Exploitation of outfield resources –

Joint Research at the University Museums of Norway

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Index

Iron extraction

Soapstone extraction

Landscape exploitation and transformation

Foreword

This book contains papers presented at an interdisciplinary workshop held at The Norwegian Institute in Rome 3–4 December 2012, entitled "Utmarksarkeologi i Norge" (Outfield archaeology in Norway).

The workshop was arranged by the archaeological research project "Forskning i Fellesskap" (Joint Research), which is a cooperative project between the five University Museums in Oslo, Stavanger, Bergen, Trondheim and Tromsø. The project runs from 2011 to 2015 and is financed by The Research Council of Norway and the University Museums.

A principal objective of "Joint Research" is to strengthen the archaeological research collaboration between the Norwegian University Museums, and also with the University Departments other relevant research institutions, particularly within adjacent scientific fields. A further aim is to establish and develop research networks within prioritised target areas. The project has three research networks, each with representatives from all five museums: Pioneer network – Agrarian network – Outfield network

The concept "utmark", which in Scandinavian literature is normally translated as "outfield", lacks a corresponding denotation in English. The outfield comprises all uncultivated land outside settlement areas and agricultural areas, i.e. lakes, bogs, forests, wasteland and mountains. When agricultural areas and settlement areas are excluded, the outfield comprises 96% of the land area in Norway.

The natural resources of the outfield have throughout the ages been of great importance in the form of hunting, fishing, gathering, grazing, forestry and raw material exploitation. The traces of such activities from prehistoric and medieval times are today cultural monuments and sites. As such they are important research items, and outfield archaeology is a central and extensive research theme at the University Museums.

The Outfield Research Network has four prioritised research themes:

- Wild reindeer exploitation
- Iron extraction
- Soapstone extraction
- Landscape exploitation and transformation

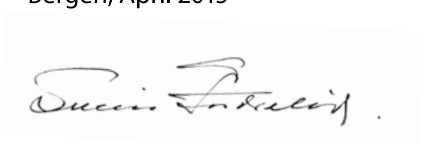
The workshop in Rome gathered 30 participants within archaeology, botany, osteology and geology. The aim of the lectures was to give an overview of ongoing outfield research in Norway.

This publication contains 23 of the 30 lectures presented at the workshop. It has been up to the lecturers to decide the levels of presentation and popularisation of the individual contributions. In the book, the lectures are largely presented in the version in which they were delivered, in most cases with minor alterations, but with references to literature, and the lectures held in Norwegian have been translated into English. Hopefully, the articles will give a fairly representative overview of current outfield research in Norway within the four prioritised research themes.

The first drafts of the manuscripts were reviewed by a committee consisting of Martin Callanan, Trondheim (wild reindeer exploitation), Kari Loe Hjelle and Sigrid Hillern H. Kaland, Bergen (landscape exploitation and transformation), Lars Stenvik, Trondheim (iron extraction) and Birgitta Berglund, Trondheim (soapstone extraction).

The final editing was carried out by an editing committee at the University Museum of Bergen: Svein Indrelid, Kari Loe Hjelle and Kathrine Stene. The articles have been translated into English by Vedis Bjørndal. Beate Helle has been responsible for the layout and design.

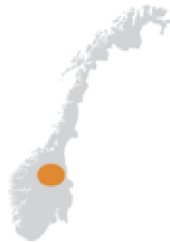
Bergen, April 2015



Svein Indrelid
Coordinator for the outfield research network (2011 – 2014)

Wild reindeer exploitation

The hunting history – part of important know-how in the wild reindeer management



Per Jordhøy & Runar Hole

Abstract

The Dovre–Rondane population has been isolated in a separate refugium since the late Ice Age. Besides bows and arrows, and more recently firearms, reindeer have been hunted in a variety of ways down the ages, not least using pitfalls and systems of fences which led the animals into traps, off precipices, or into lakes and rivers. The wild reindeer is an important barometer for measuring environmental condition in northern regions. The systems of ancient reindeer pitfalls, traps and connecting settlements in the region are very extensive and diverse. In Dovre–Rondane they indicate an original and extensive regional migration between the winter grazing grounds far inland and summer grazing range in the westernmost coastal mountains. Most trapping systems proved larger and more varied than previous work had shown.

Introduction

Norway has a particular responsibility for conserving wild reindeer in Europe. More than 90% of the European wild reindeer population is found within 23 more or less distinct populations in southern Norway. Of these populations there are few herds of original wild mountain reindeer left, because most of the populations are mixed with domestic reindeer herds from northern Norway and Sweden. The reindeer in the Dovre–Rondane district is the single remaining population of original wild mountain reindeer in Scandinavia (Fig. 1).

The understanding of the dynamics in the wild reindeer range use

A set of different data points out that most of the central mountain areas have been used by the wild reindeer in one or several periods through a long total cycle (rotation of usage). Bulls use the peripheral areas (peninsulas) most. However, they are not gregarious, often occurring either solitarily or in small groups, and their presence is often overseen – while the huge breeding aggregations which are generally found in the more central parts of the mountain areas are more easy to locate. Thus, it is important to avoid "downgrading" the peripheral (including alpine peninsulas) of the wild reindeer range. Such ranges count also as important buffer zones in more marginal situations. These are central aspects in understanding reindeer land use in an ecological perspective.

The main threat: Habitat fragmentation

In the past, the Dovre–Rondane mountain area was a more or less continuous habitat for a large reindeer herd. In the last 100 years, man has changed the habitat gradually, through construction and other disturbances. The strongest fragmentation effect in the region is caused by the highway crossing the Dovre plateau, which blocks seasonal migration and reduces resource availability for the reindeer here. Human activity and disturbance continue within certain portions

Per Jordhøy & Runar Hole

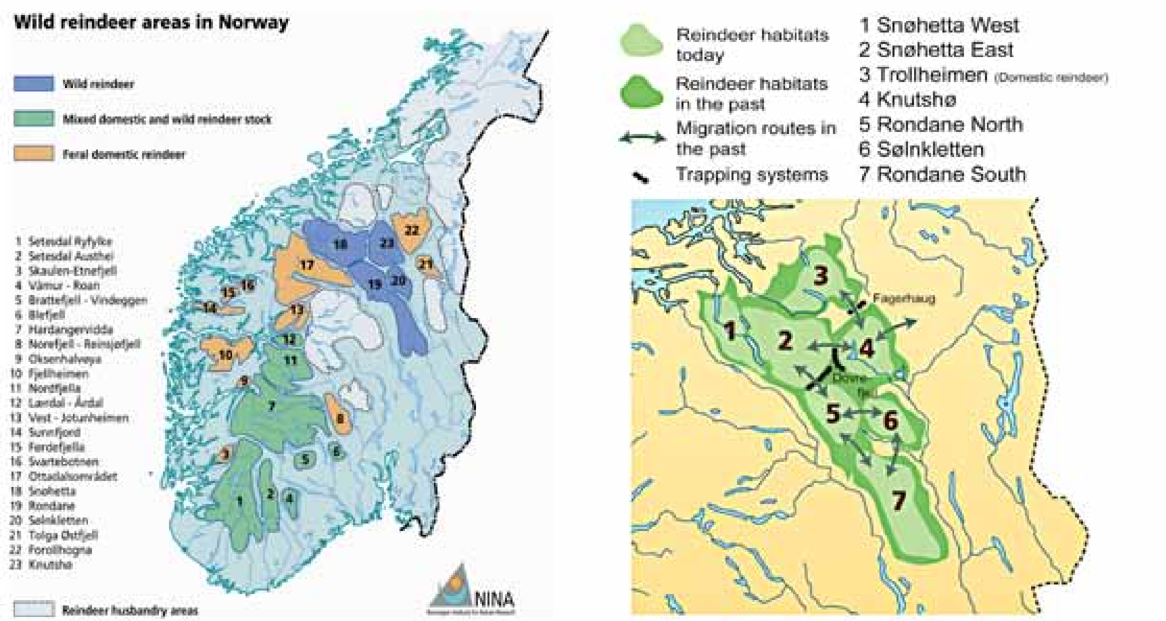


Fig. 1. Left: Wild reindeer areas in Norway. The Dovre–Rondane district is shown in blue. Right: The reindeer trapping systems at Dovrefjell and Fagerhaug. The former and present extent of suitable habitat, and apparent former migration routes in the Dovre–Rondane reindeer area, are indicated. In the past the whole region was a continuous reindeer habitat

of the range, with the consequence that the overall range is reduced and deteriorates further. Populations are closely managed and regulated by hunting so that overgrazing and range degradation are avoided. At the same time, hunting in itself is a stress factor for the reindeer during the important growth period. With the tendency we are now observing in range deterioration, restricted population management would have difficulties in compensating for future grazing damage.

An important barometer

The wild reindeer is an important barometer for measuring environmental condition in northern regions. The most important forage species on winter range, lichen, has a special ability to absorb heavy metals and radioactive compounds from the precipitation. Research focusing on the effects of long-range air pollution on terrestrial animals indicates that wild reindeer have the highest concentrations of radioactivity and heavy metals of any land mammal species in Norway. This is highlighted through research conducted on Dovrefjell and elsewhere. In general, concentrations of these pollutants are not considered as dangerous for reindeer or other organisms.

What the hunting history tell us

The systems of ancient reindeer pitfalls, traps and connecting settlements in the region are very extensive and diverse. In Dovre–Rondane they indicate an original and extensive regional migration between the winter grazing grounds far inland and summer grazing range in the westernmost coastal mountains. The migration routes over the Dovre axis are now impossible because of motor vehicle, rail traffic and disturbance.

Besides bows/arrows and pitfalls, reindeer have been hunted in a variety of ways down the ages, not least using systems of fences which led the animals into traps, off precipices. Three funnel-shaped systems (at Einsethø, Gravhø and Vålåsjøhø) are examples of such large scale trapping system at Dovre–Rondane. They have possibly been in use in the Viking Period and the Early Middle Ages.

Many people must have been involved in the trapping since the sites required well-organised construction, maintenance and operation. The substantial bag shows that the wild reindeer population must, at least periodically, have been large and sustainable, but it was also heavily harvested and probably depleted. The dating evidence suggests clear fluctuations in the trapping activity, which probably reflect corresponding fluctuations in the reindeer population.

World heritage list

Because of the various unique trapping systems found in the Dovre region (and Ottadalen), this area and accompanying cultural monuments are recommended for the World Heritage List (UNESCO).

The trapping systems

The size and nature of the sites studied are considered to be representative of the trap systems as a whole. The sites were mapped using GPS. Most trapping systems proved larger and more varied than previous work had shown. Many pitfalls were overgrown and hence difficult to discover. Individual pitfalls were mapped using GPS, and a standard procedure was used to record relevant parameters including pitfall type, their direction, dimension, detailed topographical location, condition, terrain type and incline, degree and vulnerability to influence by man, etc. The data were subsequently transferred to land-use maps (1:5000) and digital 3-dimensional terrain models, using the ArcView data-program.

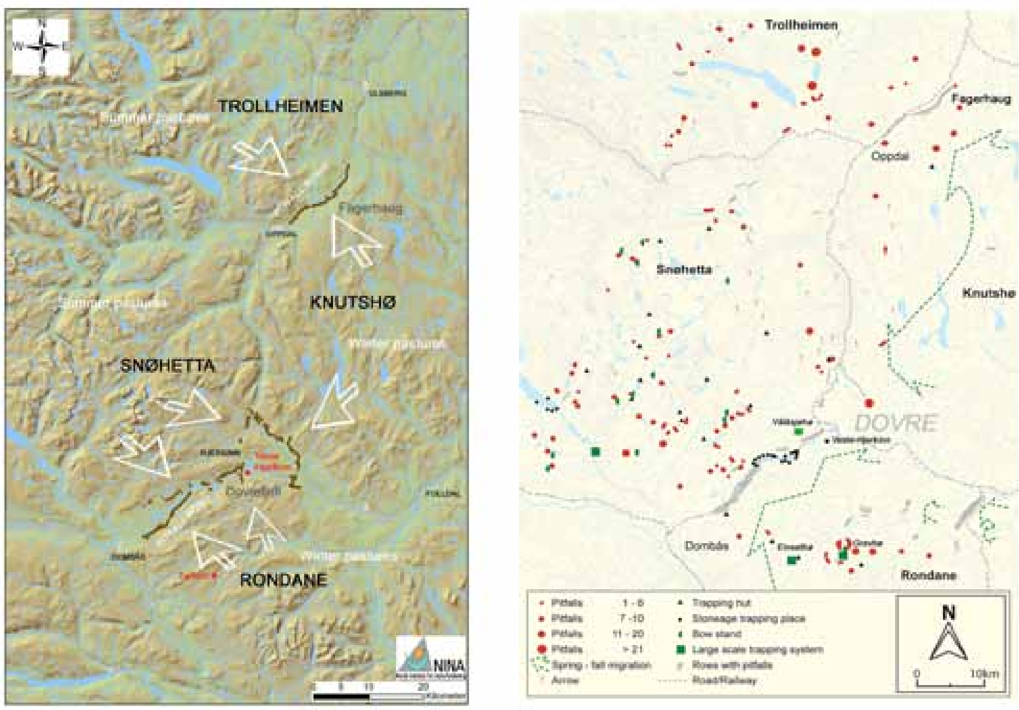


Fig. 2. Details from the pitfall rows (structures in brown colour) at Dovre and Fagerhaug and former reindeer migration corridors, and other traps and finds around the Dovre axis (right)

Fig. 3. Overgrown pitfall with original wooden construction

The pitfall rows at Dovrefjell and Fagerhaug

The east-west migration over Dovre has percolated around natural barriers in the smoothest mountains. The heaviest concentration of pitfall systems is located on a north–south axis across the main direction of the seasonal migration corridor. Fifty km further north (Fagerhaug), a similar but much smaller pitfall system is found, between Trollheimen (domestic reindeer area) and Knutshø (wild reindeer area) (Fig. 2).

Precipitation increases to the oceanic west, and decreases to the continental east. The western ranges are accordingly snow-rich and winter forage far more limited. The landscape features consist of varied and undulating mountain formations. Sparse, alpine birch forests interspersed with open heathery areas, are the main vegetation elements within the study area at Dovrefjell. Pinewood with heather on the forest floor dominates the study area at Fagerhaug.

Fig. 4. A typical stone-built pitfall

The main type of pitfall found in the two investigated systems now appears in the landscape as partly overgrown holes in the ground, usually with a visible oval ring mound around the hole (Fig. 3). These are quite different from the conspicuous, stone-built pitfalls also found in the area, which mainly occur singly and in small groups higher up in open mountain areas (Fig. 4). A total of 1547 pitfalls were recorded in the period 2001–2007; 1222 in the Dovrefjell system and 325 in the Fagerhaug system. There were only 12 stone-built pitfalls in these two systems, all in the Dovrefjell system. Conditions on the ground and available construction materials appear to have been important factors influencing these different methods of construction. The surface geology of the study area is predominantly gravels, with little stone available.

A large proportion of the main pitfall type that was found in the two systems was built in moraines/areas with moraine soil (Fig. 4). Wood (birch and pine) was used in the pitfall wall-constructions. A wood fragment from a pitfall located in the south of the Dovrefjell system, and ^{14}C dates from the same area from similar trapping systems and from settlements, indicate that the large-scale pitfall systems and funnel-shaped traps were mainly in use in the Viking Period and Early Middle Ages (Mikkelsen 1994). The Dovrefjell system (900–1000 m a.s.l.) appears in groups of pitfall rows, while the Fagerhaug system (500 to 600 m a.s.l.) consists of a continuous row (Fig. 2). *Individual* reindeer pitfall traps are aligned so that their long axis is perpendicular to the main centerline of the valley. The *line* of traps runs parallel to the line of the valley (Fig. 5).

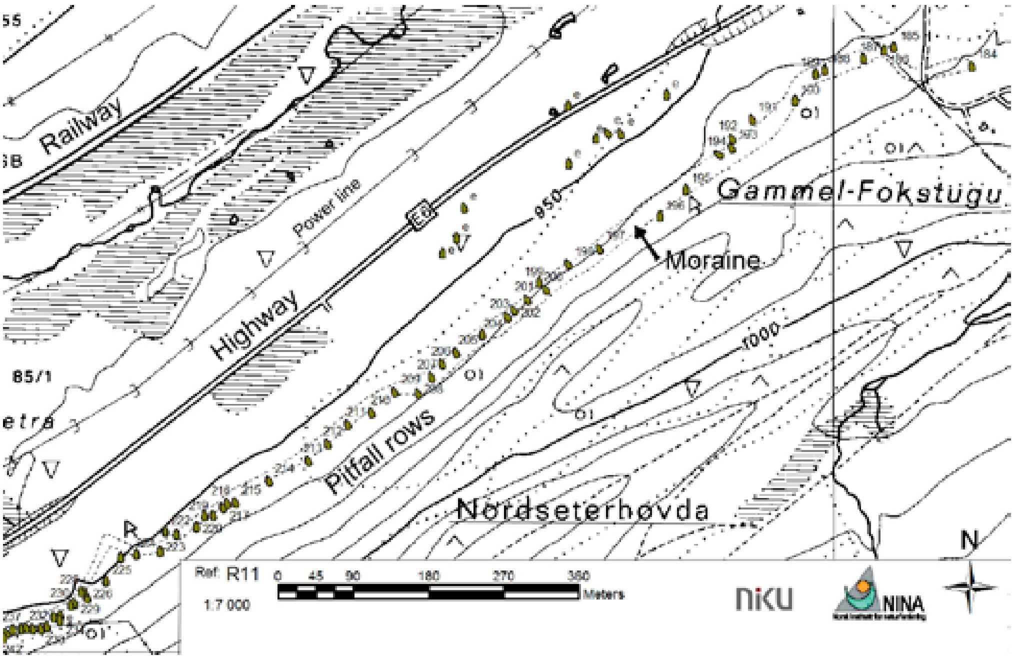


Fig. 5. Most of the pitfalls along the Dovre axis are placed in longitudinal moraines. The individual pitfall traps are aligned so that their long axis is about 90 degrees to the line of the valley. The line of traps runs parallel to the line of the valley

Measured pitfall dimensions varied considerably. The average length in the bottom of the pitfalls was about 130 cm. The depth varied considerably and was about 100 cm (probably as a result of the pitfalls' deterioration). The pitfall top was a little larger in the Fagerhaug system than in the Dovrefjell system. The average length at the top was measured to about 430 cm in the Fagerhaug system and 500 cm in the Dovrefjell system. Average distance between the pitfalls in the Dovrefjell system was about 38 m, in the Fagerhaug system about 44 m.

The conspicuous variation in pitfall dimensions may suggest that both reindeer and elk were caught in these trapping systems. However, the direction and dimension of the pitfall rows, in relation to landscape topography, indicate that the systems were mainly built for reindeer trapping. Pitfall rows built for elk trapping usually lie mainly across the direction of the valleys, as elk movements mainly follow the line of the valley.

The majority of large scale trapping systems known in the region date from the same period (Late Viking Period–Early Middle Ages) (Mikkelsen, 1994; Weber, 2007; Jordhøy, 2008). However, these systems were probably also used both earlier and later. The trap remains evident today represent the maximum extent in this trap era. The pitfall systems probably developed over several centuries.

Many people must have been involved in trapping operations since the sites required well-organised construction, maintenance and operation. The potential catch in these extensive trap systems suggests that the wild reindeer population must, at least periodically, have been considerable larger than the few thousand reindeer roaming in the fragmented ranges today. Dating evidence suggests clear fluctuations in trapping activity, which probably reflect corresponding fluctuations in the reindeer population influenced by trapping, predators or grazing conditions, or a mixture of all three factors.

Vesle Hjerkinn, a settlement near the Dovrefjell trapping system (Fig. 2), was a farmstead and an important mountain lodge for the king in the Late Viking Period and Early Middle Ages. Historical data and archaeological investigations show that the king had great economic interests in reindeer hunting here, since antlers, skin, etc. were important exports and sources of income. 88% of all animal bone finds at Vesle Hjerkinn originate from reindeer, and bones from bucks dominate this material (>60%) (Weber, 2007). Presence of large buck antlers, and finds of such material at excavations in Oslo and Trondheim from the same period, suggests antlers had export importance. The use of antlers in comb production in the Middle Ages is well known (Mikkelsen, 1994). In addition, reindeer meat was consumed both at Vesle Hjerkinn and in surrounding rural communities. Analysis of antler and bone material from Vesle Hjerkinn and some other similar settlements in the region, indicates that almost all the trapping activity took place in the summer/autumn. None of the finds indicate reindeer trapping activity during westbound spring migration in the above mentioned periods. Pitfalls filled with remaining winter snow and ice during the spring migration periods may also have made hunting impossible, at least in the Dovrefjell system.

Funnel-shaped traps nearby the Dovre axis

The trapping of wild reindeer by means of funnel-shaped constructions has on a number of occasions been mentioned in literature, which shows that this type of trapping method has been used in other countries and other parts of the world as well. In Finnish Lapland, Canada, Greenland

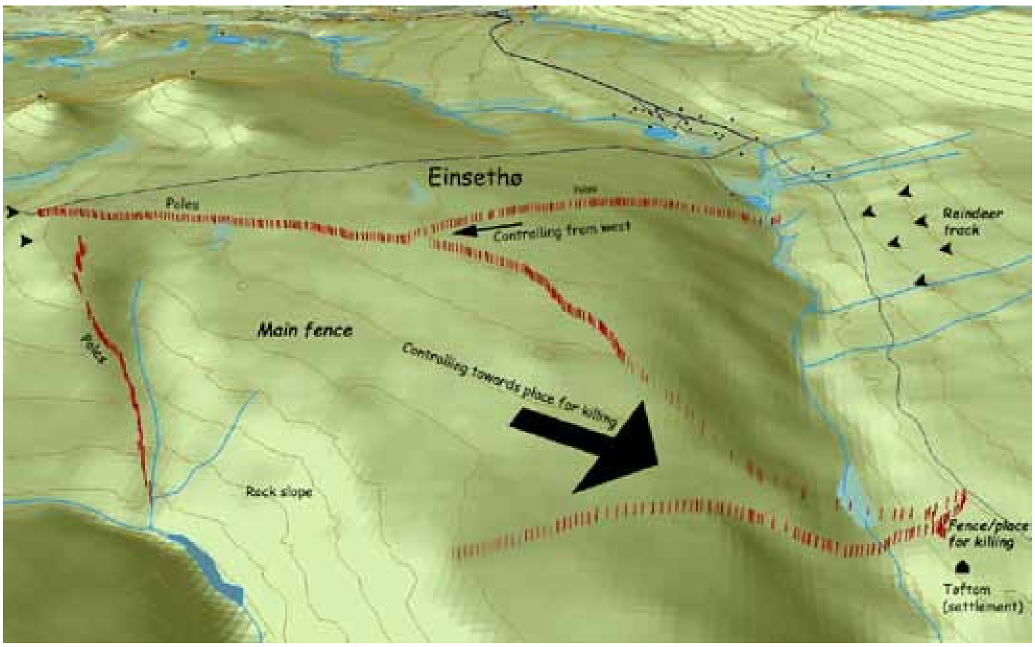


Fig. 6. The large scale trapping system at Einsethø in the Rondane north area

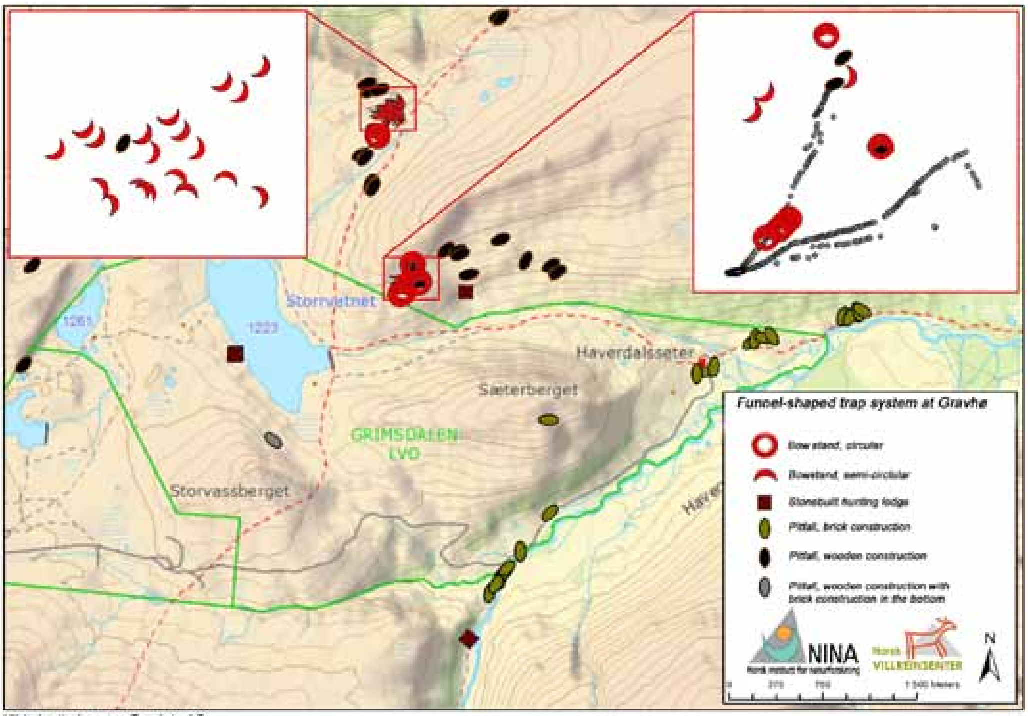


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Fig. 7. The large scale trapping system at Gravhø in the Rondane north area

and Siberia, such trapping techniques have been documented. There is a distinction between open traps (Vålåsjøhø og Gravhø) and traps with collecting pens (Einsethø). The funnel-shaped systems were constructed for the trapping of a large number of reindeer at the same time and the activities have in some areas been massive. There are many bowmen's hides around the open funnel-shaped systems and it may seem to have been more practical that these were used before the actual trapping pens came into use. This means that the obstacles (rows of cairns and/or poles) first and foremost were aimed at directing the reindeer towards the bowmen's hides, and that drive hunting of many reindeer into trapping pens was the primary goal at a later stage. In the following, we are going to explore in more detail two systems of this type, two located east of the Dovre axis (Einsethø and Gravhø) and one on its western side (Vålåsjøhø) (Fig. 2).

Funnel-shaped systems with collecting pens at Einsethø

At Einsethø in Grimsdalen in Dovre, one of the once largest reindeer mass trapping systems in South Norway is found. It was designed for hunting by means of funnels; that is, the animals were guided into a collecting pen, and afterwards towards a funnel-shaped narrow pass where they were killed and transported to the hunting camp. The main element in the construction of the system would have been poles, cairns, and on the most exposed stretches also cross-beams and/or ropes, etc. between the poles.

Here, the landscape is dominated by gentle, lichen-clad, cupola-shaped mountains and ridges. In the lowest sections towards the kill pens to the west (approx. 1180 m a.s.l.), dwarf-shrubs tend to dominate. The entryway into the system lies at Einsethø (highest point 1234 m a.s.l.) and the spit of land between Tverrgjelbekken and Grimsa, where known

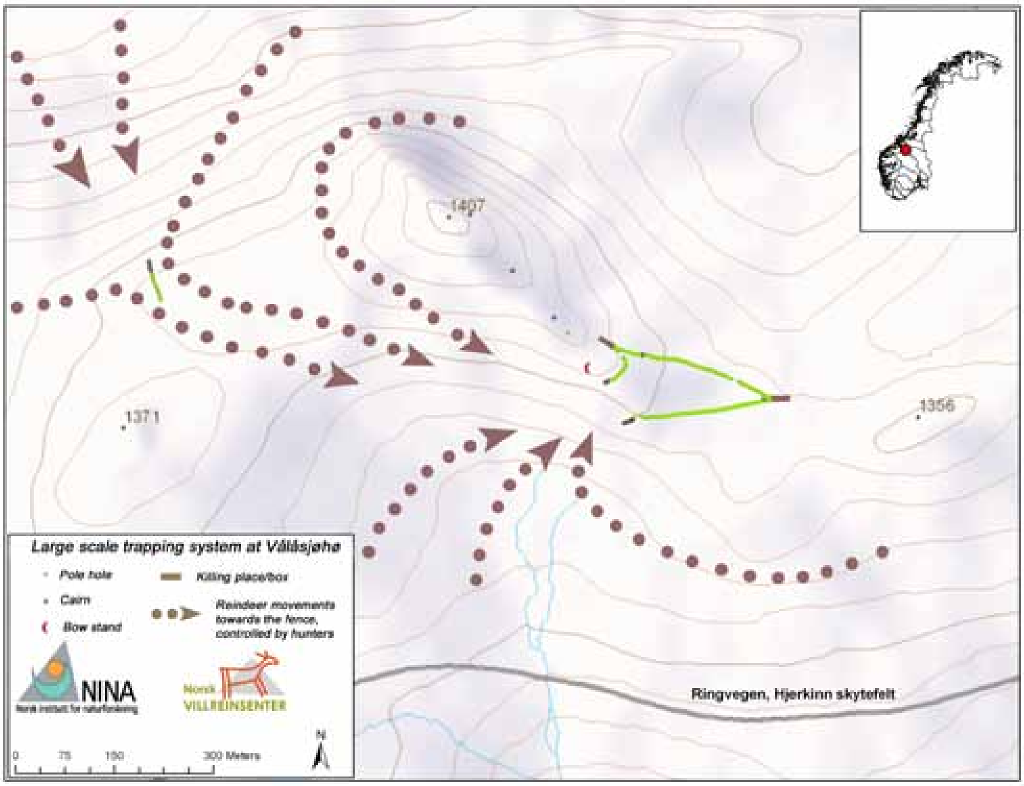

Fig. 8. The large scale trapping system at Vålåsjøhø in the Snøhetta area

reindeer migration routes also are found. Large parts of the structure are all previously known and documented. It has clear similarities to another big funnel-shaped system in the neighbouring mountains to the south west (Ottadalen). The structure is a typical example of a funnel-shaped system with a collecting pen, where one drove in, collected and was in control of a large number of animals, and then led smaller groups of animals towards the narrow part the funnel and killed them there one by one (Fig. 6).

Solid poles (possibly also some cairns) were used for obstacles and for collecting pens. These were more or less visible as poles with stone supports and their GPS position was determined when the Norwegian Institute for Nature Research (NINA) re-registered the system in 2003–2004. The total length of the row of poles in the system was measured to be more than 5.5 km. The poles may on average have had a diameter of 15–20 cm and an estimated height of 1.5–2 m.

The system is strategically localised in a central passageway for the reindeer once they have crossed Grimsdalen. The migration route is largely governed by land forms in the area and functions today roughly the way it functioned in the past. In addition to previously identified rows of poles, we have found and mapped a westerly «arm» that provides access to the main "arm" of the row of poles. This construction may have be tailored to intercept migratory reindeer on their way eastwards.

Open funnel-shaped system at Gravhø

In the northern part of Rondane, on the north side of Haverdalen and on the south edge of Gravhø, a distinct funnel-shaped system given the local name "Storgraven" is found. It has been well known for a while now and thoroughly investigated and documented. New GPS measurements of the system were carried out in 2011 by NINA, and the location is a known migration route for reindeer in the northern part of the Rondane wild reindeer area. It consists of an open funnel with distinct traces after the main obstacles (rows of poles and cairns), each stretching approximately 300 m north-east from the trapping pen (Fig. 7). There is also a shorter system of obstacles outside and parallel to the southern main row of obstacles, as well as traces of a short row of cairns that runs right-angled onto the main row of obstacles in the far north-east part of the area. The collecting pen itself is built in stone and is really big; a total length of 19 m, a width of 3 m and a height of 1.1–1.8 m. Within the drive area between the obstacles, there is also a stone-built trapping pit and several bowmen's hides. There are also additional trapping pits to the north-east of the system. The trapping pen is quite strategically placed in the migration route of the reindeer, with a small ridge to the north-east that prevented the reindeer from seeing the trapping pen until they were quite close to it and had no possibility to escape. Finally, the animals were pushed over the north-east end wall of the trapping pen itself, which would have created a ledge measuring close to 2 m. Similar conditions are also seen in other funnel-shaped systems, and they have been important experience-based elements in the hunters' planning and construction of such systems.

In the areas surrounding this system, many different cultural monuments from hunting are found. There are approximately 10 trapping pits close to "Storgraven" in the north-east, one somewhat large concentration of bowmen's hides (ca. 20) and trapping pits to the north-east of Storrvatnet, and several groups of trapping pits in Haverdalen. The area has served very important purposes for reindeer, both as grazing land and as migration area towards the northern flank of the Rondane massifs.

Open funnel-shaped system in Vålåsjøhø

The system was brought to light in 2009 during archaeological investigations in connection with the restoration of Hjerkinn shooting range to its natural state (Hole & Tiedemansen, 2010). It is situated ca. 7 km south-east of Hjerkinn (Fig. 2). The terrain where the system lies is open, but has ridges and a range of hills which the hunters exploited to make the hunt more efficient. The system has three marked rows of poles that create wedges in towards two trapping pens in an eastern and south-westerly direction. The two longest rows of poles are 230 and 280 m long, respectively (Fig. 8).

The highest peak at Vålåsjøhø rises up to 1407 m a.s.l. This is a very strategic place, with a good overview over the area. Up here, there is a good general view of Grisungdalen towards the north, the valley floor towards the south, and good visibility to the east and west of Vålåsjøhø. From this peak, the hunters were able to scout across a large area, in order to seek out a reindeer herd they could guide towards the system.

The trapping system lies in a fairly flat section, and form a part of the ridge to Vålåsjøhø. As in many similar systems, the way it was placed in the terrain prevented the reindeer from seeing the «trap» before they were inside it, between the guiding fences. Experience has shown that the wild reindeer often move upwards in the terrain when disturbed, and the hunters have taken this into consideration when they built the system.

Both funnels ended in a long and narrow trapping pen. Today, a small mound can be seen at the entrances. This may have been the foundation of a ledge, from which the reindeer had to jump down into the trapping pen and from where there was no escape. The trapping system is strategically constructed and bears witness to that the hunters had considerable insight into the behavioural pattern of the reindeer, as well as experience and knowledge about this activity.

Conclusions

Recently mapped trapping systems proved larger and more varied than previous work had shown. They were obviously located on routes which large reindeer herds followed on long migrations between their winter grazing in the east and summer grazing in the west. The radiocarbon dates indicate that the funnel-shaped traps were mainly in use in the Viking Period and Early Middle Ages. A small majority of the pitfall dates are from the same period, but these systems were most probably also used both earlier and later. Many people must have been involved in the trapping since the sites required well-organised construction, maintenance and operation. The data shows that the wild reindeer population must, at least periodically, have been large and sustainable, but it was also heavily harvested and probably depleted. The dating evidence suggests clear fluctuations in the trapping activity which probably reflects corresponding fluctuations in the reindeer population.

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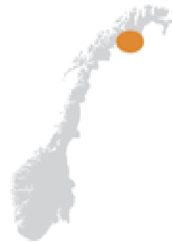
New traces of wild reindeer hunting in the alpine areas in Northern Norway

Ingrid Sommerseth



Abstract

The archaeological material in North Norway on wild reindeer hunting is rich and varied and the material reflects a time-depth from the Mesolithic to the late Middle Ages. The material implies that there must have been temporal adjustments in reindeer knowledge, landscape use, and technological knowledge. One of these adjustments in the wild reindeer hunt can be recognized in finds of iron arrowheads and archery positions from more than 1000 years ago. New finds of iron arrows from the snow patches and from high mountain passes where the reindeer have crossed show that there have been high levels of activities connected to traditional Sámi hunting during the early Iron Age. Today, the climate is warmer, and the areas where the ice has thawed around the old snowfields may contain finds of arrowheads and other tools that are intact, showing a hunting method for wild reindeer that was important for a long period before pastoralism became sustainable as an important part of Sámi economy and culture.

Introduction

During the last century, mild winters and warm summers have led to a steady decrease of the snowfields and the glaciers in the high-mountain in Norway. The Alpine mountains in the north is shaped by successive periods of glaciation and they run 1400 km down the spine of Scandinavia from the northernmost parts of Finland to southern Sweden and Norway. The average elevation is 500 m, although several peaks rise above 1000 m and occasionally even above 2000 m.

Fig. 1. A Sami woman, a dog and two men hunting on skis in the high mountain, Olaus Magnus book no.1 from 1555

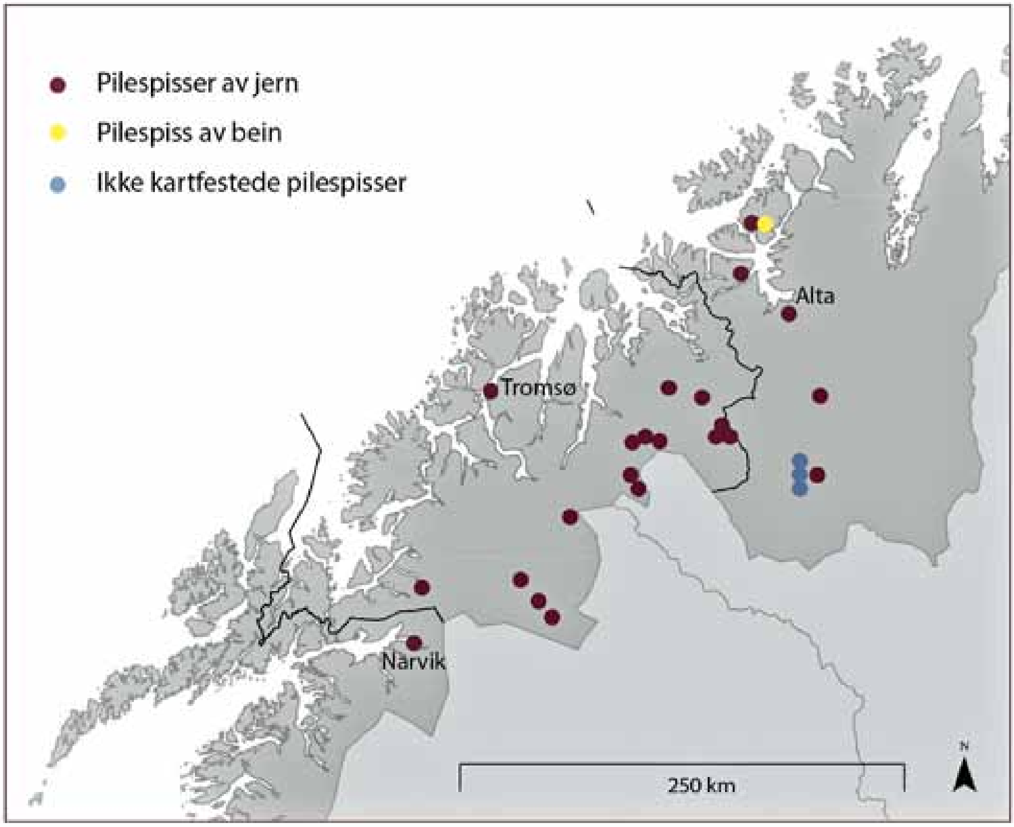


Fig. 2. Distribution of arrowheads found in the mid and high alpine zones in North Norway. Red marks: arrowheads of iron. Yellow mark: arrowhead of bone. Blue marks: not mapped but found in the interior. Illustration: I. Sommerseth and E. Høgtun, Tromsø University Museum

On several locations in the high mountains in Norway hunting and trapping equipment that have been used in the hunt for wild reindeer have melted out of the ice. The mountain areas with snowfields and snow patches as well as bare rock and boulders turn out to be the archaeological treasure chest of our time where we may find well preserved objects like arrowheads, shafts, feathers, leather, textiles, and other bow fragments or wooden elements that otherwise would never have been preserved (Callanan, 2013). Here, not only a history of old hunting weapons is revealed, but also new knowledge of a specialised form of wild reindeer hunting appears and we need to ask what attracted hunters to the area where the bows were found?

The traces found of snowfield hunting are of a type of hide hunting or drive hunting with a bow and arrow. The hunt took place on warm summer and autumn days when the reindeer withdrew to the snowfields to cool down and to avoid insects, warble flies (*oestridae*) in particular. The advantages of this type of hunt were many. The animals were easy to discover on the snow and one could retrieve the arrows from shots gone astray. This was described as early as in 1518 by archbishop Olaus Magnus who observed this on his journey to the areas in the north

(Fig. 1). Here, it appears that the Sami could retrace lost arrows by shooting a new arrow from the same spot and in the same direction as the last one. Arrows made from iron were especially valuable and especially adapted to its quarry and were therefore far too valuable to be lost in the snowfields.

Twenty-six different types of arrowheads have been found in the high mountain areas in Northern Nordland, Inner Troms and in West Finnmark. Some of these finds are concentrated on the wide expanses at the county border between Troms and Finnmark and along the border to Finland and Sweden (Fig. 2).

The majority of the arrows have been found by reindeer herders, grouse hunters and hikers over a period of 80 years, from 1920 to 2011. Most of the arrows have been accounted for, but there are still a few that have not yet been mapped and handed over to the Tromsø University Museum. Thus the find circumstances of some of the arrows are insufficiently described.

The snowfields are melting rapidly. This means that there are major possibilities for further, exciting snowfield finds in North Norway in the time ahead. More than half of the arrowheads have been found in the high alpine zone where there is little vegetation and basically nothing but rocks and scree in connection with old snow patches and snowfields that are almost gone today. The arrowheads from Finnmarksvidda were found at the lowest point of the terrain at ca. 400 m a.s.l., on moraine ridges and around low-lying hillsides consisting of stones and sparse vegetation. The arrowheads from the coast are found highest up, 12 of them were found between 800 and 1000 m a.s.l. The reason behind this can be that the wild reindeer in the past, as well as the tame reindeer today, favored the mountain areas adjacent to the fjord as well as the high mountains on

Fig. 3. Double-bladed arrow 19.4 cm long found on Finnmarksvidda. Photo: I. Sommerseth

the coastal islands in summertime to avoid tormenting insects.

Current and historical patterns of tame reindeer migration in Finnmark can be summarized as consisting of seasonal migrations between the interior and the coast. Winter pastures, used October to March, are located in the deep interior. In spring from April to June the reindeer move northwards across the Finnmarksvidda towards calving areas between interior and the mountainous areas near the coast. Summer pastures from June to September are situated in the mountain areas adjacent to the fjords or on the large coastal islands. During the fall from September to October the herds return to the interior with the fall rut occurring in mid-October (Vorren, 1962; Paine, 1994). If there has been a similar seasonal migration route in the past, the arrowheads found in the inland areas may be suggestive of an early autumn hunt when the wild reindeer were on their way back to their winter pastures.

The age of arrowheads, types and origin

The arrows found on the mountains can be roughly dated based on material and design. The oldest arrowhead was found on the island *Sievju* (Seiland) in West Finnmark. It is the only arrow made from reindeer bone that has been found in the high mountains and this particular one has been dated to 900 BC, and it resembles bone points found on settlements in East Finnmark from the same period (Olsen, 1994, p. 109). All the other arrowheads have been made from iron, and the shape of the blade and the shaft indicates roughly what time period they belong to. The shape of the tang, the part of the arrowhead that is attached and lashed onto the shaft, is particularly important. The oldest hunting arrowheads of iron are from ca. AD 400, and these have a flat blade and flat tang that were inserted into a split in the shaft. Around AD 600, there was a change over to a pointed tang that was stuck into a hole on the shaft. The youngest arrows from Late Viking Age and Early Middle Ages had an improved tang which was pointed as well, but these had an extra tang stop so that the point did not burst into the shaft when it hit the prey (Farbregd, 1972).

The iron points from North Norway are associated with traditional Sami hunting and trapping grounds. The Sami were experts at exploiting the rich resource in the north, and the mountain catch of wild reindeer was an important industry for the Sami (Sommerseth, 2011). Trade in game and leather products is often mentioned in saga literature and in written sources from the Middle Ages. The Sami had commercial contacts in the shape of a "Finn tax" (Norwegian: Finneskatt) with the sedentary Norse population in the Viking Age, and had the merchandise sent by ship to Europe and the markets down south. Exotic products like for example precious metal, glassware and textiles as well as iron tools that, among other things, were important in hunting, were returned (Storli, 2007). It is possible that some of the iron arrows were hammered and shaped locally in North Norway from iron blooms that had been transported northwards and consequently adapted to the needs and hunting tradition of the various areas. The arrows from the mountains in the north resemble a large number of iron arrows from Sami sacrifice finds in the inland on the Swedish side, with a distribution from Sørdalen in Bardu/Torneträsk in the north to Västerbotn and Jämtland in the south (Serning, 1956). These metal finds are dated from the Viking Age to the Middle Ages, ca. AD 900–1300 (Zachrisson, 1984).

Fig. 4. Iron arrow 16 cm long, found at Mollejus in 2011.
Photo: J. H. Dammann, Tromsø University Museum

The double-bladed iron arrow with a cleavage is a type of arrow that is particularly special based on individual manufacture and appears to be very effective in wild reindeer hunting (Fig. 3).

This type of arrow has a northerly distribution, but several specimens have also been found in the mountains in Oppland and the counties of Trøndelag (Finstad, Marstein, Pilø, Stokstad & Brimi, 2011). In North Finland and in North Sweden, the double-edged iron arrows are usually found in Sami sacrifice finds. In North Norway, eight double-bladed iron arrows have hitherto been found the high mountains, the majority of them were found at between 700 and 1000 m a.s.l. A few arrows of this type are associated to grave finds. In Tromsø municipality, there are two Iron Age graves that contained finds of such arrows, and these are situated at Balsnes in Malangen and in Tromvik on Kvaløya and both are dated to the Merovingian and Viking Age Periods (Sjøvold, 1974, pp. 164, 168). This means that arrows like these may have been used in the period between AD 600–1000. Initially one believed that these types of arrows were used in the hunt for wood grouse and they were therefore called "bird arrows". Today, we know that they ought to be associated with wild reindeer hunting in that they are being found in the high alpine zones associated with the snowfields where the wild reindeer stayed. A test shooting with a reconstructed bow and arrow shows that these had tremendous impact energy on a reindeer carcass at close range. The double-bladed iron point divided the animal's spine in two, and this characteristic arrow has been incredibly effective and lethal (Finnstad, Marstein, Pilø, Stokstad, & Brimi, 2011).

The iron arrows from Inner Finnmark and the county border towards Troms

In the mountain areas north westerly of Kautokeino and at the county border between Troms and Finnmark and towards Storfjord municipality, 15 iron arrows have been found. Three of these arrows were found in close proximity to one another around the 975 m high mountain Mollejus in Nordreisa municipality. Two of the arrows were handed in to Tromsø University Museum as early as in 1931 by a reindeer herder from Kautokeino. The reindeer herder had also observed a wooden shaft that was lying close to the double-bladed arrow, and this means that there are some good leads as to what we can expect to find and in which areas we are going to search for new and additional hunting tools. The last iron arrow from the mountain Mollejus that was handed in to Tromsø University Museum was picked up on a warm August day in 2011 by two Finnish hikers. This arrow was lying south west of the mountain top on a flat rock, 850 m a.s.l. (Fig. 4).

All the iron arrows from this high mountain area show that there have been high levels of activities connected to hunting on wild reindeer more than 1000 years ago. In 2011, the summer was exceptionally dry and warm in large parts of North Norway, and the climate statistics for July in the years 1930 and 1931 shows that it was it bit warmer than average in Inner Finnmark. After a dry

Fig. 5. Arrow made of bone, 18.3 cm long, found at Seilandsjøkelen. Photo: I. Sommerseth

and warm summer, the snowfields and snow patches melt more rapidly in the mountains, which may in turn lead to that tools and arrowheads from wild reindeer hunting more than a thousand years old are released from the ice.

The arrows from the coast at *Sievju* / Seiland

Two of the most spectacular arrow finds in West Finnmark were made after a record hot autumn in 1999. Both arrows were found in the mountains on the south west side of the island, on both sides of Store Kufjorden. The first arrowhead was found by the teacher and musher Harald Tunheim (Fig. 5).

Tunheim and the students at Øytun folkehøgskole (Øytun Folk University College) were on a hike heading for Seilandsjøkelen. In a north-facing slope 740 m a.s.l. at *Johkanjárhárji* (meaning: the river on the barren slope), they found the remains of a snowfield that had just melted, and the

Fig. 6. Rare iron arrow ca. 14 cm long found at the Stuora Kárrá mountain in 1999. Photo: Alta Museum

Fig. 7. The site above Inner Sildvikvatn 1000 m a.s.l. Photo: S. Wickler, Tromsø University Museum

arrow was found on a flat rock there. After many years of travelling in this area, Tunheim said that he had previously never seen a snowmelt this extensive, a phenomenon that had completely changed the landscape this year. The arrow made of bone is unique and it is the only one in North Norway that has been found in alpine areas.

The other arrowhead from Seiland was found the same autumn of 1999, but on the opposite side of Store Kufjorden, around the mountain *Stuora Kárrá* which is 836 m high. This is an iron arrow that has remains of intact lashing around the tang which resemble corresponding arrows from Mid-Norway which have been dated to Early Middle Ages, ca. 12–13th centuries (Fig. 6).

The arrowhead was stuck between two rocks close to a snowfield that had retreated, and was discovered when the finder was drinking water from a brook. The most sensational thing about the find is that the iron arrow originally was intact with a 50 cm long wooden shaft with mounted bird feathers! There were stone-built archery positions on a slope just above the site. This means that the wild reindeer hunters were lying in wait in their positions at close range and on the same altitude as the snowfields and then shot at the wild reindeer standing still on or wandering across the snow patches.

Traces of snowfield hunting in Troms and Northern Nordland

The other large group of hunting arrows were found in Inner Troms, where the first group was found along the Finnish border in Storfjord municipality between 700–1000 m a.s.l. These iron arrows were probably found at some point in time in the 1980s, but they have not yet been sent to Tromsø University Museum, which means that they may be damaged or lost to further research. In the same area, traces of large, wild reindeer mass trapping systems with pitfalls and archery positions have been found. Here, it is possible to compare the various catching methods over time in one and the same area. Several of the iron arrows from this area are dated to the Viking Age and were found by reindeer herders in the area that has Sami place names which indicate a prehistoric presence of wild reindeer. Place names like "*Goddečorut*" and "*Goddejávri*" mean "the wild reindeer top" and "wild reindeer lake". Another exciting find from Inner Troms is a well preserved double-bladed iron arrow that was found by a Swedish hiker in 1972 (Sommerseth, 2009, pp. 14, 258). The arrow was lying in the middle of the hiking trail a few kilometres from the mountain lodge Gappohytta in Isdalen. Further south, on the north side of the lake Altevatn, more arrows have been found. One of the arrows was found in 1982 in *Sieiddeláhku*, which is a flat mountain pass ca. 970 m a.s.l. between the mountains *Čoalbmoaivi* and *Doaresbákti*. This is a known passageway used by reindeer herders today. Here, on the mountainside, the hunters have been lying, waiting for the wild reindeer. The southern iron arrow in the county of Troms was found at the lake Trangdalsvannet just north of the 1200 m high Grindalstind in Skånland municipality. The arrow was found lying, like most of the others, on a flat rock on a talus slope where there previously had been a snowfield.

The only arrow from Nordland County that was found in a snowfield was found at Blåisen above Rombaksbotn in Narvik municipality. The iron arrow was found in a north-facing mountainside 1000 m a.s.l. above the lake Inner Sildvikvatn (Fig. 7).

The arrow was found in 1961 by a 17 year old boy who was on a walk in the mountains.

Fig. 8. Iron arrow with double tang shoulder 21.4 cm long.
Photo: I. Sommerseth

After interviewing him today, he was able to explain exactly where he had been walking and how he had found it. The arrowhead was found on a late summer day when he was stopping for a lunch break. In 1961, there was a large snowfield in this very same area. Today, this snowfield has retreated more than 100 meter (Wickler & Jørgensen, 2012). The iron arrow is exceptionally well preserved and is a rare type of hunting arrow of which there are very few of in Norway (Fig. 8).

The iron arrow from the massif Bønntuva in Tromsø

In 1925, an iron arrow that probably can be dated to the Viking Age was handed in to Tromsø University Museum (Fig. 9). It turns up that it was found on the mountain just above Solligården on the mainland, and the climate statistics for the summers of 1924 and 1925 show temperatures above average, in particular in August. The arrow was probably

Fig. 9. Small iron arrow 10.8 cm long, found close to Bønntuva.
Photo: I. Sommerseth

Fig. 10. View from the pass and the snowfields south of Bønntuva with the coastal islands Tromsø and Kvaløya in the background. Photo: I. Sommerseth

found on a warm, late summer's day south of the 754 m high massif Bønntuva. There is no available information as regards how handed in this arrow, but it could have been found in connection with the previous mining activity that took place right on the north side of Sollidalsaksla in Djupdalen (Sommerseth, 2013).

After a new inspection on a warm, late summer's day in 2012, large snow patches and small snowfields were still present on the south side of Bønntuva. The largest snowfield lies in a northerly slope and there were many traces of domesticated reindeer that had been standing on the snow patch to cool down (Fig. 10).

It may not be very surprising to find assemblage of cultural remains in this area where a 1000 year old hunting arrow has previously been found. Just north of the snowfield, several stone-built archery positions which are seen as small depressions with a small stone-built wall in front were found. These positions lie facing the snowfield, perfectly placed on a small elevation in the terrain. The archery position was built to keep the hunter out of sight of the wild reindeer standing on the snowfield and also hidden to the herd that came wandering over the mountain pass from Djupdalen. The iron arrow from Sollidalsaksla has never been mentioned in archaeological records or in regional and local tales. It is only now we see a connection to a past wild reindeer hunting on the snowfields of the north.

The snowfields as repositories of knowledge

In North Norway, all finds of arrowheads, archery positions and other types of hunting and catching systems are associated with places where the wild reindeer migrated. This applies particularly to mountain passes or areas where the reindeer have crossed long valleys or wide rivers. These places often mark a change of landscape in the terrain and in the Sami language they are called *suohpáš*. In Lule Sami areas the concept *suohpa* is used for solid snow bridges frozen across a river (Ryd, 2001). *Suohpáš* are also associated with the large snow patches or snowfields that in the Northern Sami language is called *jassa*, places where the reindeer often stay to escape from the warble fly. In some parts of Inner Finnmark, the concept *suohpáš* has been used for dry or frozen passages that stretched across extensive marshland (Qvigstad, 1938). The prehistoric wild reindeer has, like the later domesticated reindeer passed the same seasonal grazing land, and this may have made it easier for the hunters to plan the hunt. These places are rich in Sami place names that reflect the reindeer's affiliation to the landscape, like the example *suopháš* and the Sami name for wild reindeer (*goddi*) shows.

If one finds an archery position close to an old snowfield and in addition has the good fortune to find a hunting arrow! Then one has a complete story linked to the area where all the elements for a successful hunt are present. The hunt for wild reindeer has taken place with a bow and arrow, probably carried out by a small hunting party. The hunters have built the archery positions close to the snowfields to get at the animal at close range. Small snowfields were better than large ones, because the reindeer did not have much room there to escape from. The hunt was a combination of position, stationing, and drive hunting and it is possible that the reindeer were driven off the snowfield and felled by the hunters hiding at the edge of it. The arrows that we find today have probably either been shot astray or been lost during the actual hunt and then frozen into the snowfield or stuck in an area of loose stones. After the Middle Ages and towards the "Little Ice Age" from the 15th century, the snowfields grew as a result of a colder climate. Today, the climate is warmer, and the areas where the ice has thawed around the old snowfields may contain finds of arrowheads and other tools that are intact, from a more than 1000 year old hunting method for wild reindeer in the north.

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Medieval reindeer trapping at the Hardangervidda mountain plateau

Svein Indrelid

Abstract

This paper focuses on a certain mass-hunting technique of wild reindeer that was practised at the Hardangervidda mountain plateau, mainly during the second half of the 13th century AD.

Excavations seem to confirm a legend that migrating reindeer herds were intercepted and diverted towards lakes by means of stone cairns or wooden poles and killed in the water by hunters in boats. Questions concerning the extent of the hunt and the historical background are discussed.

Introduction

Hardangervidda, the 8000 km^2 large mountain plateau in South Norway, has the largest wild reindeer population in Europe, which today consists of 10 000 animals. Here, people from surrounding settlements have always been hunting. In the tracts close to the Hardangerjøkulen Glacier, refuse heaps of reindeer bones bear witness to a past mass trapping in which thousands of animals were slaughtered. According to an ancient legend, the hunting was carried out by driving the animals into lakes where they were killed.

The most well-known of these mass trapping localities are found at the lake Finnsbergvatn, a little less than 1200 m a.s.l. at the base of a spit of land called Sumtangen (Bøe, 1942). (Fig. 1 & Fig. 2). This has been an attractive reindeer hunting ground through thousands of years. Within an area of 100 × 100 m, there are 6 small Stone Age dwelling sites and also remains of dwellings and structures from later periods. The ruins of two stone huts are also found here, wall to wall, surrounded by a midden area of 50 m^3, packed with reindeer bones (Indrelid & Hufthammer, 2011) (Fig. 3).

The legend

The legend of Hardangervidda tells of reindeer herds migrating from the mountain massif at Hardangerjøkulen. The reindeer were diverted to the lakes by means of a system of stone cairns and poles. Similar reindeer trapping systems, where the animals are diverted into a corridor of stone cairns,

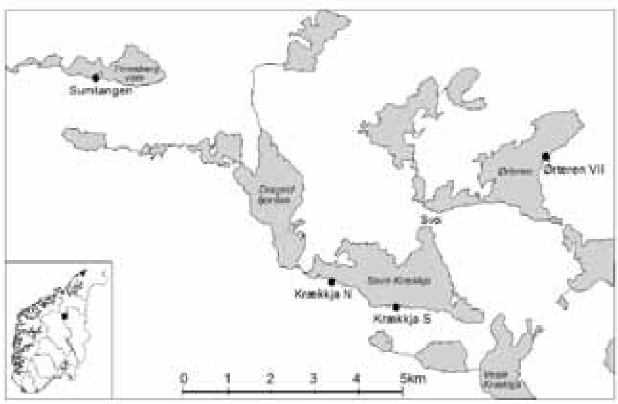

Fig. 1. The northern part of the Hardangervidda mountain plateau showing four mass trapping systems for wild reindeer (black dots)

Fig. 2. The lake Finnsbergvatn (1190 m a.s.l.) viewed towards the Hardangerjøkulen Glacier. The spit of land that from the left sticks out in the middle of the lake is Sumtangen. Photo: S. Indrelid

Fig. 3. Ruins of the two medieval stone huts at Sumtangen. They are surrounded by a midden area of 50 m3, consisting of bones from between 5500 and 7800 reindeer. The crater between the ruins is the result of an excavation in 1939-40. Photo: S. Indrelid

are well known from, among other places, Greenland, Canada, and Alaska (Blehr, 1973).

According to the Sumtangen legend, floating lines were stretched out in the water. They prevented the animals from swimming to the sides and escape. The hunters rowed out in boats, killed the animals and dragged them ashore at Sumtangen. The butchering took place outside the stone huts where the hunters lived during the hunting season. But who they were, and when the mass trapping supposedly took place, the legend says nothing about (Indrelid & Hufthammer, 2011).

Indigenous population, Lapps/Sami or farmers?

In the year 1838, the legends about the big reindeer hunting on the Hardangervidda mountain plateau reached Bergen and County Governor W.F.K. Christie, the founder of Bergens Museum. He also received samples of bones and antler remains found at Sumtangen. At that time, the prevailing view was that the Lapps or the Fins, as they were called, were the original inhabitants of Norway. County Governor Christie knew that the Lapps in olden times hunted reindeer on the water, and stabbed them with spears or lances while they were swimming. He was convinced that the people who had stayed at the Hardangervidda mountain plateau in a distant past were the original population and that they were of Lappish heritage (Christie, 1842). Christie's "theory of an indigenous population" stirred up a discussion in academic communities that came to last for precisely one hundred years.

In 1939–40, Dr. Johs. Bøe, who later became a professor at Bergens Museum, started excavations at Sumtangen. He was able to establish that there was a Stone Age dwelling underneath the stone huts and the midden, and that the mass trapping would have had to have taken place several thousand years

Fig. 4. More than one hundred boat nails have been found in the midden. The hunters at Sumtangen had boats. There wasn't any fish in the lake Finnsbergvatn before trout was planted there in 1927. The nails therefore seem to confirm that the hunt in the Middle Ages took place in the water, from boats. Photo: S. Indrelid

after this dwelling site had been abandoned. The theory of an indigenous people was thus disposed of. As he saw it, the bone middens were the result of reindeer hunting in the mountains by farmers from the fjord districts (Bøe, 1942). The discussion about a mass trapping at Hardangervidda thus subsided – for some time.

New excavations at Hardangervidda

In the beginning of the 1970s, excavations of the midden at Sumtangen were resumed, among other things, to extract material for ^{14}C dating. The dates confirmed Dr. Bøe's assumption, that the middens were medieval (Blehr, 1973).

In 2004–08, the hitherto last investigations at Sumtangen took place. This time, a comprehensive bone material was collected and analysed, and three corresponding sites a few kilometres further east were also surveyed (Hufthammer, Bratbak, & Indrelid 2011; Indrelid, 2013).

Mass trapping systems for wild reindeer

The investigations at Sumtangen encompassed merely 1½ m^3 of midden mass, but the number of bones and bone fragments was close to 35 000 (Fig. 5). Estimates based on this material, as well as data from previous excavations, show that the remains of between 5500 and 7800 reindeer are lying in the midden (Hufthammer, Bratbak, & Indrelid, 2011).

The radiocarbon dates show that the majority of the bones must have been deposited in the second half of the 1200s. The Mass trapping therefore seems to have been a relatively short episode that lasted merely a few decades, and then subsequently suddenly ceased around or shortly after the year 1300 (Indrelid & Hufthammer, 2011).

Within a distance of 12 km from Sumtangen there are three further, corresponding hunting systems with ruins of stone huts,

Fig. 5. Excavation of the midden at Sumtangen. In this excavation square measuring 1 x 1 m, there was a stratum of earth packed with bones and from the turf surface and to a depth of half a metre. Here, 11.500 bones and bone fragments were collected. Photo: S. Indrelid

Fig. 6. The lake Store Krækkja (1151 m a.s.l.) with ruins of the stone hut from the Middle Ages. It is surrounded by a midden containing reindeer bones dated to the 2nd half of the 1200s. Photo: S. Indrelid

surrounded by middens containing reindeer bones. The dimensions of these three together are approximately the same as the one at Sumtangen. At the lake Store Krækkja, two systems are found and at Ørteren one. The dates show that all four systems must have been used simultaneously – in the second half of the 13th century. From Store Krækkja (Fig. 6), a legend similar to the one from Sumtangen exists, with the use of cairns, floating lines, and the killing of swimming animals in the water (Indrelid, 2013).

An unusual butchering method

There is also another common feature in the bone material from the four localities: Bones from about the entire animal body are found in the middens, but three types of bones are strongly underrepresented: Ribs, upper front legs and antlers (Fig. 7). It shows that the hunters have cut the meat from the meat rich parts of the skeleton and thrown the bones away, evidently to keep the weight during transportation at a minimum. All long bones were smashed, and the marrow extracted (Hufthammer et al., 2011). This butchering method distinguishes itself strongly from the practice that local wild reindeer hunters from the rural districts around Hardangervidda have been using as far back as anyone can tell. At the kill site, the head with antlers and the outer parts of the limbs are normally cut off and left there, together with the intestines. With horses or other means of transportation available, the carcass could be

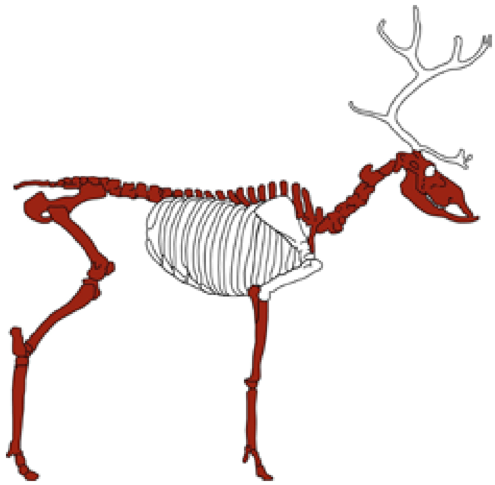

Fig. 7. The types of bones that remain in the midden at Sumtangen are marked in red. The meat has been cut from the bones, and the bones are left as waste at the site, together with the less meaty parts of the animal. The upper foreleg (shoulder) and ribs must have been carried away after the hunt with the bones remaining, as these types of bones are underrepresented. The antlers were also brought along

transported back in one piece. Otherwise, it is normally cut into pieces: leg, upper front leg (shoulder), ribs and back piece, and then carried away by the hunter.

The odd distribution of bone elements in the middens indicates that people other than farmers from the fjord and mountain districts around Hardangervidda may have been responsible for the special mass trapping in the 1200s (Indrelid & Hufthammer, 2011).

The extent of the mass trapping at Hardangervidda in the Middle Ages

Today the pure meat weight of reindeer bucks at Hardangervidda normally lies between 40 and 60 kg, and for female reindeer between 25 and 28 kg. In the material from Sumtangen, there were animals of both sexes and also a small number of calves. As regards the size of the animals, no major differences were observed between the medieval reindeer and today's wild reindeer population. If we assume an average meat weight of 35 kg per animal, the total catch at Sumtangen will be between 200 and 275 tons of pure meat. If the hunt lasted 50 years, the annual amount of meat that was transported from all four mass trapping sites would have been between 8 and 11 tons, and 200–300 hides (Hufthammer et al., 2011). It is, however, very unlikely that this kind of overhunting could last for as long as half a century. The annual yield, therefore, has, at least in some years, probably been considerably larger than these figures.

The hunt seems to have taken place in late summer and in the autumn, within a couple of months maximum, and must have required a large attendance of people, for building and inspection of the actual trapping systems, for driving the animals towards the water, for killing, butchering, the splitting of bones for marrow and the transportation out of the area of meat and hides on horseback.

Who might have been organising a venture like this?

"Skòtbog" – the hunter's pay?

Light may be thrown on this question by taking a look at the missing bones in the middens, the ribs, the upper forelegs, and the antlers.

The missing rib bones may be explained by the fact that they were transported whole from the site, as it was too time-consuming to remove the meat from the rib cages in the field.

A sentence in the Gulating Law is interesting in connection with the underrepresentation of shoulder bones. The Gulating Law was one of the four regional laws in Norway, but also for Hallingdal, the extended valley immediately east of Hardangervidda. One of the sections deals with the situation when an animal is driven into a lake and killed in

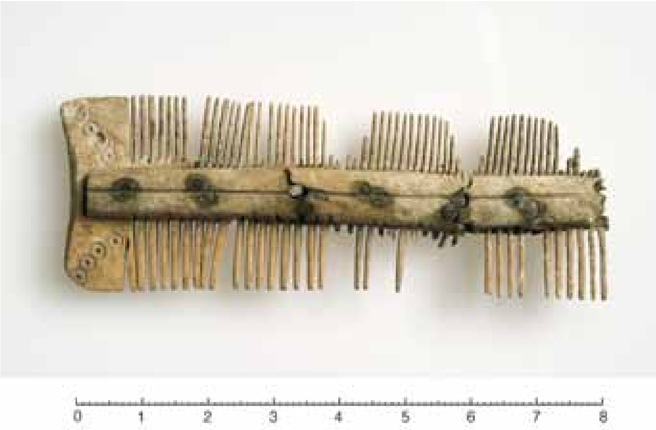

Fig. 8. Bone comb from the 1200s, found in the midden at Sumtangen. Corresponding combs were, among other things, found during the excavation of the medieval layers at Bryggen in Bergen in 1950s and 1960s, and they were presumably manufactured there. Photo: S. Skare

the water. If the person who actually kills the animal is someone else than the person who “owns” it, then the upper foreleg (shoulder) goes to the person who kills the animal. In the law, this is referred to as “skòt-bóg” and it seems to have been the payment to the hunter. It was “the owner”, that is, the person who organised or financed the hunt, who paid (Indrelid & Hufthammer, 2011).

The missing antlers are particularly interesting. The remains of the skull show that the antlers in many cases were cut off. A whole lot of off-cuts from the outer branches of the antlers have also been found. The parts of the antlers that are missing are the largest and most compact ones.

Fig. 9. Arrow-like owner’s mark (label) of reindeer bone with carved runic inscription: ”*ottar a*” (Ottar owns). On the back side it says: ”*klokær maðr*” (wise man). Photo: S. Skare

Reindeer antler was a common raw material for a number of tools in the Middle Ages, not least for combs. Comb-makers are mentioned in the Bergen town laws from 1282. At the Bryggen excavations in the 1960s, the remains of a comb-maker’s workshop with waste material and half-finished products of reindeer antlers were found (Herteig, 1969). DNA analysis of waste material found at Bryggen and antler remains in the midden at Sumtangen show no genetic differences.

Reindeer hunters skilled in runes?

At Sumtangen, several bone tools and bones with runic inscriptions have been found. The inscription “kuth er als” –”God is all”, or ”God is almighty” on a piece of bone is in itself sufficient to exclude the theory of a ”Lappish” origin. These words were obviously carved by a Christian. The Lapps were still heathens in the 1200s.

On a small bone knife it says “amunta a mik” – “Amund owns me”, and on a fragment of a rib bone a man’s name ”aslakr”. Both Amund and Aslak are still common Norwegian male names, both to the east and the west of Hardangervidda. On an arrow-like artefact, “ottar à” – “Ottar owns” has been carved on one side, and on the other it says “klokær maðr” – ”wise man” (Fig. 9). This is not an arrow, but an owner’s mark – a label, whittled in a way that it could easily be attached to load of goods. Corresponding labels have been found in large numbers at all excavation sites in medieval towns in Norway, but they are normally made of wood. The bone label from Sumtangen has obviously been manufactured at the site by a skilled rune carver who was present during the catching (Indrelid & Hufthammer, 2011).

Who were they, these three people we know the names of from the 1200s at Hardangervidda? Were they farmers from Hardanger or Hallingdal? How could it be that ordinary reindeer hunters from the surrounding rural districts around Hardangervidda in the 1200s were literate, while their descendants in the 1500s and 1600s were illiterate?

Several characteristics of the finds from the middens at Hardangervidda indicate that people other than farmers and other reindeer hunters must have been present during the mass trapping. A rib bone found in the midden at one of the trapping sites near Store Krækkja, has carved circles, made by a pair of compasses. (Fig. 10) Similar decorations were commonly used in many contexts, not least on combs. The reindeer hunters hardly brought a pair of compasses along while hunting. Could it be that the comb-makers were present in person during the hunt to select materials for their businesses?

Fig. 10. A bone fragment with circle decoration from one of the middens at Store Krækkja shows that one of the persons present during the hunt has played with a pair of compasses – hardly a tool commonly used by reindeer hunters in the 1200s. Photo: S. Skare

Fig. 11. Board game piece from the 1200s, found in a midden at Sumtangen. Photo: S. Skare

Was the mass trapping organised from the towns?

The mass trapping of reindeer in the second half of the 1200s differs from both earlier and later reindeer trapping, both as regards scale, trapping and butchering methods.

The large amounts of meat, hides, and antlers that were harvested in the course of a short period of time give evidence of a large-scale commercial activity exceeding local consumption. The use of compasses and knowledge of runes points to the towns, more so than to a rural farming population.

The nearest town in the 1200s was Bergen, the largest town in Norway, the royal seat and one of the most important trade and seafaring towns in Northern Europe. It is likely, although not proven, that Bergen was the destination of the reindeer products from Hardangervidda .

Meat and hides, and antlers were important commodities. Imports of reindeer hides are mentioned in English customs records around the 1300s. The wreck of the so-called "Darsser Kogge", built around the year 1300 and that sank outside Mecklenburg-Vorpommern some decades later, contained a cargo of, among other things, reindeer antlers and hone stones, which to all appearances came from Norway. Powerful and financially strong interests must have been behind the mass trapping. It is not unthinkable that it took place following royal orders (Indrelid & Hufthammer, 2011).

The overhunting on the scale that we see at Hardangervidda must in the course of just a few years have decimated the population of wild reindeer considerably. Sooner or later, one would have ended up below the profitability level of the venture. This is the most likely explanation for the sudden discontinuance of mass trapping around or a little later than the year 1300.

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Use of pitfall traps in wild reindeer hunting in the mountains of South West Norway: The location, construction method and use of the hunting sites

Sveinung Bang-Andersen

Abstract
The article deals with the topic of the use of stone-built pits in wild reindeer trapping in the Setedalen wild reindeer territory, one of many specialised forms of outfield exploitation that has occurred in a few areas and at certain points in time in Norway. The reindeer pitfalls in the area for analysis are quite uniform in shape and location: somewhat smaller than the length and breadth of an average man, with a pitfall chamber made from flagstones and stones cut into the ground. The devises are placed close to the waterfront and usually appear singly. Judged from the number of pits, the majority of the wild reindeer trapping in the area for analysis must have taken place in the western parts of Bykleheiene in the Early and the Late Iron Ages. Both in terms of the way the pits were constructed, and when and how the wild reindeer trapping was operated, there appears to be clear distinctions between Western Norway and the centrally located mountain districts in South Norway and the wide expanses of Nordkalotten. Among other things, earthen pits found singly or combined into large pitfall and funnel-shaped trapping systems with approach fences and slaughter pens are missing in the mountains west of the watershed.

Introduction

Hunting and catching activities have been fundamental elements in our cultural history – to our economy, social circumstances and mental wellbeing – for as long as people have been living in present-day Norway. Before the special focus of this short article is narrowed down to wild reindeer as prey animal and the methods developed to catch it, one must keep in mind that the majority of the outfield areas in large parts of Norway are not naked mountains and plains, but islands, stretches of coast, woodland and long valleys surrounded by low hilly areas. In South West Norway, for example, 60% of the outfield surface area lies below 500 m a.s.l. It is probably here, on lower and middle heights, that the majority of the hunting and catching activities in reality took place, even if the traces of such activities to a great degree have been wiped out later, or appear to be less visible to a trained hunter's eye compared to the ones in the high mountains. All in all, elk, deer or wild boar have, at least in periods, been more important as sources of food for humans compared to reindeer. No matter if the latter is the species that immigrated first and have the longest seniority as prey animal, and in addition, to a considerably greater degree than the other terrestrial game species has been surrounded by myths, superstition and fascination, the wild reindeer is but only one element in a complex and variable hunting and catching culture.

One of the most important tasks of the recently established national outfield network in the joint research programme "Forskning i fellesskap" should be to study local, distinctive features in the construction method and localisation of the wild reindeer pitfalls, to compare the pitfalls on a nationwide basis and to give an account of the economic significance of pitfalls in relation to drive hunting and shooting, possibly also in relation to the exploitation of other types of game. It is imperative to investigate how the methods that have been used differ in the various mountain districts. To achieve this, it is crucial that it is built on a common terminology and comparable data sets.

The article clarifies by way of introduction central concepts like "jakt" (hunting), «fangst» (catching) and "dyregrav" (pitfall traps). Subsequently, the archaeological material that exists from the mountains of South West Norway (Rogaland and the two Agder counties) will be presented with the intention of shedding light on the location and construction method of the pitfall traps, before one delves more deeply into things to clarify their type of use, dating, and culture-historical context. Finally, I would like to present some viewpoints on how the material from the mountain districts in South West Norway can be included in a national network collaboration that probably will be unequalled in a world sense.

Hunting and catching – pit and depression

While *hunting* means bringing down and killing of (roaming, running, flying, swimming) utility game or nuisance animals by using a weapon, *catching* involves lying in wait or forcing the animal into a physical structure and to keep the prey calm irrespective of whether it will be killed or not. Traps for furred or nuisance animals can, however, have been made to put the animal down immediately. Both hunting and catching can be divided up based on the degree of interaction. *Active* hunting and catching imply that one or several persons are present who either shoot the animal at close range or drive animal herds off cliffs, into a lake or into corrals of stone or timber where the catch can be killed. *Passive* hunting and catching are quite the opposite: here, the animal unsuspectingly moves into or down into a physical trap without the hunter being present. A distinction should also be made between *individual* hunting and catching carried out by one or, at the most, relatively few persons, and *collective* hunting and catching where it is essential that many participate in order to get at the prey (e.g. Nellemann, 1970; Bang-Andersen 2013).

In the wild reindeer areas in Norway, seen collectively, all these forms of hunting and catching have taken place to a greater or lesser degree, probably with an increased diversity of applied techniques over time. While the Stone Age hunter's activities were chiefly restricted to individual hunting with a bow and an arrow, the picture is considerably more nuanced in the Iron and Early Middle Ages. This applies in any case to areas where a large, wild reindeer populations or changing natural conditions required the use of different strategies and techniques.

With "dyregraver" (pitfall traps), in the literature also mentioned as "fangstgroper" (catch pits), "fangstgraver" (pitfall traps), "fallgraver" (catch chambers) or "reinsgraver" (reindeer pitfall traps) are understood as stationary, intentionally dug depressions in the ground, functioning as camouflaged systems for the catching of single animals. The prey moves unknowingly towards the traps, without having been hunted or alarmed. The traps are designed to capture without killing the prey instantaneously. Because of this they were not equipped with vertical impalement stakes. The classic construction in the high mountains is a rectangular stone wall chamber, the length and breadth of an average man, normally with 2/3 buried below ground level (Bang-Andersen, 2004). (Fig. 1.)
In areas with deeper and more fine-grained subsoil, like e.g. the upper parts of the wide valleys in Eastern Norway and on

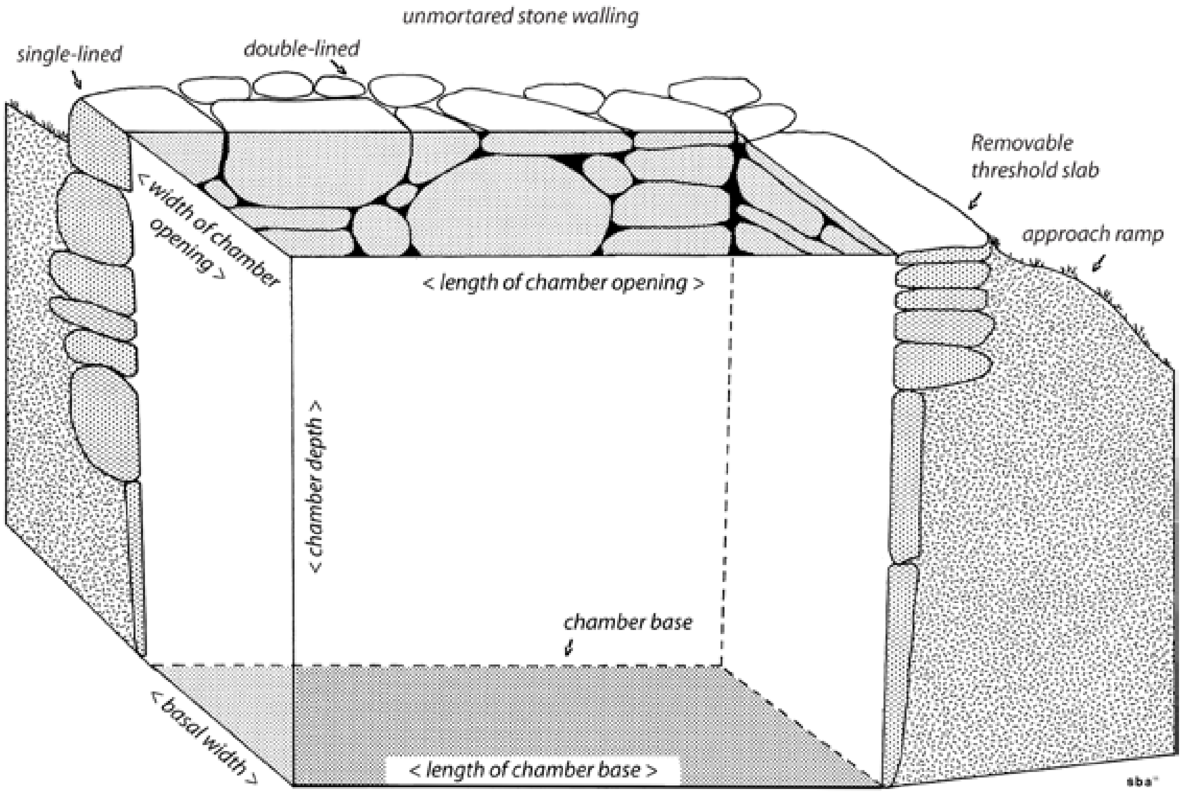

Fig. 1. Principle sketch of the main elements of a stone-built pitfall, with the exception of the camouflage cover which consisted of horizontal wooden stakes, heather and moss. Drawing: S. Bang-Andersen

Finnmarksvidda), oval, earth pits exist, often in large numbers. These lack stone-lining, but seem to originally have been supported by wooden walls (Barth, 1983; Jordhøy, 2008) or a wooden frame around the opening (Vorren, 1998). As an exception, earth pits with a small rectangular stone box towards the bottom are also found (Barth, 1996).

During the last decade, there has been an increasing tendency to name them all, no matter what type of construction it was referring to and which animal it was meant for as "fangstgroper" (pitfall traps). In addition, there is a rather arbitrary use of language, in which the author in one and the same piece of work may mention the same phenomenon using different words, e.g. both "fangstgrav", "fallgrav", "grop" and "fangstgrop" (Vorren, 1998). Such usage seems confusing and blurred. *Dyregrav* is an established and generally well-known concept; we find an early use in the oldest texts of statutes, as numerous place names on maps (dyrgrav, reinsgrov, dygra, gravene, grovene), in early literary reviews (Keilhau, 1840; Reusch, 1897) and in common everyday language. While the word "grav" (literally "grave") clarifies that the object is human-made, a "grop" (pit) might as well be natural, formed by for example dead-ice melting. When the expression "fangstgrop" (catch pit) is used, it ought to be used to name constructions for the catching of elk (and possibly deer), cf. the Swedish term "fångstgropar" (Selinge, 1974; Spång, 1981) as well as a previous, corresponding, consistent use of the word also here in Norway (Jacobsen, 1989).

The location and construction method of the reindeer pitfall traps

The area for analysis, Setesdalen wild reindeer district, lies in the low and mid alpine zones of bare mountains in South West Norway in the border area between Rogaland and Agder. Today, wild reindeer are found widespread across a largely continuous area of ca. 7800 km^2 in altitudes between 800 and 1200 m a.s.l. (Krafft, 1981). In prehistoric time, the wild reindeer game population hardly had any significant wider geographical distribution, with the exception of in the southwesterly direction (Andersen & Hustad, 2004; Bang-Andersen, 2004), but it was probably slightly more numerous compared to today's population of ca. 3200 animals in winter (Bevanger & Jordhøy, 2004).

Humans have exploited wild reindeer in the high altitude areas of Ryfylke and Setesdalen remarkably early, further back in time than any other place in the Norwegian mountains. This is apparent from archaeological investigations that have rendered up to 9600 and 9750 ^{14}C year old dates of well-preserved hunting sites from Store Myrvatnet and Store Fløyrlivatnet ca. 600 and 750 m a.s.l., respectively, on the mountain plateau on the southern side of Lysefjorden, east of Stavanger (Bang-Andersen, 2003).

The first time reindeer pitfalls seem to be have been localised and commented on beyond the more indirect mention that is evident from places names, legislation and general decrees, is in the summer of 1839. Baltazar Mathias Keilhau, who was later to become professor of geology at Det Kgl. Frederiks Universitet in Christiania (Oslo), was, during a topographical journey, shown a reindeer pitfall trap at Falkedalslegå in Upper Sirdal (Keilhau, 1840). Not until ca. 60 years later, a bit more thorough description of pitfall traps (in the mountains of Hemsedal) was provided, this time also by a geologist: Hans Reusch (Reusch, 1897). The pitfall traps in the moors of Ryfylke and Setesdalen mountains were largely left unheeded by archaeologists (Bang-Andersen, 1988). A systematic registration and archaeological investigation was for the first time carried out in the 1970s on the occasion of planned development of hydroelectric power in Øvre Otra and Ulla-Førre (Løken, 1977 and 1982; Bang-Andersen 1983, 2004, 2008 and 2009).

Pitfall traps within Setesdalen wild reindeer territory that stretches northwards to Haukeli and includes Ryfylkeheiene to the west and Sirdalsheiene to the south, are few in numbers. They show relatively little variation as regards form and location, but have still a significant value as a statement as regards type of use and dating. The majority is found as a minor concentration to the south of Haukeliseter and a somewhat larger in western moors of Bykle. From here they are reduced in numbers the further west, east, and south one gets. The southernmost, reliably documented reindeer pitfall in the area – and by all accounts in the world – is situated 835 masl. at Degjevatnet in Sirdal (Bang-Andersen, 2004). In addition, there are pitfalls from 735 to 1325 m a.s.l.; the majority between 900 and 1200 m a.s.l. Across several large high mountain stretches, pitfalls seem to be missing, a circumstance that cannot be explained in terms of topography, wildlife biology, or from the absence of investigations (Bang-Andersen, 2004).

With a typical undulating and water-dominated landscape without large moraine deposits and few open areas, the Setesdal Vesthei is not suitable to maintain large populations of wild reindeer, but very favourable for hunting and catching of wild reindeer on a small scale. Ca. 50 pitfalls, or approximately half of the total number,

Fig. 2. Pitfall in the middle of the isthmus between the two small lakes Reinsgrovtjørni (1120 m a.s.l.), Bykle, Aust-Agder. Photo: S. Bang-Andersen

have been adequately informed about to be analysed further with regard to the location, the dimensions and construction methods of the systems. It is rather striking that the densest occurrences are found on locations where Late Mesolithic and in part Early Neolithic dwelling structures for hunters have been identified (Løken, 1977; Bang-Andersen, 1999), which indicates that the reindeer's migratory behaviour in these mountainous areas has not changed significantly in relation to 6-7000 years ago. Ninety percent of the pitfalls lie less than 100 m from the waterline or a riverbank. Of these, more than half are less than 10 m from the nearest water's edge. (Fig. 2).

The pitfall builders also exploited otherwise characteristic terrain routes, such as the foot of steep mountains sides, the bottom of narrow gorges and the ridge of narrow till deposits. They appear almost always singly, only in a couple of instances two and two together and never as parts of a large continuous pitfall trapping system. The majority of them are, however, situated in such a way that they could catch animals migrating in both directions. Where the location is not ideal, physical constructions in the form of low stone-built fences, paths, approach bridges and special threshold slabs have to a large extent been used to ease the access and the further journey down into the catch chamber. Most common in the area are raised approach bridges from one or both trap ends (identified outside 56% of the pitfall trap systems), followed by approach stone fences (found at 42% of the pitfall traps). Only seven pitfalls (15%) lack any form of visible approach constructions. The majority of these are located in "bottlenecks" between the water's edge and steep or rocky terrain where no artificial barriers were needed apart from the pitfall trap chamber.

Fig. 3. A completely buried and well-preserved pitfall at Litledalsfleene (1210 m a.s.l.) , Suldal, Rogaland. The chamber has a stone-lining of up to fifteen courses. Photo: S. Bang-Andersen

One locality at the Langesæåi River in Vinje municipality, however, is located in a way that indicates that the two pitfall traps in the system hardly can have functioned effectively without approach fences, which would probably have been made from timber. Rows of post holes from previous approach fences have been identified in connection with reindeer trapping pits in other mountainous areas both in South and Mid-Norway, on the Finnmarksvidda mountain plateau and in Lapland.

The chambers of the analysed pitfall traps are without exception stone-built; the fall opening is on average 167 cm long and 76 cm wide. The relative width varies considerably, and is without any identifiable «ideal ratio». The present depth of the chambers is on average 110 cm. This is, however, strongly dependent on the preservation conditions at the site and any subsequent infilling, and says more about the pitfall's status as a cultural monument than how deep it was originally. In order to eliminate the source of error created by natural degradation and human interference, a closer analysis has been carried out of ten especially well-documented pitfall traps, of which nine have been subjected to archaeological excavation (Bang-Andersen, 2004). The original length of the fall opening of the pitfalls varies considerably, from 120 to 200 cm. The width varies between 50 and 85 cm and the depth from 130 to 190 cm. The majority of the pitfalls have a rectangular fall opening, the catch chamber tapers towards the bottom both in terms of longitudinal and cross section, and approx. 75% is cut into the ground. Nearly all the pitfalls have large, vertical slabs of stone lining at the bottom of the catch chamber, which is otherwise constructed as a dry stone wall with 5–15 courses of stone. (Fig. 3 & Fig. 4).

A detailed analysis of four pitfalls shows that it on average was necessary to remove 5 cubic metres of soil, gravel and stone before the stone-lining of the chamber could start (Bang-Andersen, 2004). For comparison, a reindeer pitfall without stone-lining required ca. 6 m^3 of mass to be dug up (Vorren, 1998), which may seem to have been a bit large. The consistent use of vertical slabs in the bottom area, and often also further up along the short end of the stone-built pitfalls, however,

Fig. 4. Pitfall at a small lake south of Vestre Gyvatnet (1000 m a.s.l.), Bykle, Aust-Agder. The catch chamber is half-way built above ground level and has a footbridge to both short ends with movable threshold slabs.
Photo: S. Bang-Andersen

saved a lot of digging. The slabs also contributed to making the pit escape-proof as the prey animal was unable to find a grip for its hooves to get up and out. The amount of time required building a complete trap including stone-lining, camouflage cover and outer approach elements must have varied considerably, with 6 man-days (MD) as a presumed average for Setesdal Vesthei (Bang-Andersen, 2004). This is in contrast to calculations from the Skjåk mountains where the volume of work per pitfall is estimated to have been 20–25 MDs (Mølmen, 1988). This is equivalent to a total of 3–4 weeks of work for one person and seems to be inconceivably high. For comparison, to build a 2.5–3.5 m wide earth pit meant for elk with an extensive inner woodwork, camouflage cover and barrier fences in a rail fence style would have required 14–15 MDs (Jacobsen, 1989).

Analysis of the pitfall traps' use and economic significance

Contrary to the mass trapping systems with corrals and slaughter pens demonstrated in several central and eastern parts of the high mountain in South Norway, the pitfall traps, whether they are found singly, in pairs or in long rows, are without doubt intended for passive catching of individual animals. The purpose was not to kill, but to keep the prey unharmed and stressed as little as possible until it would be taken care of (in reality: to be killed and slaughtered). Thus, the traps most probably did not need continuous inspection, but checking at least twice or three times a week.

Nine pitfalls in the Setesdal Vesthei were archaeologically excavated in the period from 1976 to 1979. Of these, six have been

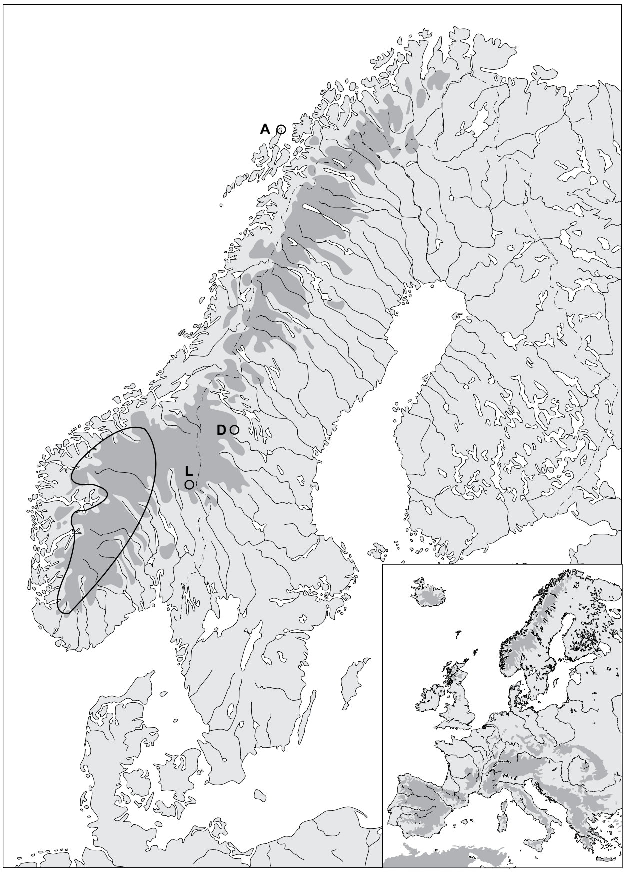

Fig. 5. The main distribution of stone-built pitfalls in Scandinavia with minor, isolated occurrences in Engerdal vestfjell (L), Ovikfjellene in Jämtland (D), and possibly also on Andøya in Lofoten (A). Altitudes above 900 masl. are shaded. After Bang-Andersen (2009)

radiocarbon dated: four by means of subfossil humus horizons, two through dating of wood remains that were found at the bottom of the catch chamber, and presumed to be the remains of a collapsed camouflage cover from the last time the pit was used. Complex stratification identified in the earthwork outside one of the pitfalls, Loc. 142 Gyvassmidjom at Lake Gyatnet in the western mountains of Bykle, provide evidence for not just one, but three user phases, interrupted by periods when the pitfall trap has been in a state of disrepair (Bang-Andersen, 1988).

Based on ^{14}C dating, five graves seem to be between 1800 and 600 ^{14}C years old, i.e. used within a period from Late Roman Period to well into the High Middle Ages. A sixth, Loc. 173 in *Gøne Hadlene* at Undeknut in Suldalsheiene, has been dated to the middle part of the Bronze Age. The dating is, however, a *Terminus post Quem* as the sample comprises a large part of the humus horizon. In Setesdalsheiene, the pitfalls are thus clearly older than the ones in Rondane where the pitfall systems, admittedly often with a weak and doubtful documentation, have on average been dated to between approx. 1200 and 1600 AD (e.g. Barth, 1996). On the other hand, the use of the pitfalls seems largely to be contemporary with corresponding activities in parts of Breheimen, the mountainous area at the head of Sognefjorden (Randers, 1986).

Regarding the question of who was behind the pitfall trap hunting in Setesdal Vesthei in the Iron Age and Early Middle Ages, the possibility that a separate group of professional hunters stayed in these parts of the high mountain areas, either on an all-year-round or seasonal basis may be ruled out by several reasons. Both the number of hunting systems and the amount of iron arrows from shots gone astray seem far too low to support such an assumption. The use of the pitfalls must, if anything, be seen as a marginal and relatively unstable outfield industry linked to the agricultural environments in the nearest neighbouring valleys in the east, north and south, and in the heads of fjords on the west side of the mountain.

An analysis of the settlement development in sixteen potential "user districts" and an estimation of the most probable transportation routes between these and the pitfalls lying closest to them (Bang-Andersen, 2004) indicates that pitfall hunting of a very modest scale could have taken place from certain farms on the *western* side of the mountain both in the Early and the Late Iron Ages. On the *eastern* side, the use of pitfalls in the Early Iron Age seems to have existed in particular from Botsvatnet/ Kyrkjebygda in Bykle (Løken, 1982). The northernmost parts of the Setesdal did probably not come into the picture before the transition Viking Age/Middle Ages, when large-scale iron production was established for instance in the Hovden area (Bloch-Nakkerud, 1987). In Setesdal south of Kyrkjebygda, no pitfall activities seem to have taken place. The distance as the crow flies between farm and pitfall traps varies from 6 to 35 km, while the altitude difference alternates between 185 and 1125 m. Assessed from geographical distance, topography, passability, and transportation options, the access to the pitfalls seems to have been the most strenuous and time-consuming from Ryfylke and Suldal. On the other hand, good waterways and little difference in altitude eased the transportation from Setesdalen and Sirdalen, respectively.

From the modest number of pitfall traps it would be impossible to decide how important wild reindeer actually were to the farm economy in the different areas in the Iron Age and the Middle Ages. In addition, a number of factors that for the time being are unknown, e.g. the extent of bow hunting, and eventual communal drive hunt activities, that need not have left any visible trace at all. Furthermore, the fact that meat caches and bowmen's hides and other constructions that undoubtedly are connected to reindeer hunting are impossible to date, poses a problem. They *may* be contemporary with pitfalls or arrow finds in the area, but may just as well be considerably younger.

Still, it seems that the wild reindeer in general undoubtedly had far less significance to the economy of the permanent settlements around the mountains of Ryfylke and Setesdalen than it had to the people who exploited the eastern parts of Hardangervidda, Rondane and Dovrefjell. Here, pits are found by the thousand, as are also large, extensive and labour-intensive mass trapping systems of various kinds.

Summary and perspectives

Stone-built pitfalls are found widespread and largely continuously from Ryfylke/ Setesdalsheiene to the south and to Trollheimen/Jotunheimen to the north, with some scattered occurrences also in a few other mountainous areas (Fig. 5). Unmortared earth pits for wild reindeer catching have been used across considerably larger areas on the Scandinavian Peninsula and in North Finland, but are not, like the stone-walled pits, documented from other areas of the world. The pitfall traps in the analysis areas emerge as rather uniform both as regards size, design, and placement in the terrain. The stone-built «high-mountain types», few in number, have almost always been constructed separately, and have particularly been used in the Early and Late Iron Ages. They display, in all respects, clear, common features with pitfalls in western mountainous areas further north in South Norway (Fig. 5).

The absence of larger systems of pitfall traps in the mountains of South West Norway, as well as elsewhere in Western Norway, may have multiple causes. This is probably to a great degree caused by the broken up topography with many lakes that strongly influences the reindeer's migratory behaviour and creates bottlenecks where one single pit generally will be sufficient. The establishment of large pitfall trap systems would neither have been possible or necessary. The reindeer populations have probably also been too small to provide a basis for drive hunting and downright massacres, the way this has been taking place on a large scale both east of the watershed on Hardangervidda (Indrelid et.al., 2007, Indrelid & Hufthammer, 2011), in Rondane (Jordhøy et al., 2012), on Dovrefjell (e.g. Jordhøy, 2008), in North Norway (Vorren, 1998) and, during later periods, also in West

Greenland (Nellemann, 1970; Grønnow et al., 1983). On Hardangervidda, the systems of stone-built pitfalls are more complex compared to those in the western mountains; normally consisting of at least 2-3 pitfalls (Blehr, 1972; Bakke, 1984). On the other hand, Setesdal Vesthei is, though a systematic concurrence in the distribution of pitfall traps and hunter camps from the Early and the Late Stone Ages, probably better than any other mountainous area, suitable to shed light on wild reindeer behaviour and human exploitation of the wild reindeer population in a long time perspective – at least 7000 radiocarbon years, or 8000 solar years (Bang-Andersen, 1999).

As there are marked differences between the reindeer pitfall traps in western mountain regions, the central mountain districts of South Norway and on Nordkalotten, time is ripe to clarify, analyse, and interpret regional distinctive features in a systematic manner and agreed methodology. The datings that hitherto are available should be evaluated and compared, while additional datings, both of stone-built and earth-dug pitfall traps in the various areas simultaneously are obtained. It will thus be possible to identify both periods of intensive use, phases of discontinuance and areas where pitfall trapping has been of little or minor significance. It will, not least, be important to gain a deeper understanding of how the pitfall traps were constructed and functioned and how they were inspected and maintained.

The reindeer pitfall traps in the mountains belong to the most distinctive and preservation-worthy elements in our cultural landscape heritage (Andersen & Hustad, 2004). Together with mass trapping systems, bowmen's hides, meat caches, hunting cabins as well as other visible traces of past times' wild reindeer hunting and catching, they contribute, more than anything else, to mark the mountains as ancient cultural landscape. It is a national commitment to realise this, so that the trapping systems can be taken better care of, and through increased knowledge, be made increasingly meaningful in the future.

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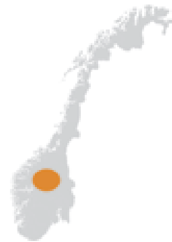
Trapping pits for reindeer – a discussion on construction and dating

Jostein Bergstøl



Abstract

In the mountains of Norway there are thousands of pitfall traps for reindeer. They are constructed in two different ways. This paper presents a discussion on how to understand this division, and propose a way to explore the problems concerning dating of the pitfalls.

Introduction

There are two distinct categories of pitfalls for reindeer. One that is dug into the ground with an oval embankment around it, and another that is rectangular and made of stone. The dry masoned pitfalls are mainly located in Southern Norway, while the dug variant are found from North to South (Vorren, 1958 ; Bang-Andersen, 2004). In this paper I will explore the reasons for this. I will also look at the dating of pitfalls.

It has been suggested that there might be an ethnic explanation for this geographical distribution, but later surveys have shown that the two types may be found in the same systems (e.g. Vorren, 1958; Jordhøy, 2007). This suggests that the reason for the two types is functional rather than ethnic. In the following I will present the two types and discuss the similarities and differences between them.

Pitfalls made of stone

The pits in scree and barren high mountain terrain were built with dry stone walls, both the easiest accessible building material, and often the only material available. The pitfalls made of stone are normally between 70 and 90 cm wide, and 180–200 cm long. Many of them have low fences from each corner, normally 2–3 meters in length and rarely more than 30 cm high. The depth is normally close to two meters in the well preserved pitfalls. This means that a reindeer

Fig. 1. Pitfall with dry wall construction. Leading fences from two corners. Photo: J. Bergstøl

Fig. 2. Pitfall of the dug type, from the erosion zone in the hydro-electric dam Aursjøen in Lesja. Photo: J. Bergstøl

with average shoulder height of about one meter will have no chance of getting out. The antlers of a grown male reindeer are wider than the pits, and they may break the neck when they fall in.

The dug pitfalls

The dug pitfalls are normally located at lower elevation, often below the tree line. Most of them appear wider and shallower than the stone-walled ones. Because of the collapse of the inner structure and following erosion, it is more difficult to see what they looked like when they were in use. The question is then; did this type function differently than the ones made of stone? To answer that question we have to find out exactly what they looked like before they collapsed. This has been discussed in detail for the pitfalls for moose (Vorren, 1979; Barth 1981; Jacobsen, 1989; Amundsen, 2007). The numbers of excavated pitfalls for moose are much greater, and thus the empirical base for the reconstruction is

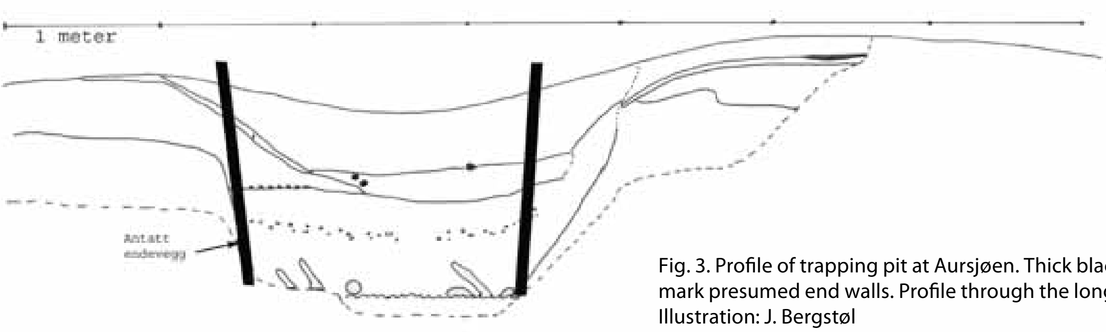


Fig. 3. Profile of trapping pit at Aursjøen. Thick black line mark presumed end walls. Profile through the long side. Illustration: J. Bergstøl

Fig. 4. Pitfall at Aursjøen after excavation. Note the burned split wood. The cut log (top right) are dated 1450–1485 AD. Photo: J. Bergstøl

much better. It is normally believed that the pitfalls for moose have been funnel shaped in the upper part, and had a rectangular box in the bottom. The pits were lined with timber, both the funnel and the bottom box (Jacobsen, 1989). This way the moose would be unable to get out of the pit once it was trapped. The moose is bigger than the reindeer, and it jumps higher. The pits for moos are thus bigger, but the technology is otherwise basically the same.

In 2006, a well preserved pitfall for reindeer was excavated in the Dovrefjell region, near lake Aursjøen (Bergstøl, 2007). The trapping pit was situated in a hydroelectric dam, and had been flooded for the past 60 years. When the water was drained because of repairs on the dam, several pitfalls were found. The top soil was washed away, but the rest of the pit was intact (Fig. 2). It had a remarkably well preserved inner structure. It may serve as an example for both the construction of these pitfalls, as well as an explanation on the erosion after the collapse of the inner structure. A good understanding of the process of the erosion is also essential for the understanding of the dating of this group of pitfalls.

The soil that was removed when the pit was dug, has been deposited as a bank around the opening. This made the pit deeper, and may have saved as much as 40 cm of digging. The flat stones on the bank were probably used to keep the covering material in place (Fig. 2). On the bottom of the pit, several twigs were found, from 1–2 cm in diameter. They are believed to have carried the covering material, consisting of birch bark and moss. When the pitfalls were in use, they were deep and narrow with vertical walls, but the erosion have made it difficult to see the original shape. This is probably the reason that has led to the assumption that there are two types.

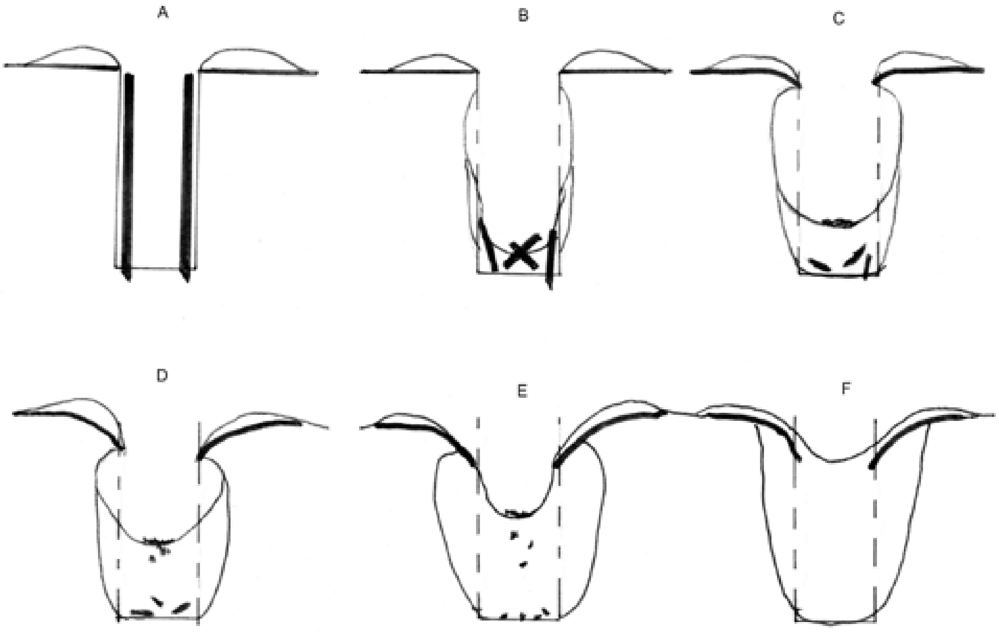


Fig. 5. Idealised sketch of decay, erosion and collapse of a trapping pit. Profile through the short side. Illustration: J. Bergstøl

Fig. 6. Charcoal pit. Note the old surface under the bank on the right side. Photo: J. Bergstøl

The excavation of this particular pitfall was done by digging one half, parallell to the length. Ca. 40 cm below today's bottom of the pit, the top of a number of standing logs were found (Fig. 3 & Fig. 4). The fine grained sand near the original river bank was very moist which gave excellent preservation conditions. The logs waried from 8 to 18 cm in thickness. The thickest logs were split, and the inside were burned, probably to prevent decay. The ca. 50 vertically placed logs formed a frame that measured 90x190 cm, i.e. the average dimensions of the pitfalls with dry stone walls (Fig. 4).

Inner construction in the "dug type"

The question is then, is this pitfall typical for the "dug type"? It is very rare that we have preserved wood in pitfalls. The profiles normally show a U-shaped division in the soil (Fig. 5F). Fig. 5 is an attempt to reconstruct a normal process of decay, erosion and collapse of an idealised trapping pit in sand and gravel. After the wood have rotted, the soil will press against the walls, and all the rest of the building material ends up on the bottom (Fig. 5B). Without this support, the walls then start to erode and slide downwards. After a while, the top soil that is held together by roots, start to sink inwards, and ends up as in Fig. 5E or F, depending on the density and firmness of the soil. It is important to note that the division of the different "layers" in the sand that may be seen in the profile, do not represent the original inner walls of the pitfall.

After looking at a number of profiles of pitfalls, the conclusion is that they may have had an inner construction. The appearance today are caused by collapse of this inner structure of wood, and following erosion.

It is possible that some of the pitfalls of this dug type may have been built without inner construction of wood? In this particular case, the sand is so loose that it would be impossible to make vertical walls stand over time. And if a reindeer was captured alive, the efforts of getting out would have made the end walls collapse, and the animals would get out easier. Some years ago I presented an interpretation of a pit for moose with a lid covering the opening (Bergstøl, 1997). That interpretation was based on a poor understanding of the process of decay and collapse after the pits were abandoned. After the excavations at Gråfjell (Amundsen, 2007) and this pitfall at Aursjøen, I had to reevaluate the interpretation of the type with a lid. They probably had a cover of thin branches, with birch bark and moss on top to hide the big hole.

Dating of pitfalls

Sadly, it is very rare that there is organic material from the construction left in the pitfalls. Poor preservation conditions in Norwegian soils normally leave only small pieces of charcoal in the eroded soils in the middle (as in Fig. 5E). The material in the pit may come from the inner wooden structure, but it may also have fallen into the pit before, or during, the collapse. In most cases, the datings may as best serve as *terminus ante quem*, and have large margins of error.

Another way of dating the pitfalls is to take samples of seeds and charcoal from the old soil that was preserved under the bank. The problem with this method is that we don't know how old the charcoal and seed were when they were covered. It can only give a dating *terminus post quem*; after the dating of the old surface. A combination of two datings, with both these methods, may give a good dating of the use of the pitfall, but it is not uncommon to see gaps of more than a thousand years between the two.

In the coming years we will try to develop this method further, by investigating the charcoal preserved under the bank from contexts we have more control over. We will excavate pits for production of charcoal used in iron extraction (Fig. 6). These pits are constructed much in the same way as the trapping pits, only shallower. By dating charcoal from the production, we will know exactly when the pit was made. Analysis of the charcoal and seeds in the covered old surface under the bank will tell us how long the material may survive in the humus. This will hopefully enable us to be able to date trapping pits more accurately in the future, or at least have more control over sources of error.

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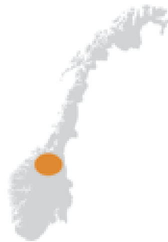
Chronological patterns among archaeological finds from snow patches in Central Norway 1914–2011



Martin Callanan

Abstract

In the years from 1914 to 2011, 234 archaeological artefacts were recovered from 28 alpine snow patch sites in central Norway. This paper presents chronological overviews for a large proportion of these finds. Age estimates for 199 snow patch artefacts are presented in a series of chronological overviews. The overviews are organized according to three distinct phases of discovering during the period 1914–2011. The dated objects are further organized according to whether they comprise of inorganic or organic components. The chronological overviews underline a series of developments that have taken place over time on melting snow patches in Central Norway. Firstly, the number of objects and productive sites discovered has increased dramatically in recent years. Secondly, it is clear that objects appear on snow patches are getting older over time. Evidence for earlier, unrecorded melting events is presented analyzing finds recovered with metal detectors. These implications of these observations both for local cultural history and for how we understand melting process on archaeological snow patches are also discussed.

Introduction

Snow patches are perennial accumulations of snow and ice, found in mountain regions around the world. Despite the fact that they usually lie in remote areas, it is increasingly clear that people used snow patches in the past for a variety of reasons such as hunting, trapping and as transport corridors. As physical structures, snow patches are products of the varying effects of weather and climate. As a result, they are dynamic contexts, prone to constant change and development. Objects that were either lost or discarded on these sites in the past are often very well preserved if recovered soon after they emerge from melting snow patches. Snow patch archaeologists around the world work to identify new productive sites and to recover important cultural material that emerge from degrading sites.

Snow patch sites have been identified in several different regions. In Scandinavia, the most productive sites are located in the mountains of southern and central Norway (Nesje, Pilø, Finstad, Solli, Wangen, Ødegård, Isaksen, Støren, Bakke, & Andreassen, 2012; Callanan, 2014). A small number of finds from upland areas in northern Norway indicate that sites are to be found in this region too (Sommerseth, 2013). Elsewhere in Europe, glacial finds and sites are until now limited to the Alps. Ötzi, the Neolithic Iceman, discovered on the border between Italy and Austria in 1992 is the best well-known glacial find in the world. There are other noteable finds sites spread across the Alpine region in Switzerland, Austria and elsewhere in Italy (Dickson, 2012; Hafner, 2012). The most significant snow patch locality is the multiphase site at Schnidejoch in the

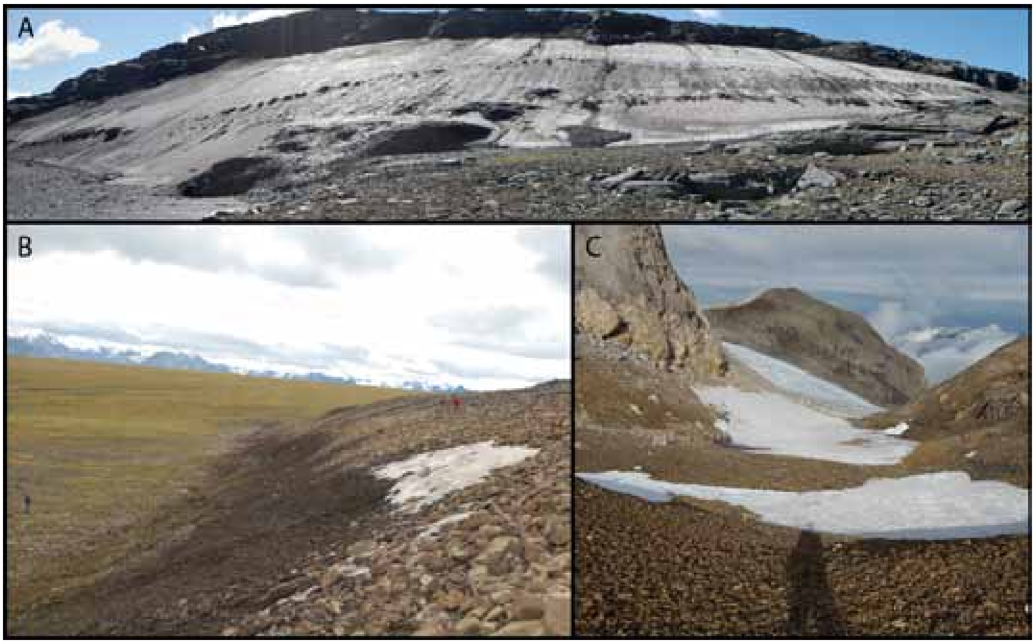


Fig. 1. Examples of snow patch sites from around the world in different stages of ablation. A. Kringsollfonna, Oppdal, Norway. Sept. 2014. B. Jaeger Patch, Wrangell-St. Elias National Park, Alaska, USA. Aug.2011. C. Schnidejoch, Bernese Alps, Switzerland. Aug. 2008. Photos: M. Callanan

Bernese Alps Switzerland (Grosjean, Suter, Trachsel, & Wanner, 2007; Hafner, 2012). In North America, productive archaeological snow patches are located in several different territories. The largest group of sites is in the Southern Yukon, Canada, where surveying and monitoring has been on-going since 1997 (Hare, Thomas, Topper, & Gotthardt, 2012). Several sites have also been identified in the neighbouring Northwest Territories, Canada (Andrews, Mackay, & Andrew, 2012). In the US, glacial finds have been discovered in two distinct regions. In Alaska, a several sites have been found in at least three different parts of the state (Dixon, Manley, & Lee, 2007; VanderHoek, Dixon, Jarman, & Tedor, 2012). The other group of glacial sites lies in the Rocky Mountains in the contiguous United States. Here, a number of sites producing both archaeological and paleobiological material were registered in Colorado, Montana and Wyoming (Lee, 2012).

Alpine snow patches in central Norway have been producing archaeological artefacts since the beginning of the 1900's (e.g. Farbregd 2009; Callanan, 2012). The recovered material consists mainly of personal equipment such as bows and arrows, knives and snares used during reindeer hunting expeditions into the mountains into the past. Due to the frozen conditions on these sites, we recover many of these implements in relatively good condition. Well-preserved snow patch artefacts offer us rare glimpses of the archery technology of the past, as the organic portions of bows and arrows are usually missing from lowland sites.

Archaeological artefacts emerge from alpine snow patches under special conditions. Ancient arrows and bows can usually only be recovered from around these sites during particularly warm summers, once the snow and ice has melted back sufficiently. In central Norway, the main period of recovery falls at

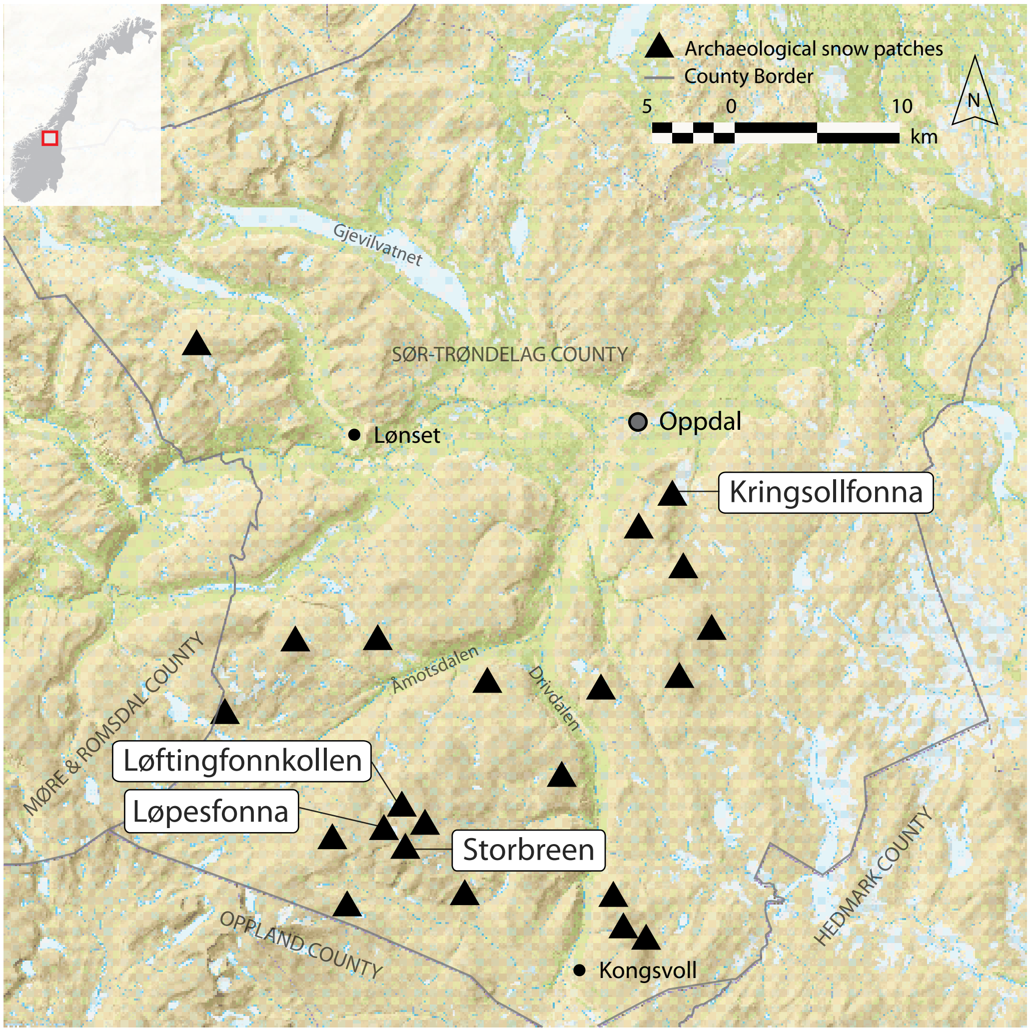


Fig. 2. Overview of snow patch sites with rchaeological finds in central Norway

the end of the summer between the middle of August and the middle of September, when snow patches have reached their minimum extent (see Callanan, 2012, Fig. 6). The majority of the region's snow patch finds have been discovered by different generations of local collectors, who survey sites when melting conditions are sufficient for artefact recovery.

One of the important characteristics of the snow patch collection from central Norway is that it has been gathered over such a long timeframe. This offers us the opportunity of analyzing long-term chronological patterns with respect to the age of artefacts that have emerged from these sites through the years. Not only will chronological analyses give information about how the use of these alpine hunting sites varied in the past, they may also be informative in relation to understanding the processes by which snow patches sites ablate and release archaeological objects over longer time-frames. The aim of this paper therefore is to present and discuss a series of chronological overviews of dateable artefacts recovered from alpine snow patches in central Norway during the period 1914–2011.

Background, data and methods

Between 1914 and 2011, a total of 234 individual artefacts were recovered from 28 different sites in central Norway (see Fig. 2, Fig. 3 and Table 1). The arrowheads, shafts and bow fragments recovered from snow patches in central Norway have been studied for many years, with particular attention paid to analysing long-term technological changes in archery technology through time. Oddmunn Farbregd presented the first complete chronological overview of snow patch artefacts from central Norway in 1972, with subsequent updates in 1983, 1991 and 2009 (e.g. Farbregd, 1972, 1983, 1991 & 2009. See also Callanan, 2010, p. 47, for a thematic overview). Until the end of the 20th century, the snow patch collection was dominated by finds from the Iron Ages and Medieval periods, with the oldest finds dated to around AD 200.

Table 1. Overview over snow patch finds and sites in central Norway

Snow Patch	Latitude (N)	Longitude (E)	Elevation m a.s.l.	Orientation	No. of Finds
Storbreen	62° 21' 51"	9° 24' 48"	1810	NE	48
Kringsollfonna	62° 30' 51"	9° 44' 38"	1520	NNE	43
Leirtjønnkollen	62° 27' 25"	9° 44' 37"	1560	NE	35
Brattfonna	62° 28' 38"	9° 46' 25"	1470	N-E	32
Løpesfonna	62° 22' 11"	9° 22' 27"	1730	NE	18
N. Knutshø	62° 19' 31"	9° 40' 26"	1630	NE	8
Vegskardet	62° 21' 56"	9° 19' 35"	1500	NE	4
Loftingfonnkollen	62° 22' 32"	9° 23' 20"	1680	NNE	3
Tverrfjellet	62° 28' 33"	9° 20' 55"	1270	NE	3
Bekkfonnhøa	62° 32' 9"	9° 41' 34"	1360	NNV	3
Kaldvellkinn	62° 30' 47"	9°44' 49"	1550	ENE	3
Sandåfjellet/ Svorundfjellet	62° 37' 46"	9° 11' 37"	1530	E	2
Langfonnskarven	62° 27' 1"	9° 38' 59"	1330	E	2
Kinnin	62° 21' 24"	9° 26' 40"	1720	E	2
Kringsollfonna+	62° 30' 52"	9° 45' 33"	1400	NNE	1
M. Knutshø	62° 18' 42"	9° 40' 49"	1545	E	1
Hesthågåhøa	62° 23' 59"	9° 35' 18"	1530	N	1
Snøhetta	62° 19' 61"	9° 17' 29"	2000	E	1
Skiråtangen, Sunndal	62° 26' 41"	9° 5' 50"	1450	NE	1
Råstu, Sunndal	62° 31' 18"	8° 47' 24"	1547	NE	1
N. Svarthammaren, Sunndal	62° 26' 55"	8° 44' 59"	1700	NE	1
Grovåbotn, Nesset	62° 21' 58"	8° 12' 55"	1390	N	1
Sissihøa	62° 33' 4"	9° 43' 36"	1360	N	1
Gravbekkfonna	62° 27' 8"	9° 30' 9"	1300	NNE	1
Namnlauskollen	62° 22' 25"	9° 25' 19"	1750	NE	1
Skirådalskardet	62° 26' 32"	9° 11' 47"	1765	E	1
Svartdalskardet	62° 28' 29"	9° 17' 15"	1585	NE	1
Håråkollen	62° 21' 54"	9° 21' 30"	1675	N	1
Sissihøa-Leirtjønnkollen	10x2 km	>1400 m a.s.l.	-	-	14
				Total	234

Since that time it has been shown that several finds recovered during the period 2003–2011 are considerably older than the previous AD 200 boundary. In 2007, Leif Inge Åstveit presented a small number of archery finds from snow patches in the region that dated as far back as the Neolithic period (Åstveit, 2007). Subsequent studies have identified and further analyzed Neolithic and Bronze Age artefacts collected since 2003 (Callanan, 2013, 2014). It is now clear that snow patch hunting is a tradition that stretches back at least 5400 years in the mountains of central Norway (Fig. 3).

The snow patch collection from central Norway is a complicated dataset. It includes finds with organic components such as wooden arrowshafts, fletchings, sinew bindings and adhesives. Also recovered are inorganic finds such as iron and stone arrowheads that have lost their organic components. The preservation of organic artefacts is one of the important characteristics of snow patch sites. When the organic components of an individual find are preserved, it tells us something about how long that find has been exposed outside the ice and snow. For this reason, in the chronological analyses that follow, a division between organic and inorganic artefacts is maintained.

In order to determine the age of the arrowheads, shafts, bows and other objects that have been collected from snow patches, two dating methods have been employed: typological dating and radiocarbon dating.

A number of factors influence the precision of typological age estimates. The first is the class of artefact under investigation, as some types of finds are more easily dated than others. Arrowheads are the class of finds more readily dated. Wooden arrow shafts are the second class of finds in terms of dating. Bow sections and fragments are more difficult to date typologically than shafts. Lastly, it is generally not possible to typologically date other wooden objects such as staffs, poles and snares even if they are found in a good condition.

The second factor influencing the precision of typological dates is the general state of preservation of individual artefacts. This is true of both organic finds such as arrowshafts, as well as inorganic finds such as iron or stone arrowheads. On iron arrowheads, the most temporally diagnostic traits are found on the tangs (Farbregd, 2009, p. 160). Usually it is possible to judge which period the projectile belongs to by examining the form and section of the tang. In some cases, the arrowheads have been exposed from snow patches over a period of time and reduced by rust. In these instances, the tang can be difficult to interpret chronologically although even in the worst cases, rough estimates are usually possible. In the case of wooden arrowshafts, the diagnostic traits include the form of the shafting and nock ends as well as the diameter and length of the shaft (Farbregd, 2009, Fig. 9). The precision of a typological date on a shaft depends on the extent to which these traits have been preserved, either individually or in combination with each other. Even the smallest shaft fragment can sometimes be dated if the nock end is still in place. But sometimes an artefact is so degraded or fragmentary that no typological estimate, however coarse, is possible.

The analysis also includes a number of radiocarbon dates that have generally been applied to artefacts thought to date to from before the Iron Age (i.e. ante 500 BC). The samples used for dating were all high quality wood samples taken from individual artefacts.

Fig. 3. A selection of projectiles that represent over 5000 years of hunting on the snow patches in central Norway. (L-R: T 25674, T25167, T15886, T25686, T23403, T25165, T23230, lead musketball and modern rifle casing date stamped 1919- all recovered from snow patches by collectors during the last 100 years. Photo: Å. Hojem, NTNU University Museum.
Layout: M. Callanan

Samples were taken under lab conditions with little danger of contamination. All samples were dated using accelerator mass spectrometry dating. Artefacts dated by C14 method are marked in the chronological overviews in Fig. 4 & Fig. 6.

Table 2 is an overview of how these different dating methods were employed in the current analysis. Typological and radiocarbon dates were possible for 199 of the total of 234 artefacts recovered between 1914 and 2011. This group of dateable finds is sufficient to

Table 2. Dating methods applied in the chronological analysis

Dates Types	Number of Artefacts (n=234)
Typological dates	177 (75.6%)
Radiocarbon dates	22 (9.4%)
No datum	35 (14.96%)

give a representative insight into the main chronological trends among snow patch materials during the period.

Finally, because snow patch artefacts have been collected over a long period of time, it is necessary to divide the history of artifact collection into different phases in order to allow us to map and compare developments over time. For this reason, in the following analysis the history of snow patch artifact recovery in central Norway during the period 1914–2011 is divided between three main phases of discovery. These phases have been defined by the numbers of finds recovered and by other important developments in the way they were collected. (The background for these three phases of discovery is described in greater detail in Callanan, 2010, 2014, Ch. 4) Following an initial discovery in 1914, the first phase (1914–1943) is marked by a large number of finds that were recovered during the late 1930s and early 1940s. There followed a second phase (1944–2000) of almost 60 years with relatively few discoveries. The third phase (2001–2011) during which large numbers of finds were again being recovered, began in 2001. The analysis was completed to include the season of 2011.

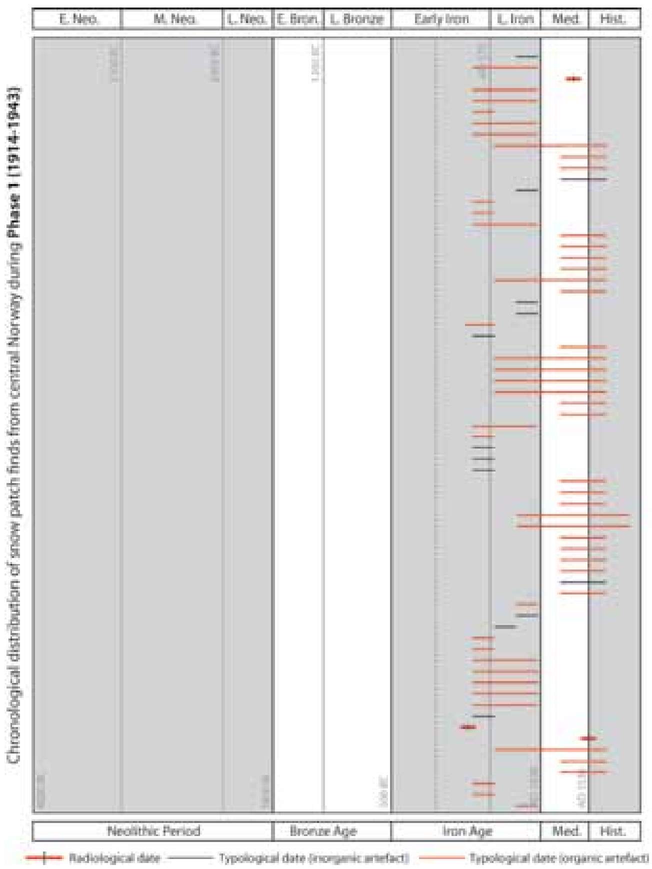


Fig. 4. Chronological overview over finds from central Norway during Phase 1 (1914–1943). Artefacts are plotted in the order they were discovered starting from the bottom up

In summary, the chronological overviews that follow are based on 199 dateable artefacts of the total of 234 objects recovered from snow patch sites in central Norway between 1914 and 2011. This time period has been divided into three distinct phases of artifact recovery. The material includes both organic and inorganic artefacts. Both typological and radiocarbon dating have been applied.

Chronological analysis – results

Recovery Phase 1 (1914–1943)

The first phase of discovery is characterised by a large number of finds recovered in a relatively short period of time (see Callanan 2014, pp. 183–184, for a detailed description). Sixty-eight of the finds were dateable. There are three radiocarbon determinations from this recovery phase, the remaining dates are typological estimates. An overview of the chronological profile of finds from this phase is presented in Fig. 4.

Many of the finds were in good condition with elements such as sinew lashings and birch bark wrappings recovered on a number of arrows (Farbregd, 1972, Pl. 1–13). This is reflected in Fig. 4 where artefacts with preserved organic components clearly dominate. This further underlines the dramatic nature of the melting events during the 1930’s where many well-preserved finds emerged from snow patches.

Clear temporal clusters are visible in the overview over phase one. Finds from two periods dominate the material during this phase: the Migration period (AD 400–600) and Early to Late Medieval period (AD 1200–1700) (Farbregd, 1972, 1983). The chronological patterning in the material from this phase is particularly neat, without any significant outliers. The chronological development is stable with no obvious changes in the age of the finds as they were recovered year after year.

In the phase one overview, we see for the first time how the broad dating ranges associated with certain periods affects the chronological resolution. In particular there are 22 finds for which only broad date estimates such as 'post AD 600' or 'ante AD 1000' could be suggested.

Recovery Phase 2 (1944–2000)

This is the longest of the three recovery phases, but is also the phase during which fewest finds were produced. During this 60 year period 12 new artefacts were discovered, all of which were dated typologically (Callanan, 2010). The main chronological characteristics observed during phase 1 are repeated in recovery phase 2. Again, the majority of finds range in age from AD 400 to 1700. The relationship between organic and inorganic finds remains balanced. Only one complete arrow was recovered during this phase. The others have all been damaged or fragmented in some way. Overall phase 2 is something of a hiatus, during which few finds were extirpated from snow patches even during hot summers when the ice cores on a number of sites were exposed (e.g. Farbregd, 1983).

Fig. 5 also includes a small group of finds for which the date of discovery has been lost. It was therefore not possible to assign these to a specific phase. However, the finds were all entered into the museums catalogue in 1955. Therefore they belong to either recovery phase 1 or 2. There is nothing in the composition or age distribution in this group that has the potential to disturb the tendencies already noted for recovery phases 1 and 2.

Recovery Phase 3 (2001–2011)

It is necessary to divide finds from this period into two different groups, based on the way in which they were discovered in the field. Between 1914 and 2000 collectors did not use metal detectors. Finds from this period were all surface finds that were either visible on the ground or on the surface of snow patches. And as we have seen, phase 1 was characterized by a large number of organic finds. From this we can conclude that the finds recovered during phases 1 and 2 were either exposed or extirpated from their patches at a point in time relatively close to the moment they were discovered. Otherwise they would most likely have been damaged either by exposure or erosion. Researchers in other snow patch regions have made similar conclusions based on field discoveries and observations-that the period of time between exposure and discovery of surface finds on snow patches must be relatively short. This is especially true with respect to organic finds or components (Lee et al., 2006, p. 38; Grosjean et al., 2007, p.

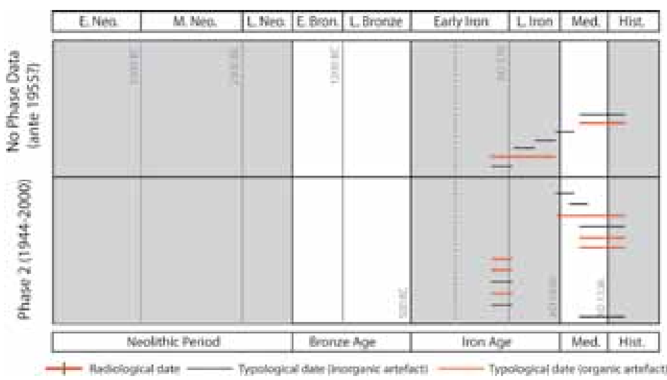


Fig. 5. Chronological distribution of snow patch finds from central Norway from 1944–2000 (Phase 2). Also included are seven artefacts that could not be assigned to a specific phase. Artefacts are plotted in the order they were discovered starting from the bottom up

206; VanderHoek, 2007, p. 197; Hafner, 2012, p. 193).

The introduction of metal detectors during snow patch surveys from the beginning of the 21st century is an important development that has contributed greatly to the number of finds recovered. But finds recovered in this way have a different contextual background than finds recovered during visual surveys. Many metal detector artefacts are not visible on the surface during surveys as they have been covered by mud and gravels or have become otherwise lost in the rocky fields that surround most patches. The environment around snow patches is very dynamic, which makes it difficult to estimate the rates of solifluction and the time scales involved in artefacts becoming covered once they have emerged from the snow patch. However, it seems clear that the metal detector finds are artefacts that melted out of the snow patches at earlier dates. And because they were not discovered within a reasonable period of time, the organic component is now lost.

Because of these differences, comparing the metal detector finds from recovery phase 3 with surface finds from the earlier phases could be problematic. If we are simply interested in the artefacts' age and location, the metal detector finds can be combined with the other surface finds from phase 3 with no further ado. However, if the aim of analysing chronological developments is to get a better view of the nature and frequency of melting events on snow patches, the metal detector finds should be removed from the dataset. Therefore the overview of dateable artefacts discovered during field surveys between 2001 and 2011 is presented in Fig. 6. Artefacts recovered during the same period with metal detectors are presented in Fig. 7.

Looking first at the distribution of finds recovered without the use of metal detectors (Fig. 6). The first noticeable feature of the plotted chronology is that artefacts with organic components once again dominate the overview of the period. The fact that so many 'fresh' organic finds are again appearing on sites after the 60 year long hiatus of period 2, demonstrates that during this period snow patches have in a sense 'reawoken', having been subject to a series of hard melts in recent years.

In terms of the chronological distribution, a number of points can be highlighted. The revised overview confirms the general impression that finds emerging from local snow patches are now significantly older than they were in earlier periods. The age of the oldest artefacts discovered has increased dramatically during recovery phase 3. At the turn of the millennium, the oldest finds recovered from snow patches were dated to ca. AD 300 (T15886). At the end of 2011 the oldest finds can be dated to ca.3 400 BC. This is a significant new development on sites that, over time, have shown themselves to be relatively stable, producing finds from within clearly defined chronological parameters.

The overview from recovery phase 3 provides clear evidence that this development is not simply based on one or two outlying finds. Rather the trend towards increasingly older finds has unfolded throughout phase 3 and includes both Bronze Age and Neolithic artefacts.

The number of finds from the Medieval period (i.e. AD 1200–1700) shows a marked reduction. It is also noteworthy that the few organic finds that can be dated to this period are all damaged in some way or another and only recovered as fragments or sections. This stands in contrast to the situation during phase 1, when a large number of whole, well preserved medieval shafts were recovered (Farbregd, 1972).

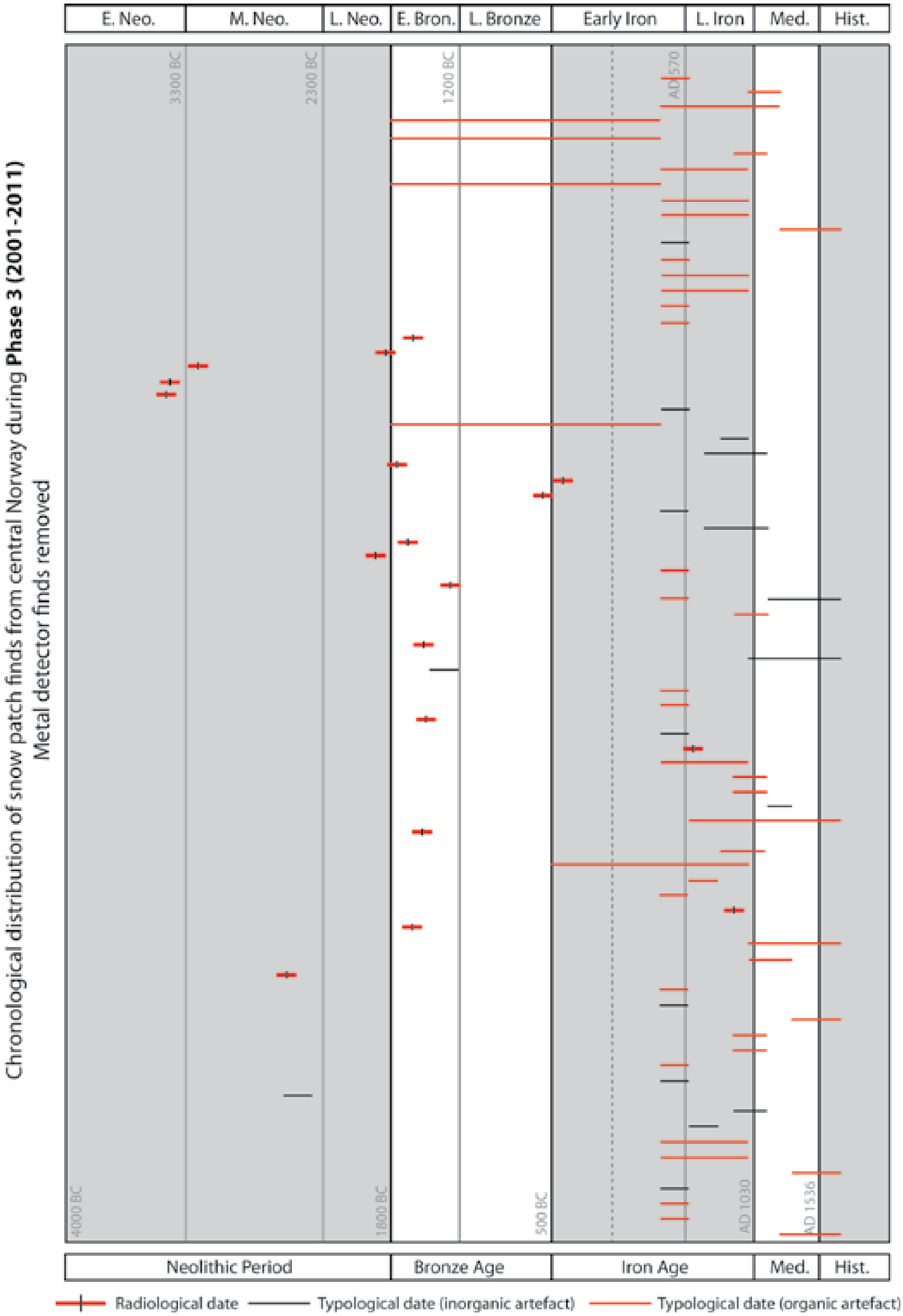


Fig. 6. Chronological distribution of snow patch finds from central Norway between 2001 and 2011 (excluding metal detector finds). Artefacts are plotted in the order they were discovered starting from the bottom up

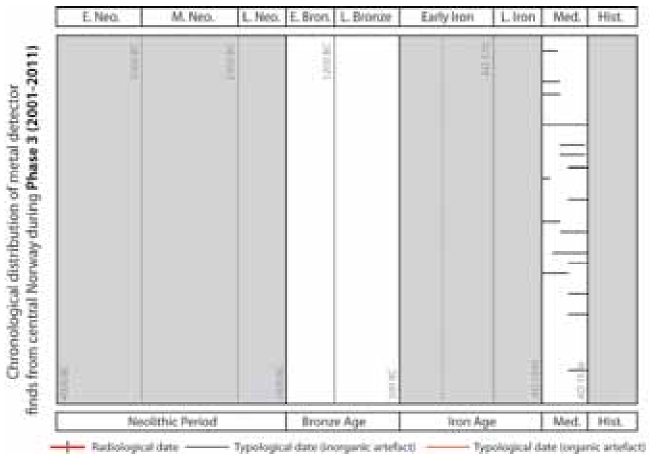


Fig. 7. Chronological distribution of artefacts discovered with metal detectors during Phase 3 (2001-2011). Artefacts are plotted in the order they were discovered starting from the bottom up

Arrowheads and shafts from the Late Iron Age (AD 800–1030) are still being recovered in significant numbers, although the coarseness of typological dates after this period may be distorting the picture somewhat. The Migration period (AD 400–600) is still well represented in the finds from recovery phase 3. This includes both organic and inorganic finds.

During recovery phase 3, it is also noticeable that finds from the period ca. 1300–400 BC are absent from the sample. This gap in the snow patch chronology has only become visible since the discovery and dating of the older Bronze Age and Neolithic artefacts. This corresponds to the Late Bronze Age and start of the Early Iron Age locally. The overview shows four shafts that may belong to this period, but this is as yet still uncertain.

Finds from the Bronze Age are markedly weighted towards the Early Bronze Age (1800–1200 BC). It is also noteworthy that these finds have been recovered regularly throughout phase 3. Again, there is a degree of uncertainty regarding at least four undated shafts that may belong to this period. However, should they subsequently show themselves to be from the Early Bronze age too, this will only reinforce the tendencies noted here.

Until now six finds can be attributed to the Neolithic period. The three oldest finds cluster at around ca. 3300 BC. These were all discovered during the 2011 season which stands out as by far the single most productive snow patch season to date. The clustering of Neolithic finds appears to be a result of one single, hard melting event rather than the regular melt patterns seen up to this point. Perhaps this is an early notice as to the kind of finds that may appear on these sites in the future?

When we examine the group of finds recovered during phase 3 using metal detectors (Fig. 7), predictably we see that inorganic iron arrowheads dominate this group of finds. As a whole the finds range from ca. AD 400 to 1700 as is the case in both phases 1 and 2. This is not surprising, as we have yet to find iron arrowheads on snow patches prior to this date (Farbregd, 2009, Fig. 9). Within this general distribution, two clusters are visible. These are during the period's ca. AD 400–600 and ca. AD 1200–1700. Again this repeats the general pattern demonstrated in recovery phases 1 and 2.

Another interesting feature of this group of finds is that it includes five arrowheads that date to the period AD 600–800. The lack of finds from this period is one of the characteristics of recovery phases 1 and 2. Between 1914 and 2000, only one iron arrowhead from this period was discovered, although at least some of the disassociated shafts found during these periods are likely to originate from this phase too. Previously, it has been suggested that the lack of finds from between AD 600–800 might be the result of subsequent melting events, during which the arrows were extirpated from the snow patches and lost (Farbregd, 2009, p. 161). The five arrowheads recovered with metal detectors appear to confirm this suggestion. If we are correct in presuming that metal detector finds recovered from under sludge and gravels originate from melting events prior to the early 1900s, then the metal detector finds give an insight to the chronological profile of finds that were lost before regular site surveys began. In a way they represent a hypothetical Phase 0 prior to 1914. If this interpretation is correct than the metal detector finds complement the picture we have of recovery phase 1 to a certain degree. However, it is at present impossible to give a precise estimate as to when they initially melted out of the snow patch based on an archaeological analysis alone. This question requires specialist studies that would need to look at solifluction rates in peri-glacial and permafrost environments as well as at the condition of the artefacts. The position of these finds might also play an important future role in reconstructions of snow patches past extent, as they might potentially give an indication of how large or small snow patches were when the artefacts melted out in the past.

Chronological analysis – discussion

The chronological overviews show that finds appearing on snow patches in the region are getting older and older over time. The oldest artefacts in the collection date back ca. 5400 years to the Early Neolithic period. 17 hunting artefacts from the Neolithic and Bronze Ages finds recovered from sites in the region during the last decade were identified in recent years. These artefacts have given us new, valuable information and perspectives on long term developments in hunting archery technology. They also cast new light on nature and antiquity of hunting related activities in the mountains of central Norway in prehistory.

The fact that artefacts have been shown to be getting progressively older as time passes and the host patches decrease, appears to suggest a systematic, layered degradation of host patches. Through the chronological overviews from each phase (Figs. 5, Fig. 6 & Fig. 7), we appear to be seeing a form of backward succession through increasingly older and older layers on some snow patches. This observation is at odds with observations from previous melting events in other regions, where it is documented that many layers were exposed and melted simultaneously (e.g. Farnell, Hare, Blake, Bowyer, Schweger, Greer, & Gotthardt, 2004; Hare et al., 2012). The reasons for this divergence is unclear. Perhaps it a question of scale. Perhaps this disparity is because we are in this instance comparing a single site with regional developments. Martinsen has recently demonstrated how small idiosyncratic differences in elevation, orientation and other physical parameters can have an effect on the materials preserved within an individual snow patch (Martinsen, 2015).

The analysis demonstrates that archaeological snow patches in central Norway are in the midst of a dramatic, active period that looks set to continue for the foreseeable future. Melting events from 2001 until 2011 have been regular, but sporadic. Survey seasons that produce no new finds are followed the next year by a season with wholesale melting and record-breaking numbers across the region. Short-term weather patterns in the region during the same period have similarly been erratic (Martinsen, 2012; Fig. 5). The short response times associated with snow patches makes developments unpredictable from year to year. Analyses of discoveries during the last decade indicate that the region's snow patches are now riding on a kind of tipping point. The ice cores on several sites are greatly reduced. The cores are also more regularly exposed when compared with earlier phases. In this context, relatively minor annual weather variations are producing large numbers of finds.

The number of snow patch finds discovered in central Norway has increased dramatically since 2001. The large classic sites are all producing significant quantities of both organic and inorganic artefacts. The number of sites producing archaeological snow patches has also increased. No new large sites producing significant numbers of finds have been identified since 2001. Instead new sites are generally characterised by being small in size and only producing low quantities of finds. A small number of finds in outlying snow patch zones (Snøhetta West and Trollheimen) underline the fact that there are other potentially productive areas in the region where finds are probably appearing on sites. Snow patches in these zones are currently not being surveyed.

Alongside the Neolithic and Bronze Age artefacts that have been recovered and identified from the region, finds from the Iron Age and Medieval period continue to be discovered too although the distribution of these finds is shifting somewhat. A detailed assessment of this shift remains difficult however, as the ranges of uncertainty associated with finds from the Medieval period are large. Therefore discreet temporal shifts that may be occurring within the material from this period may be being masked. A new find lacuna has emerged during the current chronological analysis. The overviews indicate that few finds from the period ca. 1300–400 BC have been recovered from sites in the region during recovery phase 3. As before, it is uncertain whether this reflects changes in past activities or is the result of snow patch processes. It may also be the case that the material is already present in the collection but it has not been identified yet.

The analysis demonstrates that typological dating is more than adequate for many archaeological objectives such as the construction of relative chronologies and technological overviews over finds from certain periods. However, it would not have been possible to identify many of the Neolithic and Bronze Age arrows described in this study without the use of radiometric dating. Given the fact that many of the remaining objects from snow patches in the collection have associated organic components, there is great potential for applying this method to a larger portion of the collection than has been the case until now. This has been the approach in other regions where archaeological snow patches have been discovered in recent years (e.g. Andrews et al., 2012; Hafner, 2012; Hare et al., 2012; VanderHoek et al., 2012). Through the results of these modern projects, we can see that serial radiometric dating is the first fundamental step towards transforming prehistoric and historical organics recovered from snow patches into valuable datasets for archaeology as well as other disciplines. Radiometric dating is expensive, but this method should not be limited to research projects only. Instead it should be an integrated tool available for the day-to-day analysis and management of archaeological snow patch artefacts and sites generally. This will make it possible to monitor developments on sites in an effective manner. It will also allow for the construction of data set, potentially of considerable scientific value.

The results of the chronological analysis further highlight the need for focused studies of the degradation processes that affect snow patch artefacts post-depositionally. This will involve specialist studies that can tell us something about the agents and time frames involved in the degradation of complicated organic artefacts. This is vital if we are to understand the patterns of artefact loss visible in the collection (e.g. the 1300–400 BC lacuna). It will also allow us to differentiate between primary and secondary melting events in relation to recovered artefacts. This would be an important step towards identifying the true climatic significance of certain archaeological artefacts that emerge out of the ice.

Finally, there is always the hope that snow patch artefacts might serve as independent or proxy climate indicators. This has already been attempted with some success under special circumstances (e.g. Grosjean et al., 2007; Hafner, 2012). However in other settings, converting snow patch artefacts into convincing climatic data is still proving to be somewhat of a challenge (e.g. Nesje et al., 2012; Reckin, 2013). The root cause of these difficulties lies in the fact that our understanding of both alpine snow patches as structures and of the ablation and accumulation processes associated with them is still rudimentary. A number of recent contributions highlight the complexity of these structures and processes and demonstrate some of the archaeological challenges this raises (Farbregd, 1983, Fig. 3; Callanan et al., 2010; Meulendyk, Moorman, Andrews, & MacKay, 2012; Martinsen, 2012).

The lack of models that adequately describe processes associated with snow patches specifically is problematic for archaeologists attempting to interpret finds. This is particularly acute in the case of collections that have been collected up over many years and/or have been deposited over long periods of time, as is doubly the case in central Norway. We need better models of the mechanics of modern melting and growth events for the simple reason that this may help us better understand past events that have disrupted the archaeological record as it is preserved in snow patches today. It is also important for archaeology to have more detailed and fact-based prognoses of the rate at which snow patches will ablate and ultimately disintegrate in the future. This is crucial for both field archaeologists and local and national authorities in their efforts to plan and execute effective surveys rescue campaigns.

Ultimately, these questions can only be resolved by way of focused, specialist studies of snow patches as cryptospheric structures in their own right. There is every reason to be optimistic in relation to this crucial issue. With new discoveries constantly being made and new projects coming on line, it will not take long before some of the important pieces of the snow patch puzzle begin to fall into place.

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DNA from ancient reindeer antler as marker for transport routes and movement of craftspeople, raw material and products in medieval Scandinavia

Knut H. Røed & Gitte Hansen

Abstract
This pilot project is a joint venture between natural and cultural scientists that share a common interest in exploiting whether available DNA technology makes it possible to trace back archaeologically found reindeer antler from medieval urban comb production sites to its original provenance. The provenancing of reindeer antler, used in the production of combs and other personal accessories during the Middle Ages, may be a key factor in the study of the identity and the organization of medieval combmakers. Hereunder routes of transportation used by these craftspeople and their products are important. Provenancing will also enhance the understanding of the social and economic importance of the different reindeer mass trapping systems in medieval Scandinavia.

Introduction

Reindeer constitute a biological resource of great importance to the physical and cultural survival of many communities in Arctic and sub-Arctic areas, and have been exploited for food and other subsistence commodities for thousands of years (Kofinas, Osherenko, Klein, & Forbes, 2000; Huntington & Fox, 2005). In early medieval Norway reindeer antler was mainly used as raw material for hair combs (Fig. 1) and other personal accessories made by itinerant craftspeople (Hansen, 2005; Hansen, in prep.). In Norway and in other parts of Scandinavia and Northern Europe, combmakers functioned as a motor for the dissemination of style and fashion among ordinary people. As such, these artisans were important medieval actors. They are, however, hardly known, except through their products and manufacture debris were left behind at urban and rural sites. Combmakers are typical representatives for what one may call 'anonymous actors' of the Middle Ages; people that, due to their relatively low status in the social hierarchy, seldom or never were given a voice through written records or pictorial sources (Hansen, 2015). We know little about who the combmakers were in terms of ethnicity, social and economic position etc., where they came from, how far and how often they travelled, and the socioeconomic networks they were part of. However, the archaeological sources show that they were recurrent visitors in Norwegian and other Scandinavian towns, where they left behind production debris such as antler off cuts and worn out tools. Combs made

Fig. 1. Hair comb (BRM 104/2275) from mid. 12th century Bergen. Photo: S. Skare, University Museum of Bergen

Fig. 2. Early 13th century comb production waste sampled for DNA (BRM 76/13865, 76/21550) and discarded comb tooth segments and connection plates from the mid. 12th century Bergen. Photo: G. Hansen (left) and S. Skare (right), University Museum of Bergen

of reindeer antler are found in urban as well as rural consumer contexts, spanning large geographical areas from Northern Norway in the north to Schleswig in the south and from Lund in the east, to Orkney and the Faroe Islands in the west (Hansen, 2005, 2014). How these products ended up in consumer contexts spanning such large areas is a question to be pursued in further research.

In the provenancing of antler debris from combmaker workshops (Fig. 2) lies a key to understanding who the craftspeople using reindeer were. Knowledge of where the combmakers got their raw material from opens for a possibility to identify the transport and trading networks they followed. With this knowledge at hand yet another piece in the puzzle of these "voiceless" craftspeople will be available.

Through recent years of research detailed knowledge has been achieved about the trapping of reindeer that took place in mountainous areas both in South and North Norway especially in the Middle Ages (Indrelid, Hufthammer, & Røed, 2007; Sommerseth, 2009). Archaeological investigations of trapping systems as well as of refuse heaps at butchering/carving sites give evidence of exploitation of reindeer on a large scale (Mikkelsen, 1994; Barth, 1996; Jordhøy, Binns, & Hoem, 2005, Indrelid & Hufthammer, 2011; Hufthammer, Bratbak, & Indrelid, 2011). Osteological investigations of bone from such refuse heaps show that in the medieval assemblages, antlers are strongly underrepresented compared with other bone elements (Hufthammer et al., 2011), as particularly illustrated by the bone assemblages at the Sumtangen site at Hardangervidda mountain plateau in South-Central Norway (Fig. 3). Antlers have thus not been regarded as butchering waste but rather as valuable raw materials that were transported from the outfield (Indrelid &

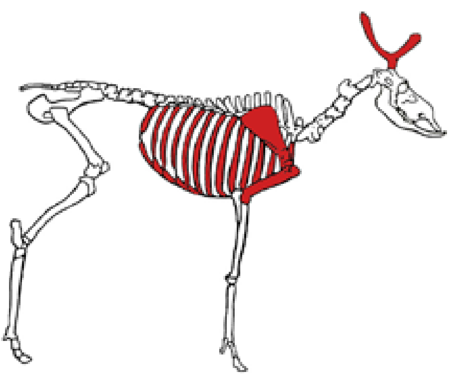

Fig. 3. Bone elements missing from the refuse heaps (red coloured) at Sumtangen site at Hardangervidda during early medieval (from Hufthammer et al., 2011)

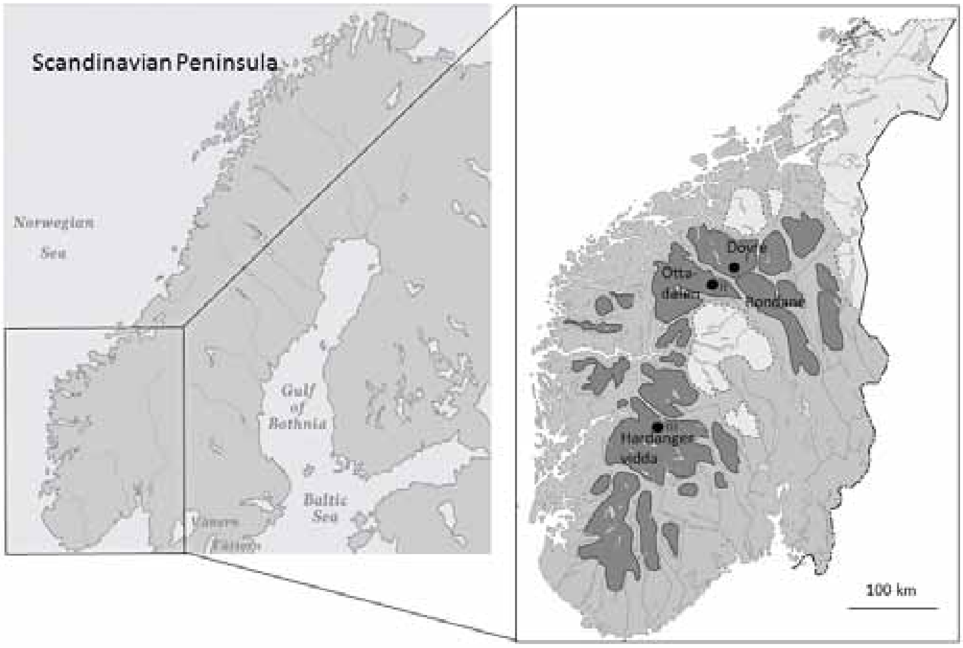

Fig. 4. Location of sampling sites of archaeological reindeer material from mountain areas in South-Central Norway (I = Vesle Hjerkinn in Dovre, II = Slådalen in Ottadalen and III = Sumtangen at Hardangervidda) together with areas with extant wild reindeer (dark shaded) and domestic reindeer (light shaded)

Hufthammer, 2011; Hufthammer et al., 2011). Where, in particular, the antler from different parts of the mountainous areas of Norway ended up is addressed in this pilot project.

Genetic variation is brought about by mutation, which is a permanent change in the DNA providing individuals and populations with distinct characteristics. These characteristics make it possible to assign individuals or remains of individuals back to its original provenance. The recent development of analyzing endogenous DNA from archaeological findings opens for tracing back reindeer antler from medieval comb production sites to its original provenance. However, this presupposes both presence of endogenous DNA in the actual archaeological reindeer material and genetic distinctness of the different alternative provenances.

Presently, the wild reindeer in Norway exist and are managed in 23 more or less separate sub-populations (Jordhøy, Strand, Gaare, Skogland, & Holmstrøm, 1996) and the extant genetic variation among several of these are characterized by being highly structured with particular genetic distinctiveness (Røed, Mossing, Nieminen, & Rydberg, 1987; Røed et al., 2008; Reimers, Røed, & Colman, 2012). The main genetic structure appears to be a trisection with the wild herds in the mountain areas of Rondane/Dovre in central Norway (Fig. 4) on the one hand, the wild herds at Hardangervidda mountain region on the other and those with a more pure domestic reindeer ancestry on the third hand (Fig. 5).

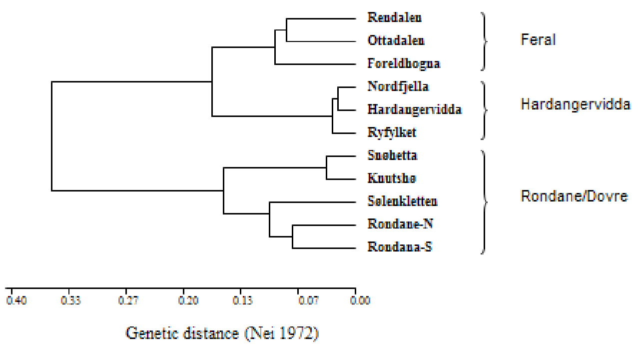

Fig. 5. Genetic distance between reindeer populations in South Norway based on analyses of twelve microsatellite loci

Table 1. Frequency of mtDNA haplotype clusters (**I-IV**) in extant and early medieval wild Hardangervidda reindeer and in extant domestic herds. N = number of samples analysed (from Røed et al. ,2011)

Herds		N	Haplotype cluster I	Ib	II	III	IV
Wild	Ancient	51	0.863	0.000	0.000	0.137	0.000
	Extant	68	0.279	0.265	0.441	0.000	0.015
Domestic	Extant	42	0.024	0.262	0.714	0.000	0.000

The distinctiveness of this structure makes it possible to trace, with statistical significance, individual material back to at least one of these trisection units.

The genetic structure of today's wild reindeer may, however, not be representative of the genetic structure during the Middle Ages. Recent genetic characterization of the genetic variation of ancient Hardangervidda reindeer based on archaeological bone material dated to the Middle Ages suggests that the Hardangervidda population has gone through rather dramatic genetic deteriorations during the last millennium (Table 1). The domestic reindeer in Fennoscandia appears to be dominated by particular genetic lineages which are phylogenetically distinct from the ancestral native wild lineages (Røed et al. 2008; Røed, Flagstad, Bjørnstad, & Hufthammer, 2011; Bjørnstad, Flagstad, Hufthammer, & Røed, 2012) and the genetic change in the Hardangervidda reindeer population is probably due to considerable introgression of the domestic gene pool during the last two centuries when reindeer husbandry was practised in this mountain region (Røed et al. 2011). The genetic changes between the medieval and extant herds, as detected in the Hardangervidda case, pinpoint the importance of relatively accurate genetic characterizing of the different medieval reindeer source populations in southern and northern Norway.

Status and strategies

Presently, we are working on testing whether it is possible to trace raw material debris from comb production workshops in the medieval towns of Bergen, Trondheim, Oslo and Skien back to the reindeer source population. As genetic marker we are using the nucleotide sequence variation in the control region of the mitochondrial DNA. This is a particular appropriate marker due to its relatively high presence in general, including in bone and teeth material, which opens for using archaeological material, and also due to the relatively high mutation rate in this DNA segment, which may be displayed as genetic distinctiveness of populations as seen in reindeer (Flagstad & Røed 2003; Røed et al., 2008, 2011).

The genetic characterizing of the medieval Hardangervidda reindeer (Røed et al., 2011) is based on the Sumtangen material where radiocarbon dating revealed that these were from a relatively short time span during the last half of the 13th century (Indrelid & Hufthammer, 2011). We are also working on similar genetic analyses of the ancient reindeer herds in Rondane/Dovre and Ottadalen mountain areas (Fig. 4, Røed et al., 2014). Both areas are characterized by extensive remains of previous reindeer trapping systems suggesting previously large wild reindeer populations (Jordhøy et al., 2011). As representative for these we prioritize reindeer remains obtained from the Vesle Hjerkin site in Dovre and the Slådalen site in Ottadalen (Fig. 4) which both are dated to the early medieval period (Weber, Molaug, & von der Fehr, 2007; Jordhøy, et al., 2005) and may possibly represent the source populations for the raw material at the sampled workshops in the towns. In the Middle Ages, Bergen, Trondheim, Oslo and Skien were important urban centres in Norway. Today medieval culture layers in these towns display favourable preservation conditions for organic materials. Extensive archaeological excavations have documented both combs made of reindeer antlers and antler debris from comb production workshops (Flodin 1989; Myrvoll 1992; Hansen 2005; Wikstrøm 2006). Samples of antler debris from 12th and early 13th century workshops in Bergen, Trondheim, Oslo and Skien have been obtained and are in the process of DNA extraction. DNA profiles of the debris will be compared with the ancient profiles of the Hardangervidda, Ottadalen and Rondane/Dovre reindeer populations.

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The medieval reindeer population (*Rangifer tarandus*) from the high mountain plateau Hardangervidda, Southern Norway: Work in progress

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Abstract

Reindeer remains from five medieval mass hunt sites on the Hardangervidda high mountain plateau present a unique opportunity to study what appears to be a representative selection of the reindeer population at the time. At the five sites, Sumtangen, Ørteren, Krækkja South, Krækkja Middle and Krækkja North, both sexes and all age groups are present, implying the use of a non-selective hunting technique. My PhD reasearch focuses on the demography, morphology, seasonality and pathology of the medieval reindeer population by means of a detailed osteological study. Analysing the highly fragmented material for this purpose requested improved methods for age and sex determinations. Therefore, the fusion times of the radius/ulna and the vertebral segments are determined for reindeer, while the epiphyseal fusion times of the long bones are reassessed. Simultaneously, the use of early- and non-fusing skeletal elements in osteometry is reevaluated.

Introduction

The high mountain plateau Hardangervidda in Southern Norway is home to Europe's largest wild living reindeer (*Rangifer tarandus*) population (Bevanger & Jordhøy, 2004). The population is known to have fluctuated greatly in size in the last 60 years; between 32 000 and 7000 animals (Skogland, 1990). In 2010 around 8400 wild reindeer were counted on the Hardangervidda (Andersen & Strand, 2011).

Hardangervidda has been targeted by reindeer hunters since shortly after the last deglaciation (Indrelid, 1994; Indrelid, Hufthammer & Røed, 2007; Hufthammer, Bratbak & Indrelid, 2011; Indrelid & Hufthammer, 2011), when reindeer immigrated into the area (Nesje & Dahl, 2007). Especially in medieval times the reindeer were hunted on a large scale. Runic inscriptions found at several locations indicate that the hunting possibly was organised by merchants in the towns (Indrelid & Hufthammer, 2011) and may have been connected to the flourishing comb industry in Bergen (Indrelid et al., 2007, 2014; Røed & Hansen, 2015). As part of my PhD project the reindeer remains from five medieval mass hunt sites are being studied in order to investigate a range of biological parameters: morphology, pathology, size variation, sex and age distribution. Furthermore, the results are compared to the current Hardangervidda reindeer population and to other sub-fossil reindeer remains in Norway, thus contributing to the understanding of reindeer palaeobiology.

The archaeological context

Most of the faunal material used in this study was collected during the Hardangervidda project 2004–2007 (Indrelid et al., 2007) at five different localities located on the shores of lakes on Hardangervidda mountain plateau. Some of the material was collected during earlier excavations (see below). The

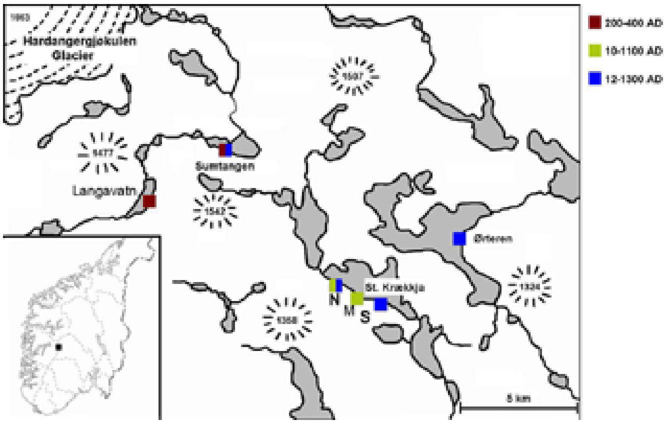

Fig. 1: The northern part of Hardangervidda with the five mass-hunt sites Sumtangen, Nordre Krækkja, Midtre Krækkja, Søndre Krækkja and Ørteren (modified from Hufthammer, *et al.*, 2011)

Table 1. ^{14}C dates from Vestbu and Austbu. Dates marked with * after Indrelid and Hufthammer (2011)

Site	Material	Lab. ref.	Layer	^{14}C age BP	Calibrated age range (AD)
Austbu S	Bone	TUa-5272*	1	695 ± 40	1285 -1305
		TUa-5273*	1	850 ± 30	1170 -1230
		TUa-5274*	3	620 ± 40	1300 -1400
		TUa-5275*	4	695 ± 40	1285 -1305
		TUa-5276*	4	685 ± 40	1285 -1375
		TUa-5277*	5	735 ± 40	1275 -1295
		TUa-5278*	5	820 ± 30	1220 -1265
Austbu N	Bone	TUa-5953*	1	800 ± 35	1220 -1280
		TUa-5954*	2	810 ± 25	1220 -1275
		TUa-5955*	4	870 ± 25	1165 -1220
		TUa-5956*	4	780 ± 25	1245 -1280
		TRa-3937	4	900 ± 30	1050 -1205
		TRa-3938	5a	950 ± 30	1030 -1160
Vestbu	Bone	TUa-5957*	1	680 ± 25	1290 -1305
		TUa-6449*	1	790 ± 25	1230 -1280
		TUa-6450*	2	800 ± 25	1225 -1280
		TUa-5958*	3	860 ± 25	1170 -1225
		TRa-3936	4	830 ± 25	1215 -1255
Austbu S	Charcoal	TUa-5279I*	4	840 ± 35	1175 -1250
		TUa-5279II*	4	935 ± 35	1035 -1165
		TUa-5280*	6	885 ± 40	1060 -1220

selected sites (Sumtangen, Ørteren, Krækkja South, Krækkja Middle and Krækkja North, Fig. 1) have a long research history (Indrelid et al., 2007) and are rich in well preserved bone material.

The Sumtangen site

The site Sumtangen is situated on the shore of lake Finnsbergvatn (1190 m a.s.l.) where a strip of land forms a narrow sound in the lake. It consists of two stone hut ruins, named Austbu and Vestbu that are surrounded by large bone middens (Indrelid, et al., 2007; Indrelid and Hufthammer, 2011). In the vicinity of the ruins, remains of stone constructions that are interpreted as hunting blinds or meat caches were found. The total volume of the middens is estimated to approximately 50 m^3 (Indrelid et al., 2007). Parts of the faunal material from these sites have been described in Hufthammer et al. (2011). In that paper bone material from three middens is discussed: from those located to the north and south of Austbu (hereafter referred to as Austbu N and Austbu S), and from the midden south of Vestbu. Indrelid and Hufthammer (2011) provided 18 radiocarbon dates for the site (see Table 1). Three new bone samples from the stratigraphically oldest bone layers were dated for this PhD project (Table 1). The mean date of the 18 samples, with uncertainties at the 68 per cent confidence level, is now the time period AD 1220–1280, indicating a slightly earlier start of the mass hunt than Indrelid and Hufthammer (2011) propose (AD 1240–1290).

The Ørteren site

The bone material from the Ørteren site (1147 m a.s.l.) was collected in 2006 during an underwater excavation: the site was inundated in the early 1960s when lake Ørteren was dammed for hydroelectric power production. The site consists of two stone ruins and bone middens that were dated to the second half of the 13th century (Hufthammer et al., 2011).

The sites on the shore of lake Store Krækkja

Three medieval reindeer hunting stations are known from the south shore of lake Store Krækkja (1157 m a.l.s.): Krækkja North, Krækkja Middle and Krækkja South (hereafter referred to as Krækkja N, Krækkja M and Krækkja S). The faunal material used for this study was collected in the periods 1970–1974 and 2006–2010 (Johansen, 1973; Hufthammer et al., 2011), material from earlier expeditions was disregarded based on the lack of archaeological context.

Krækkja N consists of the ruin of a stone hut, one large and two smaller bone middens, the remains of three boat houses and several other stone structures related to reindeer hunting. Radiocarbon dates place the site in the late 13th and early 14th century (Hufthammer et al., 2011). The volume of the largest midden (south of the hut) is estimated to 15 m^3. The lesser middens have estimated volumes of 1,5 m^3 and 0,6 m^3. None of the bone heaps showed any stratiphication (Indrelid *in prep.*).

The earliest phase at Krækkja M is a stone hut associated with a bone midden (Indrelid *in prep.*). At a later time, a boat house was constructed on the site of the hut. The hut and bone midden are dated to the 11th century AD.

Krækkja S consists of the remains of two stone buildings, three bone middens and several hunt related structures (Indrelid *in prep.*). Four bone samples from the midden (Indrelid *in prep.*) and six bone samples from structure 23 (see Table 2) place the site in the 13th century.

Table 2. ^{14}C dates from the sites on the shore of lake Store Krækkja. Dates marked with * after Indrelid (*in prep.*)

Site	Material	Lab. ref.	Structure & depth	^{14}C age BP	Calibrated age range (AD)
Krækkja N	Bone	TUa -6815*	Str. 2: 5 cm	575 ± 30	1320 - 1410
		TUa -6816 *	Str. 2: 13 cm	710 ± 30	1285 - 1300
		TUa -6817 *	Str. 2: 20 cm	645 ± 30	1300 - 1395
		TUa -6818 *	Str. 2: 24 cm	680 ± 35	1290 - 1375
		TUa -6819 *	Str. 2: 29 cm	720 ± 30	1280 - 1295
		TUa -6820 *	Str. 2: 34 cm	820 ± 35	1215 - 1265
		TUa -6821 *	Str. 2: 40 cm	795 ± 30	1225 - 1280
		Poz -23853 *	Str. 4	860 ± 30	1155 - 1220
		Poz -23854 *	Str. 4	880 ± 30	1050 - 1220
Krækkja M	Bone	Poz -23959*		880 ± 30	1055 - 1215
		Poz -23960*		875 ± 30	1060 - 1215
		Poz -23852*	20x20y SV	925 ± 30	1040 - 1160
		TRa -3939	Layer 2	925 ± 25	1040 - 1165
Krækkja S	Bone	TRa -3940	East of east wall	880 ± 25	1160 - 1220
		TRa -3941	East of east wall	915 ± 30	1045 - 1170
		TRa -3942	East of east wall	905 ± 25	1050 - 1180
		TRa -3943	Structure 4	895 ± 25	1060 - 1205
		TRa -3944	Structure 4	810 ± 30	1220 - 1275
		TRa -3945	East of east wall	809 ± 30	1220 - 1274
		TUa -6456*	B -9 cm	755 ± 30	1260 - 1290
		TUa -6457*	B -20 cm	730 ± 35	1280 - 1295
		TUa -6458*	B -35 cm	720 ± 30	1280 - 1295
		TUa -6454*	B -35 cm	775 ± 25	1245 - 1285
		TUa -6451*	E -10 cm	825 ± 30	1215 - 1260
		TUa -6452*	E -20 cm	780 ± 30	1240 - 1285
		TUa -6453*	E -32 cm	755 ± 30	1265 - 1290

Material

More than 31 000 bone fragments from the above mentioned assemblages have been identified to the level of species and bone element. More than 99% of these have been assigned to reindeer (Indrelid et al., 2007; Hufthammer et al., 2011; Indrelid & Hufthammer, 2011). The bones are very well preserved due to the cold climatic conditions in the high mountains. Even cartilage (i.e. the syrinx or the cartilage from the iliac crest) has been preserved in several cases. A low degree of decomposition can therefore be assumed; no or not much material was lost after deposition (Hufthammer et al., 2011).

When field dressing an animal, the windpipe and the esophagus have to be removed along with the other internal organs. Since

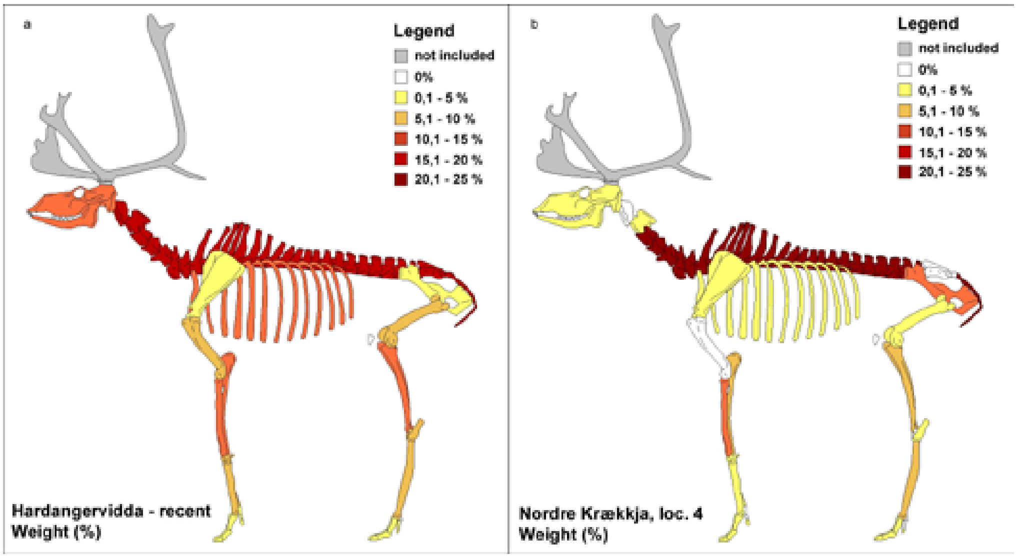

Fig 2. Distribution of weight percentage per skeletal element in recent reindeer (a) and the bone weight percentages of reindeer from Krækkja N (b)

the syrinx surrounds the windpipe, it too is removed in this process. Therefore, the presence of the syrinx indicates that the animals were killed in the immediate vicinity of the huts (as opposed to killed elsewhere and transported to the huts for further processing) (Indrelid et al., 2007).

Bone marrow was apparently systematically procured: most marrow containing elements (long bones, mandibles, etc.) are heavily fragmented; even bones with little marrow such as phalanges or calcanei appear to have been used as a marrow source. Hufthammer et al. (2011) have analysed the butchery patterns for the Hardangervidda sites and compared them both to an earlier site from the Roman Iron Age and to medieval sites from the Dovrefjell area. They state that all skeletal elements except the antlers, ribs and humeri (upper fore leg bones) have been left at the hunting stations. In a current project, Røed and Hansen (2015) compare the DNA profile of the Sumtangen reindeer to debris from several combmaker workshops. Hopefully, this will account for the missing antlers.

At all five sites the humeri and ribs are underrepresented. Most rib fragments that were found represent the proximal part of the rib (tuberculum costae and capitulum costae). Both ribs and vertebrae feature distinct cut marks indicating that the ribs were cut off close to the vertebral column (Hufthammer et al., 2011) and might have been used as pack-saddles.

A medieval hunting law concerning the payment to the hunter may account for the missing upper fore leg bones (Indrelid et al., 2007; Hufthammer et al., 2011; Indrelid & Hufthammer, 2011).

Further analysis and preliminary results

The faunal material from the bone middens was assigned to species, skeletal element and fragmentation degree. Most of the Sumtangen (Hufthammer et al., 2011) and some of the material from the other sites was previously identified by Hufthammer, but all bones were reassessed and measured by the current author. All pathologies and bone surface modifications were recorded. Indeterminable and immeasurable fragments

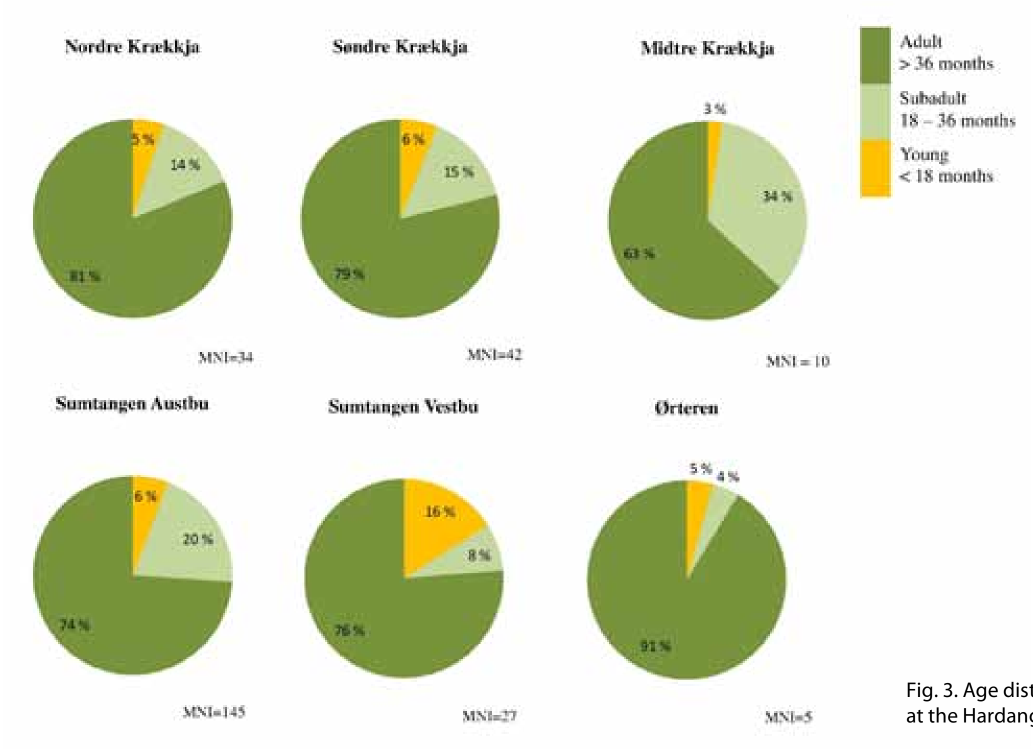

Fig. 3. Age distribution at the Hardangervidda sites

were then excluded from further study. The material was measured according to Von den Driesch (1976) and Weinstock (2000).

In order to compare the material from the different sites to each other, the Logarithmic Size Index (LSI, Uerpmann (1990)) and the Variability Size Index (VSI, Uerpmann 1979, 1982) were used. Both methods were developed to relate the dimensions of archaeological specimens to those of a standard population (Weinstock, 2000, p. 25) and use a combination of any number of measurable skeletal elements enabling the analysis and comparison of fragmented assemblages.

Even though early- and non-fusing skeletal elements ordinarily are considered unsuited for osteometric analyses, it was necessary to include these due to the fragmented nature of the material. Therefore, I measured 17 recent *Rangifer* skeletons of known age and sex in the osteological collections of the University Museum of Bergen, and applied linear discriminant analysis (LDA) to the results. This resulted in a wider spectrum of bones that can be used in osteometric studies.

The bones were, whenever possible, assigned to a sex based on morphological traits and size. Using the fact that reindeer are sexually dimorphic animals, a size-based morphological analysis was conducted. This showed that both sexes are present at all sites (Takken Beijersbergen *in prep.*). It can thus be assumed that a non-selective hunting technique was used.

Likewise, expanding the selection of bones given by Hufthammer (1995) for ageing purposes was necessary. Thus the epiphyseal fusion times of the scapula, the vertebrae, the costae and the pelvis were determined by means of recent skeletal material, while simultaneously the fusion time of the radius and ulna was added (Takken Beijersbergen and Hufthammer, 2012). Combined with teeth eruption stages (Bromée-Skuncke, 1953) the individuals could be divided into three age classes: younger than 18 months (young animals), 18 to 36 months (sub-adult animals) and older than 36 months (adult individuals). At all sites all age groups are represented (Fig. 3, Takken Beijersbergen *in prep*.).

Climatic conditions on the Hardangervidda point towards summer or early autumn as hunting season. Analysis of incremental lines in the tooth cementum will hopefully confirm this.

Conclusion

Many thus far unanswered questions concerning the medieval reindeer population on Hardangervidda should be solved with this project. In the process, some osteometric methods were reassessed and/or improved. However, it is work in progress: the results will be published in due time.

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Iron extraction

The bloomery in Mid-Norway: A retrospective glance and foresight

Lars F. Stenvik

Abstract

Investigations of iron production sites started in the 1980s at the NTNU University Museum in collaboration with metallurgy and vegetation history. Three different ways of producing iron have now been documented from Pre-Roman Iron Age to Post-Reformation Period. Production peaks and geographical and chronological variations in production intensity have been identified. The production and distribution of iron have required a different organisation in different periods of time

There are several unresolved problems linked to the iron production. It is uncertain where the knowledge about the oldest iron production came from. Trace analyses on iron objects that could lead back to a production site have not been carried out either. Iron has been reforged and refined on the way from the place of production to the consumer, but we know little about these places. Whether the production of iron has been sustainable everywhere at different places at different times, is an open-ended question. New registration methods like the use of geophysics may ease the investigations in the future. Work within this field is in progress. It is challenging, however, to secure recruitment to the auxiliary sciences for the interdisciplinary research on iron production

Introduction

After some random investigations in the 1970s (Farbregd, 1977, 1983), the research on bloomery iron working made headway in the 1980s in Trøndelag. It was in part researcher initiated projects in combination with metallurgy, in which the metallurgist Arne Espelund was a driving force, and in part a project connected to the development of hydroelectric power (Fabregd, Gustavson & Stenvik, 1984; Stenvik, 1996). Parallel to this, trials on how to produce iron were carried out, and this involved schools and museums (Berre, 1985; Stenvik, 2011a). These investigations gradually became an important basis for the teaching of subjects in archaeology at NTNU. Focus in the investigation had a distinct technological perspective in line with NTNU's primary ambition to be Norway's university for natural sciences and technology (Espelund, 2005). This did not imply, however, that societal perspectives were excluded.

The aim of this article is first of all to take stock of the archaeological investigations of iron production in Mid-Norway up until today. Secondly, the aim is to try to point to some knowledge gaps that can be filled in the years to come and at the same time suggest how this may come about.

Status

In this paragraph, some of the most important investigations will be mentioned in brief because they are central to the knowledge building that has taken place at the NTNU University Museum. In addition to these investigations, a lot of the knowledge we have rest upon registrations carried out by a number of enthusiasts before the research in

Fig. 1. Heglesvollen, Levanger, North Trøndelag. Slag pit under a furnace from Early Iron Age. Photo: L. F. Stenvik

this field became a priority area at the NTNU University Museum (Falck-Muus; Lodgaard, 1962; Mørkved, 1967).

Heglesvollen 1983–89

The excavations at Heglesvollen were the start of a period of investigations into the bloomery iron working in Trøndelag. Here we for the first time came across the furnace type that we later gave the name Trøndelagsovnen

Fig. 2. The Iron Production site from Early Iron Age at the Lake Fjergen, Meråker, North Trøndelag. Photo: L. F. Stenvik

(Farbregd et al., 1984; Espelund & Stenvik, 1993). This is a shaft furnace with a slag pit below ground level that could be used repeatedly. The furnace was probably operated with a natural draft and it was fired with pinewood. The shaft may have been funnel-shaped. Four furnaces are surrounded by a set of pits and they seem to have been operated simultaneously. Each furnace is equipped with a slag tapping unit and the amount of slag is estimated to weigh ca. 100 tons. This may be equivalent to a production of 100 tons of iron (Espelund, 2004).

At Heglesvollen, house remains were also found in connection with the bloomery iron production sites. These house ruins display a characteristic building tradition and were practically findless. The size, however, reveals that a considerable number of workers would have been involved in the production. The investigations at Heglesvollen took place in collaboration with metallurgy (A. Espelund), geology (Rueslåtten, 1985) and vegetation history (T. Solem). The vegetation history investigations showed that the iron production in the first place did not seem to have been combined with transhumance and, secondly, the investigations indicated that iron production had been taking place earlier than what we had been able to document archaeologically (Solem, 1991).

Fjergen and Stordalen: New power production in Meråker 1991-92

The next chapter of the bloomery iron production in Trøndelag was the investigations at Fjergen and in Stordalen in Meråker. Here a number of iron production sites were affected by the development schemes for hydro power (Stenvik, 1996; Rundberget, 2002). At Fjergen, an opportunity opened up to investigate a large area surrounding the actual furnaces, and new structures that had been part of the production process were found. Among other things, a system of postholes around the furnaces was seen in connection to a roof construction above the furnaces, which probably provided protection from wind and weather when the site was not operated. Both the investigations at Fjergen as well as the ones in Stordalen formed the basis for two master's degrees in Archaeology at NTNU (Prestvold, 1999; Rundberget, 2002).

During the investigations in Stordalen and at Fossvattnet in particular, observations were made that have been of vital importance to determine what the shaft in the Trøndelagsovnen looked like (Berre, 1998, 1999; Stenvik, 2005a). Elements that have been interpreted as ritual actions in connection with the iron production were also discovered here (Rundberget, 2002).

Fig. 3. The remains of a furnace from Late Iron Age at the Lake Håen , Melhus, South Trøndelag. Photo: L. F. Stenvik

Håen: Iron production in Late Iron Age and Middle Ages

In the excavations at Håen in Melhus municipality in Sør Trøndelag, we obtained knowledge about the production of iron in the Late Iron Age for the first time. We unearthed a type of furnace that is fairly well-known in other parts of Norway. It is a low shaft furnace with slag tapping (Stenvik, 1987). This type of furnace is considerably smaller than the furnaces from the Early Iron Age, and may have been operated by a couple of men, unlike the large iron production sites

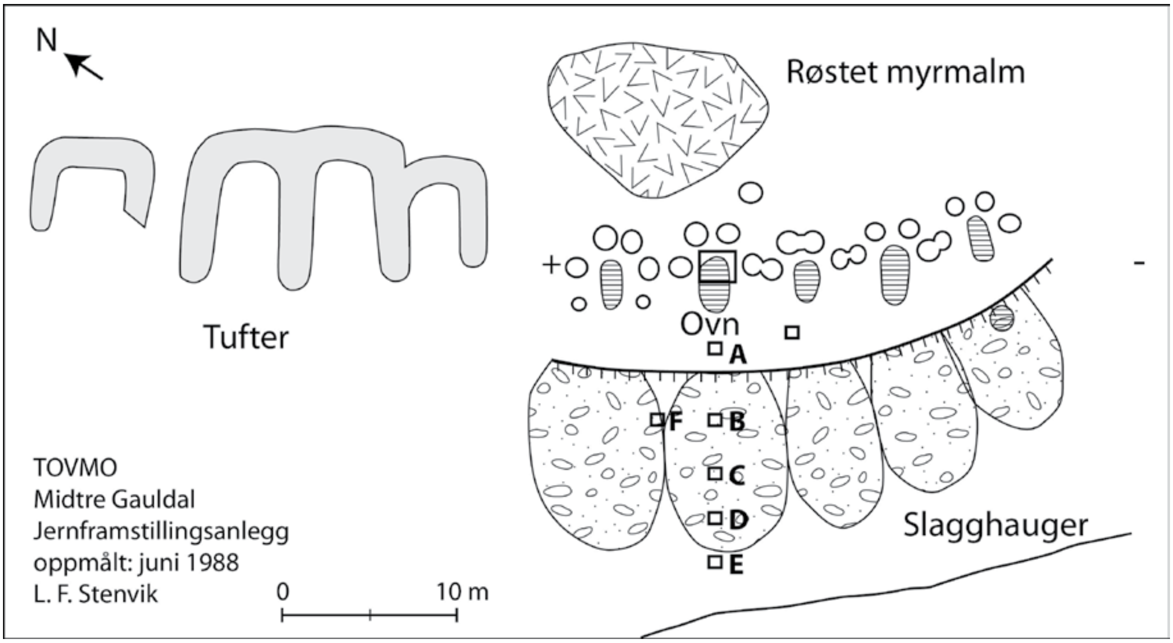

Fig. 4. Plan of a typical Early Iron Age production site at Storbekksetra, Tovmoen in Budal, South Trøndelag. Illustration: L. F. Stenvik/B.Helle

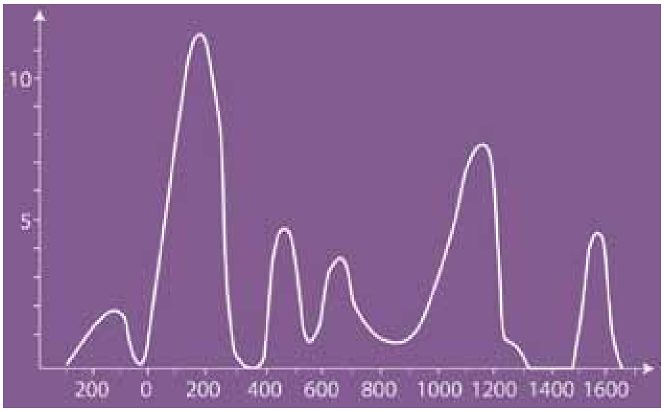

Fig. 5. The distribution of C14 dated iron production sites in Mid Norway. Illustration: L. F. Stenvik/B. Helle

from the Early Iron Age which required a crew of 10–15 men. At the site near Håen, charcoal has been used and this has been confirmed by investigations of other sites from the Late Iron Age and the Middle Ages. The charcoal kilns have, however, been hard to find. They need to lie on a flat field close to the sites, and they have left no traces that would have made it easier to find them. This is an obvious contrast to the pit kilns in Eastern Norway, which are easy to find.

Budalen

As early as the 1970s, some people became aware of the existence of an environment in Budalen where iron production could be studied in a unique landscape context (Stenvik, 1982, 1989). Through sporadic investigations in the 1980 and 1990s, iron production sites were registered and in part dated. An international congress that was held in Budalen in 1992, involved increased attention around the bloomery in this valley. An interdisciplinary project, DYLAN (Dynamic Landscapes), financed by the Research Council of Norway and lead by the NTNU University Museum has resulted in renewed focus on iron production. This was an interdisciplinary project with special focus on human impact on the natural environment, including sustainable exploitation (Stenvik, 2011b; Solem & al, 2012; Sjøgren & al. (in print).

Dating project

After the first datings from the excavations Heglesvollen had been obtained, datings of iron production in Mid-Norway became important. The dating to the Roman Iron Age deviated from what was most commonly believed: that iron production in Norway was associated with the Viking Age and the Middle Ages. This had in particular been documented in Irmelin Martens' investigations around Møsvatnet in Telemark (Martens, 1988). In the course of the 1980s and 1890s, dating samples were collected from approx. 100 iron productions sites that had been selected in order to form a representative geographical and chronological picture. These datings showed that there were production peaks and down periods throughout Prehistoric time and the Middle Ages (Stenvik, 1992a).

^{14}C dates from randomly chosen sites have rendered datings back to 3–400 BC. It is uncertain whether we with this sampling have found the oldest datings, but on the other hand, old woodwork may have been used in the process. Studies at, among other places, Gråfjell, have shown that the wood may have been 1–200 years old when it was used (Rundberget, 2007). The two uncertainty factors may perhaps cancel each other out. Vegetation history investigations is an independent dating method that has been used on production sites where charcoal horizons in the bog together with vegetation changes have been documented (Solem, 1999). This phase is dated to the transition between the Bronze Age and the Iron Age. In fact older than what we have been aware of using archaeological methods.

A site near Høltjørnbekken in Melhus municipality has been investigated twice (Stenvik, 2002; Sauvage, 2012). Four datings were carried out on this site and they are all from the middle of Pre-Roman Iron Age, and the site is therefore a fairly reliable site from this period. A puddle ball found on Hitra is dated to the transition between the Bronze Age and the Iron Age and can therefore also be viewed as an indication of very early iron production (Espelund, 1998–99; Stenvik, 2006).

It also proved challenging to understand why the bloomery turns up in the Pre-Roman Iron Age, a period that up until a few years ago appeared as a period of recession. With the topsoil removal method in rescue excavations this was turned upside down. The Pre-Roman Iron Age now appears to be a dynamic period with dense settlement in the entire region. The bloomery with its complexity appears to have been compatible with the structure of society that was revealed (Stenvik, 2010).

There has been a peak in the production in the middle of the Roman Period and in the 1100s. At the same time, differences between various parts of Trøndelag have emerged, where the centre of gravity of the production has changed locations. In the Early Iron Age, the iron production seems to be fairly equally divided between South and North Trøndelag, while Gauldalen and Orkdalen in South Trøndelag dominate in the Late Iron Age and the Middle Ages.

Social implications

In the course of the period the bloomery was a research theme at the NTNU University Museum we registered ca. 720 sites where iron was produced in prehistoric times and in the Middle Ages (Stenvik, 2005b). These production sites lie mainly on the eastern side of Trondheimsfjorden in rural valley and mountain districts with marginal settlements today and evidently also in the Prehistoric period and the Middle Ages. In connection with the production itself, and in particular in connection with distribution and logistics, some sort of organisation supporting the extensive activities must have been present (Wintervoll, 2010). Different models were therefore very soon included to obtain an understanding of the iron production (Stenvik, 1987a, 1997b, 2005, 2010; Prestvold, 1999; Johansen, 2003). First of all, production in the Early Iron Age was believed to have had connections to the chieftain model where certain chieftain's seats where picked out as possible organisers, in particular due to grave finds that were made on these sites.

Estimates have been made as to how many people worked on each individual site. Several furnaces seem to have been operated simultaneously. An average site from the Early Iron Age would have had 4 furnaces. There are, however, examples of five, six, or eight furnaces on each and the same site. People to build, repair, and operate the different furnaces were needed. In addition, ore had to be dug out from the bog and roasted. Firewood had to be cut and dried, lodgings built and food collected and prepared. We have estimated that between 10–15 men were needed to operate a site of this type. In a sparsely populated rural district

Fig. 6. Reconstructed Early Iron Age furnace. Photo: L. F. Stenvik

Fig. 7. Reconstructed Iron Production Furnace from Late Iron Age/ Medieval Period. Photo: L. F. Stenvik

like Meråker in North Trøndelag with around 50 known sites from the Early Iron Age, there probably would not have been sufficient men to man one single site. The conclusion drawn from this is that men were recruited from a wider area. It is possible that large parts of Trøndelag were involved in this (Stenvik, 1997b).

Fig. 8. Reconstructed Evenstad- furnace. Photo: L. F. Stenvik

The situation is completely different, though, when the Late Iron Age and the Middle Ages are there. At that time the furnaces were small and there would have been one or two furnaces on each site that could have been operated by a couple of men. The production on each site may have been less than 10 % of an average site from the Early Iron Age. This must have to do with a completely different type of organisation and distribution. As mentioned earlier, there is a concentration of iron production sites in South Trøndelag in the 1100s. This concerns in particular the long valleys Gauldal and Orkdal. These locations were favourable as regards transport to the town of Trondheim, because the distance is relatively short. One could well imagine that there was a market and actors in Trondheim behind the distribution. A similar situation is imaginable in Namdalen and Snåsa where there quite early seems to have been an increase in the iron production in the Merovingian Period. Namdalen seems to have overcome the crisis at the transition between the Migration Period and the Merovingian Period in a far better way compared to other regions.

Continuity and discontinuity

The iron production in Trøndelag started at some point in the Pre-Roman Iron Age with a technology it has been hard to find models to. This technology seems to have been fairly similar for hundreds of years. It is similar across Mid-Norway with an offshoot into Jämtland, but is pretty different from the contemporary technology in Eastern and Southern Norway (Larsen, 2009). There are a few locations outside this core area that have furnaces with similarities to the Trøndelagsovnen (Jørgensen, 2010). This technology disappears at some point in time in the 500s according to the datings that have been carried out. A new technology developed well into the 600s and this iron production method is very similar all over Norway. This technological epoch lasts into the Middle Ages and disappears after the

Black Death around 1350. A third way to make iron seems to have emerged in the 1400s. This technology was described by Ole Evenstad in a publication from 1782. This production appears to have been on a limited scale as very few sites have been documented so far in inner rural districts in South Trøndelag and in Meråker in North Trøndelag.

The reasons for the collapse in the 1300s can easily be associated with the Black Death and the crises that followed in the wake of it. This affected the population size, the demand for iron, and may also have led to loss of expertise. It is harder, though, to understand the changes in the 500s. In the archaeological material one has seen that the residential structure is changing dramatically. From an unstable residential structure with many settlements and change of residency, relocations within one and the same farm property, there is a tendency towards a sedentary settlement form where the settlement remained on the same location into the Middle Ages and modern times. Many abandoned farms in South West Norway indicate a crisis in the residential structure. Recently, this has been associated with natural disasters caused by a gigantic volcanic eruption or collision with an asteroid that has led to a climate crisis and made the harvesting of cereals impossible for several years (Gräslund & Price, 2012). This may have resulted in famine and starvation. An extensive epidemic disease in southern Europe at that time is known as the Plague of Justinian. This may have hit Norway with the same force as the Black Death. A summing up of the research status in Trøndelag is in the press now (Stenvik in prep.).

Knowledge gaps

Provenance

We know where the iron was produced, and we have formed an opinion as to how much was produced at different times, but we do not know what became of it. We assume

Fig. 9. The smithies site at Forsetmoen, Midtre Gauldal, South Trøndelag. Photo: Vitenskapsmuseet

that the iron produced in Mid-Norway was used in a tool and weapon industry in the region, but we lack evidence for it in the form of metallurgical analyses that would have to show that the raw material used in the production was local. Estimates of the production volume both in the Early and the Late Iron Age suggest that the production was not intended for the local market (Stenvik, 1997b). But we do not know where the iron was exported to. In some research work, trace analyses have been carried out, in which one believes to be able to suggest where the iron did come from. This applies to for example Danish moss finds that have undergone metallurgical analyses and where the origin of the iron has been suggested (Jouttijärvi, 1994).

Another challenge we face in Mid-Norway, is to find the models to the technology that emerge in the Pre-Roman Iron Age. Despite searches in literature on iron production in Europe, one has not succeeded in finding what the production technology that emerges in Trøndelag in the Pre-Roman Iron Age was modelled on. The furnaces belong to a shaft tradition with a slag pit, but the shape of the shaft is rather special in that it seems to have been funnel-shaped. In this sense, it resembles the furnace shaft from the 1700s described by Ole Evenstad. The organisation on the oldest sites are similar to what one sees on Polish and Danish production sites from the Roman Period where 4 furnaces lie in "batteries" that must have been operated simultaneously. But as of today, the question regarding the origin of the technology remains unresolved.

Smithies, refinery processes

We have a lot of information of the production sites for ironmaking. As per today, we know of just over 700 sites in Trøndelag where iron has been produced. Seemingly, this iron was not worked on the production sites. Apart from rare anvil stones on sites from the Late Iron Age, we do not have evidence for reforging or further working of iron on the production site itself. In connection with a rescue investigation at Forsetmoen in Midtre Gauldal, one of the most important ironworking areas in Trøndelag, a large area demonstrating extensive smithing activities, emerged. The investigations have not been published, but a series of ^{14}C datings back to Pre-Roman Iron Age is available. Several of the datings go back to the transition between Bronze Age and Iron Age (Øyen, 2010). It is an important task to publish this investigation as the site may represent an important connecting link in the working and distribution of iron that we have no knowledge of/information of. Otherwise, only a few smithies have been found and investigated in Mid-Norway (Sauvage, 2005). This leaves a huge knowledge gap that needs to be filled.

Charcoal production in the Late Iron Age and the Middle Ages

In the Early Iron Age, people mainly used pinewood in the production of iron. In the Late Iron Age and the Middle Ages, charcoal was used in the production instead. It still

Fig. 10. Firing with pine wood in a reconstructed furnace from Early Iron Age. Photo: L. F. Stenvik

seems that they used pine, but the wood was burned to charcoal in kilns before use. Contrary to what was common in Eastern Norway where the charcoal kilns normally were dug into the ground (Rundberget, 2007), charcoal must have been produced in kilns lying above the ground level in Trøndelag, and they are therefore very hard to find. We know of only a few kiln remains from the Late Iron Age that are associated with ironworking. There is for instance one known site in Snåsa. To find the locations of these kilns is therefore a job that needs to be done. How big are they and where are they situated in relation to the iron production furnaces and how many of them are there around each site. Does this have to do with reuse or single-time use?

In the Middle Ages, production of charcoal in small kilns, mainly in connection with forging, seems to have taken place (Berge, 2007). Forging took also place in the Early Iron Age, but we have no knowledge of charcoal kilns from this period that may have been used in forging processes.

Sustainable exploitation of resources?

The at times extensive iron production required large amounts of bog iron ore, and not least a lot of wood. Analyses of charcoal from iron production sites have documented that almost only pinewood was used. With the help of written sources from the 1700s, we have figures showing the amount of wood that was needed to produce a certain amount of iron. These figures have then been used in calculations to find out how much wood was used in the production on each individual site. At Heglesvollen, calculations have shown a volume of ca. 7000 m^3. (Berre, 1990; Espelund, 1997) In the same manner, the volume of pine at Storbekksetra in Budalen has been calculated to be ca. 3000 m^3 (Stenvik, 2011). The question, then, is to what extent this has affected the landscape around the productions sites. Studies in Budalen have shown that it must have led to deforestation over large areas and an increase in boggy land as a consequence of that (Solem et al., 2012). More interdisciplinary research is needed to investigate the extent of the iron manufacturing's impact on the landscape.

Methodical step forward, geophysics

Registrations and excavations or iron production sites have largely taken place in accordance with traditional methods. The majority of iron production sites have been found by amateurs who observed the existence of slag on the location. The sites have then been registered and measured up following rather varying standards. The need to know more about vertical organisation on sites is considerable. What installations and structures existed on the various sites at different periods of time? The archaeological investigations that have been carried out, have to a lesser degree uncovered the area outside the furnace itself. So far, the turf had to be removed in order to get an overview of structures on the production site. Today, various geophysical methods for searches are useful to obtain information about structures in the ground without having to dig. At NTNU University Museum, we have started trials using different geophysical methods, and investigations of iron production sites are part of a doctor's degree (Stamnes).

A new, theoretical orientation?

Traditionally, research on bloomeries has been procedural. People have taken a particular interest in documentation of structures, datings, profit calculations and distribution. Social implications have also been important in the research. What significance did the iron production have and what social conditions would have been a premise for the production. In Mid-Norway, importance has been attached to social conditions in several works (Stenvik, 2005; Prestvold, 1999; Rundberget, 2002). New perspectives in bloomery research have above all come through ethno-archaeological projects initiated by the University of Bergen (Barndon, 2004; Håland, 2004). Recent master's degree projects present completely new approaches to the bloomery research where cosmology is linked to spatial organisation on the bloomery sites (Hovd, 2012). New insight can be achieved if new theoretical perspectives gain ground in the bloomery research.

Research-led management

The traces of iron production are exclusively found in outfields. This is a situation that has been of great importance to the preservation. Very many iron production sites lie where they were left behind, unaffected by later activities. This makes iron production sites like these unique compared to what is common in other countries. With the introduction of new technology in forestry the situation has changed. Heavy machinery requires building of roads, felling of trees, transport, planting, and mechanical ground preparation may seriously damage the iron production sites (Stenvik, 1992b). This has put a significant pressure on cultural monuments. An overview of the existence of bloomeries is lacking and protection criteria have not been developed for this type of cultural monuments. What ought to be preserved and can be released? A protection plan for iron production sites could possibly be a tool the public administrative authorities can relate to.

Interdisciplinary competence

In the investigations of iron production in Mid-Norway, there has been a close collaboration between archaeology and metallurgy and to a lesser degree collaboration with vegetation history. The metallurgist Arne Espelund has played a key role in this and he has provided decisive knowledge about process and profits. Today, we are facing a situation where the recruitment in metallurgy is lacking. There's little interest in filling the gap after Espelund at NTNU. Thyra Solem, a specialist in pollen analysis, has made vegetation reconstructions of the areas surrounding iron production sites in Trøndelag and contributed to a better understanding of the interplay between humans and nature. Solem has no successor either who can pick up the threads of this work.

Conclusion, closing remarks

This examination has shown the results achieved within bloomery research in Mid-Norway since the research on this field started in the 1980s. A distinctive technology for the production of iron has been demonstrated in Pre-Roman Iron Age. Production peaks and changes in technology and distribution have also been demonstrated. There were interruptions in production and technology on three occasions and attempts have been made to explain the causes.

Unanswered problems for discussion still remain. This applies to provenance studies of the iron in objects and the origin of the technology that appears in Pre-Roman Iron Age. We also know little about reforging sites and smiths from Pre-Roman times and the Middle Ages. Charcoal kilns for iron production from the Late Iron Age and the Middle Ages have virtually not been investigated. The iron production's impact on the vegetation and landscape is another area one lacks knowledge of. New search methods may provide information about iron production sites that ordinarily would have required large resources. Lack of interdisciplinary competence at NTNU poses a threat to continued research.

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How did the natives of North Norway secure the supply of iron in the Iron Age?

Roger Jørgensen

Abstract
The presence of iron in North Norway seems to date back to the end of the Bronze Age. The use spread rapidly and the amount of iron in circulation increased, in particular from the Roman Iron Age, and well into the Iron Age. In North Norway, only two bloomeries have been recorded to date to the Iron Age and the need for iron was therefore met by iron produced outside this part of the country. The two bloomeries that have been found show that the technology, at least in some places, was known, but the early starts of iron production were short-lived. What may have been the reason(s) why the excessive demand for iron was not met by the local production when the technology was well established and the raw materials also were available? Could a possible explanation for this be found in the way society was organised?

Introduction

In Mid and South Norway, many iron production sites dated to the Iron Age have been found, but very few traces of similar activities have been recorded in North Norway. In total, only three sites have been found, dated to ca. 500 BC, 300 BC and the AD 1200s (Fig. 1) (Jørgensen, 2010, 2011). There are of course many iron production sites still out there that have not yet been mapped, but as these are the only ones that have been found after centuries of intensive cultivation of infields and an extensive utilisation of the outfields, in addition to more than 100 years of extensive archaeological activity, I believe that these are sufficiently strong indications to maintain that an extensive iron production did not take place in this part of the country. In what follows, my point of departure will be the iron supply to North Norway throughout the entire Iron Age, and I will look into where the natives of North Norway got the iron from and how they secured the supply.

Access to iron

Even if the iron production seems to have been small or almost non-existent, it does not seem to significantly have affected the point of time the iron was introduced or the amount of iron that was in circulation.

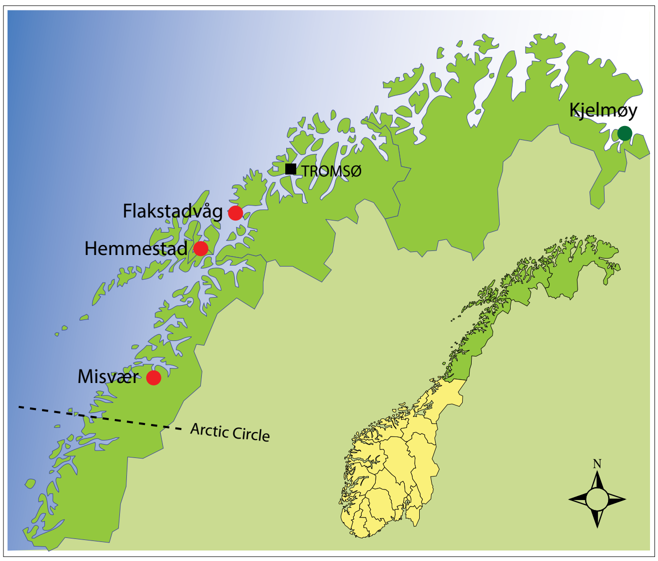

Fig. 1. North Norway with place names mentioned in the text.
Map: E. Høgtun, Tromsø University Museum

Fig. 2. Arrows made of bone with traces of attached iron heads (Olsen, 1994, p. 109, fig. 73)

With regards to population, North Norway can broadly speaking be divided into two zones, i.e., the inner areas of Nordland and Troms and all of Finnmark where hunting and catching dominated, and the outer coastal areas up to North Troms where farming and stockbreeding were important too.

The oldest recorded use of iron furthest to the north and east is from Kjelmøy in Varanger where finds from settlement layers show an extensive use of iron as early as ca. 600 BC. This use of iron does not give an impression of being exclusive, neither when it comes to areas of application nor who had access to iron, because the metal was used for a number of tools associated with everyday tasks (Olsen, 1994, p. 132; Solberg, 1909, 1911).

Fig. 3. "Risvik ceramics". Photo: A. Icagic, Tromsø University Museum

The earliest use of iron along the outer coast of Nordland and Troms seems to have been linked to the settlements containing Risvik ceramics (Fig. 2) that we find on the outer coast of Nordland and Troms, in the same areas where farm settlements sprang forth in the Iron Age. The ceramics are dated to the period 800–400 BC (Andreassen, 2002, p. 71), and they seem geographically complementary to the Kjelmøy ceramics that we find in the North and East in approximately the same period. The development and distribution of these types of ceramics are often seen as an indication of the presence of the two groups of people, the Norse and the Sami, which seem to spring up as ethnic categories in the last century BC. The extent of the use of iron in the Risvik settlements is uncertain, but we notice that the ceramics seem to have been repaired with an iron wire and that some of the vessels have been equipped with an iron collar under the rim (Fig. 2).

There was probably a quite widespread use of iron in all of North Norway by the Pre-Roman Iron Age, but it may have been limited to small and lightweight objects like the iron points that had been attached to the bone points from Kjelmøy (Solberg, 1909, pp. 42–45, Fig. 65, 66, 80, 1911, p. 351) (Fig. 3). Iron used for small objects like these would not require access to large amounts of iron.

The amount of iron in the archaeological finds is quite modest up to the Roman Iron Age when the amount of finds on the outer coast of Nordland and Troms nearly exploded. This is attributable to, in particular, the changes

Fig. 4. Sites with iron production in Northern Fenno Scandinavia. Map: E. Høgtun, Tromsø University Museum

in the burial practices, and the fact that the majority of relatively large iron finds comes from graves. The amount of iron from the settlement finds remain, however, relatively modest throughout the entire Iron Age. In the Sami communities in the North and the East, it seems that the use of iron continued uninterrupted throughout the Iron Age, but relatively few finds have been made, and it is therefore difficult to get an impression of the extent of the use of iron.

Where did the iron come from?

Although the local production was minimal, it nevertheless seems that iron was in general use all over North Norway from the start of the Iron Age. One site in North Norway and a few in North Finland have been dated to Pre-Roman Iron Age, but none of these are obvious production centres in the Pre-Roman Iron Age. It is, however, possible that the use of iron, even though it was relatively widespread, comprised relatively limited amounts of iron, possibly produced in small units on a small-scale, but sufficient production capacity for a spreading of iron and iron objects from there (Fig. 4).

The local iron production on the Cap of the North was small-scale during the Iron Age, and no sites with a significant surplus production have been demonstrated. On the Kola Peninsula, no iron production sites have been found, in North Finland, the production has been based on small, isolated sites, most probably to meet local needs, in North Sweden, only one site has been found, and in North Norway, two. If we look south, we see that there is a substantial increase in the iron production in the centuries around AD 1, in particular in North Trøndelag, but also in

Eastern Norway where the oldest furnaces dated to ca. 300 BC are found. Although new sites of bloomery iron making have been recorded in Western Norway in recent years, it is very unlikely that this production could be or was geared to meet the demand for iron in North Norway.

Therefore we are left with North Trøndelag and Eastern Norway as probable production areas for the iron that we find in North Norway in the Early Iron Age and perhaps particularly in the period around AD 1. From Senja in mid-Troms to the border of North Trøndelag, there is a distance of about 500 km as the crow flies and to Eastern Norway/Mjøsa approximately the double. The distance and availability favour the belief that the iron in North Norway came from North Trøndelag in the Early Iron Age around AD 1.

Where the iron in the initial, iron-using phase came from, is to a still higher degree an open question. Only a handful of iron production sites across Norway have been dated to the first part of the Pre-Roman Iron Age (among them Hemmestad in Kvæfjord) and none of the sites distinguish themselves with an extensive production dimensioned for trade in markets far away.

In the early iron-using phase, the amount of iron in circulation was considerably smaller than in later periods of the Iron Age. The exchange of goods or trade in iron was thus rather small-scale, and the need for transportation and communication in the initial phase of use was quite modest compared to what we see later in the Iron Age.

The two people groups in North Norway had different ways of life, economic adaptation and cultural orientation. Towards AD 1, it seems as if the North Troms and Finnmark hunter-gatherer population mainly had their important, external contacts in the East and South East. In the Bronze Age and the Early Iron Age, there seems to have been close cultural contact between North Finland and metal-using cultures (Ananjino) that flourished in the Volga and Kama areas in Russia (Mäkivuoti, 1987, pp. 59–63). The early use of iron in Finnmark should probably be seen as a result of these eastern contacts. This is changing, and around AD 1 a reorientation seems to take place among the northern and eastern hunter-gatherer settlements so that the external contacts throughout the rest of the Iron Age are found in the West and South East among the coastal population in Nordland and Troms (Hansen & Olsen, 2004). It is therefore probable that the hunter-gatherer population around AD 1 secured access to iron through these contacts.

Thus, we have a fairly good overview of the large iron-producing regions in the Early Iron Age, at least in the Roman Iron Age and the Migration Period, but the status of the Late Iron Age is more unclear. Even if the production in North Trøndelag in total decreases during the Late Iron Age, there are large regional differences, and in Namdalen, e.g., there is a huge increase in the period AD 600–700 (Stenvik, 2005). The production is also markedly lower in inner Eastern Norway in the Late Iron Age, particularly in the period AD 700–950 (Larsen, 2004). At the transition to the Late Iron Age, the iron production undergoes large technological changes, and in the Late Iron Age it is not altogether obvious what regions may have been the suppliers of iron to North Norway. The centre of gravity of the iron production in Trøndelag seems to have been relocated from North to South Trøndelag and eastwards to Jämtland (Magnusson, 1986; Johansen, 2003; Stenvik, 2005), but the production may still have been on a scale that was sufficient to provide supplies to the North Norwegian settlements.

In the Late Iron Age, as we have seen, no single area stands out as an iron supply centre for the North Norwegian settlements. A.W. Brøgger (1931, p. 25) has indicated that the trade relations with Western Norway in general were strong in the Iron Age, an assumption also Guttorm Gjessing (1939, p. 43) agrees with, but he also maintains that the finds point "… *tydelig mot Trøndelag og antakelig videre mot Sverige" ("… clearly towards Trøndelag and probably further on to Sweden*"). Thorleif Sjøvold (1962, p. 240) is also is of the opinion that contacts with the mid-Swedish area across Trøndelag in both the Early and Late Iron Ages are possible (Sjøvold, 1974, p. 358). These Norwegian-Swedish contacts were so tight that Wenche Sloman (1948, p. 55) believed them to be a result of immigration from Sweden in the Merovingian Period.

It is correct to say that a number of the finds from the Late Iron Age in North Norway may be of Swedish origin, and one of the most spectacular finds is a sword of the Valsgärde-type (Olsén, 1945, p. 30) from Karlsøy in North Troms which supposedly is the only one of this type found outside Swedish territory (Sjøvold, 1974, p. 358). This and other finds of Swedish origin may just as well, and maybe rather, be the result of connections with Trøndelag that in the Iron Age had close contact with the Swedish area. Without going into the details of this material, my preliminary conclusion is that the finds are too few and widespread to be used to substantiate hypotheses about trade relations directly between North Norway and mid-Sweden.

Technology, social organisation, and trade

In the first centuries of its use, the need for iron could probably have been met through an exchange system on a small scale, but the growing demand for, and use of iron, which we witness from and inclusive of the Roman Iron Age, presupposed a systematic supply of iron. A system founded on the assumption that settlements in North Norway received their supplies of iron from Trøndelag would have been dependant of a well-organised long-distance trade that probably was based on sea transport. A trade of this kind would have made demands upon both boat technology and social organisation.

The oldest, almost complete boat that has been found in North Norway is the 12–13 m long Bårsetbåten from Nord-Kvaløya in NorthTroms, which is dated to the end of the AD 800s (Pedersen, 2002). Our knowledge of an even older north Norwegian boat technology is rather incomplete. There is reason to believe that a people who at all times had been living in close proximity to the sea and been dependent on the ocean for their subsistence, at a much earlier point in time would have developed a boat technology that made long voyages possible. It has, for example, been established as probable that boats travelled over Skagerak between the North West of Jylland and the South West of Norway in the Late Neolithic Period and in the Early Bronze Age (Kvalø, 2007; Østmo, 2005), and on rock carvings in Alta which are dated to the last millennium BC, relatively large, seemingly ocean-going boats are depicted (Helskog, 1988, 2012). There is therefore no reason to doubt that people already at the beginning of the Iron Age had boats that made sea journeys over relatively long distances along the coast possible.

Access to boat technology alone would not be sufficient to embark on sea journeys from North Norway to Mid Norway. Without a regional central power that could safeguard the traffic between producer and market, the social organisation of the communities in the north would have been decisive as to whether long commercial voyages could be organised and carried out.

Trade vs. local production

The widespread use of iron from the early part of the Iron Age, quickly made iron a valuable raw material in great demand. Two iron production sites in North Norway have been dated to the Iron Age and the technology seems to have been known right from the initial phase of use. Hemmestad Nedre in Kvæfjord Municipality and Flakstadvåg in Tranøy Municipality, have been dated to around 500 BC and AD 300, respectively. What the sites have in common, is that they seem to have been used for a rather short period of time, so that iron has perhaps only been produced a couple of times on each site. The third site that has been recorded, Rognlivatnet at Misvær in Bodø Municipality, is dated to the AD 1200s.

If the demand throughout the Iron Age were to be our point of departure, then it is quite inconceivable that the production would have been that short-lived and on such a small-scale. Chemical analyses of slag from the sites suggest that the production was successful and finds of bog iron ore at Flakstadvåg show that lack of raw material hardly was the reason behind the cessation of the production. A systematic mapping of bog iron ore has not been carried out in this part of the country, but analyses that have been made of random finds show that the lack of raw material probably was not the main cause that contributed to that an "iron industry" did not spring into existence, like it did further south in Norway. The site at Flakstadvåg is around 800 years younger than Hemmestad, and it is very unlikely that the reason why the production lasted this briefly on both sites was the same. Hemmestad began to be used in full in the initial phase of the iron use in Norway at a time when very few mastered the production technology. A probable cause as to why the production ceased, may therefore have been that the necessary competence and technological knowledge was lost, for example, if the iron producer moved away or died.

In the matter of the site at Flakstadvåg, it was in operation in the same period of time when the production in North Trøndelag was at its peak and one may thus assume that the technological knowledge was fairly widespread and that quite a few mastered the craft. It is, however, possible that the large iron producers wished to limit the knowledge in order to strengthen their own position as producers (Stenvik, 2005, pp. 80–81), but it very unlikely, as the bloomery at Flakstadvåg shows, that a spreading of the technology could be stopped completely.

The large increase in the use of iron in North Norway that we see, in particular from the Roman Iron Age, is thus not founded in an in situ production, but the iron must have been supplied from external producers. This seems to apply to all of North Norway, and it may seem as if both the hunter-gatherer groups in the North and the East, as well as the settlements on the coast of Nordland and Troms with few exceptions, preferred to secure the iron supply from external producers rather than producing the metal themselves. Considering the fact that the raw material was available, and that the technology, at least in some places, was known, it is extraordinary that practically all of the settlements should come to the same conclusion. It may therefore look as though the causes were not linked to a lack of access to technology and raw materials, but that they rather should be looked for in the social organisation of the North Norwegian settlements.

A sketch of a model

An increase in the hierarchisation and political centralisation took place in the north Norwegian, Germanic coastal communities well into the Iron Age, and there was probably a network of Germanic magnates that through large parts of the Iron Age controlled the trade between the hunter-gatherer and farm settlements in the North and the iron producers in the South. Both the iron producers in the South and the traders in the North would profit from an exchange trade in iron and the products that the people in the North could offer. The North Norwegian elite that controlled the trade would be keen to monopolise the iron supply to both the Sami population in the North and in the East, and to the Germanic farm settlements on the coast. As sole supplier of iron, they would have secured access to the products that only the Sami population could provide that were important in both the local prestige goods economy and in their relationship to the leaders of the iron-producing societies in the South. The leaders' control of the distribution of iron in the coastal communities would have been very important in order to strengthen their position as political-religious leaders in these societies. The premises to achieve such a position and to maintain it was that the local production was oppressed. It is likely that the local leaders had this type of influence and could prevent iron production in the coastal communities, but not among the Sami population who to a large extent had a mobile settlement pattern. The reasons why an iron production tradition did not spring into existence in the hunter-gatherer environment must be searched for elsewhere than in the non-existent production in the coastal settlements.

The north Norwegian aristocracy would throughout the entire Iron Age, at least after AD 1, have taken a modest interest in an establishment of a north Norwegian bloomery iron making and they would have been eager to suppress such initiatives. The political centre of gravity in the North Norwegian coastal communities alternated between several families throughout the Iron Age, but those who were at the top of the social hierarchy would have been dependent of the same social structures and resources to uphold and maintain their position as religious and political leaders. There may, in addition, have been other reasons as to why the iron production did not prosper, but it is likely that one of the principal causes lies in the strategic choices made by the leading elites of the coastal communities.

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Late Iron Age (ca. AD 6/700–1000) – a white spot in the iron extraction history?

Bernt Rundberget

Abstract
Research on iron extraction in Norway has revealed that large-scale iron production took place in Central Norway in Early Iron Age and in large parts of Southeast Norway in the last part of the Viking Age and in early Middle Ages. In Late Iron Age, traces are, on the contrary, few. Apart from a few exceptions like Fillefjell in Oppland and, to some extent, at Møsstrond in Telemark, it is only individual ^{14}C *dates that provide indications of iron extraction took place in this period. In the light of the recessions in Europe at an early stage of the Late Iron Age, it is not unnatural that we picture the 7th and 8th centuries this way. But from an historical perspective where the Viking Age is promoted as an expansive and intense period, it is rather odd that the extraction did not leave any major marks from this period. In this article, I will consider the source material that is available from this period and further problematize what could be the cause of this chronological picture.*

Introduction – The history book recounts

In all overviews of Norwegian and Scandinavian history, the Viking Age naturally stands out as a particularly important period. There are descriptions of an expansive activity, both inside as well as outside of what was later to become the Norwegian frontier. On the other hand, the period prior to the Viking Age, the Merovingian period, is at first characterised by less activities, a phenomenon that are related to the upheavals and recessions that took place in Europe in the 6th and 7th centuries (e.g. Solberg, 2000; Myhre, 2002, pp.197–198, 201–202). The economy at the beginning of the Merovingian period is dominated by a general decline, which is seen in association with a recession and a development towards few and smaller networks. Exchange and trade certainly took place, but there are few traces of market places or foreign activities. There are also few signs of extensive *landnám* (new land-clearing). Many farms became deserted in the 7th century, particularly in Southwest Norway, as well as changes occurred in the settlement structure, as it did in Romerike. The decline is often explained by the plague that ravaged the Continent at that time. This can also be seen in research on iron extraction: Recession and discontinuation in the iron extraction in Trøndelag has e.g. been interpreted to be a consequence of the recession in the 6th and 7th centuries. And, change in technology is proposed to come as a result of this, because of the presumption that the tapping technology needed a smaller number of workers (Solberg, 2000, p. 211).

However, the decay was not complete all over the country. The Åker complex in Hedemarken is for example brought up as an expansive chieftain's seat in the 6th century. This is probably connected to the establishment of a network to Uppland. This upturn seemed, however, to have lasted for only a short incident, covering a few generations (Gudesen, 1980, pp. 112–114; Solberg, 2000, pp. 198–200).

Towards the end of the Merovingian period, the archaeological material shows signs of a new upswing. In the 8th century, it becomes

Bernt Rundberget

Fig. 1. Iron production site at Fillefjell dated to the Viking Age. Photo: J.H.Larsen

evident that chiefdoms and power centres became established and new networks of contacts start to take shape. There are, simultaneously, signs of a rise in the population growth and a major landnám takes place at several locations. Fishing and pasturing activities are also intensified at this time, while the iron extraction with the new tapping technology, still was operated on a limited scale (Solberg, 2000, pp. 203–211). The population pressure, along with an increasing desire to travel, lead in the Viking Age to the discovery of and migration to the Western Isles as well as the establishment of smaller societies on the British Isles. At the same time, it comes to a change in the economic system. Beyond the normal subsistence economy, that still was dominant among most people, the economy of the Viking Age is explained by two main factors; plundering – where the loot would provide economic gain and prestige; and trading. The first real market towns and market places were established in this period, and exchange in handicraft products and commodities from the in- and outfield was important to achieve profits in trade. In this exchange also iron is described to have an important role. Klaus Krag (2000) sees the iron in Telemark as essential merchandise in the Viking Age. The same applies to Jon Vidar Sigurðsson (1999). Sverre Bagge (2010), on the other hand, takes a step in the opposite direction in his latest book by clearly emphasising that iron, or outfield resources in general, had no significance for any trading activities in this period. Bagge's view is not unique. The outfield as a resource have often been marginalised and under communicated in history studies, and also partly in archaeology studies (Rundberget, 2013, p. 17).

Iron as a raw material

In this discussion, the expression of the grave material is important. In Early Iron Age, iron objects were not that common, but as early as in the Merovingian period, iron starts to appear more often, both as tools and weapons (Solberg, 2000; Larsen & Rundberget, 2009). It has therefore been presumed that iron became more common and available to most people as early as at the start of the Late Iron Age (Myhre, 2002, p. 199). In the Viking Age, the grave material gradually became even richer and iron is in this period is believed to have been easily available, although, people of higher status were the ones who became buried with their personal belongings. A natural interpretation of this development has been that iron extraction in Late Iron Age became a resource that more and more people took part in, and earned a profit from, and that this accelerated throughout the entire period.

Fig. 2. The three hitherto known areas with surplus production in the Viking Age. Map: B. Rundberget

Iron extraction in Late Iron Age

The image that is presented here is thus dual. It is put forward, on the one hand, that by the start of the Late Iron Age, recessions and stagnation. There are clear signs of a population decline and that established technological and organisational systems, as well as markets and mercantile networks, collapsed, probably a consequence of the upheavals that occurred on the Continent. In the transition between the Merovingian period and Viking Age, the activities improved and the society becomes more progressive and expansive.

On the other hand, the grave material generates an image that iron became more common as early as in the first part of the Merovingian period, and that a gradually development took place in terms of supply and demand of the product. As part of this, it must necessarily have been or became established both an iron extraction and an economic system in which the iron through various distribution channels became a more common product (Fig. 1). This means, while several archaeological sources indicate a decrease, there is also an apparent increase in the supply of and demand for iron. This must be seen in the context that it is actually proven a production in this period, but as of today, are only known in some few places like Fillefjell in Oppland (Larsen, 2009), Møsstrond in Telemark (Martens, 1988) and Solør in Hedmark (Rundberget, 2013) (Fig. 2).

These events were exactly what could lead to common and necessary changes. New network systems probably led to new ideas being presented and developed. The development in the iron extraction should be seen as an expression of such events. The most important technology shift in the bloomery history appears simultaneously. In Early Iron Age, large *shaft furnaces with slag pits* were used in the extraction. The furnaces of the Østland tradition were exceptionally

Fig. 3. Hellegryte (flag-lined furnace) excavated at Lisætra in Øyer. A clay shaft was placed above the pit and the furnace is dated to the second half of the 7th century. Photo: S. L. Berge

large, but relatively big furnaces have also been excavated in Trøndelag. Out of size and scale, it has been suggested that a large number of people would have been needed on each individual iron production site in Trøndelag. Lars Stenvik (1994, p. 15) and Arne Espelund (2005) postulate that as many as 10–20 persons were active at one single site, something which is a high number, as several hundred sites from the same period have been recorded. Also smaller shaft furnaces with slag pits were used in the same period, particularly in the southernmost part of Norway, but the dimensions of this extraction are for the time, being somewhat unclear.

In the Late Iron Age and the medieval period (ca. AD 800–1400) iron extraction is characterised by a completely different technology and organisation (e.g. Narmo, 1996; Rundberget, 2007; Larsen, 2009). In this phase, charcoal pits have become an integral part in the production (e.g. Narmo, 2000; Damlien & Rundberget, 2007). The technology shift also involved smaller furnaces and a different kind of slag separation. Contrary to the technology in the Early Iron Age, where the slag flowed down into the underlying pit, slag was now led or released through an opening in the shaft wall close to the bottom of the furnace (Rundberget, 2010, pp. 37–38). This type of furnace is therefore called *shaft furnace with slag tapping*.

Two factors are vital in this context: What took place in the transition between the two periods, and why did this technological change take place? Recent research indicates that there probably wasn't any discontinuance between these two unique technological expressions (Larsen, 2004). Instead, it is more likely that is was a gradual development that took place in the first part of the Late Iron Age, which I have denoted as a *hybridisation process* where the so-called *hellegryta* (flag-lined furnace), first excavated by Irmelin Martens (1988) at Møsstrond appears as a highly essential element in the interpretation (Rundberget, 2012, pp. 196–197; 2013; see also Tveiten, 2012). The existence of the flag-lined furnaces has later been confirmed in many of the iron production regions in Souteastern Norway, and the furnaces have been operating more or less at the same time all over (Fig. 3). However, to point out that such a development has taken place, says nothing about the reasons for the change. What is the underlying cause of it, i.e. what social implications and conditions do we have to look for to understand this development process?

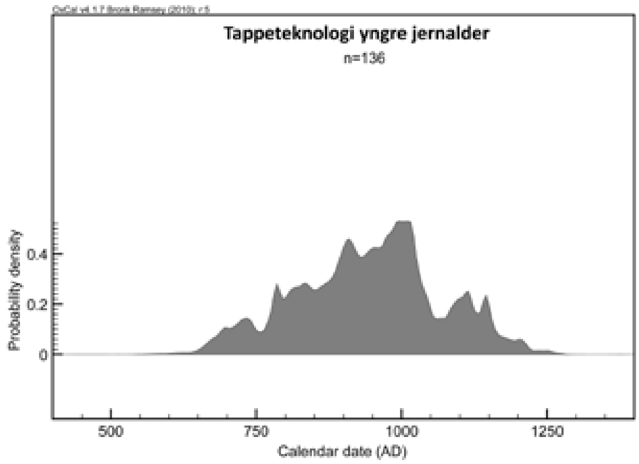

Fig. 4. The chronological development of the tapping technology in Southeast Norway in Late Iron Age based on 136 ^{14}C dates. Note that the dates with a calibrated start prior to AD 600 (uncertain technology) and after AD 950 (due to the massive increase in the production) are not included in the graph. Based on calibration curve formulated by Reimer et al. (2009). Figure: B. Rundberget

Future research focus

Much remains to grasp the basis for these changes, but one hypothesis is that it may in fact have been the need for a less resource demanding, but equally efficient production form. Central issues for future research will therefore include the Late Iron Age's bloomery (Fig. 4), and to establish what these phenomena actually reflect. Is it the case that iron as a product became more easily available from the start of the Late Iron Age, and, if so, why? Several problems for discussion can be deduced from this, of which the most important are:

- Technological change – When and why did it happen, and not least, why (impulses, needs, necessity, efficiency improvement)?

- How did the extraction develop in the period AD 600/700–1000 – Why is there a transfer from a production close to the farm to more peripheral production sites, was there a change in the use of resources, is this connected to landnám and how do the distribution and mercantile networks change?

- Dating problems and chronology – There are clear chronological variations both between and within the defined bloomery regions. What may have been the circumstances behind this and how can the variation be understood in a wider social context?

- The increase in iron objects in the grave material as early as in the early part of the Merovingian period – What does these reflect? In addition, a gradual increase throughout the entire Viking Age is seen. What is the situation in the medieval period, what is there to be found of e.g. iron objects in medieval towns?

- By whom and for whom was the production planned – Is it the farmers, thralls, semi-specialists or specialists who were the actors, and who stood behind any surplus production? What was the production volume of iron in the Late Iron Age – should the activities be defined as extensive or intensive, is there a transition between the types of operations or did different production forms run parallel (subsistence/crafts/proto-industries)?

- Where did the production take place in the Late Iron Age – Is the core areas identified or are there any undiscovered iron production regions from this period?

- What economic systems was production a part of, what markets was the surplus production, if any, intended for, and what trade routes and mercantile networks was the iron included in – Where did the iron end up?

- Was the production controlled and managed, and if so, by whom and on what level?

- What takes place around AD 950? In all of the regions in Southeast Norway, there is an increase from the last part of the Viking Age and early medieval period. When this occurs varies, but in the period towards AD 1100–1150, a change in the relationship between producer and consumer was obviously taking place.

- Is this development distinctively Norwegian – what takes place in a Scandinavian and European perspective?

The problems for discussion can to some extent be studied separately, but in many cases, they are intertwined. A possible goal should be to connect several researchers who treat the subject in different regions. Simultaneously, the research will be put into a wider framework, that is, the iron extraction should not be studied isolated, but connected to other archaeological and history research. In the Medieval period, the bloomery clearly have cyclical fluctuations that correspond to what happens within other types of activities and the development of reindeer hunting (Bergstøl, 2008), monetary system (Gullbekk, 2009), urbanisation, political development, population growth (Rundberget, 2012; 2013), and external needs (Rundberget *in press*). Studies of similar types of covariations should be topics also for the Late Iron Age. A goal should therefore also be to create larger, broader, joint research projects to be able to provide answers to many of the outlined problems for discussion.

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Soapstone extraction

Soapstone in Northern Norway: Research status, production evidence and quarry survey results

Stephen Wickler

Abstract

Archaeological research on the production and use of soapstone artifacts in northern Norway remains limited in scope and the region has received marginal attention in the Norwegian soapstone literature. Archaeological documentation of soapstone quarry locations has been minimal, although the Geological Survey of Norway has systematically surveyed a majority of the soapstone exposures in the region and provided information on quarry activity. This paper begins by reviewing the current status of soapstone from archaeological contexts in northern Norway, including an overview of material in the Tromsø University Museum collection. Soapstone production evidence is reviewed and challenges associated with quarry documentation discussed. Results from recent collaborative geological and archaeological quarry surveys are presented and some suggestions for future soapstone research provided.

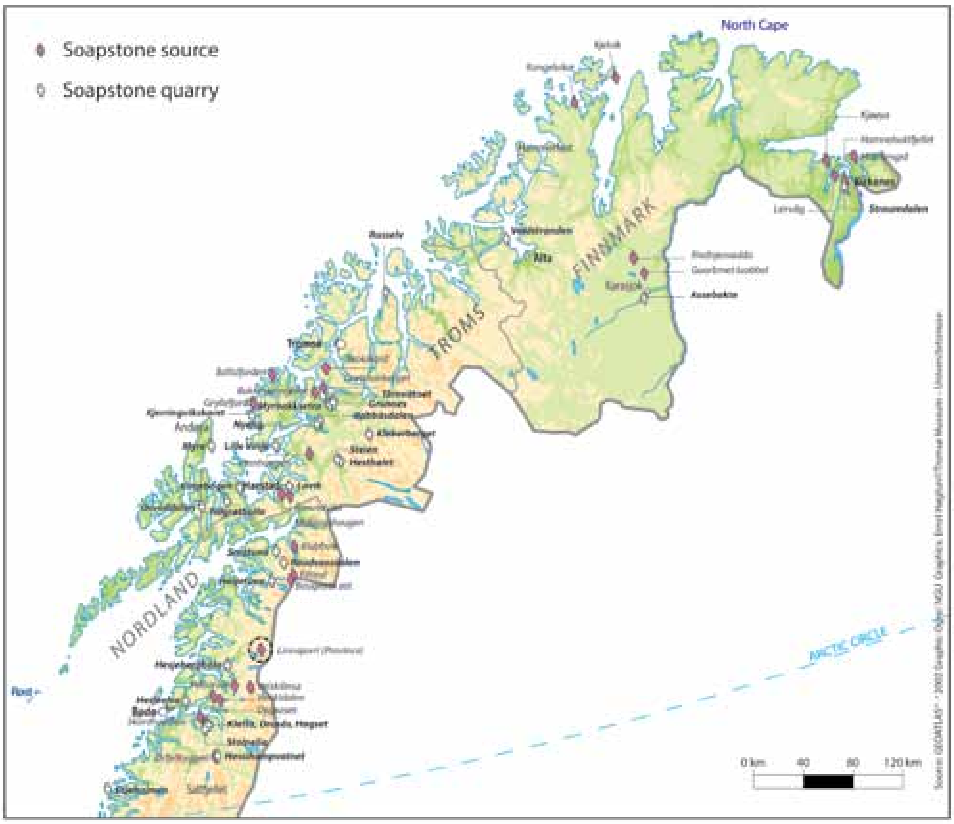

Fig. 1. Map of northern Norway showing the distribution of soapstone sources and quarry sites. Map: E. Høgtun, Tromsø University Museum

Stephen Wickler

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).

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. Grieg (1933) systematized the classification of medieval soapstone vessels based on formal attributes. More recent studies such as those by Lossius (1977) and Vangstad (2003) 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 paper provides a general status report for soapstone in northern Norway from Saltfjellet in Nordland County and northward with an archaeological overview of soapstone resources and their exploitation in the region. Soapstone production evidence is reviewed and challenges associated with quarry documentation discussed. Results from recent collaborative geological and archaeological quarry surveys are presented and some suggestions are given for future soapstone research in the final section.

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

Site type	Finnmark	Troms	Nordland
Occupation site	141	172	1248
Urban site			139
Farm mound	2	19	85
Grave site	2	20	62
Boathouse	1		1
Soapstone quarry		5	
Other / unknown	109	327	909
TOTAL	258	543	2444
Chronological Period	**Finnmark**	**Troms**	**Nordland**
Recent	100	35	48
Recent / Medieval	8	132	340
Medieval	21	178	939
Medieval / Iron Age		33	273
Iron Age / Late Iron Age	1	60	595
Early Iron Age		7	18
Bronze Age / Early Metal Age	2	3	8
Stone Age	10	4	13
Unknown	116	91	233
TOTAL	258	543	2444

Archaeological soapstone evidence from northern Norway

In order to examine the distribution of soapstone artifacts and their cultural contexts, data from the region of northern Norway administered by Tromsø University Museum found 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 museum collections in Norway. Although all archaeological finds held in the collection at Tromsø University Museum should be registered in the database, the quality and reliability of the information available varies to a considerable degree and cannot be accepted uncritically. However, it does provide coarse-grained information that is considered adequate for the broad overview presented here.

Soapstone chronology and site types

The extensive production and distribution of soapstone vessels and other objects in Norway during the Late Iron Age (Skjølsvold, 1961; Resi, 1979) and Medieval Period (Grieg, 1933; Lossius, 1977; Risbøl, 1994) is well documented. A review of soapstone finds with a known age (N=2805) from Tromsø Museum's district to the north of Saltfjellet in the national artifact database (Table 1) reveals a predominance of medieval material (over 50%) followed by the Late Iron Age (23%) and Post-Reformation/Recent Period (6.5%). Only 2.3% of the finds predate the Late Iron Age.

The distribution of finds by site type as shown in Table 1 reveals 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, more appropriately referred to as "habitation 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 number and size of these sites increase dramatically during the Medieval Period with occupation continuing up until the recent historic period, and some are still occupied. The only site classified as "urban" is the medieval settlement at Storvågan in Lofoten. 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 Table 2. All artifact types with more than 10 individual finds are listed in

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	994
TOTAL	3245

Table 2. Soapstone artifact types from northern Norway

the table. Only a small fraction of the finds predate the Viking Age and most are from the Medieval Period. A majority of the artifact types during this period exhibit only minor changes in form 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 with few complete or nearly complete vessels. 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 or fish oil (4.6%).

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 similarity in size and appearance. Both artifact types also include reworked vessel sherds.

Although only 20 have been found in Tromsø Museum's district, forge-stones from soapstone provide important supplemental evidence for the presence of smithies, only three of which from the Late Iron Age and Medieval Period have been excavated in northern Norway. 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, was an excellent material for this purpose. The only exception is a single forge-stone of fired clay. Soapstone molds are another limited (1.9%) but important artifact category associated with metalworking ranging from Early Metal Period (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 building stone, grave markers, stove parts, and other objects. Many baking plates (*baksteheller*) in the database are erroneously classified as soapstone. Baking plates are manufactured from greenschist deposits which can occur at quarries where soapstone may also be found in close proximity and building stone was extracted during the Medieval Period, such as Klungen/Øye in the vicinity of Trondheim (Storemyr and Heldal, 2002; Storemyr, Lundberg, Østerås & Heldal, 2010).

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 database (see Helberg, 1993; Olsen, 2004). A category of heavy sinkers or possible anchor stones (*senkestein*) has also been 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 find types.

Soapstone quarry documentation

The Geological Survey of Norway (NGU) has systematically mapped many of the soapstone exposures in northern Norway and placed them in a national natural stone database (http://geo.ngu.no/kart/mineralressurser/), which includes information on quarry activity viewed in relation to the economic potential for modern quarrying as well as evidence of historical use. The distribution of documented soapstone deposits from Saltfjellet and northward in northern Norway from NGU and other sources is shown in Fig. 1. Deposits where quarry activity has either been reported or confirmed are listed in Table 3 based on information from geological and archaeological literature, local historical records and literature, and unpublished sources. Quarry sites registered in the Norwegian National Cultural Heritage Database (Askeladden) are also noted. Recent research has focused on interdisciplinary stone quarry studies involving geologists and archaeologists, such as the Millstone Quarry Landscape Project led by NGU. This work reflects a broad scope concerned with the exploitation of stone resources including quarry landscapes, the use of stone in medieval church construction, and petrography and sourcing.

The earliest archaeological quarry surveys in northern Norway were undertaken by Harald Egenæs Lund (Lund, 1954, 1963, in Skjølsvold, 1961, p. 147). These included the Helgeland region of Nordland, Ofoten, and southern Troms (Harstad, Kvæfjord, Gratangen, Dyrøy,

Table 3. Reported and documented soapstone quarry sites located to the north of Saltfjellet in northern Norway

Location	Municipality	National Heritage Database ID	Age estimate
FINNMARK			
Straumdalen	Sør-Varanger	27250 (Langfjorden)	Pre-reformation
Assebakte	Karasjok		Pre-reformation?
Voldstranden	Alta		Pre-reformation?
TROMS			
Russelv	Lyngen		Historic?
Kleberberget	Målselv		Recent
Myrbakksetra	Målselv		Recent
Grunnes	Målselv		Recent
Tårnvatn	Lenvik		Recent
Kjerringvikskaret	Torsken		Recent
Nyeng	Sørreisa	28201 (Talgrøtberget)	Pre-reformation?
Rabbåsdalen	Sørreisa		Recent
Lille Vinje (Talgrøtberget)	Dyrøy		Pre-reformation?
Steien	Bardu		Recent
Hesthølet	Bardu		Recent
Talgrøtholla	Kvæfjord	8814, 35633	Pre-reformation?
Kanebogen	Harstad	74346	Historic/Pre-reformation?
Lavik	Gratangen	27198	Pre-reformation?
NORDLAND			
Myre (Dverberg / Stallberget)	Andøy		Recent
Osvolldalen	Sortland	67649 (Storkvantodalen)	Pre-reformation?
Småtuva	Ballangen		Recent
Raudvassdalen	Ballangen		Recent
Hesjetuva (Tennstrand)	Tysfjord		Historic?
Hesjeberghola	Sørfold		Recent
Hesjeelva	Bodø		Historic?
Drusås, Klette, Høgset	Bodø		Recent
Stolpelia	Bodø	57153 (Stolpe)	Pre-reformation
Hessihompvatnet	Saltdal		Recent

Inner Senja, and Lenvik). The only soapstone quarry excavation to date in northern Norway 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 ca. 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 from Saltdal to Sørfold and the Ofoten region of Nordland, and from the island of Senja southward in southern Troms (see Fig. 1 and Table 3). Of the quarry sites identified in Nordland to the north of Saltfjellet, two may have been used in the later historic period, and several have the potential for medieval or earlier use. Of the quarry sites recorded in Troms, five recently surveyed locations appear to have the potential for use prior to the Reformation. Only one confirmed quarry site is known in Finnmark (Straumdalen, Sør-Varanger), although there are historical references to potential quarries near Alta and Karasjok.

Research problems related to soapstone production

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

One inescapable attribute of quarry sites is the fact that quarrying often obscures earlier activity so that only the most recent phase is visible, although quarry locations may also have shifted over time thus preserving older evidence. Evidence from the earliest use phases may also lie deeply buried under accumulated waste material. Modern quarry production can also severely impact evidence of earlier use. Widespread sampling of soapstone to evaluate its suitability for the restoration of Nidaros Cathedral has also impacted automatically protected quarry sites.

A fundamental task is the establishment of a chronological framework for soapstone production in 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 removal 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 more intensive activity associated with temporary occupation? Can we document the social structure of quarry activity, such as the degree of elite control vs. unrestricted access? Chiefly control and specialized production is less likely for small objects easily produced by individuals from nearby communities.

Quarry sites should be viewed as integral components of quarry landscapes and documentation of broader archaeological and environmental contexts for the use of quarry sites is necessary. Relevant landscape elements include the importance of agriculture, infield vs. outfield resource exploitation, population distribution, access to transport networks on land and along waterways, and the potential influence of large farms or other power centers for potential control of production. 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.

Results of recent soapstone quarry surveys

This section presents preliminary 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. Results are presented and discussed in light of their potential for future research focusing on the excavation of spoil heaps and geochemical characterization. The surveys were initiated as an extension of ongoing millstone quarry research associated with the research project "Millstone". Geological samples were collected from three quarry sites (Talgrøtholla, Talgrøtberget, Stolpe) and Trondenes Church.

Stolpe – Misvær, Nordland

The soapstone quarry at Stolpe/Stolpelia is one of the most promising sites for potential early use and excavation. The site has been briefly surveyed by Tromsø Museum (Jørgensen, 1986) and several samples of waste material collected. Stolpelia is situated on a hillside at ca. 270–275 m a.s.l. in the outfield of a farmstead ca. 4 km south of Misvær in Bodø Municipality, Nordland. The site covers an area of approximately 40 x 30 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 smaller artifacts such as molds, sinkers, or loom weights. A rectangular foundation of soapstone blocks has been constructed on a soapstone exposure along the upper quarry margin. There is an overgrown mound near the lower margin of the quarry with waste material that appears to cover earlier traces of quarrying. Earlier quarry activity has been impacted by

Fig. 2. Evidence of modern soapstone removal at Stolpe. Photo: S. Wickler

a small scale modern quarry with an access road and the removal of soapstone slabs by drilling (Fig. 2). Geological evidence indicates that the soapstone deposit, which occurs within a gabbro, can extend more than 200 m. The material is fine-grained and of good quality and has been sampled by NGU through drilling.

The Misvær area has had a mixture of Norse and Sami influences and settlement representing both ethnic groups extending back at least to the twelfth century based

Fig. 3. Vertical soapstone face at Talgrøtholla. Photo: S. Wickler

Fig. 4. Traces of quarry activity at Talgrøtberget that have been protected by turf. Photo: S. Wickler

on excavation results from 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 decorated handles) and use of the quarry 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 ca. 630 m a.s.l. in an area with frequent rockslides, with vertical bedrock faces (Fig. 3) and loose blocks spread across the valley floor. Gunnerus (1761, p. 273) was the first to mention the quarry and Lund (1954) visited the site but was unable to locate specific quarry locations. According to local residents, the quarry had been used historically for stoves, sinkers, etc. The site was surveyed by archaeologist Asgeir Svestad in 1990 (see Askeladden ID 8814) who reported traces of quarrying in rock faces at two locations and the presence of waste material and roughouts at the top of a steep slope, some of which were collected (Ts. 6554). 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 our survey in 2012. Speculation that this quarry supplied stone for Trondenes Church appears unfounded on the basis of available survey results.

Fig. 5. Soapstone exposure with quarrying evidence at Kanebogen. Photo: S. Wickler

Talgrøtberget (Nyeng) – Sørreisa, Troms

As with Stolpe, this quarry is automatically protected and was probably 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, p. 6). The main quarry area is ca. 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 under a layer of turf (Fig. 4). 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 (Lindahl, 2013, p. 6). Traces of production vary in shape and size including larger vessels and numerous smaller rectangular depressions. As part of a *Fotefar mot Nord* project (Sandmo, 1997), an information sign and gravel parking area have been placed next to the quarry. Preparation

Fig. 6. View of Trondenes Church taken from the south. Photo: S. Wickler

of the parking area appears to have cut into a substantial spoil heap deposit, from which a sample of soapstone waste was collected by NGU. The areal extent and depth of the spoil heap deposit at Talgrøtberget is unknown but appears sufficient to warrant excavation.

Kanebogen – Harstad, Troms

This is a small quarry site situated along the shoreline of a small embayment adjacent to a campground to the south of Harstad and has been briefly surveyed by Tromsø Museum (Jørgensen, 2000). Quarrying evidence covers a roughly 10 x 10 m area extending from the high tide level up to 2 m a.s.l. with traces restricted to rectangular depressions up to 25 x 40 cm although many are smaller (Fig. 5). Evidence for the removal of similarly shaped objects, which may include larger fishing line sinkers (*jarstein*), also occurs at Talgrøtberget and Stolpe. The quality of stone is highly variable and much of the source is not actually soapstone. Given its low elevation, quarry activity is likely to have been relatively recent, although no written sources or oral traditions appear to refer to the site.

Trondenes Church – Harstad, Troms

Trondenes Church was inspected in conjunction with the survey of nearby quarry sites and is therefore included here (Fig. 6). As the northernmost medieval stone church in existence, sourcing the soapstone used in the construction of Trondenes Church is of considerable interest. The existing church building is said to be from the thirteenth century but dendrochronology has placed its completion at ca. 1434 (Eide, 2005). Although many types of soapstone were used in the church, no sources have yet been identified (Lindahl, 2013, p. 7). A majority of the soapstone is light colored and quite coarse grained, and is typical of material formed from ultramafic rock types such as peridotite and lherzolite. These can come from a number of different small sources in the region (e.g. Sørreisa, Gratangen). Some of the rock is a chlorite soapstone that is fine grained and greenish. A sample of soapstone removed during restoration of a portal was obtained from Harstad geologist Peter Midbøe, but apparently much of the original soapstone was discarded during restoration (P. Midbøe, pers. comm.).

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.

Research to date has focused almost exclusively on the production and use of soapstone within a Norse (Germanic) cultural context which fails to take into account the complex multiethnic situation in northern Norway. Finnmark and other areas with predominantly Sami settlement have been largely ignored. Although eight soapstone sources and three quarry sites have been reported in Finnmark, only Straumdalen in Sør-Varanger has been surveyed (Helskog, 1975). This site covers an area of ca. 150 x 40 m with multiple quarry locations and a potentially thick waste deposit. The site lies within a core Sami region in close proximity to settlements of central importance from the Early Metal Period and Stone Age, including Kjelmøy which is only 20 km away. Both soapstone objects and soapstone tempered ceramics have been found at Kjelmøy and other Early Metal Period sites in the area.

Attempts at geochemical characterization and sourcing of soapstone have been 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 (Olsen, 1984, p. 37) and bucket-shaped pots from the later Roman Iron Age and Migration Period (AD 350–575) (Engevik, 2010).

Despite the many challenges and unanswered questions related to soapstone in the North, recent efforts and the promise of increased attention to this field of research in the near future should provide results leading to better understanding of the important role played by soapstone since the Stone Age.

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Possibilities for a society analysis by means of soapstone – examples from Helgeland, Northern Norway

Birgitta Berglund

Abstract

The coast of Helgeland has soapstone quarries from the Viking Age and the Middle Ages, first and foremost on the islands at the mouth of the Vefsnfjorden. Building stone for the medieval churches in the area, pots and other objects like sinkers, reels and fish-oil lamps have been extracted here. In the area, there are major farms with roots back to the Early and Late Iron Ages as well as farms that the King and his church granted status to in the Middle Ages to gain control over the area. Provenance studies of soapstone will provide an opportunity to find out who was in control of the soapstone quarries, and thus contribute to a society analysis on an overall level. Analysis of the soapstone quarries as mini-societies will provide more detailed information on how the quarries were run and thereby also a connection to those holding superior power in the society.

Fig. 1. Tjøtta – an old centre of power with roots back to the Early IronAge and where, according to Snorre Sturlason's Kings' Sagas, the Viking chief Hårek stayed. Excavations in the farm mound show that the courtyard at the end of the Viking Age and the Middle Ages was lying close to the church. The water colour shows the courtyard the way it looked in the heydays of the estate, when the Brodtkorp family were the owners there. The church in the photograph burned down in 1843. Water colour by H.J.F. Berg in the period 1830-1835.
Photo: P.E. Fredriksen, NTNU University Museum

Introduction

Soapstone has been a very significant raw ware on the coast of Helgeland, especially in the Viking and Medieval Ages, and many soapstone quarries are known in the area. Here it is proposed that provenance studies of objects and building stones of soapstone could provide contributions to society studies on an overall level. Studies of quarries as mini-societies will provide information of how the quarries were run and give a link to the overall level.

Major farms on the Helgeland coast – a part of the structure of society

On the coast of Helgeland, there are major farms or centres of power that can trace their roots back to prehistoric times. There are also farms that first and foremost seem to have become increasingly important after the northern territories were included in the Norwegian realm. Here, a major farm with roots to the Early Iron Age first of all will be discussed in more detail and thereafter a farm that later acquired importance as an ecclesiastical centre. A social structure where magnates in turn, more or less stable, dominated areas and the people of a large area was replaced by a society that was controlled by the long arms of the national power (Berglund, 1995).

Tjøtta – a chieftain's seat and the centre of an estate

Tjøtta is a farm that stands out most clearly as a centre of power on the Helgeland coast from the AD 300s and hereafter (Fig. 1). On the site, a large ring-shaped courtyard settlement has been found with at least 12 more or less visible house ruins with outer turf walls, up to 17 visible earth ovens and a memorial stone. It must be mentioned that many of these settlements are not really ring-shaped, but often the houses are situated around an open square with the side gable turned to the square. Several house ruins and earth ovens were excavated by the archaeologist H.E. Lund in the 1950s and a field in the north eastern part of the site was excavated in 1977 by the author. This field was placed on a location where the house ruins were indistinct, but the excavation confirmed that three houses have existed there (Wik, 1983; Berglund, 1995). ^{14}C dates show that there has been activity in the area from around AD 300 to the beginning of the 11th century (Wik, 1983; Berglund, 1995, p. 61). The interpretation of the ring-shaped courtyard sites has been debated (among others Havnø, 1931; Lund, 1965; Rønneseth, 1966; Johansen & Søbstad ,1978; Wik, 1983; Berglund, 1995; Storli, 2001). In addition, many others have taken part in the discussion about what this type of courtyard settlement actually is. The dividing line has first and foremost been running between those who looked upon them as villages and those who believed that they were military camps, thing sites and/or cult places at a chieftain's seat. Recently Olsen (2005) has interpreted them as thing sites and Storli (2006) has interpreted them to be assembly sites for equals, both in terms of politics and law.

Long boathouse sites are found on the farm, as well as one large and many small grave fields, among other things, with memorial stones (Fig. 2). The size of some of the grave mounds is monumental. H.E. Lund examined several of the small mounds in the 1950s. All that could be dated are from the Late Iron Age. On a small island, Lille Røssøya, to the east of and close to the main island, there is a large field of cists. Some of them are lying in small cairns. The graves are, in their nature, probably from the Early Iron Age. No finds are known from the site. In several of the graves on Tjøtta, soapstone pots (Fig. 3) that according to their style are from the Viking Age have been found (Wik, 1983; Berglund, 1995).

Small parts of a large farm mound in the present courtyard settlement were excavated in 1985. The excavations revealed cultural layers up to 1.8 m thick; the layer at the bottom of one of the excavated fields consisted of turf walls from a house. They were dated to ca AD 1030, i.e. to the same period that the ring-shaped courtyard, according to ^{14}C dates, was abandoned (Berglund, 1995). The archaeological finds indicate a larger and more varied activity compared to farm mounds that were examined in the surrounding country of Tjøtta. In addition, the finds had a slightly different character, containing, among other things, imported ceramics from the Middle Ages. Traces of the processing of soapstone have also been found.

On the courtyard site, there is a stone church that was completely rebuilt in 1851 after having been struck by lightning. The church had also burned when struck by lightning previously. In the existing church, the building stone consists mainly of rubble stone, but it is obvious that ashlars of soapstone from the medieval church have been reused for the walls. The great baroque poet of Norway and vicar of Alstahaug, Petter Dass, writes in The Trumpet of Nordland (1997 [1739]) in the second half of the 17th century that the Tjøtta Church is one of the churches on the coast of Helgeland that have been built from stones, implied soapstone. The English translation by T. Jorgensen (Dass, 1954 [1739], p. 77) has however left out that the three churches of the Alstahaug parishes were built from stones:

The Alstahaug parishes three I recall;
Three churches a chapel, at Sandness, are all:
One church has on Tjøtta location.

The second at Alsten does lift up its spire;
The third one is Herøy, a sight to admire –
Of soapstone it has been constructed.

Fig. 2. The Gullhaug grave field on Tjøtta and the large Gullhaug. Curator H.E. Lund examined several of the small grave mounds in the 1950s, and based on the finds they were dated to the Late Iron Age. Sherds of soapstone vessels were found in many of the mounds. Photo: B. Berglund

Written sources, like archbischop Aslak Bolt's cadastre from ca. 1430 (Jørgensen, 1997) show that Tjøtta early on was the centre of an estate that gathered resources from the outer coastal to the inner fjord areas. Tjøtta is known from Snorres kings' sagas as the farm of Hårek of Tjøtta, one of the leaders of the army that fought against Kong Olav Haraldson in the battle of Stiklestad in 1030.

Alstahaug – an ecclesiastical centre

From an analysis of the social structure on the Helgeland coast, Alstahaug is one those places where the King and his church gain foothold in the Early Middle Ages, as a counterbalance to old power centres like Tjøtta (Berglund, 1995). A large farm mound is found here, an old rectory, and a church, the oldest parts of which were built from soapstone in the Middle Ages (Fig. 4).

Fig. 3. Soapstone pot from the Viking Age from a grave mound on Tjøtta that was excavated as early as 1828. Photo: A.-M. Olsen, University Museum of Bergen

Fig. 4. The oldest part of the Alstahaug Church is built from soapstone ashlars. A round arch of soapstone with a carved pattern of «sunken stars» is seen over the choir door to the south. The Baroque poet Petter Dass was a clergy-man here at the end of the 17th century and until his death in 1707. Photo: B. Berglund

Fig. 5. The majority of soapstone quarries on the coast of Helgeland and churches built to a large extent or a small extent from soapstone during the Middle Ages

Excavations beneath the church floor have been carried out by the Directorate for Cultural Heritage represented by Christie 1967 and 1969 (Christie, 1973). Excavations of the farm mound have been carried on several occasions in the period 1985–2006 by NTNU University Museum (Berglund, 1995, 2007). The small excavations of the farm mound revealed extensive archaeological material, among other things, a lot of household goods of soapstone. Building stone of soapstone and soapstone debris were found in an area that must have been a stone workshop from when the church was being built. Traces of other types of craft that was needed for the building of the church were also found.

Soapstone quarries, Soapstone arte-facts, and churches built of Soapstone on the coast of Helgeland

At the mouth of Vefsnfjorden, one of the largest fjords in Helgeland, there is a collection of soapstone quarries that have been used since the Viking Age, probably also prior to that (Fig. 5). In Brønnøy and Sømna in Sør-Helgeland there are similar quarries. Building stone, cooking pots and other artefacts from daily life like sinkers, reels and fish-oil lamps were taken out from the quarries. The most recent extractions are visible in the quarries. Based on the visible extractions, building stone was not extracted from all of the quarries, while the majority of them have traces of extraction of pots, both bowl-shaped and rectangular (Berglund, Heldal, & Grenne *in press*).

In a midden just outside a soapstone quarry on the farm Remman on the island Tro, the author has carried out a minor excavation in a 2.2 m thick midden (Berglund, 1995; 1999). It appeared to consist of large and small soapstone. The size decreased downwards, and at the bottom the soapstone was nearly pulverised. Almost at the bottom of the midden, there were two concentrations of charcoal. Charcoal from the lowest one was ^{14}C dated to AD 1280–1400 (calibrated), the most likely dating being AD 1295. In the midden, some fragments of unsuccessful soapstone pots of medieval type A were found.

On the coast of Helgeland, it is common to find artefacts of soapstone in settlements from the Iron Age, the Middle Ages and the Renaissance (Fig. 6). They consist of, among other things, cooking pots, oil lamps, fishing sinkers, weaving weights, spindle whorls, and casting moulds. In farm mounds, soapstone is one of the more common materials. Soapstone pots are not unusual finds in graves from the Viking Age. On the Helgeland coast, six soapstone pots have been identified based on their shape and form as being from the end of the Bronze Age and the Celtic Period (Pilø, 1990, p. 100). Based on find details, some of the latter may be from hoards.

The most noticeable uses of soapstone are seen in the churches. On the Helgeland coast, a church ruin (Tilrem) and four churches still standing (Dønnes, Herøy, Alstahaug, Tjøtta and Brønnøy) are found that to a large extent or a small extent have been built from soapstone during the Middle Ages. Several of them have been reconstructed to such a degree that it is difficult to determine whether soapstone was part of the building material. Some have mounts and other details in soapstone, while others have soapstone as the dominant building material (Berglund et al. *in press*, compare Ekroll, 1994).

Fig. 6. Soapstone objects from a farm mound on Flatøya, one of the islands at the mouth of Vefsnfjorden. There are some finished ones and some rough-outs. It is evident that the finishing of, among other things, soapstone pots, took place here. Close by, a couple of small quarries are found. Photo: B. Berglund

Work in progress and further plans

Collaboration between the Geological Survey of Norway and the NTNU University Museum has been started about provenance surveys of soapstone in churches and of selected objects of soapstone (Berglund, et al. i*n press*). The soapstone in artefacts and soapstone in churches are compared to soapstone from the quarries in the area using different methods. The project has also started providing descriptions of soapstone quarries and also investigations into the building history of the churches to accumulate knowledge about where the analysed soapstone comes from.

The further plans for the work can be summarised in the following points:

The work that has been started to identify the provenance of the soapstone in churches and selected objects from settlements and graves is, according to plans, going to be continued.

The operation of the largest soapstone quarries must at least for periods have been intensive. Consequently, there would have been a need for both overnight accommodation and areas for preparation of food. The plan is to find out what life in the community was like in one or several of these quarries, including how the quarrying itself took place and what was produced. To be able to do that, the quarry areas should first be mapped by means of modern methods.

It is conceivable that the operation of the largest quarries at least was organised and controlled by others than the people who worked there. The plan is to find out who organised and controlled the operation of the soapstone quarries and the position of the quarry operation in the social structure. It will thus be an investigation into how the mini-societies of the quarries are linked to the society at large.

The further plans also include investigations into whether the Helgeland soapstone was transported out of the area.

Soapstone quarries as mini-societies

Of the further plans, «soapstone quarries as mini-societies» will be elaborated on. The plan is to carry out field investigations in one or preferable several quarries in order to find out how they have functioned as mini-societies and whether there are any differences among them. The quarry or quarries must have properties that make them suitable to study as societies of that kind. A mapping using modern methods will be a useful tool to get a better overview.

The quarries need to be big, preferable quarries where both building stone and pots may have been extracted. A closer inspection of the surface fractures will reveal if that is the case. Middens should be left intact, as should places for further processing, if that part took place in the quarry. Areas in the immediate vicinity should be present, places that may have been overnight stops, maybe also food preparation areas and eating places. Maybe it will be possible to find house ruins or tent sites where the stone cutters may have stayed.

The process from the extraction of the soapstone until it was shipped from the quarries can be studied as well as how far the finishing of the building stones and objects went in the quarries. The various stages of the work process can be examined, and also, hopefully, the knowledge transfer and development of own traditions. In the quarries, however, only the part of the process that took place there can be examined. From investigations in some large settlements in areas like Tjøtta and Alstahaug, it seems that the finishing processes often were carried out some place else and not in the quarries. The work in the quarries will then have to be linked to the final stages of the production in settlements.

As the majority of the quarries are found on rather small islands, the distance over land between the quarry and a harbour from where the stone could be transported further would rarely have been long. Several of the quarries extend down to the seashore. Surveys of harbours combined with maritime archaeological surveys will accumulate knowledge about the transportation of soapstone and what was disposed of or lost at sea in the production process. Ideally, also harbours at places of destination should be examined. This applies in particular to harbours near stone churches where the building stone would have been transported to.

Selection of soapstone quarries

Both large and small soapstone quarries are found in the area. On Flatøya and Røøya at the mouth of Vefsnfjorden and at Sømna, several small quarries are found. All of these seem to have been quarries producing pots, but on Flatøya, at any rate, also other everyday items were produced.

One or more of the largest quarries will be selected to undergo further studies. One of the largest quarries lies on Esøya, a rather small island off Hamnøya in Vevelstad municipality. On both Haltøya and the island Tro, both lying at the mouth of the Vefsnfjorden, there are many and in part large soapstone quarries. In addition, there are relatively large quarries on Storesjeøya off the island Torget in Brønnøy municipality.

On the island Tro, there are many quarries, both large and small. There are several farms close to the quarries, and it is difficult to obtain an overview of the connection between the farms and the soapstone quarry operations. It will also be difficult to find out whether any previously unknown structures belong to the quarry operations or not. Many of the quarries have collapsed and a large refuse heap was used for road fill in the 1950s. On Tro, soapstone for building stone, pots and small everyday items have been extracted.

The soapstone quarries on the island Storesjeøya lie in a small belt on the rock face just above the seafront. It will probably be difficult to find other structures that may have belonged to the quarry operations, other than the quarry sites themselves. It is probable that structures may be found further inland on the island, but as the island is dominated by a rocky ridge, this is less likely. They will more likely be found on neighbouring islands. The quarries show that both building stone and stone for pots have been extracted here.

The two largest quarries are located on Haltøya and Esøya. They will be discussed in more detail below.

Haltøya

On Haltøya, conditions are good for finding structures that may have been linked to the soapstone manufacture at various times. Soapstone for pots and building stone has been extracted in several quarries on the rock faces of the eastern and western side of a plain in the southern part of the island. Most traces stem from the extraction of round pots, but there are also traces of extraction of rectangular pots. Traces have also been found of more recent extraction in at least

Fig. 7. *Hørtnaustan*, one of many soapstone quarries on Haltøya at the mouth of Vefsnfjorden. Photo: B. Berglund

one of the quarries near the plain, among other things, a lot of stone which has been blasted out from extraction of building stone in recent times. Close to the majority of the quarries, noticeable middens are found.

Furthest south, a 25 m long open pit on a slope of naked rock is seen with traces of extraction of round soapstone pots at the bottom and on the walls (Fig. 7). The quarry is called *Hørtnaustan*, i.e. the *hulder* boathouse. A *hulder* is a beautiful wood nymph with a long tail who tries to entice young men by playing and singing to them. In at least eight areas of the rock faces, there are traces of extraction of pots and building stone. One large quarry is called *Esjeberget*. *Esje* is an old word for soapstone. On the top of Esjeberget, soapstone has been extracted and a hollow space has been formed. This cavity has appealed to the imagination and been called *Hørtstua*, i.e. the Hulder Cottage.

Fig. 8. Building stone has been shipped from the soapstone quarries on Haltøya. An ashlar with marks has been left behind in the harbour. Geologist Tom Heldal is studying the stone while on an inspection tour to Haltøya. Photo: B. Berglund

Fig. 9. On the rock faces, traces of extraction of soapstone on Esøya outside Hamnøya in Vevelstad are found. On the surfaces, traces of workplaces, middens, and quarries are seen. A good, natural harbour where the boat crew could wait for better weather is also found here. Photo: B. Berglund

On the northwestern side of Haltøya, a harbour with a wharf made of large quarry stones and debris from the quarrying operations is found. The wharf was probably constructed in connection with more recent extraction of soapstone. A large ashlar is still lying on the beach (Fig. 8). It may seem as if ashlars were worked in the harbour area. Then the risk of any damage to the stone before loading it aboard the ship was then less. On the rock face above the beach at the harbour, there are traces of extraction of pots and other items. A farm has been in operation on the island, but it is now disused.

On Haltøya, different types of quarries that have been used for a long period of time can be examined. There is an abundance of middens on the island. They will, along with the traces from the extraction of the rock faces, be of great help to find out when the quarries were used and regarding what was produced there. Different types of quarrying technology could also be studied. There will also be a good chance of finding the living quarters of the people who worked in the mines, and a ruin, possibly a house ruin, has been observed. Investigations in the harbour areas will provide information about the transportation of soapstone and also whether the further finishing of soapstone took place there. One could also try to find out whether there is a connection between the operation of the soapstone quarries and the farm Haltøy.

Esøya

There is a large soapstone quarry on Esøya. The working faces are found on the rock faces to the west and east of a wide valley (Fig. 9). There are also working faces on knolls sticking up above the lower-lying area. Both building stone and stone for pots have been taken out. Ruined rough-outs are left behind where the workplaces once were. In the wide valley, there are several ponds that have been created because of the extraction of soapstone there.

Fig. 10. On Esøya, fracture surfaces are also found down by the seaside. The small island Vomma is seen in the background. Vomma is known from Snorre's Kings' Sagas as the place where Steigar-Tore, the mighty chieftain in the North Gudbrandsdal, was hung after disputes with Kong Magnus. In the distance, the mountain ranges Dønnamannen and The Seven Sisters are seen on each side of Vomma. Foto: B. Berglund

On a large sole in the northwestern part of the quarry, there are traces of extraction of pots, sinkers, oil lamps, and other small objects (Fig. 10). The production appears to have been on an industrial scale. A lot of the debris must have ended up in the sea. Above, the mountain is undermined through the mining operations and large blocks of stone have fallen down. The quarries and the wide valley are delimited by a pebbly beach to the north; to the northeast, there is a sandy beach. Also on Esjeholmen, which is as good as connected to Esøya, there are soapstone quarries; on the island Vomma, a bit further north, quarries are also found (Berglund et al. *in press*). The quarries on the rock faces and in the wide valley provide opportunities to study the technology from quarrying the blanks to the further preparations on the workplaces. Middens can provide a lot of information about when the extractions took place and what was produced at various times. Investigations under water could offer opportunities to study what fell into the sea. It could be debris, but also pieces of raw material that have been extracted and tool for the mining operations. There is also

Fig. 11. The longest, known runic inscription on one of the soapstone rock faces on Esøya. The runic inscription is seen beneath a bent quartz vein. The inscription has been interpreted by J.R. Hagland (1984) in two different ways: 1) *«Det er yr over, ein boge er hoggen. Ein boge i det bjuge esjeberget»*. 2) *«Ein boge er over, ein boge er hoggen. Ein boge i den bjuge esjesteinen»* (Hagland 1984, also cited in Wik 1985: 242) (For translation, see Tom Heldal's article in this book). The inscription shows that the rune carver knew of the existence of soapstone here. It may have been a stone cutter who carved the runes, but it could also be someone who sought shelter in the harbour here. Hagland believes that the runic inscription probably stems from the 11th century. Photo: B. Berglund

a chance that overnight places and other places of residence in the wide valley itself or rather on the slopes leading down to it, can be found. The short distance to the sea and the harbours there also offer an opportunity to study how the transportation took place.

There are runic inscriptions (Fig. 11) on the rock faces (Hagland, 1984, 2000), numerous signature marks, dates/years, and miscellaneous graffiti. The main reason behind this is that there was a landing place for boats/ships here. The crew of the ship has left their marks on the soft rock faces while waiting for better weather. This doesn't rule out that the stone cutters also incised marks on the rock faces.

Conclusion

An investigation of selected quarries will show how the operation of them took place, and whether there were large differences among them in different periods. This applies both to how the work was organised, which technical methods were applied in the production process, and what was produced. Even if the quarries may have functioned as small communities, they were hardly independent of the wider community surrounding them. Somebody must have needed what was produced. The soapstone objects also had to be transported from the quarries. Who the people were who first and foremost needed soapstone probably varied from time to time, although the majority of them, at least in the Viking Age and the Middle Ages, needed objects made from soapstone, e.g. household articles. Who organised and/or controlled the operation of the soapstone quarries may also have varied during different periods of time. It is also possible that organisation and control in small quarries differed from the organisation and control in large quarries. There are many possible actors here, e.g. the individual stone cutter, the individual farm, the local major farm as Tjøtta, the church as the ecclesiastical centre Alstahaug, and the king. Provenance investigations of soapstone objects from e.g. settlements, and in particular from places where the finishing of raw material from the quarries took place, can help to clarify these types of questions.

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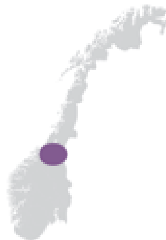
The medieval quarries at Sparbu: A Central Norwegian "little sister" of the Purbeck quarry landscape in England



Per Storemyr

Abstract
The medieval marble quarries at Sparbu in Central Norway are part of a wider quarry landscape comprising soapstone quarries and possibly quern quarries with traditions back to the Iron Age. Hence it is likely that the marble quarries were found upon procurement of soapstone for vessels and perhaps garnet micaschist for rotary querns. Together with the Allmenningen marble quarry the Sparbu quarries provided white marble for shafts, pillars, floor and tomb slabs to Nidaros Cathedral – the northernmost of Europe's great medieval cathedrals. The cathedral is heavily influenced by English medieval architecture and so is the use of marble. Marble for English cathedrals was provided by the famous Purbeck quarries with traditions back to the Roman Iron Age and even beyond, but also by Frosterly and other places. In this paper the Sparbu quarries are compared with the Purbeck quarry landscape and it is argued that they can be viewed as a miniature version of their bigger sister.

Introduction

Since 2011 I have been working on a book project on the procurement of stone to Nidaros Cathedral in Trondheim, the strongly English-inspired, northernmost of Europe's great cathedrals and the centre of the Norwegian Archbishopric in the Middle Ages. It is to become a popular science book, yet with the aim of placing stone production in a larger regional and international context, comparing it with, for example, the great stone production of Ancient Egypt, the Roman World and medieval Europe. In this way, I hope to be able to transmit key similarities and differences with stone working up north – at the "edge of the inhabitable world".

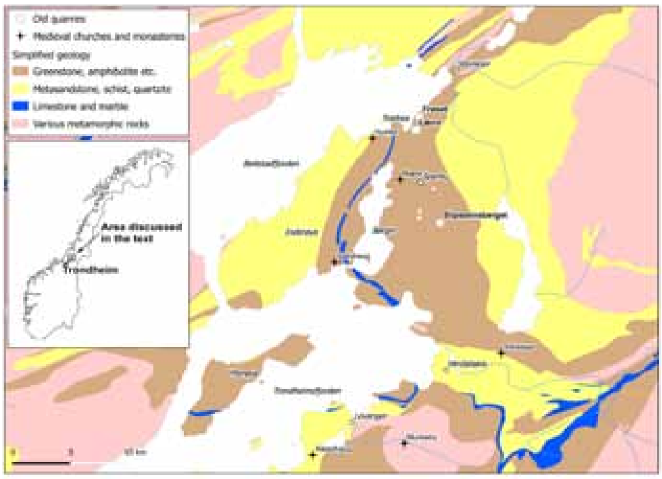


Fig. 1. Map of the innermost part of the Trondheim Fjord with places mentioned in the text as well as simplified geology (geology modified after Geological Survey of Norway, http://geo.ngu.no/kart/berggrunn)

In the course of the work I have re-investigated a number of quarries used for the cathedral, often together with Tom Heldal at the Geological Survey of Norway. At Sparbu, 90 km north east of Trondheim (Fig. 1), the large and well-known Slipsteinsberget soapstone quarry is situated (Østerås, 2002). Curiously, stone from this quarry never seems to have been applied for the cathedral, contrary to nearby marble quarries that provided fine, coarse-grained white marble for shafts, pillars, floor and tomb slabs from

Fig. 2. Remaining marble shafts at the east chapel of the octagon at Nidaros Cathedral immediately prior to restoration in 1871. Most shafts are from Lænn in Sparbu. Photo: The Restoration Workshop of Nidaros Cathedral (detail of larger photo)

the late 12th century on (Storemyr, 2003; Storemyr, Lundberg, Østerås, & Heldal, 2010) (Fig. 2). On searching for the marble quarries, we were so lucky to discover a wider quarry landscape with rich traditions – a sort of "miniature" version of grand, long-lasting quarry landscapes in Egypt, the Roman world and, especially, on the Purbeck Peninsula in Dorset, England. The famous Purbeck marble ought to be well-known for most people interested in archaeology and architectural history, and it is on a comparison between Purbeck and Sparbu that this paper will concentrate. It will be a story showing how local traditions blended with contemporary English architectural and stone procurement advances – advances with roots in the Roman marble trade and even Bronze Age stone production.

Building with stone in the Central Norwegian Middle Ages

Since Norway was well beyond the northern *limes* of the Roman Empire there were no "European" stone building traditions in the country in the 11th century, at the transition from the Viking Age to the Middle Ages. Stone building was introduced with Christianity, first in Trondheim around AD 1040, where the precursor of Nidaros Cathedral, King Olav Kyrre's Christ Church was begun ca. AD 1070 (e.g. Fischer, 1965; Ekroll, 1997). But the lack of stone *building* traditions does not imply

Fig.. 3. View from the quarries at Lænn in Sparbu - towards the Trondheim Fjord and with Frøsetvågen and the Toldnes peninsula half-hidden by the trees on the left. Photo: P. Storemyr

that Norway was without stone *procurement* traditions as the first English master builders and craftsmen arrived to aid the king and the local elite – and local craftsmen – in raising the first churches. Soapstone vessel manufacture had been going on since the Late Bronze Age, and though it seems to have largely ceased by the Roman Period, it rose to an export-oriented "industry" in the Viking Age, especially along the South Coast (e.g. Pilø, 1990). Similarly, large-scale rotary quern production, in particular from the garnet mica schist by Hyllestad at the West Coast, started by the Migration Period and had its export heydays in the Viking Age and Middle Ages (e.g. Baug, 2002). These and other traditions were certainly important as a general "backdrop" for selection, extraction, transportation, carving and dressing of stone for the medieval buildings, in the Trondheim region blending with imported English traditions.

The English building traditions were based on excellent limestone and, to a lesser extent, sandstone; a stone that is scarce in the metamorphic geology of Central Norway. Thus, as I have noted in previous papers, fine stone for ashlar, sculpture and decoration at Nidaros Cathedral, its precursor and most of the ca. 40 medieval stone buildings erected along the Trondheim Fjord, the regional "highway" in the old days, was provided from easily accessible local and regional soapstone and greenschist deposits, the latter of which was closely related to soapstone deposits, but where stone extraction displays an intimate connection with English and European methods (Storemyr, 2003; Storemyr et al., 2010).

At the transition between Romanesque and Gothic architecture, around AD 1150–1180, in England as well as at Nidaros Cathedral, a very special development took place, which has not been paid much attention to in Norway: The introduction of marble shafts along windows, portals and generally to accentuate the Early English Gothic style. Simultaneously, in England, marble put

Fig. 4. Part of the soapstone quarry at Lænn in Sparbu with characteristic cut marks from extraction of vessels. Photo: P. Storemyr

to use for baptismal fonts, floor and tomb slabs. It was a development based on what had happened at Tournai in Flanders (now in Belgium) a few years earlier, but that became a "very British" tradition essentially founded on Purbeck marble (e.g. Blair, 1991). By AD 1170–80 the building of the octagon at Nidaros was underway, aimed at completing the (by then) Romanesque Cathedral, but also at creating a timely grave chapel for St. Olav, the key Norwegian saint. The architecture of the octagon is based on far-flung ideals at e.g. the Church of the Holy Sepulchre in Jerusalem and the Rotunda of Charlemagne at Aachen, but it is generally executed in the Early English Gothic style. And for this style marble shafts were needed. They were not provided from Purbeck, but from Sparbu, and slightly later from Allmenningen, a little island off the coast, 140 km north of Trondheim. So let's first take a look at the Sparbu quarry landscape in order to try and understand why it became such a marble provider, before journeying to Purbeck – and Allmenningen.

The Sparbu quarry landscape

Sparbu is situated close to inlets in an extremely rich farming landscape at the innermost part of the Trondheim Fjord (Fig. 1). It features numerous archaeological finds from the Stone Age onward and was a key regional centre in the Bronze and Iron Ages. Here is Slipsteinsberget – one of the largest soapstone vessel quarries in Norway and the only quarry close to the Trondheim Fjord that with some degree of certainty can be said to have been in use for vessel production by the Viking Age and perhaps earlier. But the latter assumption relies on finds in nearby burial mounds (ca. AD 700) and Bodil Østerås (2002), who has undertaken a comprehensive archaeological investigation of the quarry, dates the main production phase to the Middle Ages, from about AD 1000 onward. This may be in line with what Lars Pilø (1990) has suggested for Norway as a whole; that soapstone vessel production ceased between the Roman Iron Age and the Viking Age, after starting in the Late Bronze Age. Anyway, tens of thousands of vessels were made in the quarry and so the production most likely was aimed for trading on a regional or larger scale. As we have noted in previous publications (Østerås, 2002; Storemyr, 2003), the soapstone was, to a limited extent, used as freestone for quoins and decoration in the nearby Stiklestad, Mære, Hustad and Sakshaug churches and it can also be found at the Munkeby Cistercian Abbey near Levanger (all 12th century), and later at Værnes Church around AD 1400. Moreover, several medieval baptismal fonts were crafted from the stone. In an overall Norwegian perspective it may, at first sight, seem like a typical, single vessel quarry that was additionally used for local and regional church building in the Middle Ages – with an intimate connection between the two modes of production.

But there is much more to it, indeed. In 2010 Tom Heldal and I discovered another old soapstone quarry at the farm Lænn,

Fig. 5. Part of the old marble quarry at Lænn in Sparbu with its characteristic "plate" structure. Note the simple wedge marks used to break loose material for tombslabs or floor tiles along the cleavage. Photo: P. Storemyr

by the archaeologically very rich inlet named Frøsetvågen, only eight km north of Slipsteinsberget (Fig. 3 & Fig. 4). It is smaller than Slipsteinsberget, yet substantial and with the same characteristics as its bigger counterpart. On discovering the quarry, we were not looking for soapstone, but for the medieval marble quarries that were known to exist in this area, just the ones that geologists Johan Vogt (1897) and Amund Helland (1893) maintained were used at Nidaros Cathedral from the latter half of the 12th century. And we found these quarries as well – first the spots that were used during the restoration of Nidaros Cathedral in the late 19th century; then the old quarries, which showed up as very substantial remains hidden under thick moss (Fig. 5). They are basically co-located with the soapstone quarry, characterised by superficial extraction spots and stretch for a few hundred metres in the forested area. Satisfied with the discoveries, we went to look for marble quarries at the neighbouring farm Frøset. We easily found them, or rather the remains of the 19th century exploitation, half-hidden and nearly destroyed by agriculture and modern roads. But simultaneously we accidentally discovered co-located, weathered remains of rough-outs for rotary querns made from garnet mica schist (Fig. 6). It was, in other words, one of these rare days in archaeological exploration!

The area is still awaiting thorough survey and excavation, but some inferences can already be made. At Sparbu Mother Earth has been particularly generous and laid down three geological formations useful for Man, right next to each other: Garnet mica schist for querns, soapstone for vessels and building stone - and white marble for building stone. We don't know the exact succession in exploitation of these resources, neither to what extent querns were produced. However, it is likely that vessel quarrying, including also Slipsteinsberget, started at some stage in the

Fig. 6. Tom Heldal with a weathered rough-out for a rotary quern in garnet mica schist found near the marble quarries at Frøset in Sparbu. Photo: P. Storemyr

Iron Age and grew to a substantial industry by the Early Middle Ages. Then, by ca. AD 1100, limited freestone production from soapstone began and, at last, substantial marble exploitation. Since no garnet mica schist quarries have yet been located, quern procurement is the most difficult to discern and date. It may certainly be a rather late procurement phenomenon, but it is worth pointing out that Ingrid Ystgaard (1998) mentions two rotary querns of unknown provenance that have been found in nearby Iron Age hillforts. Until more is known about these querns, we may hypothesise an origin at Frøset.

According to available evidence at Nidaros Cathedral, provided by recent observation, and from the notes of geologist Johan Vogt (1897), the diaries of master builder William Bergstrøm and reports by restoration architect Christian Christie (the latter in the archives of the Restoration Workshop of Nidaros Cathedral, NDR), Sparbu marble first turn up as columns and, possibly, floor tiles in the AD 1170s or 1180s (at the chapter house and octagon). Until the Black Death (AD 1349–50), when construction temporarily ceased, it was mainly used for numerous elite tombslabs (e.g. Ekroll, 2001) and probably floor tiles, and, most importantly, for the main pillars of the Gothic nave. As far as we know the marble was only used at Nidaros Cathedral, which may imply that some form of restriction was at work. Consequently, the marble would have been regarded an extremely valuable resource – a stone that was not readily available at other places in Central Norway.

And marble may have been regarded a valuable building material at Sparbu also much earlier: At the tiny Toldnes peninsula and environs, at the western side of Frøsetvågen, only 1–2 km from Lænn is found one of the largest concentrations of Bronze Age burial mounds in Norway, a testimony of the significance of the area as a political and ritual centre. The mounds were originally excavated by Karl Rygh (1906) more than 100 years ago, but more recently interpreted contextually by Geir Grønnesby (2012) and others. Many mounds are equipped with burial chambers (cists) made from often very large (two m and beyond in length) slabs of local schist – and marble; stone that must have been actively quarried, and not just "collected". The marble may not have been extracted at Lænn and Frøset, though, since there is a geologically slightly younger marble vein at Toldnes itself – a vein that can be followed for a few dozens of km southward across Inderøya and beyond, toward Verdal and Levanger. There is, of course, no direct relationship between quarrying in the Bronze Age and the Middle Ages, especially since the use of big stone slabs in burial contexts is not known from the Iron Age. But the Bronze Age occurrences provide a perspective to later quarrying – in terms of the profound knowledge of the rich local geologic resources that they indicate.

After the Bronze Age, Grønnesby (2012) and others have that the area around Frøsetvågen and beyond continued as a significant Iron Age centre, in particular demonstrated by a number of very large boathouses, one of which is situated at Lænn, dated to the time between ca. AD 200 and 700. They are more evidence of a hierarchical society governed by chieftains and demonstrate the profound importance of the sea for transportation - also to foreign coasts. Now, Lars Stenvik (2005) has speculated whether they are traces of a military apparatus in a period traditionally interpreted as "violent" – or if they may rather be understood in connection with trade, especially of iron, of which the production reached massive proportions in this period in Central Norway. If Stenvik is correct, it would not be too speculative to infer that a couple of querns made in the quarries at Frøset may have been loaded onto the ships, as well.

Except for the stone procurement, there is little evidence of the significance of the area around Frøsetvågen in the Middle Ages. However, according to the cadastre of Archbishop Aslak Bolt (ca. AD 1380–1450) (see Jørgensen, 1997), Frøset and Lænn were relatively wealthy farms and belonged to the Norwegian Archbishopric by the Late Middle Ages, around AD 1430. It is likely that this also reflects their status in the 13th century and one may wonder if stone procurement was part of the reason both as regards the relative wealth and the ownership. Quarrying of marble would have largely ceased after the Black Death, but soapstone production at Lænn may have been going on until the 16th century, if relying on what Bodil Østerås (2002) infers from her investigations at Slipsteinsberget. Later the records go cold and neither Slipsteinsberget, nor Frøset and Lænn are mentioned in the 18th century writings of Gerhard Schøning (1762; 1778). Schøning is the most important source on medieval quarries used at Nidaros Cathedral and the reason why he does not describe the Sparbu quarries may simply be that they were "forgotten" by the time. Though they cannot have been entirely forgotten, as the marble deposits were some of the first to be taken in use for the restoration of Nidaros Cathedral, which began in 1869. William Bergstrøm notes (diary in the archives of NDR) that the first marble from Frøset and Lænn was loaded on a ship destined for the cathedral in 1872, but – alas – the ship went down and the load could not be recovered. But later close to 1000 tonnes of marble were procured by the restoration craftsmen and shipped by *jekt* from special marble landing places (*marmorstøa*) in Frøsetvågen.

The old soapstone quarry at Lænn was also exploited with the aim of using the stone for restoring the cathedral. However, according to a letter from quarryman Lars Reitan to restoration architect Chr. Christie (1903, archives of NDR) the attempt failed since the stone was considered too hard. We can still observe a heap of soapstone from this time, extracted from an inferior part of the deposit, and a short road that was made to get it out. Very likely, the soapstone deposit was discovered while looking for the marble. It may have been precisely the other way round in the Middle Ages; that the marble was found on exploiting the soapstone.

The marble vein at Toldnes, mentioned above, just opposite Frøset and Lænn in Frøsetvågen, is the same that was put in use for several medieval buildings in the region. At Inderøya, Ytterøya and in Levanger this vein provides quite a few, good marble

Fig. 7. Purbeck marble shafts at the Angel Choir in Lincoln Cathedral. Photo: P. Storemyr

deposits (though usually not as white as at Lænn and Frøset), several of which provided limited amounts of fine stone, but apparently only for local churches (e.g. Alstadhaug and Sakshaug). However, these marble deposits were probably mainly used as sources of lime for mortar production – at Toldnes itself one of the earliest, preserved lime kilns in Norway is located (see www.kulturminnesok.no), with a history probably going back to the Middle Ages. In the early modern period Inderøya, Ytterøya and Levanger were "hubs" for lime production, and operation is still ongoing, but now along a thicker part of the marble vein in Verdal.

Summing up, based on a rich geology Sparbu and environs may be interpreted as a stone working centre growing up along pre-medieval quarrying traditions related to soapstone vessels and, very likely, rotary querns, as well as medieval church building and lime production. As Øystein Ekroll (2008) has indicated on the basis of church archaeology and architecture, it seems to have been relatively independent from the other centre that we may define along the Trondheim Fjord, with its heart at Trondheim and Nidaros Cathedral. Except for "export" of the Sparbu marble to Nidaros Cathedral, stone from Sparbu, including soapstone, rarely turn up outside its "borders" and there is also little or no "import" of soapstone and greenschist from the quarry hubs near Trondheim, such as Øysanden and Trondheim itself (Storemyr, 2003). Perhaps lime for mortar was "exported" to Trondheim, but it may also have been provided from Levanger and several other sources closer to the town.

The Purbeck quarry landscape

The use of Sparbu marble at Nidaros Cathedral, especially for shafts, is directly influenced by English Gothic architecture with its widespread use of Purbeck marble for the same purpose. Though Sparbu marble was only used at Nidaros Cathedral, there are further similarities between the two quarrying sites that may aid in understanding how a quarry hub develops over time. Quarrying at Purbeck started in the Bronze Age, not with marble extraction (though a single Bronze Age cist made from marble has been found), but with another stone: Kimmeridge oil shale, a shale that literally burns. According to Allen and co-workers (2007), it was procured for bracelets and other small items, and by the Roman period came into use for tiles and many other purposes, now together with the marble that is located a couple of km from the outcrops of shale. Purbeck marble is not a true marble in the geological sense, but a fossil-rich, hard limestone that turns black when treated with pig's fat. This was exactly

Fig. 8. Part of the Allmenningen marble quarries, off the coast 140 km north of Trondheim, with traces of medieval and late 19th/early 20th century quarrying. At the marble "bench" at the top there are several medieval wedge holes. Photo: P. Storemyr

what the medieval builders did, when the Roman quarries were reopened in the 12th century. As John Blair (1991) notes, reopening was influenced by developments further afield, in Tournai in Flanders, where the black Tournai marble, also used in the Roman Period, had been worked for shafts, fonts and tombslabs to churches and cathedrals.

With a slow development in the beginning, a similar use as in Tournai literally exploded by the late 12th century. Purbeck marble soon became so popular that it was exported to every corner of England - English cathedrals would definitely not have been the same without their Purbeck marble (Fig. 7). Simultaneously, also based on Roman traditions, Purbeck could supply fine limestone, clay for the medieval ceramic industry as well as salt. Thus, the peninsula became a veritable material procurement hub, a position it retained for centuries to come. According to Blair (1991), procurement of the marble was dominated by the wealthy at Corfe and so a private enterprise, at least by the 13th century. At Corfe, the workshops were producing shafts and other items, which were shipped from nearby Swanage to ports all over England. But the whole industry was strictly for the elite and when royal demand was high, workshops were also opened in London. It is the most fashionable stone ever used in England. Perhaps it reflected the "Great Roman Past", had meanings in a religious context, but first of all it became a trendy stone, something to show-off, a display of power, in a period where patrons, cities and towns competed in building the "largest, highest and best".

Importantly, Blair (1991) shows that there was little against Purbeck being replaced by

Fig. 9. Allmenningen marble shafts at the west front of Nidaros Cathedral, mid-late 12th century. The shafts are from the restoration, but would have given a similar impression in the Middle Ages. Photo: P. Storemyr

similar stone, substitutes or "fakes", such as Frosterly marble from the environs of Durham. What columns and pillars from Purbeck and Frosterly had in common was the striking contrast achieved when they were set against white or light yellowish limestone ashlar masonry, which is the most frequent colour in English cathedrals. However, using a black marble would not have created the same contrast at Nidaros Cathedral, for its masonry is generally darkish. Hence, white marble shafts and columns in Trondheim can be regarded as Purbeck substitutes. Except for cathedrals across England and in Trondheim, very few, if any, other medieval European buildings show the same architectural use of marble. But Nidaros Cathedral is the only building that displays such use of marble on outdoor facades: Purbeck does not like rain, so it could only be used indoors.

The extraction of Sparbu marble in the Middle Ages is thus, via Nidaros Cathedral, influenced by developments at Purbeck, at Tournai – and in the end by the Roman marble trade a millennium earlier. That close contacts existed between the Trondheim region and medieval England and other parts of Europe is, of course, very well known, but with this specific use of materials contacts become tangible. And the perhaps most tangible evidence at the stone front is a tombslab from ca. AD 1160 at Nidaros Cathedral that was perhaps intended for the first Norwegian Archbishop, Jon Birgersson. Together with James F. King and Patrick Degryse I have previously shown that it is a Tournai marble, quarried and carved at Tournai and shipped to Trondheim–the first known medieval import of stone to Norway (Storemyr, Degryse, & King, 2007).

Though small-scale, the rich stone history at Sparbu is not only paralleled at Purbeck, but by a range of other quarry hubs that grew from production of small items to building stone over the millennia. There are many examples in the Mediterranean and further north in Europe; just think of Carrara in Tuscany, with its history from the Etruscan period onward! But the best examples come from Egypt, for instance at Wadi Hammamat, where Pharaonic and Roman sculpture production has its origin in Neolithic bracelet, vessel and palette manufacture, or at Aswan, where Palaeolithic and Neolithic grinding stone production formed the direct backdrop for quarrying to Pharaonic and Roman sculpture and building stone (as interpreted from Aston and et al., 2000; Harrell and Storemyr, 2009; and Bloxam and co-workers, 2007). Useful geological deposits always form the backdrop – at Hammamat schist and greywacke; at Aswan silicified sandstone and granite -, but once established, a quarry hub is not only a place for material procurement – it is a place that becomes embedded in the socio-political development of societies and cultures.

The Allmenningen marble quarry

But, alas, there must have been problems with delivery of enough shafts from Sparbu to Nidaros Cathedral. For the observable evidence at the cathedral shows that already in the AD 1180s the builders turned to the very coarse-grained dolomitic marble at Allmenningen (Fig. 8 & Fig. 9), a small island off the coast at Fosen 140 km north of Trondheim, for more supplies. In an exemplary way, this illustrates a different – or complementary – development in procurement of stone in the Central Norwegian Middle Ages: The opening of quarries with no previous history and thus the inevitable elements of exploration and experimentation that would surely also have followed stone extraction in areas with known, "old" quarries.

On the other hand, the white marble at Allmenningen would have been very well known in the Middle Ages. For the island is fairly easily accessible and located just by the main shipping route along the coast. Also, there was habitation on the island in the Iron Age and into the Middle Ages, connected to the rich fisheries in the area, which may be the ultimate reason why the island was regarded common land (*allmenning* means common land), later to become owned by the Archbishopric. Kalle Sognnes (2005) has even found substantial remains of Neolithic habitation. Hence, the marble deposit must have been a familiar sight over the centuries and millennia, located in a hillside in open terrain and with a very characteristic cleavage pattern: Parts of the deposit in fact looks like a natural stack of columns! The craftsmen had quite an easy job wedging out thousands of up to 4–5 m long columns and – typically – the marble at Allmenningen feature the first known traces in Norway of the Roman splitting technique (including carefully carved-out wedge holes), which was in very common use in England in the Middle Ages, also at Purbeck. It may have been cumbersome, though, to get the column rough-outs the short distance down to the shore, but we have found remains of ramp-like features, indicating the use of sledges (see further description in Helland, 1893; Vogt, 1897; Storemyr, 2003; Storemyr et al., 2010).

There can be little doubt that the Allmenningen marble was "discovered" as a potential column source by word of mouth – at a time when the most well-known patron of Nidaros Cathedral, Archbishop Eystein Erlendson, was hugely aware of the developments involving the use of Purbeck marble in Early Gothic English cathedrals. Trondheim was not to lag behind their sisters in England and by the late 12th century enough knowledge and resources were available in Trondheim and Norway to venture on such big projects in, from a quarrying perspective, *terra incognita*.

For, as I we have previously remarked (Storemyr et al., 2010), the Bakkaune soapstone quarry in Trondheim itself was also made ready for bigger output at roughly the same time; this was likely just the period when we think planning of large-scale *underground* extraction took form in this quarry. Thus, in many ways, these two quarries – Bakkaune and Allmenningen – mark the final stage in the development of quarrying in the Central Norwegian Middle Ages, and in the whole of Norway, for that sake. It happened a little more than 100 years after building stone quarrying commenced, and, typically, contemporary with the introduction of the intricate Gothic style that demanded extraordinarily good stone – in the context of raising the only real European cathedral up north.

Concluding remarks

There are, indeed, huge differences between a major ancient quarry landscape like Purbeck and the quarries at Sparbu, in particular related to the fact that Purbeck marble – and its substitutes from Frosterly and elsewhere – became immensely popular stones that travelled all over Britain. As a Central Norwegian substitute, Sparbu marble had a very restricted use – at Nidaros Cathedral and nowhere else. But this is a quantitative difference, basically related to the amount of stone construction projects on the British Isles that was certainly poles apart from what went on up north, at the "edge of the inhabitable world". For in essence the two quarry landscapes have much in common: They are both located at places with a geology rich in stone useful for Man. Their archaeology is similar, from beyond the Bronze Age they were both "central places" until the Middle Ages and later. And quarrying can be followed all the way back to the Bronze Age at both places. Stone extraction was not continuous, neither at Purbeck nor in Sparbu. Still, we may state that at Purbeck there are Bronze Age precursors to the medieval industries, while at Sparbu it seems that the tradition on which the medieval (and later) extraction was based started at some time in the Iron Age.

Both places also show how local and regional traditions blended with key international trends. From an origin in Kimmeridge oil shale procurement, Purbeck became part of the Roman marble trade and later developed its fashionable, medieval marble industry, basically a result of the advance at Tournai in Flanders, which was also based on a stone of the Romans. Sparbu had its soapstone vessel traditions, perhaps also useful quern stone, as a backdrop when the late 12th century Archbishop Eystein Erlendson initiated the English-based architectural progress in demand of a marble that was found just beside existing quarries of local and regional significance. In this way there is a thread between Sparbu (and Allmenningen), and Purbeck – and the Roman marble trade.

So much for the international and regional context of these, until very recently, largely forgotten quarries at Sparbu. But the local context and true significance of the quarries can only be determined by thorough survey, excavation and provenance studies. There is a great deal of evidence of what actually took place in the quarries hidden in the forest, under a thick layer of moss.

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From collection to quarry – Lyse Abbey's role as soapstone supplier in the Middle Ages

Alf Tore Hommedal

Abstract

Geochemical analyses of four medieval building stones in the collections of the University Museum of Bergen have demonstrated a geological provenance to the soapstone quarry located close to the Cistercian Abbey of Lyse south of Bergen. The four building fragments derive from three different monumental stone buildings in medieval Bergen: The Benedictine Munkeliv Abbey Church, the Royal Residence's Great Hall and the Royal Chapel. The archaeological and historical contexts of the stones date the soapstone deliveries from Lyse to the second half of the 13th century. This article discusses the organization 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 building material to Bergen – at least documented in a period from the mid-13th century onwards.

With the establishment of the Church in Norway in the 11th and 12th centuries the Norwegians were also introduced to the European building tradition in stone with its masonry skills. The monasteries took an active part in this respect, and seem also in Norway to have followed the European norm of building their houses in stone (Hommedal, 1999, pp. 178–180). It is therefore not surprising to find a soapstone quarry for building stones connected to the Cistercian Abbey of Lyse, ca. 27 km south of Bergen. It is more surprising, however, that the location of the quarry is rather close to the monastic building complex.

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 Norwegian directly influenced by English masonry skills (Nybø, 1987, p. 185). It has even been suggested – but not proved – that the Anglo-Norman style found in Bergen from the 1160's onwards has a direct connection to the Cistercians at Lyse, who

Fig. 1. Parts of the present ruin complex at Lyse Abbey, 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

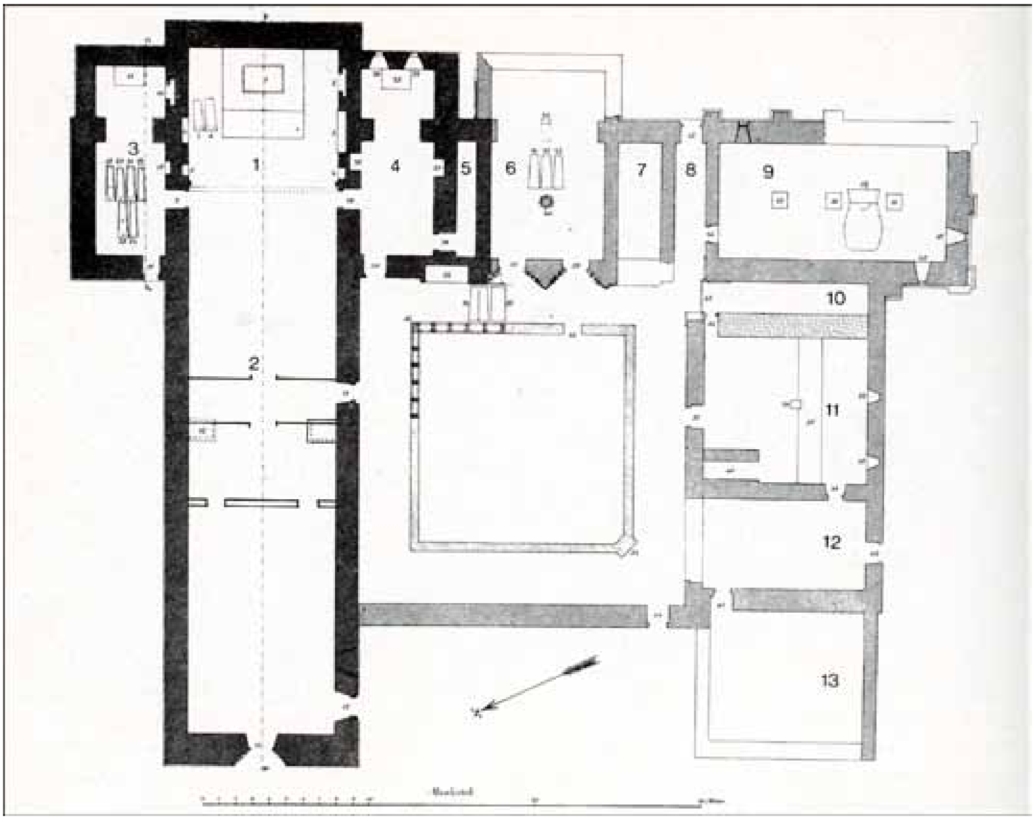

Fig. 2. The layout or ground plan of the central buildings at Lyse Abbey, with the church in the north wing to the left. As was customary for a monastery, and especially a Cistercian monastery, the cloister and the claustral buildings were situated to the south of the church. The cloister garth or garden, open to the sky, was traditionally surrounded by four cloister walks or galleries, passages giving covered access to the surrounding buildings. The east and south wing had claustral buildings in stone. If there, as would be normal, was a west wing at Lyse, this seems to have been in wood. This west wing, together with the western part of the church, was the area for the lay-brothers in the monastery (See fig. 3). Drawing by Johan Meyer, 1890. After Nybø,1987

started the erection of their own monastic complex in the decades after their arrival in 1146 (Lidén, & Magerøy, 1990, pp. 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 early 14th century. The discussion is based on the geologist Øystein Jansen's geochemical analysis of four building stones in the collections of the University Museum of Bergen, all of them with a geological provenance to the soapstone quarry at Lyse (Jansen, Heldal, Pedersen, Ronen, & Kaland, 2009, pp. 591–592). The four moulded fragments have an archaeological provenience to three different monumental stone buildings in medieval Bergen: Munkeliv Abbey Church, the Royal Residence's Great Hall and the same Residence's Royal Chapel. The ideas I am presenting are based on an interdisciplinary cooperation project within the University Museum of Bergen between Øystein Jansen and me as the archaeologist, and also involving Ole Egil Eide, an external architecture historian. We are also working on a possible architectural connection between

Lyse and Bergen in the 12th century based on analyses of the 12th century St. Mary's church in Bergen.

With the starting point in the geochemical analysis of stones from the museum collections, proving contacts between Lyse and Bergen in the 13th century, I am going to look more into the archaeological context of these building fragments. In other words: in the following I will try to put the results of the geochemical analysis into a cultural 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 said about the buildings and the institutions where the Lyse stones were used? I must stress that I will not present any finished research results, but rather give some ideas for further research.

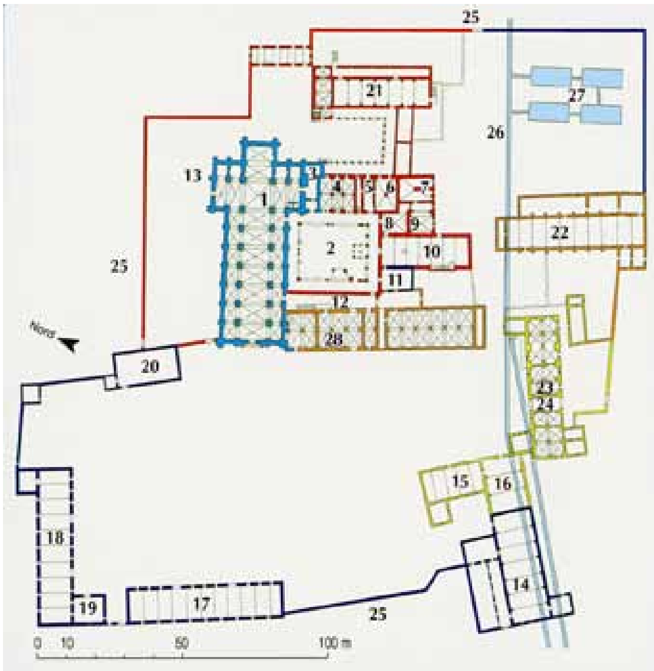

Fig. 3. The ground plan of the building complex still preserved at the Cistercian Abbey of Fossanova, Italy. In the central quadrangular with the church (1), one can see how the west wing for the lay brothers (28) was separated from the choir monk's or priest monk's lodgings (2-11) by an extra corridor or "lane" (12). This illustrates the separation between the lay brothers (*conversi*) and the priest monks in a Cistercian monastery. Outside the central quadrangular there are for instance guests' lodgings (15-16), a mill and other workshops using water (14) and a barn and other agricultural buildings (17-18, 20). Such buildings would also have been standing at Lyse. After Gasbarri et al. ,2009

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, pp. 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 (Fig. 1 & Fig. 2). 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, p. 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, pp. 30–33; Nybø, 1987, pp. 184, 186).

The soapstone quarry is located a few hundred meters into the valley to the east of the conventual quadrangle (Fig. 4 & Fig. 5). The visible quarry walls make a deep scar in the hillside and they are 6–18 meter high, enclosing an area of a possible quarry floor of 2–3000 square meters. A sizable heap of waste is found directly in front of the quarry (Jansen et al., 2009: 591). The traces of mining of building stones are distinct (Fig. 5), but two soapstone vessels have been found in the spoil heaps, also demonstrating other exploitation of the quarry (BRM 151 and BRM 182 in the museum's collections). There have not been any proper archaeological excavations in the quarry.

Fig. 4. The soapstone quarry at Lyse. The geologist Øystein Jansen shows were it has been mined for building stones (See Fig. 5)
Photo: A.T. Hommedal

The Cistercian order was one of the strictest religious orders to establish itself in medieval Norway. The monks lived a strictly 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.

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, p. 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, pp. 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 24 hours, 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*

Fig. 5. The soapstone quarry at Lyse. One can see traces of exploiting the quarry for ashlars.
Photo: A.T. Hommedal

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 the western part of the church (Fig. 3), and they were for instance not normally admitted to the cloister (Braunfels, 1972, pp. 75, 77–79; Greene, 1992, p. 234; Leroux-Dhuys, 1998, pp. 73–74; Kinder, 2002, pp. 55–58, 305–331; France, 2012).

With the Cistercian's 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 (Fig. 3). 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 (Greene, 1992, pp. 68–69), but as the historian James France has documented, both priest monks and lay brothers attended to building processes (Fig. 6), and a number of Cistercian General Chapter statutes in the 12th century refers to priest monks and lay brothers engaged in building work (France, 2012, pp. 48–56). There are also indications suggesting that the Cistercians in Norway could work as masons and house builders in the Late Middle Ages: When Munkeliv Abbey in Bergen was totally damaged by fire, the Bridgettine nuns and monks there were relocated to the Hovedøya Abbey outside Oslo from ca. 1460 to ca. 1478, while the Cistercians at Hovedøya came to Bergen, probably to rebuild Munkeliv (Lange, 1856, pp. 301–304, 415). 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.

Fig. 6. Lay brothers building the Cistercian abbey of Schönau in Germany, showing the process from quarry to masonry. Schönau was founded in 1142, four years before Lyse. After a pen-and-ink drawing from the 16th century, Germanisches Nationalmuseum, Nürnberg. After Du Colombier, 1973:48 and France, 2012: 55

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, p. 591). However, it is more likely that the quarry existed as a vessel quarry even before the monastery was established. In fact, the existence of a

Fig. 7. The restored version of Håkonshallen – King Håkons's Hall – the great hall in the Royal Residence of Medieval Bergen and built between 1247 and 1261. The building was restored in 1880-95 and again in 1957-61. Photo: University Museum of Bergen

soapstone quarry may have been one of the reasons for placing the Cistercian monastery just at this site.

Let us then return to the four Bergen stones from Lyse in the University Museum of Bergen's collection, and let us look into the architectural context of the building fragments with some of its information about the contact between Bergen and Lyse.

Håkonshallen – King Håkon's hall – and its high seat

The museum collection contains seven original stone fragments from the high seat in Håkonshallen, the still standing great stone hall from the royal residence in medieval Bergen (Fig. 7). These original high seat fragments were removed from the building during the first restoration of the hall in 1880–95. The stones are verified in the original masonry due to documentary drawings (Fig. 8) and analytical building descriptions from before the restoration (Nicolaysen, 1861; Hommedal, 2013, pp. 19, 34–35). Geochemical analyses of samples from the two stones BRM 62/2 and BRM 62/32 (Fig. 9) match the rock in the soapstone quarry at Lyse (Jansen et al., 2009).

From its architecturally and archaeologically distinctive features, Håkonshallen 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.

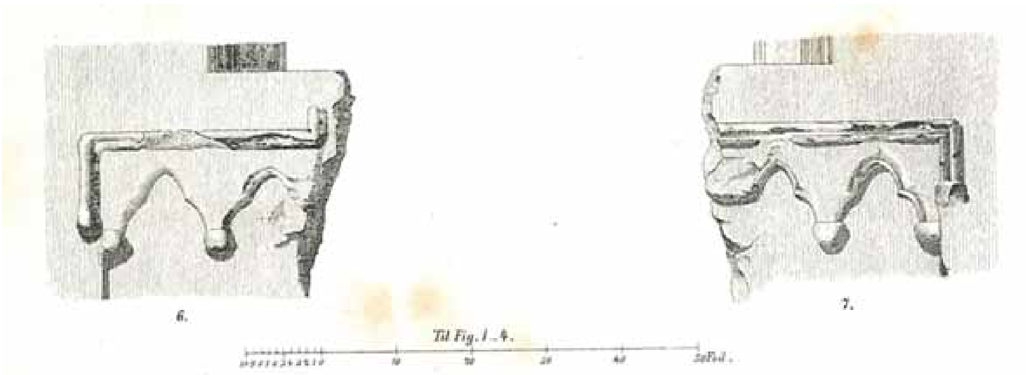

Fig. 8. Håkonshallen, the high seat with its arched moulding. The drawing shows the original, unrestored parts as drawn by the young aspiring architect Georg Andreas Bull in the 1850s. The middle part was ruined by some post medieval windows. The photo shows the restored version of the arched moulding. Two of the moulded stones from the original high seat have a geological provenience to the soapstone quarry at Lyse. Drawing after Nicolaysen 1861. The photo: O.E. Eide

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.

Fig. 9. BRM 62/2 in the collection of the University Museum of Bergen. Originating from the quarry at Lyse and used in the masonry in Håkonshallen. Photo: A.T. Hommedal

The Royal Chapel: the Church of the Apostles

The University Museum of Bergen's collection of building stones contains a lot of fragments from demolished medieval buildings at Bergenhus. The fragments have been catalogued and discussed by, for instance, the two architectural historians Ole Egil Eide and Hans-Emil Lidén. A limited number of the stones, judging from the rather complicated mouldings and delicately shaped capitals, seem to belong to one and the same structure, probably a church dating from the second half of the 13th century. The work of Eide and Lidén has shown that it is probable that these stones are fragments from the third Church of the Apostles, the royal chapel in the king's residence, built between 1275 and 1302 (Lidén, 1980, pp. 163–179, 196–199; Helle, 2013, pp. 114–115).

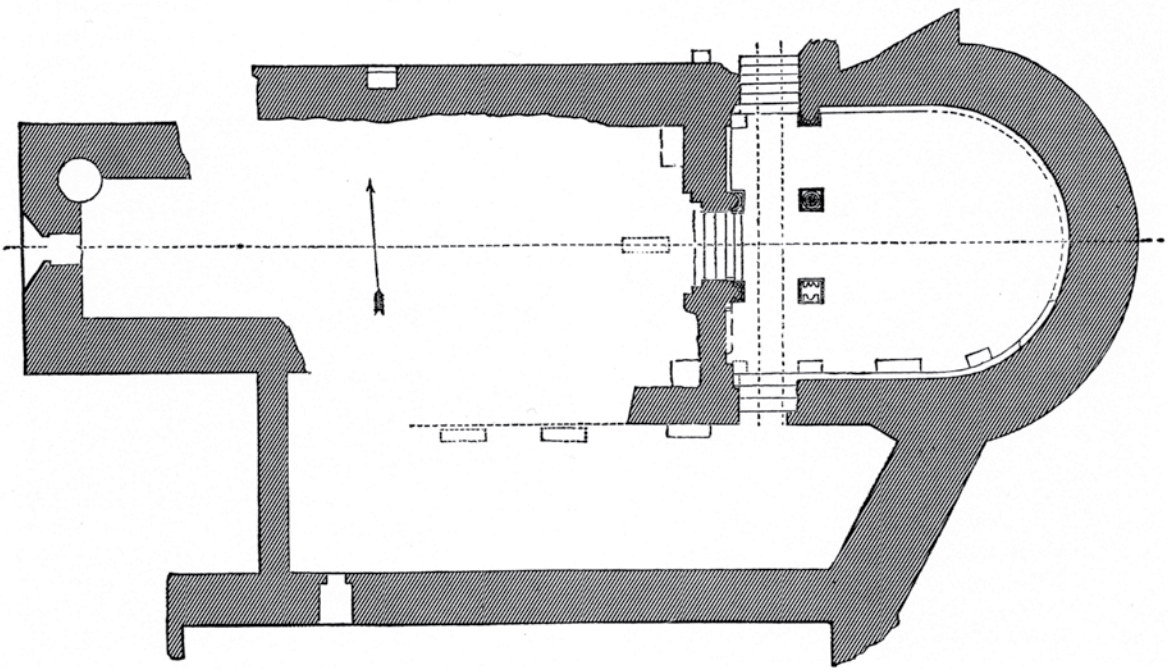

Fig. 10. The ground plan of the Benedictine St. Michael's Church at Munkeliv was archaeologically documented by the antiquarian Nicolay Nicolaysen in 1860. The church seems to have been built in the first part of the 12th century as a long church with an apsidial chancel. In the 13th century the church was extended with a west tower, and two of the moulded stones from the new west portal have 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. After Lidén & Magerøy 1980

As a royal chapel, the Church of the Apostles was originally built in wood in the first part of the 11th century and later on renewed in stone in the 1240s. When a new, third royal chapel was built just some decades later, it was intended to enshrine the precious thorn of Christ's Crown which was given to the Norwegian king by the French king in 1274. We know little about this third Church of the Apostles. Neither the layout nor the exact site of the church has been clearly established. But written sources give some information, and in combination with the stone fragments they tell us 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, pp. 137–139; 1990, p. 94; Lidén, 1980, pp. 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). With the premise that the interpretation of this building fragment 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.

Fig. 11. MA 370a in the collection of the University Museum of Bergen. The corresponding stone (MA 370b) originates from the quarry at Lyse. The stones areused in the masonry of St. Michael's Church at Munkeliv in the second half of the 13th century. Photo: A.T. Hommedal

St. Michael's Abbey Church

The last museum collection stone to be discussed is a moulded fragment from the west portal frame in St. Michael's church at Munkeliv (Fig. 10 & Fig. 11). This Benedictine Abbey Church has now totally disappeared, but the layout is known from an archaeological excavation in 1860, when also the discussed portal fragment was found in its original position. St. Michael's, the oldest monastic church in Bergen, was built in the first part of the 12th century. In 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 fragments. The mouldings indicate that the portal was erected within the three last decades of the 13th century (Lidén & Magerøy 1980: 150-157; 1990: 91, 93-94). It has even been suggested that the west portal was created by the craftsmen *Arne grjótmeistare* and *Rane grjótsmidr* who apparently worked at Munkeliv in 1287 (Lidén & Magerøy 1990: 94 endnote 18).

A geochemically analysed sample from the stone MA 370b, originating from St. Michael's west portal (Fig. 11), matches the rock in the soapstone quarry at Lyse (Jansen et al 2009). 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 their abbey church.

Discussion: Lyse and Bergen

Based on the premise that the results of the geochemical analyses are valid, we may conclude that the Cistercians at Lyse delivered soapstone from their quarry to two of the main institutions in Bergen in the second half of the 13th century. In the 1250s and again after 1275 they delivered stone material for the building activity in the royal palatium or residence at Holmen. This was a period of extensive building activity in the King's palace complex in Bergen, starting in the 1240's 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, p. 91; Helle, 2013, pp. 112–115). Even though we do not know how comprehensive the delivery was, we can at least say that the Cistercians delivered stone material during different decades of this royal building period of ca. 60 years. In the last decades of the same period, maybe in the 1280s, Lyse also supplied material for a new portal in the Benedictine abbey church at Nordnes. Since we know so little about the monastic building complex at Munkeliv, we cannot tell whether this supply was a once only delivery or whether the Cistercians also had other deliveries to Munkeliv.

It is, however, interesting to note that the Cistercians at Lyse delivered building material to two of the richest institutions in Norway: both the King and the Abbey of Munkeliv surely had soapstone quarries of their own. When they bought soapstone from the Cistercians in spite of this, it must either say something about understanding the quality of the stone, or it must have been because of the town's already established supply from the quarry at Lyse.

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, p. 592). That is absolutely a possibility, but one should also be aware of the possibility that the supplies from Lyse to Bergen started approximately 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 from this time on. The already mentioned project of the 12th century St. Mary's church and its possible architectural connection to Lyse, which is not to be discussed here, may throw light on this question.

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 order had previously used such a large number of them and to such good effect. 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, p. 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 lay brothers and masons almost entirely must have been English.

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 Cistercians 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, p. 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 must be undertaken. The accumulations of waste in the quarry will surely be a fountain of information. Analyses of the quarry waste will 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. For instance, did the Cistercians also produce and sell soapstone vessels? 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.

A preliminary conclusion at present could be that the soapstone quarry seems to have been essential to the Cistercians at Lyse, 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 – as has been documented at least in a period from the mid-13th century onwards.

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Provenancing soapstone – experiences from different geochemical methods

Øystein J. Jansen

Abstract

Soapstone has been used for the production of vessels and other utensils since prehistoric times and in Norway it was also an important source of building stone during the Middle Ages. Geochemical analyses of vessels and building stones have been compared with analyses from quarries in Hordaland County and have in many cases proved successful in finding the provenance. An overview of three geochemical methods is given and the results of each are exemplified by recent work. In many cases multiple methods are needed to pin-point the source. A majority of the quarries (the waste) in Hordaland, Rogaland and Sogn & Fjordane has been sampled, but only a few samples from the latter counties have been analysed. The collection of these samples as a whole represents a valuable source of information for identification of soapstone artefacts and building stones in western Norway.

Introduction

A large number of soapstone quarries, probably 200–300 are found in Norway. Most of them are documented in archaeological records. Very few efforts have, however, been made to find the provenance of Norwegian artefacts and building stones of soapstone until the recent 10–15 years.

The earliest work on the provenance of Norwegian soapstone was carried out by Alfsen and Christie (1979) who did a cluster analysis based on trace elements in soapstone artefacts from Hedeby, northern Germany. Their work gave indications of provenance to a few quarries in Norway and Sweden, but did not "ignite" any interest for more work on this subject. Allen, Hamroush, Nagle, & Fitzhugh (1984) proved that the distribution patterns of REE (Rare Earth Elements) in soapstone deposits along the Labrador Coast in Canada is a powerful tool in finding the source, but after the Hedeby studies more than 20 years passed without any attempts of provenancing soapstones in Norway. Work by the author and colleagues (Jansen & Heldal, 2006, 2009; Jansen, Heldal, Pedersen, Ronen, & Kaland, 2009) has documented successful provenancing of medieval building stones of soapstone and talc-containing greenschist in the county of Hordaland. These studies were based on Sr/Nd isotopic compositions and REE profiles. Work in progress (e.g. Berglund,

Fig. 1. The most typical type of soapstone; grayish green, schistose, containing veins of carbonate, often brownish weathered. Photo: Ø.J. Jansen

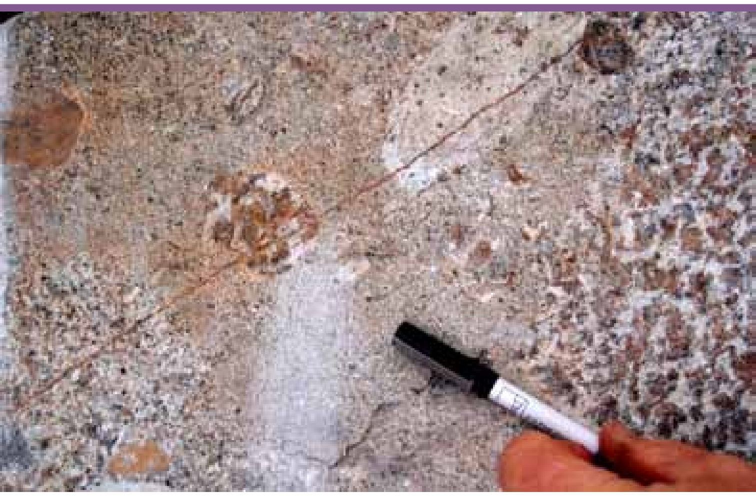

Fig. 2. Hana soapstone conglomerate containing pebbles and sand made of soapstone. Photo: Ø.J. Jansen

Fig. 3. Urda soapstone from Lykling, Bømlo. Photo: Ø.J. Jansen

Heldal, & Grenne, *in prep.*) has shown that analyses of main and trace elements by the conventional XRF method can be useful.

Richard Jones and colleagues did REE analyses of Viking steatite artefacts from Kaupang in 2006 (published in Baug, 2011), but a definite match with the five sampled quarries was not obtained. The same author and colleagues have, however, obtained successful geochemical provenancing of soapstone from Shetland quarries using both REE and Sr isotope (Jones, Olive, Kilikoglou, Ellam, Bassiakos, Bray, & Sanderson, 2007).

Geological background

The origin of most soapstone deposits is ultramafic rocks solidified in the lower part of the Earth's crust. Different geological processes may bring these rocks to the surface. On their way through the crust the ultramafic bodies will interact with hydrothermal fluids and carbon dioxide, and be altered (metamorphosed) to rocks like serpentinite and soapstone. Deposits of soapstone are often found in association with serpentinite bodies, and occationally with a remnant core of its ultramafic original rock – the protolith.

Soapstone deposits often vary, from massive to schistose, displaying different stages of transformation. Thus rocks from the same quarry may display a variety of structures, colours and mineral associations.

On the other hand the rocks from different quarries are usually difficult to separate from each other by their physical characteristics – the typical soapstone being grayish-green with varying amounts of light coloured or brownish weathered carbonate veins (Fig. 1).

A few of the quarries contain soapstone with characteristic features that make them easily recognisable; like the Hana soapstone conglomerate at Hana, Vaksdal (Fig. 2). Also the Urda soapstone from Lykling, Bømlo (Fig. 3) is easily recognised due to its characteristic brecciated structure and bluish colour.

Geochemical analysis

For most of the quarries, however, one has to identify the geochemical composition of the soapstone - "the geochemical fingerprint" - to make a proper provenance study. The fingerprint depends on two main factors:

- The inheritance – the original composition of the parent ultramafic rock

- The environment – the geochemical impact from the hydrothermal reactions in the different surroundings it has passed through on its way to the surface through millions of years (Fig. 4).

Thus, rocks from the same source may show different geochemistry if they have "chosen" different "routes" to the surface. The following analytical methods have been tested by the author and colleagues:

XRF Main and trace elements analyses

X-ray fluorescence (XRF) is a powerful quantitative and qualitative analytical tool for elemental analysis of materials. This is a well-known standard method, and due to the low cost it has been one of the most widely used methods for analysis of major and trace elements in rocks. A disadvantage of this method is that rather large samples (15 grams) of material are needed and also the method's problem of detecting elements that occur in minor amounts.

A large programme of analyses of main and trace elements of soapstone samples from quarries and vessels was carried out at Geological Survey of Norway (NGU) in 2006/2007. The analysed samples were collected from spoil heaps of quarries in the western part of Norway, mainly Hordaland County where the city of Bergen is situated. The vessels sampled are both urban medieval vessels collected at Bryggen, Bergen, and Iron Age vessels from rural sites in Hordaland. The vessels belong to the collections of The University Museum of Bergen.

The technique of interpreting the analyses is to use covariant plots, a measure of how much two random variables change together. A pilot study at NGU showed that the following combinations seemed to be the most successful for the XRF soapstone analyses: MgO/Al_2O_3, Ni/Fe_2O_3, Ni/Co, Ni/Cr, and Zn/V.

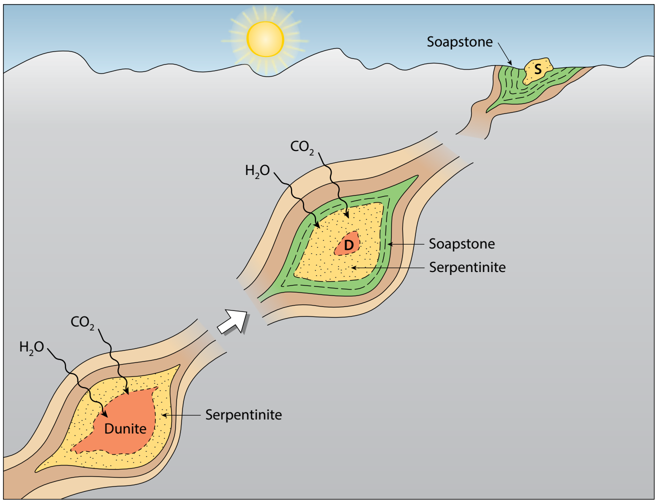

Fig. 4. From the lower crust to the surface. A simplified illustration of the processes involved as an ultramafic rock (dunite) are metamorphosed and converted to deposits of soapstone and serpentinite at the surface. Illustration: Ø.J. Jansen/E. Bjørseth

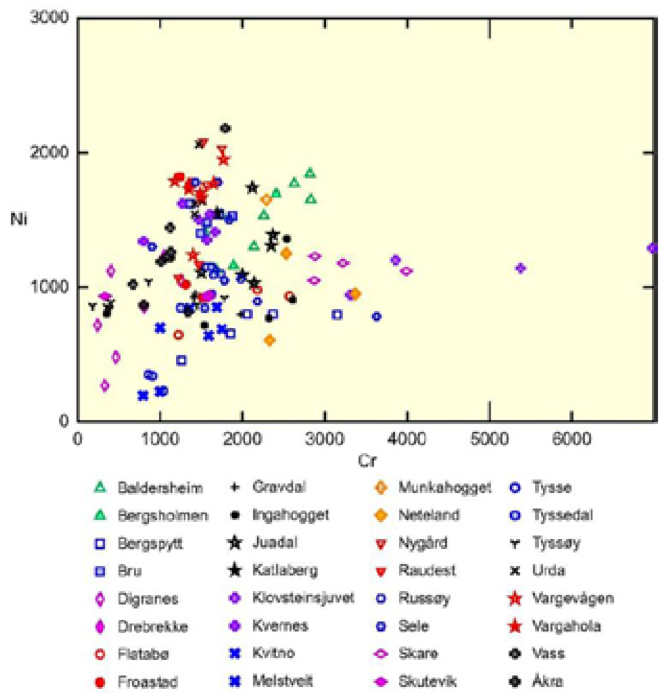

Fig. 5. Plot of Ni/Cr ratios for quarries in the Hordaland County. Between 2 and 8 analyses are plotted from each quarry. Diagram: T. Heldal

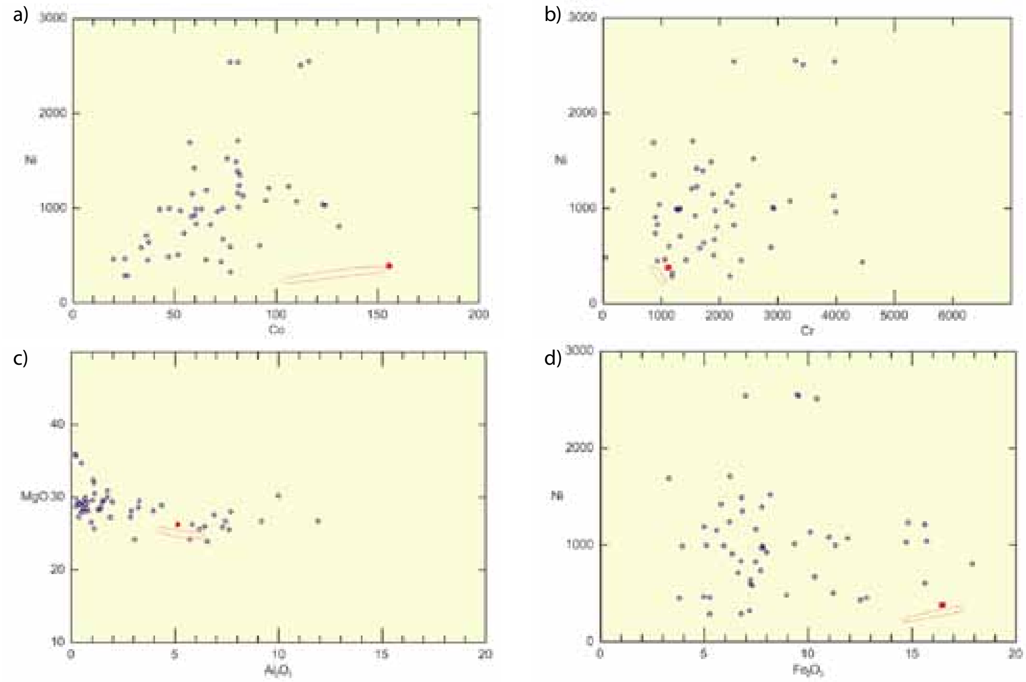

Fig. 6. The XRF values (ppm) of the Eidfjord vessel (marked in red) plot very close to the inscribed (in red) clusters of the Tysse quarry for all four diagrams. Diagrams: T. Heldal

An example is shown in Fig. 5 showing Ni/Cr ratios for 32 quarries. Some quarries show similar values of the analysed samples giving a reasonably defined cluster, while others display a more scattered pattern due to a more varying content of the different elements.

A successful example of provenancing is shown in Fig. 6. A vessel found at Eidfjord in Hardanger is pinpointed to a quarry at Tysse in Åkrafjorden. The Eidfjord/Tysse example is however not a common case. More often the size of the clusters is quite large, reducing the accuracy of the analyses. Also, a visual interpretation of the plots is of course subjective when it comes to the acceptance of "close enough to the cluster" – "in the trend", etc. On the other hand, use of multivariate analysis software did not work properly, mainly due to a rather large internal variation of the results from some of the quarries.

The sufficient number of analysed samples is normally set to five for each quarry. In some cases, however, it became obvious that additional samples were needed to include the geochemical variations of some quarries.

However, with all its "disadvantages" – the XRF method gave quite satisfying results, identifying the provenance for about a third of the 150 analysed vessels from the collections of The University Museum of Bergen (Jansen et al., *in prep.*).

Thus, even though some problems are pointed out for this method it can be a valuable tool in provenance studies of soapstone – but should be supported by other geochemical methods.

ICP-MS Rare Earth Elements (REE)

ICP-MS is a method used for determination of elements introduced in the 1980s. Only small samples are needed (less than one gram), and its superior detection abilities makes it an excellent method for detecting elements that occur in small amounts – like the occurrence of Rare Earth Elements (REE) in soapstone. The slope of REE graphs will show the enrichment or exclusion of the various REEs, giving each sample a characteristic profile. The geometric pattern is the most important aspect of the profiles, while a variation on the logarithmic scale is considered less important.

Fig. 7, 8 and 9 show varying degree of conformity between REE profiles of samples from three chosen quarries – from acceptable to excellent. In some cases REE profiles of soapstone masonry from the same building reveal supplies from different sources, as shown in Fig. 10.

An example of successful application of the REE method in provenancing a building stone of talc containing greenschist from Onarheim Church at Tysnes is shown in Fig. 11.

TIMS – Sr and Nd isotopes

TIMS is a mass spectrometer that is capable of making very precise measurements of isotope ratios of elements. The method has been tested on the relationship between stable isotopes of Strontium and Neodymium (Sr/Nd). The method is the most expensive of the analytical methods carried out, and the results are of varying quality.

A problem with this method is that soapstone in general exhibits very low Neodymium (Nd) concentrations, making Nd isotope analyses of such rocks difficult. Although the analyses of several samples have failed, we have obtained reliable results from at least 80 % of the samples. The results show that the Nd isotopic composition of the soapstone reflects the complex geological processes that formed them. In general, the Sr and Nd isotope compositions of the analysed samples are inversely correlated (i.e. high Nd values are associated with low Sr values) – which is the typical pattern of terrestrial

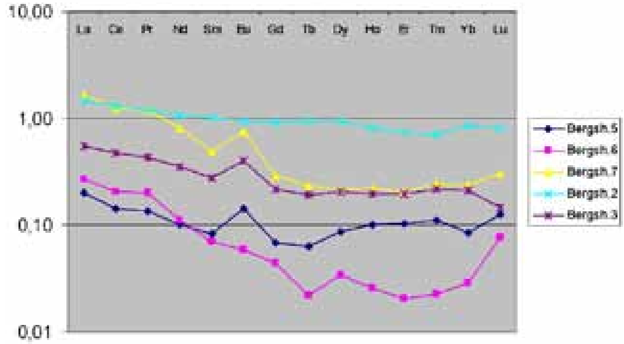

Fig. 7. REE profiles of 5 samples from the Bergsholmen quarry displaying some variation of the geometric pattern. The general trend is sloping down to the right, most lines with a "tail" at the end – giving an acceptable characteristic trend for the Bergsholmen quarry. The differences between the profiles reflect internal geochemical variations in the quarry. Diagram: Ø.J. Jansen

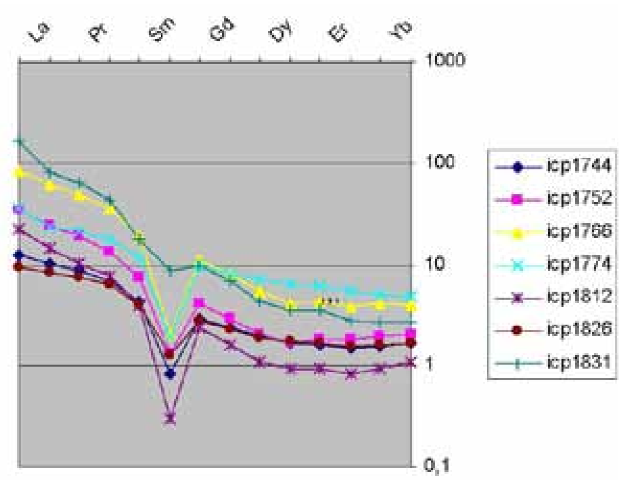

Fig.8. REE patterns of 7 vessels from an unknown quarry, identifying only minor internal differences. Diagram: Ø.J. Jansen

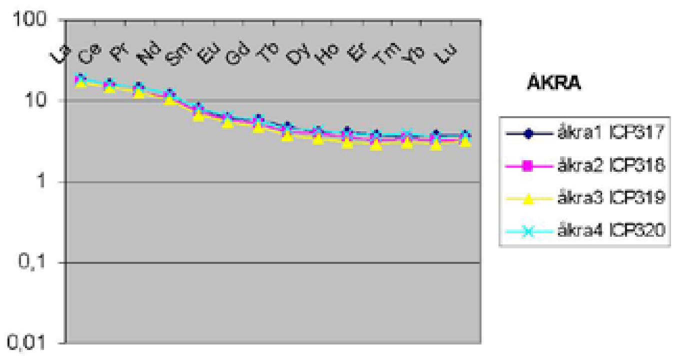

Fig. 9. REE profiles of samples from the Åkra quarry, an example of extremely constant REE values. Diagram: Ø.J. Jansen

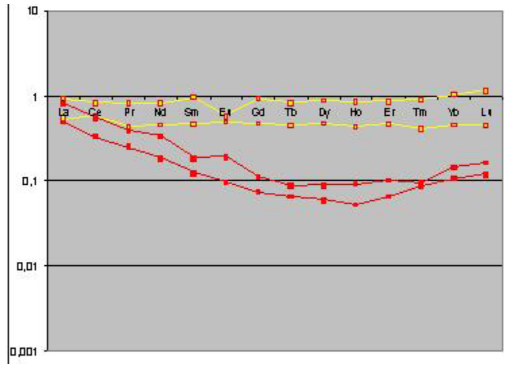

Fig. 10. REE profiles of soapstone from the medieval Munkeliv monastery – showing two different geometric patterns, possibly indicating two sources. Figure from Jansen & Heldal (2006)

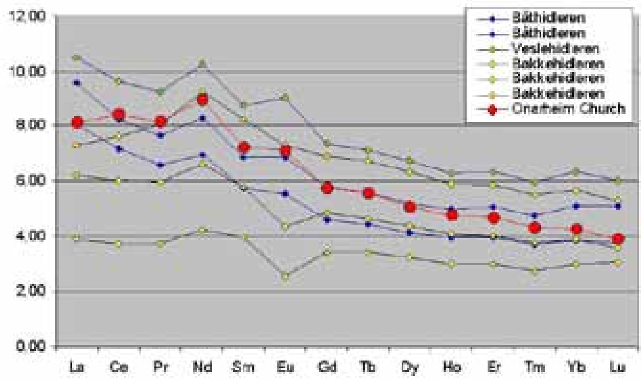

Fig. 11. REE profiles of talc containing greenschist quarried for baking slabs, building stones and roofing schist at Ølve-Hatlestrand, Kvinnherad. Six samples from 3 quarries are shown in different colours and a sample from a building stone from the medieval Onarheim church shown in red. The diagram shows a successful use of the REE method. The quarries are all situated near each other in the same geological formation, and show similar profiles with minor variations. The general down sloping to the left at the start of the "church sample" may indicate that the Bakkehidleren quarry was the supplier of the stones to the Medieval Onarheim Church. Diagram: Ø.J. Jansen, from Jansen & Heldal (2009)

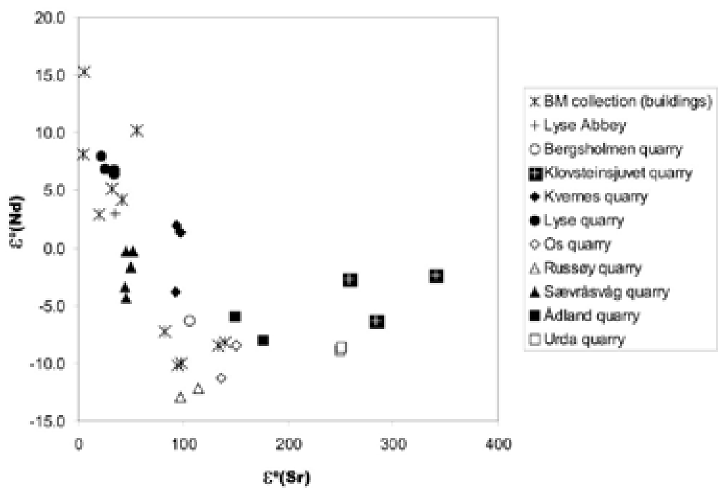

Fig. 12. TIMS-plot of Sr-Nd isotopes of samples from quarries (by symbol and name) and buildings (one sample from Lyse Abbey, the rest of predominantly 12th and 13th century soapstone masonry from the collections of The University Museum of Bergen). Most of the samples from the museum collections tend to cluster in two groups, one low Sr/high Nd, and one low Nd/medium Sr values, indicating that at least two quarries were involved. However, only the former group seems to match directly with one quarry, namely the Lyse quarry. In addition the quarries at Sævråsvåg and Klovsteinsjuvet show a well defined cluster separated from most others. Figure from Jansen et al. (2009)

rocks. This makes combined use of Sr and Nd isotopes a potentially powerful tool for the provenance analyses of soapstone. This is demonstrated in that multiple analyses from some individual quarries define distinct fields, but for several quarries this method did not give satisfying results. An example which demonstrates a successful use of this method is shown in Fig. 12.

Conclusions

The geochemical methods described have during the last years been applied on soapstone from different quarries and samples from the collections of the University Museum of Bergen. As shown by the examples given in this paper, the provenance of soapstone vessels and building stones has in many cases been successfully identified, mostly by using multiple methods.

Most of the quarries localised in the counties of Rogaland, Hordaland and Sogn & Fjordane have been sampled, but very few samples from Sogn & Fjordane and none from Rogaland have been analysed. About 45 quarries in Hordaland have been sampled and for most of them geochemical analyses are available. For some quarries all three types of analyses have been carried out, but for most quarries analyses from only one or two of the methods are available.

A complete geochemical database for all the soapstone quarries is of course the ultimate goal. Work in progress will improve the situation even more for the Hordaland quarries in the coming years. Analyses from the other counties have less priority, but samples from most of the quarries in Rogaland and Sogn & Fjordane have been collected – and will be analysed as soon as economic support for the laboratory work is available.

A future geochemical database for all the soapstone quarries in Hordaland, Rogaland and Sogn & Fjordane would give an excellent opportunity for interdisciplinary provenance studies of the soapstone trade in western Norway.

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Perspectives on the characterization of ancient soapstone quarries

Tom Heldal

Abstract

Empirical characterization of soapstone quarries includes the description of a range of geological and archaeological parameters. A soapstone quarry can be viewed as a production system consisting of features related to different aspects of soapstone quarrying relating to different periods of production. The geology of the soapstone deposit forms the framework from which the layout and architecture of the quarrying operation originate. The extraction evidence found on the quarry face, spoil heaps, features related to transport and to sustaining the people involved, collectively tell us much about the quarrying process from the selection of stone to be quarried to the social organization.

Introduction

Stone quarries are found more or less everywhere where there has been human activity, from the earliest hominids up to the present day. Hence, quarries can give us insights into important aspects of the daily life of our ancestors in terms of how they exploited and used natural resources. Thus, quarries may provide important "pools of knowledge" of ancient technology, social organization, trade and communications. Since many quarry landscapes were exploited over thousands of years, quarries can also be "indicators" of important events or changes in society. For instance, traces of quarrying that may reflect changing technologies over time, and such changes may often be linked to key historical transformations in society.

Quarrying techniques and stone working have for a long time fascinated researchers and the lay audience, particularly in connection to the great monuments of Antiquity. In Egyptian archaeology, this include the works of Petrie (1883) on the pyramid sites, Clarke and Engelbach's interpretation of the unfinished obelisk quarry in Aswan and other works on Egyptian masonry (Clarke & Engelbach, 1930), and although much later, Röder (1965) on the quarrying of the Aswan granite. With regard to the Greco-Roman world, Ward-Perkins gained interest in marble quarrying quite early, summarised in Ward-Perkins (1971). The excavations of two Roman quarry sites in the Western Desert of Egypt run by the University of Southampton (Peacock & Maxfield, 1997; Maxfield & Peacock, 2001) definitely demonstrated that quarry sites can contain a rich archaeological record.

Since full archaeological excavation work is not an option in most cases, one has to rely on quicker surveys obtaining a rougher characterization of quarries. Heldal, Storemyr, Bloxam, Shaw, Lee & Salem (2009) demonstrates the use of GPS-based mapping and GIS-systems for a large Egyptian quarry site. Grenne, Heldal, Meyer & Bloxam (2009) and Heldal & Meyer (2011) brought similar methods into a Norwegian context - the surveying of millstone quarry landscapes. Partly, a general methodology applied by Heldal (2009) formed the basic perspectives.

Studies of soapstone quarries in Norway are rather limited. Skjølsvold (1961) did a national survey and described a number of quarries. Later Skjølsvold (1968) surveyed and excavated the yet oldest soapstone quarry in the country, namely the Early Iron Age vessel quarry at Bubakk, Kvikne. Berglund (1995, 1999) did excavations of soapstone quarries on the Helgeland coast, and concluded that vessel blanks made in the quarries were brought to farms for finishing. In recent years, a few studies of quarries containing soapstone and related rocks have been carried out in Trøndelag (Storemyr, Berg & Heldal, 2003; Østerås, 2002; Lundberg, 2007) and Hordaland (Jansen, Heldal, Pedersen, Ronen & Kaland, 2009).

Fig. 1. Distribution of soapstone quarries in Norway. Illustration: T. Heldal

Use and production of soapstone in Norway

For nearly 3000 years, soapstone has been a key geological outfield resource (Storemyr and Heldal, 2002), due to the rich occurrence of soapstone deposits all over the country (Fig. 1). Soapstone was an important part of the household, used for many different purposes: cooking vessels, baking slabs, moulds, spinning wheels, loom weights, fishing weights, oil lamps, ovens, fire places and chimneys. Soapstone gained such 'popularity' due to its low hardness (easy to work with common tools), but also because the rock has an extremely low heat conductivity, and consequently appear both heat resistant and when heated, it can store the heat for a long time. This is the main reason for the present-day use of soapstone in heat-efficient ovens.

Since Christianity arrived in Norway in the 11th Century, soapstone has been widely applied for building- and ornamental stone in Norway. High quality stone was in demand for the construction of churches and monasteries in the Medieval Period. Since most of the Norwegian bedrock consists of hard crystalline rocks, the many soapstone deposits, well known from before, became an obvious choice in the search for easily workable stone for construction. In parts of the country (in particular Western Norway, Trøndelag, Nordland and Troms) soapstone became the most important ornamental stone of this period. Also in modern times, in particular since restoration of the medieval buildings began in the late 19th century, soapstone became widely use in buildings. The use of soapstone in Norway during the last three thousand years is briefly summarized in Fig. 2.

The soapstone quarries bear witness of the use of the rock in various periods. Some of them have been exploited more or less continuously through several thousand years, displaying evidence for many phases of quarrying for different purposes. For instance, many of the 'old' vessel quarries, especially those located close to harbour facilities, were turned into building stone quarries in the 12th and 13th century. In modern times, the same quarries were visited again for extraction of stone for restoration and construction. Other quarries were exploited for a short period only, leaving a frozen image of production during a narrow time frame.

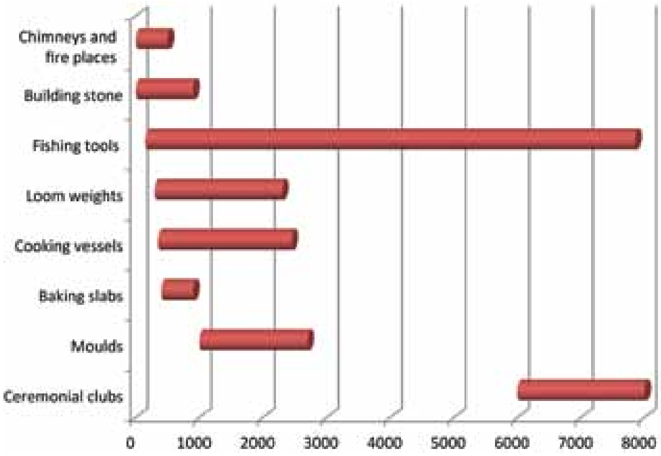

Fig. 2. Brief overview of applications of soapstone through time in Norway

Describing and characterizing soapstone quarries

All quarry landscapes, whether these are Neolithic chert quarries, Roman marble quarries or paving stone quarries from the Industrial Period, have aspects and features in common that can be examined and analysed in a systematic way, establishing a base of empirical characterization. A quarry site may be visualized geologically (the conditions for quarrying) and from the material remains left by the various processes involved in the exploitation, over one or several periods. These remains might include traces of the extraction of rocks (tool marks), deposition of excess rock (spoil), work areas, roads and paths, shelters for the workers, etc. Collectively, these physical remains tell us something about the processes involved from the selection of stone to be quarried, to the production of stone objects, the transport and the social organization.

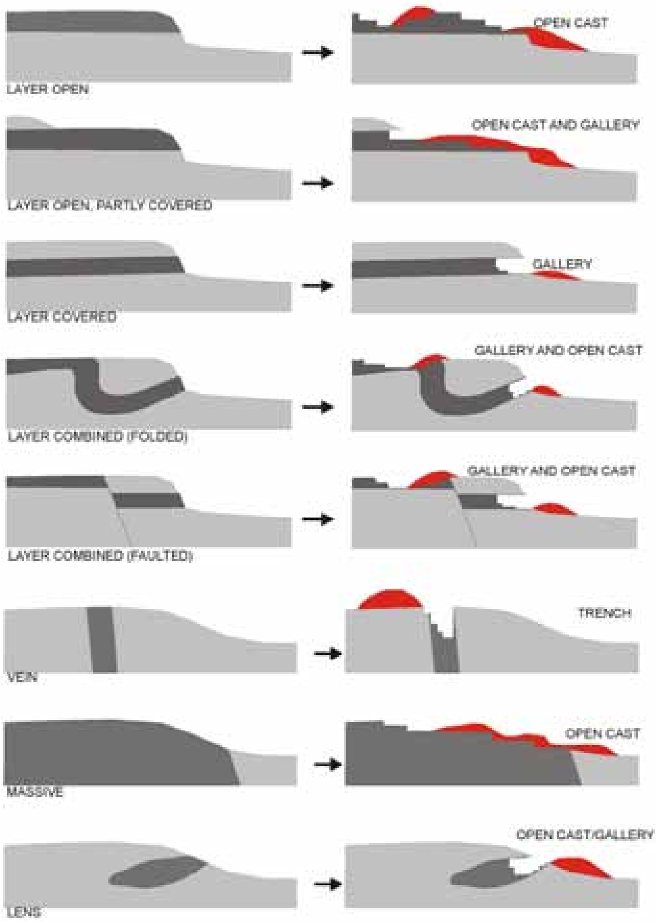

Fig. 3. Relationship between geological geometry of stone deposits and quarry layout. Illustration: T. Heldal

The geology behind the quarries

One of the important aspects of resource characterization is to find the link between the quarry and the consumption of its products (provenance). This aspect will not be treated in the present paper. But there are also other important aspects of the stone resources that can shed light on the quarrying activities: the selection of stone type to be quarried (commodity and quality in use), the physical landscape in which the stone resources occur (morphology and geometry of deposit) and the condition of the deposit (production quality) in choosing the place for quarrying.

Soapstone is composed of soft minerals, talc being the most important constituent. Other common minerals include iron-magnesium carbonate, chlorite, serpentine and amphibole (tremolite or actinolite). Soapstone is formed by alteration of iron-magnesium rich rocks such as peridotite, dunite, serpentinite, gabbro and dolomite during hydrothermal processes at the sea floor or orogenic metamorphism. Thus, soapstone deposits commonly occur as veins or layers in other rocks or as a thin coating on other rock masses. During orogenic processes, soapstone bodies may be tectonically emplaced to form isolated lenticular bodies or clusters of such. Moreover, soapstone deposits tend to be extremely varying in mineralogy, texture and structure over short distances, implying a need for highly selective quarrying for obtaining the desired quality.

Fig. 4. Map of the Bubakk quarry, Kvikne. Dark grey = serpentinite (core of the deposit). Shaded = soapstone outcrops and quarries. Dotted lines = assumed borders of the rock types. Illustration: T. Heldal

Table 1. Relationship between geological/morphological geometry and resulting type of soapstone quarry

Deposit geometry	Quarry type
Open layer	Simple quarry layout, open cast quarry
Covered layer	Gallery (underground) quarry, or open cast quarry were cover rock has been removed
Complex layer (folded or faulted)	Combinations of quarry types
Steep layer or vein	Trench quarry
Lens	Combinations of open cast and gallery quarries
Zoned lens	Combinations of open cast and gallery quarries, enveloping a non - exploited core
Massive	Open cast quarry

Many soapstone quarries therefore consist of several extraction areas targeting ‘pockets’ of good quality within a larger deposit.

Fig. 3 illustrates different geological geometries of stone deposits and how this will have influence on the final geometry of a quarry. Norwegian soapstone deposits in particular tend to occur as layers, steep or inclined veins and lenses. Many soapstone deposits are zoned, typically composed of a core of hard serpentinite enveloped by a softer rim of soapstone. This may be seen at the Bubakk quarry, Kvikne (Fig. 4). Others are highly irregular, as shown in Fig. 5.

Thus, the geological structure and geometry of the soapstone deposits carry a significant impact on the resulting layout and organization of quarrying activities. Table 1 gives a simple classification of quarry types based on geological constrains.

Fig. 5. Small soapstone vessel quarries, Lesja. The dotted red line defines the boundary between light coloured soapstone and darker coloured serpentinite. The quarry is actually exhausted. Photo: T. Heldal

Dynamic evolution of a quarry

Quarrying can be described as a transformation process of solid rock to debris, from pristine nature to an exhausted rock deposit. The extraction site is the place where rock is quarried from the bedrock. The loose pieces may be further worked at a designated work area, or they may be ready for transport to another place directly after extraction. The leftover stone from extraction and further working (spoil heap) is deposited close to the quarry, preferably not covering future extraction areas. Thus, a quarry site is composed of extraction areas, deposition areas and (possibly) work areas. The location of these will change according to the progress of quarrying, as illustrated in Fig. 6. Moreover, the extent and volume of the spoil heaps will grow as time goes by, and finally the quarry may consist of large mounds of spoil with little left of the extraction area. Fig. 7 shows an exhausted soapstone quarry.

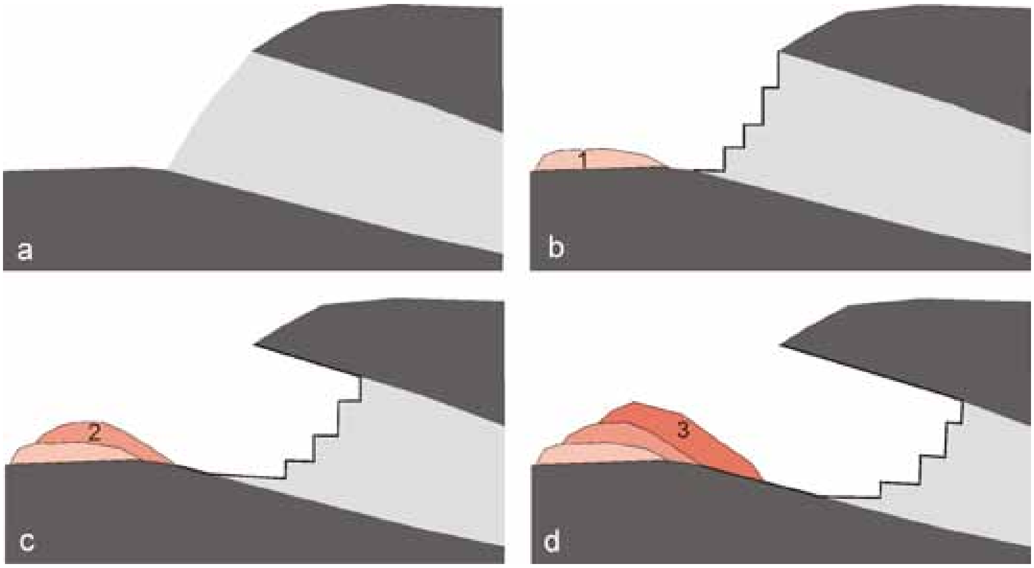

Fig. 6. Stages a-d in a quarry operation, with resulting spoil heap stratigraphy (1-3). Illustration: T. Heldal

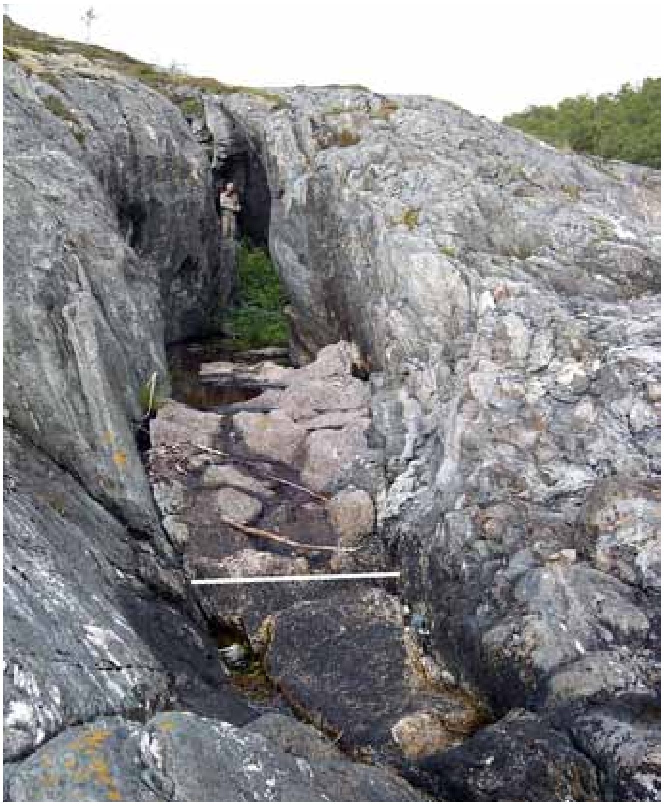

Fig. 7. Exhausted soapstone quarry at Haltøy, Nordland. The cavity defines the extracted volume of the original soapstone deposit. White line represent ancient shoreline by the time of quarrying.
Photo: T. Heldal

Extraction area

The quarry face gives important information about the intended objects to be produced (at least in the final stage of quarrying) and the technology involved in the extraction. Since soapstone is a soft rock, most of the extraction took place by carving separation channels in the bedrock around the intended products (Fig. 8). When all the sides were made free from the bedrock, the last (base plane) was split from the bedrock using wedges or repeated picking or chiselling along the base of the block. The pattern of separation channels, the imprints on the rock face of the split blocks and remaining, failed attempts of extraction, give important insight in the quarrying process (Fig. 9). This is of particular importance when separating building-stone quarrying from the extraction of vessels. Quarrying of ashlars (i.e., for construction of Medieval churches) leaves a distinct pattern of channels defining a range of extracted block sizes. Vessel quarrying, on the other hand, leaves shallow, hemispherical depression on the rock face.

The quarry faces also display tool marks that may be important for interpretation of the quarrying process and even the timing of quarrying. A Pick axe was probably the most important tool for soapstone quarrying, leaving curved lines on the quarry face and blunt depressions at the bottom of the channels. The curving is a result of the worker's fixed position, where the angle between the pick axe and the point of impact changes when progressing deeper into the rock. Frequent changes in the worker's position (and direction of working) will result in a "herringbone" pattern of lines on a quarry face. Eva Stavsøien (2011) at the Nidaros Cathedral Restoration Workshop did full-scale experiments in a soapstone quarry, copying the old tool marks using a heavy pick axe.

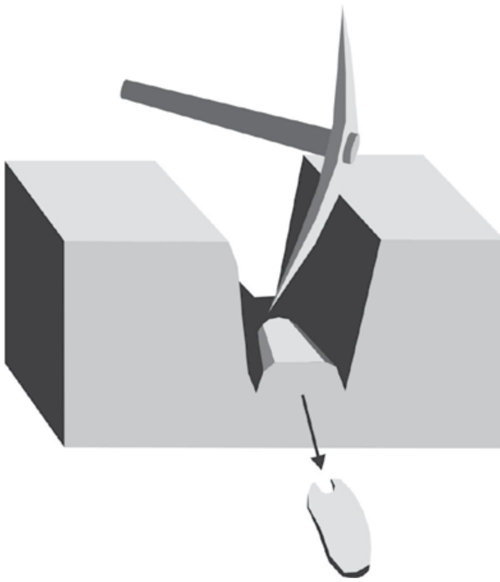

Fig. 8. Principle of carving channels in soapstone using a pick axe. Illustration: T. Heldal

Fig. 9. Top photos: ashlar quarries from the Medieval Period, used for the construction of the Nidaros Cathedral, Trondheim. Lower left: soapstone quarry for cooking vessels, Lesja, with remaining unfinished roughouts. Lower right: rectangular depressions from the production of fishing weights, Harstad. Photo: T. Heldal

Quarrying with hammer and chisel would create different tool marks. The most significant difference from a pick axe is that the angle between the tool and the rock at the impact point can be kept more stable, leaving a pattern of straight, parallel lines. This is illustrated in Fig. 10.

On a vertical quarry face, a broad-edge adze may leave marks similar to a pick axe. The difference is seen at the bottom of the channels. The Early Iron Age quarry at Bubakk, Kvikne (Skjølsvold, 1968), displays such tool marks, indicating the use of an adze with a 6 cm broad edge (Fig. 11). As such, this quarry differs from later ones, and the tool marks provide important evidence for the early soapstone production technology in Norway.

Debris from production

Spoil (or rock waste) may be defined as the lithological leftovers from the quarrying. Whilst the quarry face may display only the later stage of production, the spoil heaps define a stratigraphy of accumulated waste rock from the start to the end of quarrying at the site. Each of the steps in the process of quarrying leaves behind spoil material characteristic of that specific process. Ideally, a quarry that displays many steps of

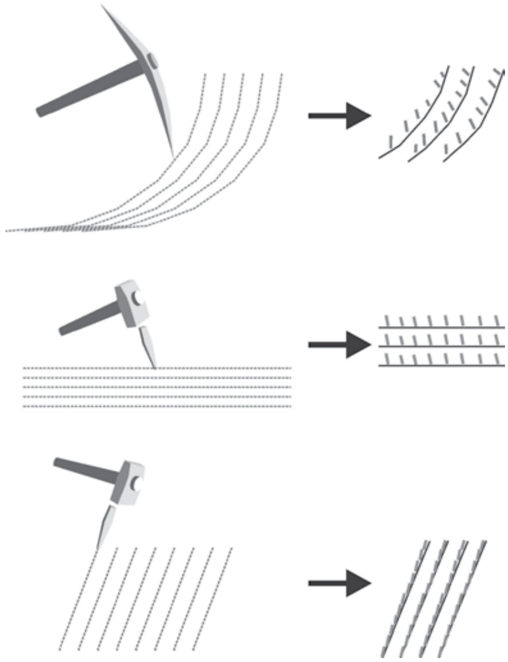

Fig. 10. Illustration of relationship between tools and quarry marks. Top: pick axe. Middle: chisel worked on horizontal shifts. Lower: chisel worked on inclined shifts. Illustration: T. Heldal

Fig. 11. Top left: marks from pick axe at the bottom of a channel (Bakkaunet, Trondheim). Top right: marks from broad-edge adze in vessel quarry, Kvikne. Lower left: straight, parallel tool marks that may have been made by chisel. Quarry in Haugesund (photo: Stavanger Museum). Lower right: steep quarry face with 'herringbone' pattern tool marks, made by pick axe. Photo: T. Heldal

production involving changes of techniques will have a variegated "construction" of spoil heaps, while quarries with few steps and/or a single technique of working will have a uniform composition. Also, if all steps in the production are carried out in one place, the spoil will be mixed and perhaps display a cyclic vertical stratigraphy. Likewise, if movement from one step to the other involves physical movement of the blocks or cores, we may see a lateral separation of characteristic types of spoil – i.e. "extraction spoil" with large fragments (Fig. 12) and "work areas" containing fine debitage (Fig. 13). The composition and distribution of spoil heaps also depend on the geometry of the soapstone deposit. For instance, lateral movement of the quarry face during production results in spoil heaps defining a lateral, onlapping stratigraphy.

Spoil heap shapes and their relationship with the quarry faces are important to characterize. They can give important information about the number of people and teams working simultaneously in a quarry.

The occurrence of unfinished and broken objects in the mounds provides important information about the production process. The mounds usually contain ash and other organic material that can be dated, and are thus the most important source for establishing the chronology of quarrying, and identifying gaps in the production. In one of the main quarries supplying the stone for the Nidaros Cathedral, Trondheim, the quarry face displays evidence of the extraction of baking slabs in addition to ashlar blocks. Broken baking slabs in the spoil heaps below the quarry not only confirmed that such production did take place, but also contemporary with the production of building-stone for the making of the cathedral (Lundberg, 2007).

Features related to transport of stone

The transport of stone blocks and products is an important element of all quarrying activities. Clearly, the production of small objects that can be carried by a man or a horse does require less constructed infrastructure than huge blocks. However, whatever the output of the quarrying was, the remains of elements related to transport are important to characterize. Such remains may be constructed ramps, roads and quays, or less visible features such as cairns (site lines) and worn paths, or even post holes for fixing lifting devices. These remains can be divided into four groups:

- Internal logistics (inside the quarry until finishing/semi-finishing)
- Stockpiling and loading
- Overland transport
- Quay/harbours/waterways.

The internal logistics in a quarry may be defined as all transport between the production steps, and from the final step to a place of stockpiling or specific loading area if that exists. Depending on the pattern of production (Fig. 14) and the outcome of it, the internal logistics between the production steps may include constructed features or not. A Medieval soapstone quarry at Russøy, south of Bergen (Jansen et al., 2009) contains a wooden construction (surface of parallel logs) for sliding blocks from the quarry floor up to the terrain surface. In the same quarry, there is a pathway leading from the quarry to a primitive quay by the shore.

Transport features are usually difficult to identify in and around Norwegian soapstone quarries. Transport of cooking vessels and utensils could easily be carried out by a man and a horse. Building-stone quarries are mostly situated close to the sea, and moving the blocks the short distance to the harbour did not require more sophisticated constructions than a well-made pathway.

Fig. 12. Typical situation at an ancient soapstone quarry, Haltøy, Nordland. Carved quarry face to the left (extraction area), spoil heap with coarse debris to the right defining a semicircular heap in front of the extraction area. The quarry may continue deep below the water surface. Photo: T. Heldal

Other remains of importance

Extrapolating the social context through which ancient quarrying was expedited is key to understanding the social organization behind the quarrying. As historical sources are extremely rare when it comes to soapstone quarrying before the late 19th century, evidence must largely be extracted

Fig. 13. Fine debris in a work area in front of a soapstone quarry, Haltøya, Nordland. Photo: T. Heldal

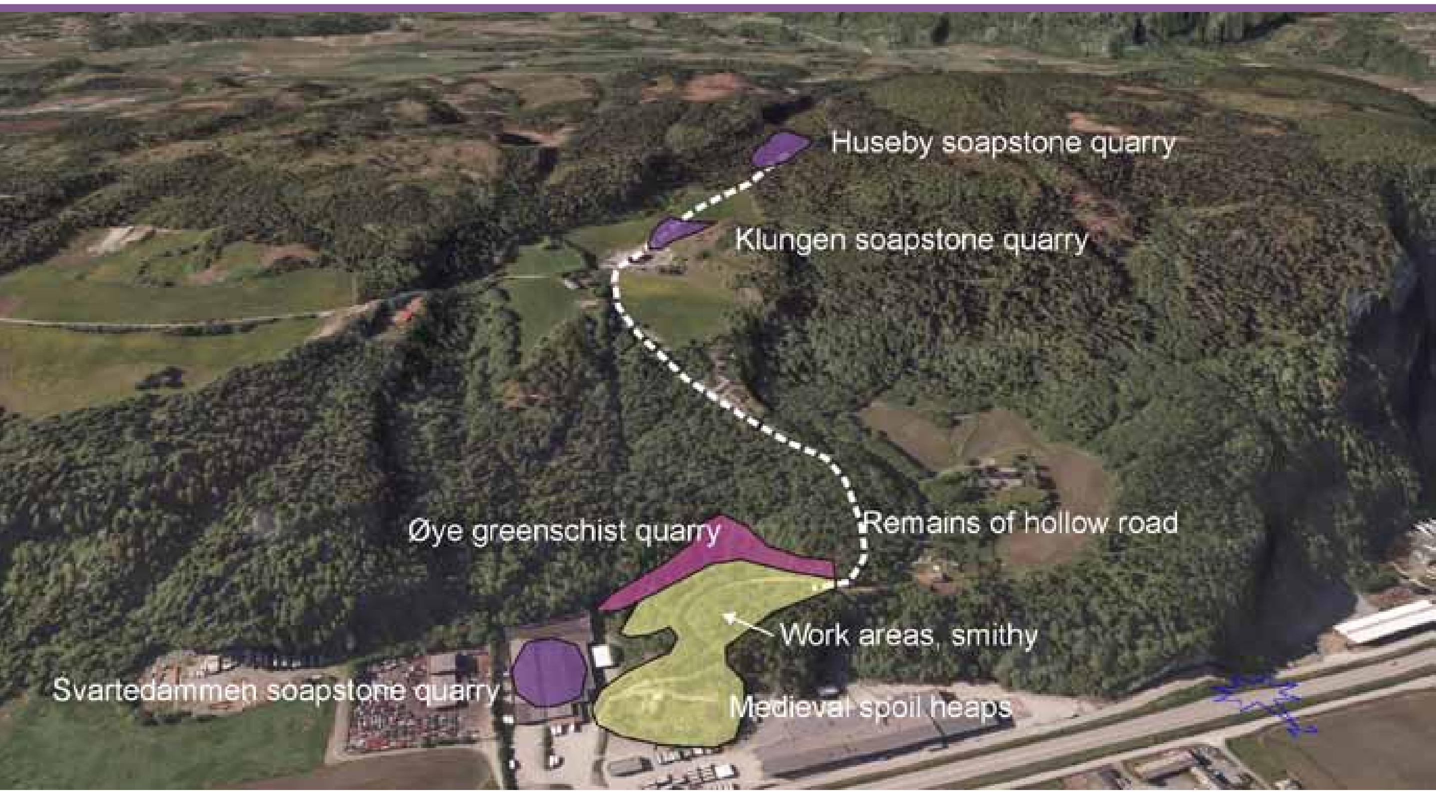

Fig. 14. Quarry systems and connected logistics in the Øye-Huseby area, south of Trondheim. These quarries were important production sites of soapstone and soft greenschist to the Nidaros Cathedral. Photo: T. Heldal

from material remains in the quarries. Elements of the 'social infrastructure' that might be found across an ancient quarry site, vary from built features to epigraphic data. Although sophisticated buildings and "quarrymen villages" most likely did not exist at these quarry sites, one should expect more temporary shelters and places for food production close to the quarries. Yet, no such features have been identified in Norwegian soapstone quarries, but they have hardly been searched for either. Berglund (this volume) do mention a possible dwelling structure on the Haltøya island, Nordland.

Moreover, the soft soapstone is like a magnet to various kinds of graffiti, and there is hardly any deposit in Norway that has not been subject to inventive people with a knife and a message to the world. A runic inscription, dating to the 12th Century (Hagland, 1984, 2000), is found in a soapstone quarry at the Esøya island near Brønnøysund in Nordland. It is located next to a bow-shaped quartz vein, saying:

"One bow is above, one bow is hewn, one bow in the curved soapstone rock" [1]

The text indicates a close connection to the soapstone quarrying, but with the exception of this little indication of the quarrymen's sense of humour, we know little about the people involved. Perhaps more studies of the rock art of soapstone quarries will reveal more.

Any quarrying operation using iron tools will need regular sharpening of these. Lundberg (2007) found slag from a smithy in one of the Nidaros Cathedral quarries close to Trondheim.

No such evidence have been found in other quarries, but one should expect that smithies were present in most quarries of some size, perhaps with the exception of those located in the immediate vicinity of permanent dwellings.

Interpreting the operational chain in soapstone quarries

A key question regarding soapstone quarrying is whereby products (cooking vessels, building blocks, etc.) were finished in the quarry or if rough-outs were brought to other places for finishing. In a general sense, quarrying can be described as a four step process: extraction of block from bedrock, block reduction to 'cores', semi-finishing of cores to rough-outs, and finishing to the final product (Heldal, 2009). A 'core' can be defined as the smallest stone block in the quarrying process before shaping to the final product, whilst a 'rough-out' (sometimes referred to as a 'blank') is a roughly shaped object, ready for finishing with finer tools (and skills).

The production evidence on the quarry faces of many soapstone quarries indicates that cores and even rough-outs were carved directly from the bedrock, thus reducing the steps to three or even two. We know less about the finishing. There are examples of finished baking slabs in quarries, and Berglund (1995, 1999) found failed cooking vessels in spoil heaps in a soapstone quarry at Tro island, Nordland. However, Berglund also provided evidence of finishing of soapstone vessels on farms far from the quarries, and indicates that this was probably the most common practise. Nevertheless, we have to realize that there are numerous aspects of soapstone quarrying yet to be revealed.

Conclusion

A soapstone quarry can be viewed as a production system consisting of features related to different aspects of quarrying, different stages of production and different phases of production. The geology of the soapstone deposit forms the framework from which the layout and architecture of the quarrying operation originate. The extraction evidence provides information about intended products (purpose of quarrying), the technology involved and indication of mass production or not. The spoil heaps carry information of time depth, the chain of operation and evolution through time. Features related to lifting and moving stone objects tell us about the logistical system within a quarry, and those related to sustaining the people involved increase our knowledge of the social organization of quarrying.

When investigating soapstone quarries, all these features should be addressed, as shown in Table 2. A survey of the quarry area and immediate surroundings may quickly identify features to follow up in more detailed excavations.

Table 2. Features of a soapstone quarry divided in five main groups: resource, extraction, deposition, logistics and social infrastructure

Geological resource	Geometry, structure, quality
Extraction area	Intended products, tool marks, mass production or artisan
Deposition area (spoil heaps)	Morphology, vertical and lateral stratigraphy, failed objects, size distribution of fragments
Logistics	Internal transport in the quarry, constructions, roads and paths, harbour
Social infrastructure	Shelters and dwellings, evidence of food production, organic remains, smithies

1. Freely translated from Norwegian by the author

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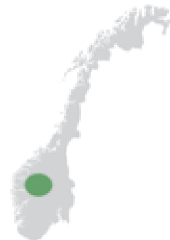
Landscape exploitation and transformation

Resource exploitation and settlement in mountain areas in Southern Norway during the Early Iron Age – an altered perception of landscape and landscape use?



Kathrine Stene

Abstract

An increasing exploitation – trapping, iron production and livestock grazing – took place in the mountainous areas in Southern Norway from the beginning of the Iron Age. Previously, the material from mountain regions has mainly been interpreted from an agrarian-economic point of view, where livestock grazing and settlements are tied to seasonal utilisation. The aim of the paper is to discuss whether resource utilisation in mountain landscapes in Western and Eastern Norway in the Iron Age, mainly the period AD 1–600, may be linked to more permanent occupation. The focus is on traces of agrarian activities and settlements from areas in the inner fjords in Sogn, Western Norway, and from the Dovre region in Eastern Norway.

Introduction

Mountainous and wooded areas with their outfield resources were of high importance for people in Southern Norway during the Iron Age. A multifaceted utilisation took place in these landscapes such as extraction of iron, hunting and trapping, quarrying of stone, and the use of summer pasture and shielings (Myhre, 2000). This exploitation underwent a number of changes during the Iron Age and may have caused a changed mentality in the relation between humans and nature through time.

Results from archaeological and palaeo-botanical investigations reveal an increasing activity at the beginning of the Iron Age. Opening-up of the forest, decline in the treeline and increased grazing are documented through pollen analytical data (e.g. Paus, Jevne, & Gustafson, 1987; Kvamme, Berge, & Kaland, 1992; Høeg, 1996; Moe, 1996; Hjelle, Hufthammer, & Bergsvik, 2006). During the Early Iron Age livestock grazing increases in intensity and from the Late Iron Age and the Middle Ages grazing is utterly intensified towards the development of the summer farming system known from historical times.

The material from Western and Eastern Norway show a number of similarities, but also some major differences. Although the utilisation of a landscape may depend both on natural and cultural conditions, the activity and the exploitation in the Iron Age are most often interpreted as seasonal occupation seen in the context of the growing agrarian settlements, the farms, and the development of political centres, chiefdoms, in low-lying areas, by the fjords and main valleys (e.g. Myhre, 1987; Solberg, 2000, p. 57; Austad, Øye et al., 2001, p. 161; Myhre, 2002, 2003). However, some of the material may indicate more permanent settlements.

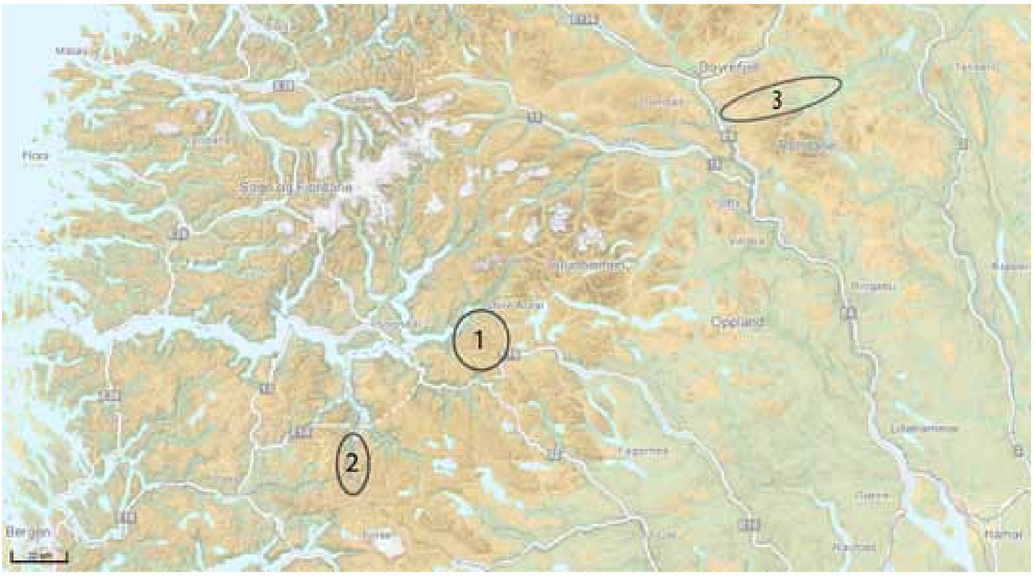


Fig. 1. The location of the three mountain areas discussed in the text; Nyset-Steggje (area 1), Gudmedalen in Flåmsfjella (area 2) and Grimsdalen/Haverdalen (area 3). Map: Kartverket (Norwegian Mapping Authority)

In the paper data and arguments in support of permanent occupation will be discussed. This will be illustrated through archaeological and pollen analytical data from three mountain areas (sub-alpine areas around 1000 m a.s.l.); the area by the Nyset-Steggje drainage systems and Flåmsfjella in the inner fjords in Sogn, Western Norway, and the two adjacent valleys Grimsdalen and Haverdalen at the Dovre region in Eastern Norway (Fig. 1). Traces of settlement remains (buildings) and agrarian activities (livestock grazing and grain cultivation) will be emphasised, mainly in the period ca. AD 1–600. The range of mountains, Langfjella, is separating Western and Eastern Norway. Differences in geology and climatic conditions provide variable settlement and resource potentials. By placing emphasising more on local conditions and the upland communities, the remains of occupation and

Fig. 2. Vikadalen, Nyset-Steggje, where it is surveyed and excavated several house remains sites. Photo: K. Stene

outfield use may display altered relationship to the mountainous landscape, landscape use and management in the Iron Age.

Nyset-Steggje, Årdal municipality, Sogn og Fjordane county, Western Norway

The mountain area by the Nyset-Steggje drainage systems is situated about 950–1350 m a.s.l. in the innermost part of the Sognefjord (Fig. 2). In the 1980s extensive archaeological and botanical studies were conducted and 3 and 4 km^2 sub alpine terrain investigated (Bjørgo et al., 1992). There has been an intensive and long-term utilisation since the Stone Age, probably due to good conditions for wild reindeer and livestock grazing. Botanical investigations indicate that the area was influenced by pastoral activities as early as the late Neolithic. However, it is not before the Bronze Age and pre-Roman Iron Age that a marked vegetation change can be witnessed, interpreted due to an increasing grazing impact (Kvamme et al., 1992, pp. 27–128).

From the Late Roman Iron Age and Early Migration period, the archaeological material enlarges. Numerous sites with house remains are dated from this period and into the Middle Ages. In most cases, buildings were in groups of 2–4 houses, sometimes only one (Bjørgo, 2005, p. 213). The houses differed in size with an inner floor covering of 15–30 m^2 (Fig. 3). The buildings have been solid structures with wide walls made by soil, turf and stones. Hearths were located in the middle of the inner parts of the buildings, and clearly indicate that these were for residential purposes. There is no evidence of buildings that can be interpreted as barns. Based on the rich and varied artefact assemblage a wide range of activities such as spinning, weaving, manufacture of beads and iron objects, as well as hunting and trapping is displayed. Osteological analyses have identified a range

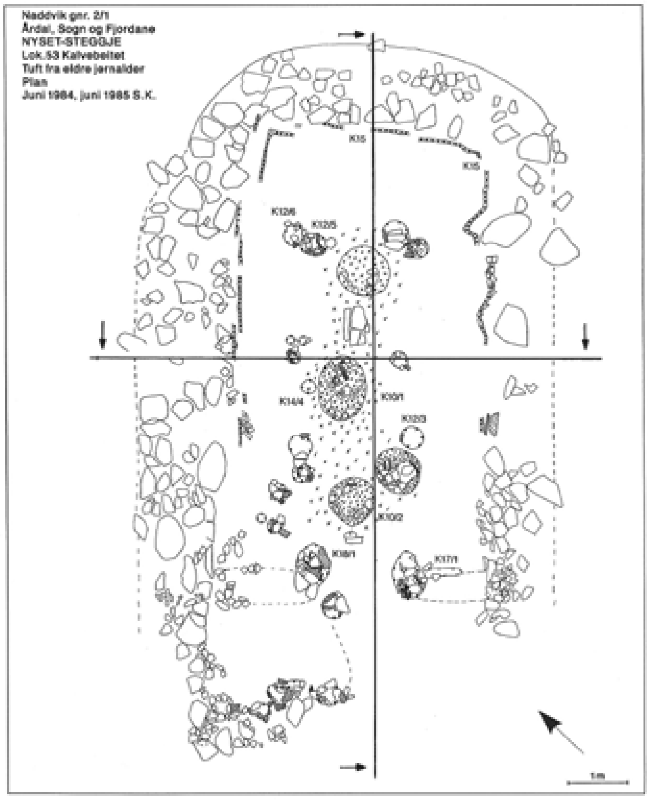


Fig. 3. Plan drawing of a house remain dated to the Early Iron Age at the site Kalvebeite. After Bjørgo et al., 1992, Fig. 130, p. 179

of wild and domesticated species (Lie, 1992). The pollen analysis demonstrates that the areas were intensively grazed in the same Period as the houses were used. Moreover, grain pollen also indicates cereal cultivation at one site, 'Hellingbøen' about 970 m a.s.l. The cultivation may have started around the birth of Christ and lasted until the Middle Ages (Kvamme et al. 1992, p. 62). The total data thus indicate a complex economy. An interesting feature at Nyset-Steggje is that the sites with the oldest house remains are associated with a single or sometimes two grave mounds/cairns. The graves are dated to the Late Roman Iron Age and the Migration period (Bjørgo et al., 1994, pp. 177–187, 231–265).

Fig. 4. The site Gudmedalen, a house remain in the forefront of the photo. Photo: K. Stene

Gudmedalen in Flåmsfjella, Aurland municipality, Sogn og Fjordane county, Western Norway

Gudmedalen is situated about 1000 m a.s.l. at the edge of the mountain plateau Flåmsfjella, surrounding the Flåm Valley in the Aurland fjord, an arm of the Sognefjord (Fig. 4). Here, a collection of at least 14 house remains, and an iron production site dated to the Roman Iron Age is situated ca. 3–400 metres east of the house remains. The site forms a contrast to Nyset-Steggje where only few buildings were surveyed at the same site. The house remains at Gudmedalen are located in two parallel rows. Only two house remains are partially excavated and some of the others are radiocarbon dated. The dates show that the site has been in use from the Late Roman Iron Age into the Viking Age, most frequently in the Early Iron Age. Several of the buildings have probably been in use simultaneously (Indrelid 1988, pp. 111, 116).

Although the buildings differed in size, they were nevertheless constructed in the same manner (Fig. 5). They show similarities with the houses at Nyset-Steggje with their solid wall foundations, but they are generally larger, the longest building 19 metres, and seem to have two rooms. In the inner room there is a fire place, indicating residential purpose. The function of the outer room is unclear. However, parallels with "longhouses" at farms in the lowlands suggest that they might be barns. Few artefacts have been documented compared to Nyset-Steggje, however many of the same categories are represented. The small amounts of artefacts may be due to limited investigation. A grave dated to the Roman Iron Age/Migration Period transition was found close to the largest and one of the oldest buildings.

Pollen analytical studies in Flåmsfjella demonstrate evidence of grazing around the birth of Christ (Moe unpublished). This pattern is also shown in a pollen diagram from a site in Gudmedalen. There is a correlation between the start of livestock grazing and the establishment of the settlement.

The house remains sites – seasonal or permanent settlements?

In mountain regions of the inner parts of Sogn several sites with house remains have been surveyed and some have been partially excavated. The house remains are dated to the Iron Age and into the Middle Ages. Investigations show that the oldest buildings were constructed in the Roman Iron Age, and it may look as if the majority of them were built and in use in the Late Iron Age (Randers 1982, Fig. 2, p. 16; Bjørgo, 1992, p. 304, Skrede, 2005, p. 35). The number of house remains on each site varies from just one to large clusters of a little less than 20. The sizes of the buildings have varied, and whether they contain one or two rooms; most of them have only one room.

Tore Bjørgo (1992, pp. 307–308) concludes that the majority of the house remains in Nyset-Steggje are related to mountain pastures. Moreover, they represent a form of prehistoric summer farming that goes back to the transition between the Roman Iron Age/ Migration Period, with farming traditions back to the Late Bronze Age. It was farmers from the low-lying fjord areas who started using the area in the Early Iron Age when the population growth resulted in limited areas for cultivated fields, pastures and fodder collection on and around the farms. At the same time, the houses in the mountains could also be used in connection with hunting and fishing. A corresponding interpretation has been put forward by Svein Indrelid (1988) for the Gudmedalen site. He argues that the house remains at Gudmedalen represent a summer farm for one of the main farms in the Flåm Valley. Nevertheless, it is clear that the large and solid buildings at Gudmedalen

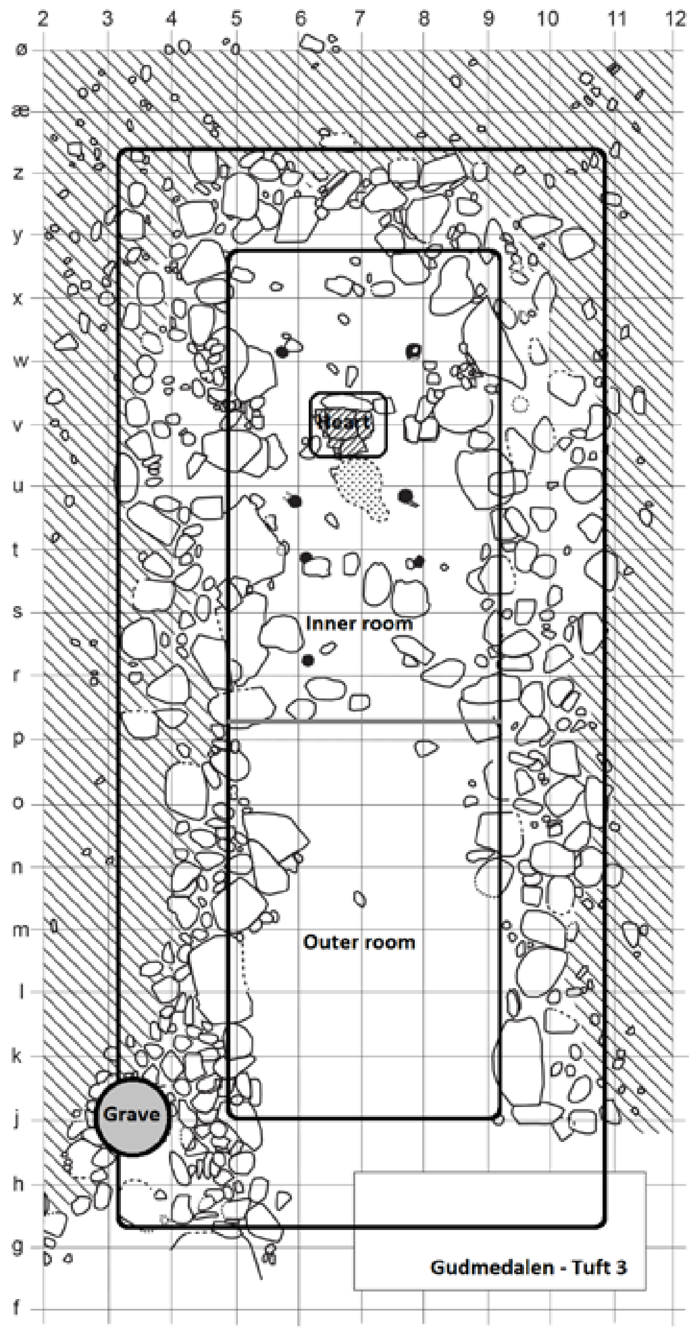


Fig. 5. Plan drawing of a house remain dated to the Early Iron Age at the site Gudmedalen. Illustration: S. Indrelid/E. Hoff, University Museum of Bergen, University of Bergen

Fig. 6. The shieling Tollefshaugen in Grimsdalen. A view towards Rondane in the south. Photo: K. Stene

indicate another form of summer farming than what is known from historical times. In studies of other house remains sites the settlement traces are also interpreted as seasonal occupation; summer farming connected to the farms by the fjords (Magnus, 1986; Randers 1992; Skrede, 2005).

However, the issue whether some of the house remains sites may represent permanent settlements have been raised (Randers, 1982, p. 18; Bjørgo 1992, p. 30; 2005; Kristoffersen, 1993). Bjørgo (2005, pp. 225–227) argues that some of the sites may represent permanent settlements. He claims that there are three indications for this interpretation of the material from Nyset-Steggje: 1) the amount of work that has been invested in the houses, 2) burial mounds close to some of the houses dated to the Early Iron Age, and 3) a general similarity between some of the sites and lowland farms (e.g. Ytre Moa, Årdal (Bakka, 1971)). He also refers to historical sources from the eighteenth century where permanent settlements with cattle and cereal production have been documented close to 1000 m a.s.l., along the mountain route between Hallingdal (Buskerud county, Eastern Norway) and the Sognefjord.

Siv Kristoffersen (1993) discusses the mountain settlements from Sogn, including Nyset-Steggje, in connection with her analysis of the low-land farm Modvo in Sogn. She sees mountain settlements as part of the "decentralised farm structure" in the Iron Age. In the Roman Iron Age and Migration Period this structure is expressed by a low-land farmstead as a base. Related settlements in the mountain valleys were the extensions of this base and thus the use of the mountain in winter. Various members of the household

Fig. 7. The shieling Haverdalsseter in Haverdalen. Photo: K. Stene

related to the base unit may have been responsible for different operations, where the mountain settlements took advantage of the good hunting and grazing opportunities. Lack of barns suggests that the animals were kept in the lowlands during the winter.

Grimsdalen and Haverdalen, Dovre municipality, Oppland county, Eastern Norway

The two adjacent valleys Grimsdalen and Haverdalen are situated in the mountainous region of Dovre around 820–1100 m a.s.l. The valleys contain good quality meadows for husbandry and conditions for wild reindeer, and this reflects the activities taken place in the valleys in a long time perspective, namely hunting and trapping of reindeer, and livestock grazing and summer farming (Fig. 6). Unlike the Sogn district no prehistoric house remains related to pasture or graves dated to the Early Iron Age are known from the district.

Pollen analysis from *Grimsdalen* demonstrates that the landscape changed at the later part of the Bronze Age and during the pre-Roman Iron Age (Høeg, 2011). Excavation of a pitfall trapping system for reindeer, indicates that it was established and in use in the latter part of the Bronze Age and through the pre-Roman Iron Age. The use of the system probably ended around the birth of Christ (Stene & Gustafson, 2011, pp. 68, 108). In the following centuries, traces related to grazing are recorded in the pollen diagrams. Clearer evidence of grazing and reduction of the forest can be shown throughout the Roman Iron Age and Migration period (Høeg, 2011, p. 153). An interesting feature is that several pits in the trapping system seem to be intentionally re-filled at the same time, tentatively suggested due to livestock grazing.

Pollen analysis from the shieling Haverdalsseter (ca. 1050 m a.s.l.) in *Haverdalen* (Fig. 7) demonstrates a different pattern than the analysis from Grimsdalen (Høeg, 2011). The most striking difference is traces of cereal cultivation. A first attempt of grain cultivation occurred as early as 500 BC, together with livestock grazing. From the transition to the Late Iron Age there is continuous grain cultivation of oats and barley, and somewhat later of rye into the Middle Ages. The local climatic conditions at Haverdalsseter may have been the reason for the long period of cultivation. The continuous production of grain seems to suggest that there has been permanent settlement; a farm may have been established in the latter part of the Early Iron Age (Stene & Gustafson, 2011, p.109). A pitfall trap system for reindeer is crossing the shieling. The system is not dated, but some of the pitfall traps are refilled indicating that the system is older than the establishment of the present day shieling.

Similarities and differences in settlement and outfield utilisation

The review of the material from the three areas point at a number of similarities but also some major differences in occupation and outland use. In all regions an intensification of livestock grazing is happening around the birth of Christ, but the evidence is much clearer in Western Norway. For a few sites there have been long periods of cereal cultivation, as early as from the Roman Iron Age. The most striking disparity is that solid houses are built from the Roman Iron Age in Western Norway. A number of artefacts display a wide range of activities, activities that are as much reflective of ordinary farm activities as anything specialised in relation to animal husbandry. The investigated house remains sites at Nyset-Stegje and Gudmedalen, as other sites from Western Norway, have many similarities but they are also different, as shown above. Despite this, the houses are primarily related to livestock grazing. However it is argued that some of the sites may represent permanent settlements. In Eastern Norway the equivalent or other buildings related to pasture are not known from the Early Iron Age. This may be due to different construction practises leaving no visible traces of buildings on the surface, or an absence of this type of settlement.

Despite the fact that there are differences in the material, most of the previous interpretations are more or less identical. The traces of settlement and outland use are interpreted as seasonal occupation related to the lowland agrarian societies and seen in the context of the development of chiefdoms.

During the Iron Age the rural settlement expanded in the lowlands. This led to pressure on areas around the farms, especially by the fjords and valleys in Western Norway where there probably has been a shortage of arable land (Solberg, 2000, p. 153). It was necessary to make use of grazing resources in the mountains, and therefore the mountain pastures became part of the farming system. However, it is unlikely that there were shortages of arable land in the main valleys in Eastern Norway during the Early Iron Age although the exploitation included agrarian activities in the mountains may reflects the farming expansion in the lowland main valleys. The pollen analytical data from Grimsdalen and Haverdalen and Dovrebygda, the adjacent present day agrarian community, suggest that livestock grazing and cereal cultivation occur earlier in the low-lying main valley than in the mountains. However, an intensification occurs during the Roman Iron Age, strikingly simultaneous in Dovrebygda and in the mountainous areas (Gunnarsdóttir, 1999; Høeg, 2011).

The establishment of the house-sites is more or less simultaneous to a change in the furnishing of some graves that can be observed along the coast of Western Norway (Myhre, 1987, p. 169; Mydland, 1990, pp. 38–39). Roman imports appear more frequently, as well as items of silver and gold, weapons and jewelry of high quality (Myhre, 1987, p. 170). Outfield products such as wool, textiles, skins and antlers were important for the kingdoms of Europe, and it is claimed that political leaders in the Scandinavian centres knew to take advantage of long-distance trade in such commodities (Kristoffersen, 1993, p. 204; Myhre, 2003, p. 61). The buildings and related animal husbandry in the mountains may therefore be connected with production of wool and textiles, maybe also hunting/trapping products; products that was intended for exchange or trade.

The agrarian activities are not so clear in the mountains in Eastern Norway. From the main inland valleys there are few grave finds from the Early Iron Age, and it is assumed that permanent farming settlements were established relatively late, in the Migration period such as Dovrebygda (Hougen, 1932; Hofseth, 1980; Mikkelsen, 1994). However, botanical analysis and many trapping systems for wild reindeer in adjacent sub-alpine areas dated to the later part of the Roman Iron Age and Migration period, suggest a relatively largely settled and organised society of a certain size at that time (Finstad & Vedeler, 2008; Finstad & Pilø, 2010; Nesje, Pilø, Finstad, Solli, Wangen, Ødegård, Isaksen, Støren, Bakke, & Andreassen, 2012). The scale of the trapping points to a surplus production and that the trapping products were part of exchange or trade systems. This may indicate that hunting and trapping played a more important role within the economy in the communities in Eastern Norway than in Western Norway.

Sign of changed values in social structures and perception of landscape, landscape use and management?

The material from the mountain areas must be viewed and explained in the context of the expansion of farm settlements and the developments of political centres in low-lying areas. But it may be fruitful to study the material more on its own terms, on a local level. The so-called marginal communities with their inhabitants have been a part of the general society in the Iron Age and could therefore be prime movers in outfield utilisation. By emphasising more on the upland societies and local conditions, more nuanced interpretations about changing perception of the landscape, landscape use and management appear.

The exploitation of the outlands demands specialized knowledge, equipment and organisation. If more permanent settlements were established in these landscapes, it is likely that it was a conscious choice that the people who settled here was familiar with these landscapes and the opportunities these landscapes gave. The ability to combine agriculture with other niches such as hunting, trapping and fishing was probably a driving force, an aspect that is well known in Norway (Martens, 1989:74). This is a topic that has been central in Norwegian research (e.g. Brøgger, 1925; Gjessing, 1944; Hougen, 1947; Bakka, 1973; Martens, 1989). The valuable products from the mountains, such as wool, textile, antler, skins and hides, could be exchanged or traded for goods they could not produce themselves. In the mountain areas the condition for "ordinary farming" was limited. The cereal cultivation was therefore probably not a main economic resource. Maybe the cultivation was more like a social strategy of expressing a farmer-identity.

The presence of grave mounds at some sites with house remains does not necessarily have direct significance for the question of permanent settlements in the mountains (Kristoffersen 1993). The graves are only found in connection with the oldest houses, dated to the Late Roman Iron Age and Migration Period, and therefore represent the establishing of this type of settlement. The graves in the mountains may therefore represent claims to the use of land. It is possible that the graves also have a direct connection with the establishment of property rights (Kristoffersen, 1993, pp. 201–202; Prescott, 1999, p. 220).

In Grimsdalen and Haverdalen there is no evidence of similar house remains or grave mounds from the Early Iron Age. However, it may be useful to transfer the interpretation regarding ownership/property rights to this material. The use of the pitfall trap system for reindeer in Grimsdalen ceased when livestock grazing increased. Some pits were intentionally re-filled at the same time. This suggests an altered relationship to the landscape, where an agricultural ideology now prevails. Furthermore, it may indicate that some actors – families or groups, tried to establish ownership or property rights to the mountain areas. Nonetheless, the many stray finds of arrowheads show that hunting and trapping was still important for the local economy.

Rupture and changes in the exploitation and occupation of the mountainous areas in the Iron Age can be interpreted as a sign of changed values – in social structures and perception of landscape use. As such, the establishment of settlements, whether it is seasonal or permanent, may be seen as a colonization of these landscapes and shows resilience within the local communities. Through occupation and resource exploitation the local inhabitants could maintain their identity and be a part of the social changes that occurred in the later part of the Early Iron Age, with the development of more hierarchical societies.

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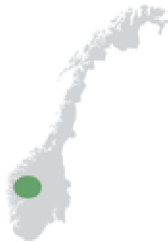
The outfields as a precondition for farming in the early historical period



Jan Anders Timberlid

Abstract
Agriculture in the early historical period was dependant on the outlying fields to produce the increasing needs for food. This meant a constant pressure on the resources within the limits set by labour and technology. The utilization of the outlying fields through grazing and harvesting of fodder were of crucial importance, and allowed the farmers in Sogn og Fjordane County, Western Norway, to keep cattle and sheep over the national average in the 1850's. Through the winter-fodder from the outlying fields the arable soil got manure as a bonus; through this transportation the unbalance between arable soil and meadow on the inlying field was equalized. Through this the farmers were able to produce the necessary food and were able to feed the increasing population in the first half of the 19th century.

Introduction

The presentation is an attempt to say something about the significance of the outfields in the old animal husbandry in Sogn og Fjordane, Western Norway, that is to say, in the period up until the big changes emerged in the last half of the 1800s. A common feature of several rural districts was that they had limited access to cultivated land or land that could be cultivated. On the other hand, many of them, especially the central and inner ones, had access to large outlying areas that were to become the basis of a large livestock production. The summer farms/shielings, found in different distances to the farm, were important. The term summer farm will in the following be used for shielings in the mountains used during summer time, whereas spring and autumn farm are found between the summer farm and the farm.

Extensive animal husbandry

In the mid-1800s, the county of Sogn og Fjordane was among those with the highest average of livestock keeping per farm; the Census of Agriculture in 1855 showed that only Oppland County had more (Dyrvik, 1979, p. 28). Rich grazing areas ensured an abundant supply of summer fodder, but the thing that was to become the minimum factor, however, was the winter fodder. It was a type of livestock keeping that struggled along through the winter due to a disproportion between the number of animals and the amount of winter fodder that had been grown. In the summer half of the year, however, there was plenty of fodder from pastures to choose from when both fodder collecting and pasturing were moved to the outfields. In those areas where the access to outlying areas was limited, farmers took the consequences of this and had a different type of production with a stronger emphasis on house feeding; the calving and the milk production had, among other things, to be adapted to a house feeding period. Topographically, there are large differences in Sogn og Fjordane, something

Fig. 1. Map of Sogn og Fjordane county with municipalities mentioned in the text. Illustration: B. Helle

which led to different types of exploitation (Fig. 1). Large outlying highlands are distinctive characteristics of central and inner parts of Sogn and inner districts of Sunnfjord and Nordfjord. The remaining parts of the county were worse off with a limited access to summer fodder. The farmers took this into account and had a different type of annual rhythm than the above-mentioned; the farmer had, among other things, to plan for a longer period of house feeding. In his characterisation of Larvik Parish from the 1830s, Ole Elias Holck (1968, p. 27–28) talks about a more balanced feeding and production throughout the year:

«De Gaarde som have meget ringe Sommergræsning gjøre dog heri en Undtagelse fra Regelen, thi da Disse maae producere det meste af deres Smør, Ost etc. om Vinteren, saa holde de forholdsvis en mindre Besætning og fodrer runderligere.» (The farms that have very poor summer pastures still make an exception to the rule in this, and as they have to produce the majority of their own butter, cheese, etc. in the winter, they keep a relatively small livestock and feed them more generously.)

Winter and summer fodder – an imbalance

The available cultivated land was used for arable farming. Based on the Land Registry Commission from the 1860s, grasslands on uncultivated ground produced small crops compared to cultivated meadows.

But there were large differences between the high-quality and the poor hayfield. The best meadow was one that had some manure spread on it, and in addition had been cleared of the biggest stones. These fenced-in meadows produced the best hay, which was given to the dairy cows and the horse. The amount of nutrients and feed value could often be the double compared to the poor hay that was cut in the outskirts (Timberlid, 1990, p. 42). Some cultivation efforts were also made on this type of land. As there were trees all over the fenced-in meadow, it had to be cleaned up first thing in the spring. This means that it was raked and twigs and leaves were cleaned out. This meadow was only occasionally fertilised; the only form of manure came from grazing livestock. This grazing, which took place everywhere on the infield areas in spring, was in many ways disadvantageous as it contributed to a considerable reduction in the meadow's production ability. The result was, accordingly, small crops and hay of a very varying quality.

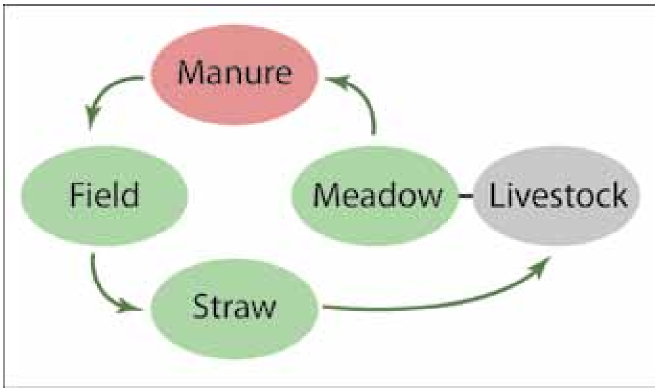


Fig. 2. The nutrient balance on the infield between tilled land and meadow. Here the manure is an essential condition for tilled land to produce enough food. Illustration: J.A. Timberlid/B. Helle

The imbalance between the periods of house feeding and grazing thus produced a shortage of manure. This had to be solved to secure that the most important production area, the cultivated fields, did not lose any nutrients. In both contexts, both as regards the winter fodder and the manure, the outfield turned out to be the factor that corrected this imbalance.

Shortage of manure

The period towards 1850 was marked by a strong population growth, a fact that put increasing pressure on the soil at a time when the majority of the population had their economic base in agriculture. A lot of the available land was used for cultivation, and this led to a shortage of winter fodder. A stronger emphasis on arable farming produced more "direct" food. But in the long run, this change in the relationship between the livestock and the cultivated area had negative consequences for the tilled land. The nutrient balance in agriculture was thus made worse because a stronger emphasis on crop farming led to a shortage of manure; with less winter fodder, the farmer would have to reduce the number of animals in his herd, which in turn produced less livestock manure, barren fields and decreasing yields (Fig. 2).

The haymaking in the outfields

The most important winter fodder collected from the outfield was hay. This was cut almost everywhere where grass was growing. Today, it is easy to envisage a clear-cut division between the infield and the outfield, but 150 years ago, no clear-cut divisions existed in the cultural landscape. The farmers hardly distinguished between the fenced-in meadows surrounding the farm houses and the outlying meadows; where the boundary between infield and outfield lay, could often be hard to define.

In the outfield, they cut grass even in the most inconvenient places and the quality of this outfield hay varied a lot. The hay that was cut on the summer farm pens could measure up to the best of the infield hay because manure from the summer farm barn had been spread

Fig. 3. The foliage was stored in so-called *lauvrauk* (stacks containing bunches of twigs with leaves) until winter. The fodder was then brought home in snowy conditions. Photo: Private

on it. This was not the situation for the other outfield plains. At the best, droppings from grazing cattle helped manure it, and generally this hay was of poor quality. The farmers probably tried to collect the hay as close to the farm as possible because the time was limited during summer. The nearby strips of fields were the most sought-after, and each holding obtained rights to areas where the land had not yet been divided. In these areas, the majority of the outlying meadows were situated at heights up to ca. 300 m a.s.l., and the grazing animals had no access there. But they also cut grass further up in the mountains, even though it took a considerable amount of work to get it home. Haymaking this far away was in particular carried out in connection with the work at the summer farm. Quite often there was a considerable amount of work to do and people had to come up from the main farm to lend a hand. The meadow around the mountain dairy itself, which was fenced-in, was lying on the open milking-place for cows, but examples from Inner Sogn show that meadows also could be located further down. Here too, the hayfields were clearly delimited from the grazing land.

A certain system seemed to be regular; if parts of the outfield were to be used for haymaking, it could not be heavily grazed during summer. If these resources were to be used as winter fodder, grazing land had to be provided for the livestock elsewhere in the period when the grass was growing in the outfield. The only thing that could release the resources for winter fodder was the practice of summer farming. Thus, grass was made the best possible use of: at first, as pasture for a short period of time in early summer, adding some manure to the soil from the grazing animals. Then the grass had a chance to grow undisturbed until it was cut in July/August in order to once again be used as grazing land for the farm animals who were returning from the mountains at some point in September. But this also gives us some additional information; the longer they managed to keep the livestock at the summer farms, the more winter fodder could be harvested from the outfield.

As regards the amounts of harvested hay, we have reports from 15 out of 37 municipalities from the 1860s. On average, the outfield haymaking represents nearly a fifth of the collected winter fodder. The variation is, however, large; from Luster where hay from outfields amounted to almost half the winter fodder, to Gaular, where it amounted to only 4%.

Other types of fodder from the outfield

Of the other types of fodder collected from the outfields, foliage was the most important one. But as mentioned earlier, a clear-cut division between the infield and outfield did not seem to exist. In the fenced-in meadow surrounding the farmhouses, dense clusters of deciduous trees were growing, and leaves were cut. The Land Register mentions that foliage cut in the infield was used in the majority of the municipalitites, but few have specified the amounts. One thing is certain: It was important in many rural districts, particularly where the sheep husbandry was important. The leaves were mainly collected in bunches, that is, fresh branches with leaves were cut in lengths of 1–1.5 m and tied together. The foliage was usually dried where it was cut, and if the distance to get back was convenient, it was transported back home right away and stored indoors. If it was further away, the dry bunches of leaves were stacked together and transported back home during winter when the overall workload was reduced.

What types of leaves people collected depended on what was available, but there were strong opinions as to which were the best ones. The fresh foliage could also be removed from the trees by hand, and in many places they raked and swept the fallen leaves together into piles. In the spring, they used branches without any leaves, broke the twigs off and gave them to the animals (shredding). If the trees were thicker, the bark was peeled off and then used as fodder (Fig. 3).

As regards the foliage, it was problematic to get data on the amounts collected in the outfields. One open question is whether we will obtain reports on the harvested foliage; another is where this was taken. From Gloppen and Breim, we know that the deciduous forest was dense, also in the infield, and it is therefore highly likely that some leaf-cutting took place here too. But for the most part, we have to assume that the majority of the foliage was gathered from the farm's neighbouring hillsides, and that this belonged to the nearby outfield.

Other types of fodder that were widely used were peeled bark, beet, seaweed and moss. How much, however, is hard to get hold of; the Commission from the 1860s sometimes set a value on these resources, but to conclude from this what the amount may have been, is impossible. As regards reports on the other types of fodder, peeled bark/scarpings and twigs with buds, few figures are available. From Hafslo, however, we have reports on how many cows they could keep. In this case, scraping and bundled spring twigs could have fed 173 cows over the winter, which means that there was enough winter fodder for 3% of the livestock.

Would it then be possible to say something definite about the volume of this fodder? Could it be that the foliage was merely half the meal – literal translation of: «lauvet var halve føda"? We can examine the reports obtained from the preparatory writings of the Land Register. Even if this is a thin basis on which to make a statement, we have some leads. That the foliage represented half the fodder is in all cases rejected by these figures; the foliage played an important role in Jostedal where it represented 15% of the winter fodder. In other municipalities with available figures, this fodder type amounted to ca. 4%.

The precondition for this activity was an abundant labour supply; increasingly more manpower was needed in order to bring this fodder back home and it took quite a few days from the most remote outlying meadows. In addition, this happened at a time of the year when the family had other tasks. This is why we often see that the outfield fodder was stored until the arrival of winter and people had more time available to bring it home.

Besides, this was easier during the winter time because bogs and lakes were frozen. But they also brought the fodder back home when it was dry or freshly cut.

This work could also be dangerous and a risk to one's life. In the autumn of 1825, the three young people Johannes and Bård Bårdsson Kvåle and Synneva Trondsdotter Kvåle from Sogndal went to the outfields to cut heather. They loaded a boat and rowed across the fjord where they met with a strong wind and the boat overturned. None of them were ever found. In connection with the leaf-collecting, they often had to climb trees to cut the branches, and slippery shoes made it difficult to find foothold. On 7 July 1841, Lars Mikkelsson Nornes fell down from a birch tree in the outfield in Sogndal and was killed. While driving hay from the outfield in Sogndal, the 16 year old Hans Lassesson Åberge lost his life in January 1861.

The nutrient balance restored

As mentioned at the beginning, a shortage of winter fodder in the infield was found, which in turn led to a too small amount of manure for the tilled land. This value stream improved the manure situation a bit after a reorganisation from meadow to tilled land had taken place in many rural districts. The production of winter fodder could be moved to the outfield, an area that had previously been reserved for grazing. The advantage of such an arrangement would be that the farmers could keep more animals, and this would mean larger amounts of manure which in turn could lay the basis for large areas of cultivated land. This could thus replace some of the manure loss that took place when meadow was converted to cultivated land. Because the amount of manure in many places determined the agricultural area, the grain-growing was influenced by the animal husbandry and hence also by the utilisation of the outfield. The livestock in good grazing districts was more determined by the forage from pastures than of winter fodder produced in the infield. We can thus see a clear link between agricultural area, livestock keeping and outfield use. With the help of the outfield, the farmers could keep a larger livestock than they could if they only had the infield to resort to. Moreover, the infield was dependent on a period of rest if it were to produce any winter fodder at all. This is why the farmers tried to bring the animals to the outfields as soon as possible.

How important was this outfield fodder to the farmers? The source material is rather weak as regards expressing this, but indirectly we learn that those farms that to a large extent collected fodder in the outfield, kept more animals and in generel fed them better than those who had only the infield as fodder producer. It wasn't only farms that did poorly and cotter's farms that started exploiting the outfields for this fodder. Farms with rather large infield areas also used this resource. The question is whether the significance of this fodder increased as the pressure on the resources increased in the 1800s. To make a general statement about this is difficult. Still, in many rural districts, the exploitation was so extensive that both the in- and outfield were exploited too hard, as expressed by bruksdeling (the division of a farm into several parts), strip farming, cotter's farms and poor manure management. One could say that things were heading towards an ecological crisis.

The outfield as grazing area

But it was as grazing land the outfields were to play the most important role in the old farming community. The grazing period in the old farming system was a time of production. In late winter, the calves, the lambs and the kids were born, and most of the milk production took place when the animals were grazing the pastures.The outfield was thus the very foundation of the animal husbandry at that time. In these short summer months, the livestock had more or less unlimited amounts of fodder in the central and inner rural districts. The variation did not only apply to pasture quality and quantity, but also to climatic differences that played a part in deciding the length of the grazing season.

In areas with abundant pastures, the foundation for a large livestock was present. The house feeding, however, was worse off; seen in relation to what the infield could provide of winter fodder, the livestock was too large. From that time's way of thinking, it was not only the economy, but also a matter of prestige to keep as many animals as possible in the barn. It was important to be able to feed as many as possible through the winter and then to let them out to graze the next spring. How many animals one could have at grass, was in reality controlled by the number of animals the farmer could winter-feed on the farm. In periods when there was plenty of space on the pastures, this was not a problem. But when conflicts over the grazing land arose, stricter demands were placed on the size of the livestock, and one had to, among other things, resort to expert assessment over the pastures. There are many examples of this; in some rural districts in inner parts of Sogn it was decided how many kyrlag (a unit of a certain number of cows) per skyldmark (taxes owed in "mark"=unit of money) each farmer was entitled to (e.g. Timberlid & Selseng, 2007, p. 318). But in essence, the conditions were not that tight regarding summer pastures as the situation in Inner Sogn; largely, one could put to grass what one managed to raise where wide stretches of pastures were available. It was important to have many animals grazing throughout the summer in view of the fact that it was during these few months the actual production took place.

The summer farms in the mountain

The summer farms were an important part of the pasture system. This is, among other things, confirmed through an investigation carried out by dairyman J. Grude on the upland summer dairying in Western Norway in the 1880s. Here we can read that of the 1.8 million litres of milk that were produced yearly in Balestrand, nearly half of it came from the 110 days of mountain dairying (Grude, 1891, pp. 148–149). But there were great variations between the individual municipalities, depending on how good the pastures were. The summer farms were supposed to provide grass for the livestock as the outfield grass gradually grew taller. Simultaneously, the summer mountain grazing was supposed to relieve the pressure on the outfield close to the farm so that it could recover until it was time for the animals to return as autumn approached. Thus we see that the part that was situated downhill was left in peace the entire summer. On the whole, there existed a complicated regulatory framework for the use of the pasture resources. In the old farming system, the production took place during the grazing period. In this period, the farmers fetched their profit from the livestock, and it was therefore important to extend the grazing season as much as possible. Best conditions had farmers who could use the pastures at different times during the summer, which in practice meant where the difference in altitude between the farm and the summer farm was marked. The placement of the summer farms was to a large degree determined by topographical and commercial conditions. This means that we find large variations in the county as regards how many summer farms the different bygdelag (rural local organizations formed by the inhabitants in a "bygd") had, where they were situated and how useful they were.

The landscape in the outer parts of Nordfjord, Sunnfjord and Sogn was not shaped in such a way that it was possible to have a stage

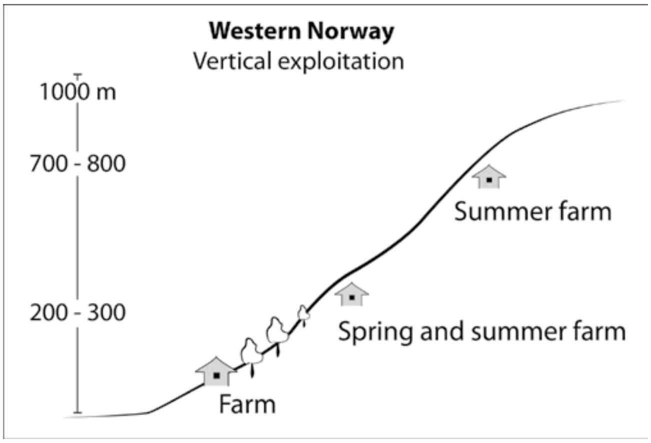


Fig. 4. Parts of landscape in Western Norway was of a nature that could be exploited vertically. Thus, the farmers established summer mountain farms in the uplands so that the grazing season could be extended. Illustration: J.A. Timberlid/B. Helle

by stage system as was the case in inner Sogn. In addition to the summer farm in the mountains, the farmers had shielings mainly found in an area up to 300 m a.s.l., used in spring and autumn. In the autumn and spring, the animals were grazing in the area close to home where there were no living houses, but in some places they had a dairy barn. This is where the milking took place. It wasn't only the cows and the goats that were milked; they also used the milk from sheep. Because many of these milking sheds were lying at the edge of a wood, the distance to the milking area was short. Obviously, if the farmers were to exploit the spring farm early in the summer, it could not be situated too high up in the landscape. To be able to move the grazing gradually from low-lying to higher-lying areas as soon as the grass had reached a certain size, it was essential that it was lying in the correct height between the infield and the summer farm. If we take a look at the extent of spring and autumn farms, the distribution of this system is varying. The system seems to be most common in the middle and inner parts of Sogn, of which Jostedal stands out.

The summer farms were situated above this area. The majority seemed to lie in an area about 3–600 m a.s.l., and here the treeline was the upper limit in that it provided a supply of firewood. Very few were situated below 300 m a.s.l., while municipalities like Balestrand and Luster had summer farms well above 600 m a.s.l. For Luster's part, the majority were found above 600 m. In fact, seven summer farms were situated at a height of 1000 m a.s.l. Besides, one third of the spring and autumn farms were lying above 300 m a.s.l.

The road up to the summer farm varied a lot; for those that were situated furthest away, it could be a couple of hours' walk (Timberlid, 1990, p. 55ff). At the ones lying closest, the dairymaid went up in the evening and did the evening and morning milking. She brought the milk down to the farm where they made cheese and butter of it. When the grown-ups were away, the shepherd boys and girls were responsible for the animals. These so-called summer dairy farms were more common in Jølster, Naustdal and in parts of Nordfjord (Timberlid, 1990, p. 56). They are found in refined versions where the distance to the summer farm was fairly short and where the livestock keeping was comparatively small. Geographically, this type belonged in the outer areas of Western Norway. If we move further inland in the county, we find intermediate and mixed forms. Here, the dairymaids did the majority of the work and transported the milk products home to the farm a couple of times a week. Because the milk was used for cheese and butter production, she could take on more dairy cows compared to what was possible for a summer dairy farm where only milk was produced. This type of summer farming manifested itself also in outer parts of Sogn. In the inner parts of Sogn, we find summer farms where the dairymaid lived the whole summer (fullseterbruk). This type of summer farming allows for a higher number of animals than the other types; in fact, we find

Fig. 5. During the summer the cows were brought to the mountain summer farms where the women took care of the milking and production of cheese and butter. Photo: Private

a number of examples where the dairymaids looked after animals that did not belong to the farm (Fig. 4).

The conditions regarding where the summer farms could be situated were strict. It was not an option to establish one too high up in the landscape; one precondition was that the snow would have to disappear quite early so that the pastures could start to green up. If the summer farms were siuated too high up in the landscape, the animals would have to be let out at a later date. In a situation like this, the infield, or possibly the close-by outfield, would be heavily pressured in its capacity as a hayfield, resulting in reduced crops. But the pastures needed to be good; this was especially essential to the dairy cows that needed good fodder to produce satisfactory milk in the short period they spent on the summer farm. It was thus essential to find the most suitable height with a reasonably long grazing period where also good and plentiful pasture was available. Usually, one could find a concurrance between the treeline and summer farms, where the latter usually were situated fairly at the same height or a little bit above the treeline. As regards the supply of firewood, it might also be convenient to place them close to the treeline. For the production of cheese they needed large amounts of firewood, and by placing the summer farm close to this energy source, they problaby lightened the work situation for those people who had to transport all the firewood to the houses. As the wood gradually thinned out, the treeline would creep quite a bit further down the landscape. Thus, it became problematic to provide enough firewood for the cheese making. It was also important to have ample supply of good and cold water in connection with the cheese and butter production. A final factor needs to be mentioned; namely that both the meadow and the buildings had to be safely located in relation to snow- and rockslides. But it might prove difficult to fulfil all the above-mentioned requirements.

We have now, based on the topography, been able to create an image of where the summer farms were placed and the types that were most common around 1900. If we go back to the years around 1850, when the pressure on the outfield was even stronger, we would expect an even higher number above 600 m a.s.l. With the concurrent pressure on the outfield resources, the farmers were forced to move further out in the outfield areas to avoid conflicts that could arise in areas at lower altitudes in the landscape. Here it was not only the grazing from other summer farms one could get mixed up with; the outfield haymaking was also an important part of the exploitation of the resources in this area, even if it for the most part took place further downhill in the landscape.

We have now mentioned these continuous movements in the landscape, and we also touch upon the function of the summer farms; this system was supposed to provide alternating pastures for the animals while they attained full growth (Fig. 5). But how comprehensive was the system at its peak in the middle of the 1800s? In this connection, it is natural to look at the volume based on three factors: the number of summer farms, the length of the period at the summer farm, and most importantly; the number of grazing animals.

The number of summer farms

The oldest reports we have of used summer mountain farms come from Dairyman Grude from the 1880s, a material he had obtained by interviewing local people. But these pieces of information are unsure, as he clearly states in his commentary on the work. Despite these weaknesses, he documents that in the middle and inner parts of Sogn, nearly 100% of the farms had summer farms. He had obtained similar figures for the inner areas of Nordfjord and Sunnfjord. In the outer areas, there were but a few. Twentyfive years later, the first comprehensive Census of Agriculture was conducted; the counting from 1907 includes, among other things, reports on the number of summer farms in use, the number of animals on the summer farm and how long they stayed there. This is the first time we get reports that record the use in such a great extent. It underpins Grude's reports. In the 1930s, the Institute for Comparative Research in Human Culture (Instituttet for sammenlignende kulturforskning) carried out a census of summer farms. In this, guarantors of titles were to record both summer farms that were in use and those that had possibly been used in the past. With this, there was a hope to go back to the middle of the 1800s, a period when summer farming was at its peak. If we compare this information with the census in 1907, we can rectify the information from both Grude and the Census of Agriculture. The pattern, however, stands firm; the number of summer farms was highest in the inner areas of the county, but decreases as we get closer to the coast.

The time at the summer farm

In order to find out how much the summer farms were used, we can look at how many days they spent there on average. Large differences were found, and the most important criteria for a lenghty period, was the quality of the pastures. In the best pasture districts in inner Sogn the animals and the people looking after them spent as much as 105–110 days on the summer farm. The reason behind this is that the inner rural districts had larger grazing areas at various altitudes and a higher number of summer farms. With additional spring and autumn farms, they could extend the grazing season considerably compared to those who only had one. We see a clear concurrence between those municipalites having summer farms that were used for long time periods and those that had several summer farms available. But also the availability of good pastures as well as how many animals that had been sent to the summer farm, would decide the length of the period they spent there. Other special conditions that could decide how long they stayed could be the weather that particular summer. But also the farming system itself was decisive as regards the length of the time spent at the summer farm; it did depend on, among other things, how long they could manage without the work capacity of the dairymaid in a hectic season.

The number of animals on the summer farms

The number of summer farms and the length of the period they spent there may say something about the extent of the summer farming system. To find out the number of animals they kept there may, however, be more important. When we talk about grazing animals on summer farms, we essentially refer to dairy cows, young cattle and goats. But the sheep was also important because it was milked in the old animal husbandry. In inner Sogn, an example of this was found as late as in 1870, and the sheep thereby had to use the same grazing land as the other animals. The beast nuisance also stressed the importance of keeping the herd consentrated in one area. To keep the animals from being exposed to beasts of prey, the farmers hired shepherds. This meant a more concentrated grazing compared to the type we see later when sheep are left unattended for long periods of time. The same grazing pattern was found for the young animals, a collective grazing in certain areas during the day, and then brought back to the summer farm at night where they were gathered within a small area.

As documented by Grude, the 1880s was a period when farmers in the middle and inner parts of Sogn sent nearly all the dairy cows to the summer farm. He also found similar figures in inner Nordfjord and Sunnfjord. These figures were confirmed by the Census of Agriculture in 1907, when 95% of the dairy cows in the middle and inner parts of Sogn were sent to the summer farm; there is a small difference between the municipalities here, somewhat smaller for the inner areas of Sunnfjord and Nordfjord. As regards the outer areas of the county, the number of animals was low because considerably fewer farms had a summer farm. As for the goats, we find nearly the same high numbers as we did for the dairy cows. If we turn to the young cattle, the figures are higher compared to the number born on the farm back home. This comes as a result of the large intake of animals on hire on the summer farms.

Was the outfield the foundation of the farming system in the early historical period?

To produce the food that was needed, farming in earlier time periods depended on the outfields. There was a constant pressure on the resources, within the limitations that workforce and technology sat. The outfield in the capacity of grazing land and winter fodder came to mean a lot to enable the farmers to have a number of animals above the average in the 1850s. In connection with the winter fodder from the outfield, the farmers also got the farmyard manure into the bargain; thus, the imbalance in nutrient balance on the infield between tilled land and meadow evened out. They were thus capable of producing the food they needed and managed to keep up with the strong population growth in the first part of the 1800s.

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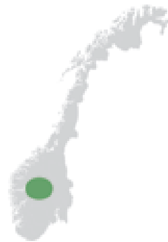
Market places in "Mountain-land" – a research project on communication and exchange of commodities in the Viking Age and the Middle Ages



Kjetil Loftsgarden

Abstract

In the Norwegian Viking Age and Middle Ages there is an increase in specialized production and utilisation of resources. A prerequisite for this was stable exchange networks and seasonal market places. The market places were arenas not just for economic transactions, but functioned as one of the sole assemblies, and thus had social and political implications. This project aims at investigating these market places and the role they played in the society as a whole.

Introduction

Written during the latter half of the 12th century, "Historie Norwegie" divides Norway in to three geographical areas, The Coastal-land – *Zona itaque maritime*, The Central or Mountain-land – *Mediterranea zona/ De montanis Norwegie*, and the land of the Sami people – *De Finnis*. The main focus for this project is the "Mountain-land" and the distribution and trade of the resources

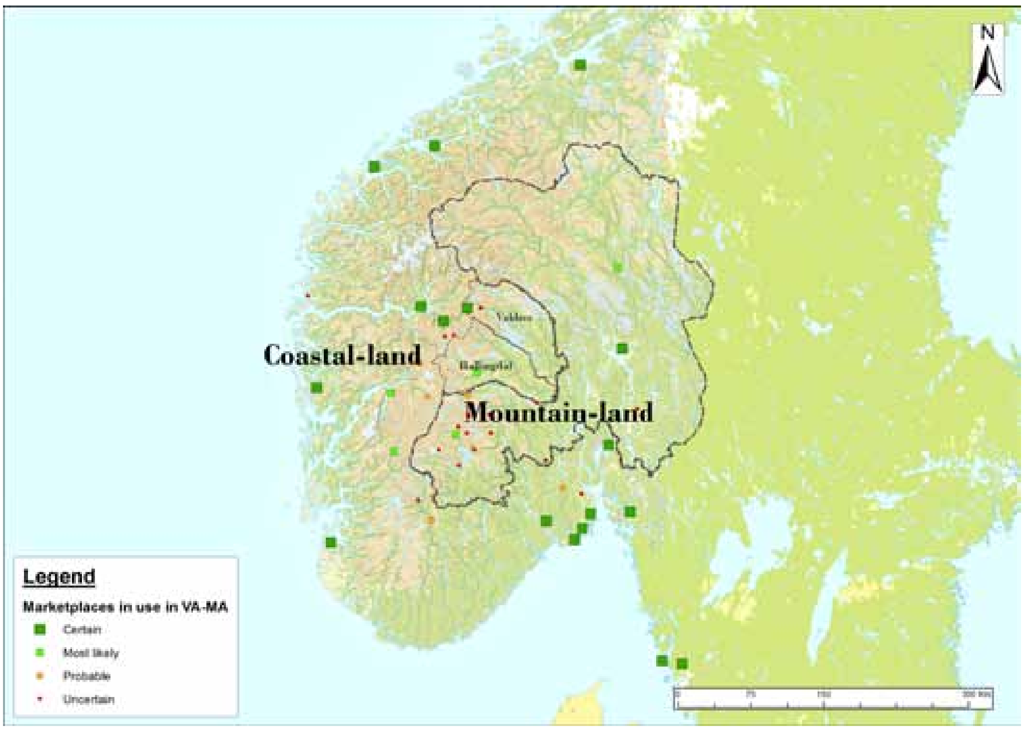


Fig. 1. The map shows seasonal marketplaces in Southern Norway, with a preliminary assessment on whether they were in use in the Viking age and Middle Ages. Background map: Kartverket (Norwegian Mapping Authority)

exploited here and how this related to the Viking Age and Middle Age society as a whole. The widespread exchange of commodities from the "Mountain-land" was dependant on stable networks with market places that connected various regions based on a resource economy. This project aims to study the use of inland seasonal market places and the economic, social and political role they played.

In Norway, contrary to many parts of Europe, the archaeological remains from the exploitation of outfield resources have to a large degree been left intact by later activities, be it iron production sites, trapping sites, stone quarries, shielings or other traces of settlement and activities. Several historical and archaeological research projects in the last 40 years has shown the major importance of outfield and outfield resources in both historic and prehistoric times (Martens & Rosenqvist, 1988; Larsen, 1991, 2009; Narmo, 1997; Svensson, 1998; Holm, Innselset, & Øye, 2005; Rundberget, 2007).

The aforementioned "Mountain-land" can roughly be equated with the inland areas of Southern Norway. Several seasonal market places are known from this area, some were used in historic times, while others may have been used in the Viking Age and Middle Ages (cf. Fig. 1). A working hypothesis in this project is that seasonal market places paved the way for an efficient spread of innovations and ideas, and established relations between different geographical regions. An increased knowledge of seasonal market places will shed light not just on trade within a resource-based economy, but aspects of social and political nature. Market places must have been important arenas for social

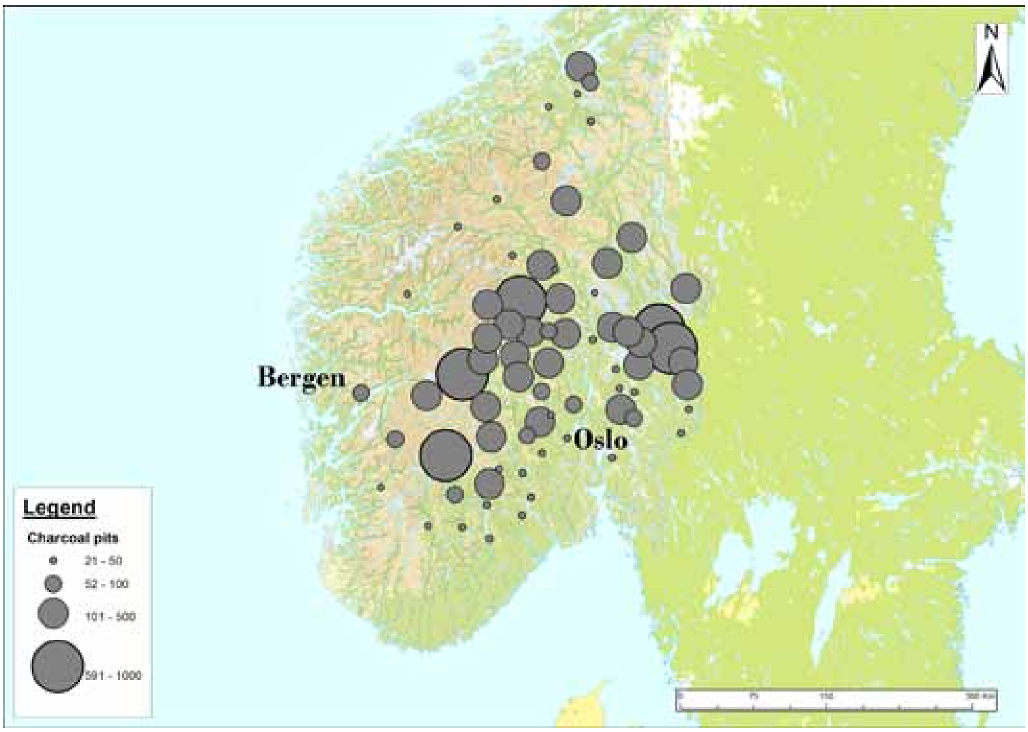


Fig 2. Distribution of charcoal pits, and thus iron production sites in the Viking Age and Middle Ages. Mapping data come from The Norwegian Cultural Heritage Database, "Askeladden". Background map: Kartverket (Norwegian Mapping Authority)

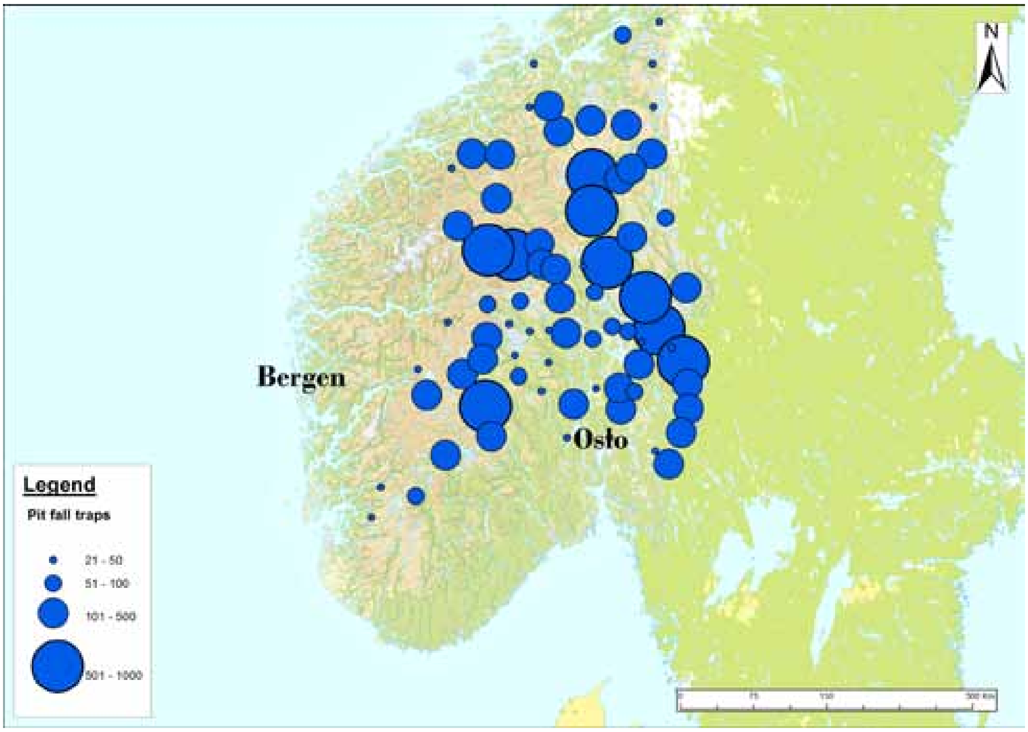


Fig 3. General distribution of pit fall traps. Mapping data come from The Norwegian Cultural Heritage Database, Askeladden. Background map: Kartverket (Norwegian Mapping Authority)

interaction with exchange of ideas, thoughts, technology, and the shaping and re-shaping of regional identities. Assemblies where groups of people met on a regular basis must have been particularly important to a society with few urban centres.

Thus, a central problem for discussion in this project will be what impact did the outfield resources and the trade in these have on the integration process between the inland areas and the central coastal areas during the Viking Age and Middle Ages. This project will also aim to explore what resources and commodities were part of the trade and what actors were involved at the seasonal market places.

Empirical perspective

Archaeological studies have shown that the production of iron in the inner parts of Southern Norway in the Viking Age and the Middle Ages to a large degree surpassed the local demand (Martens & Rosenqvist, 1988; Larsen, 1991, 2009; Loftsgarden, 2007, 2011; Tveiten, 2012). Thus the substantial archaeological remains of iron production sites is a testament to the major role of iron as an exchange commodity, either as in a standardised form like an ingot, or in the shape of forged tools or weapons. In comparison to Eastern Norway, the amount of iron produced in Western Norway was modest at best (Bjørnstad, 2003; Tveiten, 2005). The distribution of iron production is shown in figure 2. This is a map showing the distribution of charcoal pits in Southern Norway. Charcoal pits are in most cases seen in connection with iron production sites in the Viking Age and Middle Ages. Since charcoal pits are more easily detectable

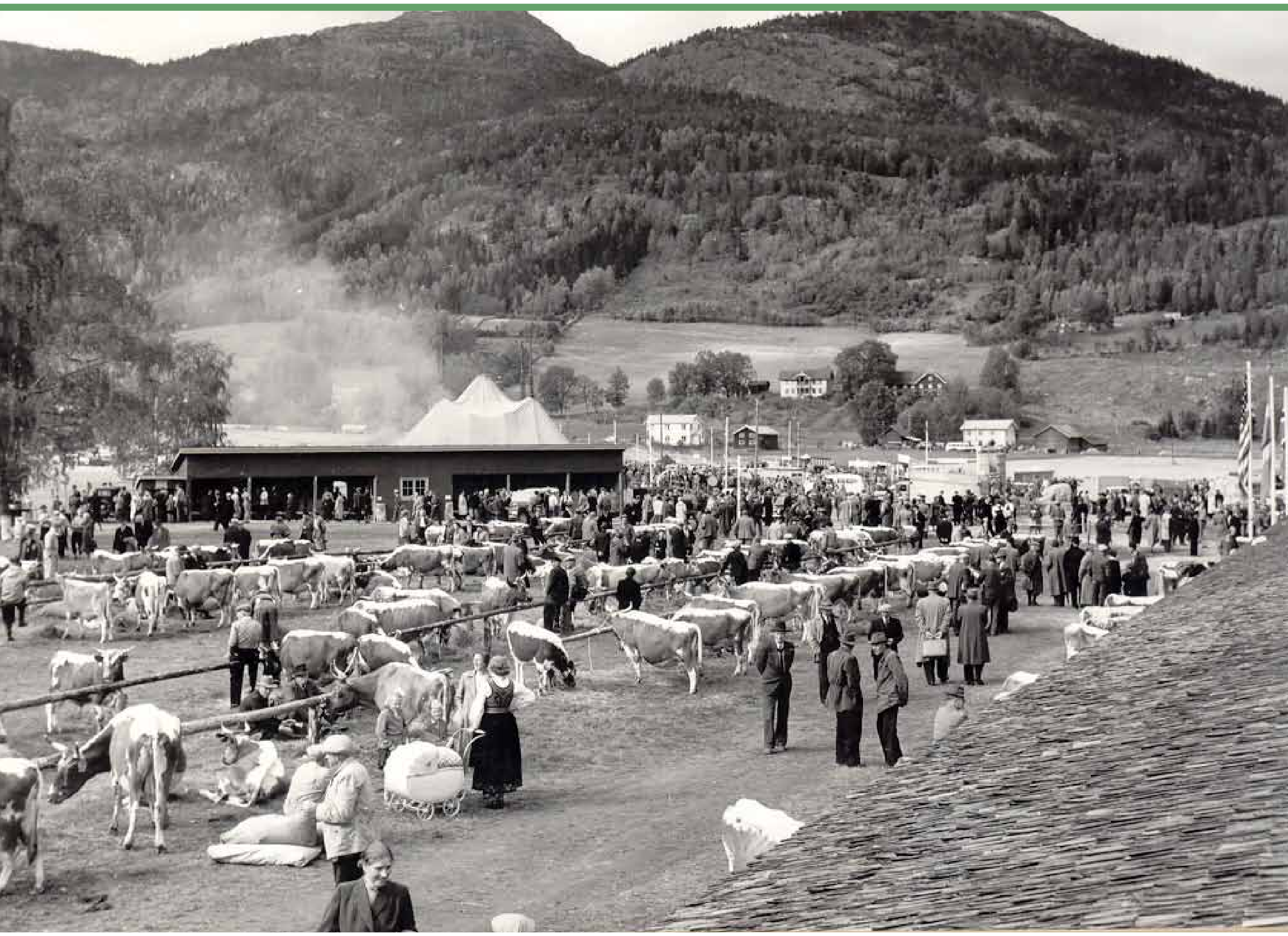


Fig 4. Photo showing the event "Dyrskun" in Telemark in 1956 (press photo). Here, there have been an annual cattle show and marketplace since 1866. Though most of them now are destroyed, there are known to have been as many as 150 grave mounds here. Making it the largest concentration of burial mounds in the region and pointing towards the area as a central place in prehistoric times

during archaeological surveys they are a better indication of the general distribution of iron production than the iron production sites themselves.

Just like iron produced from bog ore, hunting and trapping constituted an important outfield resource. Fur, antlers and meat were highly sought after commodities (Kaland, 1972, pp. 159–160). As with iron production sites a great many pit fall traps are situated in the "Mountain-land", as shown in figure 3. In addition to pit falls, house ruins with middens containing bones and antlers provide visible evidence of the significance of hunting and catching. Sumtangen at Finnsbergvatn at the mountain plateau Hardangervidda is one of the first to be known and several investigations have been carried out here (Indrelid, 2009). These have revealed that an extensive trapping seems to have taken place during two periods, one in the Late Roman

Iron Age and one in the High Middle Ages. The material from the Middle Ages suggests that there was an organised mass trapping with trade being the ultimate goal (Indrelid, 2010). That the medieval towns were the recipients of a lot of the resources from the trapping has become clear following the many archaeological investigations that have been carried out here.

Iron and products from hunting and trapping thus constituted commodities that were part of exchange networks between the "Mountain-land" and the "Coastal-land". As well as stone resources, like whetstones, soapstone and quern stones, in addition to commodities that are more or less invisible in the archaeological material, like grain, fish, or salt. A prerequisite for this specialized resource utilisation is stable trade networks and market places. From historical times, we know that such market places were in use no more than a week each year. In addition market places were often moved. Thus the accumulated archaeological remains are somewhat limited. Still, several seasonal market places are known in inland Southern Norway (Midttun, 1940; Fønnebø, 1988; Roland, 2001), cf. figure 1 and 4. However our historical and archaeological knowledge of these varies and an important aspect of this project will be to investigate these seasonal market places and the role they played in the Viking and Middle Ages. This will be done by piecing together existing historical and archaeological data, as well as my own field work. As few of the seasonal market places have been subject to thorough archaeological surveys, I will first carry out a documentation of the landscape, structures and the organisation of these. Moreover, basic archaeological excavations will be carried out, such as test pits for documentation and collection of samples for wood type analyses and radiocarbon dating.

Theoretical perspective

Following anthropological economic theories with a focus on gift exchange and redistribution systems, research on trade and exchange of commodities in the Viking Age and the Middle Ages has in the past fifty years been marked by a notion of the past as fundamentally different from our own time, and a questioning of the relevance of concepts like market economy and trade (Polanyi, Arensberg, & Pearson, 1957; Lunden, 1972; Hodges, 1982). This view has in recent years been challenged and market trade have once more been made relevant (Kilger, 2008; Helle, 2009). This is supported by results from recent archaeological investigations, not least the Kaupang investigations (Skre, 2008). Still, this does not imply that we should disregard all aspects of economic anthropology. Economic choices were also governed by social and cultural considerations. Human activities are linked to social relations, and exchange of commodities and services in the Viking Age and the Middle Ages were interwoven in cultural patterns and social strategies, and had other aspects than the purely economic ones (Latour, 1993; Steinsland, Meulengracht Sørensen, & Aartveit, 1994; Olsen, 2003). Social structures, identity, social, political and economic conditions are fundamental elements to take into account when one attempts to analyse the utilisation of outfield resources and exchange of commodities.

The actors involved in the trade at seasonal market places probably formed a mutually dependent relationship, but have also been part of extensive networks. The upper elite of the society, chieftain, king, nobility, and clergy relied on outfield resources, be it iron, soapstone, fur or antlers. Thus a stable distribution network must have been essential. The direct or indirect control over the outfield resources may have been claimed through organisation and control of trade routes and market places or through social bonds and alliances.

The seasonal market places were arenas where not only commodities where exchanged, but also where human and non-human entity relations were allowed to take place. In line with some recent archaeological research, I would like to make an attempt to break down the isolation of social relations from the material world. In «We have never been modern» Bruno Latour (1993) maintains that neither nature nor culture/society are fixed points that we exclusively can found our interpretations on. The interesting, and the factual, can be found between these distinctions (Olsen, 2006, p. 14). The society itself is not an empty vessel that all individual actions can be anchored in or projected on. A society is sooner a complex network of relations that chain and tie humans and things together. That is, a collective where humans and non-humans work together; "A society is not what holds us together, it is what is held together" (Latour, 1986, p. 276). Humans and non-humans are interlaced in complex heterogeneous networks that have a continual influence on each another. Things enable and stabilise networks. The structures and institutions do not only demand networks of relations between entities, but also qualities like stability and recognition that are made possible through things. Through exchange and other types of interaction with things, our manners, methods of operation are normalised and predictable, and in this way social structures are sustained and maintained (Olsen, 2006, p. 15). Social relations become long-lasting, durable, and permanent through material culture.

In a society with few urban centres, the most probable opportunity for an extensive communication would have been assemblies, where large groups of people met at regular intervals. Assemblies, in the form of market places and thing meetings, would have been essential for social interaction and enabled an effective spread of innovations and ideas. When such assemblies gathered people from wider areas at one and the same time, one has to see them as potentially decisive in connection with the establishment of cultural norms, including norms for material culture. Interaction across Southern Norway took place between regions relying on a resource economy and between groups with different regional identities. Regional identity is constructed by members of social groups, where the identity is expressed through differences in relation to neighbouring regions, often based in topographical elements and the physical landscape (Barndon, 2010, pp. 248–258). Market places and thing meetings one could expect to have belonged to one of the most important mechanisms for regionalisation, and also the subsequent establishment of a communal culture and identity in the Viking Age and the Middle Ages. Gradually, traditions and routines for the contact will be established, and a social order regarding how the contact and the trade were to take place. In retrospect, this might create an impression of stable networks, made durable through material culture.

In this brief text I have attempted to outline my ongoing research project. As with most projects this is growing and changing as the work continues. However a main ambition remains constant and that is to illuminate the inland trade and communication and the significance of this in the Viking and Middle Ages society.

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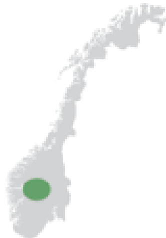
Contextualizing cup marks: An approach for a better dating and understanding of their meaning and function



Trond Klungseth Lødøen

Abstract
This paper specifically addresses the question of cup marks, one of the least understood categories of rock art. The aim is to offer a tentative approach to enhance their potential, through new documentation and systematic sampling of data from minor excavations and associated scientific analyses. A systematic approach of this kind will in all certainty produce new evidence for a deeper knowledge of their age, meaning, potential function – ritual or profane – and their use. In its initial phase, a large number of sites will be prospected and surveyed in order to identify the best objects for detailed studies, and at a later stage many of these will be more closely investigated. This will provide the best background for the identification of new patterns within the cultural context in which they occur, and detailed analyses from a more holistic perspective.

Introduction

Cup marks are one of the simplest categories of motifs in Scandinavian rock art, and also one of the most common types in a number of regions where rock art is found (Fig. 1). They are known from most parts of the world and over extended periods of time, either as single motifs or in combination with other figures. Their shape and character varies, although they are normally round, semi-circular depressions, with a width of up to 10 or 12 centimetres and a depth ranging from very shallow indentations to a couple of centimetres. Their simple shape, widespread distribution and lengthy period of use make cup marks the most mysterious and puzzling of all rock art motifs. In recent years their dating and chronological framework has been more and more questioned, and the background for previous suggestions debated. For a better understanding of the images' meaning dialectic studies of both the rock art and its contemporary archaeological context are therefore essential. A most needed prerequisite for such enhanced understanding will be to develop a better dating framework and a more detailed chronology for this category of rock art. This dating makes it possible to identify the contemporary context, and from

Fig. 1. The cup mark site *Fosshagen* in the municipality of Leikanger, Sogn og Fjordane. Photo: P. Fett

Fig. 2. A cup mark site at the summer farm *Hodnane* in the municipality of Luster, Sogn og Fjordane. Photo: J. Bøe

this angle their meaning in the light of the contemporary situation will be enlightened, both in the immediate vicinity of different cup mark sites, but also in a much wider context. In its initial phase, a large number of sites will be prospected and surveyed in order to identify the best objects for detailed studies, and at a later stage many of these will be more closely investigated. This will provide the best background for the identification of new patterns within the cultural context in which they occur, and detailed analyses from a more holistic perspective. The idea is that a systematic approach towards this subject of research, over a project period of 3–5 years, will produce more knowledge. The research scope will be Western Norway, although this may be widened to include other parts of Norway and also other areas of Europe (such as Spain) that have large concentrations of cup marks.

Distribution of cup marks in Western Norway

Cup marks within the area in question can be found along the coast, in the fjords, inland valleys and subalpine areas (Innselset, 2005). Some sites have only one single cup mark on a rock surface, while others contain more than one hundred. In our area they are often randomly distributed over surfaces, but occur also in groups, in lines, or form other patterns. It has also been commented that some are linked with shallow grooves, and others incorporated into more complex figurative motifs. In some mountainous farm meadows, concentrations of rock surfaces or earthbound stones are almost completely covered with cup marks. The densest concentrations in Western Norway occur in the inner parts of Sogn in the municipalities of Aurland, Leikanger, Luster, Lærdal and Vik (Mandt, 1991). The municipality of Luster in particular has several examples of these concentrations (Bøe, 1944; Mandt, 1991) (Fig. 2). In Hardanger, cup marks are found in the municipalities of Odda, Ullensvang and Ulvik, the majority of which are on the hillsides around Sørfjorden in Ullensvang (Bakka, 1963). Most cup mark sites in high-lying areas are concentrated in the regions of Western Norway and Valdres. Elsewhere in Southern Norwegian mountain areas, only a few sites are known, amongst these in the upper parts of Gudbrandsdalen, in Østerdalen and in the western part of the Telemark area.

Rock art traditions

Scandinavian rock art is normally separated into two different traditions, generally termed *hunters*' and *agrarian* rock art, or lately the *Northern* and *Southern Tradition* (Lødøen & Mandt, 2010). The Northern Tradition is associated with hunter-gather-fishers and generally dated to the Mesolithic and the Neolithic periods, with motifs of wild animals such as red deer, reindeer, elk and bear, but also anthropomorphic images. The Southern Tradition has been strongly associated with agricultural societies, dated to the Late Neolithic, the Bronze Age and even the Early Iron Age, and characterised by ship images, concentric ring figures and spirals, but also anthropomorphic images and cup marks. On the basis of recent research (e.g. Skrede, 2002), and a growing number of radiocarbon dating results associated with cup mark sites, it seems likely that the practise of making this type of rock art continued much later on in time, and that many areas in Scandinavia with locations consisting solely of cup mark sites should potentially be separated from the former traditions.

The difficult dating of rock art

The dating of engraved, pecked and polished rock art has always been a challenge, which also accounts for the panels with cup-marks, as to date no methods for direct dating have been proven successful, and the indirect methods are all associated with a number of uncertainties.

The prevailing dating method for rock art of the Northern Tradition has been shoreline displacements and the assumption that the images were carved on clean surfaces close to the contemporary shoreline in the past. The dating it self has therefore been based on geological studies of post-glacial land-uplift which has provided a background for a *terminus post quem* dating of this shore-bound rock art. The close connection between the rock art and past shore lines has been legitimized by a focus on the inland situation where most of the figurative hunters' rock art is found in the close vicinity of water tables at lakes or rivers. In this perspective it has been argued that the coastal rock art originally had a similar close connection, and that the dating of the corresponding shorelines immediately below the images will provide a convincing dating of the rock art. This method has been strongly debated, since the levels chosen for images in the past may have varied due to wave action, sea splash etc. Therefore, there will always be a risk that contemporary images could be ascribed to periods that are separated by hundreds and even thousands of years. For a better dating and understanding of the Northern Tradition, and in order to compensate for the weakness of traditional methods, more and more excavations have been carried out in the vicinity of panels, providing additional data for a more accurate dating.

For the figurative motifs of the Southern Tradition, comparisons have been made with motifs on artefacts and stones in isolated burial contexts which have led to more convincing results, although it is questionable whether images on items such as Bronze artefacts are necessarily comparable with pecked or engraved rock art.

The indirect methods used for cup marks are even weaker, as the locations of the sites are often far away from shorelines and the stylistic comparisons with other images are less convincing. The absence of other rock art motifs with which to associate the cup marks makes it extremely difficult to date and interpret them. As for contrast to motifs that depict images of more or less recognizable subjects or things we know and can compare them with, the cup-shaped depressions can represent just about anything at all. In the case of rock art of the Northern tradition, it is considered valuable to excavate small areas in the vicinity of the cup mark panels or at least get a better understanding of the stratigraphic situation, the potential correspondence between cup marks and specific layers, and collect scientific samples.

What are cup marks?

In the Scandinavian context, cup marks have been associated with the world of ideas and religious practices of the Bronze Age, partly because cup marks are the most frequent motif in Bronze Age rock art, and partly because stones with cup marks have been found in many Bronze Age graves. A common and long-lived interpretation has also

Fig. 3. View from Børve, municipality of Ullensvang, Hardanger in Hordaland. Several cup mark sites are distributed on slopes and terraces above the Hardangerfjord. Photo: T. K. Lødøen

been that cup marks were used in offering ceremonies, and that the depressions served as containers for the items or substances offered (e.g. Bøe, 1944; Innselset, 1995). It has been argued that these offerings could have been berries, blood from slaughtered animals, semen, milk or even butter to be melted by the sun. In some areas there has even been a tradition of leaving offerings at these locations up until modern times (e.g. Bøe, 1944), although how far back in time these practises can be followed is of course associated with uncertainties, leaving it fairly open that the original purpose of the cup marks could have been of a complete different kind. We do not know what kind of practise that took place in the vicinity of the different cup mark sites, or if rituals were performed in the vicinity. Small excavations and systematic sampling may reveal the nature of this potential action. Perhaps the cup mark itself was not of prime importance, but rather the very act of carving out a section in the rock. Since cup marks are connected to farming or pastoralism, it is interesting to bring into the debate the numerous folklore notions concerning forces of a supernatural nature to be dealt with associated with farm life (Innselset, 1996, 2005). Farmers did not only have to protect grazing animals from predators, but also had to adjust to underworld spirits and forces to avoid spells being cast on them. However, it has been argued that if cup mark production was associated with historical farming (Fig. 3), which also included summer farming in

Fig. 4. The *Huldresteinen* cup mark site, at the summer farm Nos in the municipality of Stryn, Sogn og Fjordane. The vicinity of the boulder with cup marks is investigated by test-pits. Photo: T. K. Lødøen

the subalpine areas, then more traces of this custom would still remain in local folklore (Innselset, 1996, 2005).

Previous approaches

A first attempt to achieve a better understanding of cup marks in western Norway was made by Johs Bøe in the 1930s, when he investigated a number of sites in the municipality of Luster in Sogn og Fjordane. Large concentrations were reported from mountainous areas, which led Bøe to refer to them as *subalpine rock art* (Bøe, 1944). He also argued for the close connection between cup mark sites and summer farms (Fig. 4), where the places with cup marks were explained as pre-stages for the summer farm tradition known from historical time. Bøe meant

Fig. 5. Test excavation in the vicinity of the Hodnane cup mark site. Palynological samples will be analysed from several stratigraphic layers, and charcoal collected for radio-carbon dating from all sites under scrutiny. Photo: T. K. Lødøen

that the Bronze Age farmers turned to the rich mountain pastureland as an important resource for the farming societies in the fjord regions (Bøe, 1944). Several sites with cup marks found along the paths between mountain farms or on the cattle tracks from the permanent farms up to the mountains were also taken as arguments for this interpretation. Bøe and his contemporaries interpreted the cup marks first and foremost as a phenomenon of the Bronze Age, but did not dismiss the possibility of a later dating (Bøe, 1944; Hougen, 1947). It is also clear that cup marks are found in a number of other areas than in the subalpine zone.

Pioneer pastoralists

It has also been argued that the cup marks in elevated areas may be associated with the livestock pioneers from the end of the Neolithic. The inland areas of western Norway seem to have been settled by pastoralists, who also began to grow grain from as early as the Late Neolithic and during the transition from the Late Neolithic and into the Bronze Age. These groups needed to establish their ownership rights over the new territory they began to use. In this perspective, the cup marks on the rocks and stones in the grazing areas may have served as physical, visible markings to demonstrate the connection between these people and the landscape, as well as their temporal links to their ancestors (Innselset, 2005). At the same time, they may have served to establish property rights for newcomers in relation to the people who had exploited the resources in the mountains before their arrival.

Late Iron Age and medieval activity

In recent years, a number of surveys and investigations have indicated that more emphasis should be placed on associating cup mark sites with both the Early and Late Iron Age. Surveys and test excavations carried out to clarify the impact electric power lines have on cultural heritage, have further documented cup marks in areas where prehistoric mountainous farms or summer farms have provided radiocarbon results dating to the Late or Early Iron Age rather than the Bronze Age. For example, research around the mountain farm of Svolset in Leikanger at the head of Friksdalen, almost 800 m a.s.l., has been used to argue for a fairly late dating of cup marks (e.g. Skrede, 2002). In this area at least sixteen dwelling features, around fifty charcoal pits and ten earthbound stones with cup marks have been documented. Despite palynological evidence revealing traces of extensive grazing from the Late Bronze Age, most of the dated dwelling features and charcoal pits have provided evidence of intensive use from the middle to the late Early Iron Age, until the Viking Age, from about 200–300 to AD 1000. It is therefore highly interesting that cup marks have been documented in the immediate vicinity of these dwelling features, such as at their entrances. It seems also reasonable that the cup marks were made during the period when the buildings at Svolset were in use, namely during the latter part of the Iron Age.

New approaches

The long period of use and the diverse contexts in which the cup marks occur make interpretations challenging, and it is also clear that their meaning may have changed consistently over time. A few examples are known associated with the Northern tradition (Bakka, 1973), some on stones in and around Iron Age graves, and even on gravestones from the Middle Ages (Hougen, 1947; Mandt, 1970; Slomann, 1971). In recent years a number of archaeological excavations have been carried out in the vicinity of rock art sites in order to provide new material and a better background for such dating (Lødøen, 2003, 2007). A similar approach will therefore be aimed at the cup marks, in which archaeological excavations in combination with palynological investigations may provide a better background in order to identify relevant patterns for a better understanding of cup marks (Hjelle & Lødøen, 2010).

Within the framework of the indicated approach for a better understanding of cup marks, a large number of locations will be evaluated in more detail in the near future. Where conditions appear to be favourable, small squares will be excavated for stratigraphic studies and to collect samples for both radiocarbon dating and palynology (Fig. 5). Since it is clear that cup marks occur in different regions – not only in the subalpine areas – all relevant areas will be under scrutiny. The process will follow a chain of events and actions, as there are restrictions on sampling due to the Cultural Heritage Act. However, there are possibilities for research excavations and data sampling, although applications to the Directorate for Cultural Heritage are required in order to gain permission for intrusive actions.

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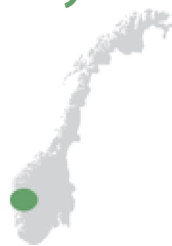
Osteological assemblages from rock shelters as source data for subsistence from Bronze Age to the Middle Ages in Western Norway



Anne Karin Hufthammer

Abstract

Animal bones that have been found at archaeological sites are the source material of a number of cultural questions; for example diet, hunting and catching, settlement patterns, everyday life and animal husbandry. In the osteological collections at the University Museum of Bergen, there are several bone assemblages that only to a lesser degree are known to the archaeological community. Many, in particular those from West Norway, are from caves and rock shelters where bones in general have been better preserved than those found on open air sites. In this paper, some of the rich assemblages of sub-fossil bones that have been excavated from 12 rock shelter sites in the county of Hordaland are presented. Three sites have cultural layers from the Bronze Age, nine from the Early and the Late Iron Age, and one from the Middle Ages. Some of the characteristics of the finds that relates to hunting, catching and diet are highlighted and not least, the potential inherent therein with a view to knowledge of cultural changes from the Bronze Age to the Middle Ages.

Introduction

Animal bone assemblages found in rock shelters and caves are among the most important source materials that can shed light on the use as well as changes in the use of the outfields in West Norway after the introduction of agriculture. The object of this article is to show some of the potential osteological material from archaeological contexts may have to increase the knowledge of the economy of early farming culture in West Norway.

Generally, there exist very few bone finds from a purely agricultural context, that is, from the infield, as the traces in general have been cleared away due to agricultural activities. By shifting the focus from the infield of the farm to the outfield, where to a lesser degree cultivation and building activities have taken place, other parts of the farm's economy could also be shed light on.

In caves and rock shelters, where bones lie protected from the decay by natural elements; light, water and wind, the preservation conditions for bone are especially favourable. Places like these have been used as a place to stay and for activities for people throughout prehistory. Many of the largest finds of unburned sub-fossil bones held in the osteological collections at the University Museum of Bergen come from rock shelters, and many of the finds are from the county of Hordaland in particular. Even if the rock shelters have been investigated and excavated by archaeologists, little research has been carried out on the majority of them, and therefore several culture aspects that could be interpreted from the bone material are less known.

The majority of the investigated rock shelters are located in the lowlands and on the coast. Although these areas demonstrably are areas where farming have existed through

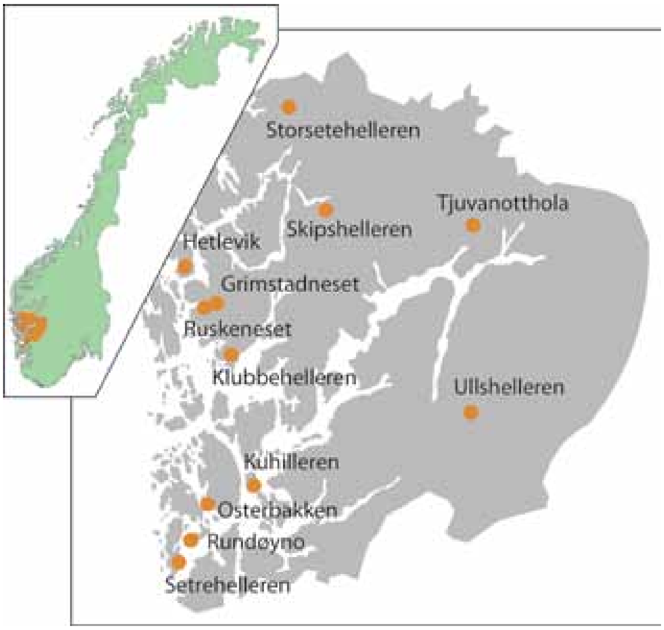


Fig. 1. Map of Hordaland and the location of the rock shelter sites. Illustration: B. Helle

Fig. 2. The osteological collection at the University Museum of Bergen comprises bone assemblages from ca. 1700 Norwegian localities, and is one of the largest collections of sub-fossil bones from archaeological sites in Europe

thousands of years, a common feature is that the rock shelters are localised in areas that today lie in the outfield, that is, outside cultivated area. All rock shelters from the Bronze Age were located close to the shore.

Material and methods

The investigation covers bone material from 13 cultural layers in 12 rock shelters in Hordaland County; three from the Bronze Age, five from Pre-Roman Iron Age, four from Roman Iron Age/Migration Period and one from the High Middle Ages (Fig. 1 and Table 1). The bone assemblages from the respective rock shelters have been recorded as JS numbers and are being stored in the osteological collections at the University Museum of Bergen (Fig. 2).

Only a few of the finds have been investigated scientifically and published. Neither have any new osteological analyses been carried out in connection with this study, which is based on records, that is, species identification lists and archival data. The bones have previously been analysed (identified to species and bone element) at the laboratory of the osteological collections and the results of the analyses are available from the archives of the collections. *Number of identified specimens* (NISP), that is bones that have been identified to species, and in a few cases only to genus, are included in the present publication.

In some instances, species that are found only seasonally on the coast of Hordaland have been identified. Such *seasonal indicators,* together with morphological, skeletal features that might suggest the age at death of the individual, assessed e.g. from teeth and epiphysis situation, provide a basis to suggest at what time of the year the site had been used. Examination of individual age was carried out in just a few of the 13 bone assemblages: Sometimes because the bones and teeth that can be used in this kind of

Table 1. The Table gives an overview of the rock shelters that are included in the investigation, their registration numbers (JS) in the osteological collections archeological registration number (B), references to excavation details and year of the excavation. The ^{14}C values have been calibrated by OxCal calibration program, version Calib 7.0: http://calib.qub.ac.uk/calib/

Museum number	Rock shelter	Age	References	Year of Excavation
JS 1 B 6824	Ruskeneset	Bronze Age: 4 ^{14}C datings: cal. BC 2339–485 (2 sigma)	Brinkmann & Shetelig, 1920	1914
JS 199 B 7562	Rundøyno	Bronze Age: 2 ^{14}C datings: cal. BC 211–509 (2 sigma)	Archiv, University Museum Bergen Rosvold et al. ,2013	Ca. 1922
JS 258 B 8600	Skipshelleren	Bronze Age: Cultural layer 3:1 ^{14}C dates: cal. BC 793– 485	Bøe, 1935; Olsen, 1976; Rosvold et al., 2013	1930 & 1931
JS 258 B 8600	Skipshelleren	Pre-Roman Iron Age: Cultural layer 1 and 2. 5 ^{14}C dates: 1 cal. BC 782– 432, 4 cal. BC 412–2	Bøe, 1935; Olsen, 1976; Rosvold et al., 2013	1930 & 1931
JS257 B 8039	Osterbakken	Pre-Roman Iron Age: layer 5: 1 ^{14}C date: cal. BC 399–208	Bommen, 2009	1927 & 1929
JS 1057 B11916	Kuhelleren	Pre-Roman Iron Age: Cultural layer 2:1 ^{14}C date: cal. BC 351– AD 0	Bommen, 2009	1968
JS 901 B12598	Hetlevik	Pre-Roman Iron Age	Archiv, University Museum Bergen	1972
JS 428 B 7580	Setrehelleren	Pre-Roman Iron Age: Layers 3, 4, 5. 2 ^{14}C dates: cal. BC 193– AD 73	Olsen & Shetelig, 1933 Bommen 2009	1933
JS 362 B10925	Grimstadneset	Roman Iron Age: 2 ^{14}C dates: cal. BC 190–AD 129	Archiv, University Museum Bergen, Rosvold et al., 2013	Ca. 1956
JS 443 B11676	Ullshelleren	Roman Iron Age –Migration period (0–AD 600)	2013 Odner, 1969	1962 & 1963
JS 119 B 7081	Klubbehelleren	Migration Period	Hougen, 1922	1918
JS 1269	Tjuvanotthola	Migration Period	Archiv, University Museum Bergen	Unknown ca. 1878
JS 722 B 6755	Storsetehilleren	Medieval Period	Archiv, University Museum Bergen Bjørn, 1914-15	1914

analyses are absent, other times because the bone assemblages had not been analysed to a satisfying degree. Therefore, the season for occupation at the site is in most cases inexplicable.

The size of the bone material can give an indication of how much or how often the rock shelter was used. But there are many sources of error in this, especially due to excavation procedures and taphonomy. Many finds were collected at a time when the bone material was considered to be of less importance in an archaeological context. In some instances, all bones that were found during the excavation were collected, in others only large and well preserved fragments were selected. In only a few exceptional cases the excavated masses were sieved.

Fig. 3. The Skipshelleren rock-shelter was a favored seasonal settlement site from the Middle Mesolithic to the Early Iron Age. A total of 23710 bones representing at least 93 vertebrate species have been identified from this locality. Photo: A. K. Hufthammer

Some of the rock shelters are in an exposed location, with small overhangs that give little protection for wind and weather. In cases like these, one would expect that merely a small fraction of the organic remains from the visit have been preserved, and then for the most part large, solid bones. Berensmeyer (1981) maintains that bones from small animals show poorer preservation compared to those of large animals. A clear correlation has been noted between the animal's live weight and the expected "survival" of skeletal parts (Behrensmeyer and Boaz 1980). This applies probably also to young animals, where the bones are less compact compared to those of fully grown individuals. Irrespective of how thorough the collection of osteological material is, the excavated material will therefore be "biazed". Compared to what was originally there, relatively fewer small bones, bones from young animals and bones from small species than larger bones from big animals will be found.

An important factor in the assessment of the bone material's representativeness is the size of the excavated cultural layers. The cultural layers in Ruskeneset (which in fact are from two neighbouring rock shelters), Skipshelleren, , Kuhilleren, Osterbakken and Setrehelleren are almost fully excavated. In Grimstadneset, ca. 84% of the area and in Rundøyno ca. 50% of the area has been excavated. As regards the remaining rock shelters, the percentage of excavated cultural layers is uncertain. The bones from Tjuvanotthola were collected by amateurs in the 1870s, and the rock shelter has probably never been investigated by archaeologists.

The bone material from Skipshelleren (Fig. 3) was analysed by Håkon Olsen in 1976. In his investigation, he primarily treated and correlated the mammal material to cultural layers. Fish and birds have been recorded but not correlated. It is therefore not possible to obtain exact information about the number of fish and birds in the individual cultural layers, but based on the results from the individual excavation layers, one can assume that fish, both in the Bronze Age and the Iron Age, in numbers, constitutes a little less than half of the bones, roughly estimated fish 45%, and that of birds 1–2%.

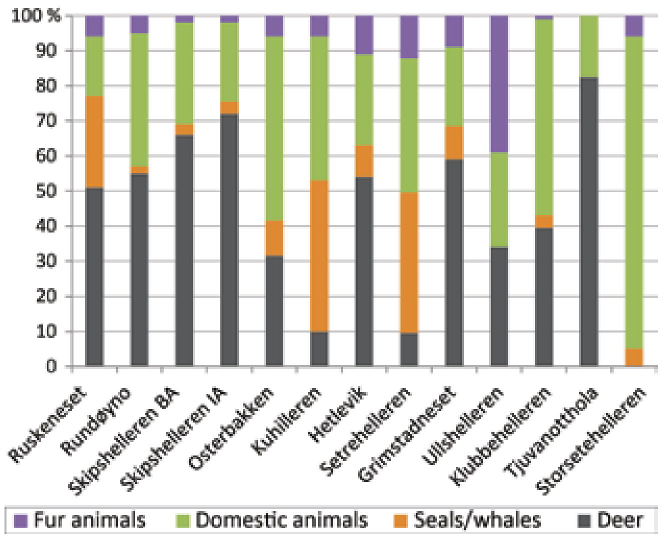


Fig. 4 shows the distribution of deer (red deer, elk, reindeer), seal and whale (common seal, grey seal, small species of whales), domestic animals (cattle, sheep or goats, pig, horse) and fur animals (otter, lynx, pine marten, fox, squirrel). In the latter category, a few observations of brown bear, wolf and hedgehog are included. The rock shelters are ordered from the Bronze Age to the left, to medieval time to the right

Table 2. The table shows numbers of bones identified to species (NISP) and numbers of species of fish, birds and mammals that have been identified from the Bronze Age, Pre-Roman Iron Age, Roman Iron Age/Migration Period and the Middle Ages in the 12 rock shelters. Mammals that are presumed to have occurred naturally, like mice and shrews, are not included in the overview

Age	Sites	Fish		Birds		Mammals	
		N bones	N species	N bones	N species	N bones	N species
Bronze age	Ruskeneset	1351	18	41	41	2108	15
	Rundøyno	160	7	6	?	142	7
	Skipshelleren	?	ca. 10	?	ca. 10	491	10
Pre-Roman Iron Age	Skipshelleren	?	ca. 11	?	ca. 28	2925	17
	Osterbakken	772	12	45	6	1032	11
	Kuhilleren	80	3	1	1	81	7
	Hetlevik	5	1	3	3	35	5
	Setrehelleren	315	7	73	16	220	8
Roman Iron Age/Migration period	Grimstadneset	33	4	8	4	168	10
	Ullshelleren	2	1	615	12	233	8
	Klubbehelleren	8	3	5	3	86	9
	Tjuvanotthola	0		0		82	4
Medieval	Storsetehelleren	70	6	0		82	5

Main characteristics of the bone assemblages – discussion

Even if there are considerable components of uncertainty as regards the representativeness of the materials as a consequence of taphonomic conditions, procedures for collecting and collected volume, a common feature is that the large, rich bone finds date to the Bronze Age and the Early Iron Age – up to approx. AD 1. The quantity of bones found in the oldest cultural layers is considerably higher than what has been found in layers from younger phases. This is the case at localities 1–5 in Table 2 and reflects that the rock shelters most likely were used to a larger degree in the Bronze Age and the Early Iron Age than in later periods. The largest finds have been made in rock shelters where the use seem to have been minimal after Pre-Roman Iron Age, e.g. Skipshelleren and Ruskeneset. This could mean that the economy of these early phases of farming was closely associated with the use of rock shelters.

The oldest finds are large and the bones well preserved, and they have obviously been lying on the ground for a short period before new masses of organic material have covered them up. It may indicate that the groups that visited the rock shelter and left bone refuse behind, were either larger than those in the later periods or that the visit frequency was higher.

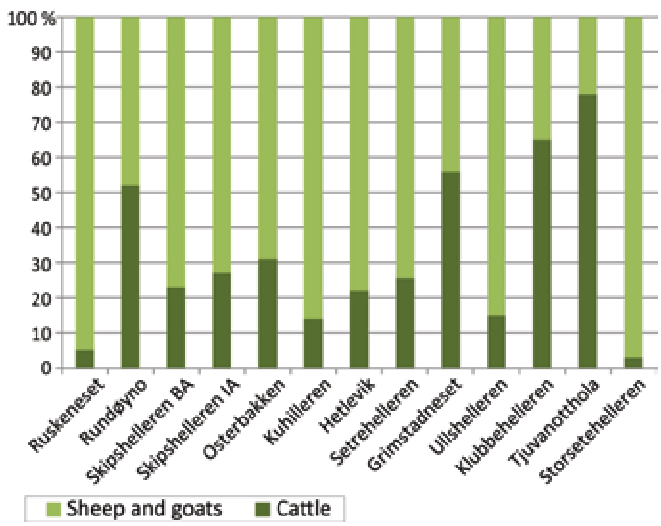


Fig. 5. Distribution expressed as percentage of cattle and sheep and goats. The rock shelters are ordered from the Bronze Age to the left, to medieval time to the right

In my view, it is likely that the rock shelters from the Bronze Age and the Early Iron Age reflect a fixed usage system, perhaps seasonal visits (Fig. 4). This is supported by ^{14}C dates on bones from these periods in Skipshelleren. Rosvold et. al (2013) who has ^{14}C dated red deer (*Cervus elaphus*) and elk (*Alces alces*) from the cultural layers, have six dates from 761 cal BC to AD 3. In addition, a date on bone of sheep exists, dated to cal AD 215–325 (archival data). This is the youngest date on bone in Skipshelleren and indicates that regular use of the rock shelters ceased in the course of the Early Iron Age.

Nor are there any dates from the younger periods from Ruskeneset. Four dates within the time period 2339–485 cal BC (2 sigma) (Rolf Lie, unpublished manuscript) suggest that the rock shelter was used in the last part of the Late Stone Age and in the Bronze Age.

Domesticated animals

In all of the oldest periods, the mammal share of domesticates (cattle *Bos taurus,* sheep *Ovis aries* and goat *Capra hircus*, pig *Sus scrofa* and horse *Equus caballus*) is high: in the Bronze Age at Ruskeneset 16,5%, Rundøyno 38% and Skipshelleren 29%. In addition, bones from domesticates have been identified in all bone assemblages, and the percentage is high also from the younger settlement phases.

The lowest percentage of domesticated animal bones from the Pre-Roman Iron Age was found in Grimstadneset (20%) and the highest in Osterbakken (53%). We do not know if these bones originate from animals that were slaughtered during the stay in the rock shelter or animals that were slaughtered elsewhere. At Ruskeneset, clear indications exist that slaughtering of sheep and goat took place on the site. Two *os hyoideum* (hyoid bone-tong bone) from sheep or goat were found here. The hyoid bone complex of ruminants is made up of several bones and functions as support for the tongue. It is attached at the back of the larynx and will normally come out when the tongue is cut out after slaughtering. Where such bones are found, the animal was probably slaughtered on the site.

In Skipshelleren and Osterbakken, domesticates were probably slaughtered also. In Skipshelleren, 25 hyoid bones from cattle and 13 from sheep or goat, and in Osterbakken one from cattle and 2 from sheep or goat, were found. Hyoid bones have not been found in the other rock shelters, but this may not necessarily mean that domesticates were not slaughtered there. The tong bones are small and bones of domestic animals are in general few. The probability of finding small, on the whole fragile hyoid bones is therefore small. In one instance, Tjuvanotthola, the location makes it quite unlikely that animals were slaughtered on the site. This cave lies on a cliff wall and the only possible way to get domesticates to it alive is to hoist them up.

Sheep and goat are more common than cattle (Fig. 5). In Skipshelleren, Ruskeneset and Osterbakken, where bones of domestic animals are rather numerous, the percentage of cattle is from 5% to 31% and consequently sheep and goat contributes between 69% and 95% of the domestic animals. In Skipshelleren, the percentage of cattle is fairly similar in the Bronze Age and the Iron Age, 23% and 27%, respectively.

In some of the rock shelters there is a remarkable lack of bones from the meat-rich parts of domesticates. Bone elements from

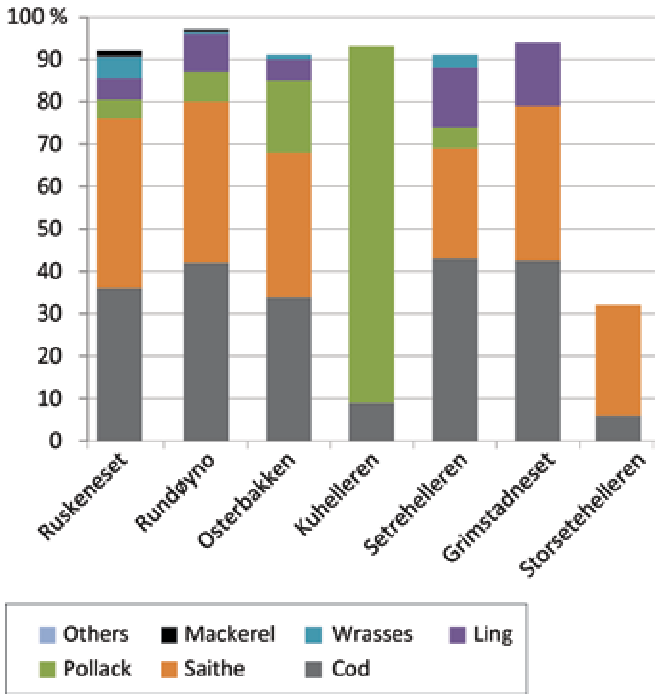


Figure 6. The distribution of fish species. There is no basis for including the fish in Skipshelleren in the figure, as that material is correlated to the collective term cultural layer 1-3 only (Olsen 1976). The rock shelters where the NISP of fish is less than 33 have not been included either. The rock shelters are ordered from the Bronze Age to the left, to medieval time to the right

the thigh (*femur*), the upper part of the fore leg (*scapula* and *proximal humerus*) and the vertebral column are under-represented. This applies particularly to cattle. In Ullshelleren, for instance, only bones from the lower leg (metapodes, phalanges) and from the cranium (cranial and mandibular bones and teeth) have been found. The same applies to Kuhelleren and Setrehelleren. Seemingly, the dwellers there would have had to be content with marrow and cartilage from the poorest part of the carcase of cattle.

Wild mammal species

In all occupation layers, with the exception of Storsetehelleren, deer, (red deer, elk and reindeer *Rangifer tarandus*) are important species. This is clearly distinguishable in the oldest periods, in particular in the Bronze Age in Ruskeneset, Rundøyno and Skipshelleren where they constitute between 51% and 66% of all identified bones of mammals species. Irrespective of sources of error, like taphonomic processes and procedures for collecting, I believe that this find scene shows that the catching of deer was a decisive factor for the visits to many of the rock shelters.

Red deer is by far the most common species and in Skipshelleren og Ruskeneset in particular a lot of bones from red deer have been found. The finds from these sites, suggest that the deer population in the Bronze Age and the Early Iron Age was substantial on the coast of Hordaland. In the younger periods, the relative occurrence of red deer is lower; it may seem that hunting for red deer had decreased compared to previous periods. But we do not know whether this is because there were fewer deer to hunt for or because the rock shelters were used for other purposes. In modern time, up to ca. 1950, the red deer was a relatively rare species in most parts of the country, but throughout the last half of the 20th century, the population increase has been large in Norway (Langvatn, 1998). This may be due to e.g. hunting (selective hunt) and landscape changes, and, among other things, regrowth of trees and shrubs. Red deer often graze in open fields, but spend large parts of their time in the woods, often deciduous forest, where they are protected. Besides, shrubs and trees are major food sources during winter in the form of browse. The rock shelters, which reflect the fauna presence through 2,500 years, can, especially if newer methods in genetic and isotope studies are put to use, contribute to new knowledge about the changes in the deer population in Hordaland. Indirectly, the finds may also provide information about the development of the landscape and the farm, especially about the proportions between agricultural land (open landscape) and forests.

It is striking that in most rock shelters, not only from the coast, but also from the fjord areas, one finds relatively large amounts of marine mammal bones; seals and small whale species. The most common is the harbour or common seal *Phoca vitulina,* but in some sites, like in Ruskeneset and Skipshelleren, small whale species are also found, though few in numbers. In Osterbakken the species grey seal *Halichoerus gryphus* occurs. In Ruskeneset, where the number of identified bones of mammal species (NISP) is 2108, 553 bones from seal and whale have been identified. This means that seal and small whale constitute a major part of the find, only outnumbered by deer. In particular, the occurrence of seal in Storsetehelleren is unexpected. This rock shelter, which is dated to the Middle Ages, lies in the Matre valley, ca. 3.5 km from the sea. An even more extreme example is found in Buhelleren in the Samnanger municipality, a fjord area. As only a small test pit has been investigated this rock shelter is not included in the present study. Buhelleren is situated 400 m a.s.l. and is presumed to be from the Iron Age. Of the 45 identified mammal bones, 31 are of seal, probably common seal. The remaining are from domestic animals.

The overall picture thus is that seal hunting has played a significant role on the coast and the outer fjord areas of Hordaland, from the Bronze Age to the Middle Ages. Seal products, like for example oil and skin must have been important, but the bone finds from Storsetehelleren and Buheller also show that seal meat and possibly blubber were important elements of the diet. In the Middle Age town of Bergen, the picture is however quite another one, there seal bones are rare. During the period 1170–1527 from the locality Dreggen, only five fragments of seal have been found, while the NISP of mammals is 8606 (Undheim, 1985).

Fish and birds

Other noticeable features in the rock shelters from the Bronze Age and the Early Iron Age include that the percentage of fish generally is high, while there are few birds. The species variation is however, high, both for mammals, fish and birds (Fig. 6).

The two dominating fish species are atlantic cod (*Gadus morhua*) and saithe (*Pollachius virens*). In the rock shelters Ruskeneset, Rundøyno and Osterbakken, which all lie on the coast, the two species are nearly equally common. In the Bronze Age and Iron Age layers in Skipshelleren, the proportion is different; there is considerably more saithe than cod, 5:1 according to Olsen (1976). This may be due to local conditions; Skipshelleren, which is located in a fjord area, had better supply of saithe than cod, compared to the coast. It may, however, also mean that the visits to Skipshelleren were of a different character or they may have taken place at other times of the year than the ones to coastal rock shelters. Atlantic pollock (*Pollachius pollachius*) and ling (Molva molva) are also relatively common in several of the rock shelters. The high percentage of pollock in Kuhelleren is particularly interesting. Although pollock is found in the majority of the rock shelter finds from West Norway, it hardly ever is the dominant fish species. With the exception of the spawning season, spring/early summer, when it gathers in shoals, the pollock is solitary. So, even though the material from Kuhelleren is small, NISP of fish is 80, this may indicate that Kuhelleren was used in the spring. Mackerel (*Scomber scombrus*), an indication of summer catches, is found in all Bronze Age contexts, but is later lacking.

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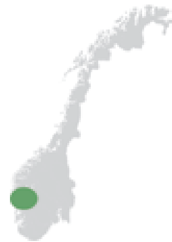
Open landscapes and the use of outfield resources through time – methodological aspects and potential of pollen analysis



Kari Loe Hjelle

Abstract

Pollen analysis is the main method to reconstruct vegetation development, and thereby the environment of people, through time. The vegetation has changed significantly from the environment of hunting populations in the Mesolithic to the environment of farming communities in the Iron Age and medieval time. Woodlands have been transformed into open land and plants have been exploited and cultivated. After the introduction of farming, human activity has probably been the main factor causing vegetation changes in large parts of Europe. Especially grazing has been important in maintaining open vegetation and landscape types. The history of heathlands and grass dominated pastures documents the long tradition of exploitation of outfield resources from the coast to the mountains and the importance of these resources in the farming society. A recently developed modelling approach, the Landscape Reconstruction Algorithm (LRA), has made it possible to differentiate between local and long distance pollen, and transformation of pollen percentages to vegetation cover can be done. Compilation of pollen data from Southern Norway is in progress and LRA will be applied with the aim to study the relationship between tree cover and cover of open landscapes connected to exploitation of outfield resources on different spatial and temporal scales.

Introduction

After the retreat of the ice more than 11 000 years ago, Northern Europe quickly became forested. Open vegetation existed in mountains above the climatic tree line, along sea shores and lakes, on mires and screes. Natural fires and storm may have caused openings in the forests and also wild animal grazing may have resulted in more open woodlands during the Mesolithic than hitherto anticipated (Vera, 2000). In mountainous areas the climate has been decisive for the altitude of the tree line. More than 9000 years ago, pine was growing in what are today open mountains in Norway (e.g. Moe, 1979; Bjune, 2005; Paus, 2010) and between 8000 and 6000 years ago the glaciers in southern Norway were melted away at least once, due to high summer temperatures and/or reduced winter precipitation (Nesje, Bakke, Dahl, Lie & Matthews, 2008). From ca. 6000 years ago, the glaciers started to form again (Nesje, Dahl, Andersson & Matthews, 2000; Nesje et al., 2008) and gradually the climate became colder, resulting in lowering of the tree line (Nesje & Kvamme, 1991; Bjune, 2005). At about the same time, the knowledge of agriculture reached Scandinavia (e.g. Bakka and Kaland, 1971; Berglund, 1991; Hjelle, Hufthammer & Bergsvik, 2006; Sørensen & Karg, 2012). By the emergence of agriculture – including both animal husbandry and cultivation – the landscape opened up (e.g. Berglund, 1991; Nielsen, Giesecke, Theuerkauf, Feeser, Behre, Beug, Chen, Christiansen, Dörfler, Endtmann, Jahns, de Klerk, Kühl, Latalowa, Odgaard, Rasmussen, Stockholm, Voigt, Wiethold &

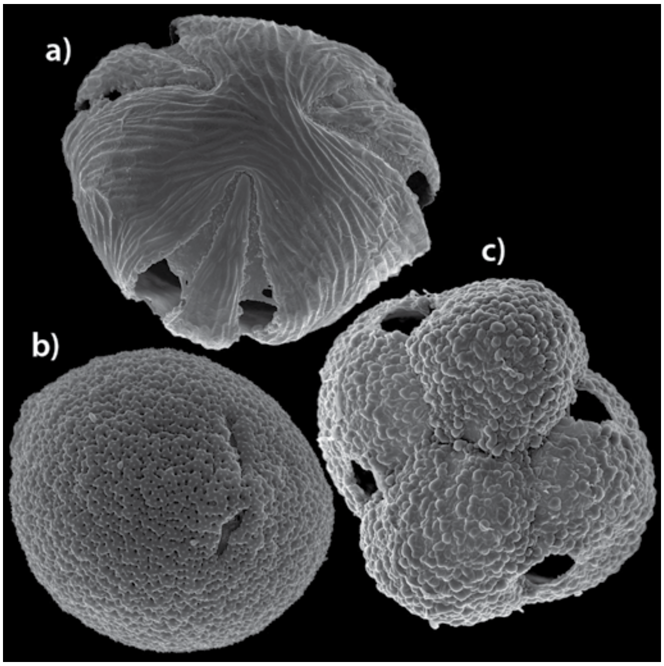


Fig. 1. Pollen grains of species favored by exploitation of outfield resources, a) *Potentilla erecta*, b) *Rumex acetosa*, c) *Calluna vulgaris*. Photo: J. Berge, UiB

Wolters, 2012). Although the impact was low in the first millennia, people became increasingly more important for shaping the vegetation and landscape.

The potential for farming depends on natural conditions and is limited by constraints in soil, topography and climate. Some areas are well suited for cultivation and settlement whereas others are better suited for forest exploitation or grazing. Norway is a country of large climatic and topographic gradients, giving conditions for different land-use practices and subsequent, different open vegetation types. Pollen diagrams aid to identify this activity in the past (cf. Behre, 1981). Whether animal husbandry or cultivation, common to pollen diagrams is that the activity is reflected as decrease in tree pollen and presence of anthropogenic indicators (Fig. 1). Assuming that human activity is the main factor causing changes in the relationship between tree cover and cover of open vegetation the past ca. 6000 years, and that changes in this relationship reflect changes in land-use practices and in the society, a reliable estimate of vegetation cover may be a key parameter to reconstruct past societies and their landscapes. Recent development in transformation of pollen percentages to vegetation cover – the Landscape Reconstruction Algorithm (Sugita, 2007a, b) – creates new possibilities for understanding the vegetation development and thereby the environment of people through time and space. The focus of this paper is to present the Landscape Reconstruction Algorithm, and the increased importance of and potential for a close collaboration between archaeology, history, osteology and palynology, given by this methodological development within pollen analysis. Interdisciplinary research is needed to understand the results; when and why do we see changes in land cover through time?

In the following, the term "outfield resources" is used in relation to an agrarian economy where infields represent the cultivated areas connected to the settlement, whereas the outfields are the areas supporting the farm with necessary resources to be able to feed the animals and maintain the cultivated fields, as well as with firewood and timber for building purposes as documented for historical time periods (Timberlid, 2015). The differentiation between infields and outfields may be traced back to the Late Bronze Age (Diinhoff, 1999), but heathlands, pastures and leaf fodder are in the following treated as "outfield resources" also for earlier time periods. Grazing and the subsequent need for open pastures are supposed to be some of the main factors for opening-up the landscape, and important for keeping the vegetation open. Heathlands represent the most important outfield resources along the coast, whereas grass-dominated pastures represent outfield grazing both by the coast, in the fjord region, inland and in the mountains.

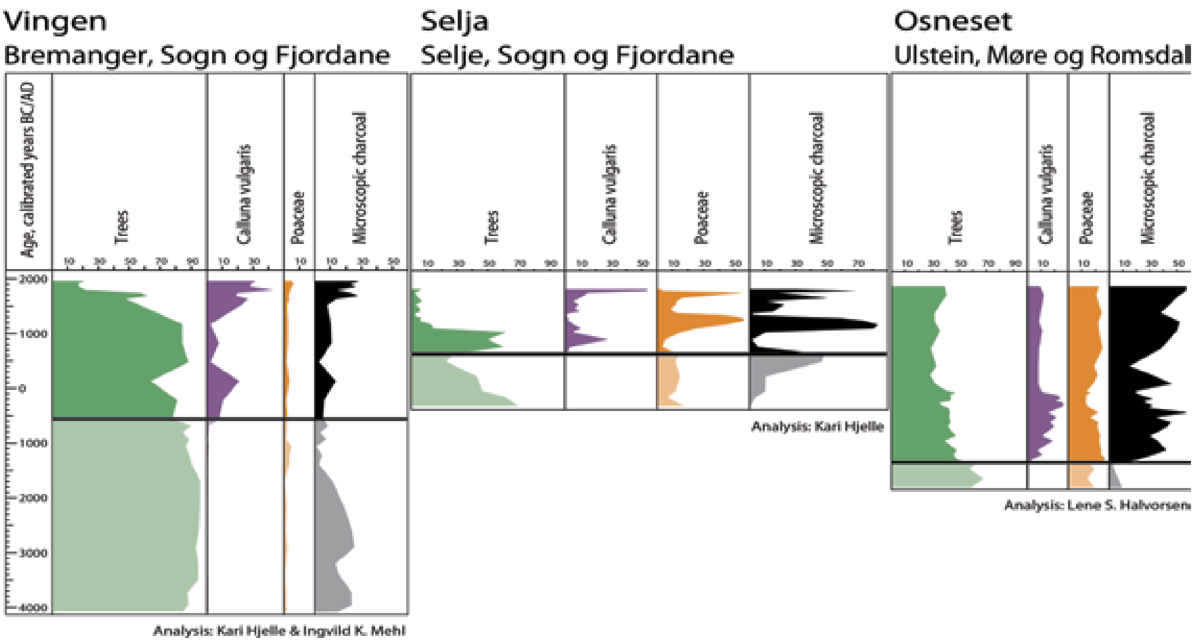


Fig. 2. Development of heathlands and relationships between tree pollen and non-tree pollen at three sites along the west coast of Norway. Among these, the first heathlands developed where natural resources provided the basis for permanent cultivation from the Bronze Age onwards, and a combination of infields and outfields existed from that time (Hjelle et al., 2010). Illustration: B. Helle

A high number of pollen diagrams have been analyzed in relation to cultural heritage management at the University Museums in Norway. Compilation of these data represents an excellent opportunity to investigate the relationship between people and environment through time and space.

Coast, fjords, inland and mountains – regions reflecting different landscape exploitation

Heathlands developed along the coast of Norway through several thousand years (Kaland, 1986; Prøsch-Danielsen & Simonsen, 2000; Tveraabak, 2004; Hjelle, Halvorsen & Overland, 2010). The light demanding heather (*Calluna vulgaris*) is growing naturally in open vegetation, but is favored by burning and grazing and, in contrast to grasses and herbs, it produces winter fodder. The mild coastal climate makes whole year grazing possible and an effective heathland management includes burning at regular intervals to keep the heather young (Kaland, 1986). To be able to interpret heathland management from pollen diagrams, the combination of *Calluna* pollen and other indicators of grazing (Behre, 1981) together with microscopic charcoal, is

Fig. 3. The investigated site at Osnes in Ulstein – today grass covered playing ground. A large grave mound is found at the hill top to the left. Photo: K.L. Hjelle

Fig. 4. The investigated site at Vingen – a small bog on poor ground surrounded by sea. Photo: T.K. Lødøen

used. In a mild oceanic climate, other natural constraints such as soil conditions and the potential for an agricultural economy have probably been decisive for the development of heathlands in time and space. Three pollen diagrams, reflecting different coastal landscapes (Fig. 2), illustrate these differences. Decrease in tree pollen is reflected at all sites prior to the development of heathlands, connected to some human activity and possible grazing (Hjelle et al., 2010). Osneset (Fig. 3) is the only site centrally located in relation to modern farming settlement. The site is found close to sandy soils well suited for cultivation, giving the possibilities to differentiate between cultivated areas and areas for whole year grazing already from the Bronze Age. The site of the Vingen pollen diagram is a bog close to the sea (Fig. 4). People have used the area and cleared the forest at different time periods, but it was not until the start of the Iron Age that heathlands developed as part of a management system. The pollen diagram from Selja is from a bog close to the medieval monastery that existed on the island (Fig. 5). Here, *Calluna* increased in the Early Iron Age, probably reflecting low grazing pressure, followed by cultivation and grass-dominated meadows in the monastery period. A further development of heathlands took place after the abandonment of the monastery. All sites show development of *Calluna* heathlands, but what does this mean in terms of vegetation cover at the individual sites? And how open has the vegetation and landscape been in different phases of human impact?

Fig. 5. The investigated site at Selja - heathland in front of the ruins of the medieval monastery. Photo: B. Helle

Mountains are landscapes for wild animals, but also huge areas exploited for grazing by domesticated animals, probably back to the Late Neolithic and the Bronze Age (Kvamme, Berge & Kaland, 1992; Prescott, 1991, 1996; Hjelle et al., 2006). Summer farms or shielings (Fig. 6) existed in the Norwegian mountains at least from the Late Iron Age when they became important parts of the farming system. At several sites intensification in activity at that time is reflected in pollen diagrams by decrease in tree pollen, increase in anthropogenic indicators, and high values of microscopic charcoal (Kvamme, 1986; Moe, 1996; Hjelle, Kaland, Kvamme, Lødøen & Natlandsmyr, 2012). Whether this reflects summer farming, another activity or whole year settlement has been discussed (Bjørgo,

Fig. 6. The summer farm/shieling Storesætra in Erdalen where pollen analyses from a bog and several archaeological contexts reflect the development from forest clearance, grazing and use of elm for fodder in the Early Iron Age, to intensified use of the valley in relation to summer farming in the Iron Age and medieval time (Hjelle et al., 2012). Photo: K.L. Hjelle

Kristoffersen & Prescott, 1992; Stene, 2015). Is it possible to get an increased understanding of the impact on the landscape and the type of activity by transforming pollen percentages to vegetation cover?

The geographical area between the coastal heathlands and mountains represents most of the farming communities of Western Norway. In addition to cultivation in the infields, lowland valleys and mountain sides have been exploited for leaf-fodder and grazing (Fig. 7) and been important resource areas for the farms (Hjelle & Kaland, 1994; Austad, Hauge & Kvamme, 2014). So far less attention has been paid on long-term exploitation of outfield resources in these areas compared to heathlands and mountains. This is partly due to the lack of bogs and lakes in the fjord areas of Western Norway as well as in inland valleys, characterized by steep hillsides or relatively dry terraces/hillsides. However, some diagrams exist and an aim for the future is to test whether new information is obtained by applying the Landscape Reconstruction Algorithm also on these pollen data.

Fig. 7a. Barn wall covered by juniper (*Juniperus communis*) at the farm Havrå on Osterøy in the fjord area. Photo: B. Helle

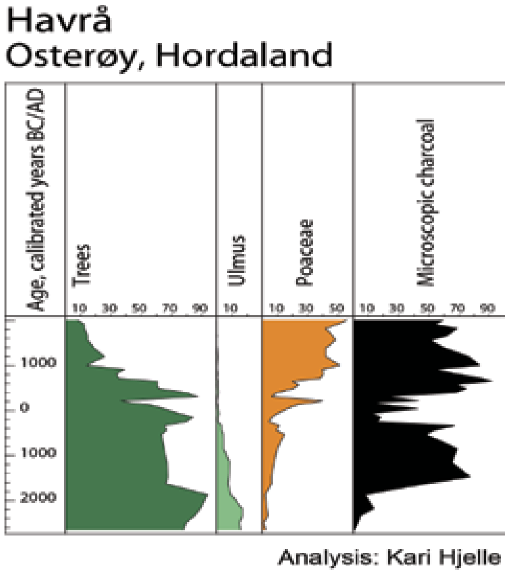


Fig. 7b. Pollen diagram from the infield of the Havrå farm indicating pollarding (elm decline), low-scale grazing (increase in grasses) and settlement (charcoal) prior to mowing (high value of grasses) locally at the site (Hjelle, 2009). Illustration: K.L. Hjelle/B. Helle

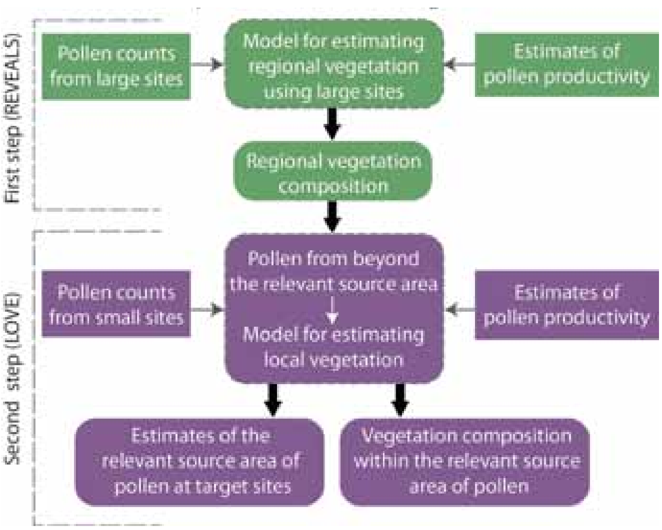


Fig. 8. The principle of the Landscape Reconstruction Algorithm (LRA) with the two steps REVEALS and LOVE, and input data as well as input parameters needed in the models. Modified from Sugita (2013). Illustration: B. Helle

Changes in vegetation cover through time – regional differences related to exploitation of outfield resources?

Two main challenges within pollen analysis have been to identify the size of the area reflected in a pollen sample and to transform pollen percentages into vegetation cover in the landscape. Shinya Sugita (2007a, b) developed the Landscape Reconstruction Algorithm (LRA) where pollen counts and pollen productivity are incorporated into dispersal models (Fig. 8). The LRA-approach consists of two steps. Based on pollen assemblages from large lakes (≥100–500 ha) or alternatively several small lakes or bogs, the regional vegetation may be reconstructed using the REVEALS (Regional Estimates of VEgetation Abundance from Large Sites) model. In theory, this model estimates the vegetation cover within an area of radius 50–100 km (Sugita, 2007a). The estimated regional vegetation cover is one of the input parameters to the LOVE (LOcal

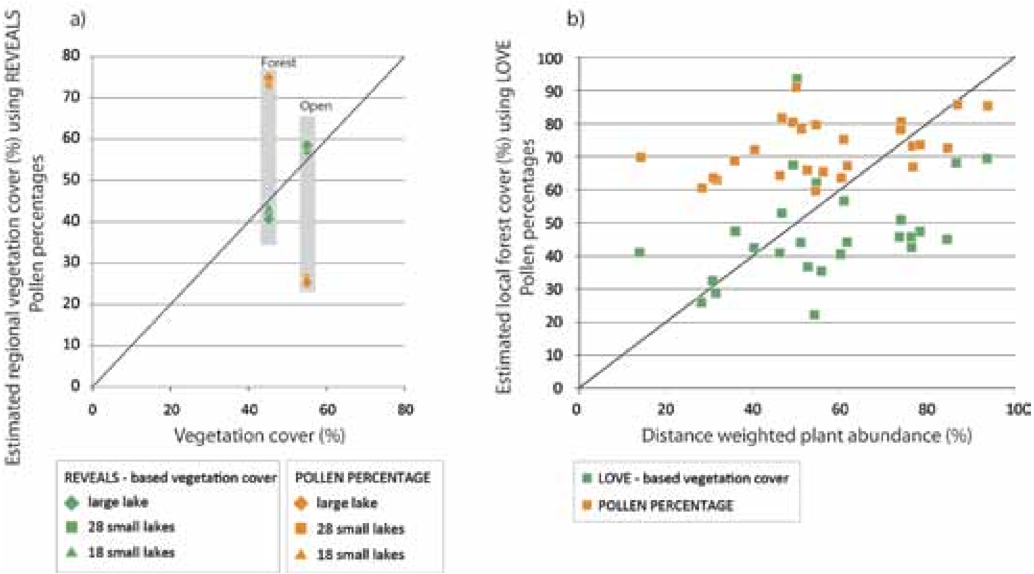


Fig. 9. a) Tree pollen percentages and REVEALS-based estimates of forest cover, open-land pollen percentages, and REVEALS-based estimates of open land, in relation to forest cover/open-land based on CORINE land cover maps, b) Tree pollen percentages and LOVE-based estimates of forest cover from small lakes, in relation to forest cover based on vegetation maps in a radius of 2000 m surrounding each lake (modified from Hjelle et al., 2015). Illustration: K.L. Hjelle/B. Helle

Vegetation Estimates) model (Sugita, 2007b) in the second step. Together with pollen counts from small sites (lakes or bogs) within the same region, background pollen may be separated from local pollen and the local vegetation cover within the Relevant Source Area of Pollen (RSAP) may be estimated. The RSAP is defined as the area beyond which the relationship between pollen loading and vegetation does not improve (Sugita, 1994). Less than 50% of the pollen composition may arrive from within RSAP (Sugita, 1994), indicating the importance of separating local pollen from background pollen. In Western Norway, RSAP is found to be ca. 1000–1100 m for small lakes today (Hjelle & Sugita, 2012). The size of RSAP depends on the vegetation pattern and will change through time (Bunting, Gaillard, Sugita, Middleton & Broström, 2004; Sugita, 2007a,b). By using the Landscape Reconstruction Algorithm the regional and local pollen may be separated and estimated vegetation cover through time in different geographical areas may be compared.

Ingvild K. Mehl (2014) has applied and tested the approach on data from Hordaland in her PhD thesis. A good relationship between REVEALS-estimated forest cover and forest cover based on Corine land cover maps was found, whereas tree pollen percentages indicate more forest than the Corine data (Fig. 9a). Likewise, a good relationship between estimated openness and open vegetation based on Corine land cover is found, whereas non-tree pollen underestimates the cover of open land. Large lakes are often missing in the landscape. Fig. 9a indicates that the results are comparable whether one large lake or several small lakes are used. A comparison of pollen percentages and REVEALS-estimated vegetation cover the last 6000 years based on a diagram from a large lake in Hordaland clearly shows the larger openness given by REVEALS than by the pollen percentages (Fig. 10).

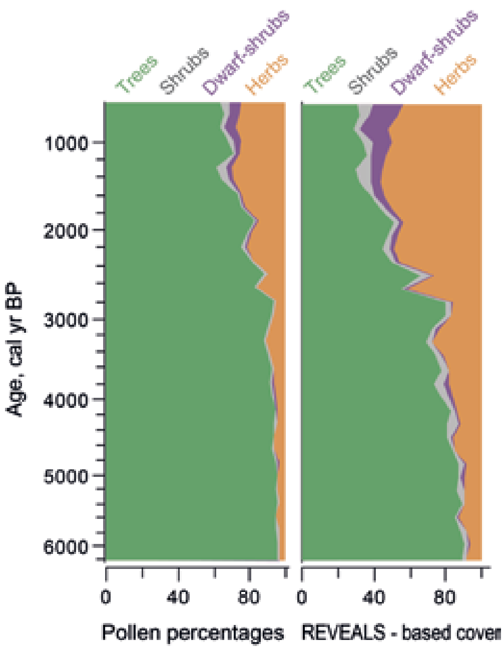


Fig. 10. Pollen percentages and REVEALS-based estimates of trees, shrubs, dwarf shrubs and herbs, based on samples from Kalandsvatn, a large lake in Hordaland. The REVEALS-based estimates indicate a more open Landscape than given by the pollen percentages (from Mehl and Hjelle, 2015). Illustration: B. Helle

We may use REVEALS for investigation of changes in vegetation cover on large spatial scales as done in e.g. Great Britain (Fyfe, Twiddle, Sugita, Gaillard, Barratt, Caseldine, Dodson, Edwards, Farrell, Froyd, Grant, Huckerby, Innes, Shaw & Waller, 2013), Germany and Denmark (Nielsen et al., 2014), and LOVE for studies on landscape exploitation and transformation on more local scales (e.g. Mehl, 2014). Fig. 9b shows the results of pollen percentages and LOVE-estimated vegetation cover from small lakes in relation to forest abundance surrounding the small lakes. As with REVEALS, a better relationship is found using LOVE-based estimates than by the pollen percentages, indicating that reasonable reconstructions of local vegetation cover may be carried out.

Within the "Landscape exploitation and transformation" network, pollen diagrams from the University Museums of Bergen, Oslo, Stavanger and Trondheim are now being compiled in a first attempt to reconstruct vegetation cover on regional and local scales in southern Norway. This opens for discussions on when and why the landscape has opened up. Do changes in vegetation cover appear at the same time in different geographical regions and is this connected to expansion, consolidation or regression phases in human activity? Are these phases also connected to exploitation of outfield resources? Hopefully these and other questions may be studied and answered in future research projects in collaboration between archaeologists, historians and natural scientists.

Conclusions

The University Museums hold a high amount of pollen data which inform on the environment of people, landscape exploitation and how people have transformed their surroundings through time and space. By the newly developed Landscape Reconstruction Algorithm, pollen percentages can be transformed to vegetation cover in specified time intervals, and studies of regional similarities and differences carried out. The examples given have shown differences on temporal and spatial scales in utilization of outfield resources. They have also shown that exploitation of these resources has contributed to shaping the vegetation and the landscape. The Landscape Reconstruction Algorithm gives the possibility to get an overall pattern of landscape utilization through time and space by combining pollen data in a new way. Hopefully this will develop into research projects and fruitful collaboration between scientific disciplines as well as between institutions within Norway, and internationally, in the years to come.

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Exploitation of outfield resources – Joint Research at the University Museums of Norway

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Exploitation of outfield resources

Wild reindeer exploitation

Iron extraction

Soapstone extraction

Landscape exploitation and transformation

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