	-1	-1	-1	95
Vessels, rural																
B4253	59,5	0,67	3,78	0,035	29,9	0,071	-0.1	-0.01	0,025	-0.01	4,83	98,8	-1	-1	-1	236
B4369	46,0	6,56	11,2	0,107	23,9	5,44	0,11	0,018	0,183	0,017	5,65	99,2	-1	-1	8,4	237
B4432	58,0	0,715	6,2	-0.01	28,5	0,125	-0.1	0,028	0,173	0,028	4,98	98,8	-1	1,4	-1	238
B4719	33,4	0,487	6,8	-0.01	34,7	0,104	-0.1	-0.01	0,096	-0.01	23,3	98,9	-1	-1	-1	239
B4836	43,7	5,11	16,5	0,221	26,2	0,3	-0.1	0,019	0,139	0,026	6,17	98,4	-1	-1	16,3	240
B6204	44,1	5,83	15,6	0,471	26,3	2,18	0,1	0,031	0,223	0,05	5,57	100	-1	2	30,2	299
B6982/b	32,7	0,18	5,94	-0.01	35,9	0,104	-0.1	-0.01	0,119	-0.01	25	99,9	-1	-1	-1	241
B7018	53,5	1,3	7,47	0,02	28,3	0,02	-0.1	-0.01	0,094	-0.01	6,82	97,6	-1	-1	-1	242
B7019	56,7	0,462	6,77	0,016	28,0	0,492	-0.1	-0.01	0,072	0,02	5,38	97,9	-1	-1	-1	243
B7105	55,5	0,952	9,53	0,034	26,5	1,03	-0.1	-0.01	0,113	-0.01	4,48	98,2	-1	-1	11,7	244
B7829	54,6	1,1	10,3	0,032	25,7	1,78	-0.1	-0.01	0,231	0,089	4,63	98,6	-1	-1	-1	245
B7888	52,1	3,22	7,74	0,105	28,6	0,191	-0.1	-0.01	0,078	0,051	6,61	98,7	-1	-1	20,3	246
B7925	58,0	1,43	4,97	0,051	28,8	0,281	-0.1	-0.01	0,046	-0.01	4,94	98,6	-1	-1	-1	247
B7960	59,3	0,277	5,26	-0.01	29,5	0,052	-0.1	-0.01	0,127	-0.01	4,6	99,1	-1	-1	-1	248
B8300	57,8	0,351	7,71	-0.01	27,3	1,13	-0.1	-0.01	0,234	0,014	3,33	98	-1	-1	-1	249
B8308	56,2	1,88	5,81	0,012	27,2	2,46	-0.1	0,01	0,103	-0.01	4,96	98,7	-1	-1	-1	250
B8321	32,7	0,212	6,24	-0.01	35,7	0,131	-0.1	-0.01	0,092	0,032	25	100	-1	-1	-1	251
B8995	51,2	1,12	9,47	0,024	30,5	0,021	-0.1	-0.01	0,026	-0.01	6,22	98,6	-1	-1	-1	252
B9976	41,4	11,9	7,17	0,052	26,7	5,94	0,22	0,061	0,167	-0.01	7,41	101	-1	-1	-1	253
B10270	41,3	9,99	8,95	0,319	30,2	0,323	-0.1	-0.01	0,116	0,048	9,19	101	-1	2	22	255

Table 1a. *(Continued)*

Vessels, rural	SiO[2]	Al[2]O[3]	Fe[2][3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Mo	Nb	Zr	NGU/UIB
B10454	39,2	7,6	17,9	0,655	25,5	1,69	-0.1	0,019	0,216	0,046	7,05	100	-1	-1	26,9	256
B10457	58,1	0,6	6,76	0,013	28,0	0,634	-0.1	0,025	0,172	-0.01	3,84	98,2	-1	-1	-1	257
B10462/b	40,8	9,17	12,5	0,445	26,7	0,312	-0.1	-0.01	0,138	0,014	8,03	98,1	-1	-1	-1	259?
B10462/c	54,4	0,663	6,83	0,018	29,0	0,124	-0.1	-0.01	0,115	0,128	7,57	99	-1	-1	-1	260?
B10462/a	58,5	0,4	6,32	-0.01	29,0	0,8	-0.1	0,012	0,138	-0.01	4,11	99,2	-1	-1	-1	258?
B10462/d	38,6	4,34	14,7	0,229	28,9	0,247	-0.1	-0.01	0,206	0,042	11,9	99,2	-1	-1	20,4	261?
B10481	53,4	2,85	7,31	0,057	27,3	2,33	-0.1	-0.01	0,15	-0.01	5,44	98,9	-1	-1	13,3	262
B10655	55,5	0,792	7,21	0,031	28,1	1,51	-0.1	0,034	0,205	0,024	5,46	98,9	-1	-1	-1	263
B10680/a	43,3	6,17	15,7	0,337	25,6	1,05	-0.1	0,023	0,146	0,049	6,71	99	-1	-1	31,1	264?
B10680/b	42,0	7,69	11	0,406	28,0	1,18	-0.1	0,033	0,094	0,107	8,98	99,5	-1	-1	28	265?
B10697	58,8	0,772	3,95	0,014	29,3	0,483	-0.1	-0.01	0,028	-0.01	4,68	98	-1	-1	-1	266
B10980	48,0	0,194	3,29	-0.01	28,7	5,94	-0.1	0,011	0,065	0,013	12,9	99,1	-1	-1	-1	267
B11115	53,3	3,03	12,8	0,238	24,2	1,41	-0.1	-0.01	0,218	0,026	4,46	99,7	-1	-1	9,3	269
B11116	57,1	1,02	5,26	0,031	29,6	0,648	-0.1	-0.01	0,071	-0.01	5,36	99,1	1,2	-1	-1	270
B11422	46,4	5,72	15,6	0,402	24,2	0,235	-0.1	0,017	0,411	0,076	5,49	98,6	-1	2,2	34	272
B11551/a	39,3	1,07	10,4	0,023	32,0	0,236	-0.1	-0.01	0,124	0,01	16,4	99,6	1,5	-1	1,2	273
B11564/g	57,9	0,514	5,1	0,01	28,6	0,122	-0.1	-0.01	0,123	0,143	4,87	97,5	-1	-1	-1	274
B11630	51,8	3,96	7,98	0,059	28,1	0,06	-0.1	-0.01	0,116	-0.01	5,95	98	-1	-1	-1	275
B11636	55,7	1,36	6,98	0,01	28,3	0,011	-0.1	-0.01	0,061	0,076	5,37	97,9	-1	-1	-1	276
B11686	35,8	1,05	8,17	0,013	32,4	0,774	-0.1	0,032	0,119	0,607	21,4	100	-1	-1	-1	277
B11797	38,8	6,9	11,3	0,45	27,6	2,51	-0.1	0,042	0,131	0,127	10,4	98,2	-1	-1	31,7	278
B11815/b	42,6	6,43	14,8	0,269	26,0	1,52	-0.1	0,022	0,132	0,095	7,23	99,1	-1	-1	24,5	279
B11835	54,2	1,98	6,62	0,05	29,4	0,319	-0.1	0,023	0,074	0,012	5,76	98,4	-1	-1	14,7	280
B11867/a	43,2	1,73	7,76	0,014	30,9	0,067	-0.1	-0.01	0,124	0,1	13,9	97,8	-1	-1	-1	281
B11868/b	48,7	1,72	7,22	0,028	30,0	0,328	-0.1	-0.01	0,116	0,041	10	98,2	-1	-1	-1	282
B11869/c	45,2	0,342	9,35	-0.01	29,0	0,055	-0.1	-0.01	0,177	0,141	13,4	97,7	-1	-1	-1	283
B11878/a	40,8	2,89	7,79	0,02	28,1	2,45	0,3	0,045	0,115	0,042	17,6	100	-1	-1	-1	284
B12025/b	55,2	1,48	7,84	0,013	29,5	0,147	-0.1	0,116	0,168	0,041	4,23	98,9	-1	-1	-1	285
B12050/a	44,4	7,28	11,9	0,301	25,9	1,94	0,2	0,224	0,176	0,042	7,24	99,6	-1	-1	18,4	286
B12314	48,2	3,26	7,48	0,027	29,5	0,018	-0.1	-0.01	0,041	-0.01	9,08	97,6	-1	-1	-1	287
B12372	49,1	2,97	10,7	0,203	28,5	1,63	-0.1	0,017	0,182	0,04	6,81	100	-1	-1	-1	288

Table 1b. *Trace element data for quarries and vessels expressed as ppm element.*

Quarry	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
1 Arnafjord # 1	n.d	84	7				2276	29						34	71	1898		73		UIB
1 Arnafjord # 12	1,1	72	2,7	-2	-4	26,3	1050	26,2	71	-5	-0.02	-10	6,5	55,8	-2	938	20,7	41,2	-20	99
1 Arnafjord # 16	1,3	75,4	5,6	-2	-4	26,4	680	25,3	47	-5	-0.02	-10	5	45,1	-2	742	14,6	34,2	-20	100
1 Arnafjord # 2	-1	77,7	1,1	-2	-4	23,5	1710	25,9	24	-5	0,092	-10	4,3	31,7	47,7	1210	31,9	68,2	-20	96
1 Arnafjord # 3	-1	-1	-1	-2	-4	20,4	1240	11,8	95	-5	0,044	-10	2,8	26,3	4	1540	35,2	71,8	-20	97
1 Arnafjord # 9	-1	-1	-1	-2	-4	20,6	1140	6,1	-10	-5	-0.02	-10	3,6	61,4	-2	1420	34,9	69,2	-20	98
2 Baldersheim # 1	-1	6,5	-1	-2	-4	21,1	2820	47,5	28	13,6	-0.02	-10	5,1	42,7	38,6	1840	41,7	102	-20	101
2 Baldersheim # 2	1,5	68,7	1,5	-2	-4	21,3	2140	47,5	-10	-5	-0.02	-10	4,8	29,3	15	1300	26,1	75,6	-20	102
2 Baldersheim # 3	-1	12,6	1,1	-2	-4	20	2830	57,6	19	15,1	-0.02	-10	5,3	48,6	10,4	1650	38,2	93,7	-20	103
2 Baldersheim # 4	-1	57,2	1,2	-2	-4	22,2	2260	53,9	-10	6,8	0,032	-10	5,4	43,9	16,1	1530	32,7	75,4	-20	104
2 Baldersheim # 5	-1	6,8	-1	-2	-4	21,1	2630	53,5	21	10,6	-0.02	-10	5,7	41,8	20	1770	34	89,9	-20	105
2 Baldersheim # 21	ND	45,774					3892,281	95,242						44,649	31,1	1649		87,818		UIB
2 Baldersheim # 19	ND	6,584					3868,053	63,101						19,066	30,7	1771		92,655		UIB
3 Bergsholmen # 2	-1	39,9	1,2	-2	-4	21,5	1740	11	-10	-5	0,058	-10	3,3	78,8	10	1540	32	92,4	-20	106
3 Bergsholmen # 3	-1	47,8	-1	3	-4	22,6	1540	16,3	-10	-5	-0.02	-10	3,6	32,5	-2	1410	33,4	69,6	-20	107
3 Bergsholmen # 4	-1	1,6	-1	-2	-4	21,6	2410	11,8	-10	-5	0,032	-10	2,3	24	9,3	1690	34,2	76,8	-20	108
3 Bergsholmen # 5	-1	10,3	-1	-2	-4	19,4	1890	9,4	-10	5,8	0,038	-10	3,1	22,1	-2	1160	23,9	66,6	-20	109
3 Bergsholmen # 7	-1	122	1,3	-2	-4	20,9	1680	12	-10	-5	0,101	-10	2,8	27,2	31,4	1130	23,5	68,2	-20	110
3 Bergsholmen # 1	n.d	30	n.d				5508	46						52	48	2780		132		UIB
4 Bergspytt # 10	7,6	60,5	2	-2	-4	20,2	3150	112	-10	14,1	-0.02	13	10,1	85,6	7,3	794	12,7	101	-20	114
4 Bergspytt # 13	9,3	62,2	2,1	2,2	-4	21,6	2060	72,7	-10	9,2	0,024	-10	8,2	77,4	14,3	799	12,9	97,5	-20	115
4 Bergspytt # 2	8	48,5	1,6	3,2	-4	20,4	2370	129	-10	16,9	0,07	14	9,2	76,7	98,8	801	10,4	115	-20	111
4 Bergspytt # 4	13,1	97,2	1,7	3,9	9,6	23,6	1260	59,9	-10	5,2	-0.02	-10	11,7	90,1	-2	457	-5	100	-20	112
4 Bergspytt # 5	8,3	23,3	1,7	-2	8,5	22,2	1860	76,6	-10	7,4	0,055	-10	10,6	85,2	4,1	654	8,7	99,4	-20	113
4 Bergspytt # 1	9	31	10				3575	52						93	28	641		137		UIB
5 Bru # 1	-1	-1	-1	-2	-4	21,4	1720	18,5	-10	-5	-0.02	-10	7,2	65	-2	1540	33,1	72,2	-20	116
5 Bru # 2	2,3	4,1	-1	-2	-4	19,6	1370	27,6	-10	-5	-0.02	-10	8,1	62,7	-2	1620	36,5	76,9	-20	117
5 Bru # 3	-1	-1	-1	-2	-4	19,1	1490	16,9	-10	-5	-0.02	-10	4	62,5	-2	1400	34	57,6	-20	118
5 Bru # 4	-1	-1	-1	-2	-4	21,1	1570	14,6	-10	-5	-0.02	-10	5,7	62,1	-2	1480	34,8	70,3	-20	119
5 Bru # 5	-1	-1	-1	-2	-4	20,4	1880	36,7	-10	-5	-0.02	-10	11	61,5	-2	1530	35,1	73,8	-20	120
6 Digranes # 1	20,4	2,9	2,2	3,9	10,1	19,9	462	154	-10	19	-0.02	-10	25,5	224	-2	480	-5	63,4	29	120
6 Digranes # 10	36,9	4,9	1,8	8,9	20	20,8	328	261	15	35,3	-0.02	17	30,4	271	20,1	269	-5	78,6	89	123
6 Digranes # 11	13,4	6,6	3	3,5	-4	22	402	63,4	-10	12,4	-0.02	20	8,9	157	-2	1120	27,5	55,1	-20	124
6 Digranes # 12	24,2	6,3	2,2	4,4	10,7	22,3	238	77,8	-10	11	-0.02	11	21	218	-2	717	13,2	68,5	113	125
6 Digranes # 2	21,6	4,5	1,9	2,9	8	21,3	1250	79,6	-10	12,2	-0.02	13	17,7	218	-2	1050	21,9	70,1	-20	122
7 Drebrekke # 2	1,3	15,3	6,6	-2	-4	20,2	1050	14,4	743	-5	-0.02	-10	3,8	133	-2	1230	30,3	59	-20	297
7 Drebrekke # 3	2,8	14,3	3,5	-2	-4	21,3	805	14,1	314	-5	-0.02	-10	3,8	107	-2	850	21,4	53,4	-20	298
7 Drebrekke # 1	n.d	15	14				1445	17						151	n.d	1044		92		UIB

Table 1b. *(Continued)*

Quarry	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
8 Flatabø # 1	5,2	5,6	1,7	-2	-4	20,3	2180	29,9	257	5,5	-0.02	-10	7,2	68,4	-2	979	12,9	46	-20	130
8 Flatabø # 2	2,7	3,2	1,5	-2	-4	20,6	2570	34,1	121	-5	-0.02	-10	9,7	67,4	-2	934	16,2	26,1	-20	131
8 Flatabø # 3	2	-1	12,4	-2	-4	22,5	1220	14,1	160	5,4	-0.02	15	4,9	122	-2	645	11,9	42,7	-20	132
8 Flatabø # 29																				UIB
9 Froastad # 1	-1	-1	-1	-2	-4	19,4	1310	33,9	24	-5	-0.02	-10	13,7	26,9	-2	1020	21,5	37,6	-20	133
9 Froastad # 2	-1	-1	-1	-2	-4	19,9	1520	20,9	76	-5	-0.02	-10	4,6	29,9	2,4	922	20,8	37	-20	134
9 Froastad # 3	-1	3,5	-1	-2	-4	20,6	1360	10,8	-10	-5	-0.02	-10	2,1	21,5	7,8	1760	41,7	76,7	-20	135
9 Froastad # 4	-1	3,5	-1	-2	-4	19,8	1240	9,1	-10	-5	-0.02	-10	2,1	21,3	6,5	1820	38,4	77,8	-20	136
10 Ingahogget # 1	9,8	-1	1,2	-2	4,1	23	348	29,4	12	13,7	-0.02	-10	7,7	69,9	4	804	16,8	98,9	25	140
10 Ingahogget # 2	2,4	15,3	1,7	-2	-4	22,8	2540	46,5	102	7,8	-0.02	-10	7,4	81,9	16,6	1360	28,1	107	-20	141
10 Ingahogget # 4	-1	-1	1,2	-2	-4	21,2	2320	50,9	-10	9,4	0,218	-10	8,1	66,8	134	769	10,1	84,2	-20	142
10 Ingahogget # 5	2,1	-1	1,4	-2	-4	21,5	2610	44,1	-10	9,5	-0.02	-10	9,8	84,2	11,6	903	14,8	94,1	-20	143
10 Ingahogget # 6	4	8	1,2	-2	-4	20,3	1540	50,3	-10	17,9	-0.02	-10	7,7	61,1	6,1	715	7,6	77,9	-20	144
11 Juadal # 1	-1	-1	-1	-2	-4	20,7	2120	26,8	285	7,5	-0.02	-10	3,3	27,2	4,5	1740	41,4	81,5	-20	145
11 Juadal # 10	-1	3,4	-1	-2	-4	21,3	2370	26,2	922	5,5	-0.02	-10	5,4	32	-2	1390	32,5	54,5	-20	147
11 Juadal # 11	-1	12,5	1,2	-2	-4	22,5	2140	40	268	8,5	-0.02	-10	8,6	34,9	46,1	1030	24,5	38,3	-20	148
11 Juadal # 12	-1	80,2	1,3	-2	-4	22,3	2000	28,3	378	5,3	-0.02	-10	7,4	35,8	-2	1090	27,3	33,9	-20	149
11 Juadal # 13	-1	-1	-1	-2	-4	21,5	1500	20,9	410	-5	-0.02	-10	5,3	39,7	-2	1110	23,5	40,4	-20	150
11 Juadal # 2	-1	-1	-1	-2	-4	21,2	2350	25,3	259	-5	0,048	-10	5,9	29,5	35,7	1310	33,2	51,7	-20	146
11 Juadal # 1/UIB																				UIB
11 Juadal # 2/UIB	n.d	n.d	7				2967	34						34	6	2388		108		UIB
11 Juadal # 3/UIB	n.d	n.d	n.d				4646	25						43	20	1488		91		UIB
11 Juadal # 2/2/UIB	n.d	n.d	7				2967	34						34	6	2388		108		UIB
11 Juadal # 3/3/UIB	n.d	n.d	n.d				4646	25						43	20	1488		91		UIB
12 Katlaberg # 1	-1	32,5	-1	-2	-4	22,6	1690	20,3	16	5,7	-0.02	-10	2,8	28,7	-2	1550	35,9	86,6	-20	UIB
13 Klauvsteinsberg # 2																				UIB
13 Klauvsteinsberg # 3	ND	ND					3374,374	28,197						44,875	ND	1772		109		UIB
13 Klauvsteinsberg # 1	ND	ND					3385,683	17,751						33,983	ND	2120		101		UIB
14 Klovsteinsjuvet # 3	1,9	19,3	1,1	-2	-4	23,3	6980	85	-10	10,5	0,059	-10	8,5	78,4	113	1290	30,4	106	-20	152
14 Klovsteinsjuvet # 5	2,7	36,2	1,7	-2	-4	23,4	3310	74,7	-10	6,9	0,038	-10	7,2	65,6	124	943	21,2	87,8	-20	153
14 Klovsteinsjuvet # 6	4	28,3	2,1	-2	-4	23,4	5380	74,3	-10	11,4	0,048	18	7,5	90,4	124	1140	25,6	100	-20	154
14 Klovsteinsjuvet # 8	-1	10,7	1,2	-2	-4	23,1	3860	69,7	-10	14,1	0,056	-10	6,9	68,1	147	1200	21,9	106	-20	155
14 Klovsteinsjuvet # 3	n.d	n.d	7				3587	23						51	n.d	2464		110		UIB
14 Klovsteinsjuvet # 4	6	39	n.d				7603	62						68	102	1142		109		UIB
15 Kvernes # 10	-1	-1	-1	-2	-4	21,7	1270	11	-10	-5	-0.02	-10	2,9	31,6	-2	1620	37,3	69,8	-20	156
15 Kvernes # 11	-1	-1	-1	-2	-4	21	800	8,7	35	-5	-0.02	-10	2,9	43	-2	1340	31,9	47,5	-20	157
15 Kvernes # 20	-1	-1	-1	-2	-4	20,7	1470	13,6	184	-5	-0.02	-10	2,7	28,5	4,3	1500	34,2	66	-20	158

Table 1b. *(Continued)*

Quarry	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
15 Kvernes # 21	-1	27	-1	-2	-4	21,5	1570	12,7	61	-5	-0.02	-10	2,9	28,8	9,7	1350	29,1	67,7	-20	159
15 Kvernes # 22	-1	-1	-1	-2	-4	19,4	1600	13	110	-5	-0.02	-10	2,3	27,2	2,7	1540	37,8	65,2	-20	160
15 Kvernes # 23	-1	27,3	1,1	-2	-4	21,5	1670	15,4	54	-5	-0.02	-10	3,2	29,8	34,4	1410	31,2	82,4	-20	161
15 Kvernes # 1																				UIB
15 Kvernes # 2	5	19	n.d				2544	32						43	18	2211		104		UIB
15 Kvernes # 3	5	37	5				2154	28						32	19	1895		95		UIB
16 Kvitno # 1	-1	-1	-1	-2	-4	22,1	1000	13,8	529	-5	-0.02	-10	3,9	89,2	-2	699	20,2	30,7	-20	162
16 Kvitno # 10	-1	4,6	-1	-2	-4	20,7	1590	12,1	340	-5	0,032	-10	4,8	88,3	4,3	640	12,6	25,9	-20	166
16 Kvitno # 5	2,1	-1	1,2	-2	-4	19,9	1750	28,1	697	-5	-0.02	-10	6,1	113	-2	690	18,4	41,3	-20	163
16 Kvitno # 6	3,4	1,1	1,5	-2	-4	19,8	1690	40,7	962	5,6	-0.02	-10	8,2	106	-2	851	19,6	23,9	-20	164
16 Kvitno # 7	1,2	8,3	1	-2	-4	20,3	1360	11,8	817	-5	-0.02	-10	4,2	88,9	-2	842	27,6	32,4	-20	165
16 Kvitno # 1/UIB	n.d	n.d	5				1738	13						101	n.d	284		59		UIB
17 Lysekloster # 1	6	27	n.d				2502	56						90	13	765		131		UIB
17 Lysekloster # 10	7	71	n.d				1943	41						87	10	831		114		UIB
17 Lysekloster # 11	6	90	n.d				2380	46						86	24	871		109		UIB
17 Lysekloster # 12	8	28	n.d				2619	58						88	9	768		111		UIB
17 Lysekloster # 13	6	51	n.d				2233	50						84	n.d	793		119		UIB
17 Lysekloster # 14	10	46	n.d				1521	65						107	27	760		81		UIB
18 Melstveit # 1	1,2	117	3,5	2,1	-4	20,3	795	98,9	11	21,3	-0.02	19	10,9	26,9	-2	193	-5	47,6	-20	167
18 Melstveit # 2	2,1	123	2,5	-2	-4	19	1000	112	-10	25,3	-0.02	21	12,3	31,6	5,4	224	-5	48,2	-20	168
19 Munkahogget # 1	-1	37,3	-1	-2	-4	20,6	2290	17,1	-10	-5	-0.02	-10	5,1	24,9	184	1650	42,5	94,3	-20	169
20 Nygård # 1	-1	-1	-1	-2	-4	19,6	1560	12,4	-10	5,9	-0.02	-10	2,2	24,3	2,7	1760	43,7	91,1	-20	172
20 Nygård # 2	-1	-1	-1	-2	-4	21,1	1750	43,9	-10	9,7	-0.02	-10	10,2	40,5	-2	2030	48	85,6	-20	173
20 Nygård # 3	-1	-1	-1	-2	-4	21,4	1390	11,6	-10	-5	-0.02	-10	2,2	24,4	2,9	1790	41,8	92,4	-20	174
20 Nygård # 4	-1	-1	-1	-2	-4	20,8	1520	17,7	-10	-5	-0.02	-10	2,3	23,1	3,8	2080	47,9	99,1	-20	175
20 Nygård # 1/UIB	n.d	6	n.d				2777	26						43	9	2539		110		UIB
21 Rauberg # 1	-1	-1	-1	-2	-4	20,2	1570	22,4	60	7,3	-0.02	-10	3,1	29,1	4,8	1560	40,5	78,7	-20	182
21 Rauberg # 1/UIB		3,4	<1	<2	<4	7,9	1760	18,7	132	5,3	<0.02	<10	<1	31,8	4,8	1410	<5	52,9	<20	UIB
21 Rauberg # 2/UIB		<1	<1	<2	<4	8,7	1140	<5	<10	<5	<0.02	<10	<1	28,2	<2	1880	<5	70,3	<20	UIB
21 Rauberg # 3/UIB		<1	<1	<2	<4	7,3	2230	26,2	116	5,9	<0.02	<10	<1	32,7	5,4	1790	<5	91,5	<20	UIB
21 Rauberg # 5/UIB		<1	<1	<2	<4	7,8	2310	25,1	48	6,8	<0.02	10	<1	54,1	5,2	1590	<5	107	<20	UIB
22 Rauberg # 4/UIB		6,2	<1	<2	<4	9	1340	13,1	87	<5	<0.02	<10	<1	33,7	2,1	1480	<5	83	<20	UIB
22 Raudesteinane # 1	-1	-1	-1	-2	-4	20,2	1220	7,2	114	-5	-0.02	-10	7,6	74,6	-2	1070	23,6	42,6	-20	183
22 Raudesteinane # 2	-1	-1	-1	-2	-4	21,1	1470	11,5	26	-5	-0.02	-10	6,1	56	-2	1170	32,6	42,1	-20	184
23 Russøy # 12	-1	2,3	-1	-2	-4	20,3	1660	18,3	12	-5	0,032	12	2,7	30,8	4,8	1130	28,2	65	-20	291
23 Russøy # 1	-1	15,1	-1	-2	-4	20,8	1740	17,7	17	6,7	-0.02	-10	2,6	20,7	2,8	1100	25,8	62,6	-20	185
23 Russøy # 10	-1	-1	-1	-2	-4	21	1980	19,5	53	6,6	-0.02	-10	3	25,6	3,4	1060	21,9	78,3	-20	188
23 Russøy # 13	-1	-1	-1	-2	-4	20,9	1560	15,6	11	5,7	0,025	-10	2,8	23,7	-2	1150	23,4	59,8	-20	189

Table 1b. *(Continued)*

Quarry	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
23 Russøy # 2	-1	3	-1	-2	-4	21	1840	18,2	-10	5,9	0,028	-10	3,2	33,9	12,9	1500	36,3	79,9	-20	186
23 Russøy # 4	-1	122	1,2	-2	-4	24,7	2180	13,4	-10	-5	-0.02	-10	4,5	13,9	-2	894	23,3	75,2	-20	187
23 Russøy # 1/UIB																				UIB
23 Russøy # 2/UIB	n.d	7	6				3398	29						46	21	2159		112		UIB
23 Russøy # 10/UIB	ND	ND					3353,714	26,812						18,39	8,33	1394		97,2		UIB
24 Sele # 1	3,8	123	2,1	-2	-4	29	1650	78,7	-10	9,6	-0.02	11	6,9	79	-2	1090	19,4	92,5	-20	190
24 Sele # 2	3,4	70,1	1,8	-2	-4	24,8	1620	74,4	-10	8,6	-0.02	-10	6,6	81,5	-2	1150	25,1	97,3	-20	191
24 Sele # 3	3,8	190	2,3	-2	-4	21,1	1540	70	14	7,2	-0.02	-10	6,4	54	26,5	845	16,8	71,9	-20	192
24 Sele # 4	4	259	2,5	2,5	-4	22,3	1630	76,1	-10	6,4	-0.02	14	7	51,7	3,2	947	19,3	89,4	-20	193
24 Sele # 5	3,6	161	2	-2	-4	22,5	1780	91,3	-10	10,8	-0.02	15	8,3	81,7	2,3	1050	18,6	91,3	-20	194
25 Sjusete # 1	-1	133	1,4	-2	-4	21,9	1700	15,6	-10	-5	-0.02	30	2,9	24,3	15	1780	37,6	78,1	-20	195
25 Sjusete # 2	-1	-1	1	-2	-4	20,9	3630	66	-10	9,7	-0.02	-10	7,6	69,8	91,4	781	12,5	75,4	-20	196
25 Sjusete # 3	-1	223	1,6	-2	-4	21,9	1430	15,6	-10	-5	-0.02	-10	3,9	23,6	9,7	1780	46,2	89,3	-20	197
25 Sjusete # 4	-1	-1	-1	-2	-4	20,7	902	16	-10	-5	-0.02	-10	6,3	25,7	5,3	1300	29,5	64,7	-20	198
26 Skare # 3	8,5	93	6,4	-2	-4	19,6	3990	74,1	42	8,6	0,049	16	11,6	94,4	18,7	1120	27,9	85,3	-20	199
26 Skare # 4	7,4	86,2	3,5	2	-4	20,2	2880	66,2	-10	10,5	-0.02	14	9,8	109	6,1	1230	25,1	104	-20	200
26 Skare # 5	7,2	87,9	8,1	-2	-4	22,1	2870	64,2	17	9,4	0,029	27	9,4	89,2	11,9	1050	20,7	86,1	-20	201
26 Skare # 6	6,4	52,5	4,2	-2	-4	20,5	3220	71,1	28	9,6	-0.02	15	10	100	4,2	1180	24,5	95,4	-20	202
27 Svanøy # 1	-1	-1	-1	-2	-4	18,8	524	13,2	12	-5	-0.02	-10	4,6	25,8	-2	755	16,5	40,6	-20	206
27 Svanøy # 2	-1	-1	-1	-2	-4	19,8	1970	20,7	77	5,1	-0.02	-10	3	31,2	4,7	1440	30,1	57,3	-20	207
27 Svanøy # 3	-1	-1	1,1	-2	-4	18,7	375	124	-10	13,1	-0.02	-10	23,7	69	-2	614	9,7	54,1	-20	208
27 Svanøy # 4	-1	19	-1	-2	-4	20,4	1880	25,3	-10	6,5	0,023	-10	5	39,6	10,4	993	23,7	69,7	-20	209
28 Sævråsvåg # 10	5	122	n.d				1962	23						44	23	1225		54		UIB
28 Sævråsvåg # 11	5	5	5				2348	20						80	n.d	988		84		UIB
28 Sævråsvåg # 12	6	134	n.d				1950	20						36	n.d	1190		56		UIB
28 Sævråsvåg # 13	6	14	7				1084	205						67	7	656		97		UIB
28 Sævråsvåg # 14	n.d	116	n.d				2106	17						46	7	1256		53		UIB
28 Sævråsvåg # 2	6	149	n.d				1935	17						34	13	1488		52		UIB
28 Sævråsvåg # 3	n.d	6	6				422	15						73	n.d	1081		69		UIB
28 Sævråsvåg																				UIB
29 Tysse # 1	2,1	-1	1,1	2,4	-4	21	860	56,4	-10	14	-0.02	17	8,7	115	29,7	351	-5	153	-20	210
29 Tysse # 2	8,9	9,3	1,2	3,3	-4	19,6	908	69,2	-10	13,2	0,045	-10	11	107	39,4	342	-5	138	-20	211
29 Tysse # 3	14,7	11,7	1,7	2,6	-4	19	1040	67,7	-10	15,5	-0.02	-10	8,5	94,4	-2	230	-5	104	-20	212
30 Tyssedal # 6	3,1	-1	-1	-2	-4	19,7	1250	40,7	227	5,3	-0.02	-10	7,5	97,2	-2	845	17,3	31,1	-20	213
31 Tyssøy # 1	-1	37,5	1	2	-4	18,3	1450	24,8	13	6,2	0,037	-10	5,6	71,5	143	870	14,9	139	-20	214
31 Tyssøy # 10	-1	40,8	1,4	-2	-4	19,9	386	24,5	-10	6,2	0,031	-10	5,2	66	99,7	841	12,8	143	-20	220
31 Tyssøy # 2	-1	4,5	1,2	-2	-4	19,3	179	26,5	11	10,9	-0.02	-10	5,5	74	8,5	861	13,9	133	-20	215
31 Tyssøy # 3	-1	31,2	1,4	-2	-4	19,1	403	14,3	14	-5	-0.02	-10	4,2	69,3	34,6	890	15,3	134	-20	216

Table 1b. *(Continued)*

Quarry	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
31 Tyssøy # 6	-1	41,1	1,3	-2	-4	18,2	351	22,3	12	8,8	-0.02	-10	5,6	69,4	72,8	857	16,5	147	-20	217
31 Tyssøy # 8	-1	5,6	1,3	-2	-4	19,2	862	38,1	16	14,1	0,031	13	4,7	96,5	86,1	1040	20	149	-20	218
31 Tyssøy # 9	-1	37,4	1,2	2,8	-4	19,5	1780	38,3	10	8,5	0,058	-10	5,4	72,3	128	917	12,4	147	-20	219
31 Tyssøy # 27																				UIB
31 Tyssøy # 14	ND	45,145					1931,841	41,898						77,209	255	1125		141		UIB
31 Tyssøy # 10/UIB	ND	17,307					380,529	37,9						71,554	74	873		129		UIB
32 Urda # 17	-1	86,4	1,1	-2	-4	18,8	1420	15	62	-5	-0.02	-10	2,8	20,6	4,8	1540	34,1	87,6	-20	221
32 Urda # 18	-1	5,3	1,2	-2	-4	20,5	1510	16,6	11	5,8	0,298	-10	2,7	29,8	3,7	1640	34	107	-20	222
32 Urda # 19	-1	-1	-1	-2	-4	19,2	1470	14,6	-10	-5	-0.02	-10	2,1	17,6	2,2	2060	47,5	73,9	-20	223
32 Urda # 20	-1	1,5	-1	-2	-4	19,9	1420	21	36	6,4	-0.02	-10	2,7	19,5	-2	1620	38,5	64,7	-20	224
32 Urda # 5	n.d	11	8				2357	27						26	10	2173		104		UIB
32 Urda # 1																				UIB
32 Urda # 14	n.d	5	6				3533	18						80	30	2316		126		UIB
32 Urda # 2																				UIB
33 Vargahola # 1	3,5	170	1,8	-2	-4	25,9	1500	9,2	-10	-5	0,045	-10	3,2	48,6	135	1670	36,6	56,9	-20	231
34 Vargavågen # 1	-1	-1	-1	-2	-4	20,4	1490	9,4	-10	5	-0.02	-10	2,6	24,9	-2	1700	39	81,5	-20	225
34 Vargavågen # 2	-1	-1	-1	-2	-4	19,1	1400	8,8	-10	-5	-0.02	-10	3	25,8	-2	1240	31,3	70,1	-20	226
34 Vargavågen # 3	-1	-1	-1	-2	-4	19,4	1350	10,1	-10	6	-0.02	-10	2,8	32,1	-2	1730	37,9	80,6	-20	227
34 Vargavågen # 4	-1	-1	-1	-2	-4	20	1650	15,8	-10	7	-0.02	-10	2,5	24	2,8	1770	36,5	85	-20	228
34 Vargavågen # 5	-1	-1	-1	-2	-4	18,5	1770	14,4	-10	-5	-0.02	-10	2,6	29,7	-2	1950	46,2	87,1	-20	229
34 Vargavågen # 6	-1	2,3	-1	-2	-4	19,7	1180	6,9	-10	-5	-0.02	-10	2,8	20,6	2,4	1790	39,6	80,2	-20	230
35 Vargavåg Gryte # 1																				UIB
35 Vargavåg Gryte # 3	n.d	7	n.d				4053	27						36	18	2591		119		UIB
35 Vargavåg Gryte # 4	n.d	10	n.d				2688	24						31	15	2721		110		UIB
36 Vassenden # 1	-1	2,6	-1	-2	-4	20,3	1340	14	376	-5	0,046	-10	3	116	3,9	817	19	46,1	-20	292
36 Vassenden # 2	2,4	21,9	1,2	-2	-4	19,1	671	10,7	-10	-5	0,061	-10	3,1	80,5	3,6	1020	26	43,6	-20	293
36 Vassenden # 3	-1	4,6	-1	-2	-4	19,5	1120	12,5	36	-5	0,039	-10	3,1	108	4,7	1440	36,6	68,1	-20	294
36 Vassenden # 4	1,4	13,4	-1	-2	-4	20,1	802	12,1	-10	-5	0,041	-10	3,6	84,2	3,6	869	23,6	39,1	-20	295
36 Vassenden # 5	-1	6,8	1,1	-2	-4	18,8	1790	23	-10	-5	0,259	-10	5,4	97,4	15,7	2180	56,2	84	-20	296
37 Ådland # 1																				UIB
37 Ådland # 2																				UIB
38 Åkra # 1	5,7	75,6	2,1	2,3	-4	19,3	1120	59,6	-10	9,2	-0.02	11	10	109	10,8	1220	20,9	123	-20	232
38 Åkra # 2	5,5	66	1,8	-2	-4	17,3	1090	58,1	-10	8,3	-0.02	13	9,6	113	20,7	1230	23,2	124	-20	233
38 Åkra # 3	5,1	99,9	2,3	2,3	-4	19,6	1010	51,4	-10	7,1	-0.02	12	9,2	107	42,2	1190	24	121	-20	234
38 Åkra # 4	5,9	60,9	1,9	2,4	-4	20	1130	58,4	-10	10	-0.02	27	9,8	111	56,6	1260	21,8	125	-20	235
Vessels, urban.																				**NGU-lab no**
BRM 0/42937	-1	1,1	-1	-2	-4	20,9	1410	18,3	-10	-5	0,072	-10	3	31,9	-2	1720	44	81,9	-20	1
BRM 0/43530	-1	41	-1	2,2	-4	20,2	3570	63,9	-10	10,4	0,13	-10	8,3	152	25,9	1840	42,1	109	-20	2
BRM 0/43549	4,1	47,4	7,3	-2	-4	22	3550	105	-10	17,6	2,64	43	8,6	124	102	1180	23,1	142	-20	3

Table 1b. *(Continued)*

Vessels, urban	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
BRM 0/44163	-1	1,9	-1	-2	-4	20,6	1400	14,2	-10	-5	0,087	-10	3,8	47,8	2,7	1530	35,2	77,3	-20	4
BRM 0/44650	1,7	166	2,2	3,4	-4	21,1	50,4	31,5	-10	7,9	0,157	38	8	120	-2	481	-5	137	-20	5
BRM 0/44931	-1	3,1	-1	-2	-4	35,4	1550	15,8	-10	-5	-0.02	-10	2,8	76,1	-2	1460	37,5	69,7	-20	6
BRM 0/44934	-1	5,5	-1	-2	-4	24,7	1630	15	59	-5	0,038	-10	3,9	35,8	16	1500	37,4	68,2	-20	7
BRM 0/44998	2,9	49,3	1,6	-2	-4	23	3430	39,3	-10	5,9	0,065	-10	6	136	29,2	1350	31	118	-20	8
BRM 0/45373	-1	48,4	1	-2	-4	25	1520	18	-10	-5	0,061	-10	3,4	30,9	5,5	1480	37,1	70,2	-20	9
BRM 0/45465	-1	1,5	-1	-2	-4	22,5	1370	12,7	-10	-5	0,086	-10	4	28,9	-2	1490	39,1	78,7	-20	10
BRM 0/45548	-1	22,3	-1	-2	-4	20,9	1050	9,9	-10	5,1	0,171	16	3,2	29,6	-2	1420	38,1	67,5	-20	11
BRM 0/45695	1,4	26,4	1,8	-2	-4	23,7	2070	61,3	-10	7,9	0,144	12	7,5	42	9,6	1430	29,4	96,5	-20	12
BRM 0/45792	-1	-1	-1	-2	-4	21,9	1530	14,3	-10	-5	0,045	-10	4,1	73,8	-2	1630	36,6	77,9	-20	13
BRM 0/45810	-1	-1	-1	-2	-4	20,2	1500	14,1	-10	-5	0,04	-10	4,3	71,8	-2	1600	44	76,4	-20	14
BRM 0/45843	6,5	34,7	1,3	-2	-4	23,9	2190	88,3	-10	12,5	0,581	15	9,2	67,4	15,1	1340	30,2	81,4	-20	15
BRM 0/45857	9,7	-1	135	-2	4,3	21,9	1310	48,9	-10	6,4	-0.02	104	11,5	136	-2	1300	29	63,9	27	16
BRM 0/45938	-1	127	2	-2	-4	22,4	3180	36	-10	-5	1,65	24	4,1	43,1	94,8	1370	27,2	101	-20	17
BRM 0/46144	2,8	3,5	1,7	-2	-4	23,7	1930	42,7	-10	-5	0,05	31	8,5	105	-2	1230	24,8	68,5	-20	18
BRM 0/54177	-1	13,2	-1	-2	-4	21,8	1650	12,6	98	-5	0,062	-10	2,4	47,6	10	1430	28,6	65,7	-20	19
BRM 0/54478	-1	-1	-1	-2	-4	22,7	867	8,1	-10	-5	-0.02	-10	3,1	28,2	5,3	1440	38,8	69,4	-20	20
BRM 0/54795	-1	-1	-1	-2	-4	23,9	1350	17,3	-10	-5	-0.02	-10	3,5	41,6	-2	1520	36,3	72,6	-20	21
BRM 0/55200	-1	12,8	2,5	-2	-4	23,9	5110	39,9	78	-5	0,866	12	6,4	201	34,1	1240	25,4	88,1	-20	22
BRM 0/63018	6,4	53,1	1,4	-2	-4	37,4	1860	14,7	10	8,2	0,139	14	4,4	63,3	7,7	1790	44,5	92,1	-20	23
BRM 0/63600	-1	19,1	1,4	-2	-4	23,7	1670	15,7	-10	-5	-0.02	65	4,4	76,2	-2	1450	35,5	75,8	-20	24
BRM 0/63801	-1	20,5	1,4	-2	-4	32,6	1650	10,9	-10	-5	0,109	-10	4,7	51,4	61,3	2130	54,3	96	-20	25
BRM 0/63998	-1	11	-1	-2	-4	23,6	1470	13,5	-10	-5	-0.02	-10	3,9	52,4	-2	1520	35,9	78,4	-20	26
BRM 0/64002	-1	4,2	-1	-2	-4	23,7	1230	7,7	11	-5	0,029	-10	3,7	69,7	3,6	1200	31,7	58,8	-20	27
BRM 0/64060	-1	2,8	-1	-2	-4	24	581	7,2	16	-5	-0.02	-10	4,2	88,2	-2	933	26,5	34,7	-20	28
BRM 0/64141	1,9	26,3	-1	-2	-4	21,1	1660	70,8	-10	12,8	0,305	-10	7,7	93,6	38,5	1380	31,7	82,9	-20	29
BRM 0/64255	13,4	1,4	240	2,6	10,1	24,2	1130	23,8	15	-5	-0.02	67	11,4	140	-2	1550	34,3	74,4	39	30
BRM 0/64272	-1	33,7	4,3	-2	-4	28,7	3440	63,5	-10	14,5	0,115	52	7,7	195	-2	1070	16,6	91,1	-20	31
BRM 0/64393	-1	-1	1,4	-2	-4	58,7	1860	9,6	180	-5	0,023	-10	3,4	61,6	2,6	1430	31,3	74,7	-20	32
BRM 0/64422	-1	16,2	-1	-2	-4	26,3	1730	13,2	11	-5	0,073	-10	4	62,7	12,4	1280	33,8	69,4	-20	33
BRM 0/64487	-1	4,2	1,1	-2	-4	24,4	1610	7,7	-10	-5	0,221	-10	3,6	59,8	8,5	1190	28,6	58,3	-20	34
BRM 0/64621	-1	65,2	1,5	-2	-4	24,1	4950	53,8	-10	8	0,108	-10	5,5	39,2	-2	1530	33	99,9	-20	35
BRM 0/64638	-1	2	1,5	-2	-4	24,9	1130	15	536	-5	-0.02	-10	4,2	43	-2	1340	36,7	47,4	-20	36
BRM 0/64641	-1	111	1,1	-2	-4	20,6	1650	23,2	11	9,3	0,149	157	7	63,5	321	1640	39,5	66	-20	37
BRM 0/64657	12,6	6,6	1,2	3	-4	23,3	1300	178	-10	13,1	0,206	-10	15,3	111	27,4	699	11,2	47	-20	38
BRM 0/64742	-1	1,1	1,1	-2	-4	22,5	1470	15,7	-10	5,1	0,033	-10	3,3	23,3	5,1	1130	24	67,5	-20	39
BRM 0/64786	-1	14,3	1,3	-2	-4	21,3	1780	25,5	-10	-5	0,138	21	5,9	52,3	3,7	1780	39,3	76,9	-20	40
BRM 0/64803	-1	65	1,8	-2	-4	22,4	4910	53,2	-10	6,1	0,107	14	5,7	39,3	-2	1520	32,2	101	-20	41
BRM 0/64828	-1	25	-1	-2	-4	22,3	1190	11,9	-10	-5	-0.02	-10	3,2	29,1	6,8	1450	39,5	74	-20	42

Table 1b. *(Continued)*

Vessels, urban	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
BRM 0/64984	-1	92,9	1,2	-2	-4	28,5	1030	12,4	-10	-5	0,026	-10	3,2	25,1	-2	1340	33,5	67,4	-20	43
BRM 0/64994	-1	2,6	-1	-2	-4	23,3	1350	10	-10	-5	-0.02	-10	4,9	33,8	-2	1360	35,5	67,9	-20	44
BRM 0/65004	-1	124	1,5	-2	-4	26,1	2000	24	181	-5	0,14	-10	5,3	42,6	19,5	1230	27	39,5	-20	45
BRM 0/65007	-1	8,1	-1	-2	-4	21,7	1710	13,2	-10	-5	0,056	-10	4,2	59,3	7,2	1120	25,6	59,3	-20	46
BRM 0/73087	-1	24,2	1,2	-2	-4	20,5	800	5,1	-10	-5	0,04	-10	5	26,2	-2	970	35,7	51,2	-20	47
BRM 0/73155	-1	24,9	1,4	-2	-4	20	840	5,7	-10	-5	0,038	-10	5,2	26,2	-2	979	35,7	52,3	-20	48
BRM 0/73346	-1	8,9	-1	-2	-4	24,4	359	37,2	-10	5,7	0,073	-10	4,4	35	110	1360	33,5	104	-20	49
BRM 0/73353	2,5	178	1,7	-2	-4	46,3	1280	7,4	-10	-5	-0.02	-10	3,7	51	-2	1410	33,3	66,2	-20	50
BRM 0/73441	-1	54,9	-1	-2	-4	23,6	1140	14,2	-10	-5	0,082	687	4,2	38,2	5,6	1540	31,6	51,5	-20	51
BRM 0/75316	-1	56,4	1,3	-2	-4	28,5	2420	22,3	123	-5	0,037	50	3,9	282	6,3	1780	36,9	63,3	-20	52
BRM 0/75671	-1	20	1	-2	-4	19,4	926	5,9	-10	-5	0,027	-10	5,5	27,6	-2	1030	34,4	54,2	-20	53
BRM 0/75767	-1	8,5	-1	-2	-4	22,9	1380	9,3	12	-5	-0.02	-10	3,6	76,9	5,5	1200	25,4	60	-20	54
BRM 0/77526	-1	21,7	1,2	-2	-4	22,8	1810	48,4	-10	8,8	0,123	-10	5,8	53,5	158	675	12,2	68,3	-20	55
BRM 0/77531	-1	47,2	1,1	-2	-4	22,5	1130	9,9	-10	-5	0,038	-10	6,1	35,8	4,9	1070	41,3	46,9	-20	56
BRM 0/77564	-1	18,6	-1	-2	-4	23,3	1460	27,2	-10	-5	0,047	-10	4,9	34,6	3,6	1660	33,9	75,4	-20	57
BRM 0/77576	-1	857	4,5	3,2	-4	27,5	911	10,4	-10	-5	0,142	-10	3,5	22,7	2,7	1150	26,8	45	-20	58
BRM 0/79750	-1	48,9	1,1	-2	-4	25	1250	12,6	-10	-5	0,046	-10	6,1	36,5	9	1090	43,4	50,5	-20	59
BRM 0/80155	-1	37,6	-1	-2	-4	22,9	1540	15,2	-10	-5	0,028	-10	6,4	38,5	5,6	1210	37,7	55,5	-20	60
BRM 0/80210	-1	37,6	1	-2	-4	22,9	1560	15,3	10	-5	0,026	-10	6,3	39,1	6	1220	40,7	55,4	-20	61
BRM 0/80253	3,8	152	1,9	-2	-4	22,2	3070	38,2	-10	-5	0,688	13	7,3	104	85	716	13,5	90,3	-20	62
BRM 0/80455	7,6	163	12,1	-2	-4	23,9	2980	43,5	-10	5,3	0,079	19	7,7	84,8	13,8	956	19,1	79,7	-20	63
BRM 0/80803	-1	34,5	1	-2	-4	23,9	1260	12,3	17	-5	0,041	-10	3,6	29,6	16,8	1190	27,7	58,6	-20	64
BRM 0/80852	-1	25,8	-1	-2	-4	23,9	1310	10,5	-10	-5	-0.02	-10	4	22,6	-2	1410	27,3	77,2	-20	65
BRM 0/80871	4,3	48,8	1,6	-2	-4	21,5	1770	93,2	-10	15	0,025	11	9,2	71	24,6	904	20	108	-20	66
BRM 0/81128	-1	44,2	-1	-2	-4	26	1550	19,5	-10	-5	0,06	-10	4,3	30,2	3,4	1590	36,9	73,7	-20	67
BRM 0/81366	-1	-1	-1	-2	-4	22,1	1380	14,8	-10	-5	0,065	-10	4,1	24,9	-2	1620	35,7	72,4	-20	68
BRM 0/81374	-1	32,8	-1	-2	-4	23,9	1530	16,3	-10	-5	0,059	-10	4	25,6	11,8	1630	39,3	68,1	-20	69
BRM 0/85416	-1	-1	-1	-2	-4	23,7	1630	19,2	-10	-5	0,036	-10	2,7	27,2	19,5	1610	37,1	90,8	-20	70
BRM 0/85447	-1	-1	-1	-2	-4	81	1990	18	-10	-5	0,122	-10	3	29,5	6,2	1660	36,8	83,5	-20	71
BRM 0/85448	-1	1,2	-1	-2	-4	23,8	1550	10,3	-10	-5	0,036	-10	3	25,9	4	1550	31,9	75,3	-20	72
BRM 0/85465	-1	158	1,3	-2	-4	31,5	1090	7,4	37	-5	-0.02	-10	3,1	31,1	-2	1260	28,2	51,5	-20	73
BRM 0/85502	-1	3,6	1,4	-2	-4	86,5	1410	17,9	-10	-5	0,154	-10	2,9	31,5	11,3	1850	48,9	84,8	-20	74
BRM 0/85503	-1	1,1	-1	-2	-4	23,1	1820	16,3	-10	5,9	0,03	-10	2,6	34	6,8	1690	37,9	79,8	-20	75
BRM 0/85556	1,5	2,9	1,2	-2	-4	23,1	947	48,2	352	20,8	-0.02	12	12,7	38,7	-2	2060	35,5	110	-20	76
BRM 0/85580	-1	37,6	4	-2	-4	23,1	2170	16,3	69	8,2	3,77	21	2,7	41,6	183	2750	66,4	111	-20	77
BRM 0/85591	-1	1,8	-1	-2	-4	31,9	1900	17	-10	-5	0,176	-10	2,8	28,1	5,5	1660	37,7	83,5	-20	78
BRM 0/85635	-1	77,6	1,4	-2	-4	24,4	2270	17,8	248	-5	0,759	-10	2,9	59,2	-2	2250	51,6	90,5	-20	79
BRM 0/86150	-1	-1	-1	-2	-4	22,2	1590	12,5	12	-5	-0.02	-10	4,7	58,1	3,7	1470	32,4	60,2	-20	80

***Table 1b.** (Continued)*

Vessels, urban	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
BRM 0/86199	-1	-1	-1	-2	-4	21,9	1010	17,7	-10	-5	-0.02	-10	5	51,9	-2	1480	34,1	71,3	-20	81
BRM 0/86220	-1	43,7	1	-2	-4	24	1430	11,6	-10	-5	0,1	-10	2,6	31,5	2,4	1640	40,9	77,2	-20	82
BRM 0/86878	2,2	24,5	1,1	-2	-4	21,2	1950	58,5	-10	11,5	0,11	10	7,4	95,1	5,8	925	16,2	124	-20	83
BRM 3/697	1,4	37,1	-1	-2	-4	22,2	1180	10,6	-10	-5	0,173	21	3,2	134	18,3	361	10,2	28,6	-20	84
BRM 3/702	-1	73,1	1	-2	-4	21,5	2110	29,7	97	-5	0,102	-10	5,2	41,9	6,5	876	22,2	38,3	-20	85
BRM 76/11041	3	133	1,3	-2	-4	25	1480	13,6	-10	-5	0,053	-10	4	35,6	24,5	1060	28,7	58	-20	86
BRM 76/11048 # 1	-1	1,3	-1	-2	-4	21,8	234	9,7	-10	-5	-0.02	-10	3,5	40,3	-2	1310	32,8	70,8	-20	87
BRM 76/11048 # 2	-1	-1	-1	-2	-4	19,7	784	111	-10	30,8	0,086	14	13,9	58,4	-2	826	15,7	103	-20	300
BRM 104/2180	3	28	1,3	-2	-4	20,8	1700	60,1	-10	10,7	0,068	-10	9,5	94,9	16,7	891	18,2	98,1	-20	88
BRM 104/2299	-1	153	1,6	-2	-4	22,2	1450	11,5	-10	-5	0,133	-10	3,4	28,5	40,7	1190	27	61	-20	89
BRM 104/2356	2,5	45,7	1	-2	-4	20,3	2000	47,4	-10	9,3	0,598	14	7,1	64,9	36,9	1360	33,9	80,2	-20	90
BRM 110/5518	-1	15,1	-1	-2	-4	44,7	1840	18,8	660	5,5	0,082	-10	4	29,6	-2	1440	34	60,3	-20	91
BRM 110/5651	7,2	120	2,2	-2	-4	22,7	2060	85,6	13	12,4	0,055	-10	7,8	109	24,3	891	16,8	76,8	-20	92
BRM 110/5959	-1	-1	-1	-2	-4	20,2	1310	10,9	-10	-5	-0.02	-10	4,2	72,8	-2	1620	36,7	74,2	-20	93
BRM 110/6463	-1	445	2,8	-2	-4	23,4	1210	13,4	-10	-5	0,491	-10	3,9	30,5	8	1650	41,7	58,6	-20	94
BRM 237/1277	6,5	68	2	-2	-4	96,9	2440	29,8	-10	9,3	0,023	64	4,9	256	28,4	1470	37	57,3	62	95
Vessels, rural																				
B4253	-1	-1	-1	-2	-4	20,2	927	10	429	-5	-0.02	-10	3,4	73,6	-2	451	12,2	36,8	-20	236
B4369	-1	23,5	1,1	-2	-4	20	1900	114	59	15,9	-0.02	11	9,3	65,9	-2	508	-5	51,7	-20	237
B4432	-1	-1	2,2	-2	-4	19,2	2320	11,3	43	-5	-0.02	26	5	116	-2	1240	25,1	81,8	-20	238
B4719	-1	-1	-1	-2	-4	19,9	1850	12,5	97	-5	-0.02	-10	2,5	37,4	2,3	1490	37,4	80,2	-20	239
B4836	6,5	1,6	2,3	2,6	-4	18,7	1130	68,4	-10	18	-0.02	66	8,7	140	28,3	385	-5	156	-20	240
B6204	4,7	19,9	2,7	2,4	-4	21,3	1130	69,2	11	7,7	0,039	20	10,8	113	22,9	605	6,4	91,8	-20	299
B6982/b	-1	1,5	-1	-2	-4	19,6	1260	6,5	327	-5	-0.02	11	2,2	32,2	-2	992	21	63,2	-20	241
B7018	-1	1	1,5	-2	-4	19	2250	29,5	977	7,3	-0.02	13	3,7	47,4	2,5	825	15	67,7	-20	242
B7019	-1	10,6	-1	-2	-4	20,1	2180	10,9	29	-5	0,439	-10	3,2	90,5	78,4	288	-5	26,8	-20	243
B7105	-1	-1	1,4	-2	-4	19,3	3970	52	-10	-5	0,13	-10	4	67,5	48,1	2540	51,1	77,3	-20	244
B7829	-1	18,9	1,3	-2	-4	22	1910	30,6	-10	16,7	-0.02	70	3,7	82,8	-2	672	10,3	74	-20	245
B7888	-1	1,1	1,2	-2	-4	19,8	3990	46,5	11	6,6	0,154	-10	7,2	57,9	78,5	966	20,8	71,3	-20	246
B7925	-1	-1	-1	-2	-4	18,4	1060	13,8	131	-5	-0.02	-10	3,8	112	-2	466	9,6	25,5	-20	247
B7960	-1	-1	1,3	-2	-4	19,9	1180	7,6	631	-5	-0.02	-10	2,9	127	-2	284	-5	25,4	-20	248
B8300	1,4	2,7	1,6	-2	-4	17,5	899	8	171	-5	-0.02	-10	3,7	113	-2	737	15	54,6	-20	249
B8308	-1	8,7	-1	-2	-4	20	1610	20,7	-10	-5	0,039	-10	5,6	27,1	12,7	1420	32,1	59,8	-20	250
B8321	-1	3,1	-1	-2	-4	19,7	1540	11,3	-10	-5	-0.02	18	2,1	32,4	-2	1710	40,3	81,2	-20	251
B8995	-1	-1	-1	-2	-4	23,1	3300	51,7	-10	15,4	-0.02	-10	4,1	63,1	-2	2550	54,5	116	-20	252
B9976	-1	3,3	1,4	-2	-4	18,3	1190	79,5	-10	23,3	-0.02	-10	7,2	132	-2	322	-5	77,5	-20	253
B10270	2,5	2,7	-1	-2	-4	19,6	52,9	120	-10	21,2	-0.02	15	12,3	78,4	-2	485	7,3	47	-20	255

Table 1b. *(Continued)*

Vessels, rural	Y	Sr	Rb	U	Th	Pb	Cr	V	As	Sc	S	Ba	Ga	Zn	Cu	Ni	Yb	Co	Ce	NGU/UIB
B10454	4,8	76,2	1,9	2,5	-4	18,9	1950	94,4	-10	13,6	-0.02	24	13,7	148	74,7	806	5,5	131	-20	256
B10457	-1	1,7	2,2	-2	-4	19,4	928	12,3	44	7	-0.02	-10	4,1	99,4	-2	834	18,4	60,8	-20	257
B10462/b	-1	-1	1,5	-2	-4	19,2	4450	185	14	34,5	-0.02	26	11,5	89,7	-2	434	-5	73	-20	259?
B10462/c	-1	5,9	1,3	-2	-4	22,5	866	15,1	302	7,1	-0.02	29	2,9	65,6	-2	1350	28,8	82,2	-20	260?
B10462/a	-1	2,4	1,6	-2	-4	19,6	906	8,8	506	-5	-0.02	-10	3,4	74,9	-2	908	19,5	58,3	-20	258?
B10462/d	1,6	4	1,6	-2	-4	19,4	2220	75,6	16	16,7	-0.02	43	9,2	127	16,9	1030	19,9	124	-20	261?
B10481	11,7	3,3	1,1	-2	-4	18,7	1660	54,8	720	5,6	0,058	17	6,4	102	10,8	583	8	33,6	-20	262
B10655	2,3	13	1,3	-2	-4	19,4	1730	20,2	16	-5	0,022	-10	4,3	52,6	13,1	639	14,5	37,3	-20	263
B10680/a	4,5	8	2	2,2	-4	20,4	962	50,3	-10	7,9	-0.02	-10	9,1	133	40,1	1040	20,5	123	-20	264?
B10680/b	7,3	25,6	3,5	-2	-4	19,4	3210	73,6	23	11,8	-0.02	13	10,8	117	16,8	1080	22,9	94,7	-20	265?
B10697	-1	-1	-1	-2	-4	17,8	1300	7,2	-10	-5	-0.02	-10	3,1	52,9	20,3	987	23,8	42,7	-20	266
B10980	-1	48,7	1,2	-2	-4	18,5	866	5,4	500	-5	0,026	-10	2,4	23,4	12,3	1690	38,7	57,5	-20	267
B11115	4,1	1,6	1,5	-2	-4	17,9	2370	220	-10	21,4	0,069	12	8	126	30,9	455	-5	65,5	-20	269
B11116	1,3	5	-1	-2	-4	19,7	1420	14,5	762	-5	0,108	-10	4,1	72,2	33,4	460	7,5	19,9	-20	270
B11422	4,6	2,2	1,9	2,7	-4	21,3	1520	46,8	-10	9,4	-0.02	-10	9,3	172	2,2	1210	14,4	96,3	-20	272
B11551/a	-1	5,7	-1	-2	-4	22,4	3430	28,4	-10	7,8	-0.02	-10	3,7	42,9	-2	2510	55,8	112	-20	273
B11564/g	-1	2,4	-1	-2	-4	22	1320	7,7	-10	-5	0,033	13	3,4	70,9	27	998	24,1	47,4	-20	274
B11630	-1	-1	-1	-2	-4	20,5	1580	28,9	283	-5	-0.02	10	7,9	69,7	-2	926	18	60	-20	275
B11636	-1	3,8	-1	-2	-4	23,1	2250	24,5	-10	-5	0,05	11	4,3	61,2	7	2540	63,4	81,3	-20	276
B11686	-1	25,9	1,9	-2	-4	27,8	2580	20,8	-10	-5	-0.02	209	3,3	39,7	2,3	1520	37,9	76	-20	277
B11797	6,7	127	4,3	2,2	-4	23,7	2930	72,2	43	9,3	0,034	37	9,9	91,3	22,6	999	20,9	73,6	-20	278
B11815/b	5	12	1,9	-2	-4	20,9	1610	64,6	75	9,8	-0.02	19	10	110	6,3	1230	27,5	106	-20	279
B11835	-1	2,3	2,2	2,6	-4	21,1	1320	15,2	-10	-5	-0.02	-10	7	63,1	8,6	710	16,1	36,1	-20	280
B11867/a	-1	3,3	-1	-2	-4	38,4	1710	23,6	13	8,9	-0.02	36	4	139	2,7	1390	37,9	81	-20	281
B11868/b	-1	7,2	-1	-2	-4	42,8	2880	34,1	-10	17,2	-0.02	24	3,9	106	-2	593	12	77,4	-20	282
B11869/c	-1	1,7	-1	-2	-4	31,9	2910	16,3	385	-5	-0.02	53	2,5	98,1	-2	1010	22,7	81,6	-20	283
B11878/a	-1	62,4	-1	-2	-4	22,6	1280	9,3	64	-5	-0.02	22	2,5	59,8	4,2	989	20,9	60,4	-20	284
B12025/b	-1	-1	8,6	-2	-4	20,9	1920	15,9	403	-5	-0.02	-10	4,8	130	-2	974	21,9	52,8	-20	285
B12050/a	1,5	-1	1,6	-2	-4	19,7	2120	59	45	11,2	-0.02	15	8,5	95,7	135	1070	22,8	110	-20	286
B12314	-1	-1	-1	-2	-4	22,7	2210	69,5	-10	9,2	-0.02	-10	5,3	46,5	3,7	1160	30,6	81,2	-20	287
B12372	-1	8	-1	-2	-4	21,5	2780	59,2	-10	17	0,026	18	4,6	68,6	39,9	370	-5	69,5	-20	288

Table 2. *Rare earth element data for quarries and vessels.*

Quarry no. and sample no. Samples n= 100	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Lab no. GEO/ UIB
1 Arnafjord # 1	0,8820	0,6172	0,6266	0,4774	0,3769	0,8493	0,3470	0,3032	0,3265	0,3145	0,3141	0,3330	0,3437	0,3656	icp296
1 Arnafjord # 2	1,7507	1,1328	1,0789	0,9549	0,7498	0,4572	0,7088	0,6319	0,5379	0,4943	0,4587	0,4139	0,4744	0,4932	icp1832
2 Baldersheim # 3	0,1682	0,1649	0,1919	0,2132	0,2930	0,2376	0,2807	0,3030	0,3037	0,3310	0,3503	0,3922	0,5149	0,6050	icp198
2 Baldersheim # 2	0,5879	0,7005	0,9325	1,1266	1,4730	1,1011	1,5742	1,5243	1,6299	1,6052	1,5822	1,4960	1,4938	1,3975	icp199
2 Baldersheim # 1	0,1478	0,1477	0,1841	0,2005	0,2708	0,2047	0,2692	0,2533	0,2951	0,3037	0,3292	0,3500	0,4629	0,5418	icp200
2 Baldersheim # 4	0,4229	0,3607	0,4119	0,5333	0,6308	0,5185	0,6460	0,6915	0,6980	0,6782	0,6862	0,6639	0,7206	0,7026	icp910
2 Baldersheim # 5	0,1839	0,1500	0,1496	0,1697	0,1864	0,1546	0,1904	0,2088	0,2214	0,2156	0,2405	0,2907	0,3723	0,4688	icp911
3 Bergsholmen # 2	1,4770	1,2916	1,1913	1,0616	1,0198	0,9492	0,9324	0,9548	0,9532	0,8064	0,7331	0,7085	0,8579	0,7880	icp201
3 Bergsholmen # 3	0,5565	0,4770	0,4343	0,3508	0,2793	0,4023	0,2146	0,1915	0,2054	0,1940	0,1943	0,2158	0,2099	0,1443	icp202
3 Bergsholmen # 5	0,2023	0,1409	0,1359	0,1004	0,0826	0,1428	0,0688	0,0627	0,0877	0,1018	0,1031	0,1109	0,0852	0,1263	icp503
3 Bergsholmen # 6	0,2694	0,2036	0,1995	0,1108	0,0695	0,0580	0,0433	0,0222	0,0338	0,0252	0,0203	0,0225	0,0290	0,0766	icp504
3 Bergsholmen # 7	1,6560	1,2375	1,1687	0,8049	0,4826	0,7586	0,2917	0,2325	0,2142	0,2212	0,2043	0,2458	0,2395	0,3032	icp505
4 Bergspytt # 2	4,9276	5,4641	6,6944	6,8172	7,2574	4,2471	6,3916	5,6470	6,0081	5,7064	5,2782	5,5602	5,0158	5,4040	icp510
4 Bergspytt # 3	6,7517	7,5434	8,9340	8,5999	8,4792	3,9687	7,2371	6,1000	6,1976	5,8822	5,4401	5,6807	5,3302	5,5330	icp511
4 Bergspytt # 1	9,0607	9,0543	9,5296	9,1482	8,4002	4,4398	6,8210	5,6939	5,7523	5,6419	5,2291	5,5848	5,5704	5,7082	icp298
5 Bru # 1	16,6452	11,1881	7,3443	5,0550	2,4718	1,7415	1,3938	1,1603	0,8540	0,7242	0,6619	0,6173	0,5646	0,4348	icp3020
8 Flatabø # 1	0,9968	1,4097	1,8197	1,8917	2,3385	0,5714	2,5637	3,1224	3,4565	3,3148	3,6762	4,1358	4,8995	4,9379	icp3021
9 Froastad # 1	0,1355	0,1374	0,0000	0,1033	0,0000	0,0000	0,0000	0,0000	0,0714	0,0000	0,0810	0,0000	0,1148	0,0000	icp3022
10 Ingahogget # 1	57,6306	42,7169	35,1285	27,3339	14,7125	2,9336	8,3764	7,6413	8,2081	8,8516	8,6562	8,7032	8,2619	8,4461	icp308
10 Ingahogget # 2	7,9175	6,9634	6,8843	6,1426	4,1503	1,6925	2,2922	1,8594	1,7010	1,5408	1,3524	1,4508	1,4739	1,4899	icp309
10 Ingahogget # 3	14,7874	12,4940	12,1506	10,3761	7,0353	3,8121	4,1796	3,6461	3,7104	3,6682	3,6272	3,6228	3,6984	3,9128	icp310
10 Ingahogget # 4	0,3063	0,3319	0,4341	0,4350	0,4152	0,0397	0,3322	0,2783	0,2644	0,2298	0,2168	0,2244	0,2488	0,2490	icp311
11 Juadal # 11	2,3791	0,7353	1,1703	0,8425	0,4808	0,2342	0,3251	0,2681	0,1899	0,1744	0,1725	0,1560	0,1808	0,1669	icp192
11 Juadal # 10	0,5778	0,3730	0,3479	0,2204	0,1534	0,0828	0,1170	0,0960	0,0984	0,1328	0,1750	0,2248	0,2898	0,3319	icp193

Table 2. *(Continued)*

Quarry	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	NGU/UIB
11 Juadal # 2	0,5667	0,3273	0,2889	0,2182	0,1366	0,0668	0,0999	0,1070	0,1189	0,1301	0,1688	0,2010	0,2664	0,2595	icp181
11 Juadal # 1	0,1793	0,1241	0,0959	0,0741	0,0641	0,0337	0,0430	0,0449	0,0542	0,0481	0,0634	0,0673	0,0917	0,0487	icp182
13 Klauvsteinsberget # 1	0,5749	0,3166	0,3141	0,3060	0,2864	0,1137	0,2229	0,2252	0,2026	0,1737	0,1600	0,1516	0,1722	0,1448	icp914
13 Klauvsteinsberget # 3	3,4784	3,3411	3,4145	3,5547	3,1073	1,5309	2,0974	1,9270	1,4662	0,9900	0,7538	0,4411	0,3747	0,3002	icp916
14 Klovsteinsjuvet # 1	2,5587	2,3877	2,2635	1,9782	1,7676	1,2073	1,6943	1,6942	1,8743	2,0978	2,1896	2,4165	2,4854	2,6710	icp321
14 Klovsteinsjuvet # 2	2,5641	2,3588	2,2078	1,9715	1,8205	1,5544	1,8858	1,7522	1,9875	2,2610	2,1722	2,6679	2,7497	3,0870	icp322
14 Klovsteinsjuvet # 3	0,1748	0,1813	0,1822	0,1572	0,1870	0,0479	0,1658	0,1698	0,1604	0,1424	0,1025	0,1070	0,0895	0,0844	icp323
14 Klovsteinsjuvet # 4	8,6999	7,0043	6,0569	4,6347	3,0074	0,9246	2,4700	2,1902	2,2986	2,4598	2,5414	2,7333	2,9049	3,2710	icp324
15 Kvernes # 1	6,3491	5,4143	4,4936	3,5732	2,3066	1,8040	1,5460	1,4261	1,3238	1,2039	1,2662	1,2174	1,3374	1,2633	icp184
15 Kvernes # 3	1,0118	1,0521	0,9584	0,8660	0,8927	0,5595	0,6976	0,7203	0,7062	0,7295	0,7729	0,8436	0,9296	0,8501	icp189
15 Kvernes # 10	0,2445	0,1424	0,1564	0,1104	0,0734	0,0528	0,0470	0,0439	0,0270	0,0249	0,0199	0,0332	0,0270	0,0001	icp194
15 Kvernes # 11	0,1465	0,1252	0,0877	0,0548	0,0362	0,0367	0,0214	0,0340	0,0189	0,0171	0,0182	0,0208	0,0191	-0,0052	icp196
15 Kvernes # 20	0,1405	0,1068	0,1023	0,0628	0,0707	0,0294	0,0335	0,0387	0,0631	0,0726	0,0947	0,1153	0,1256	0,1503	icp524
15 Kvernes # 21	0,3943	0,2936	0,2659	0,1856	0,1652	0,1025	0,1213	0,1026	0,1304	0,1078	0,1112	0,1142	0,1589	0,1965	icp525
16 Kvitno # 1	1,5219	0,9907	0,9756	0,8377	0,8090	0,2407	0,6852	0,6553	0,6617	0,6380	0,6436	0,7300	0,7053	0,7259	icp297
17 Lysekloster # 1	3,4051	3,1376	3,0631	3,0350	2,4603	1,9129	1,7017	1,5669	1,2290	1,1169	1,1162	1,2477	1,1772	1,2391	icp62
17 Lysekloster # 10	3,8915	4,0495	4,2829	4,5216	4,5495	4,1105	3,3176	2,9715	2,4653	2,1085	2,0158	1,8675	2,0128	1,9373	icp63
17 Lysekloster # 11	1,5038	1,7635	2,0074	2,2487	2,7017	3,2056	2,5254	2,3088	2,2764	1,9546	1,9067	1,7751	1,8823	1,8857	icp64
17 Lysekloster # 12	3,3861	3,2581	3,4999	3,6705	3,6274	2,3789	2,6137	2,4931	2,0447	1,8104	1,7435	1,5284	1,5987	1,5002	icp65
17 Lysekloster # 13	0,7948	0,8057	0,8931	1,0428	1,3588	1,3754	1,1887	1,2119	1,1362	1,0790	1,0293	1,0273	1,1005	1,1730	icp66
17 Lysekloster # 14	2,9944	3,1397	3,4016	3,6768	3,8557	2,7953	3,4824	3,5076	3,1100	2,9612	2,8600	2,6310	2,6501	2,5254	icp67
20 Nygård # 1	0,0000	0,0524	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0622	0,0000	icp3023
21 Rauberg # 1	0,0000	0,0854	0,0000	0,0667	0,0000	0,0000	0,0000	0,0000	0,0404	0,0000	0,0619	0,0000	0,0861	0,0000	icp3024
22 Raudesteinane # 1	1,6161	0,5656	0,5574	0,4050	0,3436	0,0000	0,4749	0,5274	0,4627	0,4875	0,4476	0,4630	0,4976	0,5590	icp3025

Table 2. *(Continued)*

Quarry	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	NGU/UIB
22 Raudesteinane # 2	0,7903	0,2376	0,4508	0,3250	0,1795	0,0000	0,1737	0,1899	0,1460	0,1393	0,1429	0,0000	0,1722	0,2484	icp3026
23 Russøy # 2/UIB	0,6889	0,4858	0,3611	0,2404	0,1569	0,1393	0,0950	0,0772	0,0638	0,0591	0,0651	0,0790	0,0996	0,0908	icp176
23 Russøy # 2	0,2143	0,1348	0,0884	0,0655	0,0476	0,0283	0,0248	0,0180	0,0316	0,0363	0,0430	0,0714	0,1059	0,1122	icp177
23 Russøy # 1/UIB	0,6875	0,6071	0,4685	0,3352	0,2164	0,1204	0,1343	0,1299	0,1069	0,0794	0,0951	0,0835	0,1214	0,1103	icp187
23 Russøy # 13	0,3458	0,2492	0,2116	0,1384	0,0926	0,0411	0,0620	0,0664	0,0569	0,0760	0,1067	0,1610	0,1801	0,1969	icp195
23 Russøy # 11	0,1521	0,1130	0,0989	0,0694	0,0339	0,0278	0,0272	0,0241	0,0219	0,0216	0,0188	0,0272	0,0268	0,0050	icp197
23 Russøy # 10	0,4714	0,3805	0,3044	0,2821	0,2212	0,0574	0,1542	0,1657	0,1526	0,1470	0,1520	0,1787	0,2230	0,2382	icp909
25 Sjusete # 1	1,5032	0,6881	0,6311	0,5550	0,4359	2,4354	0,3784	0,3586	0,3478	0,3621	0,4286	0,5247	0,7081	0,8696	icp3027
26 Skare # 1	45,2258	34,9134	30,0656	24,6333	12,3128	5,1701	7,9073	6,4557	4,9037	4,0947	4,1238	3,5185	3,7033	3,6646	icp3028
28 Sævråsvåg # 10	1,6838	1,6269	1,5822	1,4855	1,3623	2,6940	1,1411	1,1367	1,0335	1,0155	1,0799	1,0834	1,1472	1,1352	icp68
28 Sævråsvåg # 11	0,1078	0,1101	0,1056	0,1156	0,1366	0,1579	0,0891	0,1033	0,0965	0,0837	0,0921	0,0808	0,0870	0,0932	icp69
28 Sævråsvåg # 12	2,6740	2,7886	2,6511	2,5221	2,2536	2,5375	1,8743	1,9899	1,9126	1,9963	2,0671	1,9461	1,9951	1,9014	icp70
28 Sævråsvåg # 14	1,2932	1,1414	0,9963	0,8402	0,5800	2,1625	0,4193	0,3868	0,3324	0,3273	0,3520	0,3717	0,4452	0,4572	icp72
28 Sævråsvåg	8,2461	7,0065	5,8442	4,6580	2,8851	4,2567	1,6964	1,3518	1,0633	0,9825	0,9740	0,8917	1,0057	0,9720	icp205
29 Tysse # 1	2,2415	2,4123	2,8303	2,9682	3,0983	0,7748	2,6627	2,2504	2,1428	2,0324	1,8995	1,9834	2,0550	2,2505	icp325
29 Tysse # 2	1,2081	1,1644	1,1933	1,1687	1,0391	0,2728	0,9402	0,8836	0,9422	0,9359	0,9227	1,0033	0,9993	1,0557	icp326
29 Tysse # 3	11,4771	10,6880	10,7671	10,0754	8,8234	2,0434	4,8748	9,1041	7,5248	7,2458	7,1237	7,7579	7,8116	7,6964	icp327
30 Tyssedal # 1	24,5000	18,3540	16,3525	13,0950	6,8923	0,9796	4,1853	3,3966	2,3820	2,0613	2,3286	2,4074	2,7751	2,8882	icp3030
31 Tyssøy # 1	0,3955	0,3900	0,5361	0,5668	0,9021	1,2526	1,0054	0,9252	1,0128	0,9796	0,9495	0,9357	0,9566	1,0584	icp312
31 Tyssøy # 2	0,1130	0,0648	0,0688	0,0567	0,0577	0,0340	0,0666	0,0677	0,0975	0,1168	0,1529	0,2299	0,2682	0,3411	icp313
31 Tyssøy # 3	0,1868	0,1618	0,1756	0,1705	0,2116	0,3526	0,2407	0,2131	0,2280	0,2575	0,2560	0,3156	0,3809	0,4909	icp314
31 Tyssøy # 4	1,8106	1,7089	2,2959	2,5967	3,1369	2,4377	3,5806	3,2363	3,4647	3,6046	3,4728	3,5447	3,4118	3,8720	icp315
31 Tyssøy # 5	3,4793	3,6763	5,0809	5,5054	6,7777	6,7424	7,4833	7,0576	7,5075	7,5475	7,1899	7,5397	7,4475	7,8568	icp316
31 Tyssøy # 6	0,3522	0,2470	0,2323	0,2264	0,2418	0,1892	0,2029	0,2153	0,2013	0,1987	0,2144	0,2389	0,2684	0,3084	icp907

Table 2. *(Continued)*

Quarry	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	NGU/UIB
32 Urda # 15	0,1045	0,0714	0,0529	0,0383	0,0385	0,1925	0,0278	0,0220	0,0562	0,0673	0,1071	0,1422	0,1947	0,2312	icp499
32 Urda # 16	0,0763	0,0577	0,0263	0,0370	0,0237	0,3159	0,0165	0,0080	0,0266	0,0327	0,0528	0,0505	0,1141	0,1731	icp500
32 Urda # 1/UIB	2,1471	1,9645	1,8940	1,6433	1,2089	0,5029	0,8009	0,7483	0,6223	0,6200	0,6163	0,4958	0,5241	0,5052	icp204
32 Urda # 2/UIB	0,1807	0,1704	0,2116	0,1496	0,1190	0,1581	0,0912	0,1095	0,0837	0,0983	0,0985	0,1374	0,1319	0,1750	icp206
32 Urda # 14	0,0402	0,0252	0,0235	0,0294	0,0363	0,1090	0,0430	0,0604	0,0561	0,0594	0,0755	0,0929	0,1074	0,1321	icp74
32 Urda # 5	0,0068	0,0037	#VERDI!	0,0026	-0,0001	0,1397	#VERDI!	0,0016	0,0077	0,0131	0,0269	0,0419	0,0622	0,1023	icp73
34 Vargavåg # 1	0,1768	0,1221	0,0991	0,0887	0,0663	0,0230	0,0638	0,0480	0,0881	0,1060	0,1445	0,1894	0,2130	0,2475	icp299
34 Vargavåg # 2	0,3047	0,1954	0,1419	0,1137	0,1087	0,0458	0,0983	0,0699	0,1265	0,1779	0,2259	0,2885	0,3618	0,4522	icp300
34 Vargavåg # 4	0,4154	0,2830	0,1953	0,1701	0,1223	0,0390	0,0813	0,0756	0,0856	0,1117	0,1320	0,1730	0,2575	0,2978	icp301
34 Vargavåg # 5	0,2323	0,1764	0,1667	0,1575	0,1876	0,0550	0,1319	0,1204	0,1448	0,1656	0,1691	0,2238	0,2835	0,4234	icp302
34 Vargavåg # 6	0,1150	0,0715	0,0346	0,0394	0,0397	0,0192	0,0287	0,0210	0,0412	0,0545	0,0901	0,1294	0,2314	0,3143	icp303
34 Vargavåg # 7	0,0825	0,0649	0,0247	0,0317	0,0349	0,0052	0,0197	0,0118	0,0280	0,0383	0,0398	0,0383	0,0517	0,0566	icp304
34 Vargavåg # 8	0,3668	0,2612	0,2059	0,1600	0,1189	0,0553	0,0601	0,0614	0,0829	0,0928	0,1379	0,1479	0,2009	0,2718	icp305
34 Vargavåg # 9	0,1307	0,1016	0,0727	0,0707	0,0558	0,0343	0,0451	0,0554	0,0696	0,0858	0,1102	0,1333	0,2367	0,3100	icp306
34 Vargavåg # 10	0,2796	0,1784	0,1387	0,0864	0,0748	0,0943	0,0387	0,0348	0,0419	0,0701	0,0900	0,1110	0,1730	0,2010	icp307
35 Vargavåg gryte 4	0,1647	0,0568	0,0382	0,0361	0,0359	2,7745	0,0177	0,0162	0,0231	0,0321	0,0586	0,0791	0,1147	0,1295	icp178
35 Vargavåg gryte 3	0,1330	0,0879	0,0639	0,0399	0,0252	0,0775	0,0204	0,0185	0,0258	0,0248	0,0314	0,0432	0,0685	0,0572	icp179
35 Vargavåg gryte 1	0,1254	0,0799	0,0510	0,0349	0,0306	0,0870	0,0158	0,0183	0,0260	0,0325	0,0362	0,0407	0,0729	0,0646	icp183
35 Vargavåg gryte 2	0,1159	0,0720	0,0423	0,0303	0,0263	0,0514	0,0243	0,0196	0,0268	0,0266	0,0344	0,0435	0,0750	0,0787	icp190
36 Vassenden # 3	1,2581	1,0965	1,1967	1,0917	0,8769	0,0000	0,7799	0,7806	0,7547	0,7799	0,8048	0,8642	0,8804	0,9938	icp3031
36 Vassenden # 4	1,8645	2,1015	2,6311	2,6950	2,3590	0,8980	1,9305	1,7300	1,5000	1,3649	1,1857	1,1111	1,1675	0,9938	icp3032
37 Ådland # 1/UIB	0,0677	0,0493	0,0349	0,0333	0,0259	0,0149	0,0311	0,0261	0,0321	0,0277	0,0257	0,0252	0,0305	0,0130	icp185
37 Ådland # 2/UIB	0,1117	0,0847	0,0616	0,0512	0,0472	0,0238	0,0337	0,0364	0,0649	0,0802	0,1201	0,1815	0,2795	0,3454	icp186
37 Ådland # 1	0,3155	0,2862	0,2371	0,1875	0,1343	0,0877	0,1149	0,1033	0,1167	0,1142	0,1416	0,1699	0,1806	0,1880	icp203

Table 2. *(Continued)*

Quarry	**La**	**Ce**	**Pr**	**Nd**	**Sm**	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**NGU/UIB**
38 Åkra # 1	18,9881	16,2525	14,7237	12,0545	8,1861	6,2582	5,8929	4,7245	4,2205	4,0627	3,7430	3,6009	3,6957	3,7044	icp317
38 Åkra # 2	17,2808	14,5780	13,0017	10,8424	7,3102	5,7394	5,1661	4,2065	3,8509	3,5586	3,2979	3,3274	3,2076	3,2851	icp318
38 Åkra # 3	16,9963	14,5588	12,9003	10,7114	6,8645	5,5743	4,8902	3,7549	3,3935	3,0942	3,0107	3,0247	2,9727	3,2392	icp319
38 Åkra # 4	18,6366	16,0673	14,5018	12,4312	8,0487	6,5260	5,8689	4,6292	4,3629	4,0296	3,7622	4,0223	3,5748	3,7742	icp320
Urban vessels	**La**	**Ce**	**Pr**	**Nd**	**Sm**	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	
BRM 0/42937	0,0728	0,0513	0,0387	0,0342	0,0178	0,0379	0,0148	0,0123	0,0121	0,0118	0,0135	0,0085	0,0104	0,0098	icp1737
BRM 0/43530	1,3589	1,7473	1,9169	2,0605	1,8621	0,7901	1,5258	1,3073	1,1712	1,1031	1,1553	1,1353	1,2310	1,3233	icp1738
BRM 0/43549	3,6522	3,6844	3,1836	2,9863	2,6605	1,8855	2,7339	2,7838	2,7822	2,8065	2,8976	2,8677	2,9373	3,1085	icp1739
BRM 0/44163	0,0937	0,0857	0,0752	0,0687	0,0587	0,0448	0,0595	0,0608	0,0517	0,0514	0,0552	0,0627	0,0773	0,0983	icp1740
BRM 0/44650	10,2829	9,3052	7,8980	6,3727	3,5105	2,4391	2,2857	1,7183	1,2539	1,0614	1,0395	0,9150	0,9324	1,0139	icp1741
BRM 0/44931	0,9366	0,7092	0,5512	0,4804	0,3756	0,1979	0,3859	0,2818	0,2272	0,1868	0,1664	0,1322	0,1198	0,1510	icp1742
BRM 0/44934	0,1837	0,1468	0,1245	0,0919	0,0723	0,0549	0,0742	0,0662	0,0760	0,0644	0,0628	0,0766	0,0801	0,0937	icp1743
BRM 0/44998	12,3279	10,2530	8,6271	6,9925	4,3207	0,8373	2,9079	2,4285	1,9806	1,6735	1,6419	1,4765	1,5513	1,6752	icp1744
BRM 0/45373	1,0035	0,6776	0,4788	0,3785	0,2524	0,2495	0,2814	0,3002	0,3808	0,4962	0,6443	0,9648	1,2786	1,4510	icp1745
BRM 0/45465	0,0312	0,0255	0,0197	0,0179	0,0135	0,0171	0,0144	0,0187	0,0132	0,0146	0,0173	0,0188	0,0182	0,0228	icp1746
BRM 0/45548	0,6806	0,4870	0,3958	0,3073	0,1959	0,1230	0,1624	0,1305	0,1277	0,1201	0,1135	0,0947	0,0996	0,1004	icp1747
BRM 0/45695	0,2082	0,2131	0,3551	0,4582	0,5443	0,5070	0,5799	0,5826	0,5886	0,5647	0,5897	0,5550	0,5967	0,6514	icp1748
BRM 0/45792	0,2820	0,2104	0,1552	0,1272	0,0754	0,0354	0,0493	0,0427	0,0453	0,0373	0,0414	0,0385	0,0427	0,0653	icp1749
BRM 0/45810	2,1167	2,1288	2,2695	2,4339	2,6110	2,7556	2,1497	1,8084	1,4787	1,1507	1,0540	0,9598	1,0373	1,0692	icp1750
BRM 0/45843	3,3861	3,3345	3,9596	4,3787	4,7365	2,5395	4,4948	4,4141	4,3259	4,0264	4,0680	3,8756	3,8453	3,6893	icp1751
BRM 0/45857	33,8488	24,5595	18,8451	13,6215	7,3451	1,3338	4,0609	2,8864	2,0110	1,6624	1,8350	1,8149	1,9670	2,0521	icp1752
BRM 0/45938	3,6557	1,2859	0,9318	0,7191	0,3691	0,3619	0,3288	0,2469	0,2256	0,2064	0,2181	0,2016	0,2268	0,2426	icp1753
BRM 0/46144	0,9877	1,2025	1,3677	1,5520	1,7648	0,6222	1,8713	1,8944	2,0668	2,1034	2,1651	2,3238	2,5625	2,5885	icp1754

Table 2. *(Continued)*

Vessels, urban	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	NGU/UIB
BRM 0/54177	0,1864	0,1131	0,0794	0,0641	0,0397	0,0632	0,0348	0,0402	0,0328	0,0337	0,0446	0,0603	0,0775	0,1115	icp1755
BRM 0/54478	0,1283	0,0906	0,0744	0,0553	0,0413	0,0278	0,0426	0,0548	0,0512	0,0532	0,0452	0,0483	0,0428	0,0583	icp1756
BRM 0/54795	0,0389	0,0290	0,0238	0,0194	0,0183	0,0138	0,0169	0,0159	0,0109	0,0100	0,0122	0,0136	0,0141	0,0194	icp1757
BRM 0/55200	0,7995	0,6871	0,7155	0,6821	0,5871	0,1043	0,4861	0,4059	0,3653	0,3544	0,3566	0,3516	0,3514	0,4059	icp1758
BRM 0/63018	5,4592	4,4539	3,7019	3,1450	3,0531	3,5889	3,1625	3,3510	3,3584	3,0925	3,0216	2,8101	2,5368	2,1253	icp1759
BRM 0/63600	0,1758	0,1392	0,0957	0,0848	0,0479	0,4104	0,0664	0,0768	0,0637	0,0716	0,0642	0,0620	0,0692	0,0842	icp1760
BRM 0/63801	0,5258	0,4493	0,3037	0,2518	0,1795	0,1311	0,1684	0,1553	0,1815	0,2025	0,2627	0,2960	0,4054	0,4808	icp1761
BRM 0/63998	0,5260	0,3729	0,3526	0,3223	0,2676	0,0592	0,2593	0,2592	0,3088	0,3373	0,4330	0,4653	0,5483	0,6502	icp1762
BRM 0/64002	0,3981	0,2618	0,1499	0,1147	0,0814	0,0377	0,0542	0,0550	0,0494	0,0403	0,0398	0,0392	0,0434	0,0579	icp1763
BRM 0/64060	0,5992	0,2437	0,2847	0,3058	0,3534	0,0796	0,4193	0,4341	0,5138	0,6518	0,8868	1,2147	1,7918	2,2451	icp1764
BRM 0/64141	3,7829	3,8737	3,8498	3,6686	2,9397	0,9442	2,3004	1,9468	1,6229	1,4325	1,3812	1,1315	1,1101	1,1484	icp1765
BRM 0/64255	85,4755	62,4624	48,2846	36,1201	19,1479	2,0778	11,1390	7,9559	5,3546	4,1781	4,2284	3,7867	4,0800	3,9512	icp1766
BRM 0/64272	1,4999	1,3474	1,2989	1,2583	0,9544	0,5600	0,6959	0,6003	0,5988	0,5925	0,6845	0,7975	0,9568	1,0364	icp1767
BRM 0/64393	0,3987	0,3278	0,2328	0,1786	0,1219	0,0526	0,1050	0,1283	0,1119	0,1076	0,1211	0,1425	0,1998	0,2312	icp1768
BRM 0/64422	0,1537	0,1459	0,0986	0,0922	0,0592	0,0560	0,0546	0,0596	0,0588	0,0472	0,0474	0,0544	0,0505	0,0802	icp1769
BRM 0/64487	0,2261	0,2245	0,1055	0,0828	0,0585	0,0336	0,0521	0,0669	0,0504	0,0488	0,0534	0,0757	0,1088	0,1254	icp1770
BRM 0/64621	0,4226	0,3514	0,3770	0,3904	0,4926	0,7956	0,5962	0,6352	0,6445	0,6234	0,6371	0,5988	0,6558	0,6481	icp1771
BRM 0/64638	0,2488	0,1885	0,1244	0,1113	0,0759	0,0767	0,0590	0,0674	0,0618	0,0518	0,0614	0,0587	0,0688	0,0783	icp1772
BRM 0/64641	0,7248	0,5890	0,4569	0,3720	0,2703	1,0704	0,2194	0,1873	0,1976	0,2442	0,2897	0,3119	0,4128	0,5132	icp1773
BRM 0/64657	35,1720	23,5043	21,6381	17,6943	11,9668	1,9756	9,7543	8,1285	7,1969	6,3772	6,1038	5,4702	4,9960	4,8907	icp1774
BRM 0/64742	4,4320	2,8712	2,2267	1,5869	0,8240	0,2999	0,5015	0,4060	0,2872	0,3090	0,3830	0,4515	0,5503	0,5910	icp1775
BRM 0/64786	0,4417	0,3410	0,3424	0,3072	0,3313	0,2002	0,2840	0,2584	0,2774	0,3095	0,3294	0,3460	0,3722	0,4016	icp1776
BRM 0/64803	1,5036	1,1851	1,0703	0,9942	0,9993	0,7428	1,1061	1,0378	1,0280	0,9919	0,9937	0,8328	0,8295	0,9172	icp1777
BRM 0/64828	0,3639	0,2933	0,2441	0,2098	0,1484	0,1137	0,1222	0,1104	0,1009	0,1092	0,1254	0,1415	0,1927	0,2057	icp1778

Table 2. *(Continued)*

Vessels, urban	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	NGU/UIB
BRM 0/64984	0,7726	0,6575	0,5501	0,4817	0,4850	0,7236	0,5474	0,5886	0,6338	0,6108	0,6582	0,6580	0,6611	0,5584	icp1779
BRM 0/64994	2,4261	1,9193	1,2654	0,8868	0,5054	0,3393	0,3650	0,2867	0,2330	0,2058	0,2131	0,1917	0,2150	0,2310	icp1780
BRM 0/65004	1,6084	1,2953	1,1051	0,9353	0,8815	1,5108	0,7141	0,6003	0,5700	0,5009	0,5285	0,4979	0,5778	0,6079	icp1781
BRM 0/65007	0,0926	0,0830	0,0570	0,0458	0,0510	0,0479	0,0366	0,0496	0,0378	0,0318	0,0344	0,0327	0,0328	0,0478	icp1782
BRM 0/73087	1,7258	1,2298	1,0316	0,9219	0,7533	0,5104	0,6477	0,5960	0,5294	0,4688	0,4995	0,5431	0,5902	0,7180	icp1783
BRM 0/73155	1,2546	1,0431	0,8780	0,7224	0,5891	0,4262	0,5555	0,5531	0,5640	0,5594	0,6036	0,6328	0,7287	0,7201	icp1784
BRM 0/73346	0,7920	0,6821	0,6291	0,5712	0,5139	0,6830	0,4785	0,4520	0,4624	0,4551	0,4449	0,4294	0,4509	0,4723	icp1785
BRM 0/73353	0,7508	0,6607	0,5259	0,4980	0,4732	0,4499	0,5808	0,6512	0,9708	1,3039	1,6650	2,0485	2,3329	2,2711	icp1786
BRM 0/73441	3,8656	2,5932	1,7850	1,1795	0,5176	11,0025	0,3245	0,2457	0,1885	0,1629	0,1828	0,1697	0,1652	0,1915	icp1787
BRM 0/75316	3,8085	2,3809	1,7470	1,3986	0,7492	0,6678	0,5208	0,3865	0,3284	0,3035	0,2965	0,2590	0,2569	0,2670	icp1788
BRM 0/75671	0,2531	0,2426	0,2272	0,1924	0,1564	0,1145	0,1734	0,1548	0,1550	0,2146	0,2553	0,3099	0,3945	0,5238	icp1789
BRM 0/75767	0,0859	0,0696	0,0617	0,0541	0,0628	0,0592	0,0491	0,0414	0,0406	0,0337	0,0400	0,0384	0,0424	0,0523	icp1790
BRM 0/77526	0,3059	0,3334	0,3516	0,4469	0,6731	0,5012	0,9022	0,8900	0,9352	0,8870	0,8499	0,7522	0,7603	0,8258	icp1791
BRM 0/77531	0,1457	0,0954	0,0710	0,0452	0,0316	0,5999	0,0346	0,0310	0,0251	0,0296	0,0338	0,0490	0,0647	0,0956	icp1792
BRM 0/77564	0,1537	0,1137	0,1006	0,0972	0,1183	0,1066	0,1204	0,1232	0,1306	0,1369	0,1426	0,1615	0,1810	0,2052	icp1793
BRM 0/77576	3,6894	3,1005	2,5350	1,9384	1,1344	2,6410	0,7836	0,6428	0,5520	0,4940	0,5598	0,5710	0,6624	0,6743	icp1794
BRM 0/79750	5,7026	3,6652	2,5654	1,8850	0,9058	0,1273	0,5672	0,3449	0,2478	0,2365	0,3166	0,3044	0,3756	0,4691	icp1795
BRM 0/80155	0,1321	0,0950	0,0796	0,0600	0,0400	0,0369	0,0429	0,0574	0,0571	0,0758	0,0962	0,1109	0,1643	0,1903	icp1796
BRM 0/80210	0,5748	0,3858	0,3752	0,4182	0,5184	0,6885	0,5065	0,4257	0,4012	0,3648	0,3526	0,3422	0,3592	0,4049	icp1797
BRM 0/80253	4,9493	4,3138	4,4240	4,6314	3,8270	1,0437	3,0275	2,7326	2,4832	2,4998	2,6872	2,8533	3,2283	3,7694	icp1798
BRM 0/80455	38,7323	27,6733	20,8361	16,3133	9,9333	5,8639	6,5869	5,4852	4,6646	4,2201	4,1762	3,7654	4,1531	4,2857	icp2933
BRM 0/80803	0,9397	0,6862	0,5410	0,4498	0,2899	0,2944	0,2245	0,2123	0,1944	0,2044	0,2068	0,1992	0,2468	0,2723	icp1800
BRM 0/80852	0,6809	0,5458	0,4485	0,3698	0,2486	0,2259	0,2111	0,2171	0,2282	0,2666	0,3363	0,3822	0,5083	0,5555	icp1801
BRM 0/80871	2,2709	2,2439	2,3189	2,5006	2,6175	2,7800	2,0866	1,7493	1,4070	1,1074	1,0547	0,9198	1,0061	1,0470	icp1802

Table 2. *(Continued)*

Vessels, urban	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	NGU/UIB
BRM 0/81128	0,3606	0,2636	0,2251	0,2178	0,2015	0,2725	0,2026	0,2100	0,2461	0,3267	0,4747	0,6506	0,9559	1,1396	icp1803
BRM 0/81366	0,1140	0,0699	0,0650	0,0528	0,0585	0,0868	0,0547	0,0692	0,0568	0,0518	0,0640	0,0630	0,0642	0,0707	icp1804
BRM 0/81374	0,3243	0,2689	0,2273	0,2191	0,2017	0,1279	0,2364	0,2477	0,2805	0,3653	0,5045	0,6447	0,8175	0,9480	icp1805
BRM 0/85416	0,1946	0,1397	0,1061	0,0989	0,0786	0,0433	0,0673	0,0658	0,0677	0,0732	0,0959	0,1143	0,1494	0,2107	icp1806
BRM 0/85447	1,4630	0,8436	0,5645	0,3398	0,1420	0,1398	0,0826	0,0611	0,0516	0,0448	0,0612	0,0704	0,0918	0,1154	icp1807
BRM 0/85448	0,1934	0,1336	0,0856	0,0642	0,0546	0,0307	0,0250	0,0230	0,0262	0,0188	0,0279	0,0313	0,0446	0,0880	icp1808
BRM 0/85465	0,8442	0,6011	0,4766	0,3940	0,2923	0,7216	0,2258	0,2228	0,2271	0,2347	0,2616	0,2851	0,3531	0,4239	icp1809
BRM 0/85502	0,2477	0,1599	0,1310	0,1233	0,1093	0,0645	0,1117	0,1185	0,1297	0,1826	0,2656	0,3948	0,4878	0,5233	icp1810
BRM 0/85503	0,2989	0,2173	0,1694	0,1245	0,0910	0,0553	0,0598	0,0660	0,0472	0,0555	0,0594	0,0710	0,0849	0,1138	icp1811
BRM 0/85556	22,3011	14,3991	10,2709	7,8968	3,9172	0,2972	2,3606	1,5881	1,0797	0,9171	0,9283	0,8150	0,9279	1,0766	icp1812
BRM 0/85580	19,2471	13,4777	9,7734	6,5574	3,0008	2,0399	1,4558	1,0217	0,6037	0,4202	0,3825	0,2055	0,1547	0,1456	icp1813
BRM 0/85591	0,3377	0,2282	0,1561	0,1124	0,0716	0,0855	0,0524	0,0450	0,0436	0,0439	0,0489	0,0555	0,0793	0,1188	icp1814
BRM 0/85635	0,5729	0,3822	0,2676	0,1957	0,1284	0,4673	0,0835	0,0912	0,0742	0,0682	0,0685	0,0700	0,0727	0,0880	icp1815
BRM 0/86150	0,1986	0,1636	0,1217	0,0998	0,0612	0,0397	0,0368	0,0339	0,0248	0,0269	0,0251	0,0243	0,0295	0,0365	icp1816
BRM 0/86199	0,2711	0,1979	0,1508	0,1257	0,0866	0,0425	0,0804	0,0829	0,0855	0,0837	0,0733	0,0740	0,0703	0,0755	icp1817
BRM 0/86220	0,1684	0,1217	0,0855	0,0620	0,0352	0,1047	0,0217	0,0221	0,0185	0,0178	0,0205	0,0292	0,0382	0,0560	icp1818
BRM 0/86878	2,1520	2,0034	1,9611	1,9222	1,6419	1,3285	1,2153	1,0043	0,7958	0,6669	0,6712	0,6844	0,8279	0,9891	icp1819
BRM 3/697	1,2983	0,7898	0,7198	0,6792	0,7037	0,2716	0,8837	0,9626	0,9902	0,9543	0,9167	0,8432	0,8140	0,7135	icp1820
BRM 3/702	1,7674	1,6420	1,6524	1,5668	1,4103	0,6102	1,2104	1,1180	0,9887	0,8848	0,8357	0,7690	0,8229	0,8167	icp1821
BRM 76/11041	1,0353	1,1723	1,3664	1,5161	1,8487	0,9885	1,9711	2,1100	2,2314	2,1781	2,2476	2,2614	2,3333	2,2393	icp1822
BRM 76/11048 # 1	0,1050	0,0865	0,0659	0,0722	0,0729	0,0624	0,0805	0,0741	0,0844	0,0858	0,0806	0,0790	0,0755	0,0799	icp1823
BRM 76/11048 # 2		0,0879		0,1000	0,0769	0,0816	0,0656		0,0621		0,0667		0,0526		icp2989
BRM 104/2180	4,4514	4,1764	3,9257	3,7247	3,0337	1,7992	2,0889	1,6360	1,2258	0,9949	0,9117	0,8141	0,8200	0,8165	icp1824
BRM 104/2299	0,8820	0,6912	0,5839	0,4992	0,4447	2,1816	0,3629	0,3403	0,3031	0,2488	0,2424	0,2453	0,2673	0,2661	icp1825

Table 2. *(Continued)*

Vessels, urban	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	NGU/UIB
BRM 104/2356	9,3376	8,4116	7,5446	6,4700	4,0273	1,2934	2,7581	2,2773	1,9150	1,7152	1,7125	1,5500	1,6290	1,6983	icp1826
BRM 110/5518	0,1758	0,1439	0,1264	0,1117	0,0957	0,0871	0,0876	0,0947	0,1010	0,1211	0,1491	0,2061	0,2730	0,3320	icp1827
BRM 110/5651	10,2533	9,2756	8,9584	8,5559	7,5877	5,4625	6,0547	5,3462	4,6380	4,1693	3,9639	3,6907	3,9275	3,8379	icp1828
BRM 110/5959	0,0666	0,0585	0,0473	0,0486	0,0504	0,0362	0,0411	0,0386	0,0370	0,0370	0,0401	0,0399	0,0517	0,0715	icp1829
BRM 110/6463	2,0729	1,1285	0,8945	0,7560	0,5751	1,4874	0,4346	0,3743	0,3217	0,3166	0,3542	0,3910	0,4836	0,5551	icp1830
BRM 237/1277	167,9021	83,0073	63,9306	43,2528	17,3589	8,8137	9,7949	6,9337	4,2468	3,5341	3,6017	2,7445	2,7294	2,6537	icp1831
Vessels, rual	**La**	**Ce**	**Pr**	**Nd**	**Sm**	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	
B4253	0,2581	0,2921	0,3033	0,2950	0,2821	0,0816	0,2780	0,2532	0,2453	0,1671	0,2762		0,2967	0,3416	icp2934
B4369	0,9581	1,1980	1,2623	1,2833	1,1692	1,1701	0,9768	1,0127	0,8882	0,8078	0,8571	0,7407	0,9713	1,0559	icp2935
B4836	18,4548	12,5124	12,3770	10,4433	7,1231	1,6190	4,4826	3,6076	3,1770	2,8273	2,8333	2,5617	2,6124	2,5466	icp2938
B6204	12,5677	14,6411	15,8443	14,8950	9,3231	6,0272	5,8842	4,9367	3,8137	3,5515	3,4429	2,9938	3,3397	3,3540	icp2988
B7829	0,9323	0,8354	0,7213	0,6250	0,5077	0,9252	0,4788	0,4219	0,4068	0,3760	0,4524	0,3704	0,6746	0,7143	icp2943
B7888	4,7129	3,8069	3,2377	2,6733	1,8462	0,3537	1,3359	1,1603	1,0590	0,9053	0,9143	0,7099	0,8852	0,8696	icp2944
B7925	0,0935	0,2042	0,2705	0,3383	0,4051	0,1361	0,3900	0,4008	0,3913	0,3064	0,3762	0,2469	0,4163	0,4348	icp2945
B7960	0,5065	0,5396	0,4262	0,3367	0,3333	0,1224	0,2973	0,3376	0,2950	0,1950	0,2286		0,2775	0,2484	icp2946
B8308	0,3516	0,3936	0,5492	0,6417	0,8308	0,9524	0,6988	0,7173	0,6304	0,5710	0,6905	0,5864	0,8182	0,8696	icp2948
B9976	0,8742	1,3465	1,5902	1,5950	1,4103	1,7415	1,0695	1,0338	0,9348	0,7939	0,7571	0,4321	0,5646	0,4969	icp2951
B10454	10,4000	11,2710	12,2623	12,9633	8,6667	6,4218	5,4672	4,5148	3,4783	3,0641	2,6048	2,0988	2,0431	1,8634	icp2954
B10457	1,4452	1,3403	0,9344	0,7783	0,6564	0,4490	0,5598	0,5696	0,4938	0,3203	0,3619	0,1852	0,3923	0,3727	icp2955
B10462/a	0,5516	0,5347	0,5656	0,4600	0,4308	0,2313	0,2896	0,2954	0,2205	0,1114	0,1857		0,1914	0,1863	icp2956
B10462/d	3,0871	2,6894	2,5738	2,5500	2,2974	2,2041	1,8340	1,7089	1,4565	1,2256	1,2095	1,0494	1,2584	1,4907	icp2959
B10481	1,4226	2,0012	2,8279	3,4550	4,6923	1,1156	5,9730	6,3291	6,3323	5,9331	5,5762	5,4321	5,3732	4,8447	icp2960
B10655	1,5000	1,5470	1,4590	1,4717	1,6821	0,4762	1,7490	1,9831	1,9224	1,7549	1,6476	1,4198	1,6555	1,3975	icp2961
B11115	1,2097	1,9369	2,9180	3,6367	3,5590	1,6054	3,1004	3,1013	3,1584	3,0641	3,1952	3,3333	3,7990	3,8820	icp2967

Table 2. *(Continued)*

Vessels, rual	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	NGU/UIB
B11551/a	3,3613	2,2562	2,2049	1,7567	1,0051	0,4354	0,5830	0,4008	0,2733	0,1811	0,3095	0,1852	0,4593	0,5901	icp2971
B11797	50,6452	38,2921	31,8443	25,7167	13,4051	8,8163	8,2973	6,7932	5,1894	4,8329	4,7381	3,9198	4,0000	4,1615	icp2976
B11815/b	8,3290	7,2401	6,7049	6,1950	4,5949	2,5986	3,3475	3,1857	2,6398	2,4373	2,5000	2,0988	2,4019	2,2050	icp2977
B11835	0,1129	0,1597		0,1350	0,0821	0,1088	0,1042	0,1055	0,1056		0,1095		0,1675	0,2174	icp2978
B11867/a	0,2161	0,1931		0,1667	0,1282	0,5170	0,1274	0,1055	0,1056		0,1238		0,1579	0,2174	icp2979
B11868/b	0,3258	0,3552	0,2951	0,2917	0,2462	0,4626	0,2201	0,1899	0,2019	0,1671	0,2619		0,3014	0,3727	icp2980
B11878/a	0,7484	0,6176	0,5410	0,4700	0,3385	0,9524	0,2510	0,2743	0,2267	0,1253	0,2286		0,2297	0,2174	icp2982
B12025/b	0,8710	0,6757	0,4836	0,3900	0,3436	0,1497	0,4324	0,5696	0,6522	0,6685	0,7571	0,8025	1,0718	1,0248	icp2983
B12050/a	2,9000	3,2822	3,0000	2,9500	2,4615	1,6599	2,0270	1,9620	1,6242	1,5738	1,5905	1,2654	1,6507	1,6770	icp2984
B12134	0,4677	0,4047	0,3361	0,2700	0,1949	0,1361	0,1660	0,1477	0,1304		0,1476		0,1770	0,2174	icp2985

Table 3. *Provenancing result, in detail, for the individual 146 vessels.*

Object no.	**MTE code**	**MTE Quarry**	**Code MTE & REE code** Qu=Quarry, Ve=Vessel	**MTE & REE quarries** NC= Not conclusive, Ve=Vessel	**Transport distance** RTR=Regional on transport route	**Geological unit MTE**	**Geological unit MTE&REE**	**Vessel type**	**Score points**	**Sum score points**	**Group 1–6**
BRM 0/42937	1Q	Kvernes 8/Urda 5	1Q	Kvernes		1	1	?	3+2	5	1
BRM 0/43530	NRM	NRM	NRM			0	0	A	0	0	6
BRM 0/43549	NRM	NRM	NRM			0	0	A	0	0	6
BRM 0/44163	MC3	Arnafjord 8/Bru 8/Kvernes 8	MC2	Arnafjord/Kvernes		1/2	1	A	4+2	6	3
BRM 0/44650	SRM1	Digranes 5	Qu no REE	NC		3	-	A	2	2	5
BRM 0/44931	MC4	Arnafjord 8/Bergsholmen 8/Bru 8/Urda 8	1Q	Urda		1/2	2	A	4+2	6	1
BRM 0/44934	MC7	Arnafjord 8/Bergsholmen 8/Froastad 8/Juadal 8/ Kvernes 8/Sjusete 8/Urda 8/Svanøy 5	MC5	Arnafjord/Bergsholmen/Juadal/ Kvernes/Urda		1/2	1/2	A	4+2	6	3
BRM 0/44998	NRM	NRM	NRM				0	A	0	0	6
BRM 0/45373	1Q	Bergsholmen 8/Bru 6	NRM			1	0	?	3-2	1	6
BRM 0/45465	MC3	Bergsholmen 8/Kvernes 8/Sjusete 8	MC2	Bergsholmen/Kvernes		1/2	1	A	4+2	6	3
BRM 0/45548	MC2	Kvernes 8/Sævråsvåg 8/Bergsholmen 7	1Q	Kvernes		1	1	A	4+2	6	1
BRM 0/45695	1Q	Sjusete 8	NRM			2	0	?	3-2	1	6
BRM 0/45792	MC3	Bergsholmen 8/Bru 8/Urda 8	1Q	Bergsholmen		1/2	1	A	4+2	6	1
BRM 0/45810	NRM	NRM	NRM				0	A	0	0	6
BRM 0/45843	NRM	NRM	NRM				0	A	0	0	6
BRM 0/45857	NRM	NRM	NRM				0	A1	0	0	6
BRM 0/45938	NRM	NRM	NRM				0	B	0	0	6
BRM 0/46144	SRM1	Baldersheim 6	SRM1	Baldersheim		1	1	A	2+2	4	2
BRM 0/54177	MC5	Bergsholmen 8/Juadalen 8/Kvernes 8/Sjusete 8/ Urda 8/Froastad 6/Vass 5	1Q	Kvernes		1/2	1	B	4+2	6	1
BRM 0/54478	MC2	Kvernes 8/Sjusete 8/Bergsholmen 6/Bru 6	1Q	Kvernes		1/2	1	A	4+2	6	1
BRM 0/54795	MC3	Kvernes 8/Urda 8/Bergsholmen 8/Bru 7	MC3	Kvernes/Urda/Bergsholmen		1/2	1/2	A	4+2	6	3
BRM 0/55200	SRM2	Bergsholmen 6/Russøy 5	NRM			1	0	A	2-2	0	6

Table 3. *(Continued)*

Object no.	**MTE code**	**MTE Quarry**	**Code MTE & REE code** Qu=Quarry, Ve=Vessel	**MTE & REE quarries** NC= Not conclusive, Ve=Vessel	**Transport distance** RTR=Regional on transport route	**Geological unit MTE**	**Geological unit MTE&REE**	**Vessel type**	**Score points**	**Sum score points**	**Group 1–6**
BRM 0/63018	1Q	Kvernes 8	NRM			1	0	A	3-2	1	6
BRM 0/63600	MC2	Bergsholmen 8/Bru 8/Kvernes 6/Sjusete 6	1Q	Bergsholmen		1/2	1	A	4+2	6	1
BRM 0/63801	1Q	Urda 8/Klauvsteinsberget 5	1Q	Urda		2	2	A	3+2	5	1
BRM 0/63998	MC3	Bru 8/Kvernes 8/Urda 8/Sævråsvåg 7	1Q	Urda		1/2	2	A	4+2	6	1
BRM 0/64002	MC3	Bergsholmen 8/Sævråsvågen 8/Vassenden 8/ Arnafjord 6	1Q	Bergsholmen		1/3	1	A	4+2-1	5	1
BRM 0/64060	1Q	Vassenden 8	NRM			3	0	A	3-2	1	6
BRM 0/64141	NRM	NRM	NRM				0	A	0	0	6
BRM 0/64255	NRM	NRM	NRM				0	B?	0	0	6
BRM 0/64272	NRM	NRM	NRM				0	A	0	0	6
BRM 0/64393	MC2	Bergsholmen 8/Kvernes 8/Sævråsvåg 7	1Q	Kvernes		1	1	A	4+2	6	1
BRM 0/64422	MC3	Bergsholmen 8/Sævråsvåg 8/Vassenden 8/Russøy 6/ Sjusete 6	MC2	Bergsholmen/Vassenden		1/3	1/3	A	4+2-1	5	5
BRM 0/64487	MC3	Bergsholmen 8/Kvernes 8/Sævråsvåg 8/Arnafjord 6/ Raudesteinarne 5	1Q	Kvernes		1	1	A	4+2	6	1
BRM 0/64621	1Q	Baldersheim 8	1Q	Baldersheim		1	1	A	3+2	5	1
BRM 0/64638	MC2	Kvernes 8/Sævråsvåg 8/Juadal 7/Arnafjord 6	1Q	Kvernes		1	1	A	4+2	6	1
BRM 0/64641	MC3	Arnafjord 8/Bru 8/Urda 8/Kvernes 5	1Q	Urda		1/2	2	A	4+2	6	1
BRM 0/64657	SRM1	Svanøy 6	NRM			2	0	A	2-2	0	6
BRM 0/64742	MC2	Bergsholmen 8/Russøy 8	1Q	Russøy		1	1	B	4+2	6	1
BRM 0/64786	MC2	Sjusete 8/Urda 8/Arnafjord 5/Nygård 5	MC2	Sjusete/Urda		2	2	A	4+2	6	3
BRM 0/64803	SRM1	Baldersheim 6	NRM			1	0	?	2-2	0	6
BRM 0/64828	MC2	Bergsholmen 8/Kvernes 8/Russøy 7	MC2	Bergsholmen/Kvernes		1	1	A	4+2	6	3
BRM 0/64984	MC3	Bergsholmen 8/Kvernes 8/Sjusete 8/Urda 6	1Q	Kvernes		1/2	1	A	4+2	6	1

Table 3. *(Continued)*

Object no.	**MTE code**	**MTE Quarry**	**Code MTE & REE code** Qu=Quarry, Ve=Vessel	**MTE & REE quarries** NC=Not conclusive, Ve=Vessel	**Transport distance** RTR=Regional on transport route	**Geological unit MTE**	**Geological unit MTE&REE**	**Vessel type**	**Score points**	**Sum score points**	**Group 1–6**
BRM 0/64994	MC3	Bergsholmen 8/Juadalen 8/Sævråsvåg 8/Bru 6/Urda 5	1Q	Bergsholmen		1	1	A?	4+2	6	1
BRM 0/65004	SRM2	Juadal 6/Svanøy 5	NRM			1	0		2-2	0	6
BRM 0/65007	MC2	Bergsholmen 8/Sævråsvåg 8	1Q	Bergsholmen		1	1	A	4+2	6	1
BRM 0/73087	NRM	NRM	NRM				0		0	0	6
BRM 0/73155	SRM3	Arnafjord 6/Sævråsvåg 7/Vassenden 5	SRM2	Arnafjord/Vassenden		1/3	1/3	A	2+2-1	3	5
BRM 0/73346	NRM	NRM	NRM				0		0	0	6
BRM 0/73353	NRM	NRM	NRM				0	A	0	0	6
BRM 0/73441	MC4	Kvernes 8/Sævråsvåg 8/Urda 8/Vargahola 8/Bru 6	SRM1	Bru		1/2	2	A	4+2	6	2
BRM 0/75316	SRM3	Bergsholmen 5/Russøy 5/Vassenden 5	NRM			1/3	0	A	2-2-1	0	6
BRM 0/75671	1Q	Sævråsvåg 8/Juadalen 5	SRM1	Juadal		1	1	A	3+2	5	2
BRM 0/75767	MC3	Bergsholmen 8/Sævråsvåg 8/Vassenden 8/Kvernes 6	MC3	Bergsholmen/Sævråsvåg/Vassenden		1/3	1/3	A	4+2-1	5	5
BRM 0/77526	1Q	Ingahogget 8/Lysekloster 6/ Sele 6	1Q	Ingahogget		4	4	A	3+2	5	1
BRM 0/77531	MC4	Juadal 8/Raudesteinane 8/Svanøy 8/Sævråsvåg 8/Arnafjord 6	1Q	Sævråsvåg		1/2/3	1	B	4+2-1	5	1
BRM 0/77564	SRM4	Bergsholmen 5/Bru 5/Kvernes 5/Urda 5	SRM1	Kvernes		1/2	1	A	2+2	4	2
BRM 0/77576	1Q	Sævråsvåg 8	1Q	Sævråsvåg		1	1	A	3+2	5	1
BRM 0/79750	1Q	Sævråsvåg 8	SRM1	Russøy		1	1	A	3+2	5	2
BRM 0/80155	MC3	Bergsholmen 8/Kvernes 8/Russøy 8/Sævråsvåg 5/Vargavåg gryte 5	1Q	Kvernes		1	1	A	4+2	6	1
BRM 0/80210	MC4	Bergsholmen 8/Kvernes 8/Russøy 8/Sævråsvåg 8/Vassenden 6	1Q	Sævråsvåg		1	1		4+2	6	1
BRM 0/80253	SRM1	Lysekloster 6	NRM			2	0	A	2-2	0	6
BRM 0/80455	MC3	Ingahogget 8/Klauvsteinsjuvet 8/Lysekloster 8/sele 5	Qu no REE	NC		2/4	-	C	4-1-all	0	6

Table 3. *(Continued)*

Object no.	**MTE code**	**MTE Quarry**	**Code MTE & REE code** Qu=Quarry, Ve=Vessel	**MTE & REE quarries** NC= Not conclusive, Ve=Vessel	**Transport distance** RTR=Regional on transport route	**Geological unit MTE**	**Geological unit MTE&REE**	**Vessel type**	**Score points**	**Sum score points**	**Group 1–6**
BRM 0/80803	MC6	Bergsholmen 8/Kvernes 8/Russøy 8/Sjusete 8/ Svanøy 8/Sævråsvåg 8	MC4	Bergsholmen/Kvernes/Russøy/ Sævråsvåg		1/2	1	A	4+2	6	3
BRM 0/80852	MC4	Bergsholmen 8/Kvernes 8/Rauberg 8/Vargavåg 8	MC3	Kvernes/Rauberg/Vargavåg		1	1	B	4+2	6	3
BRM 0/80871	1Q	Bergspytt 8/Ingahogget 6	1Q	Bergspytt		4	4	A	3+2	5	1
BRM 0/81128	1Q	Bergsholmen 8/Kvernes 7, Rauberg 7	SRM1	Rauberg		1	1	B	2+2	4	2
BRM 0/81366	MC3	Bergsholmen 8/Kvernes7/Rauberg 7/Bru 6/Urda 5	MC3	Bergsholmen/Kvernes/Rauberg		1	1	A	4+2	6	3
BRM 0/81374	MC3	Bergsholmen 8/Kvernes 8/Urda 8/Sævråsvåg 5	NRM			1/2	0	B	4-2	2	6
BRM 0/85416	MC8	Bergsholmen 8/Juadal 8/Kvernes 8/Rauberg 8/ Russøy 8/Sjusete 8/Urda 8/Vargavåg 8	MC2	Rauberg/Vargavåg		1/2	1	A	4+2	6	3
BRM 0/85447	MC6	Bergsholmen 8/Juadal 8/Kvernes 8/Rauberg 8/ Russøy 8/Urda 8/Froastad 5/Sjusete 5/Vargavågen 7	MC3	Bergsholmen/ Kvernes/ Russøy		1/2	1	A	4+2	6	3
BRM 0/85448	MC8	Bergsholmen 8/Froastad 8/Juadal 8/Kvernes 8/ Rauberg 8/Russøy 8/Urda 8/Vargavåg 8/Bru 5	MC4	Bergsholmen/Froastad/Kvernes/ Russøy		1/2	1/2	A	4+2	6	3
BRM 0/85465	1Q	Sævråsvåg 8/Kvernes 6	1Q	Sævråsvåg		1	1		3+2	5	1
BRM 0/85502	MC7	Froastad 8/Kvernes 8/Nygård 8/Rauberg 8/Sjusete 8/Urda 8/Vargavåg 8/Bergsholmen 7/Juadalen 7	1Q	Urda		1/2	2		4+2	6	1
BRM 0/85503	MC8	Bergsholmen 8/Juadal 8/Kvernes 8/Rauberg 8/ Russøy 8/Sjusete 8/Urda 8/Vargavåg 8/Froastad 7/ Nygård 7	MC5	Bergsholmen/Juadal/Kvernes/ Russøy/Urda		1/2	1/2	A	4+2	6	3
BRM 0/85556	NRM	NRM	NRM				0	A	0	0	6
BRM 0/85580	SRM2	Urda 7/Vargavåg gryte 7	NRM			1/2	0	A	2-2	0	6
BRM 0/85591	MC8	Bergsholmen 8/Juadal 8/Kvernes 8/Rauberg 8/ Russøy 8/Sjusete 8/Urda 8/Vargavåg 8/Froastad 5/ Munkahogget 5/Nygård 7	MC4	Bergsholmen/Kvernes/Russøy/ Sjusete		1/2	1/2	A	4+2	6	3
BRM 0/85635	1Q	Urda 8/Klauvsteinsberget 5/Kvernes 6/Vass 5	NRM			2	0	A	3-2	1	6
BRM 0/86150	MC3	Bru 8/Urda 8/Sævråsvåg 8/Juadalen 6/ Svanøy 6	NRM			1/2	0		4-2	2	6
BRM 0/86199	MC2	Bru 8/Urda 8/Arnafjord 6/Kvernes 6/Rauberg 6	1Q	Urda		2	2	A	4+2	6	1

Table 3. *(Continued)*

Object no.	**MTE code**	**MTE Quarry**	**Code MTE & REE code** Qu=Quarry, Ve=Vessel	**MTE & REE quarries** NC= Not conclusive, Ve=Vessel	**Transport distance** RTR=Regional on transport route	**Geological unit MTE**	**Geological unit MTE&REE**	**Vessel type**	**Score points**	**Sum score points**	**Group 1–6**
BRM 0/86220	MC6	Bergsholmen 8/Kvernes 8/Juadal 8/Rauberg 8/ Sjusete 8/Urda 8	MC2	Bergsholmen/Sjusete		1/2	1/2	A	4+2	6	3
BRM 0/86878	NRM	NRM	NRM				0	A	0	0	6
BRM 3/697	1Q	Kvitno 8/Svanøy 5	1Q	Kvitno		3	3	A	3+3	6	1
BRM 3/702	1Q	Svanøy 8/Kvitno 7/Vassenden 5	SRM2	Kvitno/Vassenden		2	3	A	3+2	5	4
BRM 76/11041	MC4	Bergsholmen 8/Russøy 8/Svanøy 8/Sævråsvåg 8/ Froastad 6/Juadalen 5	NRM			1	0	A	4-2	2	6
BRM 76/11048 sample 2	BRM 76/ # 2	BRM 76/ # 2 (Sævråsvåg)	BRM 76/ #2								
BRM 76/11048 sample 1	1Q	Sævråsvåg 8/Kvernes 6	NRM			1	0		3-2	1	1
BRM 104/2180	MC3	Bergspytt 8/Ingahogget 8/Lysekloster 8	1Q	Ingahogget		2/4	4	A	4+2-1	5	1
BRM 104/2299	MC2	Bergsholmen 8/Sævråsvåg 8	MC2	Bergsholmen/Sævråsvåg		1	1	A	4+2	6	3
BRM 104/2356	NRM	NRM	NRM				0	A	0	0	6
BRM 110/5518	MC4	Bergsholmen 8/Juadalen 8/Kvernes 8/Rauberg 8/ Urda 7	NRM			1	0	?	4-2	2	6
BRM 110/5651	SRM2	Ingahogget 6/Sele 5	Qu no REE	NC		2/4	-	C	2-1-All	0	6
BRM 110/5959	1Q	Bru 8/Sævråsvåg 6	NRM			2	0	A	3-2	1	6
BRM 110/6463	MC2	Urda 8/Vargehola 8	Qu no REE	NC		1/2	-	A	4	4	4
BRM 237/1277	SRM2	Svanøy 6/Sævråsvåg 6	NRM			1	0	A	2-2	0	6
B4253	1Q	Kvitno 8	1Q	Kvitno	Reg.	3	3	-	3+2	5	1
B4369	SRM2	Bergspytt 7/Digranes 6	Qu no REE	NC		3/4	-	-	2-1	1	5

Table 3. *(Continued)*

Object no.	**MTE code**	**MTE Quarry**	**Code MTE & REE code** Qu=Quarry, Ve=Vessel	**MTE & REE quarries** NC= Not conclusive, Ve=Vessel	**Transport distance** RTR=Regional on transport route	**Geological unit MTE**	**Geological unit MTE&REE**	**Vessel type**	**Score points**	**Sum score points**	**Group 1–6**
B4432	1Q	Sævråsvåg 8/Bergsholmen 6/ Urda 5/Vassenden 7	Ve no REE	Ve no REE	Reg.	1	-	-	3	3	2
B4719	MC6	Bergsholmen 8/Kvernes 8/Rauberg 8/Russøy 8/ Urda 8/Vargavåg 8	Ve no REE	Ve no REE		1/2	-	-	4	4	4
B4836	1Q	Tysse 8	1Q	Tysse	RTR	4	4	-	3+2	5	1
B6204	MC2	Bergspytt 8/Tysse 8	1Q	Bergspytt	Vicinity	4	4	-	4+2+3	9	1
B6982b	MC3	Froastad 8/Juadal 8/Russøy 8/Sævråsvåg 6	Ve no REE	Ve no REE	Local	1/2	-	-	4+2	6	4
B7018	1Q	Sævråsvåg 8/Drebrekke 5/Svanøy 6	Ve no REE	Ve no REE	Reg.	1	-	-	3	3	2
B7019	1Q	Kvitno 8/Flatabø 7	Ve no REE	Ve no REE	Reg.	3	-	-	3	3	2
B7105	SRM3	Nygård 5/Vargavåg gryte 5/Vassenden 5	Ve no REE	Ve no REE		1/3	-		2-1	1	5
B7829	1Q	Sævråsvåg 8/Flatabø 7/Ingahogget 5	1Q	Sævråsvåg	Local	1	1	-	3+2+2	7	1
B7888	1Q	Klauvsteinsjuvet 8/Bergsholmen 5/Sele 5	1Q	Klauvsteinsjuvet	Vicinity	4	4	-	3+2+3	8	1
B7925	1Q	Kvitno 8	1Q	Kvitno	Reg.	3	3	-	3+2	5	1
B7960	1Q	Kvitno 8	1Q	Kvitno	Reg.	3	3	-	3+2	5	1
B8300	MC4	Drebrekke 8/Flatabø 8/Kvitno 8/Vassenden 8	Ve no REE	Ve no REE		3	-	-	4	4	4
B8308	MC4	Bergsholmen 8/Kvernes 8/Rauberg 8/Sævråsvåg 8/Bergspytt 6/Urda 6	1Q	Sævråsvåg	Local	1	1	-	4+2+2	8	1
B8321	MC6	Bergsholmen 8/Katlaberg 8/Kvernes 8/Nygård 8/ Rauberg 8/Vargavåg 8/Froastad 5	Ve no REE	Ve no REE		1	-	-	4	4	4
B8995	SRM3	Bergsholmen 7/Juadal 6/Kvernes 6	Ve no REE	Ve no REE		1	-	-	2	2	5
B9976	SRM2	Digranes 6/Kvitno 6	Qu no REE	NC		3	-	-	2	2	5
B10222b	S Fj 1Q	Sævråsvåg 8/Kvernes 7	S Fj SRM1	Kvernes	Local	1	S Fj.	-	3+2+2	7	2

Table 3. *(Continued)*

Object no.	**MTE code**	**MTE Quarry**	**Code MTE & REE code** Qu=Quarry, Ve=Vessel	**MTE & REE quarries** NC= Not conclusive, Ve=Vessel	**Transport distance** RTR=Regional on transport route	**Geological unit MTE**	**Geological unit MTE&REE**	**Vessel type**	**Score points**	**Sum score points**	**Group 1–6**
B10270	1Q	Svanøy 8	Ve no REE	Ve no REE	Reg.	2	-	-	3	3	2
B10454	SRM1	Bergspytt 6	SRM1	Bergspytt	Reg.	4	4	-	2+2	4	5
B10457	MC4	Drebrekke 8/Kvitno 8/Sævråsvåg 8/Vassenden 8	Qu no REE	NC	RTR	1/3	-	-	4-1	3	5
B10462a	MC2	Sævråsvåg 8/Vassenden 8/Drebrekke 7	1Q	Vassenden	RTR	1/3	3	-	4+2-1	5	1
B10462b	SRM1	Bergspytt 6	Ve no REE	Ve no REE	Vicinity	4	-	-	2+3	5	1
B10462c	MC2	Sævråsvåg 8/Vassenden 8/Bergsholmen 5/Russøy 5	Ve no REE	Ve no REE	RTR	1/3	-	-	4-1	3	5
B10462d	SRM2	Bergspytt 5/Tyssøy 6	NRM			2/4	0	-	2-2-1	0	6
B10481	1Q	Kvitno 8/Flatabø 6	SRM1	Flatabø	Local	3	3	-	3+2+2	7	1
B10655	1Q	Flatabø 8/Kvitno 6	SRM1	Kvitno	Local	3	3	-	3+2+2	7	1
B10680a	1Q	Åkra 8/Bergspytt 7/Tyssøy 6	Ve no REE	Ve no REE	Local in rel. to 1Q/MTE quarry	4	-	-	3+2	5	1
B10680b	1Q	Skare 8/Sævråsvåg 5	Ve no REE	Ve no REE	RTR	4	-	-	3	3	2
B10697	1Q	Raudesteinarne 8/Kvernes 6, Kvitno 6, Sævråsvåg 7	Ve no REE	Ve no REE	Reg.	3	-	-	3	3	2
B10980	MC2	Kvernes 8/Rauberg 8/Bru 6/Sævråsvåg 5/Vargavåg gryte 5	Ve no REE	Ve no REE		1	-	-	4	4	4
B11115	SRM2	Bergspytt 5/Digranes 5	Qu no REE	NC		3/4	-	-	2-1	1	5
B11116	MC2	Arnafjord 8/Kvitno 8	Ve no REE	Ve no REE	Reg.	1/3	-	-	4-1	3	5
B11422	SRM1	Bergspytt 5	Ve no REE	Ve no REE	Reg.	4	-	-	2	2	5
B11551a	MC5	Juadal/Kvernes/Nygård/Urda/Vargavåg/Bergsholmen 7	Qu no REE	NC		1/2	-	-	4	4	4

Table 3. *(Continued)*

Object no.	**MTE code**	**MTE Quarry**	**Code MTE & REE code** Qu=Quarry, Ve=Vessel	**MTE & REE quarries** NC= Not conclusive, Ve=Vessel	**Transport distance** RTR=Regional on transport route	**Geological unit MTE**	**Geological unit MTE&REE**	**Vessel type**	**Score points**	**Sum score points**	**Group 1–6**
B11564g	MC3	Sævråsvågen 8/Raudesteinane 8/Vassenden 8/Arnafjord 6	Ve no REE	Ve no REE		1/3	-	-	4-1	3	5
B11630	1Q	Sævråsvåg 8/Kvitno 5/Sele 6/Sjusete 6/Tyssedal 5/Vass 6	Ve no REE	Ve no REE	Local	1	-	-	3+2	5	1
B11636	MC5	Juadal 8/Kvernes 8/Nygård 8/Urda 8/Vassenden 8	Ve no REE	Ve no REE		1/2/3	-	-	4-1	3	5
B11686	MC5	Bergsholmen 8/Juadalen 8/Rauberg 8/Russøy 8/Urda 8	Ve no REE	Ve no REE		1/2	-	-	4	4	4
B11797	1Q	Skare 8	1Q	Skare	Reg.	4	4	-	3+2	5	1
B11815b	1Q	Åkra 8/Ingahogget 5	1Q	Åkra	Vicinity	4	4	-	3+2+3	8	1
B11835	MC3	Arnafjord 8/Kvernes 8/Svanøy 8	Qu no REE	NC	Reg.	1/2	-	-	4	4	4
B11867a	SRM3	Baldersheim 6/Bergsholmen 6/Juadal 6	SRM1	Bergsholmen	Local	1	1	-	2+2	4	1
B11868b	SRM1	Lysekloster 6	NRM		Local	2	0	-	2-2+2	2	6
B11869c	1Q	Sævråsvåg 8/Flatabø 7	Ve no REE	Ve no REE	RTR	1	-	-	3	3	2
B11878a	MC2	Sævråsvåg 8/Vassenden 8	1Q	Sævråsvåg	RTR	1/3	1	-	4+2-1	5	1
B12025b	MC2	Vassenden 8/Flatabø 8/Sævråsvåg 6	1Q	Vassenden	RTR	3	3	-	4+2	6	1
B12050a	MC4	Bergspytt 8/Ingahogget 8/Klåvsteinsjuvet 8/Skare 8	MC3	Bergspytt/Ingahogget/Klåvstein-sjuvet		4	4	-	4	4	3
B12314	MC2	Baldersheim 8/Sjusete 8/Juadalen 6	SRM1	Juadal	Reg.	1/2	1	-	2	2	2
B12372	NRM	NRM	Ve no REE	Ve no REE			-	-	0	0	6

Birgitta Berglund, Tom Heldal and Tor Grenne

From Soapstone Quarries to Churches: Control, Ownership and Transport Along the Helgeland Coast in North Norway

Several soapstone quarries are found along the coast of Helgeland in north Norway, including some on islands in the mouth of Vefsnfjorden, where there are significant ancient workings. Several medieval stone churches in the area are built of soapstone. Soapstone vessels are found in grave mounds from the Viking Age. In farm mounds, everyday utensils and rough-outs made from soapstone are commonly found. The most important quarries are briefly presented here, along with the soapstone churches. Provenance studies are used to determine from which quarries the soapstone used in the churches came. The results indicate that such studies may tell us much about the ownership and control of the quarries, the distribution of soapstone for building purposes, the builders of the churches and aspects related to the production and quarrying of soapstone used for building purposes.

Soapstone quarries in Helgeland

Occurrences of soapstone are found in many places in Norway, including the coast of Helgeland in the southern part of the county of Nordland. Most of these occurrences have been exploited in the past, in particular those found in coastal areas and at the mouth of the fjords (Figure 1) (Berglund 1999). These quarries seem to have been utilised since at least the Viking period, but most likely also long before (Lund 1965:296–297; Berglund 1999:19–21).

Most of the old quarries in the Helgeland district are in the mouth of Vefsnfjord, on the islands of Haltøya, Flatøya, Tro, Røøya and Esøya. A single quarry is found on Storesjeøya, beyond Torget, an island in Brønnøy, and a few quarries occur further south, in Sømna. The largest in the district are on Haltøya, Tro and Esøya.

The first written information so far known about the use of soapstone in Helgeland came from Petter Dass (1997 [1739]:71: Jorgensen 1954:77), the priest of Alstahaug and a baroque poet. In 'Nordlands Trompet', he described three churches built of soapstone. Moreover, he mentioned contemporary quarrying of soapstone for stoves and that this production was declining. In his own words: '*But many such stones in hot fire will crack; The buyer all pleasure and profit may lack; And therefore the business is lagging*' (translation Jorgenson 1954:77). Peter Schnitler, member of the boundary commission between Norway and Sweden in the 1740s, mentioned in 1742 that soapstone was quarried in Vefsn for stoves (Qvigstad & Wiklund 1929:42). Slabs for other purposes were also quarried. Helland (1893:148), a geologist, described soapstone occurrences in Sømna, Hestun in Vevelstad and Leirskardalen in Ranen, as well as several other localities in Helgeland. In addition to

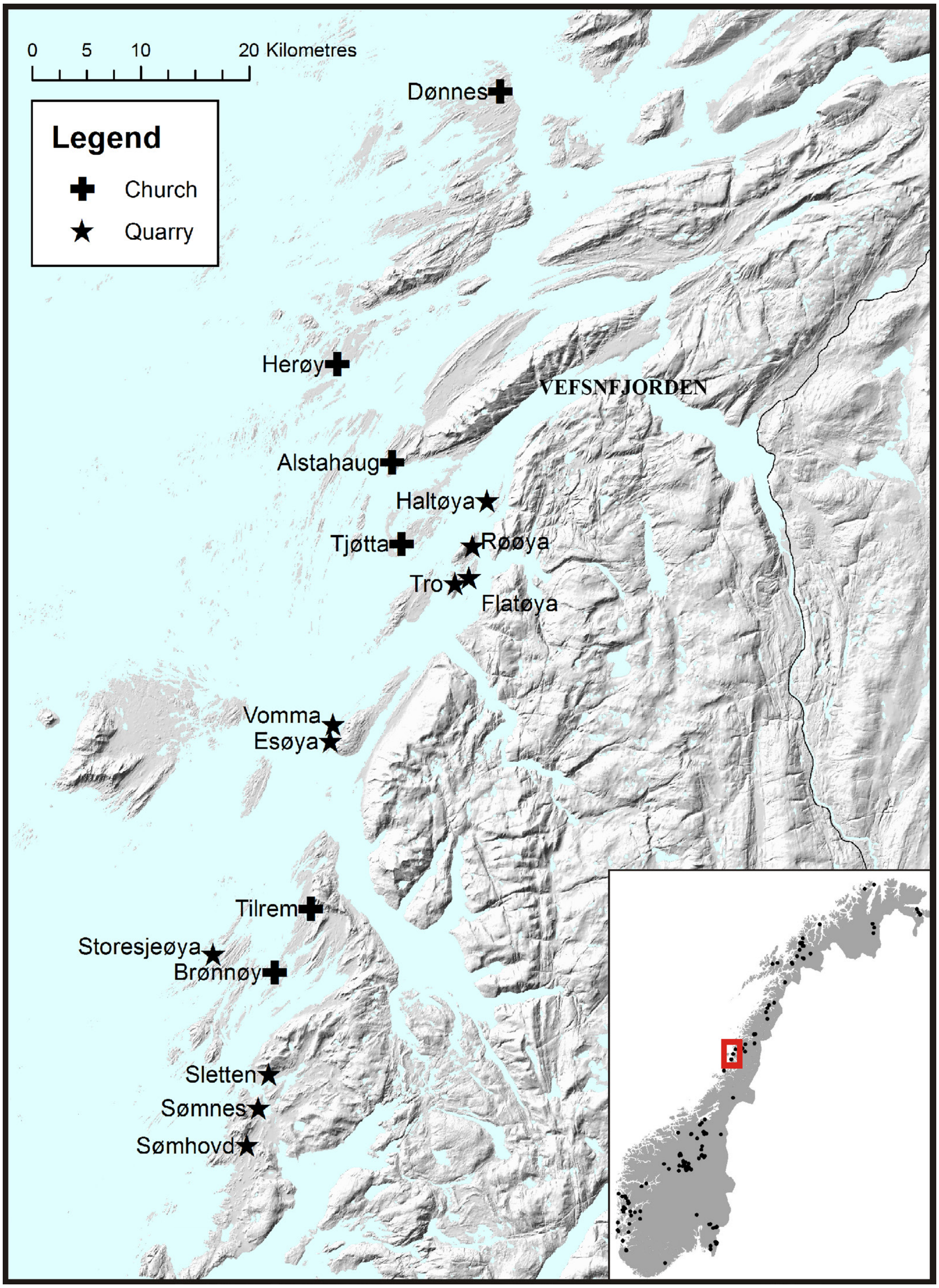


Figure 1. *Known medieval churches and soapstone quarries along the Helgeland coast.*

stoves, he mentioned that soapstone was formerly used for cooking vessels and tombstones.

Harald E. Lund, an archaeologist at the present NTNU University Museum in Trondheim, mentioned many of the soapstone quarries (Lund 1955; see Skjølsvold 1961:147). Several small quarries were investigated in the 1980s in connection with archaeological fieldwork for the land-use map series. No excavations have been carried out at the Helgeland quarries, except for a waste disposal heap excavated in 1985 at Remman, a farm on the island of Tro in the mouth of Vefsnfjorden (Berglund 1995, 1999).

On Haugen farm on Tro, a large heap of quarry waste near a small lake, Lågjen, was used as landfill during road construction in the early 1950s. Two iron chisels (NTNU University museum's inventory no.: T.17782) (one flat and the other pointed), probably used when quarrying soapstone, were found in this heap and were sent to the present NTNU University Museum in Trondheim by a teacher, Håkon Flatøy. Flatøy and Lund also brought some vessels from the same heap to the museum. Lund reported in 1963 that six vessels and vessel blanks and two sinkers from the same heap were still on the island (Berglund 1999:14–17).

There are farm names which show connections between farms in the area and soapstone quarrying. The most obvious is Hestun (Hesjutúna), where Hesju means soapstone (Rygh 1905:50). Esøya, an islet where there are large soapstone quarries, is situated near Hestun, but is not on land belonging to this farm. Es or Esje in the name of the islet has the same meaning as Hesju (Rygh 1905:50). Hestun was owned by Bakke Nunnery in the 17th century (Berglund 1995:557) and probably also in the Medieval period. Another name that may have the same meaning as Hesju is Hes in Hesgarden, which belonged to Haugen farm on Tro. There are several soapstone quarries on land attached to Hesgarden.

Use of soapstone in Helgeland in the Viking (AD 800–1030) and Medieval (AD 1030–1537) periods

The most visible use of soapstone in Helgeland is in the churches (Figure 1), usually supposed to have been built in the last half of the 12th century, mostly in Romanesque style. All are situated along the coast. Five existing churches and one that has been demolished are wholly or partly built of soapstone. Several of the churches had both outer and inner walls built of soapstone ashlars and some of them have preserved soapstone arches and archivolts.

Artefacts of soapstone, mostly spindle whorls and cooking vessels, are common grave goods from the Viking Age, especially on the islands in the mouth of Vefsnfjord in the same area as the majority of the quarries are located (Berglund 1995:149–150).

Soapstone artefacts are also found in farm mounds. These are mounds built up of material from especially buildings, fire debris and manufacturing waste, typical of long-lasting rural settlements along the north Norwegian coast. Most of the soapstone artefacts are spinning whorls, fishing weights, loom weights, cooking vessels, baking slabs and oil lamps.

Soapstone artefacts are found in mounds on farms known to be wealthy and on less wealthy ones (Berglund 1995, 2007), indicating that most people could afford the local soapstone products. Metal cooking vessels were expensive and earthenware had to be imported from the Continent or the British Isles. Pottery was more luxurious than soapstone and occurs exclusively in the rich farm mounds in the Medieval period (Berglund 1995:320, 1998:85, 2007:132–133). The use of soapstone cooking vessels seems to fall of in the 15th and 16th centuries (see Berglund 2007:96). However, even though wealthy people could afford earthenware and metal pots, they used soapstone cooking vessels as well. An important reason may be the particular qualities of soapstone; the heat capacity keeping the vessel hot long after it is removed from the fireplace, and the fact that soapstone can tolerate open fire better than pottery. The increasing popularity of earthenware among the wealthiest from the 17th century onwards may have been linked to a more advanced food culture containing several dishes with a variety of supplements (Berglund 2007:109). Surely, the more wealthy people developed this first. The heat capacity also made soapstone popular for constructing fireplaces and stovepipes in Helgeland and other parts of Scandinavia. Soapstone is still widely used in modern stoves. It was also used to cast moulds during the Bronze Age and later periods.

Soapstone blanks and rough-outs are found in some farm mounds in Helgeland, showing that some stone working was done there and not in the quarry. Considerable quantities of rough-outs and building stones revealed a stonemason's workshop close to at least one of the churches (Berglund 2007:233–235).

Approach and methods

The aim of the present investigation is to determine the origin of the soapstone used as building stone in the medieval churches in Helgeland. Establishing the provenance of the stone contributes to a better understanding of the building history of the churches, as well as the organisation behind its quarrying and transport. The building history of all the five existing churches and one ruin is examined below, with particular emphasis on rebuilding and renovation.

We have visited most of the possible Viking Age and medieval soapstone quarries in Helgeland and the quarries have been roughly characterised according to their size (from small 'artisan' quarries to large 'industrial' ones) and products (soapstone vessels, building stone and other products). Thus, we have tried to locate the most likely sources of the stone in the five churches and the church ruin, judged from the evidence of production in the quarries. When interpreting such evidence, we have assumed the following: The medieval extraction technique involved carving channels in the bedrock around ashlar blocks and vessel blanks with a pickaxe and splitting free-standing blocks and blanks along the base plane (usually the foliation in the rocks) with pickaxe or chisel blows. Roughly the same quarrying method was used up to the late 19th century, when drilling was introduced (leaving drill holes on the quarry face). Thus, observations of quarry marks can only give a rough estimation of age (pre-1870s). Visual characterisation and comparison of soapstone found in the quarries and the church walls has been important to establish whether there are 'easy' ways of suggesting provenance based on geological features unique to one quarry or a group of quarries.

Samples were collected from the five stone churches, the church ruin and the soapstone quarries in Helgeland. Major and trace elements were analysed using XRF at the laboratories of the Geological Survey of Norway (NGU). The samples were ground to powder. Powder tablets were made for the major element analyses, glass tablets for trace element analyses. The content of different elements was plotted on standard diagrams, one element against another. Four elements proved more useful than others in separating samples: Al_2O_3, MgO, Co and Ni. We have considered that at least five samples from each quarry were needed to obtain a valid result for soapstone.

Since the samples from the churches are chips that have fallen from the facade, we cannot be quite sure whether these relate to the original medieval building stone or later rebuilding. This is a limitation of the present study. The samples were, however, chosen after visual comparison with soapstone in the medieval walls of the churches, where such still exist. The building history helps to clarify whether or not soapstone was used when churches underwent rebuilding.

The provenance analysis could clarify the relations between quarries and churches, which could give a better understanding of who owned and/or controlled the soapstone quarries and who initiated the building of the various churches, the King with his church, a powerful landowner, or both? In any case, the elite must have built the churches, whether it was a king or a landowner, as the conclusion of an investigation concerning medieval churches in Trøndelag indicates (Brendalsmo 2006:285–286). In addition, the investigations could contribute to the church building history and knowledge of the transport routes for the soapstone.

Building history of the soapstone churches

As far as is known, six churches were built entirely or partly of soapstone in the Medieval period along the coast of Helgeland (Figure 1). Most of them were more or less rebuilt later, often using another type of stone. All six churches were visited.

Petter Dass (1997 [1739]:74–75; Jorgensen 1954:77) mentioned three of the soapstone churches: Tjøtta, Alstahaug and Herøy. Few old written sources mention the church buildings except in connection with accountancy, land registers, inspections and episcopal visitations. Christian Christie, an architect, undertook a journey in Helgeland in 1859 to draw plans of, and describe, the medieval stone churches there. These are the only known documents giving a detailed description, since many of the churches were extensively rebuilt a few years later.

As far as possible, we will describe and analyse aspects of the building history of these churches that are relevant for understanding the use of soapstone. The rebuilding or renovation of the churches is thus emphasised. It is possible that a church could be built of soapstone from different quarries. We assume, however, that when the church was built the soapstone came from the same quarry or a group of neighbouring quarries if the colour and structure of the soapstone in the church has a uniform character. We also think that an effort was made to use the same quarries when the church was rebuilt, to get the same colour and structure of the stone as it had originally, but we think this often was difficult to accomplish. Therefore, a church could be built of soapstone from one quarry and rebuilt using stone from another. Knowing the building history is thus an essential prerequisite for understanding the provenance analysis of the soapstone. However, when we judge the results of the analyses we need to consider differences in how well the building history of the churches is elucidated through archaeological investigations and information in the written sources.

Dønnes church

Dønnes church is usually considered to have been built in the first half of the 13th century when, according to the Saga of Håkon Håkonsson (1963:166), one of the more reliable of the Medieval Icelandic Sagas (Helle 2001:460–463), the lendmann (vassal) and landowner, Pål Vågaskalm, owned the Dynjarnes estate, today Dønnes. The will from 1308 of the mighty lendmann and landowner, Bjarne Erlingsson of Bjarkøy and Giske, mentioned Dønnes church as a recipient of gifts (Regesta Norvegica III:548), so there must have been a church there at that time. The church remained in private ownership until 1796 when it was sold to the Royal Norwegian Missionary College (Coldevin 1980:52).

According to C. Christie (1859), Dønnes church was built of rough, unhewn stone, but had soapstone ashlars in the outside corners. The frames of the west portal in the nave and the south portal in the chancel were also built of soapstone. A private grave chamber was built under the chancel at the same time as the church, and there were lofts above both the chancel and the nave (Nicolaysen 1862–1866:680; Coldevin 1980:47–49; Ekroll 1994:105–108, 1997:298–299, 1999:86–99).

The church was, however, changed before 1860. A grave chapel was built for the owner of

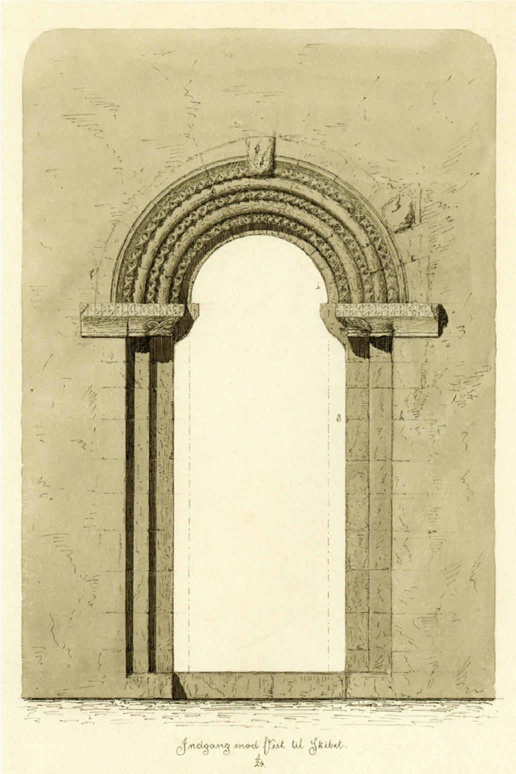


Figure 2. *The old west portal in the nave of Dønnes church as it was drawn in 1860 by C. Christie before the church was rebuilt in 1866. The frame of the portal with its ornamentation is made of soapstone. (©The Directorate for Cultural Heritage, The Archive).*

the Dønnes estate around 1690 (Coldevin 1980:46, 83). Then part of the chancel wall was demolished. When the church was rebuilt in 1866, half of the nave was removed. The rest became the new chancel (Coldevin 1980:49). The richly decorated soapstone frame forming the west portal was unfortunately removed at that time, but a drawing of it made by Christie six years before the rebuilding in 1866 still exists (Figure 2).

The church was renovated again in 1966–1974 by the Directorate for Cultural Heritage (Coldevin 1980:377). Håkon Christie, the architect responsible for this renovation, excavated the ground under the old chancel and nave in 1966–1969, and coins and other artefacts from as far back as the 13th century were discovered. Christie wrote in a letter dated September 6th 1966 to the present NTNU University Museum, Trondheim, that there were no signs of building activity on the site before the time of the stone church. In the chancel, significant amounts of soapstone rubble, including chips and pieces of building stone, were found resting on the bedrock beneath a layer resulting from burning (H. Christie 1998). This layer has been interpreted as representing remains from the oldest part of the stone church.

In conclusion, it may be assumed that soapstone found at the site of the church originates from the medieval church. No information suggests that soapstone was brought to the site during renovation work. Nowadays, soapstone is only found as recycled blocks in some parts of the church, in particular the corners.

Herøy church

Herøy church was described by C. Christie in 1859 before it was rebuilt in 1879–1880. Both the inner and outer walls were made of large soapstone ashlars (C. Christie 1859). According to his drawing from 1860 (archive of the Directorate for Cultural Heritage) the church at this time had an apse, a chancel and a nave, which he proposed had originally been longer. He also showed that the church had rich soapstone ornamentations both inside and outside, like Alstahaug church (H. Christie 1973:15).

Archbishop Aslak Bolt's Land Register from the 1430s reports that Jakob on Altern, in what is now the borough of Alstahaug, had to pay fines to the Archbishop for committing adultery and for having removed soapstone ashlars from the church to make a private stove (Jørgensen 1997:56, 80). This tells us that one or more of the church walls was in a poor state in the 15th century. The walls must have been rebuilt afterwards, since they appear undamaged in the drawing made by C. Christie.

Probably the nave was shortened in connection with this rebuilding (Nicolaysen 1862–1866:678).

H. Christie (1973), who excavated the ground beneath Herøy church in 1959 in connection with the rebuilding of the church, showed that the church has a complicated building history (Figure 3), in many ways like Alstahaug church. The old chancel is the oldest part of the church, and was built of soapstone. According to H. Christie (1973:17–19), this chancel must have belonged to an older, wooden church, even though no certain remnants were found. The chancel must originally have been the nave linked to a chancel in this wooden church. Afterwards, an apse of soapstone was built east of the chancel and a nave of the same material to the west. Both the inner and outer walls were built of ashlars, as in Alstahaug church. H. Christie (1973:21) was of the opinion that both these stone churches were built between 1150 and 1250, and that the craftsmen alternated between them. In his report from 1959, he suggested that both churches derived their inspiration in the 12th century building milieu in Bergen. The apse, he said, was scarcely built later than 1200, and the chancel must have been built before. The stone church with its chancel, apse and nave was, however, planned at the same time.

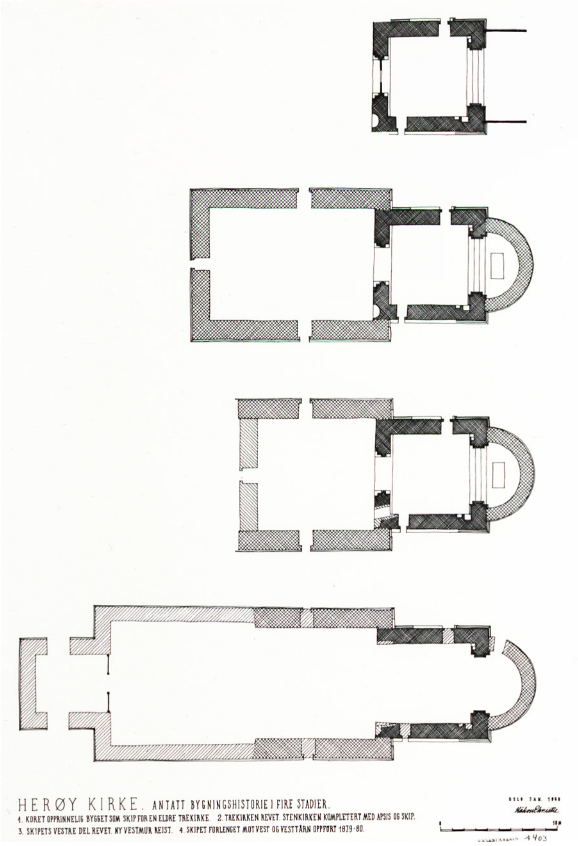


Figure 3. *The building history of the soapstone church at Herøy. Floor plan by H. Christie. (©The Directorate for Cultural Heritage, The Archive).*

During the excavation in 1959, more than 200 coins and bracteates were found in the chancel (Digre 1960:156; Ekroll 1994:105). The oldest are from the reigns of King Sverre (1177–1202) and King Håkon Håkonsson (1217–1263). Other artefacts from the same time or earlier were also found.

In conclusion, the stone church has been rebuilt several times and different quarries may have been used. Here, we postulate that the soapstone from the first stone church with its chancel, apse and nave came from a single quarry.

Alstahaug church

Alstahaug church was described by Bishop Fr. Nannestad in 1750 (Wolff 1942:50–52) and C. Christie (1859). The original church was influenced by a Romanesque style and had a chancel and a nave. From the descriptions and drawings, it seems not to have been changed from its construction (H. Christie 1973:12) until it was rebuilt in 1863–1865, shortly after the visit by C. Christie. The western part of the nave was demolished then and a new, bigger nave was built (H. Christie 1973:9) of rubble masonry from the local bedrock (Brovoll 1999:41). The eastern part of the old nave was transformed into a new chancel (H. Christie 1973:9). The medieval features of the church became less obvious with the rebuilding in the 1860s.

In 1936, a new renovation of the church began, but it was not finished until 1970. The aim was to restore the medieval features of the church. During the rebuilding of the old chancel and nave, more soapstone was required to close the big openings of the windows from the 1860s and for the upper parts of the soapstone walls. These were demolished in the 1860s to give the roof a lower pitch. The new soapstone was quarried at Haltøya in 1936, since the quarries there provided soapstone that visually matched that in the medieval parts of the church (Lund 1955; Brovoll 1999:51–54). The renovation was combined with archaeological investigations of the walls and the ground in 1967 and 1969 by Håkon Christie of the Directorate for Cultural Heritage.

The oldest chancel and nave (Figure 4) were built between 1150 and 1250 according to art history dating (H. Christie 1973:19). They were planned at the same time, but the chancel was built first (H. Christie 1973:11–12). The inner and outer walls of the chancel were made of soapstone ashlars (H. Christie 1973:9) and fine stonework. The south wall of the chancel has a round-headed portal flanked by columns. The arch is decorated with a sunken star motif (Figure 5) made using a chip-carving technique originating in wood carving. This motif was used in both Nidaros Cathedral in Trondheim and St Mary's church in Bergen in the 12th century. It originates from the Norman area in northern France and England (Ekroll 1994:99). Both the chancel and the nave have a moulded plinth with an Attic base. On the top of the southern and northern walls of the chancel is a double blind arcade frieze (H. Christie 1973; Ekroll 1994:100–102; Liepe 2001:12–16). According to C. Christie (1859), the old nave had round-headed entrances in the north and south, in addition to the one in the west. He also mentions decorations made of soapstone inside the church.

Figure 4. The medieval church at Alstahaug as it appears today after the rebuilding in the 20th century. To the right are the south walls of the old chancel and nave, built of soapstone. (Photo: B. Berglund).

The excavations inside the church revealed many graves and artefacts. The oldest dated artefacts were found in the chancel, among them an enamelled plaque from the 13th century made in Limoges in France (Berglund 2007:250–251). The oldest coins found were from the time of King Håkon Håkonsson (1217–1263) (Skaare 1970; Berglund 2007:315–316). Nine of the skeletons are ^{14}C dated. The oldest is dated to the first half of the 11th century. However, it is uncertain whether this grave is related to the stone church (Berglund 2007:297, 322–326). The church was obviously in use in the 13th century, but was probably built before.

In conclusion, the church has been rebuilt several times, but as far as is known soapstone was used only in the medieval church and when

Figure 5. *Right: The south portal of the medieval chancel of Alstahaug church with the round- headed arch with the sunken star pattern carved in soapstone. Left: The opening between the medieval chancel and nave. Drawings by C. Christie in 1860 before the church was rebuilt in 1863–65. (©The Directorate for Cultural Heritage, The Archive).*

the renovation took place in the 20th century. Soapstone from Haltøya was used in this renovation because it matched the old soapstone best. It is therefore possible that the soapstone in the medieval church and that used in the recent renovation originated from the same quarry.

Tjøtta church

The first time Tjøtta church is known to be mentioned in written sources is in Trondhjems Reformats from 1589 (1983:79), the first overview of the local ecclesiastical economy after the Lutheran Reformation in 1537. The church was in a poor state in the 17th century and, according to accountancy information and inspections, it was built of stone (Åsvang 2000:60–62).

The Church Register at Tjøtta recorded that the church was struck by lightning on 23 January 1811 and all that could burn was destroyed (Åsvang 2000:83). When the church was inspected after the fire (Åsvang 2000:84–85), it was noted on 15 June 1811 that only the stone walls were left, and some of the stones had fallen down. It was also noted that the walls were of the old type. They were double and the cavities were filled with sand and gravel like the walls in other stone churches from the 12th and 13th centuries. This information supports the view that Tjøtta church is at least as old as the other soapstone churches in Helgeland. The inspection concluded that the church was too small and a more suitable church should be built. Thus, the old walls had to be carefully taken down so that the stones could be re-used in the new church. It was decided that the new church should be a cruciform church, and it was built in 1818–1821.

This church was struck by lightning in 1843 (Åsvang 2000:90), and its rebuilding was finished in 1851. The stone walls had survived this time, too, and they were taken down during the rebuilding process and good stones were again re-used. Some soapstone was quarried on Haltøya, while rubble stone was quarried in Kalberghaugen in Tjøtta (Åsvang 2000:90–93). Ashlars from the medieval church are still visible in the walls, especially the west front (Figure 6).

In conclusion, even though the church has burnt twice, much of the soapstone from the medieval church remains in the walls. New soapstone came from Haltøya in the 19th century. Maybe this quarry was chosen to get the same colour and structure as the old stone. If so, perhaps the soapstone in the medieval church was also quarried on Haltøya.

Figure 6. *The west front of Tjøtta church as it appears today after the last rebuilding finished in 1851. Soapstone ashlars from the medieval church are visible in the wall together with rubble stone. (Photo: B. Berglund).*

Tilrem church ruin

Close to the farm mound where the central farm of Tilrem was situated, there is a church ruin from the Medieval period. A local farmer, John A. Nordhuus, mentioned already in 1848 that a farmer at Tilrem discovered hewn soapstone when he was digging a cellar there (Nordhuus 1977:49). The incident was reported to the Norwegian Culture Heritage Society which reported that the discovery took place in 1842 (Nicolaysen 1862–1866:676). No church at Tilrem is mentioned in the Trondhjem Reformats from 1589 (1983), so it must have closed earlier. Archbishop Aslak Bolt's Land Register from the 1430s mentions *Knutzkirkia j Harme* (The Church of St Knut in Harm) and the farms this church owned in Harm. Einar Høvding, an amateur historian in Brønnøy, suggested that this was the Tilrem church ruin (Høvding 1937:7–14). From the position of the farms said to be located in Harm, it seems, however, more probable that that church was in Velfjord, another part of Brønnøy (Pedersen 1994:67; Berglund 2014:177).

The Icelandic Saga of King Håkon Håkonsson tells about events that took place in Tilrem in Brønnøy in 1239 in connection with the struggle between the King and Hertug Skule, the duke (1963 edition:199–201). Jon Silke was a lendmann of the King, and his farm at Tilrem was robbed by Hertug Skule´s men while Jon Silke was away from home. The Saga does not mention a church

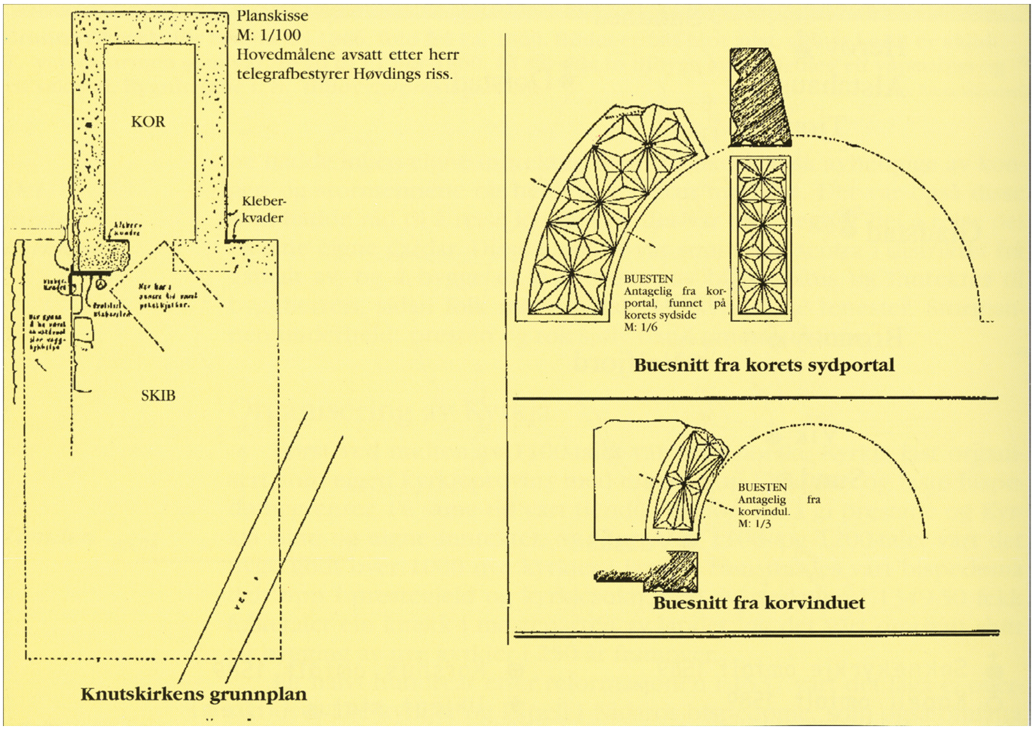


Figure 7. *Floor plan of Tilrem church after the excavation by E. Høvding in 1934–35. Parts of soapstone arches were found during the excavation. A sunken star pattern was carved in these arches. (©The Directorate for Cultural Heritage, The Archive).*

at Tilrem, but it is not unlikely that the lendmann had a church on his farm. An annual market took place at Tilrem until 1940. It was situated by the sea 700 m from the church ruin and the farm mound. It had developed from a ledingsbergting (a kind of assembly) known from written sources from the 17th century, but probably with its roots in the Medieval period (Berglund 1995:377–383, 454–457). This market could perhaps be another reason to build a church here, but if so it is difficult to understand why it closed so early.

After the owner of the Tilrem farm close to the church ruin had shown Høvding where he thought the ruin was located, Høvding excavated the ruin in 1934–1935 (Høvding 1937; Pedersen 1994:57–62). The excavation indicated, according to a floor plan made from the measurements by Høvding, that the church was of the same type as most of the medieval soapstone churches in Helgeland with a chancel and a nave, but it was mainly the chancel that was excavated (Figure 7). According to the same floor plan, it seems that both the inner and outer walls of the chancel were built of soapstone ashlars, while only the inner walls of the nave were built of such stone. Høvding (1938:143), however, wrote that the interior walls of the chancel were built of rubble stone and he found 50 soapstone ashlars on the ground in addition to 15 in the walls. There was also carved soapstone, not least part of a semi-circular arch with the sunken star motif like that above the south portal of the chancel at Alstahaug church (Høvding 1937:75–77).

The excavation does not seem to have satisfactorily answered the question of whether or not the chancel and nave were built at the same time (Høvding 1938:140–143). Erling Gjone, an architect who visited the excavation as a representative of the Society for the Preservation of Norwegian Ancient Monuments, suggested, however, that the first church consisted just of the chancel owing to how the masonry of the nave was connected to the chancel (Gjone 1934).

An excavation was carried out by an archaeologist, Kari S. Binns, in 1992 (Topographical archive, NTNU University Museum, Trondheim) in the area where the nave of the Tilrem church is assumed to be. One of the trenches was situated close to visible remnants of the northern wall of the nave, but she did not find any other parts of the walls of the nave than those Høvding located. The walls of the nave have probably been destroyed by building activity in the area. It is said that people in the neighbourhood took stones from the ruin for different purposes. Charcoal collected in the nave during the excavation was ^{14}C dated to 880±80 BP (AD 1030–1240) (Binns 2000:11), a span of time during which the church both could have been built and abandoned. The relation between the charcoal and the church is, however, somewhat uncertain. It may also be questioned whether the nave was ever finished, since such small parts of its walls have been discovered during the excavations (Berglund 2014:180–181).

The church could have closed after Tilrem, together with Tjøtta, was handed over from the immense, privately owned estate of Bjarkøy-Giske to the Archbishop soon after 1350, according to Archbishop Aslak Bolt's Land Register (Berglund 1995:395–396; Jørgensen 1997:145). This could also have happened earlier when the farm became part of the same estate, since it is likely that no local owner lived at Tilrem from this time onwards. Without a local owner, there would be no reason to maintain a church and a priest there. In this perspective, it is reasonable to suggest that the building of the church was never finished.

In conclusion, the church was left in ruins very early and has not been rebuilt. There has therefore hardly been any need to bring soapstone to the church after it was built, but in contrast stones have been taken from the church for different purposes. It is, however, uncertain whether the chancel and the nave were built at the same time or not. It is also a question whether the nave was ever finished.

Brønnøy church

Brønnøy church as it appears today is from the 19th century. It is, however, known from written sources like Archbishop Aslak Bolt's Land Register from the 1430s and the Trondhjem Reformats from 1589 that a Brønnøy church existed before the Reformation. Parts of the medieval church may therefore survive in the new church.

Bishop Nannestad stated in 1750 that Brønnøy church was a stone church (Wolff 1942:3). The church was struck by lightning in 1772 and all the wood inside the church burnt, except for some church ornaments (Nordhuus 1977:59–62 [1848]). Nordhuus wrote that the walls also suffered from the fire. Most of the walls were, nevertheless, left as in Tjøtta church. A photograph (Figure 8) from 1960 shows a section of soapstone ashlar masonry in the east wall of the old chancel.

Nordhuus (1977:61–62 [1848]) also wrote that the church was extended in 1800 and that local farmers acquired the stone needed for the extension. A photograph of the church (Ekroll 1994:92) clearly shows that transepts were built in the northern part and the rest of the church consisted of a chancel and a nave, like churches from around the 12th century in Helgeland and other parts of Norway. The transepts must be the extension that Nordhuus wrote about.

An alter mensa must also have been saved from the fire in 1772 since mouldings are visible in a drawing by C. Christie from 1860 (archive of the Directorate for Cultural Heritage). Nicolaysen (1862–1866:676) wrote that Brønnøy church was built of rubble masonry, but the doors and windows had soapstone frames.

Figure 8. *The outer east wall of the chancel in Brønnøy church. The photograph from 1960 shows that a section of the medieval wall with soapstone ashlars is preserved. (Photo: E. Høvding. ©The Directorate for Cultural Heritage, The Archive).*

The church burnt once again in 1866 and a new church was consecrated in 1870, the one that still exists. Tradition says that soapstone was brought from the church ruin at Tilrem (Lund 1961). The new church is, however, built of rubble stone. Therefore, it is possible that it was the soapstone for the frames in the earlier church that was brought from the ruin at Tilrem.

Brønnøy church was renovated in 2004–2008. Some years before, in 1999, investigations were carried out to find out whether parts of the medieval church really were preserved in the new church (Ekroll 2000:162–165). The same medieval wall with soapstone ashlars as could be seen in the photograph taken by Høvding in 1960 (Figure 8) was located. Ekroll considered it possible that some of the northern wall of the medieval chancel is also preserved and that some old soapstone from the base was recycled in the cornice of the new church. A bracteate from around 1350 was discovered under the floor of the chancel. Thus, there is little doubt that parts of the old soapstone church are preserved inside the new church.

In conclusion, the church was probably supplied with soapstone at least once after the original stone church was built. This could be for the frames of the church that burnt in 1866 or for some details in the church still existing after the fire in 1866. It is said that soapstone was brought from the Tilrem ruin to Brønnøy church in the 19th century.

Figure 9. *Features from the soapstone quarries. a) quarry at Esøya (dotted line shows extent of extraction), b) quarry floor close to sea level at Esøya, c) small ashlar quarry at Tro, d) vessel and ashlar quarry face at Storesjeøya, e) ashlar quarry at Haltøya, f) leftover ashlar blocks at Haltøya. (Photos: T. Heldal).*

The soapstone quarries

A number of quarries were visited (Figures 1, 9), from Sømna in the south to Haltøya in the north. In Sømna, three small quarries (Sømhovd, Sømnes and Sletten) are recorded. Judging by the lack of significant spoil heaps and only sporadic signs of quarrying on the rock face, they seem to have been used for local requirements only, to make vessels and small utensils. A small quarry is situated on the steep southern cliff of an islet called Vomma. There are no harbour facilities for loading ashlar blocks, and no visible sign of such production. Very small-scale exploitation of soapstone for vessels took place on Flatøya. There are some small quarries on Røøya, mainly to make vessels. Due to their small size and lack of any sign of ashlar quarrying, none of these quarries are considered to represent likely sources for ashlar blocks. Hence, they have not been part of the present study.

Four quarry areas are sizeable enough to have supported the quarrying of stone to construct churches. These are Storesjeøya, Esøya, Tro and Haltøya. They are all close to the sea and good harbour facilities, which must have been important.

Storesjeøya

The islet of Storesjeøya is far west in Brønnøy. Most of it consists of gabbroic bedrock, but a lens-shaped body of soapstone, about 8 m at its thickest, occurs within the gabbro in the northeast. A steep quarry face is seen at the southwest end of the quarry (Figure 10), and it displays traces and marks from the extraction of soapstone vessels and ashlar blocks. The quarry floor in front of the steep face also has extraction marks, and a rough estimate of the extracted volume is 500 m^3. Most of the quarrying spoil is assumed to have ended in the sea beside the quarry, but one ashlar block is found by the far northeast end.

Figure 10. *Location of the Storesjeøya quarry. Black line indicates quarry face.*

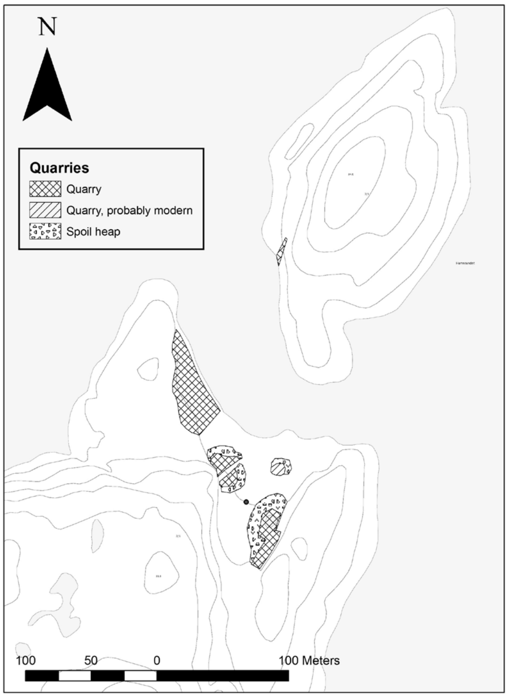


Figure 11. *The location of quarries at Esøya.*

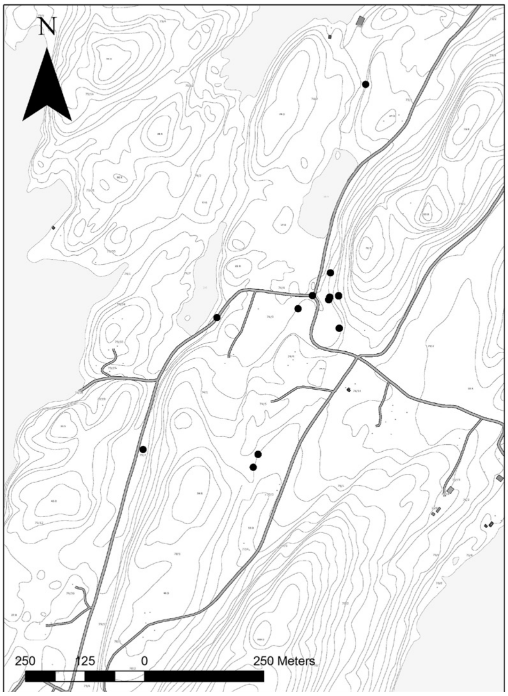


Figure 12. *The location of quarries at Tro.*

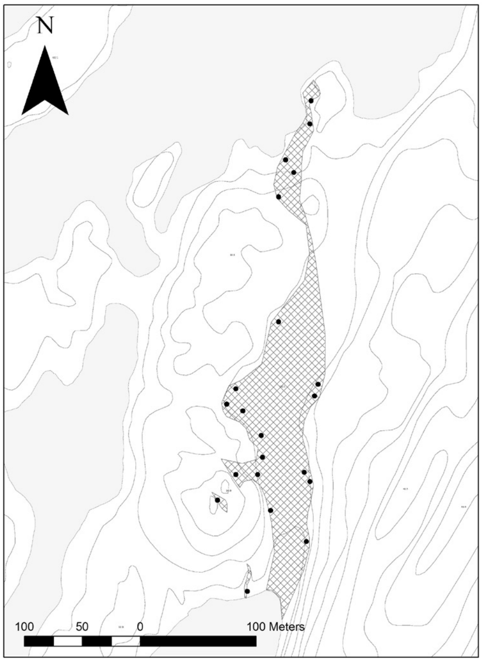


Figure 13. *The location of soapstone (cross-hatched area) and quarries (dots) at Haltøya.*

Esøya

A large quarry where at least hundreds of cubic metres of rock have been extracted is found on the island of Esøya in Vevelstad (Figure 11). Soapstone appears to have been quarried here for cooking vessels, fishing weights and building stone. There are no indications of fairly recent soapstone production, but a small deposit of actinolite seems to have been exploited by mineral collectors in recent times. The western part of the quarry displays evidence of the extraction of vessels and probably fishing weights on the quarry floor. However, a significant amount of rock has been quarried and the schist behind has been partly undermined so that large blocks have fallen onto the quarry floor. It is therefore difficult to tell whether building stone was extracted before the last phase of quarrying.

The eastern part of the quarry displays some quarry faces and spoil heaps indicating ashlar quarrying. In particular, the straight, carved quarry faces provide good indications of such

Figure 14. *Visual characterisation of soapstone from the four quarry areas. Bold shows the most characteristic feature.*

	Tro	Haltøya	Esøya	Storesjeøya
Fine network of carbonate veins		X	X	X
Folded and multidirectional thick carbonate veins		**X**	X	X
Perpendicular thick carbonate veins				**X**
Disseminated fine to medium sized carbonate grains	X	X	X	X
Disseminated large carbonate grains				**X**
Strongly foliated and sheared	**X**		X	

quarrying. A runic inscription on the rock face may indicate that production took place in the 11th century (Hagland 1984; 2000). At least, the writer knew the occurrence of soapstone and the qualities of the stone.

Tro

A large cluster of soapstone quarries is found further north, on the island of Tro in Alstahaug. We visited 11 quarries (Figure 12), but there are several more which we did not manage to cover during the fieldwork. The most prominent production seems to have been soapstone vessels, and one underground quarry used to acquire these was investigated by Berglund (1999). Only one quarry shows clear evidence of ashlar quarrying, having straight, carved faces. The quarry has not been dated, but pickaxe marks on the face and an apparent lack of drill holes indicate a medieval date.

Haltøya

Haltøya, an island in Alstahaug, north of Tro, was important for building stone production. Nineteen quarries here display evidence of ashlar quarrying (Figure 13). In addition, two quarries produced vessels. Abandoned ashlar blocks are scattered around the site. Modern workings are found in the far south of the site, probably industrial trial extraction of talc in 1935–36 (Lund 1955). Although some of the ashlar quarries may have been used in various attempts to restore medieval churches in the area, the large size of the quarry area indicates a major medieval soapstone production site.

The quarries, conclusions

Four of the quarrying areas (Storesjeøya, Esøya, Tro and Haltøya) display clear evidence of ashlar extraction and are thus the most likely candidates for exploitation of stone for the medieval churches. The soapstone in all four areas shares the same mineralogy, predominantly talc and carbonate, minor chlorite, oxides and pyrite. The structure of the rock differs however, and seven subtypes were identified, based on the structure and distribution of carbonate (types of veins, occurrence of clusters of carbonate grains and distribution and size of single grains) and the occurrence of foliation and shear structures (Figure 14).

Soapstone provenance

The visual features of the soapstone found in the churches have been described using the same criteria as the quarries (Figures 9, 14). Figure 15 summarises the observations from the churches. Figures 16, 17 show the correspondence between churches and quarries, indicating the most likely provenance.

Figure 15. *Visual appearance of soapstone observed in the churches.*

	Alstahaug	Herøy	Dønna	Tjøtta	Tilrem	Brønnøy
Fine network of carbonate veins	X				X	X
Folded and multidirectional thick carbonate veins	X	X			X	X
Perpendicular thick carbonate veins					X	
Disseminated fine to medium sized carbonate grains	X	X	X	X	X	X
Disseminated large carbonate grains					X	X
Strongly foliated and sheared			X	X		

Figure 16. *Match between visual appearances in soapstone from churches and those observed in quarries. The first number illustrates the number of similar features, whilst the last shows the opposite — the number of non-similar features. Bold represents the most likely provenance judged from visual inspection.*

Quarry\church	Tro	Haltøya	Esøya	Storesjeøya
Alstahaug	1-3	**3-0**	**3-1**	3-2
Herøy	1-2	**2-1**	**2-0**	2-3
Dønna	**2-0**	1-3	2-2	1-5
Tjøtta	**2-0**	1-3	2-2	1-5
Tilrem	1-5	3-2	3-3	**5-0**
Brønnøy	1-4	**3-1**	**3-1**	**4-1**

The soapstone found in Alstahaug and Herøy churches shows strong similarity with the Haltøya and Esøya quarries, while Dønnes and Tjøtta churches contain stone that seems to originate in the Tro quarries. The church ruin at Tilrem contains soapstone that has many features resembling the Storesjeøya quarry. Brønnøy church has soapstone that may come from several sources, and the Esøya, Storesjeøya and Haltøya quarries may be candidates.

Trace and major elements were analysed by XRF in whole-rock samples from the quarries and all the churches, excluding Dønnes (Appendix, Table 1). The number of samples analysed from the Helgeland soapstone quarries is: Esøya 13, Haltøya 7, Tro 6 and Storesjeøya 6. Since Esøya displays the largest visual variation of soapstone, more samples were taken from there (Berglund 1999:18). Haltøya and Tro have several small quarries, but most of them are close to each other (Berglund 1999:16–18) and display little variation. The Storesjeøya quarry is smaller than the others and is in a single body of soapstone (Berglund 1999:18–19). We have tried to choose representative samples from the quarries based on visual characterisation.

Several combinations of major and trace elements were plotted. Magnesium oxide (MgO), aluminium oxide (Al_2O_3), nickel (Ni) and cobalt (Co) distinguished between the quarries best. Figure 18 shows plots of MgO against Al_2O_3, Ni against MgO and Ni against Co. Only one quarry, Storesjeøya, is sufficiently unique geochemically to be easily separated from the others. Haltøya and Esøya are separated from each other, but show a small overlap. Tro plots close to Haltøya and in the overlapping field between Haltøya and Esøya.

The numbers of XRF-analysed samples from the Helgeland churches are: Herøy 2, Alstahaug 3, Tjøtta 4, Tilrem 6 and Brønnøy 4. Four samples from Tilrem plot clearly within the field of the

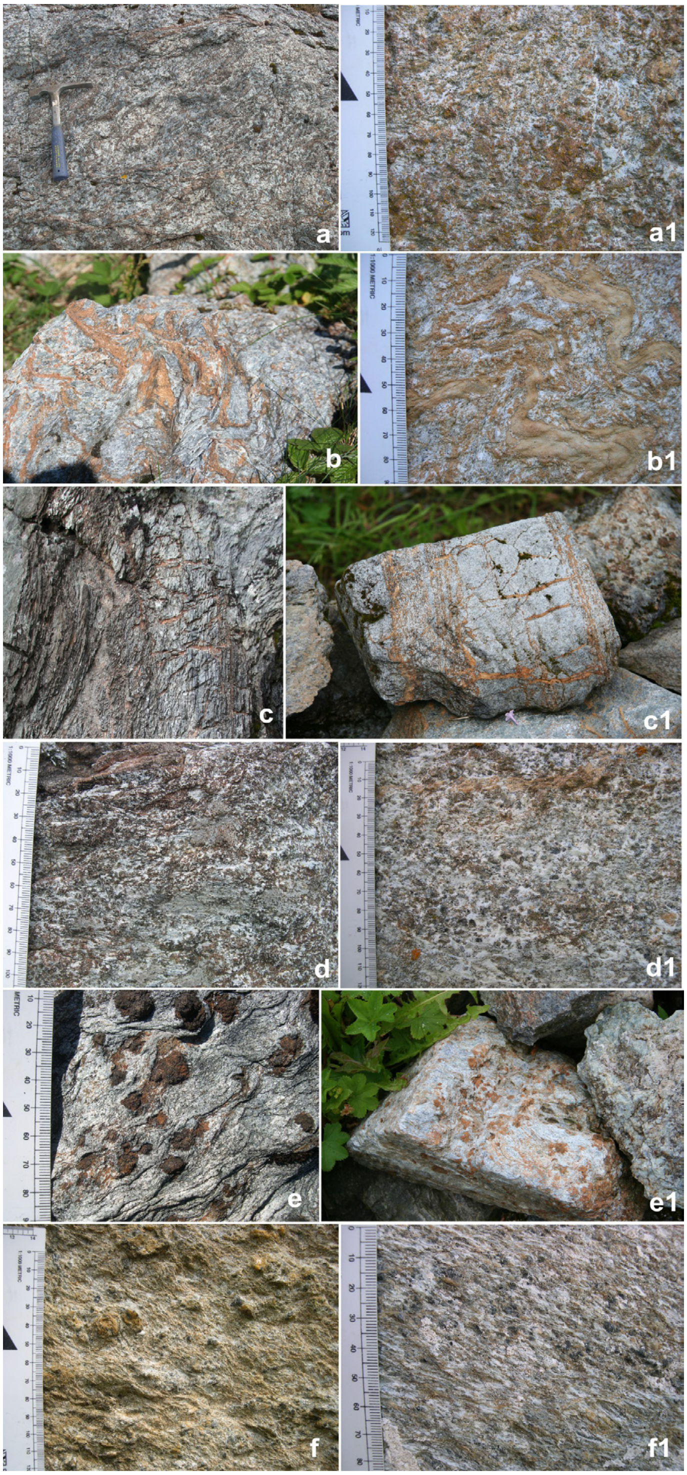
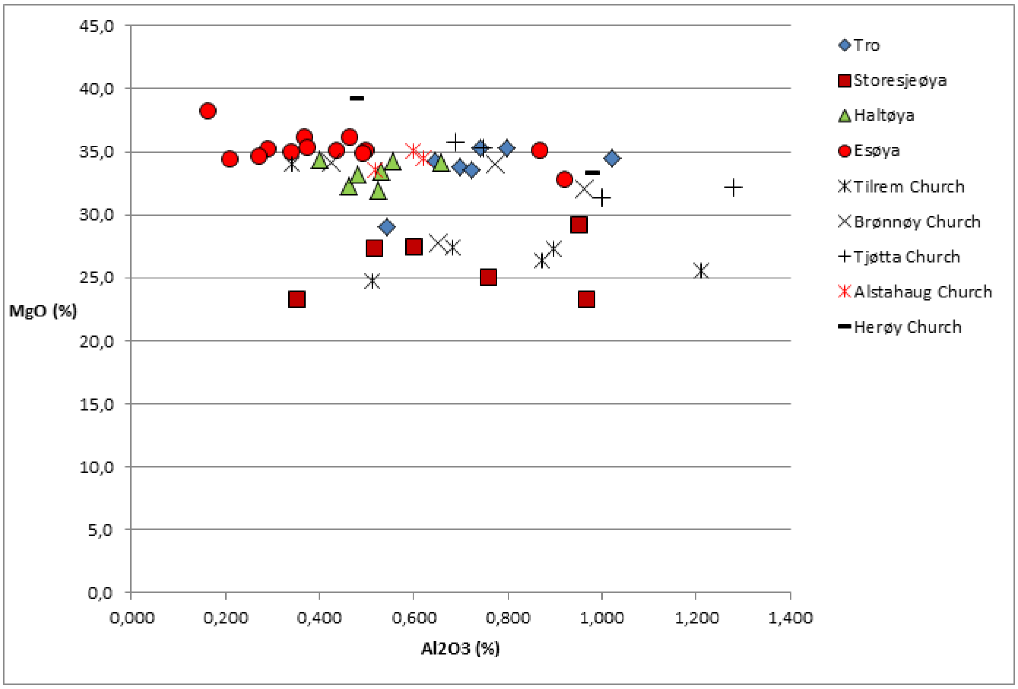
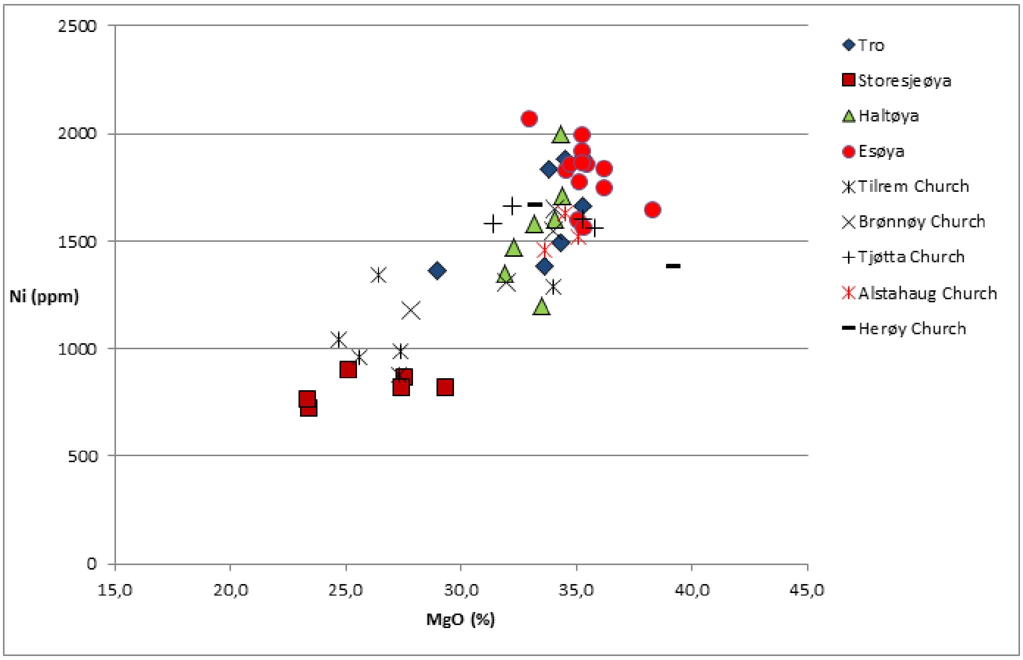


Figure 17. *Features of soapstone from quarries and churches. a) Fine network of carbonate veins (Haltøya), a1) same as seen in Alstahaug church. b) Folded and multidirectional thick carbonate veins (Haltøya), b1) same as seen in Alstahaug church. c) Perpendicular, thick carbonate veins (Storesjeøya), c1) same as seen in Tilrem church. d) Disseminated fine to medium sized carbonate grains (Esøya), d1) same as seen in Alstahaug church. e) Disseminated large carbonate grains (Storesjeøya), e1) same as seen in Tilrem church. f) Strongly foliated and sheared (Tro), f1) same as seen in Dønnes church. (Photos: T. Heldal).*



45,0
40,0
35,0
30,0
25,0
20,0
15,0
10,0
5,0
0,0
MgO (%)
0,000
0,200
0,400
0,600
0,800
1,000
1,200
1,400
Al2O3 (%)
Tro
Storesjeøya
Haltøya
Esøya
Tilrem Church
Brønnøy Church
Tjøtta Church
Alstahaug Church
Herøy Church



2500
2000
1500
1000
500
0
Ni (ppm)
15,0
20,0
25,0
30,0
35,0
40,0
45,0
MgO (%)
Tro
Storesjeøya
Haltøya
Esøya
Tilrem Church
Brønnøy Church
Tjøtta Church
Alstahaug Church
Herøy Church

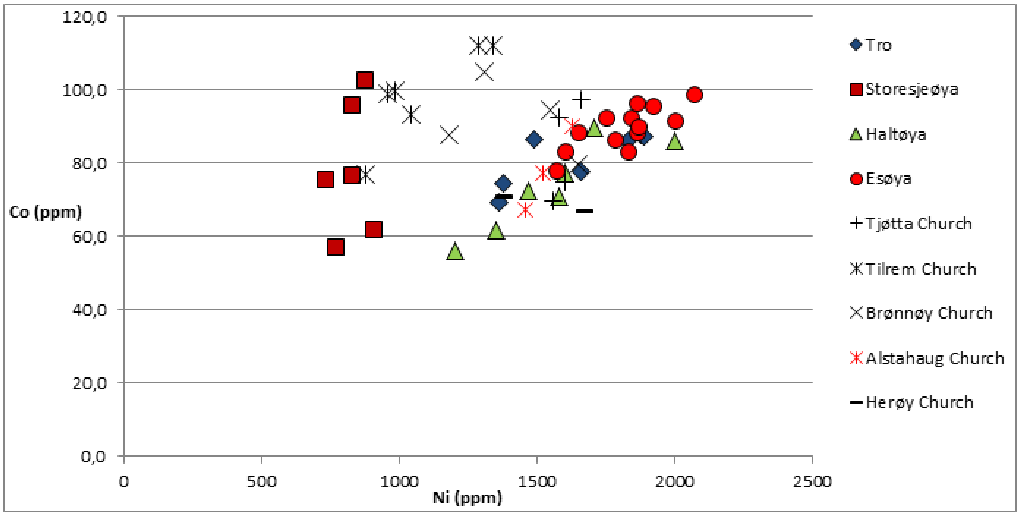


Figure 18. *MgO-Al2O3 , Ni-MgO and Co-Ni plots of samples from quarries (coloured symbols) and churches.*

Figure 19. *Likely provenance for soapstone found in the different churches. Bold means rather secure provenance.*

Alstahaug	**Haltøya**/Esøya
Herøy	Haltøya/Esøya
Dønna (only visual inspection)	**Tro**
Tjøtta	**Tro** + Esøya?
Tilrem	**Storesjeøya** + unknown
Brønnøy	**Storesjeøya** + Haltøya/Esøya + unknown

Storesjeøya quarry. Two samples plot closer to other fields. These two are clearly separated from all the quarry fields on the Co-Ni plot (Figure 18), indicating a source that is not yet identified. One sample from Brønnøy church plots together with the anomalous Tilrem samples, others between the fields, one close to the Esøya field and the last close to samples from Tro, Esøya and Haltøya. According to Høvding (1938:167–168), Rekstad at the Geological Survey of Norway compared samples from Storesjeøya and Tilrem church, and concluded that this quarry was not the source. Given that our study points towards the opposite conclusion, it may be that Rekstad got a sample from the unknown source for comparison. Rekstad also compared soapstone from Brønnøy church with the analysed soapstone from Tilrem, concluding that the soapstone from the two churches probably originated from the same quarry. The analysed stone in Brønnøy church originates from the cornice with the recycled stones (Høvding 1938:168) from the medieval base (Ekroll 2000:162–165).

Four samples from Tjøtta church split in two groups. Two of them plot closest to the samples from Tro and Haltøya, while the others show best fits with the Esøya samples. Herøy church plots close to both Tro and Haltøya, while Alstahaug church matches best with Haltøya and Esøya.

Thus, it is possible to find support in the geochemical analyses for the conclusions drawn from the visual inspection of samples. It is likely that both Tjøtta and Dønnes churches used stone from Tro. However, the analyses also indicate a second source for Tjøtta church, perhaps the Esøya quarry. Alstahaug church fits with the Haltøya quarry, but Esøya cannot be ruled out for at least one sample.

Two samples from Herøy church could indicate Haltøya or Esøya, given that visual inspection excludes Tro. Four samples from Tilrem most likely originated at Storesjeøya. Two samples and one from Brønnøy church, however, plot outside any of the fields in Helgeland, and may represent a still unknown source. Figure 19 summarises the possibilities and likelihood of provenance for the different churches.

Control, ownership and transport in the light of the provenance studies

There are some central farms in Helgeland where the landowners started to build up large landed properties early, probably not later than in the Viking Age (Høgsæt 1986; Berglund 1995). One of these properties is Tjøtta (Figure 20), in the mouth of Vefsnfjord, one of the biggest fjords in Helgeland. It is typical that these landed properties controlled people and resources both in the fjord districts and in the archipelago. They could thus collect different types of resources typical for these different areas. Archbishop Aslak Bolt's Land Register from the 1430s reported that the Vistenfjord area belonged to Tjøtta, along with many islands in the archipelago (Jørgensen 1997:145; see Berglund 1995:395–398). Torget in Brønnøy, further south in Helgeland, is another central farm which started to build up large landed properties early (Høgsæt 1986:41–59; Berglund 1994:59–62, 1995:447–450, 2011:365).

However, did the owners of this type of landed property own and/or control the soapstone quarries? The early written sources do not mention the soapstone quarries. It is known that landowners built private churches on their estates at an early date. In such cases, it is probable that a landowner

Figure 20. *Ownership of the farms where the soapstone churches were built.*

The Farm	The Saga Literature	The Land Register of Arch-bishop Aslak Bolt (1430s)	The Land Register of Archbishop Olav Engelbrektsson (1530)	The Land Registers of the central authorithy (Stattholder) 1624-26	The Taxation Land Register of 1647	The Land Commission 1661
Dønnes	Pål Vågaskalm (1232)					The Noble Man Preben von Ahnen
Alstahaug					The Benefice of Alstahaug (Alstahaug prestebol)	The Benefice of Alstahaug (Alstahaug prestebol)
Sør-Herøy				The Priest	The Benefice of Alstahaug	The Benefice of Alstahaug
Tjøtta	Hårek Øyvindsson (10^{th}-11^{th} century	X	X	The King	The King	The King
Tilrem	Jon Silke (1239)	X	X	The King	The King	The King
Brønnøy					The Benefice of Brønnøy (Brønnøy prestebol)	The Benefice of Brønnøy (Brønnøy prestebol)

Figure 21. *Ownership of farms with building stone quarries.*

The farm	The Land Register of Archbishop Aslak Bolt (1430s)	The Land Registers of the central authority (Stattholder) 1624-26	The Taxation Land Register of 1647	The Land Commission 1661
Haltøy		The Priest	The Benefice of Alstahaug	The Benefice of Alstahaug
Haugen (Lauvøy)	X	The King and private 1625: Farmer	Anne, the widow of Peder Jacobsen	Anne, the widow of P. Jacobsen, and her children
Havn: Esøya		The Church	Herøy church	Herøy church
Bolvær: Storesjeøya			Erich The King	

on the Helgeland coast used soapstone from quarries he perhaps owned and/or controlled. In Bergen, soapstone buildings initiated by the King made use of a single, main quarry probably controlled by him (Jansen et al. 2003). Perhaps this was also the case for the churches initiated by central authorities on the Helgeland coast?

Comparison between the known early ownership of farms where soapstone churches were built (Figure 20) and the early ownership of farms with building stone quarries (Figure 21) in the light of the results of the provenance studies (Figure 19) might tell us more about who owned or controlled the quarries, the distribution of the soapstone from the quarries, and the person responsible for building the church.

Dønnes – control and ownership

Dønnes farm was privately owned in the 17th century and was the central farm in a large landed property (Figure 20). According to the Saga of Håkon Håkonsson, the property was owned by the lendmann and landowner, Pål Vågaskalm, in the 1230s. As a witness, he signed a letter from King Håkon Håkonsson in 1233 (Regesta Norvegica I:628). Dønnes church is usually considered to be a private church (e.g. Ekroll 1994:100, 1999:86). Since Dønnes is neither mentioned in the land registers of the Archbishops nor in the later land and tax registers, the farm was probably privately owned by a nobleman even before 1661 when the nobleman Preben von Ahnen owned the estate (see Berglund 1995:392). Such farms did not pay taxes and therefore do not figure in the tax registers. Since Dønnes church was rebuilt with rubble stone, not soapstone, soapstone at the site probably originates from the medieval church. Tro is the likely provenance of this soapstone (Figures 16, 19). However, no connection is known between Dønnes and Tro in the first centuries of the Middle Ages. It has been argued that the owner of Tjøtta, another big landed property in the area, controlled the island of Tro and its resources at an early date (Berglund 1995:396). However, according to Archbishop Aslak Bolt's Land Register (Jørgensen 1997:145), Tjøtta was handed over to the Archbishop between 1350 and 1355, but this is 100 years later than Dønnes church is believed to have been built. Tjøtta was private property in the 13th century (Berglund 1995).

Alstahaug and Herøy – control and ownership

It is not known whether the farms of Alstahaug and Herøy were privately owned or not when the medieval churches were built, but in the 17th century the farms of Alstahaug and Sør-Herøy, where Herøy church is situated, maintained the priest of Alstahaug (Figure 20). These farms probably also had this function earlier. Alstahaug and Herøy churches were in the same parish. There are, however, no soapstone quarries on land belonging to the Alstahaug or Sør-Herøy farms. The soapstone in Alstahaug church was quarried on Haltøya and possibly also on Esøya according to the geochemical analyses, and the same applies to the stone in Herøy church (Figure 19). Since Haltøy farm maintained the priest at Alstahaug in the 17th century (Figure 21), there could be a connection between the Haltøya quarries and the Alstahaug and Herøy churches. Esøya belongs to Hamn farm, which was owned by Herøy church in the 17th century (Figure 21), so the quarries on both Haltøya and Esøya were owned or controlled by clerical institutions. If we accept that these ownerships go back to the time of the building of the stone churches, there could be a connection between these churches and the quarries. H. Christie (1973), who excavated the ground beneath these two churches, was of the opinion that the two churches were built at the same time and the craftsmen alternated between them during their construction. The use of the same quarries supports his opinion. A clerical institution, Bakke Nunnery, owned the neighbouring farm of Hestun in the 17th century (Berglund 1995:568). This strongly indicates that it was also the owner in the Medieval period. As mentioned above, the meaning of the name Hestun indicates that this farm had something to do with soapstone, probably the Esøya quarry.

Tjøtta – control and ownership

According to Snorres Kongesagaer, the early 13th century history of the Norwegian kings written by Snorre Sturlason (Holtsmark & Seip 1942), Tjøtta (Figure 20) was the farm of Hårek Øyvindsson at the end of the Viking Age. Hårek was one of the commanders at the battle of Stiklestad in 1030 where the Norwegian king, Olav Haraldsson, was killed. It seems that Tjøtta continued to be owned privately until the farm was handed over to the Archbishop in 1350–1355, according to Archbishop Aslak Bolt's Land Register from the 1430s (Berglund 1995:395–400). It is usually considered that Tjøtta church was built as a private church (e.g. Ekroll 1994:100). The most obvious building stone quarry on the island of Tro is on Haugen farm (Figure 21), which was once part of a larger farm, Lauvøy. Tjøtta may once have controlled Lauvøy farm (Berglund 1995:390–405). The provenance studies support this since the analyses of the building stone from Tjøtta church match those from Tro quarries, in addition to an unknown quarry, possibly Esøya.

Tilrem – control and ownership

Tilrem farm (Figure 20) was handed over from private ownership to the Archbishop on the same occasion as Tjøtta according to Archbishop Aslak Bolt's Land Register (Jørgensen 1997:145). At that time, 1350–1355, both Tjøtta and Tilrem were part of the enormous landed estate of Bjarkøy-Giske. Both the visual comparison and geochemical analyses of soapstone from the church ruin at Tilrem match very well with the quarries on the islet of Storesjeøya in Brønnøy (Figures 16, 19). This islet is situated seaward of Torget, a farm known from written sources such as Olav Engelbrektsson's Land Register from 1530 (Brinchmann & Agerholt 1926) and the Icelandic Egil Skallagrimsson's Saga (Egilssoga 1978). According to the former, many farms and islets, mostly in the vicinity of Torget, belonged to this estate (Høgsæt 1986; Berglund 1994, 1995, 2011). According to Egilssoga, the farm played an important role as one of the strongholds of the chieftains in this area in the 9th century. It is unlikely that the owners of Torget did not control the quarry on Storesjeøya. There could have been some sort of link between the owners of the big farm at Tilrem and the Torget estate. According to Olav Engelbrektsson's Land Register, Torget seems to have been handed over to the Archbishop little by little (Høgsæt 1986; Berglund 2011:364–366). In 1647, Storesjeøya belonged to Bolvær (Figure 21), which was owned by the King at that time. Bolvær could be one of the islands outside Torget that was handed over to the Archbishop and later confiscated by the King in connection with the Reformation in 1537. According to Rygh (1905), Bolvær was not matriculated before 1610.

Brønnøy – control and ownership

In the 17th century, Brønnøy farm maintained the priest of Brønnøy. It is not known who owned the farm when the church was built, but it is not unlikely that the farm also maintained the Brønnøy priest in the Medieval period. The farm was hardly handed over to ecclesiastical use after the Reformation in 1537. Both the visual comparison and the geochemical analyses of some of the soapstone from Brønnøy church match the soapstone on Storesjeøya (Figures 16, 19), in common with most of that from Tilrem church. The geochemical analyses also match those from Haltøya and Esøya. The soapstone from Storesjeøya was perhaps taken from the Tilrem church ruin to Brønnøy church in the 19th century, although we cannot exclude the possibility that it was taken directly from Storesjeøya in the Medieval period and was not recycled from Tilrem. If so, the medieval church could have been built of stone from Haltøya and/or Esøya since no stone from these quarries is so far known from the Tilrem church ruin.

It is interesting that the provenance studies show that the churches of Brønnøy, Alstahaug and Herøy have building stone from the quarries on Haltøya and Esøya, since all these churches are regarded as having been established by central authorities (Berglund 1995:499–500). The quarries on Haltøya and Esøya are also the ones which most clearly were owned by clerical institutions (Figure 21).

Transport of the soapstone

The transport of the building stone from the quarries to the stonemasons' workshops at the churches had to be by boat. This must have been an advantage for the soapstone quarries on the Helgeland coast. The overland transport was at most 500–600 metres from the quarry to a harbour and mostly even shorter from the sea to the churches. The quarries at Storesjeøya and Esøya are situated almost on the beach, making the logistics particularly easy.

Conclusion and further work

The provenance studies have so far not given unambiguous results, but there are some very interesting indications. In the Medieval period, soapstone from the Haltøya and Esøya quarries seems primarily to have been used in churches earlier supposed to have been established by central authorities. These are Alstahaug, Herøy and Brønnøy (Berglund 1995:499–500). The quarries on Haltøya and Esøya are the ones owned by clerical institutions. The church therefore used its own quarries for churches established after a central initiative.

Dønnes and Tjøtta churches are usually considered to have been built as private churches. According to the provenance analyses, the soapstone in these churches originates from quarries on Tro and, in the case of Tjøtta, in addition from an unknown quarry, perhaps Esøya. There could be a connection between Tjøtta and the farms on Tro, as well as between the owners of the Tjøtta and Dønnes farms. Those who initiated the building of the private churches seem therefore not to have used quarries owned by clerical institutions.

The soapstone in the church ruin at Tilrem mainly originates from Storesjeøya. As that quarry was probably controlled by the Torget estate, there could have been a connection between the owners of the Torget and Tilrem farms. This supports the idea that Tilrem was a private church since the soapstone did not originate from a quarry controlled by the church or another clerical institution. The soapstone from Storesjeøya may have been taken from the Tilrem church ruin to Brønnøy church in the 19th century, but we cannot exclude the possibility that soapstone from Storesjeøya was originally used in Brønnøy church in the Medieval period.

Judging by the geochemical analyses, there is at least one type of soapstone in the churches (Tilrem and Brønnøy) whose source is not yet identified. This could, of course, be an unknown quarry in the region, but it is also relevant to explore the possibility that soapstone from more distant medieval quarrying operations was used, for instance Trøndelag, in central Norway.

The results of the provenance studies have given information concerning control, ownership and transport of soapstone for six medieval soapstone churches and four building stone quarries in Helgeland. This pilot study should, however, be tested further with more samples from both the soapstone quarries and the churches. We plan limited investigations of two of the quarries, Haltøya and Esøya, to learn more about questions such as When were the quarries used? and Which technology was used?. It is planned to study the quarries as mini-societies (Berglund 2015:129–140). We have also made preparations to perform provenance analyses of everyday utensils from farm mounds in Helgeland.

References

Berglund, B. 1994: Saga, sentra og kystbosetning. In Berglund, B. (ed.) *Helgeland Historie, bind.2*, 27–90. Helgeland Historielag, Mosjøen.

Berglund, B. 1995. *Tjøtta-riket. En arkeologisk undersøkelse av maktforhold og sentrumsdannelser på Helgelandskysten fra Kr.f. til 1700 e.Kr.* Dr.philos. thesis, University of Trondheim.

Berglund, B. 1998. Power Structures in Pagan and Christian Times on the Coast of Helgeland in Northern Norway. In Buko, A. (ed.) *Studia Z Dziejów Cywilizacji,* 81–91. Instytyt Archeologii Uniwersytetu Warszawskiego, Warszawa.

Berglund, B. 1999. Middelaldersk klebersteinsindustri på Helgelandskysten. *Ottar* 1999 (2): 13–24, Tromsø Museum, Universitetsmuseet.

Berglund, B. 2007. *Alstahaug på Helgeland 1000–1750. Dass-dynastiet og presteskapet iscenesetter seg selv*. Det Kongelige Norske Videnskabers Selskab Skrifter 2007 (1). Tapir Academic Press, Trondheim.

Berglund, B. 2011. Folk på Torget i de eldste tider. In Mathisen, T. (ed.) *Brønnøy gård og slekt,* bind II, 309–371. Published by Brønnøy municipality.

Berglund, B. 2014. Kirkeruinens gåte og fortidsfolk på Tilrem. In Mathisen, T. (ed.) *Brønnøy gård og slekt,* bind IV, 167–185. Published by Brønnøy municipality.

Berglund, B. 2015. Possibilities for a society analysis by means of soapstone – examples from Helgeland, Northern Norway. In Indrelid, S., Hjelle, K.L. & Stene, K. (eds), Berglund, B., Callanan, M., Kaland, S. H. H. & Stenvik, L. (Co-eds). *Exploitation of outfield resources – Joint Research at the University Museums of Norway*, 129–140. Universitetsmuseet i Bergen skrifter nr. 32.

Binns, K. S. 1992. Undersøkelse av St. Knuts kirkeruin på Tilrem (108/1), Brønnøy kommune, Nordland, 22–28 July 1992. Report in NTNU University Museum. Unpublished.

Binns, K. S. 2000. *I møte med maktene.* Fotefar mot nord. Bodø.

Brendalsmo. J. 2006. *Kirkebygg og kirkebyggere. Byggherrer i Trøndelag ca. 1000–1600*. Unipub forlag.

Brinchmann, Chr. & Agerholt, J. (eds) 1926. *Olav Engelbrektssøns jordebog*, Norges Rigsarkiv, Nationaltrykkeriet, Oslo.

Brovoll, A. 1999. *Alstahaug kirke: en kulturskatt.* Alstahaug.

Christie, C. 1859. Opptegnelse fra undersøkelsesreise sommeren 1859, Herøy kirke. Report in the archive of the Directorate for Cultural Heritage, Oslo.

Christie, H. 1959. Undersøkelser i Herøy kirke mai 1959. Report in NTNU University Museum, Trondheim.

Christie, H. 1966. Dønnes kirke, Helgeland, utgravninger sommeren 1966. Report in NTNU University Museum, Trondheim.

Christie, H. 1973. To romanske Helgelands-kirker – Alstahaug og Herøy. Årbok for Helgeland 1973, 5–22. Helgeland historielag, Mosjøen.

Christie, H. 1998. *Dønnes kirke.* Utskrift av dagbok ført ved arkeologiske undersøkelser av grunnen under gulvene i skip og bygningshistoriske undersøkelser av kirkens murer gjennomført 1966, 1968 og 1969. Report in the archive of the Directorate for Cultural Heritage, Oslo.

Coldevin, S. 1980. *DØNNA bygdehistorie*. Published by Dønna municipality, Mosjøen.

Dass, P. 1997 [1739]. Nordlands Trompet. In Heggelund, K. & Apenes, S.I. (eds) *Samlede verker* I, 11–120, Oslo.

Digre, O. A. 1960. Myntkabinettet. *Det Kongelige Videnskabers Selskabs Årbok 1960*, 155–157, Trondheim.

Egilssoga 1978. Norrøne bokverk 15. Det norske samlaget, Oslo.

Ekroll, Ø. 1994. Guds hus i stein og tre. In Berglund, B. (ed.) *Helgeland Historie bind 2*, 91–112. Helgeland Historielag, Mosjøen.

Ekroll, Ø. 1997. *Med kleber og kalk. Norsk steinbygging i mellomalderen 1050–1550.* Det Norske Samlaget, Oslo.

Ekroll, Ø. 1999. Steinkyrkjene på Helgeland: Alstahaug, Herøy, Dønnes. In Hansen, I.R. (ed.) *Stemmer i stein*, 61–101. Kirkejubileet 1999, Sandnessjøen.

Ekroll, Ø. 2000. Brønnøy kyrkje – en «ny» mellomalderkyrkje? Årbok for Helgeland, 157–165. Helgeland Historielag, Mosjøen.

Gjone, E. 1934. Letter to the Society for the Preservation of Norwegian Ancient Monuments. Attached to a manuscript by Einar Høvding: St Knutskirken i Harm (et arbeidsprogram) 1935.

Hagland, J. R. 1984. Ljóđaháttr og landlege. Runeinnskrift i verseform frå Esøya i Vevelstad. *Festskrift til Ludvig Holm-Olsen på hans 70-årsdag den 9. juni 1984,* 106–114. Øvre Ervik: Alvheim & Eide.

Hagland, J. R. 2000. Grafitti på klebersteinsberg – endå ei runeinnskrift funnen på Esøya i Vevelstad. *Spor* 2000 (2):14–16. NTNU University Museum, Trondheim.

Helland A. 1893. *Tagskifere, heller og vekstene.* Norges Geologiske Undersøgelse. 10, Kristiania.

Helle, K. 2001. Håkon 4 Håkonsson. *Norsk Biografisk Leksikon* 4: 460–463, Oslo.

Holtsmark, A. & Seip, D. A. (transl.)1942. Snorres Kongesagaer. Gyldendal Norsk forlag, Oslo.

Høgsæt, R. 1986. The Torgar Estate. The Economic Decline of an Ancient Landowning Family of Helgeland in the Late Middle Ages. *Acta Borealia* 1986 (2), 41–59.

Høvding, E. 1937. St. Knutskirken i Harm. *Håløygminne* 1937 (1):74–80, Svorkmo.

Høvding, E. 1938. St. Knutskirken i Harm. *Håløygminne* 1938 (1):140–144, Svorkmo.

Jansen, Ø., Heldal, T., Pedersen, R. B., Ronen, Y. & Kaland, S. H. H. 2003. Provenance of soapstone used in medieval buildings in the Bergen region, Western Norway. *Proceedings of the 7th International Conference of Assosiation for the study of Marble and other Stones in Antiquity. Asmosia* VII,581–595. Thassos 15–20 September 2003.

Jorgensen T. (ed.) 1954. The Trumpet of Nordland by Petter Dass. Translated by T. Jorgensen, St. Olaf College Press, Northfield, Minnesota.

Jørgensen, J. G. 1997. *Aslak Bolts jordebok*. Riksarkivet, Oslo.

Liepe, L. 2001. *Medieval Stone Churches of Northern Norway*. Ravnetrykk, Universitetsbiblioteket i Tromsø.

Lund, H. E. 1955. Klebersteinsbruddene fra jernalder, mellomalder og nyere tid på Haltøya, ved Bærøya, Ytre Vefsn, Tjøtta pgd., S. Helgeland. Report Sept. /Oct. 1955, NTNU University Museum, Trondheim.

Lund, H. E. 1961. Brønnøy nye steinkirke, Brønnøy pgd., Helgeland. Report 10 July 1961, NTNU University Museum.

Lund, H. E. 1965. Håløygske hövdinge-gårder og tunanlegg av Steigen-typen fra eldre og yngre jernalder «Valhall med de mange dører», *Norsk tidsskrift for sprogvidenskap*, bind XX, 287–325. Universitetsforlaget, Oslo.

Nicolaysen, N. 1862–1866. *Norske Fornlevninger*, Kristiania.

Nordhuus, J. A. 1977 [1848]. *Beskrivelse over Brønøe hovedsogn*, 2nd edition. Helgeland Historielag.

Pedersen, L. U. 1994. *Fra Brønnøys fortid*. Brønnøysund Bokhandel.

Qvigstad, J. & Wiklund, K. B. 1929. *Major Peter Schnitlers grenseeksaminasjonsprotokoller 1742–1745*. Kjeldeskriftfondet, Bind II, Oslo.

Regesta Norvegica *I 822–1263,* Oslo 1989.

Regesta Norvegica *III 1301–1319*, Oslo 1983.

Rygh, O. 1905. *Norske Gaardnavne*, bd.16, Kristiania.

Skaare, K. 1970. Universitetets Myntkabinett, Oslo 1969. Alstahaug kirke, Alstahaug sogn og prestegjeld, Nordland fylke. (1044, 1046, 1091, 1092): 251–253. *Nordisk Numismatisk Årsskrift.* Stockholm.

Skjølsvold, A. 1961. *Klebersteinsindustrien i vikingetiden.* Universitetsforlaget, Oslo – Bergen.

Soga om Håkon Håkonsson av Sturla Tordsson. Norrøne bokverk Nr. 22. Det norske samlaget, Oslo 1963.

Trondhjems Reformats *1589*. Norske kyrkjelege jordebøker etter reformasjonen. Norsk Historisk Kjeldeskrift-Institutt, Oslo 1983.

Wolff, J. U. 1942. Biskop i Trondhjem dr. Fr. Nannestads optegnelser i hans almanakk av 1750 om kirker i Nord-Norge med noter og anmerkninger. *Tromsø Museums* Årshefter*, Kulturhistorisk avd. nr. 4. Vol. 54 (1931), nr. 3,* Tromsø.
Åsvang, A. 2000. *Tjøtta kirke og kirkested*, Vevelstad.

Appendix

Table 1. *Major and trace elements analysed by XRF from four quarrying areas and five churches.*

Locality	NGU -lab no	SiO[2]	Al[2] O[3]	Fe[2] O[3]	MgO	LOI	Total	Cr	V	Zn	Ni	Co
Tro	74007	34.6	0.542	6.16	29	21.2	99.5	1950	22.2	29	1360	69.3
Tro	74008	35.3	0.646	7.21	34.3	21.6	100	1810	23.2	33.2	1490	86.7
Tro	74009	34.3	1.02	7.62	34.5	21.7	99.6	1730	26.8	35.5	1880	87.9
Tro	74010	32.4	0.741	7.75	35.3	23	100	1570	25.2	54.1	1660	77.9
Tro	74011	33.7	0.699	7.23	33.8	22.3	99.2	1820	26.5	36.8	1830	86.3
Tro	74012	31.4	0.799	7.59	35.3	23.9	99.4	1700	23.9	31.3	1890	87.4
Tro	74013	32	0.723	6.69	33.6	23.5	99.1	1700	23.4	29.7	1380	74.6
Storesjeøya	74025	27	0.949	7.51	29.3	26.9	99.4	2330	36.7	25	824	77.1
Storesjeøya	74026	31.5	0.598	9.51	27.5	22.3	99.7	1180	45.2	29.8	873	103
Storesjeøya	74027	25.1	0.965	8.09	23.4	25.6	98.6	2220	73.7	23.7	731	75.8
Storesjeøya	74028	26.4	0.516	6.69	27.4	27.2	99.6	1720	39.4	31.9	823	96.2
Storesjeøya	74029	23.8	0.351	6.14	23.3	28.4	99	1200	45.7	21	768	57.2
Storesjeøya	74030	34	0.758	6.56	25.1	20.8	99.1	2660	55	29.5	903	62
Haltøy	74037	36.8	0.555	6.08	34.3	21.6	99.6	1400	15	37.4	2000	86.3
Haltøy	74038	40.9	0.461	6.81	32.3	17.6	99	1630	16.8	42.8	1470	72.7
Haltøy	74039	34.5	0.525	6.42	31.9	22.7	99.5	1510	19.1	38	1350	61.7
Haltøy	74040	35.8	0.531	6.6	33.5	22	99.8	1240	20.7	33	1200	56.2
Haltøy	74041	32.6	0.658	7.91	34.1	23.4	99.2	2080	27.3	36.1	1600	77.5
Haltøy	74042	35.3	0.481	7.17	33.2	22.2	99.4	1490	17.7	39.2	1580	71.1
Haltøy	74043	36.8	0.4	5.85	34.4	21.4	99	2100	17.2	48.2	1710	89.8
Esøya	74201	35.7	0.495	7.46	35.2	21.2	100	1660	22.2	39.8	2000	91.8
Esøya	74202	21.1	0.16	8.34	38.3	32	100	1230	20	37.4	1650	88.4
Esøya	74203	42.6	0.919	7.36	32.9	15.2	99.1	1810	26.2	44.1	2070	98.8
Esøya	74204	27.9	0.489	6.07	35	27.3	99.6	1350	15.5	31.9	1600	83.3
Esøya	74205	33.8	0.867	7.05	35.2	22.2	99.4	1680	19.8	43.7	1920	95.7
Esøya	74206	28.7	0.366	7.92	36.2	26.1	99.5	1780	23.7	42.4	1840	92.5
Esøya	74207	31.3	0.461	7.84	36.2	23.9	99.8	1710	22.7	33.3	1750	92.4
Esøya	74208	35.2	0.371	6.22	35.4	21.7	99.1	1520	15.8	34.8	1860	88.6
Esøya	74209	36.2	0.289	6.03	35.3	21.6	99.6	1490	9	38.3	1570	78.2
Esøya	74210	33.4	0.337	7.43	35.1	22.7	99.2	1750	17.6	33.9	1780	86.5
Esøya	74211	33.5	0.207	8.88	34.5	22.1	99.3	2010	21.2	32.4	1830	83.5
Esøya	74212	31	0.269	9.07	34.7	23.8	98.9	1560	16.9	33.7	1860	96.4
Esøya	74213	33.6	0.435	7.62	35.2	22.4	99.4	1630	18	33.5	1870	90.3
Tjøtta church	74219	34.2	0.69	7.05	35.8	22.4	100	1540	22.1	62.3	1560	69.7
Tjøtta church	74220	35.7	1.28	8.42	32.2	20.1	99.2	2970	36.8	52	1660	97.2
Tjøtta church	74221	32	1	8.46	31.4	22.7	99.3	3300	35.8	53.7	1580	92.7
Tjøtta church	74222	30.2	0.749	6.89	35.3	24.8	99.4	1620	19.4	119	1600	74.9

Table 1** (continued)**.

Locality	NGU -lab no	SiO_2	Al_2O_3	Fe_2O_3	MgO	LOI	Total	Cr	V	Zn	Ni	Co
Tilrem church	74223	34.5	0.512	7.88	24.7	20.1	99.2	1450	60.1	29.6	1040	93.5
Tilrem church	74224	37.8	0.897	6.58	27.3	19	98.7	2600	39.6	31.4	876	76.8
Tilrem church	74225	36.7	1.21	10.2	25.6	17.1	99.1	2260	68.6	35.4	959	99.1
Tilrem church	74226	28.4	0.342	8.49	34	26.6	99.2	3010	14.6	32.1	1290	112
Tilrem church	74227	33.7	0.684	8.55	27.4	21	99.3	1670	48.8	34.6	984	99.7
Tilrem church	74228	35	0.873	9.23	26.4	19.2	98.7	2760	50	35.7	1340	112
Brønnøy church	74229	27.4	0.962	9.95	32	25.8	99.3	4020	25.3	57.4	1310	105
Brønnøy church	74230	25.1	0.652	6.54	27.8	28.2	99.2	2830	22.8	41.5	1180	87.9
Brønnøy church	74231	28.6	0.773	9.91	34	24.6	99.2	4230	30.6	54.8	1550	94.7
Brønnøy church	74232	29.5	0.424	8.77	34.1	24.8	99.1	1860	19.6	190	1650	79.6
Alstadhaug church	74233	26.7	0.621	9.38	34.5	26.9	99.5	3010	29.4	68.7	1630	90.2
Alstadhaug church	74234	28	0.6	8.09	35.1	27.1	99.4	1380	20.3	73.2	1520	77.4
Alstadhaug church	74235	22.2	0.517	8.26	33.6	30.9	99.3	1300	17.8	39.3	1460	67.3
Herøy Church	49354	34.95	0.98	7.14	33.27	22.33	101.8	1991	65	41	1669	67
Herøy Church	49355	22.45	0.48	6.96	39.25	31.64	102.15	1407	25	34	1380	71

Øystein J. Jansen and Tom Heldal

The Building Stones from the Vanished Medieval Church at Onarheim, Tysnes, Hordaland County in Western Norway: Provenancing Chlorite Schist and Soapstone

This study centres on the provenance of soapstone and chlorite schist building stones at Onarheim church, 50 km south of Bergen and also provides geochemical results that are of key interest in further studies of Norwegian chlorite schist bakestone. The present Onarheim church is made from wood but building stones from previous stone churches at the site (12th century and early 19th century) are found in foundation walls and the walls surrounding the churchyard. Geochemical analyses (main and trace elements, Sr-Nd isotope composition and rare earth profiles) from such stones were compared with results from similar analyses from a variety of quarries, including reference quarries in Rogaland and Trøndelag (chlorite schist). Unsurprisingly, the nearest soapstone quarry (Baldersheim) and the regional source of chlorite schist (Ølve-Hatlestrand) gave the best matches. However, the results also indicate two additional sources of soapstone, one of them is the distant Arnafjord quarry. This may represent an input of soapstone for post-medieval restoration and/or early 19th century construction works. A very important result of the study was that Sr-Nd isotope ratios distinguish between the known medieval chlorite schist quarries in Norway and different quarries at Ølve-Hatlestrand. Bakestone made from chlorite schist is found all over Norway and the opportunity to fingerprint their origin may aid in future interpretation of medieval trade patterns.

Introduction

The present wooden church at Onarheim in the Tysnes municipality, south of Bergen, was built in 1891/92 (Figure 1). However, building stones in the foundations of the church and in dry stone walls surrounding the church yard are believed to be re-used from older stone churches at the site: a medieval church dating from AD 1180–1200 and a larger stone church replacing the medieval one in 1819. The external measures of the former were, according to records from 1686 and 1721, 11.9 x 10 m, whilst the latter was significantly larger, measuring 32.6 x 13.1 m (Hoff & Liden 2000:267–268). Ashlars of chlorite schist (Figure 2a) and soapstone (Figure 2b) are seen in the foundations of the present church and occasionally found in the dry walls surrounding the grave yard. The majority of the reused stones are, however, undressed slabs and rubble of banded gneiss, augengneiss, quartzite, rhyolite and greenschist, probably supplied from local bedrock and erratics (Figures 2b and 2c). Remnants of lime mortar are found on the majority of the chlorite schist and soapstone ashlars and

Figure 1. *Onarheim church, built in wood 1891/92. (Photo: Ø. J. Jansen).*

also on many of the slabs of local rocks, supporting the idea that both the dressed stones and rubble blocks were reused stones from the older stone churches.

During archaeological excavations at the churchyard in 1990, dressed stones were collected from portals and window frames, supposedly from the medieval stone church (Hoff & Lidén 2000:268). The majority of the collection, stored at the University Museum of Bergen (inv. no. BRM 454), consists of chlorite schist but also include two blocks (Figure 3b) and a pillar base of soapstone. Based on the large amount of ashlars found, Anne-Marta Hoff and Hans Emil Lidén (2000:268) proposed that the previous generation(s) of church(es) at Onarheim were clad with ashlars of chlorite schist and soapstone, at least on the external walls. The find of a scalloped capital (Figure 3a) and a pillar base displaying a waterholding profile (Figure 3c), both made from chlorite schist, are particularly important for dating the ornamented building remnants to around 1180–1200. Thus, it is reasonable to assume that the masonry of chlorite schist and possibly soapstone, predominantly originated from the medieval church. For these two rock types, there are some likely sources close to Onarheim displaying strong visual and mineralogical similarities with the rocks found at the church site.

Numerous chlorite schist quarries are located in the Ølve-Hatlestad area, about 20 km from the church. Judging by the marks on the quarry faces and other evidence, these were quarried for several purposes: bakestones, roofing slate, slabs for grain drying and building stone (Weber 1984; Naterstad 1984; Jansen & Heldal 2009; Baug 2013, 2015, this vol.). Several of the quarries display marks from the extraction of ashlars of similar dimensions as those from the Onarheim Church. Commonly, such ashlar extraction overprints the typical circular depressions from baking slab production (Jansen &

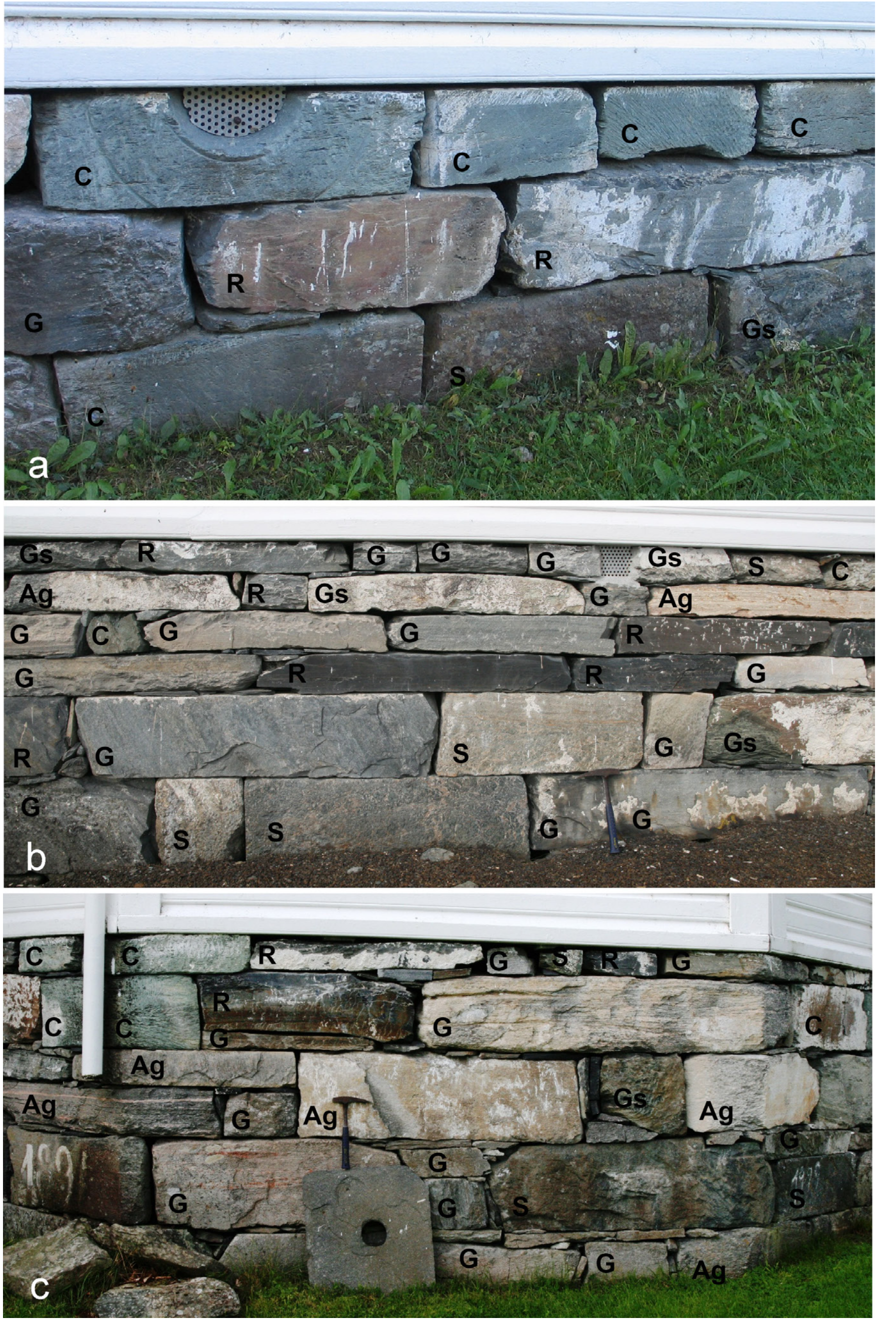


Figure 2. (a) Ashlars from chlorite schist in the upper course of the western foundation wall. Note the reused Romanesque window frame. (b) Ashlars of soapstone set in a coursed dry stone wall of undressed slabs and rubble. (c) Coursed dry stone walling in the north eastern part of the foundations displaying large blocks of mainly gneiss, however in the upper left corner are a few ashlars of chlorite schist. Legend: C = chlorite schist, S = soapstone, Ag = augengneiss, G = gneiss, Gs = greenschist, R = rhyolite. (Photo: Ø. J. Jansen).

Figure 3. *The University Museum of Bergen Collections: (a) Scalloped capital of chlorite schist; (b) Dressed block of soapstone; (c) Pillar base of chlorite schist. (Photo: Ø. J. Jansen).*

Heldal 2009; Baug 2013, 2015, this vol.). ^{14}C dating of charcoal in the spoil around quarries gave an age interval from AD 1025 until AD 1635 (Baug 2013:210, 2015), indicating the possibility that the 12th century production for Onarheim church could have taken place here.

A soapstone quarry with tool marks in accordance with the extraction of ashlars is located near the sea at Baldersheim, about 30 km NNE of Onarheim. There is no direct evidence of 12th century quarrying here but the similarities with other medieval soapstone quarries do provide indirect evidence of medieval production.

In the present study, our hypothesis is that these two quarry areas were the main providers of stone to the original medieval Onarheim church. We tested this hypothesis using various geochemical analyses on stone samples from the vanished church. As reference for the soapstone ashlars we have data sets from Baldersheim quarry and from 10 selected soapstone quarries in the Hordaland region (Baldersheim, Bergsholmen, Juadal, Klovsteinsjuvet, Kvernes, Russøy, Tyssøy, Vargahola, Vargavågen, Arnafjord, Lysekloster and Sævråsvåg). As reference for the chlorite schist ashlars we have data sets

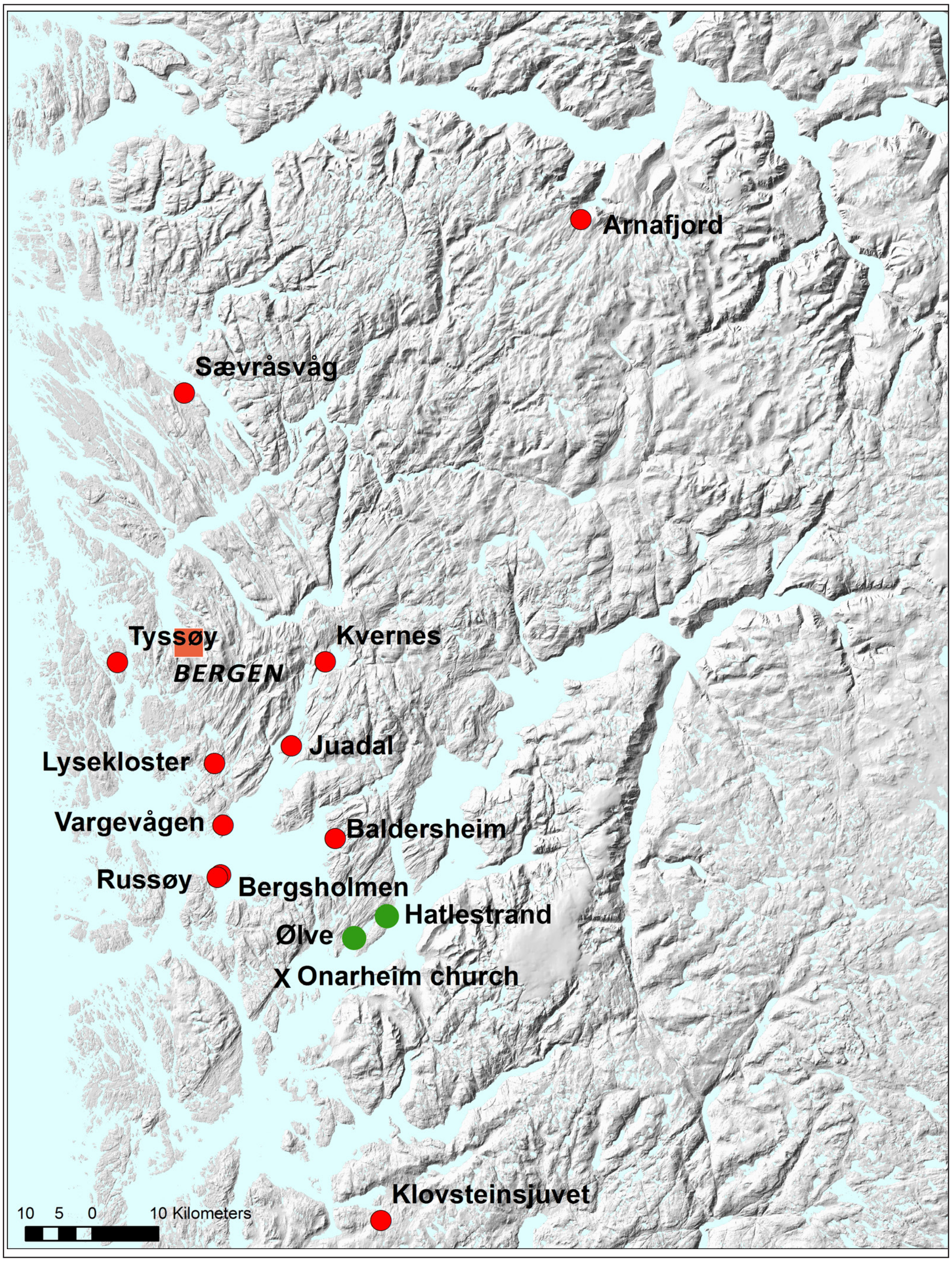


Figure 4. *The location of the chlorite schist quarries at Ølve and Hatlestrand (green dots). Baldersheim soapstone quarry and a selection of Medieval soapstone quarries in the area (red dots). The Onarheim church is marked as (x). (Map: T. Heldal).*

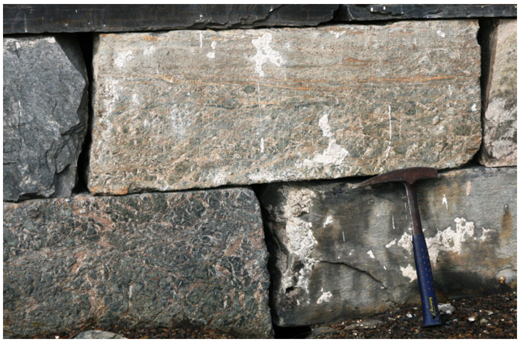


__Figure 5.__ Onarheim church. Two soapstone ashlars (s) with a bluish tint displaying a brecciated structure, with veins of talc and carbonate. The upper half of the stone above the hammer demonstrates how the massive, lower part has been transformed to rock with well-developed foliation. (Photo: Ø. J. Jansen).

__Figure 6.__ Soapstone ashlar with bluish tint in the dry walls surrounding the Onarheim churchyard. The ashlar was (re) worked parallel to the foliation, clearly displaying layers and lenses with chlorite, talc and carbonate. (Photo: Ø. J. Jansen).

__Figure 7.__ Small soapstone ashlar in the western foundation wall of the Onarheim church displaying a medium-grained mosaic of talc, carbonate and chlorite. The small piece above, sampled for analysis, shows the difference between weathered and un-weathered surfaces. (Photo: Ø. J. Jansen).

from the quarries at Ølve-Hatlastrand in Hordaland (Figure 4), as well as from the other known chlorite schist quarries in Norway: The Ertenstein quarry in Rogaland (some 25 km from Stavanger) and the Øye and Skaun quarries in Trøndelag (close to Trondheim). Moreover, we have visited the quarry sites to investigate whether they contain visible marks from the production of ashlars.

The soapstones

The majority of the soapstone ashlars present in the foundations of the church and in the surrounding drywalls are characterised by a more or less pronounced bluish tint, a colour which is not common among the Hordaland soapstone quarries. Thin section studies show that the bluish tint is probably caused by fine-grained magnetite and a minor content of serpentine. The stones occur as both massive and foliated. Massive varieties often show a characteristic, brecciated structure, with a network of talc and carbonate veins. Figure 5 shows both massive and foliated soapstone contained in one ashlar. The massive, veined lower part is transformed into soapstone with well-developed foliation in the upper half, which has a less pronounced bluish tint. Foliated soapstone are defined by layers and lenses of chlorite, talc and carbonate. This demonstrates that both foliated and massive, veined varieties occur in the same quarry, with the foliation being the result of shear zones developed during the formation of the soapstone. When ashlars are worked parallel to the foliation the foliated, lensoid structure is clearly displayed (Figure 6).

The other soapstone types have not yet been studied in detail but seem to be of a more common type, visually similar to soapstone from many quarries in the area – containing a medium-grained mosaic of talc, carbonate and chlorite (Figure 7). These soapstone blocks appear in markedly smaller size than the 'bluish' ones, which often appear in large ashlars, with a length of up to 1.10 m.

The Baldersheim quarry

The underground Baldersheim soapstone quarry (Askeladden ID no. 64089) is located at Sørtveit in the outskirts of Baldersheim village, about 200 m from the sea and about 55 m ASL. The entrance to the quarry has a triangular shape, about 10 m wide and 6 m high (Figure 8) but narrows to about 4 x 2.5 m at the NNE termination, about 30 m from the entrance. The accessible volume of the present quarry is calculated to be between 700 and 800 m^3. The quarry floor is covered with spoil and loose blocks of phyllite that have fallen from the ceiling; thus, the extracted volume is definitely larger than the accessible part but impossible to calculate. The ceiling and much of the upper quarry walls consist of the enveloping phyllite, with scattered grooves made by iron picks (Figure 9). Attempts, probably quite recent, to extract small tabular pieces, perhaps for fishing sinkers, are common. Soapstone appears mainly in the terminal northern quarry wall and in the lower part of the inclined side walls, especially in the western wall where tool marks made by iron picks are abundant. A few circular marks from vessel extraction appear at the upper terminal wall (Figure 10). At the base of the western wall abundant tool marks made by heavy iron picks indicate the extraction of large ashlars (Figure 11). At the base of the steep western wall a possible westerly extension may be concealed by large amounts of waste filling up to the ceiling. A ramp made from large blocks, 2–3 m above the quarry floor, is located near the entrance of the quarry: probably a base for a winch (Figure 12). A modern road passes 25 m from the quarry entrance and at the seaward side of the road a steep slope faces the sea. Spoil heaps are identified outside the quarry and a brief reconnaissance survey did not reveal quarry waste in the seaward slope; such waste is probably covered by rock masses from the construction of the road. No harbour/quay has been found.

Figure 8. *Baldersheim soapstone quarry with the triangular-shaped entrance to the underground operations. (Photo: Ø. J. Jansen).*

Figure 9. *Baldersheim soapstone quarry. Scattered grooves made by iron picks during extraction of soapstone attached to the enveloping phyllite. (Photo: Ø. J. Jansen).*

Figure 10. *Baldersheim soapstone quarry. Circular quarry marks from extraction of vessels at the upper terminal wall. (Photo: Ø. J. Jansen).*

In conclusion, the majority of the quarry marks and the ramp indicate that building blocks were the main output from the quarry. The circular depressions at the terminal wall (from extraction of cooking vessel blanks) and late extraction of tabular pieces may represent more, perhaps minor, stages in the history of the quarry.

As for the geology of the Baldersheim quarry, it is located in a lens-shaped body of soapstone embedded in phyllite. The phyllite is part of the Samnanger complex, consisting of micaschist, phyllite and greenschist and including bodies of ultramafic and mafic rocks. The rocks are mostly of ophiolitic origin and mainly of Ordovician age (Ragnhildstveit & Helliksen 1997). A range of serpentinite bodies of varying size occur NE of the quarry. These are interpreted as altered metadunites (Qvale 1978) and the quarried soapstone probably represents a further stage in the transformation of serpentinite to soapstone. The soapstone exposed in the quarry contains a high percentage of dark, greenish-blue chlorite-rich layers and abundant veins of carbonate, often appearing as lensoid aggregates (see Figure 11).

The latter rock is visually similar to the bluish, foliated ashlars at Onarheim church. The massive type of soapstone, however, does not appear in the quarry walls, nor in the waste. A possible explanation could be that the massive soapstone is covered by waste, or may have been quarried in the possible above-mentioned westerly extension, which seems to be concealed by large amounts of waste.

Ølve-Hatlestrand quarry area

In the Ølve-Hatlestrand area, 71 quarries were documented by Baug in connection with her doctoral work (2013:20, 2015, this vol.), all of them located in a zone of talc-actinolite-bearing chlorite schist (called chlorite schist in this paper) (Naterstad 1984; Jansen & Heldal 2009). Most of the quarries are situated in the Ølve area, surrounding Lake Kvitebergsvatnet

Figure 11. *Tool marks made by heavy iron picks at the base of the western quarry wall of Baldersheim soapstone quarry show extraction of large ashlars. The exposed soapstone has a banded appearance due to layers and lenses containing variable amounts of chlorite, talc and carbonate. (Photo: Ø. J. Jansen).*

Figure 12. *A ramp, probably a base for a winch, is seen in the foreground at the entrance to the Baldersheim soapstone quarry. (Photo: Ø. J. Jansen).*

but a major quarry area is also found by the sea at Netteland in the Hatlestrand area (see Figure 4). Our work is based on reconnaissance surveys between 2002 and 2010, the latest simultaneously with the archaeological excavations organised by Baug. The quarries included in the present study are (Baug's archaeological references in parentheses. For detailed location see Baug this vol.: Fig. 4): Bakkehidlaren (Fugleberg trenches 1 and 2), Båthidlaren (Netteland trench 1), Veslehidlaren (Fugleberg trench 3) and Hellebruddet (Fugleberg trench 4).

Ølve: Veslehidlaren, Hellebruddet and Bakkehidleren by Lake Kvitebergsvatnet

Veslehidlaren and Hellebruddet are small, underground quarries situated in the upper zone of quarries south of Lake Kvitebergsvatnet. At the entrance of Veslehidlaren, negative imprints of 'half-cylinders' occur on the walls, clearly related to the extraction of thin, circular bakestones, which were successively split loose from top to bottom after the outline was carved. Otherwise, the quarry marks reflect extraction of various products. Walls featuring oval to rectangular outlines, including rounded corners, probably represent extraction of bakestones with forms deviating from the common circular shape. Straight, vertical quarry walls seem, however, more likely the result of the production of ashlars for building stones or flagstones for different purposes, whilst extraction of sub-circular, thin slabs from the ceiling of the quarry may represent a late stage production of roofing slate (Baug 2013:179, 2013, 2015, this vol.). At Hellebruddet the quarry marks and spoil heap indicate that roofing slates were the main product but discarded bakestones also appear in the spoil.

Bakkehidlaren is located in the lower zone of quarries near Lake Kvitebergsvatnet. It is one of the biggest quarries with large underground works (Baug 2013:168–170). Most of the tool marks

Figure 13. *Bakkehidlaren chlorite schist quarry. The quarry marks and angular corners at the base of the quarry wall imply the production of slabs and ashlars, while the pick and chisel marks in the ceiling are related to extraction of square flagstone – probably for roofing purposes. (Photo: Ø. J. Jansen).*

indicate the extraction of rectangular blocks of various sizes, such as ashlars. In addition, there are marks reflecting extraction of rectangular schists – possibly for roofing – a few centimetres thick (Figure 13).

The quarries near Kvitebergsvatnet (9 m ASL) shared a common logistic in that stones had to be brought from the quarries (at 145–160 m ASL) down to the lake. They were then shipped on the lake to the south part of Ølve village, located only a few hundred meters from the sea.

Hatlestrand: Båthidlaren and Mannahidleren by Netteland

The Netteland quarry area is located by the fjord, in a bay offering excellent harbour facilities for all the quarries in the area. The small bakestone quarry, called Båthidlaren, is situated in this area and all samples for geochemical analyses representing the Netteland area are labeled Båthidlaren after this quarry. Close to the northern part of the Netteland bay, vertical quarry walls, up to 5 m tall, stretch laterally for about 100 m and display abundant marks from extraction of rectangular blocks. In front of the quarry wall facing the sea, a horizontal quarry floor is partly uncovered, exposing worked channels for extraction of square blocks measuring about 90 x 90 cm (Figure 14). Nearby, in the hillside about 100 m from the shore, a large underground quarry named Mannahidleren is located. The entrance is covered by scree and fallen blocks but inside the vertical quarry walls display tool marks typical of exploitation of rectangular blocks (Figure 15). Consequently, the area surrounding the bay of Netteland, was probably a quarry area producing large volumes of building blocks.

A proper investigation of other quarries in the Ølve-Hatlestrand area was not possible in our study. However, brief visits do indicate that building blocks may have been one of several products from several of the other quarries, as well.

Figure 14. *A quarry floor at the Netteland chlorite schist quarry area exposing worked channels for extraction of square blocks. (Photo: Ø. J. Jansen).*

Figure 15. *At Mannahidlaren chlorite schist quarry, a large underground quarry, the walls display tool marks made by heavy iron picks, typical of exploitation of rectangular ashlars. (Photo: Ø. J. Jansen).*

Discussion

The traditional view of the Ølve-Hatlestrand quarry area is that it predominantly produced bakestone (Naterstad 1984;Weber 1984). As is understood, this view has now been considerably modified (Jansen & Heldal 2009; Baug 2013, 2015, this vol.). Building blocks were a major product during some periods, especially in the Middle Ages. Moreover, written sources mention a shipment of stone from Netteland to Kronborg Castle in Denmark in the early part of the 17th century (Buch 2011[1813]:14–15). The indications of roofing slate production can be explained by its local use in the area in the modern period; chlorite schist is found on several local roofs. A small production of grave monuments in the 19th century was also supplied by chlorite schist from the Ølve-Hatlestrand quarries.

The quarries in the Ølve-Hatlestad area are situated in a thin, sub-horisontal/low dip zone (1.5–6 m thickness) of chlorite schist sandwiched between layers of harder greenschist (Naterstad 1984:164; Baug 2013). The rocks belong to the Varaldsøy Complex: a sequence of metamorphosed volcanic rocks of early Ordovician age (Ragnhildstveit & Helliksen 1997). The mineral content is actinolitic hornblende, talc and chlorite and J. Naterstad (1984:161) proposed that the original rock was a basic/ultrabasic layer of tuff or lava. The grain size varies; when fine-grained (mainly chlorite-talc) the schist appears with smooth, shiny surfaces and an excellent cleavage (type locality at Båthidlaren). However, usually larger and harder grains of actinolitic hornblende appear as 'knots', a few mm in size, giving the schist surfaces a more rugged appearance and a less pronounced cleavage.

The lateral extension of the quarried zone is estimated to measure about 5 km (Naterstad 1984:161). The quarried schist zone is enveloped in a harder and more resistant type of typical greenschist above and below, with nodules and lenses of light green epidote. The contrasting durability of the rocks results in natural 'overhang'-shelters, which have been dramatically enlarged by quarrying over the centuries.

Although there are some geological (and thus expected geochemical) variations across the Ølve-Hatlestrand quarry landscape, we know of no other rock unit in the region that bears strong similarities with these rocks. We have to move to other regions in Norway in order to find similar rock types containing a history of bakestone and building stone production in the Medieval period, for example in Rogaland (Ertenstein quarry) and Trøndelag (Øye chlorite schist quarry and similar quarries at Skaun) (Heldal & Storemyr 1997:9–12; Storemyr 2001:67, 2015:189–191; Lundberg 2007; Storemyr et al. 2010:189–192; Jansen 2013:78; Baug 2015, this vol.). Although we consider it entirely unrealistic that these rocks were applied for building the Onarheim church, we included them in the geochemical investigation for reference.

Geochemical analyses and methods

Soapstone samples from Onarheim church were analysed and compared with analyses of samples from Baldersheim quarry and from 10 other soapstone quarries in the Hordaland region. Chlorite schist samples from Onarheim church were analysed and compared with samples from chlorite schist quarries in the Ølve-Hatlestrand area (Figure 4). As reference materials one chlorite schist quarry in Rogaland and two in Trøndelag were also included for this rock type. The soapstone quarries were selected because they display rocks with similar visual appearances, as well as a documented or likely record of production in the Middle Ages. Three methods for geochemical provenance were applied:

- Main and trace element (MTE) analyses by conventional x-ray fluorescence spectrometry XRF, carried out at Geological Survey of Norway (NGU) and the Department of Earth Science, University of Bergen.
- Sr and Nd isotope compositions: measured at the University of Bergen on a Finnigan 262 thermal ionisation mass-spectrometer (TIMS). Analytical techniques are described in Pedersen & Furnes (2001).
- Rare Earth Element (REE) determination by inductively coupled plasma mass spectrometry solution (ICP-MS) analysis at the Department of Earth Science, University of Bergen.
- Numerical data from all analyses can be found in Appendix Tables 1–6.

Analyses of soapstone

Main and trace elements

Five different combinations of MTE were plotted (Figure 16). Collectively, the eight samples from Onarheim church define three groups with visible differences in geochemical composition (i.e., we consider it likely that they represent three different quarries). All samples in Group 1 were cut from

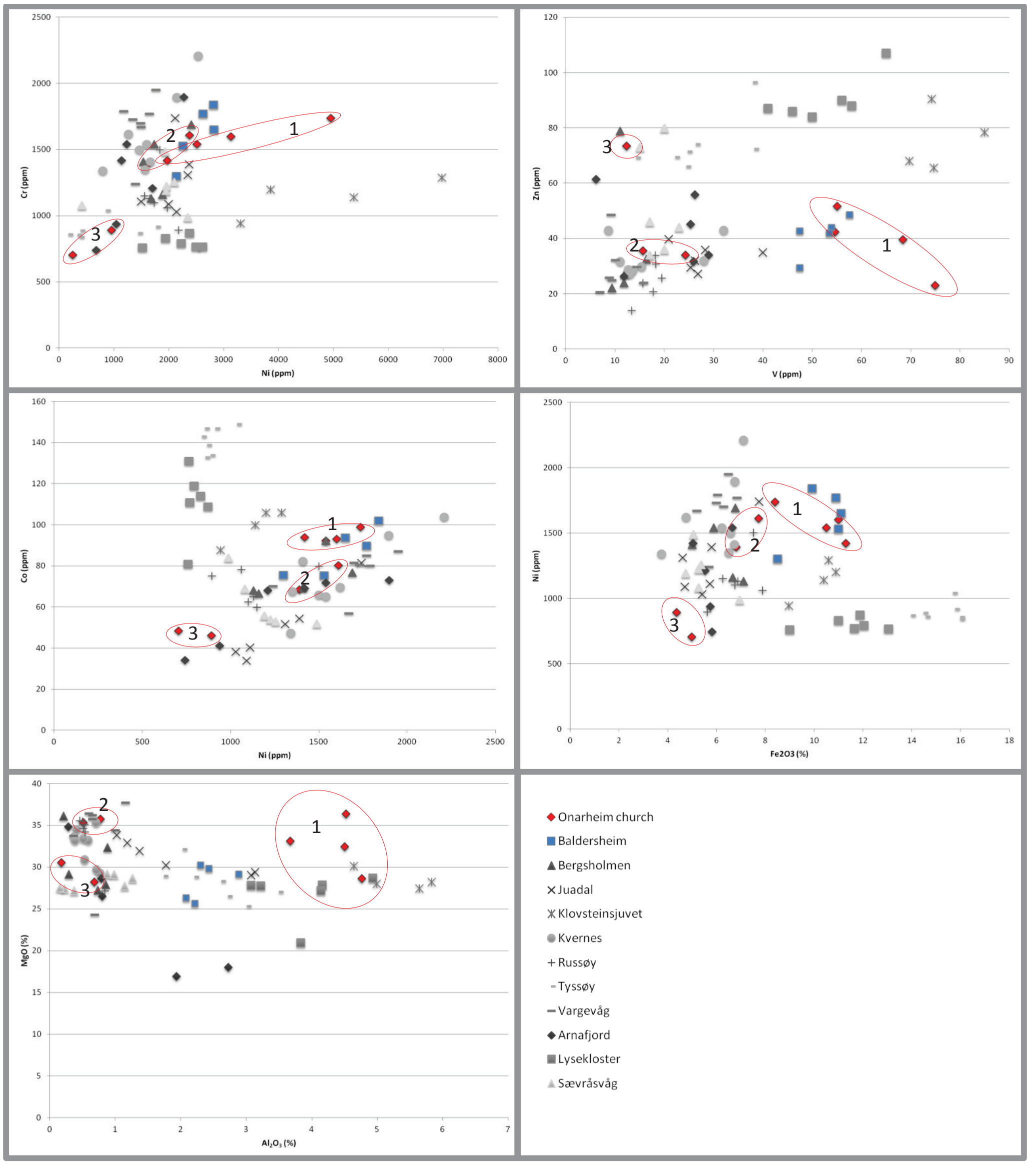


Figure 16. *MTE analyses of soapstone samples from the Onarheim church and different quarries. Group 1, 2 and 3 from the Onarheim church (described in the text) are marked.*

Figure 17. *Summary of MTE matches of soapstone quarries to the samples from the Onarheim church.* ***Bold*** *text implies a good match, normal text implies a weak match.*

Cr-Ni	Group 1	**Baldersheim**, Juadal
	Group 2	**Bergsholmen**, Baldersheim, Juadal, Kvernes
	Group 3	**Arnafjord**, Tyssøy
Zn-V	Group 1	**Baldersheim**
	Group 2	**Arnafjord, Kvernes**, Juadal, Sævråsvåg, Russøy, Bergsholmen
	Group 3	**Sævråsvåg, Tyssøy, Bergsholmen,** Arnafjord
Ni-Co	Group 1	**Baldersheim**, Bergsholmen
	Group 2	**Kvernes, Bergsholmen, Vargevågen**, Arnafjord, Baldersheim, Juadal
	Group 3	**Arnafjord**, Juadal
Co-V	Group 1	Baldersheim, Lysekloster, Klovsteinsjuvet
	Group 2	Russøy, Kvernes, Arnafjord, Sævråsvåg, Juadal, Bergsholmen
	Group 3	Arnafjord, Kvernes, Sævråsvåg
Al_2O3-MgO	Group 1	Klovsteinsjuvet, Lysekloster, Juadal, Tyssøy, Baldersheim
	Group 2	**Vargevåg, Kvernes**, Russøy, Arnafjord, Bergsholmen, Juadal
	Group 3	**Bergsholmen**, Arnafjord, Sævråsvåg, Kvernes
Fe_2O_3-Ni	Group 1	**Baldersheim**
	Group 2	**Juadal**, Russøy, Kvernes, Bergsholmen
	Group 3	Arnafjord, Russøy

the bluish, foliated type – a type which is not represented in the other groups.

The Baldersheim quarry is the only one that displays a good fit for Group 1 for Cr, Ni, V, Zn, Co, Fe2O3 and MgO. For Al2O3, the analyses from Baldersheim quarry display higher values than the church samples. However, as seen in the Al2O3-MgO plot, several quarries do display highly varying Al2O3 content. In particular, such variations only seem to occur when Al2O3 exceeds 1%. Thus, although Baldersheim and Onarheim church show two distinct clusters, we will not rule out Baldersheim as a possible source and none of the other quarries come anywhere close to a match.

Group 2 samples display best fit with the Bergsholmen quarry (which is one of the closest); however, neither Juadal nor Kvernes can be ruled out.

Only the Arnafjord quarry shows a rather good fit with Group 3. This was highly unexpected, since this particular quarry is the most distant to Onarheim of all selected for analyses (for location see Figure 4). Figure 17 summarises the results of the MTE analyses.

Sr and Nd isotopes

In Figure 18, Group 1 of Onarheim samples shows a close fit to the Baldersheim quarry. Also, the Lysekloster and Tyssøy quarries are found in the same cluster of analyses, but these have been ruled out by the MTE analyses.

Group 2 is more difficult to evaluate. The closest fits are Juadal (which could not be ruled out from the MTE analyses) and Arnafjord (which was ruled out). The Kvernes quarry fits one of the samples but not the other and the Bergsholmen quarry displays a weak fit to the latter.

Group 3 (only one sample gave valid isotope values) shows a good fit with the Klovsteinsjuvet

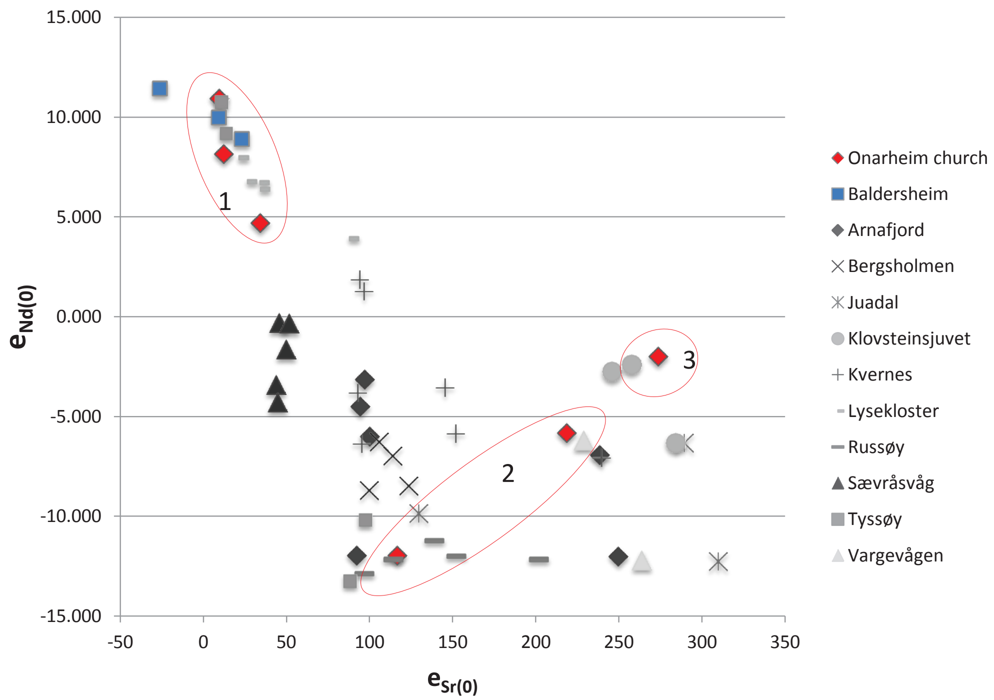


Figure 18. *Sr-Nd isotope plot of soapstone samples from the Onarheim church and different quarries. Group 1, 2 and 3 from the Onarheim church (described in the text) are marked.*

quarry but this match is completely ruled out by the MTE analyses. A weaker fit is found to the Arnafjord quarry but the spread in the Arnafjord isotope values shows that this method does not work for Arnafjord, which shares this problem with a lot of other quarries.

REE profiles

Five samples from Onarheim church were analysed (Figure 19). These indicate three different sources. Two samples, both with bluish tint, have a smooth REE profile, gradually ascending from left to right, showing best fit with the Baldersheim quarry.

Two samples display weakly ascending to fluctuating curves. None of the three quarries, as indicated from the MTE and isotope analyses (Baldersheim/Bergsholmen, Juadal and Kvernes), display a perfect match, yet considering the bluish tint of the samples and a reasonable match with one of the Baldersheim quarry REE profile lines, Baldersheim is regarded as the best match.

One sample describes a smooth REE curve, interrupted by a distinct negative europium (Eu) anomaly. One sample from the Arnafjord quarry shows a similar trend. The Group 3 sample was cut from an ashlar in the foundation of Onarheim church (Figure 7), which displays a good visual match with the soapstone quarried at Arnafjord. In addition, the two blocks of Onarheim soapstone stored in the University Museum of Bergen (Figure 3) also display the same visual similarity with the soapstone quarried at Arnafjord. Thus the proposed Arnafjord provenance seems to have both visual and geochemical support.

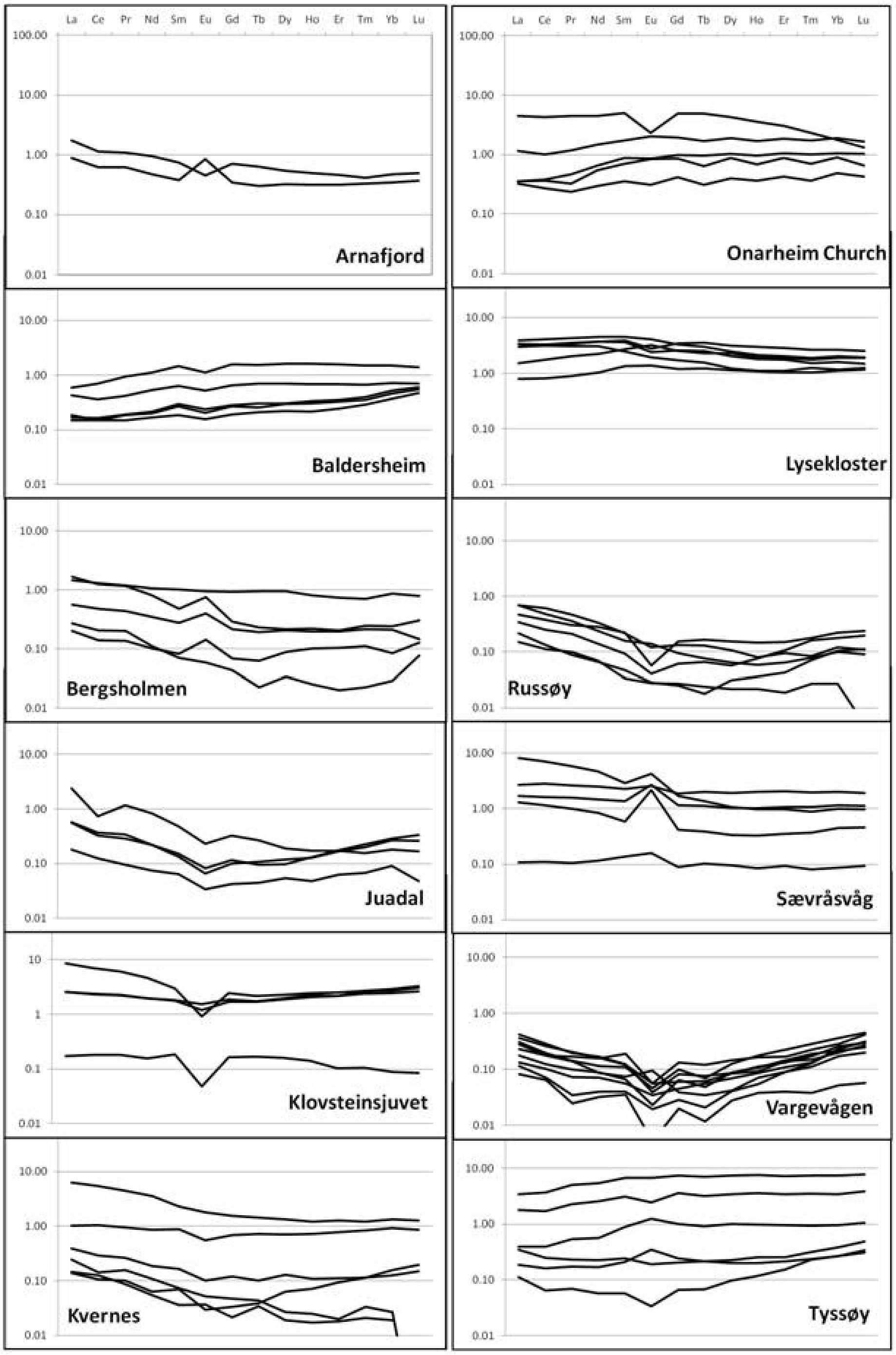


Figure 19. *REE profiles of soapstone samples from the Onarheim church and different quarries. Note logarithmic vertical scale.*

Discussion

The analyses of soapstone do seem to provide fairly good evidence that the Baldersheim quarry delivered stone to Onarheim church, most likely to the medieval version. It was, however, surprising that the analyses indicate two additional sources. One of them may have been another nearby quarry – Bergsholmen, Juadal or Kvernes. The analyses are yet too inconclusive for more specific provenance.

Even more surprising was the possible match with the Arnafjord quarry, which was very distant to Onarheim (about 240 km by boat). This may be related to restoration or rebuilding of the church; the Arnafjord quarry may have been one of few active quarries during the construction of the second stone church at Onarheim in the early 19th century.

Analyses of chlorite schist

Main and trace elements

Figure 20 shows plots of the main elements Al2O3-MgO and trace elements Ni-Cr for Onarheim church and most of the surveyed quarries in the Ølve-Hatlestrand quarry landscape, as well as the reference quarries in Rogaland (Ertenstein) and Trøndelag (Øye and Skaun). The main elements do not show significant variations between the quarries and, with the exception of the Vetlehidlaren quarry, they all roughly match the analyses from Onarheim church.

The Ni-Cr diagram is not much better for discrimination. We can vaguely see linear trends defined by the points, which is to be expected for these elements in such rocks. The Onarheim church samples together with the Ølve-Hatlestrand quarries define a weak trend between the Rogaland quarry and the Trøndelag quarries. This indicates that the Onarheim samples and the Ølve-Hatlestrand quarries are from the same geological formation. However, since we know that the Veslehidlaren quarry belongs to the same formation as the other two in this quarry area, there must be some overlap between the Ølve-Hatlestrand quarries and the ones from Sør-Trøndelag. Moreover, the two points clustering in the bottom left corner (Onarheim church and the Øye quarry) may easily lead to a conclusion of a geochemical match between the church and this quarry. This is misleading as the clustering of analyses in this diagram is along the lines and not defined by the proximity of points.

In conclusion, the MTE analyses on the chlorite schist samples did not provide reliable results; only a vague, inconclusive link between the church and the Ølve-Hatlestrand area is indicated.

Sr-Nd isotopes

The diagram in Figure 21 shows Sr-Nd isotope plot of the Onarheim church chlorite schist samples and samples from the four quarries in the Ølve-Hatlestrand area, the Trøndelag chlorite schist quarries (Øye) and the Rogaland quarry(Ertenstein). The samples from Onarheim church plot within the field of the Ølve-Hatlestrand quarry area. In more detail, they plot close to the Båthidlaren and Veslehidlaren quarries and clearly away from the Bakkehidlaren quarry.

REE profiles

The REE profiles in Figure 22 point in the same direction as the isotopes in that the four samples from the church have REE trends displaying a best match with the Veslehidlaren and the Båthidlaren quarries and a clearly lesser match with the Bakkehidlaren quarry.

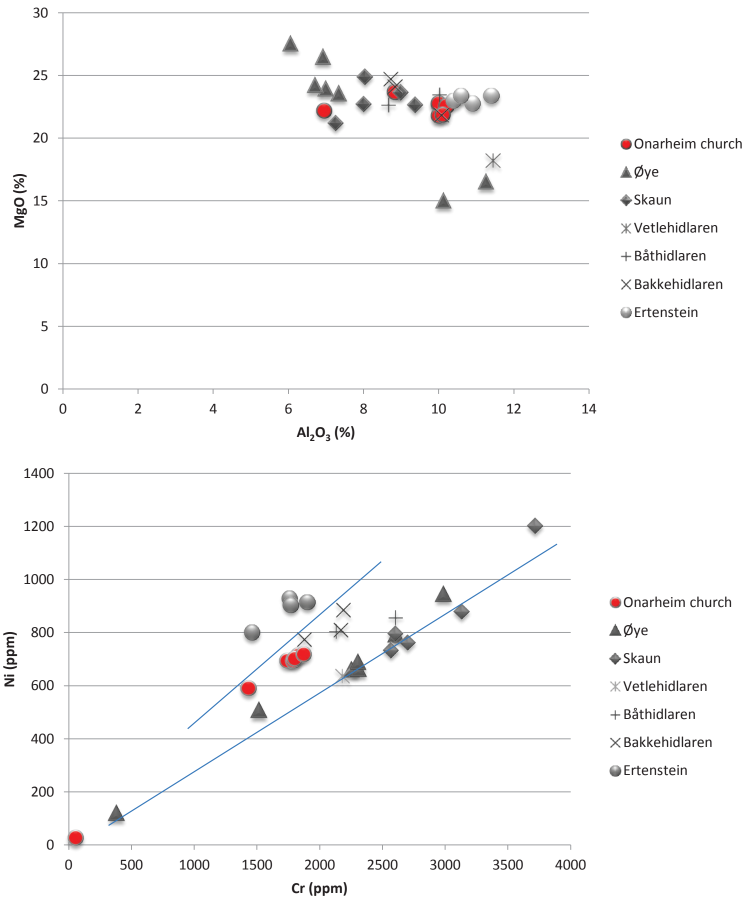


__Figure 20.__ MTE plots for chlorite schist samples from the Onarheim church compared with the Ølve-Hatlestrand quarries and other known chlorite schist quarries in Norway.

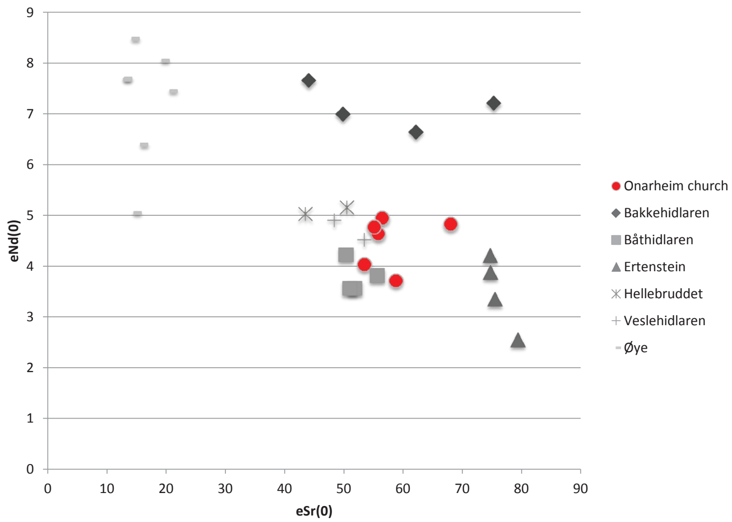


__Figure 21.__ Sr-Nd isotope plot of chlorite schist samples from the Onarheim church and quarries.

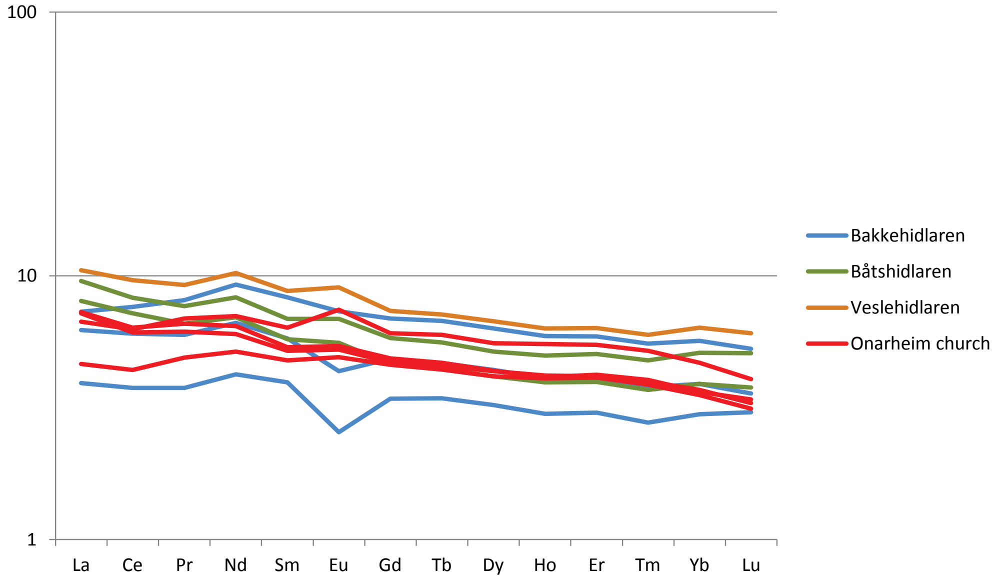


Figure 22. *REE profiles of samples from the Onarheim church and quarries in the Ølve-Hatlestrand area. Note logarithmic vertical scale.*

Discussion

The geochemical analyses (with the exception of MTE analyses) clearly indicate that the chlorite schist used at Onarheim church came from at least one quarry within the Ølve-Hatlestrand area. There are close geochemical fits for both the Veslehidlaren quarry (Ølve area, above Kvitebergsvatnet) and the Båthidlaren quarry (by the Netteland fjord in the Hatlestrand area). Since we do not have data for all 71 quarries in the Ølve-Hatlestrand area, it is difficult to provide evidence for a more specific provenance.

Even if we would have managed to carry out an extensive geochemical program involving all 71 quarries, our present data suggest that a significant overlap between quarries should be expected and thus the cost-benefit for further analyses would probably be limited. For logistical reasons, we consider it more likely that the quarries at Hatlestrand were employed for the construction of the church, rather than the ones much farther away from harbour facilities. Moreover, this is the area that carries most visible remains of building stone quarrying.

Concluding remarks

Our hypothesis, that the nearest quarries were the main sources of ashlar and decoration for the medieval construction of Onarheim church, has largely been confirmed. Both the Ølve-Hatlestrand chlorite schist quarries and the Baldersheim soapstone quarry bear direct or indirect evidence of medieval production of building-stone and we have established a convincing geochemical match between the church and these quarry areas.

Somewhat surprising was the geochemical data, which indicated that at least two additional soapstone quarries supplied Onarheim with stone. This either implies that several soapstone quarries were employed simultaneously for building the medieval church, or that new quarries further away, including the distant Arnafjord quarry, were used in later rebuilding and restoration works. Stone from Arnafjord quarry is unknown in medieval buildings in Hordaland.

We suggest that the quarries at the fjord by Hatlestrand are the most likely sources of chlorite schist. In addition to logistics, there are other aspects supporting this. Baug (2013, 2015, this vol.) established a timeline for the production of bakestone in the whole Ølve-Hatlestrand quarry landscape. According to Baug, production peaked between the 13th and 15th centuries. Thus, since the construction of Onarheim church and possibly other buildings took place earlier (starting in the 12th century), it may be that only a few quarries were employed for bakestone production by then. The fact that the seaward quarries at Hatlestrand mostly contain evidence from building stone quarrying could perhaps imply that they were depleted when the main phase of bakestone production started.

The geochemical analyses indicate that Sr-Nd isotopes separate the main known chlorite schist quarries in Norway and even different quarries within the Ølve-Hatlestrand area. Thus isotope analyses may provide a good tool for further studies of chlorite schist building stone and bakestone. We know that bakestones are found in households all over Norway in the Middle Ages and the opportunity to fingerprint the stones' origin may surely aid future interpretation of medieval trade networks.

Provenancing soapstone geochemically is, however, not straightforward. This study shows that there is a need to combine several methods and even then it is difficult to obtain results with high confidence. This challenge is confirmed by other studies (i.e., Forster & Jones this vol. and Hansen et al. this vol.).

Acknowledgements

The authors greatly acknowledge L. Meltzers Høyskolefond and the Norwegian Research Counsel/ University Museum of Bergen (Småforskmidler) for funding field work and geochemical analyses.

References

Baug, I. 2013. *Quarrying in Western Norway. An archaeological study of production and distribution in the Viking period and the Middle Ages*. Unpublished doctoral thesis in archaeology, University of Bergen.

Baug I. 2015. *Quarrying in Western Norway. An archaeological study of production and distribution in the Viking period and Middle Ages*. Archaeopress Archaeology, Oxford.

Hoff, A. M. & Lidén, H. E. 2000. Norske minnesmerker. *Norges kirker*. Hordaland. Bind II, Oslo.

Buch, L. von 2011 [1813]. *Travels through Norway and Lapland during the years 1806, 1807, 1808* (translated from the original German by John Black). Printed for Henry Colburn, British and Foreign Public Library. London.

Heldal, T. & Storemyr, P. 1997. Geologisk undersøkelse og arkeologisk registrering av de middelalderske bruddene ved Øye, Klungen og Huseby i Sør-Trøndelag. *Geological Survey of Norway*, *report, no.* 97. 149.

Jansen, Ø. J. & Heldal, T. 2009. Medieval greenschist quarries near Bergen, western Norway. *The 9th International Conference of ASMOSIA. Tarragona, 8–13th June 2009. Interdisciplinary studies of ancient stone.* Book of abstracts, 54.

Jansen, Ø. J. 2013. Stein til klostermurane. In Økland, B. G., Jünger, J. C. S. & Øye, I. (eds) *Halsnøy kloster. Til kongen og Augustins ære*, 69–83, Oslo.

Lundberg, N. 2007. Øye – en arkeologisk undersøkelse av et klorittskiferbrudd. Unpublished master thesis in archaeology at NTNU, Trondheim.

Naterstad, J. 1984. Den geologiske bakgrunn for bakstehelleindustrien ved Kvitebergvatnet, Hardanger. *Viking,* XLVII–1983, 161–164.

Pedersen, R. B, & Furnes, H. 2001. Nd- and Pb-isotopic variations through the upper oceanic crust in

DSDP/ODP Hole 504B, Costa Rica Rift, *Earth and Planetary Science Letters*, 189, 221–235.
Qvale, H.1978. Geologisk undersøkelse av et kaledonsk serpentinittfelt ved Baldersheim i Hordaland. Unpublished cand. real. thesis in geology, University of Oslo.
Ragnhildstveit, J. & Helliksen, D. 1997. Geologisk kart over Norge, berggrunnskart Bergen –M 1:250 000, Norges geologiske undersøkelse.
Storemyr, P. 2001. Restaurering av koret i Stavanger domkirke. De ytre fasadene 1997–1999. *Foreningen til norske fortidsminnesmerkers bevaring, årbok*, 63–74.
Storemyr, P., Lundberg, N., Østerås, B. & Heldal, T. 2010. Arkeologien til Nidarosdomens middelaldersteinbrudd. In Bjørlykke, K., Ekroll, Ø. & Syrstad Gran, B. (eds) *Nidarosdomen – ny forskning på gammel kirke*. Nidaros Domkirkes Restaureringsarbeiders forlag, Trondheim, 238–267.
Weber, B. 1984. "I Hardanger er Qvernberg og Helleberg… og Hellerne, det er tyndhugne Steene, bruger man til at bage det tynde Brød Fladbrød på…" *Viking*, XLVII – 1983, 149–160, Oslo.

Internet sources

Askeladden: The Norwegian National Cultural Heritage Database (last visited 03.02.2017):: https://askeladden.ra.no/Askeladden/Pages/LoginPage.aspx?ReturnUrl=%2faskeladden
The National Natural Stone Database, Geological Survey of Norway (NGU) (last visited 03.02.2017): http://geo.ngu.no/kart/mineralressurser/

Appendix

Tabel 1. *Main and trace element (MTE) compositions of soapstone.*

Sample	Locality	SiO[2]	Al[2]O[3]	Fe[2]O[3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Pb	Cr	V	Ga	Zn	Cu	Ni	Yb	Co
ONARH.-1	Onarheim kirke	32.8	0.772	7.72	0.014	35.7	0.113	-0.1	-0.01	0.097	-0.01	22.8	100	25.5	2380	24.3	3	34	-2	1610	39.3	80.3
ONARH.-2	Onarheim kirke	36.8	4.5	11	0.316	32.4	1	-0.1	-0.01	0.128	-0.01	13.5	99.7	21.3	3140	68.4	7.3	39.5	40.8	1600	41.6	93.2
Onarh2b	Onarheim kirke		4.52	8.4		36.35									4955	75		23		1737		99
ONARH.-3	Onarheim kirke	34.6	3.67	10.5	0.063	33.1	1.21	-0.1	-0.01	0.184	-0.01	16.5	99.8	22.3	2520	55.1	6.4	51.6	34.2	1540	40.3	92.4
ONARH.-3B	Onarheim kirke	40.4	4.76	11.3	0.11	28.6	3.11	-0.1	-0.01	0.082	-0.01	10.9	99.3	22	1980	54.6	7	42.4	33	1420	35.6	93.9
ONARH.-4	Onarheim kirke	31.1	0.51	6.8	-0.01	35.3	0.316	-0.1	-0.01	0.157	-0.01	25	99.2	22.9	1610	15.6	2.7	35.5	9.1	1390	33.9	68.5
ONARH.-5	Onarheim kirke	16.9	0.175	4.99	-0.01	30.5	11.5	-0.1	-0.01	0.237	-0.01	35.8	100	67.1	249	-5	2.3	595	59.5	705	20.6	48.4
ONARH.-6	Onarheim kirke	24.9	0.677	4.36	-0.01	28.2	12.5	-0.1	-0.01	0.195	-0.01	29.3	100	27.7	959	12.3	2.7	73.4	-2	891	20.9	46.2
BALDER-1	Baldersheim	39.3	2.3	9.92	0.086	30.2	1.09	-0.1	-0.01	0.115	-0.01	15.2	98.2	21.1	2820	47.5	5.1	42.7	38.6	1840	41.7	102
BALDER-2	Baldersheim	33.7	2.21	8.51	0.075	25.6	10	-0.1	-0.01	0.144	-0.01	19	99.2	21.3	2140	47.5	4.8	29.3	15	1300	26.1	75.6
BALDER-3	Baldersheim	35.8	2.43	11.1	0.089	29.8	1.87	-0.1	-0.01	0.164	-0.01	17.2	98.5	20	2830	57.6	5.3	48.6	10.4	1650	38.2	93.7
BALDER-4	Baldersheim	42.6	2.08	11	0.076	26.3	5.2	-0.1	-0.01	0.089	-0.01	11.8	99.1	22.2	2260	53.9	5.4	43.9	16.1	1530	32.7	75.4
BALDER-5	Baldersheim	41.3	2.88	10.9	0.139	29.1	1.15	-0.1	-0.01	0.106	-0.01	12.5	98.1	21.1	2630	53.5	5.7	41.8	20	1770	34	89.9
BERGSH.-2	Bergsholmen	55	0.733	5.88	-0.01	27.2	1.91	-0.1	-0.01	0.062	-0.01	7.08	98	21.5	1740	11	3.3	78.8	10	1540	32	92.4
BERGSH.-3	Bergsholmen	54.9	0.854	5	-0.01	27.9	1.9	-0.1	-0.01	0.039	-0.01	7.19	97.8	22.6	1540	16.3	3.6	32.5	-2	1410	33.4	69.6
BERGSH.-4	Bergsholmen	27.3	0.209	6.77	-0.01	36.1	0.211	-0.1	-0.01	0.115	-0.01	28.4	99.1	21.6	2410	11.8	2.3	24	9.3	1690	34.2	76.8
BERGSH.-6	Bergsholmen	37.8	0.877	6.67	-0.01	32.3	1.06	-0.1	-0.01	0.05	-0.01	20.3	99	19.4	1890	9.4	3.1	22.1	-2	1160	23.9	66.6
BERGSH.-7	Bergsholmen	27.2	0.286	7.1	-0.01	29.1	7.97	-0.1	-0.01	0.246	-0.01	26.2	98.1	20.9	1680	12	2.8	27.2	31.4	1130	23.5	68.2
JUADAL-1	Juadal	34.5	1.02	7.74	-0.01	33.8	0.137	-0.1	-0.01	0.054	-0.01	22.4	99.8	20.7	2120	26.8	3.3	27.2	4.5	1740	41.4	81.5
JUADAL-10	Juadal	42.8	1.18	5.8	-0.01	32.9	0.231	-0.1	-0.01	0.058	-0.01	16.5	99.4	21.3	2370	26.2	5.4	32	-2	1390	32.5	54.5
JUADAL-11	Juadal	53.5	3.13	5.41	-0.01	29.4	0.531	-0.1	0.011	0.02	-0.01	6.79	98.7	22.5	2140	40	8.6	34.9	46.1	1030	24.5	38.3
JUADAL-12	Juadal	47.8	3.07	4.7	0.028	29	2.7	-0.1	0.114	0.053	0.029	11.3	98.8	22.3	2000	28.3	7.4	35.8	-2	1090	27.3	33.9
JUADAL-13	Juadal	48.3	1.37	5.72	-0.01	31.9	0.067	-0.1	-0.01	0.034	-0.01	12.6	100	21.5	1500	20.9	5.3	39.7	-2	1110	23.5	40.4
JUADAL-2	Juadal	57.2	1.77	4.62	-0.01	30.2	-0.01	-0.1	-0.01	-0.01	-0.01	5.72	99.5	21.2	2350	25.3	5.9	29.5	35.7	1310	33.2	51.7
KLOVSTEINSJ.-3	Klovsteinsjuvet	40.5	5.83	10.6	0.105	28.2	1.84	-0.1	-0.01	0.099	0.011	9.92	97.1	23.3	6980	85	8.5	78.4	113	1290	30.4	106
KLOVSTEINSJ.-5	Klovsteinsjuvet	40.7	5.64	8.96	0.084	27.4	3.73	-0.1	-0.01	0.142	-0.01	11.3	98	23.4	3310	74.7	7.2	65.6	124	943	21.2	87.8
KLOVSTEINSJ.-6	Klovsteinsjuvet	39.2	4.99	10.4	0.094	28	2.66	-0.1	0.011	0.141	0.012	12.2	97.8	23.4	5380	74.3	7.5	90.4	124	1140	25.6	100
KLOVSTEINSJ.-8	Klovsteinsjuvet	42.3	4.64	10.9	0.059	30.1	0.844	-0.1	-0.01	0.09	-0.01	9.04	98	23.1	3860	69.7	6.9	68.1	147	1200	21.9	106
KVERNES-10	Kvernes	60	0.761	4.75	-0.01	29.3	0.01	-0.1	-0.01	0.022	-0.01	4.67	99.5	21.7	1270	11	2.9	31.6	-2	1620	37.3	69.8
KVERNES-11	Kvernes	60.2	0.713	3.74	-0.01	29.7	-0.01	-0.1	-0.01	-0.01	-0.01	4.77	99.1	21	800	8.7	2.9	43	-2	1340	31.9	47.5
KVERNES-20	Kvernes	37.8	0.368	6.58	-0.01	33.6	0.128	-0.1	-0.01	0.069	-0.01	20.3	98.8	20.7	1470	13.6	2.7	28.5	4.3	1500	34.2	66
KVERNES-21	Kvernes	34.4	0.378	6.5	-0.01	33.2	1.83	-0.1	-0.01	0.111	-0.01	22.8	99.2	21.5	1570	12.7	2.9	28.8	9.7	1350	29.1	67.7
KVERNES-22	Kvernes	35.6	0.405	6.22	-0.01	34.5	0.121	-0.1	-0.01	0.055	-0.01	22.2	99.2	19.4	1600	13	2.3	27.2	2.7	1540	37.8	65.2
KVERNES-23	Kvernes	44.5	0.527	6.73	-0.01	30.9	1.91	-0.1	-0.01	0.135	-0.01	14.9	99.7	21.5	1670	15.4	3.2	29.8	34.4	1410	31.2	82.4
KVERNES 1	Kvernes	39.99	0.58	7.89	0.02	33.19	2.29	n.d	n.d	0.11	0.01	17.09	100.83									
KVERNES 2	Kvernes	40.8	0.7	7.11	0.01	35.32	0.83	n.d	n.d	0.08	0.01	15.67	100.21		2544	32		43	18	2211		104
KVERNES 3	Kvernes	42.67	0.51	6.75	0.01	33.43	1.62	n.d	n.d	0.12	n.d	16.49	101.34		2154	28		32	19	1895		95
ROSSØY-12	Russøy	31.8	0.454	6.87	-0.01	35.5	0.391	-0.1	-0.01	0.174	-0.01	24.4	99.6	20.3	1660	18.3	2.7	30.8	4.8	1130	28.2	65
RUSSØY-1	Russøy	34.4	0.507	6.75	-0.01	34.6	0.961	-0.1	-0.01	0.111	-0.01	21.2	98.5	20.8	1740	17.7	2.6	20.7	2.8	1100	25.8	62.6
RUSSØY-10	Russøy	33	0.494	7.88	-0.01	35.4	0.1	-0.1	-0.01	0.11	-0.01	21.2	98.3	21	1980	19.5	3	25.6	3.4	1060	21.9	78.3
RUSSØY-13	Russøy	35	0.534	6.26	-0.01	34.2	0.099	-0.1	-0.01	0.123	-0.01	22.4	98.6	20.9	1560	15.6	2.8	23.7	-2	1150	23.4	59.8

Tabel 1 *(continued).*

Sample	Locality	SiO[2]	Al[2]O[3]	Fe[2]O[3]	TiO[2]	MgO	CaO	Na[2]O	K[2]O	MnO	P[2]O[5]	LOI	Total	Pb	Cr	V	Ga	Zn	Cu	Ni	Yb	Co
RUSSØY-2	Russøy	34	0.526	7.51	-0.01	35.1	0.318	-0.1	-0.01	0.122	-0.01	21.2	98.8	21	1840	18.2	3.2	33.9	12.9	1500	36.3	79.9
RUSSØY-4	Russøy	42.2	0.835	5.63	-0.01	27.1	7.83	-0.1	-0.01	0.114	-0.01	15.9	99.7	24.7	2180	13.4	4.5	13.9	-2	894	23.3	75.2
TYSSØY-1	Tyssøy	37.9	2.72	14	0.034	26.5	4.59	-0.1	-0.01	0.152	-0.01	13.1	99	18.3	1450	24.8	5.6	71.5	143	870	14.9	139
TYSSØY-10	Tyssøy	29	2.62	16	0.042	28.3	4.35	-0.1	0.015	0.258	-0.01	20	101	19.9	386	24.5	5.2	66	99.7	841	12.8	143
TYSSØY-2	Tyssøy	45.9	3.5	14.6	0.059	27	0.559	-0.1	-0.01	0.022	-0.01	7.04	98.7	19.3	179	26.5	5.5	74	8.5	861	13.9	133
TYSSØY-3	Tyssøy	35.1	1.74	14.5	0.024	28.9	3.54	-0.1	-0.01	0.19	-0.01	15.6	99.6	19.1	403	14.3	4.2	69.3	34.6	890	15.3	134
TYSSØY-6	Tyssøy	30.8	3.01	16	0.04	25.3	6.95	-0.1	-0.01	0.171	-0.01	17.6	99.9	18.2	351	22.3	5.6	69.4	72.8	857	16.5	147
TYSSØY-8	Tyssøy	38.4	2.03	15.7	0.101	32.1	0.603	-0.1	-0.01	0.165	-0.01	10.1	99.2	19.2	862	38.1	4.7	96.5	86.1	1040	20	149
TYSSØY-9	Tyssøy	28.5	2.21	15.8	0.059	28.8	4.65	-0.1	-0.01	0.299	-0.01	19.5	99.9	19.5	1780	38.3	5.4	72.3	128	917	12.4	147
VARGAH.-1	Vargahola	28.7	0.683	5.19	-0.01	24.3	15.5	-0.1	0.013	0.25	-0.01	25.8	101	25.9	1500	9.2	3.2	48.6	135	1670	36.6	56.9
VARG.-1	Vargevågen	32.7	0.65	6.3	-0.01	36.2	0.08	-0.1	-0.01	0.077	-0.01	24.2	100	20.4	1490	9.4	2.6	24.9	-2	1700	39	81.5
VARG.-2	Vargevågen	26.9	1.15	5.69	-0.01	37.7	0.104	-0.1	-0.01	0.134	-0.01	28.5	100	19.1	1400	8.8	3	25.8	-2	1240	31.3	70.1
VARG.-3	Vargevågen	35.9	0.995	6	-0.01	34.4	0.064	-0.1	-0.01	0.046	-0.01	21	98.6	19.4	1350	10.1	2.8	32.1	-2	1730	37.9	80.6
VARG.-4	Vargevågen	32.9	0.649	6.85	-0.01	35.7	0.071	-0.1	-0.01	0.075	-0.01	23.8	100	20	1650	15.8	2.5	24	2.8	1770	36.5	85
VARG.-5	Vargevågen	32.7	0.594	6.49	-0.01	36.4	0.063	-0.1	-0.01	0.093	-0.01	22.2	98.6	18.5	1770	14.4	2.6	29.7	-2	1950	46.2	87.1
VARG.-6	Vargevågen	38	0.361	6.04	-0.01	33.7	0.636	-0.1	-0.01	0.152	-0.01	20.6	99.4	19.7	1180	6.9	2.8	20.6	2.4	1790	39.6	80.2
Arnafjord 1	Arnafjord														2276	29		34	71	1898		73
ARNAFJORD-12	Arnafjord	47.2	2.72	5.74	0.017	18	9.86	0.23	0.047	0.168	-0.01	16.4	100	26.3	1050	26.2	6.5	55.8	-2	938	20.7	41.2
ARNAFJORD-16	Arnafjord	45.8	1.93	5.82	0.028	16.9	11	-0.1	0.098	0.231	-0.01	18.2	99.9	26.4	680	25.3	5	45.1	-2	742	14.6	34.2
ARNAFJORD-2	Arnafjord	45.5	0.798	5.53	-0.01	26.5	6.08	-0.1	-0.01	0.078	-0.01	12.7	97	23.5	1710	25.9	4.3	31.7	47.7	1210	31.9	68.2
ARNAFJORD-3	Arnafjord	32.9	0.282	6.65	-0.01	34.8	0.153	-0.1	-0.01	0.111	-0.01	24.3	99.3	20.4	1240	11.8	2.8	26.3	4	1540	35.2	71.8
ARNAFJORD-9	Arnafjord	59.2	0.783	5.03	-0.01	28.6	-0.01	-0.1	-0.01	0.031	-0.01	4.57	98.2	20.6	1140	6.1	3.6	61.4	-2	1420	34.9	69.2
LYS 01	Lysekloster	41.18	4.93	13.06	0.25	28.67	1.47	n.d	n.d	0.18	0.04	11.53	101.1		2502	56		90	13	765		131
LYS 010	Lysekloster	37.39	3.07	11	0.26	27.77	4.93	n.d	n.d	0.2	0.03	16.17	100.59		1943	41		87	10	831		114
LYS 011	Lysekloster	38.06	3.22	11.89	0.19	27.73	4.69	n.d	n.d	0.16	0.03	14.69	100.35		2380	46		86	24	871		109
LYS 012	Lysekloster	47.43	4.16	11.66	0.46	27.84	1.96	n.d	n.d	0.14	0.03	8.02	101.39		2619	58		88	9	768		111
LYS 013	Lysekloster	40.87	4.14	12.05	0.24	27.16	3.04	n.d	n.d	0.17	0.04	11.95	99.536		2233	50		84	n.d	793		119
LYS 014	Lysekloster	38.97	3.83	9.01	0.19	20.93	12.8	n.d	0.01	0.21	0.02	14.41	100.12		1521	65		107	27	760		81
SÆV 010	Sævråsvåg	42.37	1.14	5.26	0.02	27.73	8.41	n.d	n.d	0.13	n.d	16.05	100.78		1962	23		44	23	1225		54
SÆV 11	Sævråsvåg	59.32	0.98	6.95	0.01	29.14	0.16	n.d	n.d	0.03	0.01	4.7	100.99		2348	20		80	n.d	988		84
SÆV 12	Sævråsvåg	46.47	1.26	4.74	0.02	28.64	6.65	n.d	n.d	0.09	n.d	14.21	101.83		1950	20		36	n.d	1190		56
SÆV 14	Sævråsvåg	43.59	0.22	5.38	0.01	27.43	8.15	n.d	n.d	0.12	0.01	15.85	100.71		2106	17		46	7	1256		53
SÆVRÅS 2	Sævråsvåg	39.73	0.37	5.06	0.01	27.16	10.36	n.d	n.d	0.13	n.d	18.8	101.3		1935	17		34	13	1488		52
SÆVRÅS 3	Sævråsvåg	60.73	0.15	5.27	0.01	27.55	3.25	n.d	n.d	0.08	0.01	3.94	100.7		422	15		73	n.d	1081		69
SÆVRÅSVÅG	Sævråsvåg	42.64	0.87	5.23	0.02	29.19	6.39	n.d	0.01	0.13	0.01	16.77	101.17									

Tabel 2. *Sr and Nd isotope compositions of soapstone.*

Lab#	Sample	Location	$\varepsilon_{Nd(0)}$	$\varepsilon_{Sr(0)}$
øj 3989	Arnafjord 1	Arnafjord	-3.141	96.93
øj 4720	Arnafjord 12	Arnafjord	-11.938	92.2
øj 4721	Arnafjord 16	Arnafjord	-5.989	100.03
øj 4695	Arnafjord 2	Arnafjord	-4.467	94.32
øj 4696	Arnafjord 3	Arnafjord	-11.997	249.60
øj 4719	Arnafjord 9	Arnafjord	-6.925	238.31
øj 4339	BALD 1	Baldersheim	11.470	-26.29
øj 4340	BALD 2	Baldersheim	10.007	9.04
øj 4722	Balder 3	Baldersheim	8.915	23.15
øj 3957	Bergholmen 1	Bergsholmen	-6.262	105.75
øj 4409	BERGSH. 5	Bergsholmen	-8.466	123.71
øj 4400	BERGSH. 6	Bergsholmen	-8.681	99.77
øj 4401	BERGSH. 7	Bergsholmen	-6.964	114
øj 4381	JUADAL 10	Juadal	-9.851	129.64
øj 4382	JUADAL 11	Juadal	-12.25	309.79
øj 3951	Juadalen 2	Juadal	-6.301	289.35
øj 3914	Klauvsteinsjuv l	Klovsteinsjuvet	-2.731	245.66
øj 3915	Klauvsteinsjuv ll	Klovsteinsjuvet	-2.380	257.62
øj 3950	Klauvsteisjuvet 4	Klovsteinsjuvet	-6.301	283.94
øj 3923	Kvernes	Kvernes	-3.804	92.74
øj 4383	KVERNES 10	Kvernes	-7.062	239.54
øj 3955	Kvernes 2	Kvernes	1.287	96.66
øj 4495	Kvernes 21	Kvernes	-3.531	145.31
øj 4741	Kvernes 22	Kvernes	-5.838	151.75
øj 4742	Kvernes 23	Kvernes	-6.359	95.14
øj 3956	Kvernes 3	Kvernes	1.873	93.93
øj 4057	Lys 011	Lysekloster	7.978	21.39
øj 4058	Lys 012	Lysekloster	6.730	33.85
øj 4059	Lys 013	Lysekloster	6.398	34.10
øj 4060	Lys 014	Lysekloster	3.940	87.78
øj 4014	Lysekloster 1	Lysekloster	6.788	26.39
øj 4727	Russøy 14	Russøy	-11.197	138.67
øj 4728	Russøy 15	Russøy	-11.997	151.98
øj 4729	Russøy 16	Russøy	-12.153	201.87
øj 3958	Russøy 2	Russøy	-12.875	96.71
øj 3918	Russøy l	Russøy	-12.153	114.15

Tabel 2 *(continued).*

Lab#	Sample	Location	$\varepsilon_{Nd(0)}$	$\varepsilon_{Sr(0)}$
øj 4061	Sæv 010	Sævråsvåg	-0.293	45.58
øj 4062	Sæv 014	Sævråsvåg	-1.639	49.78
øj 3922	Sævråsvåg	Sævråsvåg	-3.394	43.78
øj 3959	Sævråsvåg 2	Sævråsvåg	-4.272	44.78
øj 3960	Sævråsvåg 3	Sævråsvåg	-0.332	51.71
øj 4335	TØ 1	Tyssøy	10.768	10.70
øj 4411	TØ 3	Tyssøy	9.196	13.8
øj 4749	TØ 6	Tyssøy	-13.226	88.32
øj 4750	TØ 7	Tyssøy	-10.163	97.39
øj 4336	VARG 4	Vargevågen	-12.192	263.88
øj 4337	VARG 5	Vargevågen	-6.184	228.73
øj 4733	On 1	Onarheim church	-11.938	116.51
øj 4734	On 2	Onarheim church	4.721	34.17
øj 4807	On 2B	Onarheim church	8.173	12.31
øj 4341	ON 3	Onarheim church	10.963	9.40
øj 4342	ON 4	Onarheim church	-5.794	218.52
øj 4735	On 5	Onarheim church	-1.970	273.67

Tabel 3. *REE compositions of soapstone.*

LabNo	ICP-296	icp1832	ICP-198	ICP-199	ICP-200	icp -910	icp-911	ICP-201	ICP-202	icp 503		
Sample	Arnafj 1	Arnafj 2	Balder 3	Balder 2	Balder 1	Balder 4	Balder 5	Bergsh 2	Bergsh 3	Bergsh 5	Bergsh 6	Bergsh 7
Location	Arnafjord	Arnafjord	Baldersheim	Baldersheim	Baldersheim	Baldersheim	Baldersheim	Bergsholmen	Bergsholmen	Bergsholmen	Bergsholmen	Bergsholmen
La	0.88199677	1.75070968	0.16817419	0.58794194	0.14784194	0.42294194	0.18385484	1.4770129	0.5565	0.20225806	0.26944194	1.65595484
Ce	0.61719012	1.13275	0.16493688	0.70047153	0.14774505	0.36068688	0.14995173	1.29160025	0.4770099	0.14087531	0.20355926	1.23747901
Pr	0.62664167	1.07890164	0.19188525	0.93246721	0.18408197	0.41190984	0.14955738	1.19128689	0.4342623	0.1359	0.19953333	1.16869167
Nd	0.47743	0.954885	0.21317167	1.12657333	0.20046333	0.533325	0.16967167	1.06162	0.35077333	0.10042333	0.11079167	0.804905
Sm	0.37694	0.74980513	0.29295897	1.47299487	0.27076923	0.6308	0.18637949	1.01982051	0.27933333	0.08258	0.06953	0.482605
Eu	0.84931429	0.45721088	0.23759184	1.10111565	0.20466667	0.51846259	0.15462585	0.94915646	0.40229932	0.14278571	0.05804286	0.75855714
Gd	0.34703846	0.70884556	0.28068726	1.57423166	0.26917375	0.64599614	0.1903861	0.93242857	0.21462548	0.06875769	0.04326923	0.29171923
Tb	0.30324	0.63185654	0.30295359	1.52432489	0.25331224	0.69149789	0.20883966	0.95483122	0.19151899	0.0627	0.02222	0.2325
Dy	0.3264625	0.53788509	0.30370186	1.62992547	0.29514286	0.69795652	0.22142236	0.95315528	0.20535093	0.08767188	0.03383438	0.21417188
Ho	0.31454286	0.49426184	0.33097493	1.60519499	0.30370474	0.67824513	0.21561281	0.80643454	0.19399721	0.10178571	0.02517143	0.22121429
Er	0.31405238	0.45865714	0.35032857	1.5821619	0.3292381	0.68618571	0.24054762	0.73310476	0.19431429	0.10307619	0.0202619	0.20433333
Tm	0.333	0.41385802	0.39222222	1.49604938	0.34996914	0.66385802	0.29070988	0.70845679	0.21583333	0.11093333	0.02253333	0.24576667
Yb	0.34368571	0.47435885	0.51488995	1.4937799	0.46292344	0.72061722	0.37234928	0.85788995	0.20990909	0.0851619	0.02895238	0.23948571
Lu	0.36556667	0.4931677	0.605	1.39745342	0.54177019	0.70257764	0.46881988	0.78804348	0.14434783	0.12626667	0.0766	0.30316667
LabNo	ICP-192	ICP-193	ICP 181	ICP 182	ICP321	ICP322	ICP323	ICP324	ICP 184	ICP 189	ICP-194	ICP-196
Sample	Juadal 11	Juadal 10	Juadal 2	Juadal 1	Klauvj 1	Klauvj 2	Klauvj 3	Klauvj 4	Kvernes 1	Kvernes 3	Kvernes 10	Kvernes 11
Location	Juadal	Juadal	Juadal	Juadal	Klovsteinsjuvet	Klovsteinsjuvet	Klovsteinsjuvet	Klovsteinsjuvet	Kvernes	Kvernes	Kvernes	Kvernes
La	2.37912903	0.57777097	0.56668065	0.17932903	2.55870645	2.56412258	0.17484516	8.69994516	6.34905484	1.01181613	0.24446452	0.14650645
Ce	0.73531683	0.37304208	0.32734653	0.12410149	2.38770741	2.3587679	0.18132099	7.00433704	5.4142599	1.05210644	0.14239356	0.12521658
Pr	1.17027049	0.34786066	0.28889344	0.09594262	2.26345833	2.20778333	0.18215	6.05688333	4.49360656	0.95837705	0.15638525	0.08767213
Nd	0.8425	0.22039	0.21823	0.07410667	1.97816833	1.97152	0.15719167	4.6347	3.57320667	0.866005	0.11041667	0.05483333
Sm	0.48083077	0.1533641	0.13661026	0.06412308	1.767625	1.820475	0.186995	3.007395	2.30655385	0.89270769	0.07342564	0.03624103

Tabel 3 *(continued)***.**

Eu	0.23423129	0.08284354	0.06680272	0.03370068	1.20731429	1.5544	0.04787143	0.92462857	1.80395918	0.55948299	0.0527619	0.0367483
Gd	0.32512355	0.11697297	0.09994208	0.04304633	1.69431923	1.88583077	0.16575	2.46995769	1.546	0.69763707	0.04696139	0.02142085
Tb	0.26812236	0.09603376	0.10700422	0.04493671	1.69422	1.75222	0.1698	2.19016	1.42607595	0.72027426	0.04394515	0.03400844
Dy	0.18986646	0.09841925	0.1189441	0.05424534	1.87425938	1.98747813	0.16043125	2.2985875	1.32379193	0.70623292	0.02695963	0.01892236
Ho	0.1744429	0.13279944	0.13013928	0.04809192	2.0978	2.26095714	0.1424	2.45978571	1.20392758	0.72952646	0.02487465	0.01714485
Er	0.17254286	0.17496667	0.1687619	0.0634	2.18955238	2.17215238	0.10248095	2.54140952	1.26624762	0.77288571	0.0199	0.0181619
Tm	0.15595679	0.22475309	0.20095679	0.06731481	2.4165	2.66786667	0.10696667	2.73326667	1.21743827	0.84358025	0.03324074	0.02083333
Yb	0.18075598	0.28976077	0.26637321	0.0916555	2.48535238	2.74972857	0.0895	2.90490952	1.33739713	0.92964593	0.02703349	0.01907177
Lu	0.16686335	0.33189441	0.25950311	0.0486646	2.67103333	3.08696667	0.08436667	3.27103333	1.26326087	0.85009317	9.3168E-05	-0.00521739
LabNo	ICP524	ICP525	icp 62	icp 63	icp 64	icp 65	icp 66	icp 67	ICP 176	ICP 177	ICP 187	ICP-195
Sample	Kvernes 20	Kvernes 21	Lyse 1	Lyse 10	Lyse 11	Lyse 12	Lyse 13	Lyse 14	Russøy II	Russøy 2	Russøy I	Russøy 13
Location	Kvernes	Kvernes	Lysekloster	Lysekloster	Lysekloster	Lysekloster	Lysekloster	Lysekloster	Russøy	Russøy	Russøy	Russøy
La	0.14049032	0.39433871	3.40505161	3.89152581	1.50376774	3.38612903	0.79475161	2.99436774	0.68885806	0.21429355	0.68750323	0.34584839
Ce	0.10678395	0.29358148	3.13760644	4.04946782	1.76354703	3.25813366	0.80566955	3.1397005	0.48577847	0.13476485	0.60713366	0.24922153
Pr	0.10228333	0.26585	3.06306557	4.28287705	2.00737705	3.49987705	0.89305738	3.40160656	0.36107377	0.08836885	0.46854098	0.21163934
Nd	0.06282167	0.18564833	3.03496167	4.521595	2.24865667	3.67050167	1.04275167	3.676835	0.24037167	0.06552333	0.335155	0.138415
Sm	0.070675	0.165175	2.46029231	4.54945641	2.70171282	3.62738974	1.35876923	3.85567692	0.15693846	0.04761026	0.21637436	0.09262051
Eu	0.02941429	0.10252857	1.91285714	4.11051701	3.20564626	2.37887075	1.37542857	2.7952517	0.13926531	0.0282585	0.12038095	0.04111565
Gd	0.03350769	0.12132692	1.70166409	3.31759073	2.52537838	2.61374903	1.18871815	3.48236293	0.09504633	0.02482625	0.13426641	0.06195367
Tb	0.03868	0.10256	1.56685654	2.97147679	2.30879747	2.49312236	1.21189873	3.50763713	0.07723629	0.01797468	0.12991561	0.0664135
Dy	0.06309063	0.13040625	1.22895342	2.46531988	2.27640683	2.04468944	1.13618012	3.11	0.06375466	0.03158696	0.10691615	0.05688199
Ho	0.07261429	0.10784286	1.11689415	2.10852368	1.95456825	1.81038997	1.07899721	2.96115599	0.05905292	0.03626741	0.07935933	0.07603064
Er	0.09466667	0.11118571	1.11620952	2.01578095	1.90667143	1.7435	1.02926667	2.85999524	0.06505238	0.04302857	0.0951	0.10670476
Tm	0.11526667	0.11423333	1.24765432	1.86753086	1.77506173	1.52839506	1.02734568	2.63098765	0.07901235	0.07141975	0.08354938	0.16098765
Yb	0.1256381	0.15893333	1.17717225	2.01278469	1.88227273	1.598689	1.10054067	2.65013397	0.09955024	0.10592344	0.12139713	0.18014833
Lu	0.15033333	0.19653333	1.23906832	1.93729814	1.88565217	1.50021739	1.17295031	2.52537267	0.0907764	0.11223602	0.11031056	0.19689441

Tabel 3 *(continued)***.**

LabNo	ICP-197	ICP -909					ICP-205	ICP312	ICP313	ICP314	ICP315	ICP316
Sample	Russøy 11	Russøy10	SÆV 010	SÆV 011	SÆV 012	SÆV 014	Sævråsvåg	Tø1	Tø2	Tø3	Tø4	Tø5
Location	Russøy	Russøy	Sævråsvåg	Sævråsvåg	Sævråsvåg	Sævråsvåg	Sævråsvåg	Tyssøy	Tyssøy	Tyssøy	Tyssøy	Tyssøy
La	0.15207097	0.47139355	1.68383548	0.10779677	2.67399032	1.29318387	8.2461	0.39551935	0.11302903	0.18680968	1.81062581	3.47931613
Ce	0.11295173	0.38053342	1.62687005	0.11011386	2.78861386	1.14137376	7.0065198	0.38996173	0.06478148	0.16184691	1.70892716	3.67625679
Pr	0.09890984	0.30436066	1.5822459	0.10561475	2.65109836	0.99631967	5.84422131	0.53608333	0.068825	0.17556667	2.2959	5.080925
Nd	0.069395	0.28211667	1.48550333	0.11561167	2.52206167	0.84020667	4.657985	0.56680333	0.05674167	0.17051667	2.59673667	5.50537333
Sm	0.03389231	0.22118974	1.36232308	0.13664103	2.25362564	0.58004615	2.88511282	0.90205	0.057735	0.211635	3.13686	6.777685
Eu	0.02782313	0.05738776	2.69397279	0.15791837	2.53748299	2.1624898	4.25665306	1.25257143	0.034	0.35258571	2.43774286	6.74244286
Gd	0.02723166	0.15417761	1.14111197	0.08911583	1.87425483	0.41927027	1.69637838	1.00543077	0.06658462	0.24074231	3.58061923	7.48328462
Tb	0.02405063	0.1657173	1.13670886	0.10331224	1.98985232	0.38679325	1.35177215	0.92524	0.06768	0.21306	3.23628	7.05762
Dy	0.02191925	0.15256832	1.03346894	0.09645031	1.91257143	0.33240994	1.06326708	1.01279688	0.0974625	0.22795	3.4647125	7.50751563
Ho	0.02160167	0.14696379	1.01552925	0.08367688	1.99625348	0.32733983	0.98247911	0.97961429	0.11681429	0.25751429	3.60457143	7.5475
Er	0.01879048	0.15195238	1.0799381	0.09209048	2.06714762	0.35199048	0.97400476	0.94953333	0.15291905	0.25602857	3.47281429	7.1898619
Tm	0.02722222	0.1787037	1.08342593	0.08080247	1.94614198	0.37166667	0.89169753	0.9357	0.22993333	0.3156	3.54473333	7.53966667
Yb	0.02679426	0.22303349	1.14717225	0.087	1.99505263	0.4452488	1.00572249	0.95662381	0.26817619	0.38094762	3.4117619	7.44747619
Lu	0.00496894	0.2381677	1.13521739	0.09322981	1.90139752	0.45717391	0.97201863	1.0584	0.34106667	0.49086667	3.872	7.85676667
LabNo	ICP907	varg 1	varg 2	varg 4	varg5	varg 6	varg7	varg 8	varg 9	varg 10		
Sample	Tø6	ICP-299	ICP-300	ICP-301	ICP-302	ICP-303	ICP-304	ICP-305	ICP-306	ICP-307		
Location	Tyssøy	Vargevågen	Vargevågen	Vargevågen	Vargevågen	Vargevågen	Vargevågen	Vargevågen	Vargevågen	Vargevågen		
La	0.35219355	0.1768	0.30465806	0.4154	0.23226452	0.11502258	0.08253226	0.36681935	0.13071613	0.27956129		
Ce	0.24704332	0.12209877	0.19535185	0.28304815	0.17638272	0.0714679	0.06494568	0.26117778	0.10158889	0.17839506		
Pr	0.23230328	0.09909167	0.14190833	0.19534167	0.166675	0.034625	0.02471667	0.20588333	0.07269167	0.13865833		
Nd	0.22644333	0.08869833	0.11372667	0.17011833	0.15754	0.03935667	0.03172333	0.15996667	0.07074333	0.08642667		
Sm	0.24182564	0.0663	0.10866	0.122255	0.187565	0.03972	0.034905	0.118885	0.055795	0.074815		
Eu	0.18915646	0.02297143	0.04578571	0.03898571	0.05504286	0.0192	0.00515714	0.05528571	0.03434286	0.09432857		
Gd	0.20288803	0.06382308	0.09827308	0.08131154	0.13191538	0.02872692	0.01971923	0.06013846	0.04506923	0.03872692		

Tabel 3** (continued).**

Tb	0.21529536	0.04798	0.06988	0.07564	0.12038	0.02098	0.01178	0.06144	0.0554	0.03476		
Dy	0.20131988	0.08811563	0.12645938	0.08556875	0.14484063	0.04121563	0.02804375	0.08285938	0.06961875	0.04191563		
Ho	0.19869081	0.10597143	0.17792857	0.11171429	0.1656	0.05447143	0.03827143	0.09284286	0.0858	0.07012857		
Er	0.2144	0.14453333	0.22591429	0.13203333	0.1691	0.09008095	0.0397619	0.13785714	0.1102	0.08999048		
Tm	0.23888889	0.1894	0.2885	0.173	0.2238	0.1294	0.03833333	0.14793333	0.13333333	0.11103333		
Yb	0.26837321	0.21298095	0.36179524	0.2575381	0.28348571	0.23144286	0.05173333	0.20088095	0.23668571	0.17301429		
Lu	0.30838509	0.24746667	0.4522	0.29783333	0.4234	0.31433333	0.05656667	0.2718	0.30996667	0.20096667		
LabNo	ON 2	ON 5	ON 15/2	ON 15/3	ON 15/4							
Sample	Onarheim church	Onarheim church	Onarheim church	Onarheim church	Onarheim church							
Location	0.35422343	4.44141689	0.32697548	1.14441417	0.35422343							
Ce	0.37617555	4.24242424	0.27168234	1.0031348	0.36572623							
Pr	0.45985401	4.49635036	0.23357664	1.16788321	0.32116788							
Nd	0.64697609	4.48663854	0.29535865	1.47679325	0.54852321							
Sm	0.87012987	4.96969697	0.35497835	1.72294372	0.70562771							
Eu	0.86206897	2.34482759	0.31034483	2.04597701	0.83908046							
Gd	0.99019608	4.88888889	0.41503268	1.94117647	0.8496732							
Tb	0.96551724	4.9137931	0.31034483	1.70689655	0.63793103							
Dy	1.02624672	4.2335958	0.39370079	1.87401575	0.88451444							
Ho	0.96470588	3.55294118	0.36470588	1.69411765	0.68235294							
Er	1.04417671	3.03614458	0.42570281	1.83935743	0.87148594							
Tm	1	2.33333333	0.36111111	1.72222222	0.69444444							
Yb	1.05645161	1.77419355	0.48790323	1.88104839	0.89112903							
Lu	1.02631579	1.31578947	0.42105263	1.65789474	0.65789474							

Table 4. *Main and trace element (MTE) compositions of chlorite schist.*

Region	Sample	Quarry/site	SiO2 %	TiO2 %	Al2O3 %	Fe2O3 %	MnO %	MgO %	CaO %	Na2O %	K2O %	P2O5 %	Total %	Cr ppm	Ni ppm
Hardanger	26 Veste1	Veslehelleren	44.76	0.45	11.44	9.87	0.15	18.22	7.21	1.26	0.1	0.05	54.61	2179	637
Hardanger	16 Båts_1	Båthidlaren	44.39	0.3	8.66	10.94	0.16	22.66	7.31	0.47	0.06	0.06	56.56	2132	805
Hardanger	15 Båt_b1	Båthidlaren	41.88	0.36	10.01	11.18	0.16	23.48	6.34	ND	0	0.05	58.53	2606	857
Hardanger	25 Bakke3	Bakkehidlaren	41.7	0.51	10.07	10.79	0.16	21.87	7.25	0.23	0.1	0.05	57.43	1877	775
Hardanger	9 Bakke1	Bakkehidlaren	42.26	0.4	8.72	10.84	0.16	24.72	5.81	ND	0	0.03	58.16	2189	885
Hardanger	8 Bakke2	Bakkehidlaren	43.58	0.39	8.83	10.5	0.16	24.14	6.5	ND	ND	0.03	57.12	2171	810
Trøndelag	TG-04-44A	Skaun (Eidsli)	44.96	0.63	7.25	11.09	0.2	21.24	8.54	0.42	0.04	0.05	99.78	2602	798
Trøndelag	TG-04-44B	Skaun (Eidsli)	42.4	0.72	8.98	12.23	0.19	23.68	3.82	0.27	0.01	0.09	99.31	2567	734
Trøndelag	TG-04-44C	Skaun (Eidsli)	41.56	0.79	8.03	14.85	0.16	24.92	1.63	0.23	-0.01	0.07	98.95	3715	1203
Trøndelag	TG-04-34	Skaun (Skausetra)	44.17	0.55	8	11.24	0.15	22.74	6.01	0.31	0.02	0.04	99.05	3130	881
Trøndelag	TG-04-35	Skaun (Skausetra)	42.14	0.68	9.37	11.23	0.17	22.69	6.5	0.37	0.02	0.05	99.5	2699	764
Trøndelag	Ø1	Øye	43.62	0.82	11.26	10.93	0.18	16.54	6.74	2.04	0.05	0.08	99.48	1514	507
Trøndelag	Ø8	Øye	42.36	0.44	6.92	14.16	0.16	26.49	2.99	0.26	0.02	0.04	99.12	377	119
Trøndelag	Ø3	Øye	40.08	0.59	7.34	12.9	0.18	23.58	4.99	0.39	0.04	0.03	99.79	2253	661
Trøndelag	Ø4	Øye	43.4	0.41	6.99	11.59	0.21	23.95	6.19	0.31	0.03	0.04	99.7	2985	946
Trøndelag	Ø5	Øye	44.27	0.48	6.06	13.86	0.1	27.53	1.06	0.26	0.01	0.01	99.22	2309	663
Trøndelag	Ø6	Øye	38.22	0.51	6.7	12.75	0.21	24.24	4.94	0.32	0.02	0.02	99.23	2607	793
Trøndelag	Ø7	Øye	39.37	0.75	10.13	9.9	0.16	15.03	6.15	1.88	0.04	0.08	99.21	2303	689
Hardanger	Onarh.10	Onarheim church	41.4	0.393	10	10.8	0.161	22.7	6.61	<0.1	0.032	0.048	99.1	1740	695
Hardanger	Onarh.12	Onarheim church	43.7	0.387	8.83	10.4	0.155	23.7	6.79	<0.1	0.028	0.052	98.7	54	28
Hardanger	Onarh.13	Onarheim church	42	0.373	10	10.8	0.167	21.8	7.04	0.2	0.074	0.052	98.9	1790	695
Hardanger	Onarh.14	Onarheim church	46.1	0.231	6.95	9.61	0.157	22.2	8.34	<0.1	0.028	0.031	98.9	1430	590
Hardanger	Onarh.15	Onarheim church	41.8	0.348	10	10.9	0.162	22.8	6.62	0.11	0.041	0.044	99.5	1830	714
Hardanger	Onarh.16	Onarheim church	41.2	0.442	10.2	11	0.172	22.6	6.46	<0.1	0.037	0.068	98.9	1800	703
Hardanger	Onarh.17	Onarheim church	41.7	0.498	10.1	11	0.166	21.9	7.23	0.17	0.078	0.065	99.4	1870	719
Rogaland	1	Ertenstein	43.4	0.308	10.4	10.3	0.2	23	6.84	0.48	0.079	-0.01	100	1900	916
Rogaland	2	Ertenstein	40	0.328	10.9	9.8	0.177	22.8	7.66	0.47	0.077	0.016	99.8	1460	801
Rogaland	3	Ertenstein	40.4	0.313	10.6	9.52	0.174	23.4	7.71	0.33	0.077	0.021	99.3	1760	930
Rogaland	4	Ertenstein	42.2	0.367	11.4	10.6	0.188	23.4	6.60	0.51	0.075	-0.01	100	1770	904

Table 5. *REE compositions of chlorite schist.*

Sample	bakke1	bakke2	bakke3	båts1	båtb1	vesle1	ONARH2	ONARH3	ONARH5	ONARH6
Location	Bakkehidlaren	Bakkehidlaren	Bakkehidlaren	Båthidlaren	Båthidlaren	Veslehidlaren	Onarheim church	Onarheim church	Onarheim church	Onarheim church
La	6.22074839	3.91883226	7.29493871	8.03484516	9.5633129	10.4951677	4.63215259	7.19346049	6.70299728	7.27520436
Ce	6.02868812	3.74815594	7.62718564	7.2094245	8.25808045	9.6045198	4.39916405	6.09195402	6.26959248	6.36363636
Pr	5.97617213	3.7585	8.07313115	6.57103279	7.67017213	9.2375	4.89781022	6.1459854	6.87591241	6.58394161
Nd	6.63069167	4.22524333	9.26101167	6.94857667	8.28438167	10.231995	5.16174402	6.00562588	7.0323488	6.4416315
Sm	5.77935385	3.94064103	8.27641538	5.74653333	6.87050769	8.74524103	4.77489177	5.18614719	6.34632035	5.35064935
Eu	4.35219048	2.5467483	7.31742857	5.56820408	6.85953741	9.03651701	4.90804598	5.24137931	7.42528736	5.4137931
Gd	4.83746718	3.41922008	6.88829344	4.62118147	5.79983012	7.36192664	4.59150327	4.69934641	6.05555556	4.8627451
Tb	4.65187764	3.42512658	6.73822785	4.41934599	5.59253165	7.12894515	4.4137931	4.55172414	5.96551724	4.67241379
Dy	4.39220186	3.22956832	6.31016149	4.14931988	5.15829193	6.72145031	4.15485564	4.33858268	5.5511811	4.35433071
Ho	4.08473538	2.9983844	5.90584958	3.93630919	4.98662953	6.30735376	4.08235294	4.17647059	5.50588235	4.12941176
Er	4.01536667	3.02024762	5.88501429	3.9622	5.05534762	6.33512857	4.1124498	4.16064257	5.46586345	4.20883534
Tm	3.77901235	2.77253086	5.52395062	3.68916667	4.77987654	5.97558642	3.86111111	3.97222222	5.19444444	4.02777778
Yb	3.88588995	2.98790909	5.66510526	3.88123923	5.10119139	6.34859809	3.52419355	3.69354839	4.68145161	3.62903226
Lu	3.57658385	3.04074534	5.28950311	3.77201863	5.07782609	6.04335404	3.13157895	3.28947368	4.05263158	3.39473684

Table 6. *Sr and Nd isotope compositions of chlorite schist.*

Lab#	Sample	Location	eSr(0)	eNd(0)
øj 5417	Bakke 4	Bakkehidlaren	49.8221681	7.00299236
	Bakke 2	Bakkehidlaren	44.0367179	7.66622841
	Bakke 3	Bakkehidlaren	75.2689716	7.21756873
	Bakke 1	Bakkehidlaren	62.1164846	6.6518674
øj 5412	Båtb. 2	Båthidleren	55.5845374	3.82336073
øj 5414	Båtb. 4	Båthidleren	51.8370564	3.56977048
	Båtb. 1	Båthidleren	50.2968719	4.23300653
	Båts 1	Båthidleren	50.9598138	3.56977048
øj 5408	Erten 1	Ertenstein	74.69	4.21349958
øj 5409	Erten 2	Ertenstein	75.5	3.35519411
øj 5410	Erten 3	Ertenstein	74.72	3.88188156
øj 5411	Erten 4	Ertenstein	79.36	2.55540947
øj 5391	TH 001A	Gravdal	62.7533306	2.84801361
øj 5392	TH 001B	Gravdal	33.8235295	2.65294418
øj 5395	Gravdal 2	Gravdal	42.4395791	2.71146501
øj 5396	Gravdal 3	Gravdal	34.8025918	2.6139303
øj 5399	Helle 1	Hellebruddet	43.4618971	5.03279117
øj 5407	Helle 2	Hellebruddet	50.4749471	5.16933977
øj 5403	Onar 3	Onarheim	53.4125042	4.0379371
øj 5404	Onar 5	Onarheim	56.4644515	4.9547634
øj 5405	Onar 6	Onarheim	58.7782534	3.72582602
øj 5406	Onar 8	Onarheim	55.7405012	4.64265232
	Onø 1	Onarheim	68.050947	4.83772175
	Onø 2	Onarheim	55.083148	4.77920092
øj 5400	Vesle 2	Veslehidlaren	53.4552079	4.52561066
	Vesle 1	Veslehidlaren	48.3410313	4.91574952
th 4954	Ø1	Øye	15.6816384	6.39827715
th 4955	Ø3	Øye	14.2324278	8.48552
th 4956	Ø4	Øye	14.5346189	5.05229811
th 4957	Ø5	Øye	19.2669289	8.05636726
th 4958	Ø6	Øye	12.807198	7.68573535
th 4959	Ø7	Øye	12.9533972	7.7052423
th 4960	Ø8	Øye	20.6196258	7.45165204

Alf Tore Hommedal

Cistercian Soapstone. Production and Delivery of Building Material from Lyse Abbey to Bergen in the 13th century

Geochemical analyses of four medieval building stones in the collections of the University Museum of Bergen and one sample from a standing church have demonstrated a geological provenance to the soapstone quarry located close to the Cistercian abbey of Lyse south of Bergen. The five samples derive from four different monumental stone buildings in medieval Bergen: The Benedictine abbey church (Munkalif), the Franciscan friary church (St. Olaf's), the royal residence's great hall (King Håkon's Hall), and the same Residence's Royal chapel (the Church of the Apostles). The archaeological and historical contexts of the building and building fragments are discussed, dating the soapstone deliveries from Lyse to the second half of the 13th century. This paper also discusses the organisation of a Cistercian abbey and asks if the lay-brothers in the abbey may have played an important role as craftsmen in the quarry at Lyse. The soapstone quarry seems to have been essential for the Cistercians, not only for building their own monastic complex from the mid-12th century onwards but also as a source of income, selling soapstone material to royal and ecclesiastical building projects in Bergen – at least documented in a period from the mid-13th century onwards.

Introduction

Among the soapstone quarries in western Norway the quarry at Lyse is interesting due to its close connection to a monastery and thus to an organised economical unit of international character. Norwegian monasteries took an active part in introducing the European building tradition of masonry to Norway, and seem to have followed the European norm of layout and building material in their houses (Hommedal 1999:178–180). It is therefore not surprising to find a soapstone quarry for building stones connected to the Cistercian abbey of Lyse, c. 27 km south of Bergen.

Lyse abbey (*cænobium Vallis lucidæ*) was founded in 1146, from Fountains abbey in England, as the first of altogether four Cistercian foundations in medieval Norway. This close connection to England also explains the 12th century Anglo-Norman architectural style of the buildings at Lyse. The high quality of the architectural details indicates that the stone sculptors were English, or Norwegians who were directly influenced by English masonry skills (Nybø 1987:185). It has even been suggested – but still not fully documented – that the Anglo-Norman style found in ecclesiastical monuments in Bergen from the 1160s onwards has a direct connection to the Cistercians at Lyse, who started the erection of their own monastic complex in the decades after their arrival in 1146 (Lidén & Magerøy 1990:87–90).

In this paper I will not discuss the possible architectural influence of the Cistercians in 12th century Bergen, but rather look into the connections between Lyse and Bergen in the 13th and the very beginning of the 14th century. The discussion is based on the geologists Øystein J. Jansen and Tom Heldal's visual analysis of ashlars in situ in the Franciscan church of St. Olaf's, i.e. the present Bergen Cathedral (Jansen et al. 2009:591–592). In addition, the discussion is based on the results of geochemical analyses of five soapstone samples: four from moulded building stones in the collections of the University Museum of Bergen and one in St. Olaf's church (Jansen et al. 2009; Jansen & Heldal 2015; Hommedal 2015 b; Jansen pers. comm. 2016). The content of trace elements (Ni, Co, Cr, Zn and V) and Sr/Nd isotopes of the sampled building stones has been compared with similar data from 14 quarries in or near the Hordaland County (Jansen & Heldal 2015). According to Jansen and Heldal (2009; 2015) the visual analysis of in situ masonry as well as the geochemically sampled moulded masonry stones point out Lyse as the most likely origin quarry for the building stones under study.

The discussed geological analyses relate to four different monuments in medieval Bergen. In addition to the still standing Franciscan St. Olaf's church, the archaeological provenience of the sampled building fragments relates to the Benedictine church of St. Michael's (*Munkalif*, now burried), the royal residence's still standing great hall (today known as *King Håkon's hall*), and to the same Residence's (third) royal chapel dedicated to the Apostles (now either location or extent of possible ruins are certain). The altogether four soapstone receiving monuments discussed thus relate to the royal palatium (two monuments) and to two monastic institutions, the Benedictine abbey and the Franciscan friary. A third monastic institution, the Cistercian abbey at Lyse, is the presumed deliverer of stone material.

With the starting point in the geochemical and visual geological analysis strongly indicating contacts between Lyse and Bergen in the 13th century, I am going to look more into the archaeological context of the four buildings involved. In other words, in the following I will try to put the results of the geological analyses into a cultural and historical context. How did a Cistercian monastery function with regard to building activity and crafts, and in what way does it tell or indicate that the quarry at Lyse was a part of a Cistercian institution? What can be indicated about the buildings and the institutions in Bergen where the Lyse stones were used?

The Cistercians abbey and the soapstone quarry at Lyse

The ruins of the abbey at Lyse are among the best preserved sites of a total of 31 monasteries known from Norway's Middle Ages (Hommedal 1999:156–157). The central buildings at Lyse were built as a complex with four ranges or wings like most monasteries of the order, even though the west range is now lacking and may have been built in wood (Figure 1). The function of the rooms seems largely to follow the usual pattern for a Cistercian house. According to the art historian Marit Nybø, the building of the church started just after the foundation of the abbey in 1146, and it seems likely that the conventual quadrangle, with the cloister, was finished within the first third of the 13th century (Nybø 1987:186). Outside the conventual quadrangle the remains of two buildings, one of them probably the monastery's tannery, have been discovered together with traces of the monastery's drainage system (Lidén 1976:30–33; Nybø 1987:184, 186).

The soapstone quarry is located a few hundred meters into the valley to the east of the conventual quadrangle. The visible quarry walls make a deep scar in the hillside and they are 6–18 m high, enclosing an area of a possible quarry floor of 2–3000 m^2. There have not been any proper archaeological registrations and excavations in the quarry. One would, for example, have expected a road for stone

Figure 1. *Parts of the central quadrangular of the abbey at Lyse, with the cloister garth and the surrounding cloister walks. The arcade arches are reconstructed. The ruined walls of the church lie in the background. (Photo: A.T. Hommedal).*

transportation from the quarry to the monastery site and to the fjord, since it seems improbable that all stones were transported on snow sledges during winter. A sizable heap of waste is found directly in front of the quarry (Jansen et al. 2009:591) but no workshops have been documented. The traces of mining of building stones are distinct (Figure 2), but two unfinished and abandoned soapstone vessels have been found in the spoil heaps, also demonstrating other exploitation of the quarry. One of the vessels (BRM 182 in the University Museums of Bergen's collections) seems to be a cooking vessel. The other one (BRM 151) is, however, with its quadratic shape (c. 24 x 24 cm), 6–10 cm height, and the 3–4 cm thickness of its sides, not consistent with a vessel for food, even though the vessel is not finished. It seems also to be too large to be a type of oil lamp. A possibility is that this vessel was intended to be a laver for holy water located at the entrance of a church. Since the vessel has no mark of connection to a stone wall it seems to have been intended to be free-standing, and maybe intended for a wooden church. It is absolutely conceivable that the Cistercians in their quarry also produced such liturgical artefacts for themselves or to sell.

The Cistercian order was one of the strictest religious orders to establish itself in medieval Norway. The monks lived a contemplative life with a totally imposed stabilitas loci – which means living absolutely inside the monastery's premises or enclosing walls where the religious rules and routines governed the monastic life. At Lyse one would expect that the area of the quarry was included in the monastery's premises, even though it must have been located outside the precinct walls.

Figure 2. *The soapstone quarry at Lyse. One can see traces of exploiting the quarry for ashlars. (Photo: A. T. Hommedal).*

In a Cistercian monastery one would find two kinds of 'monks'. In addition to the ordained clergy or choir monks one would also find the conversi or lay brothers, that is, the brothers who were not priests. They were also defined by their beard and cloak. The system of lay brothers seems most likely to have been introduced to the order between 1111 and 1119 (France 2012:34), and thus before the foundation of the abbey at Lyse. After a period, the system seems to have declined, especially during the 14th century, and in the 15th century no conversi are recorded in many of the European monasteries (France 2012:306–322).

The lay brothers are especially interesting in the discussion of the building activity in a Cistercian monastery – and at Lyse then also of the quarry. The priests and the lay brothers lived and practiced on different levels. For the choir monks the day-and-night cycle was divided into three parts. The first third was reserved for the divine office with liturgical prayer and mass, preceding all other activities. The second third was reserved for reading and studies and manual work. The last third was reserved for rest and sleep. The three parts were subdivided into intervals so that the choir monks, for example, gathered eight times in the church to pray during a given day, seven times during the day and once during the night. The lay brothers, on the other hand, took the same vows as the choir monks after a year-long novitiate, but they were not required to observe the full divine office. They were therefore more available for manual work. This class-divided monastic society, also excluding the conversi from the administration of the monastery, is illustrated by the fact that the lay brothers were restricted to their own quarters in the west range of the conventual quadrangle and to the western part of the church. They were, for instance, not normally admitted to the cloister (Braunfels 1972:75, 77–79; Greene 1992:234; Leroux-Dhuys 1998:73–74; Kinder 2002:55–58, 305–331; France 2012).

With the Cistercians' ideology of ora et labora – pray and work – not only the lay brothers, but also the ordained clergy, as already pointed out, were required to perform manual work. However, the main part of the material business of the abbey, such as agricultural labor and work in workshops of different kinds, would mostly be dealt with by the lay brothers. Due to their ideology, and with the international contacts of the Cistercians, inventions were often developed in monasteries, for instance when it comes to technology. It is then only to expect that the Cistercians also introduced new elements to Norway – such as, for instance, the Anglo-Norman style in the architecture at Lyse – especially since the monks should normally erect their building complexes themselves. This last statement, however, has been disputed (see e.g. Greene 1992:68–69), but as the historian James France has documented, both priest monks and lay brothers attended to building processes, and a number of Cistercian General Chapter statutes in the 12th century refer to priest monks and lay brothers engaged in building work (France 2012:48–56). There are also indications that the Cistercians in Norway could work as masons and house builders in the late Middle Ages: When Munkalif abbey in Bergen was destroyed by fire, the Bridgettine nuns and monks there were relocated to Hófuðey abbey outside Oslo from c. 1460 to c. 1478, while the Cistercians at Hófuðey in the same period were in Bergen, probably to rebuild Munkalif (Lange 1856:301–304, 415; Hommedal 2014:622). This was after the general main period of the conversi, and most likely the priest-monks must have taken an active part in the rebuilding process.

For the Cistercians at Lyse, the soapstone quarry would therefore have been essential already from the foundation of the abbey. It is not surprising that the geochemical analysis of a soapstone sample from the abbey ruins isotopically matches the rock in the quarry. It has even been suggested that the quarry was established for the purpose of building the abbey (Jansen et al. 2009:591). This is conceivable, but there is also a possibility that the quarry existed as a vessel quarry before the monastery was established, even though this is not documented. In fact, the existence of rich soapstone resources may have been one of the reasons for placing the Cistercian monastery just at this site.

In the following I will return to the four masonry buildings in Bergen where building material from Lyse quarry are geochemical documented.

Håkonshallen – King Håkon's hall – and its high seat

The museum collection contains seven original stone fragments from the high seat in King Håkon's hall, the still standing great stone hall from the royal residence in medieval Bergen (Figures 3 and 4). These original high seat fragments were removed from the building during the first restoration of the hall in 1880–95. The stones are verified as part of the original masonry due to documentary drawings and analytical building descriptions from before the restoration (Nicolaysen 1861a; Hommedal 2013:19, 34–35). Geochemical analyses of samples from the two stones (BRM 62/2 and BRM 62/32

Figure 3. *Håkonshallen – King Håkons's hall – the great hall in the royal residence of medieval Bergen, built between 1247 and 1261. The building was restored in 1880–95 and again in 1957–61. (Photo: University Museum of Bergen).*

Figure 4. *King Håkon's hall, the high seat with its arched moulding in the present, restored version. Two of the moulded stones from the original high seat have a geological provenience to the soapstone quarry at Lyse. (Photo: O. E. Eide).*

Figure 5. *The moulded stone BRM 62/2 in the collection of the University Museum of Bergen. Originating from the quarry at Lyse and used in the masonry in King Håkon's hall. (Photo: A. T. Hommedal).*

– see Figure 5) match the rock in the soapstone quarry at Lyse (Jansen et al. 2009; Jansen & Heldal 2015).

Based on its architecturally and archaeologically distinctive features, King Håkon's hall must have been built in the middle of the 13th century. Based on a written source, the saga of King Håkon Håkonsson, written in the 1260s, the period of construction can be defined more precisely to between 1247 and 1261 (Fischer & Fischer 1980:124–125; Helle 2013:111–113).

We can thus conclude that the Cistercians at Lyse in the 1250s delivered soapstone from their quarry for the construction of the royal banquet hall in Bergen. The Lyse material was at least used for moulded parts of the King's high seat.

The royal chapel: The Church of the Apostles

The University Museum of Bergen's collection of building stones from demolished medieval buildings at Bergenhus have been catalogued and discussed by, for instance, the two architecture historians Ole

Egil Eide and Hans-Emil Lidén. The work of Eide and Lidén has shown that a small number of these stones most probably are fragments from the third version of the Church of the Apostles, the royal chapel in the King's residence. This third church was initiated by King Magnus the Law Mender (1263–80) and built between 1275 and 1302 (Lidén 1980:163–179, 196–199; Helle 2013:114–115).

We do not know much about this third Church of the Apostles. Neither the layout nor the exact site of the church has been clearly established. But narratives give some information, and in combination with the identified stone fragments with rather complicated mouldings and delicately shaped capitals, we learn that the church must have been one of the most precious high Gothic buildings in Norway. The church was torn down in 1529–30 and parts of the stone material was reused in other buildings in the present day Bergenhus and therefore preserved until today (Lidén & Magerøy 1980:137–139; 1990:94; Lidén 1980:164–165).

A geochemically analysed sample from the stone (BRM 62/162) from a window frame matches the rock in the soapstone quarry at Lyse (Jansen et al. 2009; Jansen & Heldal 2015). With the premise that the interpretation of this building fragment as part of the third Church of the Apostles is correct, we can then conclude that the Cistercians at Lyse in the third quarter of the 13th century delivered soapstone for the construction of the new royal chapel in Bergen.

St. Michael's abbey church at Munkalif

The last museum collection stone to be discussed is a moulded fragment from the west portal frame in St. Michael's church at Munkalif, meaning 'where the monks are living' (Figure 6). The layout of the Benedictine abbey church is known from an archaeological excavation in 1860 (Nicolaysen 1861b:59–79). Then also the discussed portal fragment was found in its original masonry position. St. Michael's, the oldest monastic church in Bergen, was built in the first part of the 12th century. In

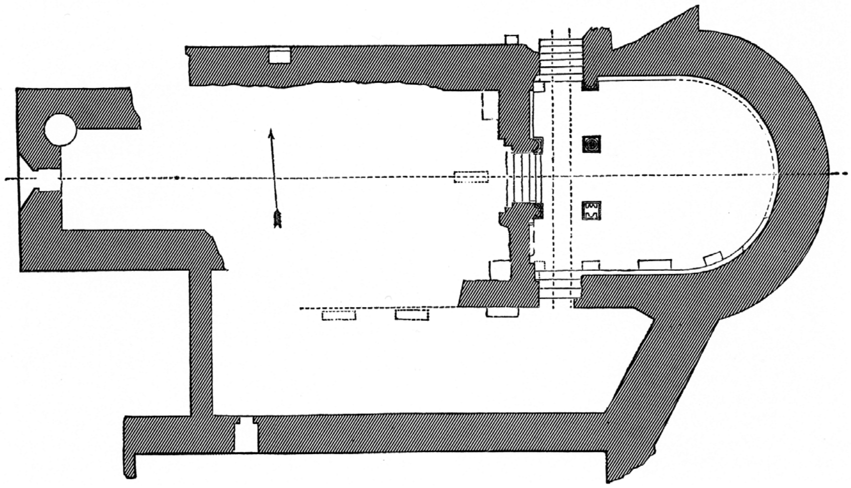


Figure 6. *The ground plan of the Benedictine St. Michael's church at Munkalif. The church was about 35 m long and 13 m wide. It seems to have been built in the first part of the 12th century as a long church with an apsidial chancel. In the 13th century the church was extended with a west tower, and one of the moulded stones from the new west portal has a geological provenience to the soapstone quarry at Lyse. The south aisle of the church was originally the northern cloister walk of the Benedictine conventual buildings. (Drawing: N. Nicolaysen 1861 in Lidén & Magerøy 1980:151).*

Figure 7. *The moulded stone MA 370a in the collection of the University Museum of Bergen. The corresponding stone (MA 370b) originates from the quarry at Lyse. The stones are used in the masonry of St. Michael's church at Munkalif in the second half of the 13th century. (Photo: A.T. Hommedal).*

the 13th century the church seems to have been extended with a west tower, or at least a new west portal which also comprised our fragment. The mouldings indicate that the portal was erected within the last three decades of the 13th century (Lidén & Magerøy 1980:150–157; 1990:91, 93–94). It has been suggested that the west portal was created by the craftsmen Arne grjótmeistare and Rane grjótsmidr who apparently worked at Munkalif in 1287 (Lidén & Magerøy 1990:94, endnote 18).

A geochemically analysed sample from a stone (MA 370b) originating from St. Michael's west portal (Figure 7) matches the rock in the soapstone quarry at Lyse (Agdestein & Jansen 2006:17; Jansen et al. 2009; Jansen & Heldal 2015). We may therefore conclude that the Cistercians at Lyse in the last decades of the 13th century, maybe in the 1280s, delivered soapstone to the Benedictines in Bergen for the new west portal of the abbey church.

St. Olaf's friary church

The last building to be discussed is St. Olaf's church, first erected in stone c. 1150, probably as a parish church. The church seems to have been donated to the Franciscans in the 1240s, possibly by King Håkon Håkonsson, even though this is not clearly documented (Ullern 1997:116–120). During the rest of the century the church was rebuilt by the friars on two or three occasions and subsequently also extended, first to the west with a prolonged nave, in the decades around 1270, and then to the east with a new chancel within the period 1270–1301 (Figure 8). The eastern extension seems to be related to the extension's function as royal grave chancel for King Magnus the Law Mender. In connection with the Reformation in 1536–37 the church was given a new function as the Lutheran cathedral, a function it still retains (Lidén & Magerøy 1983:9–13; Ekroll 1994; Hommedal 2014:625–626).

It seems that soapstone from Lyse was used in both the western and eastern extensions of St. Olaf's. In the western extension the identification is based on visual geological assessment of the masonry. The majority of the ashlars are, according to Jansen and Heldal (2015),

'…typical greyish/green, schistose, containing talc, chlorite and carbonate with intercalated veins and lenses of brownish weathering carbonate. Some of these ashlars contain a characteristic feature; dark green veins of chlorite with a rim of talc – often displaying spectacular folding structures. The visual appearance of the stone is similar to the ones with proposed Lyse provenance from the University Museum of Bergen collection…' (Jansen & Heldal 2015).

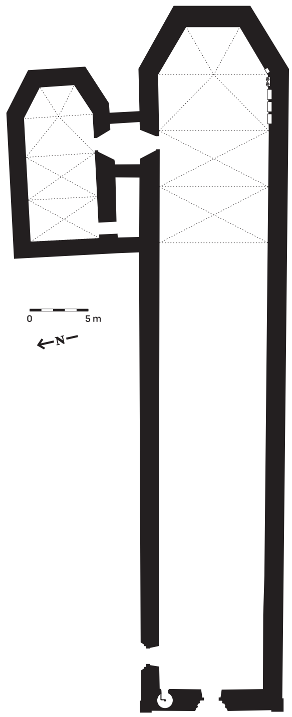


Figure 8. *The ground plan of St. Olaf's, the Franciscan friary church in Bergen, as it occurred at its consecration in 1301. The vestry, to the left, is first mentioned in 1309. In the chancel's south wall the sedilia, the piscine and a repositorium are marked (compare to Figure 9). (Drawing revised by P. Bækken & A. T. Hommedal, after drawings by O. E. Eide (unpublished) and E. B. Andersen in Lidén & Magerøy 1980:282).*

In addition, some soapstone samples from the masonry of the western extension, not fully discussed here, seem to maintain the indication to the quarry at Lyse (pers. comm. Øystein J. Jansen 2016).

It is interesting to observe that in this western extension of St. Olaf's, the monumental west portal is very similar in architectural expression to the corresponding portal at Munkalif (Lidén & Magerøy 1983:29–33, 1990:107). With a documented Lyse provenance of the stone material of the Benedictine portal at Munkalif, erected in the same period as the portal in St. Olaf's, one would not be surprised if the stone material in the Franciscan portal also turned out to originate from the same quarry. This is for future research to decide.

In the eastern chancel extension of St. Olaf's, the identification of Cistercian soapstone is related to a sample (BRM 1083/1) from the sedilia (Figures 8 and 9) inserted in the south wall of the new chancel (Hommedal 2015b). The sample has been geochemically analysed and matches

Figure 9. *The sedilia inserted in the south wall of the extended St. Olaf's. The soapstone sample matching the quarry at Lyse originates from the original sidewall of the easternmost sedile, i.e. the masonry filling out between the sedilia and the piscina. The sedilia with its three sedile represents the seats of the celebrating priest and assisting deacon and sub-deacon during mass, and the sedilia is therefore situated by the main altar. To the east (left) of the piscina a repositorium (cupboard) is inserted in the wall. (Photo: A.T. Hommedal).*

the rock in the soapstone quarry at Lyse (pers. comm. Øystein J. Jansen, 2016).

We may therefore conclude that the Cistercians at Lyse in the course of the last decades of the 13th century delivered at least some soapstone from their quarry to the Franciscans' extension work of their church's chancel. The delivery of Cistercian soapstone had probably also taken place earlier, in the third quarter of the 13th century, when the Franciscans extended their church's nave to the west.

The actors at Lyse and in Bergen

Based on the premise that the results of both the visual geological and the geochemical analyses are valid, we may conclude that the Cistercians at Lyse delivered soapstone from their quarry to three of the main institutions in Bergen in the second half of the 13th century: The King, the Benedictine abbey and the Franciscan friary. In the 1250s and again after 1275 the Cistercians delivered stone material for building activity in the royal palatium or residence, respectively, for King Håkon's hall and the third Church of the Apostles. This was a period of extensive building activity in the King's palace complex in Bergen, starting in the 1240s with the second Church of the Apostles and ending in 1302 with the consecration of the third royal chapel with this same dedication (Lidén & Magerøy 1990:91; Helle 2013:112–115). Even though we do not know how extensive the delivery from Lyse was, we can at least say that the Cistercians delivered stone material during different decades of this royal building period of c. 60 years.

In the last decades of the same period, maybe in the 1270s and 1280s, there are indications that Lyse also supplied material for the western extension of the Franciscans' friary church with its new western portal, and at around the same time Lyse supplied stone material for a similarly shaped new western portal in the Benedictine church at Munkalif. Since we know so little about the monastic building complex at Munkalif, we cannot tell whether this supply was a once only delivery or whether the Cistercians also had other deliveries to the Benedictines. For the Franciscan, however, the Cistercians at Lyse seem to have delivered stone material throughout the 13th century and at least towards the completing and consecration of the new Franciscan church in 1301, one year before the consecration of the Church of the Apostles in 1302.

It is also interesting to note that the Cistercians at Lyse delivered building material not only to two of the richest institutions in Norway, the King and the abbey at Munkalif, but also to the Mendicants in St. Olaf's church. The Franciscans were not allowed to have any estate giving income, and formally they were even not allowed to own their own friary. We must assume that the King and the Benedictines at Munkalif had soapstone quarries of their own, whereas it is unlikely that the Franciscans as Mendicants had such quarries. We know that the Franciscans in Bergen in 1277 got a precious testamentary gift from King Magnus the Law Mender, and the testament tells the gift already was disbursed (DN IV, no. 3). The King also selected for himself to be buried in the Franciscan church, probably partly explaining the extension of the church chancel in the last decades of the 13th century (Lidén & Magerøy 1983:9, 18). King Magnus, instructing the erection of the third Church of the Apostles in the King's palatium c. 1274, thus also obtained the money for the Franciscans' building activity in Bergen at the same time. This may suggest that the supply of building material for St. Olaf's was at least partly organised in cooperation with the royal deliveries. Maybe the construction work even was performed by the masons from the royal mason lodge? Lidén (Lidén & Magerøy 1990:65–67) has suggested that King Håkon Håkonsson established a royal building workshop when renewing the (second) Church of the Apostles in stone in the 1240s, continuing with King Håkons's hall and other secular buildings in the royal precincts, but also with buildings in the town itself. Lidén suggests that the royal mason lodge was re-constituted in connection with building

King Magnus the Law Mender's (third) Church of the Apostles, and that this was the workshop's main task. There may be a possibility that the royal mason lodge also was given the task of organising and performing the building work at the Franciscan church, especially since King Magnus was going to be buried there. Could the King even formally own the Franciscan church and friary, since the Franciscans were not allowed to own property themselves? In all cases, even if the Franciscan building activity was performed by the royal mason lodge, the architectural expression of the work in St. Olaf's was given a typical Franciscan character, still visible, e.g., in the west front's combination of a large tracery window over the west portal (Figure 9). The Franciscan architecture is likewise visible in the location of a north portal in combination with the west portal (Figure 8), in a characteristic Mendicant way (Larsen 2015:114–115).

When the King and the Benedictines at Munkalif seem to have bought soapstone from the Cistercians at Lyse in the three last decades of the 13th century, this may be because of the quality of the stone. Another explanation would simply be that a network between the Cistercians at Lyse and different institutions in Bergen then was already established. The abbey at Lyse, with its quarry, was also well located in connection with Bergen and with a relatively short sea route from the Lyse fjord to the town.

It has been suggested that the Lyse quarry could have been a major source of soapstone for Bergen from the late 12th century onwards and throughout the 13th century (Jansen et al. 2009:592). That is absolutely a possibility, but one should also be aware of the possibility that the supplies from Lyse to Bergen started at the time of the beginning of the extensive building activity undertaken by the King, that is around 1240. As already mentioned, it seems likely that the building of the conventual quadrangle at Lyse was finished within the first third of the 13th century. There is a possibility that the Cistercians until then had been giving priority to their own building activity, and that they started more external deliveries to Bergen within the second third of the 13th century. It is in this connection interesting to see that at Munkalif, geochemical analyses of the few, preserved soapstone fragments of the 12th century church seem not to give the provenience of Lyse, but rather Russøy and Bergsholmen, two other quarries south of Bergen (Agdestein & Jansen 2006:16–17). Even other quarries within the present county of Hordaland seem to have delivered soapstone to buildings in Bergen in the 12th century, but Lyse is not documented among them (Jansen et al. 2009).

When building the monastery at Lyse in the 12th and early 13th century, we must assume that the conversi worked in the mason's lodge as stone cutters and sculptors, and also, for instance, as carpenters and smiths. Although the system of lay brothers was not a Cistercian innovation, no religious order had previously used such a large number of them and to such good effect (France 2012). At the time of the foundation of Lyse in the mid-12th century, a Cistercian monastery could normally have two or three times as many lay brothers as priests or choir monks (Leroux-Dhuys 1998:74). If we assume that Lyse had the lowest possible number of choir monks for a Cistercian abbey, i.e. 13, we can assume that there were between 20 and 40 lay brothers. The conversi were normally recruited from among the local peasants. We must suppose this also was the situation at Lyse except during the founding period, when the monks and the masons, and then probably also lay brothers, seem to have been English (Gunnes 1995:135–136; Nybø 1987:185; Lidén 2014:21).

The Cistercian conversi were, to a certain extent, allowed to take part in activities outside the enclosure walls (France 2012). We can therefore also assume that some of the lay brothers at Lyse worked as craftsmen in the quarry and with related activities. In addition to the conversi, other men generally associated with a Cistercian monastery may have been employed there as hired workers (mercenarii) or as familiares, that is, men who lived in close association with the conversi and who did much of the same work, but did not have the same religious duties and obligation (Kinder 2002:308).

We must learn more about the structures, the activities and the actors in the monastic quarry at Lyse. Surely archaeological excavations would give valuable information on both the working techniques and on labor structures as well as on workshops, lodges and roads. More geochemical investigations regarding the relations between the raw material in the quarry and the stones in the walls of the monastic ruins should be undertaken. The accumulations of waste in the quarry would surely be a fountain of information. Analyses of the quarry waste would probably throw light on the question of whether the quarry is older than the Cistercian foundation, and also provide information about how long the Cistercians used this soapstone source or even if the quarry was used after the dissolution of the monastery. Likewise, analyses of the quarry could possibly tell if the Cistercians also produced other goods such as soapstone vessels for cooking and items for religious purposes. Further geochemical analyses of the building material delivered to Bergen and maybe to other places will be important, as will be a discussion about the economic income that the soapstone deliveries could generate. And last, but not least, it is necessary to address the question of the role which the conversi, the familiares and the mercenarii played as actors in the quarry industry, and the question of the extent to which the general decline in the numbers of conversi in the late Middle Ages affected the Lyse quarry.

At present we can conclude that the soapstone quarry at Lyse seems to have been essential to the Cistercians, not only in building their own monastic complex from the mid-12th century onwards, but also as a source of income, selling building material to Bergen. This network seems to have been documented at least in a period from the mid-13th century onwards and throughout the century, giving unique building material to some of the town's most prestigious royal and ecclesiastical building projects of the time.

Comments and acknowledgements

This paper is an edited and extended version of the paper 'From collection to quarry – Lyse abbey's role as soapstone supplier in the Middle Ages' (Hommedal 2015a). The author wishes to thank the architecture historian Ole Egil Eide and the geologist Øystein J. Jansen for extended discussions of the presented ideas, related to an interdisciplinary cooperation project on St. Mary's church in Bergen. The author also wishes to thank Gitte Hansen, Ann Meeks Hjemgaard, Eva Stavsøien, Hilde Vangstad and Bodil Østerås on the discussion and interpretation of the soapstone vessels BRM 151 and BRM 182 in the University Museum of Bergen.

References

Agdestein, S. O. & Jansen, Ø. J. 2006. Kleberbruddene på Russøy og Bergsholmen – gjemt, men ikke glemt. Sogeskrift for Tysnes 2006, 7–20.

Braunfels, W. 1972. Monasteries of Western Europe. The Architecture of the Orders. Thames and Hudson, London.

DN = Diplomatarium Norvegicum I–XXI. Christiania 1849 – Oslo 1976.

Du Colombier, P. 1973. Les Chantiers des Cathédrales. Éditions A. J. Picard, Paris.

Fischer, G. & Fischer, D. 1980. Norske kongeborger. Bd. II: Bergenhus. Gyldendal Norsk Forlag, Oslo.

France, J. 2012. Separate but Equal. Cistercian Lay Brothers 1120–1350. Cistercian studies series no. 246. Cistercians Publications, Liturgical Press, Collegeville, Minnesota.

Ekroll, Ø. 1993. Norske fransiskanarkonvent, in Eriksson, J.E.G. & Schei, K. (eds), Seminaret «Kloster og by» 11–13. november 1992. Tverrfaglige seminarer i Tønsberg, Rapport nr. 1, Tønsberg, 135–153.

Greene, J. P. 1992. Medieval Monasteries. Leicester University Press, London and New York.

Gunnes, E. 1995. Ordener og klostre i norske samfunnsliv. Collegium Medievale, vol. 8,131–145.

Helle, K. 2013. The Political Centre of the High Medieval Norwegian Kingdom. In Brekke, Ø. H. & Ersland G. A. (eds) Håkonshallen 750 years. Royal Residence and National Monument, 111–121. Dreyers Forlag, Oslo.

Hommedal, A.T. 1999. Kva fortel bygningsrestane av dei norske klostra om kontinental norm og norsk praksis innan ordensliva? In Mundal, E. & Øye, I. (eds): Norm og praksis i middelaldersamfunnet. Kulturtekster 14, 149–183. SEK Senter for Europeiske Kulturstudier. Universitetet i Bergen, Bergen.

Hommedal, A. T. 2013. King Håkon's Hall and its Authenticity. The Medieval Hall and its Archaeology in the 19th and 20th Centuries. In Brekke, Ø. H. & Ersland G. A. (eds) Håkonshallen 750 years. Royal Residence and National Monument, 17–43. Dreyers Forlag, Oslo.

Hommedal, A. T. 2014. Monks, nuns, canons and friars in medieval Bergen». In Gläser, M. & Schneider, M (eds) Die Klöster. Lübecker Kolloquium zur Stadtarchäologie im Hanseraum IX. 613–628. Verlag Schmidt-Römhild, Lübeck.

Hommedal, A.T. 2015a. From Collection to Quarry. Lyse Abbey's role as Soapstone Supplier in the Middle Ages. In Indrelid, S., Hjelle, K. L. & Stene, K. (eds) Exploitation of outfield resources – Joint Research at the University Museums of Norway. Universitetsmuseet i Bergen, Skrifter nr. 32. 155–166. University of Bergen, Bergen.

Hommedal, A. T. 2015b. Notat. Bygningstilstanden i Bergen Domkirke og utrasa steinfragment frå sedilia i koret. (Fragment: BRM 1983 i Universitetsmuseet i Bergen sine samlingar). Notat av 14. april 2015. 1–3. Archive report Topografisk arkiv. University Museum of Bergen.

Jansen, Ø. J., Heldal, T., Pedersen R. B., Ronen, Y. & Kaland, S. H. H. 2009. Provenance of soapstone used in medieval buildings in the Bergen region, western Norway. *Asmosia VII. BCH Supplément (Bulletin de correspondence hellénique)* 51, 581–595.

Jansen, Ø. J. & Heldal, T. 2015. Identifying soapstone from the Lyse quarry in medieval buildings, Bergen. Archive report Topografisk arkiv. University Museum of Bergen.

Kinder, T. 2002: Cistercian Europe. Architecture of Contemplation. Cistercian Publications Kalamazoo, Michigan.

Lange, C.C.A. 1856. De norske Klostres Historie i Middelalderen. Anden omarbeidede Udgave. Chr. Tønsbergs Forlag, Christiania.

Larsen, M. 2015. Klosterkultur mellem ideal og realitet. Arkæologiske studier af Danmarks middelalderlige tiggerklostre. Unpublished Ph.D. thesis in archaeology, the Graduate School of Arts, University of Aarhus.

Leroux-Dhuys, J.-F. 1998. Cistercian Abbeys. History and Architecture. Könemann, Köln.

Lidén, H.-E. 1976. En nyoppdaget bygning på Lyse kloster. In Tschudi Madsen, S. & Vea, E. (eds) Vern og Virke 1975. Årsberetning fra Riksantikvaren og den antikvariske bygningsnemnd, 30–33. Grøndahl & søn trykkeri AS, Oslo.

Lidén, H.-E. 1980. Bygningsstein frå Bergenhus. In Fischer, G. & Fischer, D. Norske kongeborger. Bind II: Bergenhus, 163–179 and 196–199. Gyldendal Norsk Forlag, Oslo.

Lidén, H.-E. 2014. Lyse kloster. Bodoin Forlag, Bergen.

Lidén, H.-E. & Magerøy, E. M. 1980. Norges kirker. Bergen Bind I. Gyldendal Norsk Forlag, Oslo.

Lidén, H.-E. & Magerøy, E. M. 1983. Norges kirker. Bergen Bind II. Gyldendal Norsk Forlag, Oslo.

Lidén, H.-E. & Magerøy, E. M. 1990. Norges kirker. Bergen Bind III. Gyldendal Norsk Forlag, Oslo.

Nicolaysen, N. 1861a. Kongehallen paa Bergenhus – The King's Hall at Bergenhus. Norske Bygninger fra Fortiden (Norwegian Buildings from Former Times), Förste Række, 6–18, Kristiania.

Nicolaysen, N. 1861b. Om Munkelifsklosteret i Bergen og dets levninger. Årbok for Foreningen til norske fortidsminnesmerkers bevaring, Aarsberetning 1860, 59–79.

Nybø, M. 1987. Lyse kloster. Vårt første cistercienseranlegg. Årbok for Foreningen til norske fortidsminnesmerkers bevaring, Vol. 141, pp.169–186.

Ullern, I. -J. 1997. Tiggerordenene i de norske middelalderbyene. Unpublished master thesis (hovedfag) in history, University of Oslo, 1997.

List of Authors

Irene Baug
Department of Archaeology, History,
Cultural Studies and Religion,
University of Bergen (UIB),
5020 Bergen, Norway
Irene.Baug@uib.no

Irene Baug's (b. 1973) M.A. and Ph.D. were connected to quarries and large-scale production during the Viking Age and the Middle Ages in Western Norway. She is now a post-doctoral fellow at UIB. Her research includes production landscapes and artefacts studied within a societal context, where social, economic and socio-political relations are analysed. Baug's research also focuses on trade and exchange, and contacts and networks are analysed and discussed based on different types of sources – both archaeological and historical. Her research interests are furthermore connected to the use of artefacts in relation to food and food culture, where aspects such as identity and tradition gain focus.

Birgitta Berglund
Dept. of Archaeology and Cultural History,
University Museum,
Norwegian University of Science and
Technology (NTNU),
7491 Trondheim, Norway
birgitta.berglund@ntnu.no

Dr.philos. Birgitta Berglund (b. 1948) is a professor of archaeology at the NTNU University Museum. Her research interests are primarily north European coastal rural settlements, power relationship, identity and burial practices AD 0–1800, outfield resources as soapstone and the material culture of religion, including the Sámi.

Knut Andreas Bergsvik
Department of Cultural History
University Museum of Bergen
University of Bergen (UIB)
5020 Bergen, Norway
Knut.bergsvik@uib.no

Knut Andreas Bergsvik (b. 1961) is a professor of Stone Age archaeology at the University Museum of Bergen. His research interests and publications include the social and territorial organization of Stone Age hunter-gatherer/fisher groups, the transition to agriculture in Scandinavia and the human use of caves and rockshelters in a long-time perspective. He has conducted several excavation projects in western Norway.

Laura Bunse
Department of Cultural Sciences
Tromsø University Museum, UiT –
The Arctic University of Norway
P. Box 6050 Langnes
9037 Tromsø, Norway
laura.bunse@uit.no

Laura Bunse (b. 1985) has a M.A. degree, which includes archaeology, anthropology and Scandinavian studies from the University of Münster, Germany and the University of Tromsø, Norway (2010). She is currently a Ph.D. fellow in archaeology and studies the utilization of soapstone resources north of Saltfjellet in northern Norway, from prehistoric to early modern times. Her research interests include soapstone use and quarrying as well as Prehistoric horse remains and horse tack.

Amanda K. Forster
DigVentures
The Workshop
26 Newgate
Barnard Castle DL12 8NG, UK
manda@digventures.com

Amanda Forster (b. 1975) undertook her first degree in Archaeology and completed her Ph.D. research at the University of Bradford, UK. She completed her doctoral research on Shetland and the trade of steatite goods in the North Atlantic region during the Viking and early Medieval period, in 2004. Since then, Forster has worked in a number of roles in British archaeology, working as Senior Post Excavation Manager at Birmingham Archaeology and training students at the University of Birmingham, developing and delivering membership communications with the Chartered Institute for Archaeologists and, in her current position, as Programme Manager with DigVentures, a social enterprise specializing in digital and collaborative archaeology.

Tor Grenne
Geological Survey of Norway (NGU)
P. Box 6915 Sluppen,
7491 Trondheim, Norway
tor.grenne@ngu.no

Tor Grenne (b. 1951) obtained his Dr.techn. in 1990 at The Norwegian Institute of Technology (NTH) in Trondheim. He works as a geologist at NGU. His research interests include ore geology, bedrock mapping and lithogeochemistry, regional paleotectonic reconstructions, origin of chemical sedimentary rocks, early earth paleoceanography and early life, and mapping of soapstone and millstone quarries with provenance studies of associated artefacts.

Gitte Hansen
Department of Cultural History
University Museum of Bergen
University of Bergen (UIB)
5020 Bergen, Norway
gitte.hansen@uib.no

Gitte Hansen (b. 1961) obtained her Cand.mag. in Medieval Archaeology and Geography from Aarhus University in Denmark and wrote her Dr.art. dissertation on the emergence of Bergen as a town (UIB 2004). She holds the position as associate professor in medieval archaeology at the University Museum of Bergen. Her main research interest is early and high medieval producers and consumers of everyday household products and personal accessories. These actors are studied through a point of departure in artefacts made of domestic and exotic low-cost raw materials.

Tom Heldal
Geological Survey of Norway (NGU)
P. Box 6915 Sluppen,
7491 Trondheim, Norway
tom.heldal@ngu.no

Tom Heldal (b. 1961) works as Division Director at the Geological Survey of Norway. He is a geologist and has carried out research in the field of natural stone resources and historical use. He was the coordinator of an EU research project on the subject: QuarryScape (the conservation of ancient stone quarry landscapes in the Eastern Mediterranean) 2005–2009.

Alf Tore Hommedal
Department of Cultural History
University Museum of Bergen
University of Bergen (UIB)
5020 Bergen, Norway
alf.tore.Hommedal@uib.no

Alf Tore Hommedal (b. 1956) has a Mag.art. in Archaeology (UIB 1986). He holds the position of associate professor of medieval archaeology at the University Museum of Bergen, UIB. He has published on various subjects, mostly related to the Middle Ages, mainly concerning the archaeology of such buildings as churches and monastic sites in Medieval Norway.

Mogens Skaaning Høegsberg
Moesgård Museum
Moesgård Allé
8270 Højbjerg, Denmark
mho@moesgaardmuseum.dk

Mogens Skaaning Høegsberg (b. 1976) has a Ph.D. in Medieval and Renaissance Archaeology from Aarhus University in Denmark (2009) and is now an archaeologist at Moesgård Museum. His M.A. thesis was on the Greenland Norse bishop's seat Garðar, and his Ph.D. focused on the cultural identity of the Greenland Norse. The latter included an analysis of several thousand artefacts from Norse Greenland, including many soapstone artefacts.

Øystein J. Jansen
Department of Natural History
University Museum of Bergen
University of Bergen (UIB)
5020 Bergen, Norway
oystein.jansen@uib.no

Øystein James Jansen (b. 1946) has a Cand.real. degree in geology (UIB 1976). He has teaching and research experience at UiB and has also done extensive outreach activities, including TV-programmes, lectures and excursions. He published *Steinbyen Bergen* with Tom Heldal in 2000, a book about the history of the stones of the town of Bergen. His research interest the last 20 years has mainly focused on interdisciplinary geo-archaeological studies, particularly on provenance studies of different rocks (for different use) from building stones to vessels, millstones and whetstones.

Richard Jones
Archaeology
Gregory Building
School of Humanities
University of Glasgow
Glasgow G12 8QQ, UK
richard.jones@glasgow.ac.uk

Richard Jones (b. 1947), until recently, was Senior Lecturer in Archaeological Science at Glasgow University. After leaving Greece in 1992, where he was the first director of the Fitch Laboratory at the British School of Archaeology at Athens for many years, he came to Glasgow and expanded his work on the science-based analysis of materials and artefacts for information on origin and technology from a Mediterranean (Greek and Italian) perspective to one devoted more to northern Europe. A product of the latter has been his rewarding involvement (with many collaborators) on mainly Viking period soapstone.

Ingvar Lindahl
Geological Survey of Norway (NGU)
P. Box 6915 Sluppen,
7491 Trondheim, Norway
E-mail: ingvar.lindahl@ngu.no

Ingvar Lindahl (b. 1943) has a Siv.ing. degree and Dok.ing. degree from the Norwegian Institute of Technology (NTH) in Trondheim. He has worked on various ore types, industrial minerals, dimension stone as well as bedrock mapping through the decades. Lindahl finished his professional career at the NGU with the book Bygningsstein i Nordland (2012), a review on the use of dimension stone from Nordland County.

Lars Petter Nilsson
Geological Survey of Norway (NGU)
P. Box 6915 Sluppen,
7491 Trondheim, Norway
lars.nilsson@ngu.no

Lars Petter Nilsson (b. 1951) has a Siv.ing. degree in ore geology (chromium ore). He has worked on ore deposits, industrial minerals, dimension stone as well as bedrock mapping for nearly 38 years at NGU. He has devoted much time to talc/soapstone exploration through the years, culminating in his discovery with Ingvar Lindahl of the large Linnajavri talc/soapstone deposits in 2000.

Torbjørn Preus Schou
UNITAR
Reichweins gate 5
0254 Oslo, Norway
topresch@gmail.com

Torbjørn Preus Schou (b. 1980) wrote his M.A. thesis on the soapstone trade of Agder, southern Norway, during the Viking Age (University of Bergen 2007). He also worked on the Palmyrena project in Syria (www.org.uib.no/palmyrena), where he did his Ph.D. dissertation on mobile pastoralist groups in the Near Eastern Bronze Age (2015). Associated with this, Schou conducted extensive satellite surveys of Syria and analysed climatic and environmental developments in the region. His main research interests are remote sensing surveys, landscape archaeology, networks in antiquity and environmental studies. He currently works for UNITAR, analysing the effects of war on cultural heritage sites in Syria.

Eva Stavsøien
Nidaros Domkirkes Restaureringsarbeider (NDR)
Bispegata 11
7012 Trondheim, Norway
es937@kirken.no

Eva Stavsøien (b. 1961) is a restoration technician with 30 years of work experience from The Restoration Workshop of Nidaros Cathedral in Trondheim, Norway. She has a craft's certificate in stonework, as stonemason/-carver, and her main field of work is making copies to replace damaged stones at the Nidaros Cathedral. In 2012, she earned a B.A. of Technical Building Conservation and Traditional Craftsmanship at the Sør-Trøndelag University College (HiST), and she later completed a M.A. degree in Cultural Heritage at the Norwegian University of Science and Technology (NTNU) in Trondheim.

Lars F. Stenvik
Dept. of Archaeology and Cultural History,
University Museum,
Norwegian University of Science and
Technology (NTNU),
7491 Trondheim, Norway
lars.stenvik@ntnu.no

Lars F. Stenvik (b. 1950) is a professor of archaeology at the NTNU University Museum. He has studied the exploitation of outfield resources in the Iron Age and the Medieval period. Iron production in these periods has been especially studied as both technological and social expressions.

Per Storemyr
Archaeology & Conservation Services,
6957 Hyllestad, Norway
per.storemyr@hotmail.com

Per Storemyr (b. 1963) is a geo-archaeologist with a Ph.D. in the stones of Nidaros Cathedral in Trondheim (1998). He has worked on ancient quarries, stone buildings and rock art in Norway, Egypt and continental Europe, and especially in Switzerland. Managing his own company, 'Archaeology and Conservation Services', he also holds a position as Associate Professor at the Museum Foundation in Sogn and Fjordane County, Norway and its department 'Norwegian Millstone Centre'.

Hilde Vangstad
Norwegian Maritime Museum
P. Box 720 Skøyen
0214 Oslo, Norway
hilde.vangstad@marmuseum.no

Hilde Vangstad (b. 1966) wrote her M.A. thesis about soapstone vessels from medieval Bryggen in Bergen (University of Bergen 2003). She works as a researcher at the Norwegian Maritime Museum in Oslo. For the last decennia, she has worked primarily with urban harbour archaeology, and her main research focus is material culture of the Medieval and early modern period.

Stephen Wickler
Department of Cultural Sciences
Tromsø University Museum, UiT –
The Arctic University of Norway
P. Box 6050 Langnes
9037 Tromsø, Norway
stephen.wickler@uit.no

Stephen Wickler (b. 1958) has his M.A. and Ph.D. in anthropology from the University of Hawai at Manoa, USA. He is a maritime archaeologist and has worked as a researcher at the Tromsø University Museum in Norway since 1997. His research interests include the provenance, distribution and utilization of stone resources, focusing on the Iron Age and Medieval periods in Arctic Norway.

Bodil Østerås
Stiklestad Nasjonale Kultursenter
Department Egge Museum
Fylkesmannsgården
Eggevegen 40
7715 Steinkjer, Norway
bodil.oesteraas@snk.no

Bodil Østerås (b. 1974) wrote her M.A. thesis on the Sparbu soapstone quarry in the community of Steinkjer, Nord-Trøndelag (2002). She is the leader of Egge Museum in Steinkjer, Norway. She has been involved in several excavations of soapstone quarries in Trøndelag, Norway. Her research interests include quarries of soapstone and marble as well as cultural relics in the landscape.

Soapstone in the North. Quarries, Products and People. 7000 BC – AD 1700

Soapstone is a remarkable rock. While it is soft and very workable, it is also durable and heat-resistant, and with a high heat-storage capacity. These properties have been recognised and valued around the world since prehistoric times, and soapstone has been used for a multitude of purposes, ranging from everyday household utensils to prestigious monuments and buildings. This book addresses soapstone use in Norway and the North Atlantic region, including Greenland. Although the majority of the papers deal with the Iron Age and Middle Ages, the book spans the Mesolithic to the early modern era. It deals with themes related to quarries, products and associated people and institutions in a broad context. Recent years have seen a revival of basic archaeological and geological research into the procurement and use of stone resources. With its authors drawn from the fields of archaeology, geosciences and traditional crafts, the anthology reflects cross-disciplinary work born of this revival.

ISBN: 978-82-90273-90-8