Geological evolution and stratigraphic relationships of the ophiolitic terrane in the outer Hardangerfjord area: evidence from geochronology and geochemistry

Håvard Hallås Stubseid

Thesis for Master degree

in Geochemistry and Petrology

Department of Earth Science

University of Bergen

September 2017

Abstract

Field relations, geochemistry and U-Pb single zircon ages have provided new information about the rocks of the outer Hardangerfjord area that represent a part of the Upper Ordovician ophiolitic terrane of south-western Norway. Trace element compositions of the basaltic greenstones and the volcanogenic sedimentary sequence of the Varaldsøy-Ølve Complex (VØC) indicate supra subduction zone (SSZ) affinity. This is similar to other ophiolitic and immature island arc sequences in the Sunnhordland region formed around 490 Ma.

The immature island arc sequences are unconformably overlain by more mature island arc volcanics. This is represented by the rhyolitic lavas of the Huglo Formation now dated to around 473 Ma, similar to the Siggjo and Kattnakken Volcanics.

The metasedimentary Mundheim Group has been correlated with the sediments of the Vikafjord Group on Bømlo, based on similarities in the zircon populations. This sedimentary sequence is suggested to have been deposited in a marginal basin formed by rifting of the Laurentic margin. Sediment provenance of volcaniclastic rocks present at the base of the Mundheim Group on Varaldsøy suggest a local source of sediment from the Huglo Formation, or other volcanic sources with a similar age and affinity. This is based on the geochemical similarities and that the dominant zircon population has a similar age as the rhyolitic volcanics in the region. The quartzites and metasandstones in the area reveal multiple sediment sources dominated by Proterozoic grains, with a minor influence of an Archean source. This suggests that these complexes were formed adjacent to a continental margin. These sediments are overlain by a thick pile of limestones with Sr isotopic compositions suggesting a deposition age of 445-460 Ma. The limestones are deposited directly on top of the quartzites/metasandstones. Further development of this basin led to a transgression resulting in reducing condition. The limestones are covered in pelagic metasediments, such as phyllites and mica schists.

By combining previous knowledge about the region with the findings from this study, we have been able to improve our understanding of the outboard terrane in the Hardangerfjord area. A geological evolution is presented together with a renewed stratigraphy for the outer Hardangerfjord area.

Acknowledgements

First and foremost, I wish to thank my supervisor Professor Rolf Birger Pedersen for giving me the opportunity to work with such an interesting project. I am grateful for all the critical discussions, valuable comments and feedback both during the field work and at the office. Also, I want to thank Rolf Birger for allowing me to work as a scientific assistant at the Centre for Geobiology (CGB), and for letting me participate as a field assistant on several courses. These experiences have been important in my professional development.

Furthermore, I want to thank my good friend Andreas Lambach Viken for being an excellent field assistant, and for useful discussions and critical reviews on my thesis. I also want to thank Tor Helge Storstein, Kay Sørbø and Vilde Nesbø Bakke for their valuable comments on previous drafts. Thank you to Johannes Vik Seljebotn for inspiring me and for giving me ideas throughout the project. Also, thank you to Ole Marius Solvang, Karoline Thu Skjærpe and Kristine Alvestad for assistance during sampling on Huglo and Skorpo. I want to thank Ole Henrik Jacobsen for providing a place to stay in Ølve, and for great help with various car and boat troubles during the field work.

I am very grateful to Martina Suppersberger Hamre for introducing me to the sample preparation, mineral separation techniques and LA-ICP-MS analyses, and to Irina Maria Dumitru for preparing the thin sections. Thank you to Irene Heggstad and Trygve Knag for helping with the SEM, and to Ole Tumyr for XRF analyses. I thank Siv Hjorth Dundas for LA-ICP-MS and ICP-MS analyses, Hildegunn Almelid for ICP-OES analyses, and Yuval Ronen for sample preparations and Sr isotope measurements.

I wish to thank all my fellow geology students for five unforgettable years at the University of Bergen. Thank you to all the guys at "Hjørnerommet" for great discussions among us master students. Finally, I would like to thank my family for all their support during my time at the university. Thank you very much!

Bergen, 10.09.2017

Håvard Hallås Stubseid

Table of contents

Chapter 1: Introduction

The coastline of south-western Norway represents a section through ophiolite and island arc sequences, mafic to felsic plutons and intrusions, extrusive volcanic complexes and different metasedimentary units, deposited on top of the Precambrian basement. This study has focused on Huglo, Skorpo, Ølve and Varaldsøy in the outer Hardangerfjord areas, south-east of Bergen (Fig. 1.1). The area represents a part of the outboard terrane that constitutes the Upper Allochthon of the Caledonian nappe sequence.

The Ølve/Varaldsøy area was first studied by Foslie (1955) who conducted detailed mapping and petrographic descriptions. Compared to other areas in the region, such as Karmøy and Bømlo, the geology of the outer Hardangerfjord is far less investigated. Bømlo and Karmøy have been studied by several different scientists during the last decades, and are interpreted to represent a Lower Ordovician ophiolitic terrane formed adjacent to the Laurentic margin (Pedersen et al., 1992; Pedersen and Dunning, 1997). Færseth (1982) clearly stated that there is a connection between these well-studied areas and the rocks exposed in the outer Hardangerfjord area. This is supported by Andersen and Andresen (1994) suggesting the Huglo, Skorpo, Ølve and Varaldsøy areas to represent a similar history in terms of age and affinity as the rock complexes on Bømlo and Karmøy. Even though the rocks in the Hardangerfjord area are suggested to represent similar ophiolitic and island arc sequences as present on Bømlo and Karmøy, no real evidence clearly confirm this interpretation. Due to the lack of investigation in the area, little data is present in terms of geochemistry, geochronology and sediment provenance.

By the use of different analytical methods, this thesis will address several of these issues. Geochemical results (major- and trace elements) have been used for classification of the different rocks, and to improve the understanding of the environment of which the different rocks were formed. Single zircon dating of volcanic and sedimentary rocks have been applied with regards to provide absolute ages and provenance of different sedimentary sequences. This gives a better understanding of the age perspective of the volcanic rocks as well as the age and affinity of different sedimentary units. Sr isotopic composition has been used for dating the limestones in the area.

By combining field observations and analytical results, this study has been able to improve the understanding of the geological evolution of the outer Hardangerfjord area. The study has also been able to clarify the stratigraphic relationships of the area and to correlate the different units with other parts of the Sunnhordland region.

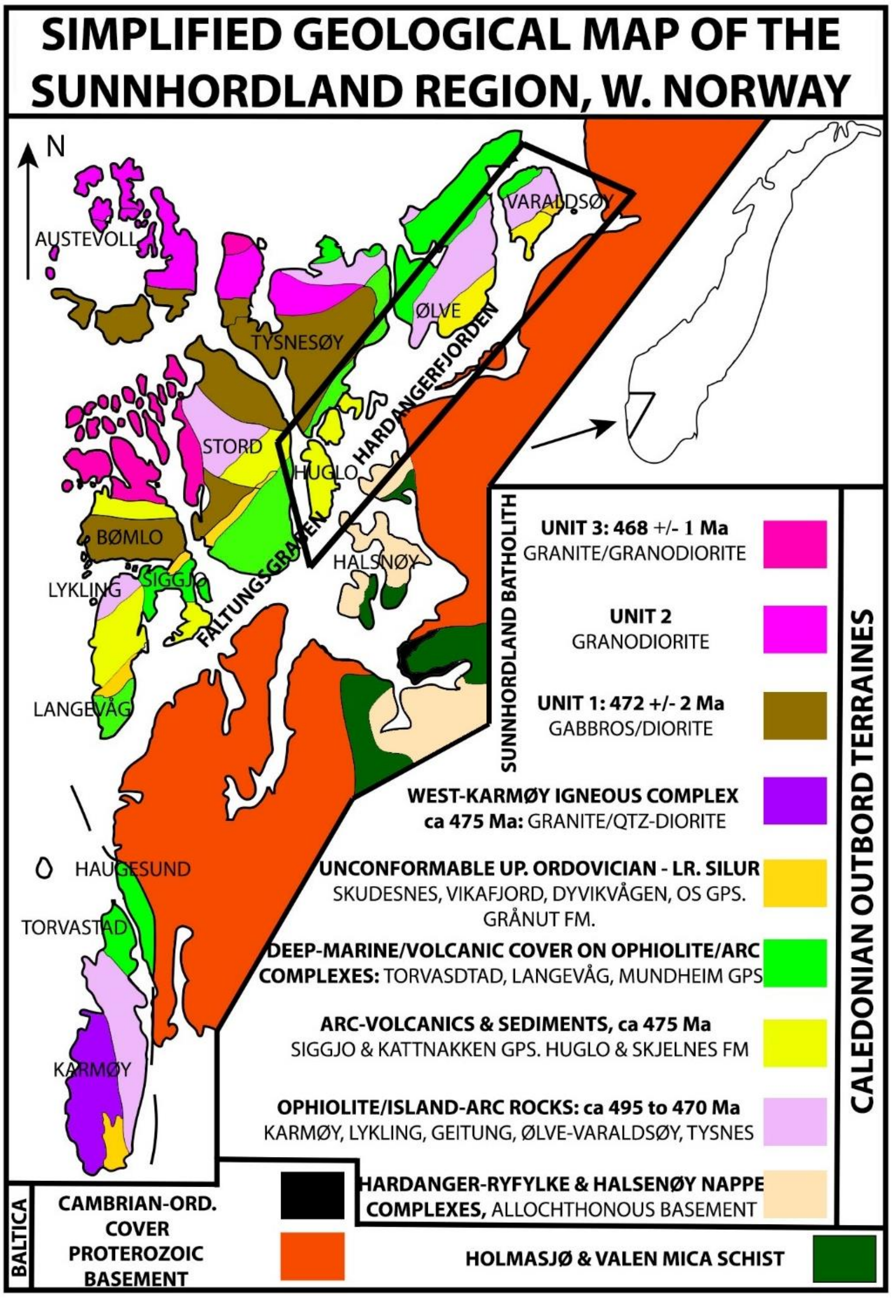

Figure 1.1: Geological map of the Sunnhordland region. The study areas in the outer Hardangerfjord (Huglo, Skorpo, Ølve and Varaldsøy) are seen in the top of the map. Redrawn and modified after Andersen and Andresen (1994).

Chapter 2: Geological setting

2.1 Scandinavian Caledonides

Caledonian evolution and tectonostratigraphy

The evolution of the Caledonian orogen initiated in the Neoproterozoic when Baltica started to rift from Laurentia, forming the Iapetus Ocean (Corfu et al., 2007, and references therein). Convergence between these landmasses in the Ordovician and Silurian resulted eventually in continent-continent collision and subduction of Baltica underneath Laurentia in the Late Silurian to Early Devonian (e.g. Roberts, 2003). During the Caledonian collision, nappes of different origin were emplaced onto the Precambrian Fennoscandian Shield. The tectonostratigraphy of this nappe stack is divided into the Autochthon-Parautochthon, and the Lower-, Middle-, Upper- and Uppermost Allochthons (Roberts and Gee, 1985). The Autochthon-Parautochthon constitutes the Fennoscandian basement. Fossen (1992) divided the southern part of the Norwegian Caledonides into three major tectonic units: 1) the Baltic Shield (Precambrian basement), 2) a décollement zone and 3) an overlying orogenic wedge of far-travelled nappes. The décollement zone was developed within the sediments deposited on the Baltic Shield in the Late Precambrian to the Early Paleozoic. Mechanically weak phyllites acted as a basal thrust, making it possible for the far-travelled nappes to be emplaced onto the Baltic margin (Fossen, 1992).

The Lower Allochthon comprises sediments of Late Proterozoic to Early Paleozoic age as well as basement lithologies of the Fennoscandian Shield (Andersen and Andresen, 1994). These sediments have been transported tens of kilometers (Fossen and Hurich, 2005). Slama and Pedersen (2015) suggested that the provenance of these sediments is dominated by two major sources, namely the; Timanian orogen to the north and the local Fennoscandian Shield. The Timanian source indicates long-distance sediment transport through a drainage system across the whole paleocontinent (Slama and Pedersen, 2015).

Precambrian gneisses, which are cut by mafic intrusions, dominates the Middle Allochthon (Roberts and Gee, 1985). These gneisses are locally overlain by metasediments of Lower Paleozoic age (Andersen and Andresen, 1994). One of the best examples from this unit is the far-travelled Jotun Nappe (Hossack and Cooper, 1986).

The Upper Allochthon constitutes the outboard and exotic terranes comprised of ophiolitic and island-arc lithologies (Roberts and Gee, 1985). In SW Norway, such complexes are exposed on Karmøy, Bømlo, Ølve/Varaldsøy, and in the Bergen Arcs. It was earlier suggested that these sequences formed adjacent to the Baltic margin in the Early Ordovician (e.g. Brekke et al., 1984; Sturt, 1984). Based on single zircon ages and faunal provenance data, Pedersen et al. (1992) suggested a formation closer to the Laurentic margin. Zircon provenance signatures of different magmatic and sedimentary rocks, revealed a very significant Archean detrital component in many rock units within the ophiolitic terrane of SW Norway. As the Baltic Shield of southern Norway does not contain rocks of this age, the most likely source is from the large Archean terranes on the Laurentian side of the Iapetus Ocean. This has led to the conclusion that the outboard terranes were formed closer to the Laurentic margin, and were later accreted onto the Baltic Shield during the final closure of the Iapetus Ocean.

Nordland and Troms contain the only remnants of the Uppermost Allochthon (Roberts and Gee, 1985). This unit is comprised of a great variety of rocks such as gneisses, schists and marble deposited in post-orogenic local basins, as well as Paleozoic granitoids (Roberts and Gee, 1985; Corfu et al., 2007). The Uppermost Allochthon is interpreted to represent a remnant of the Laurentian continental margin (Stephens et al., 1985; Roberts et al., 2002; e.g. Barnes et al., 2007; Roberts et al., 2007).

Caledonian extension

After the Caledonian collision, extensional collapse started to affect the orogen during the Late Paleozoic. This involved a change in direction of deformation, from a south-east oriented collision and nappe transport, to a west and north-west trending extension (Andersen, 1998). The extension resulted in thinning of the nappes, as well as reworking and decompression of high-pressure rocks. These high-pressure metamorphic rocks are well exposed in the Western Gneiss Region. The orogenic collapse also led to the formation of large-scale detachment faults, and Devonian detachment basins (Andersen and Andresen, 1994; Osmundsen, 1996; Osmundsen et al., 1998).

The post-collisional extension can be separated into two different modes; Mode 1 and Mode 2 (Fossen, 1992). Mode 1 shows a total reverse of the thrust direction of all the different nappes. Mode 2 is also dominated by the development of a major oblique extensional shear zone, called the Hardangerfjord Shear Zone (Fossen and Hurich, 2005).

This ductile structure occurs as a NW-SE zone in the Hardangerfjord area, in south-western Norway (Fig. 2.1). It is oriented parallel to the Caledonian orogenic belt (Fossen and Hurich, 2005).

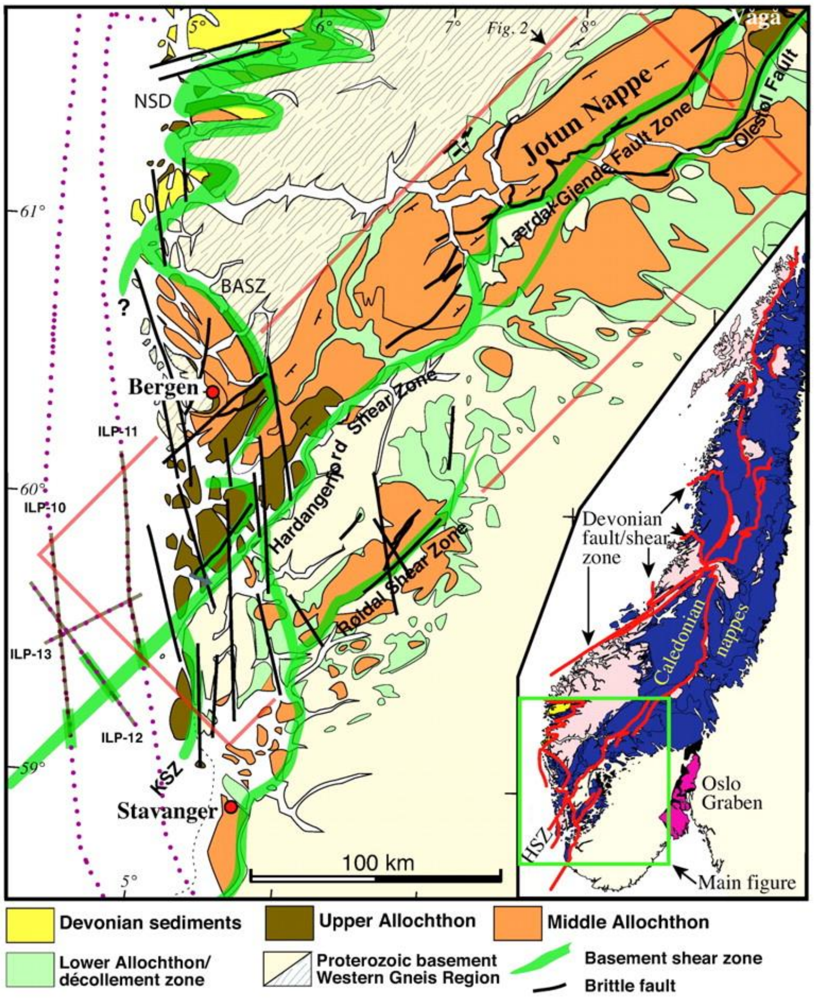

Figure 2.1: Simplified geological map of south-western Norway with different post-collisional structures. The Hardangerfjord Shear Zone is marked as a thick green line through the whole Hardangerfjord. All the green lines represent Mode 2 structures. From Fossen and Hurich (2005).

On the south-eastern side of the shear zone the Precambrian basement is exposed. The Precambrian basement consists of mainly autochthonous units with low-grade affection of the Caledonian deformation. These basement rocks are dominated by plutonic and intrusive rocks formed during two main events; The Labradorian-Gothian Orogeny from 1750 Ma to 1550 Ma (Starmer, 1996), and the Sveconorwegian (Grenvillian) Orogeny (from 1250 Ma to 950 Ma (Starmer, 1993; Slagstad et al., 2013). This Precambrian surface was peneplained during the

Late Paleozoic, and later covered by different sediments that acted as the basal thrust during the collision (Bockelie and Nystuen, 1985).

The different Caledonian nappes are located both in the foreland and the hinterland. The upper Allochthon, which comprises the ophiolitic and island arc complexes, is mostly found on the north-western side of the shear zone. This constitutes the hanging wall of the Hardangerfjord Shear Zone (Fossen and Hurich, 2005), and includes areas like Ølve/Varaldsøy, Stord and Bømlo, as illustrated as the outboard terranes in Fig. 2.2.

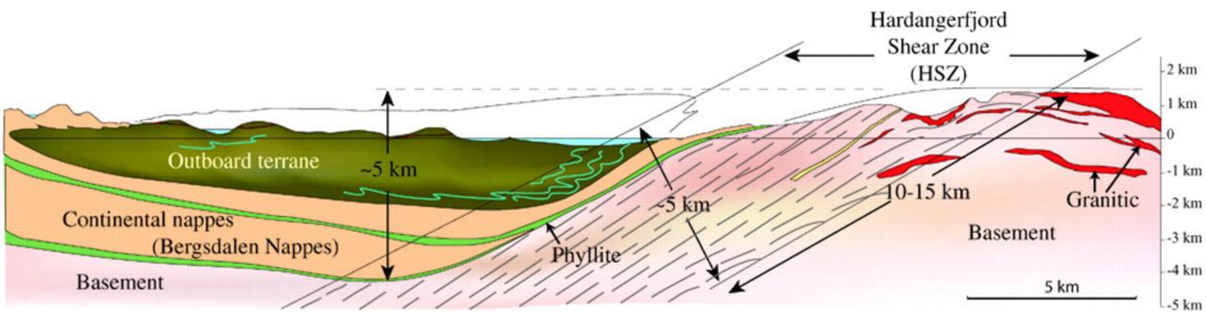

Figure 2.2: Profile through the south-western region of Norway. The Hardangerfjord Shear Zone is separating the outboard terranes from the Precambrian basement rocks. Ølve/Varaldsøy, Stord and Bømlo are located in the outboard terrain, i.e. the hanging wall. From Fossen and Hurich (2005).

2.2 The Ophiolitic Terrane of South-Western Norway

Several ophiolitic and island arc sequences have been recognized within the Scandinavian Caledonides during the last decades (Furnes et al., 1979; Furnes et al., 1985; Stephens et al., 1985; Pedersen et al., 1988). Dunning and Pedersen (1988) divided these ophiolites into two major groups based on the age of the formation. The oldest complexes were formed in the Early Ordovician (Tremadocian-Arenigian), followed by the youngest ophiolites in the Late Ordovician (Ashgillian). The Upper Allochthon exposed in SW Norway comprises ophiolite and island arc fragments from the oldest group. Based on geochronology and geochemistry, in combination with field relations, the formation and accretionary history of this suspect terrane has been detected within the Bergen Arcs, as well as on the islands of Bømlo and Karmøy (Dunning and Pedersen, 1988; Pedersen and Dunning, 1997). These ophiolite complexes and island arc related sequences are intruded by granitic complexes and they are all overlain by younger sediments of Silurian age. Together these rock complexes provide knowledge about the evolution of the Caledonian outboard terranes prior to the late Silurian continent-continent collision.

The Karmøy Ophiolite Complex and the Torvastad Group

Karmøy, and adjacent islands, consist of four major rock units. These are the Karmøy Ophiolite Complex, the West Karmøy Igneous Complex (WKIC), the Torvastad Group and the Skudeneset Group (Pedersen and Hertogen, 1990, and references therein).

Karmøy Axis Sequence (KAS) is the oldest part of the Karmøy Ophiolite Complex. It is dominated by layered gabbros grading up to a sheeted dyke complex. The sheeted dyke complex is named the Feøy Sheeted Complex. Small pods of plagiogranite, regarded to be cogenetic with the gabbros, are dated to 493+7/-4 Ma (Dunning and Pedersen, 1988). This unit was later intruded by an assembly of trondhjemites, tonalites and diorites called Sauøy Diorite. The intrusions revealed a U-Pb zircon age of 485±2 Ma (Dunning and Pedersen, 1988).

Both the KAS and the Sauøy Diorite are intruded by several younger dike swarms of boninitic affinity. Based on orientations and cross-cutting relations, Dunning and Pedersen (1988) divided the dyke swarms into three groups; Duøy, Helganes and Laksodden Dyke Swarms. The dyke swarms are all intruded by the calk-alkaline Feøy Gabbro dated to 470+9/-5 Ma (Dunning and Pedersen, 1988).

The Torvastad Group represents a mixture of volcanic and sedimentary rocks. The sequence is equivalent to a number of plutonic rocks on the island (Pedersen and Hertogen, 1990). It can be divided into four different groups. The Midtøy Formation represents intermediate pyroclastic flows, crystal tuffs and some basaltic lava flows. The Velle Formation is dominated by more mafic pyroclastics or volcaniclastics like the Feøy Gabbro. The Vikingstad Formation comprises greenstones, with local layers of different sediments, such as chert and phyllite. The Håland Formation consists of phyllite and chert. Pedersen and Hertogen (1990) suggested this group to be an Early Ordovician back-arc deposit. The Langevåg Group on Bømlo, and the Mundheim Group on Ølve/Varaldsøy, show similarities to the Torvastad Group, and may represent a similar deposit with the same age and history (Andersen and Andresen, 1994).

The Lykling Ophiolite Complex and associated volcano-sedimentary sequences

Bømlo is a group of islands located in the south-western part of Norway. It comprises a great variety of rock types and represents a section through a Caledonian convergent plate margin. The different rock units belong to the Upper Allochthon and range from Cambrian to Silurian age (Brekke et al., 1984). Brekke et al. (1984) divided Bømlo into five lithostratigraphic units, namely; the Lykling Ophiolite, the Geitung Unit, the Siggjo Complex, the Vikafjord Group and the Langevåg Group. These units represent a stratigraphy through old oceanic crust, overlain by island arc sequences and marginal basin deposits (Brekke et al., 1984).

The Lykling Ophiolite is the oldest unit. It represents an almost complete section through an ophiolite complex (Nordås et al., 1985). The age of the ophiolite is still unknown. The basalts of this ophiolite are structurally similar to basalts formed at a mid-oceanic ridge, but contain geochemical signatures related to subduction zones (Pedersen and Dunning, 1997). This has led to the conclusion that the units have formed because of supra-subduction magmatism. Thus, the basalts have been generated at a spreading centre located directly above a subduction zone (Pedersen and Dunning, 1997).

The ophiolite is unconformably overlain by the Geitung Unit. This unit consist of a mixture of extrusive volcanics, and sediments (Brekke et al., 1984). It contains greenstone (pillow lavas), "quartz-keratophyre" and volcanic breccias. The volcanics are typically interbedded with thin layers of different sediments, such as chert, conglomerates and sandstones (Amaliksen, 1983; Nordås et al., 1985). This unit is interpreted as an immature island arc sequence and tholeiitic volcanics, indicating formation at an early stage of arc development (Amaliksen, 1983; Brekke et al., 1984; Pedersen and Dunning, 1997). U-Pb ages of extracted zircons revealed a crystallization age of 494±2 Ma for this unit, which post-date the Lykling Ophiolite. (Pedersen and Dunning, 1997).

The Langevåg Group is exposed in the southernmost parts of Bømlo, and was originally suggested to represent the youngest group (Brekke, 1983; Brekke et al., 1984; Nordås et al., 1985). However, Færseth (1982) suggested that the Langevåg Group is a part of the Hardangerfjorden Group, and that it represents the oldest unit in the area. The lowermost part of the Langevåg Group comprises subaerial calc-alkaline volcanics covered in submarine volcanic breccias, aa-lavas and tuffs. The upper part of the group consists of greywackes, bedded cherts and greenstones of tholeiitic to alkaline affinity (Nordås et al., 1985). Brekke (1983) assumed that the group was the youngest in the area, as the sequence was correlated with the sediments covering the assumed Ashgillian limestones on Huglo. The Langevåg Group shows similarities with the Torvastad Group on Karmøy, both in terms of lithostratigraphy and geochemistry. These two groups have therefore been correlated, and they have been suggested to represent Lower to Middle Ordovician strata that were deposited in a back-arc basin (Pedersen and Dunning, 1997).

The Siggjo Complex lies unconformably above the Geitung Unit. The unconformity between these units is represented by folding and erosion before deposition of the Siggjo Complex. This complex is dominated by subaerial volcanics mixed with some sedimentary rocks (Nordås et al., 1985). The different rocks range in composition from basaltic to rhyolitic (Furnes et al., 1986). The lower parts of the complex consist of basic to intermediate volcanic rocks, representing highly vesicular flows. The upper parts are dominated by more acid rocks, comprising thicker and more massive units (Brekke et al., 1984). Analyses of andesites from this complex yielded a U-Pb zircon age of 473±2 Ma (Pedersen and Dunning, 1997). The geochemical pattern, with recognizable negative Ta and Nb anomalies, indicates a typical calc-alkaline island arc sequence. A similar unit is found on the island of Stord, called the Kattnakken Volcanics. This unit is assumed to be a lateral continuation of the Siggjo Complex and is dated to 476±4 Ma (Pedersen and Dunning, 1997).

The Vikafjord Group is dominated by different sedimentary rocks and some mafic volcanics, and the group rests unconformably on top of the Siggjo Complex. Brekke et al. (1984) suggested that the conglomerates in the lower parts of the unit represent alluvial debris flow deposits. This deposit is overlain by a unit of fossiliferous limestone and calcareous phyllites, indicating a marine transgression. These sedimentary rocks comprise the base of a coarsening upwards sequence of turbiditic greywackes, that is covered in sandstone. The sequence is interpreted to represent a prograding delta (Brekke et al., 1984). This is further overlain by fine-grained phyllites, cherts and non-fossiliferous limestones, probably representing a transgression. Conglomerates and coarse sandstones cover the basal deposits, representing an ancient fan-delta (Brekke et al., 1984, and references therein). On top of these sedimentary rocks is a thick unit of subaerial mafic volcanics called the Eriksvatn Formation (Brekke et al., 1984; Nordås et al., 1985).

Gullfjellet Ophiolite Complex

The Major Bergen Arc is an arcuate Caledonian structure. It is regarded as a thrust sheet being divided into two units; the Gullfjellet Ophiolite Complex and the Samnanger Complex. The Gullfjellet Ophiolite Complex consists of mafic and ultramafic plutonic rocks, as well as different volcanic products (Thon, 1985a). It contains sheeted dykes, gabbros and arc-related intrusions of granitic rocks. Dunning and Pedersen (1988) dated the complex by extracting zircons from plagiogranites associated with the gabbro-sheeted dyke transition. This revealed a crystallization age of 489±3 Ma. A younger part of the complex was dated from an arc-related tonalite with an age of 482+6/-4 Ma (Dunning and Pedersen, 1988).

The West Karmøy Igneous Complex and the Sunnhordland Batholith

The ophiolite complexes and the arc/back-arc sequences of the ophiolitic terrane of SW Norway are intruded by large granitic complexes.

The West Karmøy Igneous Complex (WKIC) intrudes the plutonic parts of the Karmøy Ophiolite Complex and the different dyke swarms. The complex comprises different felsic to intermediate rocks. Outer parts are mainly composed of quartz diorite. The central parts are dominated by granodiorite and granite (Pedersen and Dunning, 1997). U-Pb zircon dating of the quartz diorite revealed an age of 479±5 Ma. Analyses of other parts of the complex revealed only zircons with Proterozoic ages from about 1500-2000 Ma (Pedersen and Dunning, 1997). The grains are interpreted to be inherited, suggesting that a major part of this complex comprises S-type granitoids. These rocks are interpreted to have formed as a result of subduction of continental material below an island-arc during arc-continent collision (Pedersen and Dunning, 1997). One sample from a granite pegmatite yielded a U-Pb zircon age of 474+3/-2 Ma. This age is considered to represent the crystallization age of both the pegmatite and the surrounding pluton (Pedersen and Dunning, 1997).

The Sunnhordland Batholith is a 1000 km^2 batholith located in the south-western part of Norway, south of Bergen. The batholith is exposed on the northern parts of the islands of Bømlo, Stord, Tysnes and Austevoll. Earlier on, the name "Sunnhordaland Igneous Complex" was used for the igneous rocks in this region (Andresen and Færseth, 1982). Later studies discovered differences in ages between these rocks, and were also able to detect ophiolitic and island arc lithologies within the complex (Brekke et al., 1984; Nordås et al., 1985). Based on this, the earlier term was abandoned and the plutonic rocks were named the Sunnhordland Batholith. The Sunnhordland Batholith intrudes the ophiolite complex and the overlying island arc sequences. The composition ranges from gabbroic to granitic (Andersen and Jansen, 1987). Geochemical data indicates that the batholith is an I-type complex, showing a differentiation trend from basic to more acidic composition with time. Based on its composition, the batholith is divided into three major units (Andersen and Jansen, 1987). Unit 1 is dominated by gabbros and diorites, that has been dated, using the U-Pb zircon method, to 472±2 Ma (Pedersen and Dunning (1997). Unit 2 is dominated by granodiorites with a yet unknown age. The youngest unit, unit 3, generally consist of different granitic rocks. Fossen and Austrheim (1988) dated a part of this unit, named the Krossnes Granite, using the Rb-Sr isotope whole-rock method. Their study yielded an isochrone age of 430±6 Ma. However, later studies have shown that this age rather represents a metamorphic overprint during the Caledonian collision. The crystallization age of the granites in unit 3 have been correctly dated to 468±1 Ma using the U-Pb zircon method (R.B. Pedersen, pers. comm., 2017).

On Bømlo, the Bremenes Migmatite Complex is associated with the Sunnhordland Batholith. The migmatite complex consists of meta-arkoses, schists, quartzite and marble being partly migmatized. The complex is in tectonic contact with the ophiolite. It seems to be genetically related with the with S-type granites in the Karmøy area, that was partly formed by subduction of sediments, and dated to 474+3/-4 Ma (Pedersen and Dunning, 1997). This suggests that the Bremnes Migmatite Complex was accreted to the ophiolitic terrane around 475 Ma (Fonneland, 2002). As the provenance signature of this migmatite complex is dominated by grains of Archean and Paleoproterozoic age, Fonneland (2002) suggested a Laurentic affinity. This indicates that the ophiolitic terrane was located close to the Laurentic continental margin at this time. The migmatite complex is intruded by the Vardafjell Gabbro of the Sunnhordland Batholith (Pedersen and Dunning, 1997).

Late Ordovician to Early Silurian sedimentary sequences

The Skudeneset Group is the youngest group on Karmøy, and was deposited unconformably on top of the older lithologies after a period of uplift and erosion (Sturt and Thon, 1978). Pedersen and Hertogen (1990) suggested an Upper Ordovician (Ashgillian) age for this group.

In the same area, a sequence of Lower Silurian conglomerates called Utslettefjell Conglomerate covers the Vikafjord Group. The group is thought to be the youngest on Bømlo. Færseth (1982) suggested that these conglomerates belong to the Dyvikvågen Group.

Unconformably on top of the Gullfjellet Ophiolite Complex lies the sedimentary Ulven Group of Upper Ordovician to Lower Silurian age. The sediments comprise quartzites, conglomerates and fossil bearing phyllites (Thon, 1985b). Provenance studies reveal a signature dominated by grains of Early Proterozoic to Middle Proterozoic age (1800 Ma to 900 Ma). This signature has been proposed to indicate that the ophiolitic terrane was accreted to the Baltic margin before deposition (Fonneland, 2002).

The Solund-Stavfjord ophiolite complex

The Solund-Stavfjord Ophiolite Complex is located in the district of Sogn and Sunnfjord in Western Norway. The complex yielded a U-Pb zircon age of 443±3 Ma, and together with the Sulitjelma Ophiolite Complex it represents the youngest ophiolite complex in the Scandinavian Caledonides (Dunning and Pedersen, 1988). This proves that spreading related magmatism took place during the Late Ordovician to Early Silurian times (Furnes et al., 1990; Pedersen et al., 1991). The metabasalts of the complex show normal to enriched mid-ocean ridge basalt (N- to E-MORB) affinity, with the typical low values for Ta and Nb indicating subduction influence (Furnes et al., 1990). The ophiolite is conformably overlain by metasediments and metavolcanics, called the Stavenes Group. This group comprises continentally derived metasediments, as well as metavolcanics with MORB, island arc tholeiite (IAT), calc-alkaline and alkaline characters (Furnes et al., 1990). This indicates that the Solund-Stavfjord Ophiolite Complex formed in a marginal basin close to a continental margin (Furnes et al., 1990). Provenance studies of the sediments revealed Precambrian and Ordovician ages. Based on this, Pedersen and Dunning (1993) suggested a formation in a marginal basin receiving material from the uplifted Lower Ordovician ophiolitic terrane.

2.3. Magmatic and tectonic evolution of the outboard terranes

Pedersen and Dunning (1997) have demonstrated that the ophiolite and arc sequences of the ophiolitic terrane of SW Norway are closely related both in time and space. Based on U-Pb zircon dating and geochemistry of the range of magmatic rocks, 25 million years of continuous supra-subduction zone magmatism were documented. From the use of U-Pb zircon ages, geochemical data and field relations, Pedersen and Dunning (1997) suggested the following magmatic evolution:

- Formation of ophiolitic crust before, during and after the formation of an immature arc sequence dated to 494±2 Ma.
- A 20 Ma gap is documented between the immature and the mature island arcs, dominated by spreading related volcanism Intrusion of dyke swarms of boninitic and IAT affinity occurred before and after 485±2 Ma. This was followed by the intrusion of tonalitic and quartz dioritic rocks dated to 485±2 Ma, 482 +6/-4 Ma, 479±5 Ma to 474+3/-2 Ma.

- Formation of mature island arc volcanics characterized by extrusion of subaerial high-K calc-alkaline volcanics dated to 473±2 Ma, followed by intrusion of calc-alkaline plutons on Bømlo (472±2 Ma) and on Karmøy (470+9/-5 Ma).
- Final magmatic activity represented by extrusion of shoshonites and finally OIB-like lavas.

Based on zircon provenance and fossil fauna, Pedersen et al. (1992) constructed a tectonic model for the evolution of the Caledonian oceanic terrane (Fig. 2.3). The new findings suggested that the ophiolitic terrane was formed adjacent to the Laurentic margin. This is in contrast to the earlier assumptions by e.g. Brekke et al. (1984) who suggested a formation closer to the Baltic margin.

The tectonic evolution is described in six steps. Step 1 and 2 show the beginning of an eastward dipping subduction with the development of ophiolitic crust and an immature island arc system. This developed to a mature island arc system located close to the Laurentic margin showing evidence from the Toquima-Table Head Fauna, illustrated in step 3. Step 4 shows the accretion of the oceanic terrane onto the Laurentic margin. A switch in plate motion to a westward dipping subduction led to the rifting of an active continental margin forming a marginal basin seen in step 5. The final step shows a further development of the marginal basin, containing evidence from Hirnantian and Holorhynchus fossil faunas. The rifting led to a second phase of back-arc spreading forming the younger generation of ophiolites. These sequences were later emplaced onto the Baltic shield during the Caledonian collision.

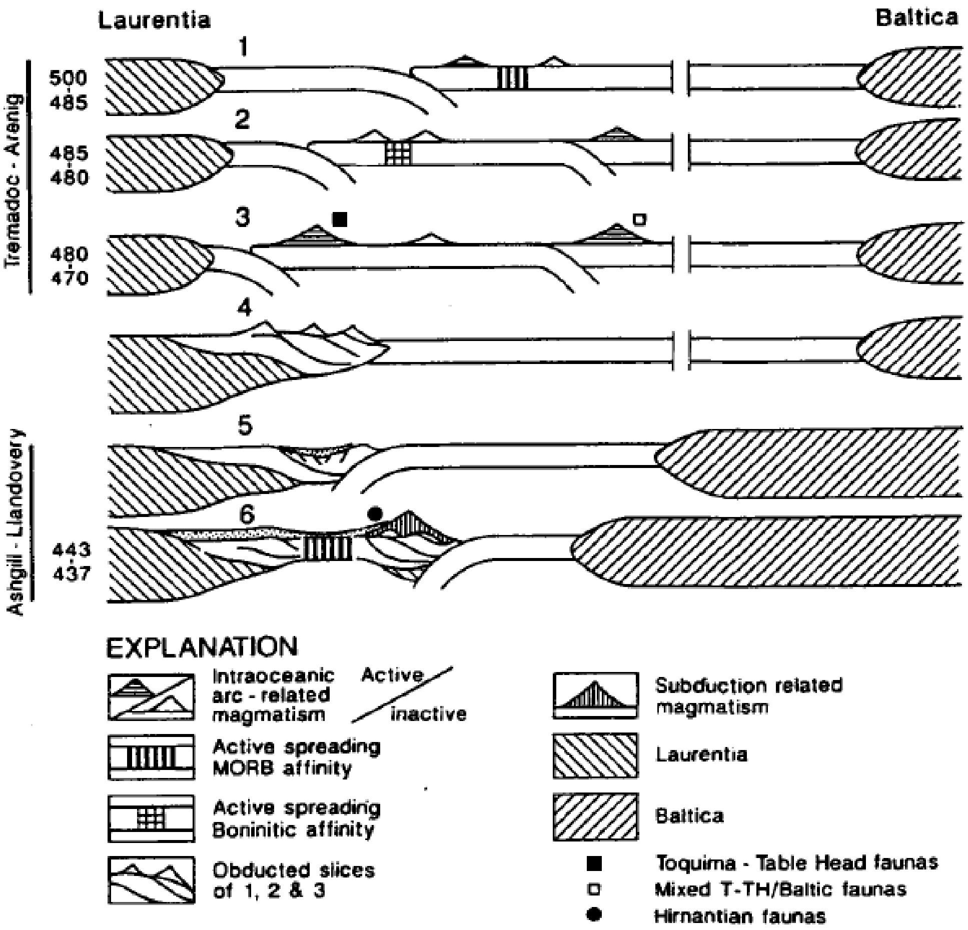

Figure 2.3: Evolution of the oceanic terrane. Step 1 and 2 show the formation of an immature arc on top of older oceanic crust. Step 3 indicates the build-up of a more mature island arc closer to the continental margin. This resulted in formation of S-type granites and migmatites from subduction of sediments below the island arc. Further on, these sequences were accreted to the Laurentic margin sometime after 475 Ma. The two last steps illustrate rifting and a new episode of back-arc spreading forming the younger generation of ophiolites. From Pedersen et al. (1992).

2.4 Geology of the study area in the outer Hardangerfjord region

Færseth (1982) divided the Hardangerfjord area into 7 main lithostructural units (Fig. 2.4). The Sunnhordland Precambrian basement consists of the already described granitic gneisses. The Valen Mica Schist represents shallow marine deposits of a Cambrian-Ordovician age, and is directly overlying the top of the Precambrian basement. These two units represent the Autochthon - Parautochthon units described earlier in section 2.1. Five different allochthonous units are described: Sunnhordland Igneous Complex, Dyvikvågen Group, Hardangerfjorden Group, Halsnøy Complex and Bergsdalen Nappes. As the Bergsdalen Nappes comprise non-ophiolitic Caledonian Nappes, it will not be further discussed.

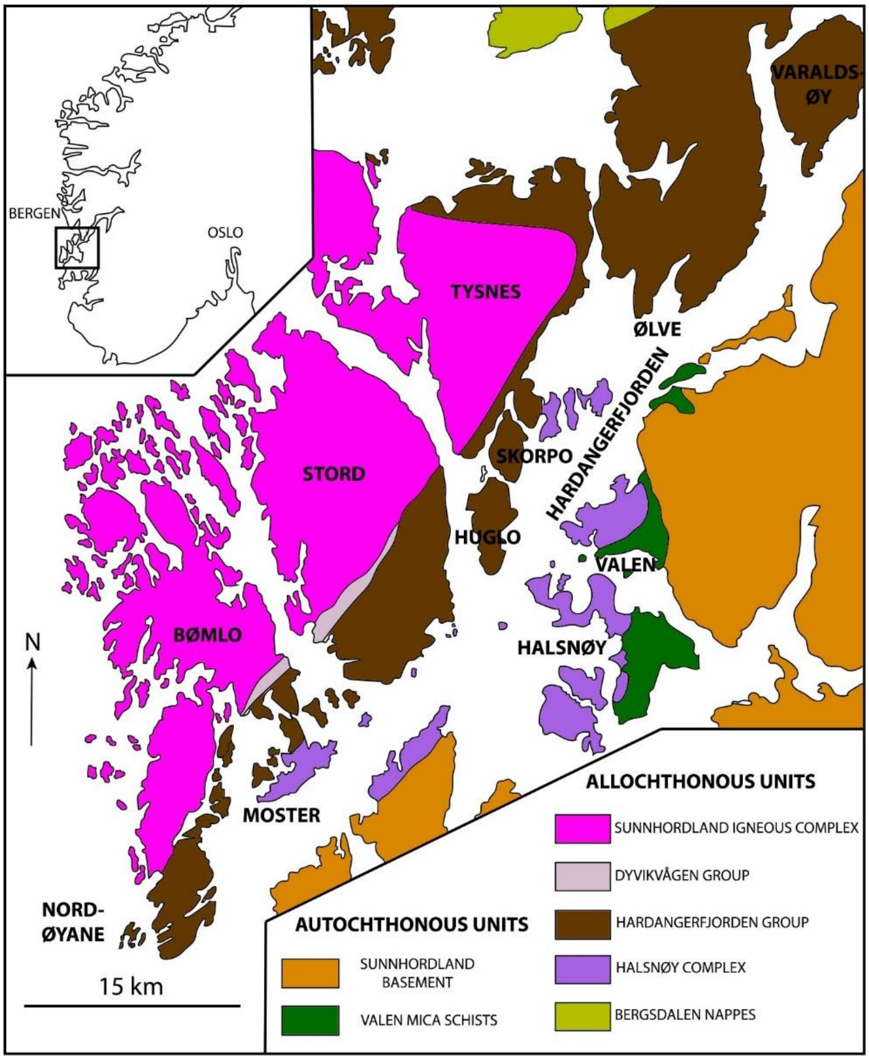

Figure 2.4: Simplified geological map of the Sunnhordland region. The map shows the exposure of the autochthonous units as well as the allochthonous. Ølve and Varaldsøy are seen in the upper right of the map, within the Hardangerfjorden Group. Redrawn and slightly modified from Færseth (1982).

As mentioned earlier, Sunnhordland Igneous Complex comprises all the igneous rocks on Bømlo, Stord, Tysnes and Austevoll. However, this old term was abandoned, and the complex has been divided into more accurate lithological units. Southwest of this complex, lies the Dyvikvågen Group representing the metasediments and metavolcanics on Stord and Bømlo (Færseth, 1982). The Halsnøy Complex constitutes a variation of gneisses and metasupracrustal rocks in the area.

The last, and most important unit for this study, is the Hardangerfjorden Group. This group comprises the rocks on the north-western side of the Hardangerfjord Shear Zone (Fig 2.1), and is further subdivided into five formations (Færseth, 1982). The Huglo Formation is dominated by “quartz-keratophyres”. The term “quartz-keratophyre” is an old, and now abandoned, expression for metamorphosed sodium rich volcanic rocks with an intermediate to felsic composition. The term is mostly used in the Nordic countries (Schermerhorn, 1973). It is the dominant lithology on the islands of Huglo and Skorpo, and can also be traced all the way to the southern parts of Ølve and Varaldsøy (Fig. 2.4). Local layers of pelite and quartzite are also observed within the formation. In addition to this, thick layers of conglomerate are also present. Færseth (1982) suggest that the "quartz-keratophyre" was deposited as lava flows, and where the conglomerates indicate the boundary between different flows. The "quartz-keratophyre" contains phenocrysts of varying size and occurrence.

The Haukanes Formation is located stratigraphically above the Huglo Formation. It is dominated by limestone, with thin layers of pelite and psammite. The formation crops out on Huglo/Skorpo and all the way to Ølve and Varaldsøy. A conglomeratic layer occurs at the base of the formation on Huglo, containing fragments from the underlying "quartz-keratophyre". Dark phyllites are the dominating lithology of the Ådland Formation and are covering the limestones in the area. Further west, a mixture of psammitic and semi-pelitic rocks crops out with a maximum thickness on the southern parts of Stord. These sediments are named the Agdestein Formation. The last formation in the area is the Sagvågen Formation. This formation is interpreted to be of volcanic origin (Færseth, 1982). It is dominated by a fine-grained, schistose greenschist. The high schistosity might be due to tuffaceous material within the lavas. Chert is a common feature in several of these formations, especially within the Sagvågen- and the Agdestein Formation (Færseth, 1982).

Ølve and Varaldsøy

Andersen and Andresen (1994) constructed a simplified geological map of the Sunnhordland region, showing the distribution of the different stratigraphic units in the area. A modified version of this map is shown in Fig. 2.5. The map clearly states that there is a connection between the lithologies on the outer islands and in the Hardangerfjord area.

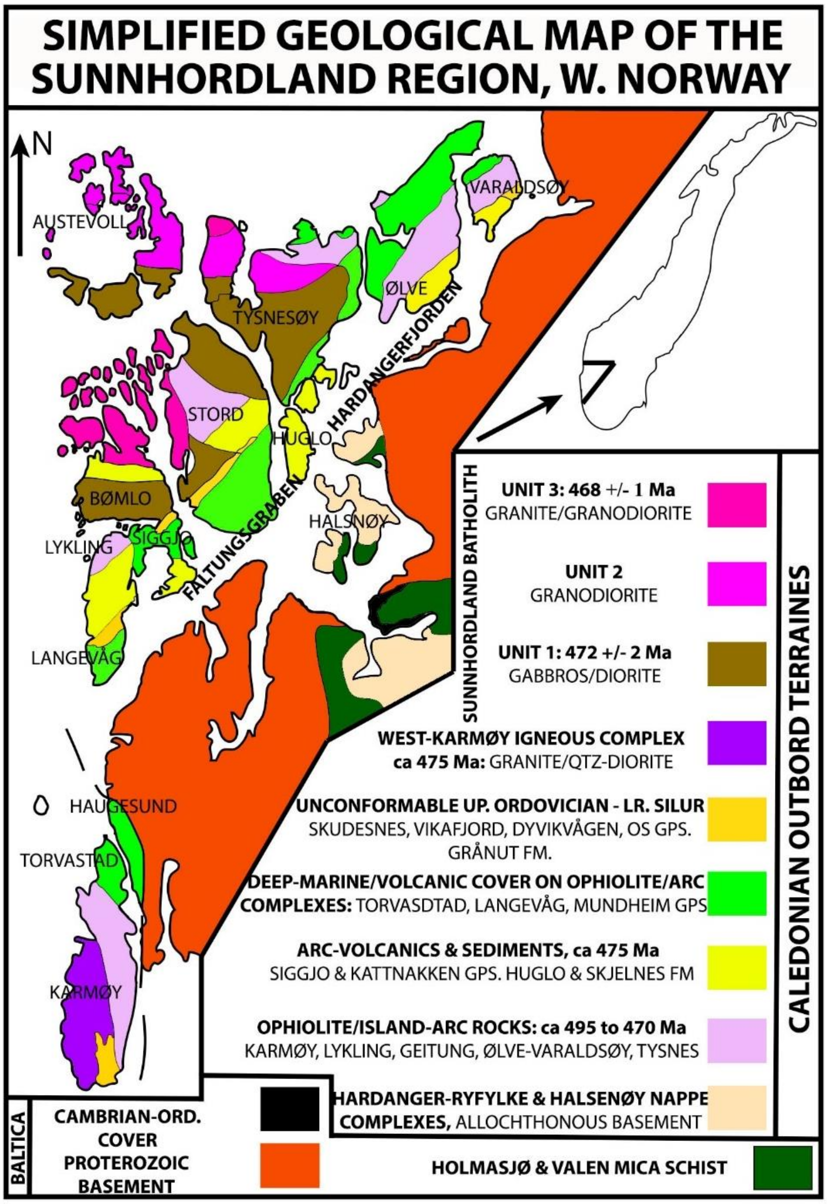

Figure 2.5: Simplified geological map of south-western Norway. The map shows all the different lithologies, from the Proterozoic basement, to the outboard terranes. Redrawn and slightly modified after Andersen and Andresen (1994).

During the 1940s, Foslie (1955) carried out detailed mapping and petrographic descriptions of the entire Ølve and Varaldsøy area. At least two major unconformities were described, being supported by later studies (Andersen and Andresen, 1994; Mæland, 1996; Adolfsen, 1997). Andersen and Andresen (1994) divided the Ølve and Varaldsøy area into three main units; the Varaldsøy-Ølve Complex (VØC), the Mundheim Group and the Grånut Formation.

The Varaldsøy-Ølve Complex consists of ophiolitic and island-arc lithologies of a yet unknown age. The complex is dominated by a large unit of greenstone (Fig. 2.6). It also contains gabbros, sheeted dykes, intrusive quartz diorite, pillow lavas, volcaniclastics and local zones with talk-schist. This is the oldest part of the unit, and represents similar lithologies as the ophiolite and island arc sequences found on Karmøy, Stord and Bømlo. The upper part of the unit is represented by a sequence of rhyolitic metavolcanics, exposed in the southern parts of Ølve and Varaldsøy. This sequence belongs to the Huglo Formation where Færseth (1982) classified the rock as a “quartz-keratophyre”.

These volcanics are overlain by the metasedimentary Mundheim Group. The Mundheim Group is deposited non-conformably on top of the Varaldsøy-Ølve Complex. It consists of conglomerates, limestones, deep-marine phyllites, cherts, greywackes, black shales and meta-sandstone, with some mafic metavolcanics. The conglomerate contains pebbles dominated by the underlying ophiolite and arc lithologies, representing a hiatus of deep erosion of the Varaldsøy-Ølve Complex (Færseth, 1982). Hence, the provenance of the group is dominated by the underlying oceanic lithologies (Andersen and Andresen, 1994). On top of the conglomerate rests a thick sequence of limestone containing poorly preserved crinoid fragments (Andersen and Andresen, 1994). This limestone and conglomerates represent the Haukanes Formation (Færseth, 1982). Above the limestones, the lithology is dominated by dark marine phyllites, cherts, and black shales. These sediments represent the Ådland Formation in this area (Færseth, 1982). On top of this formation rests the Agdestein Formation, consisting of metasandstone and quartzite. The uppermost parts of the Mundheim Group, comprise mafic volcanics. A basaltic unit crops out at Lukksund in the western part of the Ølve area. These metavolcanics are correlated with the Sagvågen Formation on Stord (Færseth, 1982).

This metasedimentary unit can be traced all the way through Tysnes, Stord and Bømlo. The Mundheim Group is presumed to represent the same sequence as the Langevåg Group on Bømlo. The age of the group is yet unknown, but Andersen and Andresen (1994) suggested that it might represent a similar deposit as the Torvastad Group on Karmøy.

The youngest unit on the island of Varaldsøy is the unconformable Grånut Formation. This formation represents metasediments exposed in the central parts of the island. It comprises mature quartzite conglomerates, quartzite and mica-rich phyllites (Adolfsen, 1997). The provenance is more similar to a continental margin-type source, rather than the underlying mafic Varaldsøy-Ølve Complex or the Mundheim Group (Andersen and Andresen, 1994). Andersen and Andresen (1994) suggested that the sediments were deposited shortly before, or during the Caledonian collision, representing an Early to Middle Silurian age for the formation.

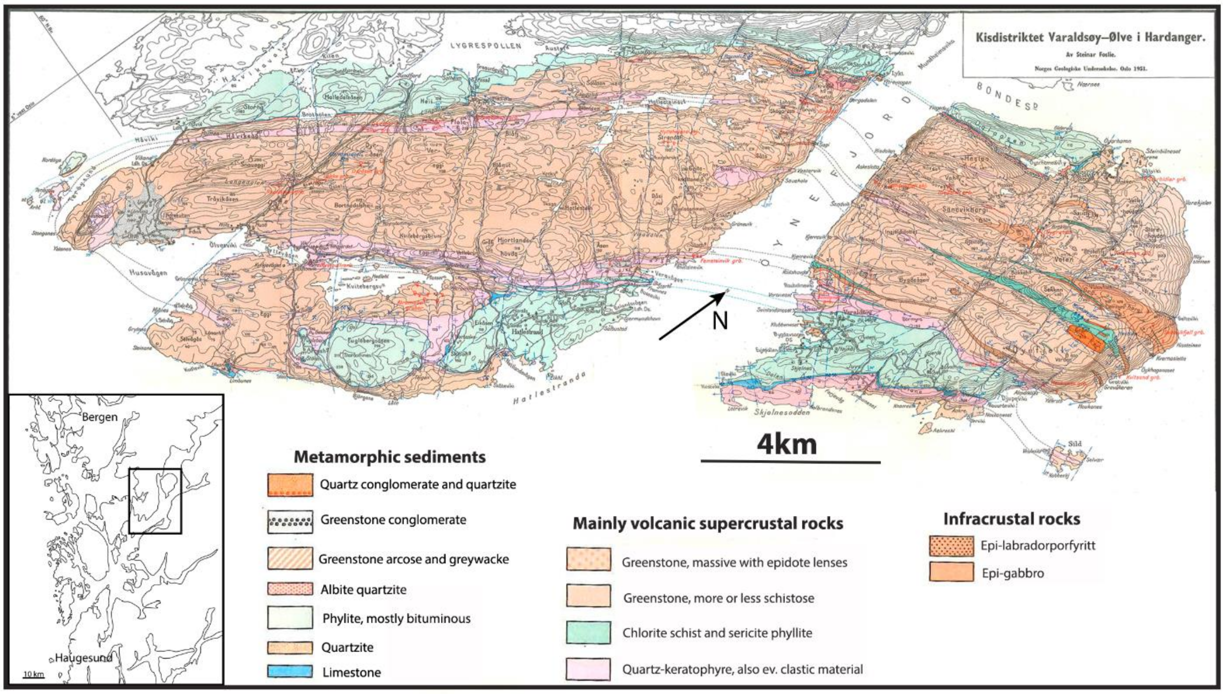

Figure 2.6: Geological map of the Ølve-Varaldsøy area. The dominant lithology is represented by the lowermost basalts and basaltic-andesites indicating a brown colour, followed by the "quartz-keratophyres" illustrated with a pink colour overlain by limestones (pale blue colour). This represents the Varaldsøy-Ølve Complex. The green parts show the metasediments of the Mundheim Group. On the eastern part of Varaldsøy, an orange area is marked representing the Grånut Formation. Modified from Foslie (1955).

Mineral deposits

The Sunnhordland region is known for its mining activity during the last couple of centuries. Different mines are seen on nearly all the islands in the area, such as Bømlo, Stord, Ølve and Varaldsøy. The mining has been conducted on minerals such as pyrite, chalcopyrite and magnetite. More than 20 mines are spread all over the Ølve-Varaldsøy area. The oldest known mine in the Ølve area was the Lilledal iron mine, where mining started in 1642 (Foslie, 1955). Later on, the pyrite and chalcopyrite deposits became more important. Several of the mines were therefore closed and reopened many times. The mining in these areas continued to the mid-1900s, even after the Foslie (1955) publication. The last known active mine in the area was the Stordø Kisgruber on the island of Stord, which was active until 1968 (Wulff, 1993).

The size of the different mines varied a lot. The biggest mine on Varaldsøy was the Valaheien mine with an annual production of average 8000 tons and a total production of 162 000 tons. Other mines on the island is regarded as small and insignificant (Foslie, 1955). The largest mine in the area was the Stordø mine with a production of as much as 149 000 tons a year, at the best.

Most of the deposits are located within the ophiolite and island arc sequences. A younger generation of gold mineralization on Bømlo is associated with the Sunnhordland Batholith (Wulff, 1993). The massive sulphide mineralization on Bømlo is found within the Lykling Ophiolite and the Geitung Unit (Wulff, 1993). On Ølve and Varaldsøy, the mineralization occurs in the greenstones of the Varaldsøy-Ølve Complex (Foslie, 1955). The Stordø Kisgruber is located in the sedimentary greenstones and phyllites of the Dyvikvågen Group (Wulff, 1993).

The mineralization of the outer parts of the Hardangerfjord is suggested to represent volcanogenic massive sulphide deposits (VMS) (Wulff, 1993), reaching through Bømlo and Stord to Ølve and Varaldsøy. Such deposits are suggested to represent ancient analogues of seafloor massive sulphides (SMS) formed in hydrothermal systems at the seafloor (Ohmoto, 1996; Scott, 1997; Franklin et al., 2005; Tornos, 2006; Hannington, 2014).

Chapter 3: U-Pb zircon geochronology and sediment provenance

Zircon is a useful mineral with regards to absolute ages of crystalline rocks and provenance of different sediments. It is a heavy mineral ($\rho > 2.80\ ^{g}/cm^{3}$), which is common in nearly all sedimentary rocks, and as an accessory mineral in magmatic differentiated rocks. Zircon, is a zirconium (Zr) silicate with chemical formula of $ZrSiO_4$. The mineral exhibit zirconium – hafnium solid solution (Morton, 1991) and zircon also contains small fractions of rare-earth elements (REE) as well as long lived isotopes, such as uranium (U) and thorium (Th). These long-lived isotopes break down to different isotopes of lead (Pb) through different decay series that have different half-lives. ^{232}Th decays to ^{208}Pb with a half-life of 13 Ga, ^{238}U decays to ^{206}Pb with a half-life of 4.47 Ga, and ^{235}U decays to ^{207}Pb with a half-life of 707 Ma (Davis et al., 2003). Common lead (non-radiogenic lead) is not present, or at least in very small fractions, in zircons. This means that all of the measured lead in a zircon are radiogenic, as a result of the decay of U or Th (Andersen, 2002).

Because of zircons physical and chemical behaviour, it is an extremely resistant mineral to many geological processes, such as metamorphism, volcanic events, erosion and transport. It also has the unique ability to preserve its initial amount of uranium and its radiogenic amount of lead during heating (Davis et al., 2003). This is due to its closure temperature which normally is greater than 900 degrees Celsius (Lee et al., 1997). Therefore, there are no diffusion of any of these isotopes in a zircon crystal, unless the temperature is raised far above 900 degrees Celsius. The crystal is isotopically closed below this temperature (Lee et al., 1997). This makes zircons very useful for geochronology.

Because zircon is a refractory mineral at the Earth’s surface, it is present in almost all sedimentary rocks. This can provide information about source rock, transportation and deposition of the sediments (Fedo et al., 2003). By applying precise single-grain analysing techniques of these detrital zircons, it is possible to determine its composition. The objective of a detrital zircon analysis is to develop the geological history of a sedimentary basin in relation to the surrounding source region from the interpreted provenance of the zircons (Fedo et al., 2003).

Chapter 4: Methods

4.1 Fieldwork and sampling

In total this study involved 12 days of fieldwork that was aimed at establishing critical field relationships and sampling. Four sessions of sampling were conducted as part of this project. In 2015, seven samples of "quartz-keratophyres" and quartzites in the Ølve-Varaldsøy area were acquired with regards to U-Pb zircon dating. Four of these samples were used for U-Pb zircon dating. Geochemical analyses were conducted for all the samples.

The main fieldwork was carried out during one week in June 2016. A representative amount of rock samples (approximately 50) were collected from different locations all around the field area. Of these samples, thirteen were selected for geochemical analyses. Additional samples from the islands of Huglo and Skorpo were collected in the fall of 2016. These islands are located south-west of the Ølve-Varaldsøy area. The objective was to determine the age of the different samples in terms of U-Pb zircon dating for the "quartz-keratophyre" (2 samples) and Sr-isotopic analyses for limestones (2 samples). A final round of sampling was done during the spring of 2017, this in order to get samples for a more thorough investigation of the limestones in the area. In total 7 samples were collected from limestone localities in Ølve and Huglo.

The collected samples have been analyzed at laboratories at University of Bergen using a range of analytical techniques that are described in the following part.

4.2 Single zircon dating of volcanic and sedimentary samples

Sample preparation and mineral separation

To prepare for mineral separation, the samples were cut into 3 cm slices using a diamond saw. For each sample, a sub sample was saved for geochemical analyses and thin section preparations. The rock slices were then crushed using a hammer before the samples were pulverized in a Fritsch Pulverisette 13 discmill, and shaken through a strainer to select the sub 315 µm fraction for mineral separation.

A Holman-Wilfley table was used in the first step of the mineral separation procedure. This separates the heavy minerals from the lighter ones and removes the dust. Heavy minerals, like zircon, apatite and so on, are collected in a separate box. Following initial removal of the ferromagnetic minerals by a hand magnet, the sample was then put through a Franz Magnetic

Separator. During two sets of separation, with a current of 0.3 A and 1.2 A, the other magnetic minerals were removed. Both a forward and sideway tilt of 15 degrees was used during the separation.

Finally, the samples were put through two different heavy liquids to separate minerals of different densities. For the largest samples, quartz and feldspars and other light minerals were first removed using a concentrated solution of lithium heteropolytungstates in water (LST). This was used at a density of 2.9 g/mL at room temperature. The heavy fraction was then separated further using di-iodomethane (DIM), at a density of 3.3 g/mL. This liquid removes the apatites from the zircons. During all the stages, extreme care was taken to avoid any contamination.

Mount preparation

The zircons were then handpicked using a microscope and forceps. For the analyses in this study, approximately 200 zircons were picked for each sample. Care was taken to select a representative subset of the total population. An exception was made during the picking of grains in sample 15Ølv-7, where a subset of 40 grains were selected based on their prismatic shape, in addition to the approximately 200 randomly picked grains.

Handpicked zircons were then mounted in epoxy-filled grain mount blocks. Each block was polished to remove the epoxy and to obtain even surfaces of the grains. The polishing was done during three different stages. First the blocks were grinded on a glass plate with a 1200 µm silicon carbide powder. This was done to remove the epoxy and to split the grains in half to access the core. Next the blocks were polished using a 6 µm diamond powder. The last step was a 30 second polish on a 0.05 µm silicon carbide powder to obtain properly even surfaces suitable for analyses. Finally, each mount was imaged using a Leica MZ APO microscope connected to a Leica DFC 420 camera. The pictures were acquired using the LAS V3.8 software.

Cathodoluminescence imaging

In order to guide the subsequent laser ablation ICP-MS analysis, the internal structures of the zircon grains were imaged using cathodoluminescence (CL). The CL-imaging was carried out on carbon coated sample blocks using a Zeiss Supra 55 VP Scanning electron microscope equipped with a CENTAURUS CL detector. The CL-images reveal zonation patterns and inclusions, and if other minerals than zircons accidently have been selected during the picking process. The images can also show if some zircon grains are metamict, or if they have other defects that may affect the quality of the analysis. Zircons composed of older corroded cores and younger rims are also revealed, which makes it possible to select different parts of the grain for age dating.

LA-ICP-MS

Prior to the LA-ICP-MS analysis, all the samples were cleaned by immersing the samples in 2% HNO_3 for approximately five minutes, before they were washed in an ultrasonic bath with de-ionized water. The laser ablation analyses were carried out using a Laser Resonetics 193 mm Excimer connected to a Nu ATTOM. ICP-MS.

Three different standards were applied for age determination and data quality assessment (91500, GJ-1 and Plešovice). The 91500 standard, also known as Harvard 91500, is a Canadian zircon crystal with an age of 1065 Ma (Wiedenbeck et al., 1995). GJ-1 is a known standard from an African pegmatite with a crystallization age of 609 Ma (Morel et al., 2008). The last used standard was the Plešovice zircon, which is a 337 Ma grain extracted from a potassic granulite from the Bohemian Massif of the Czech Republic (Sláma et al., 2008) All three standards were analyzed two times each after every 14th sample. Standards and samples were analyzed using a laser spot size of 26 µm, 50% attenuator, a beam energy of 90 mj, and a frequency of 5 Hz.

Data processing

For processing of the data, Iolite version 3.0 and Isoplot were used. Iolite was used for reduction of the data, involving instrument mass bias and element fractionation as well as correction of gas blanks. The primary 91500 (1065 Ma) standard was used for correction and normalization. Both the Plešovice and GJ-1 was used for quality control.

Further processing of the data was conducted using the Isoplot “Add-In” for Windows Excel. This software is developed at the Berkley Geochronology Center (BGC) (Ludwig, 2008). Isoplot was used for plotting of concordia diagrams and probability density plots. Only analyses that are less than 10% discordant were used at this stage.

4.3 Geochemical analyses

To prepare samples for geochemical analyses, they were first crushed to a fine powder using a hammer, a steal mortar and a vibrator disc mill. For small samples, less than 90 ml, an agate mortar was used.

Loss on ignition (LOI) was measured for all samples. Between 2 - 4 grams of the samples were accurately weighed into a crucible and heated to 1000 degrees Celsius for two hours in an oven, and then weighed again. This procedure removes all the water and organic material present in the samples.

X-ray fluorescence (XRF)

Glass beads for XRF-analyses were prepared using lithium tetraborate ($Li_2B_4O_7$) as a flux agent. For each sample, 6.72 grams of the flux was mixed with 0.96 grams of the sample. Fusion of a rock sample like this breaks down minerals into a homogenous mix of soluble compounds. Glass beads were made using a fusion furnace (Claisse, model Fluxy) that was running at around 1000 degrees Celsius for approximately 30 minutes, while steering the samples automatically.

Elemental concentrations were analyzed for ten major elements and reported as oxides (Na_2O, MgO, Al_2O_3, SiO_2, P_2O_5, K_2O, CaO, TiO_2, MnO and Fe_2O_3). A S4 PIONEER X-ray spectrometer was used for the analysis. Two standards were used for calibration and quality control (BCR-2 - Colombia River Basalt and GSP-1 - Silver Plume granodiorite). The standards were analyzed after every 8th sample.

Inductively coupled plasma mass spectrometry (ICP-MS)

Before ICP-MS analyses, the rock powders were first dissolved using hydrofluoric acid (HF). Approximately 100 mg of the samples was accurately weighed into a 25 ml PFA Savillex beaker and dissolved in 3 ml concentrated HF on a hot plate. To evaporate the excess acid, the solution was heated at 135 degrees Celsius for about 48 hours. The fluoride residue was then hydrolysed by adding a weak solution of nitric acid (HNO_3) and further evaporated to dryness at temperatures below boiling point to avoid any sample loss. This procedure transforms the unsolvable fluorides to solvable nitrates. The residue was again dissolved, and diluted to 50 ml by adding 2% HNO_3. The samples were further diluted first 500 times, and finally, just prior to being analyzed, to an exact reported dilution factor for each sample.

The abundance of a range of trace elements (Li, Sc, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, Rb, Sr, Y, Zr, Nb, Cs, Ba, Hf, Ta, Pb, Th, U and REE) were analyzed using an Element XR (Thermo Scientific) Inductively Coupled Plasma Mass Spectrometer (ICP-MS). All the samples were analyzed with two different dilution factors for comparison. Five ml. of each sample was introduced to the mass spectrometer. Indium was used as an internal standard, and both the BCR-2 and SPS-SW2 (surface water) standards were analyzed for calibration. Both standards were analyzed in the beginning and at the end of a sequence, and the SPS-SW2 was also analyzed a couple of times in between the different samples. In addition, two different blanks were analyzed together with the standards. One that contains only HNO_3 used for dilution, and one that is a full procedural blank that underwent the same process of dissolving and dilution as the samples. A negative Zr and Hf anomaly is present in all the analyzed samples. This is regarded an analytical error, and may be due to precipitation of these elements from the solutions.

4.4 Sr-isotope measurements

Sr isotopic compositions were measured on limestones from several key localities in the study area. The limestones were cut into slices using a diamond saw, and the best preserved parts were then crushed and grinded to a homogeneous powder using an agate mortar. To extract Sr for isotopic analyses, the samples were prepared in a clean lab environment where the powders were leached with two different acids. First, a very weak solution of 1% acetic acid (CH_3COOH), to dissolve only the most easily dissolvable calcium carbonate and thereby to limit contamination from more impure parts of the sample, and next, a 3N nitric acid (HNO_3). Strontium was then separated from the other elements using a Sr-specific ion exchange resin. The $^{87}Sr/^{86}Sr$ ratios of the different samples were finally analyzed on a Finnigan MAT262 Thermal Ionization Mass Spectrometer (TIMS). The SRM 987 Strontium Carbonate Standard was analyzed together with the samples and used for quality assessment.

Chapter 5: Results

The following results are based on the sampling and analyses of the two major stratigraphic units in the area, the Varaldsøy-Ølve Complex and the Mundheim Group. The lowermost unit comprises basaltic to andesitic greenstones suggested to represent ophiolite and island arc sequences (Færseth, 1982; Andersen and Andresen, 1994). This unit has been sampled at four main localities, and analyzed with respect to its major- and trace element composition. Above the greenstones rest "quartz-keratophyres" and quartzites, of previously unknown age and affinity. Major- and trace element compositions have been analyzed for classification of the different rocks. Single zircon dating and sediment provenance studies have been conducted on selected samples. These rocks are covered in different metasediments comprising the Mundheim Group. Above the "quartz-keratophyres" and quartzites rest limestone of variable thickness with a lateral continuity all the way to Bømlo. Sr isotopic measurements were performed to obtain age of deposition for the limestones.

The present study aims to investigate and elucidate the stratigraphic relationships and the geological evolution of the area. The greenstones of the Varaldsøy-Ølve Complex will be compared to similar units on Karmøy and Bømlo. The "quartz-keratophyres" are interpreted to be of a volcanic origin, and to represent the upper part of the Varaldsøy-Ølve Complex (Andersen and Andresen, 1994). Geochemistry and zircon dating could reveal if these rocks are of volcanic origin, or if they represent sedimentary deposits. The Sr isotopic measurements from the different limestones will be used to interpret when and where these deposits were formed.

5.1 Metavolcanics of the Varaldsøy-Ølve Complex

The Varaldsøy-Ølve Complex comprises mainly gabbroic rocks, greenstones, pillow-lavas and volcaniclastics/pyroclastics. Four different locations were studied and sampled, two in greenstone (Gravdal and Lyrehola) and two in the presumed volcanogenic sedimentary sequence (Steinaneset and Haukanes) (Fig. 5.1).

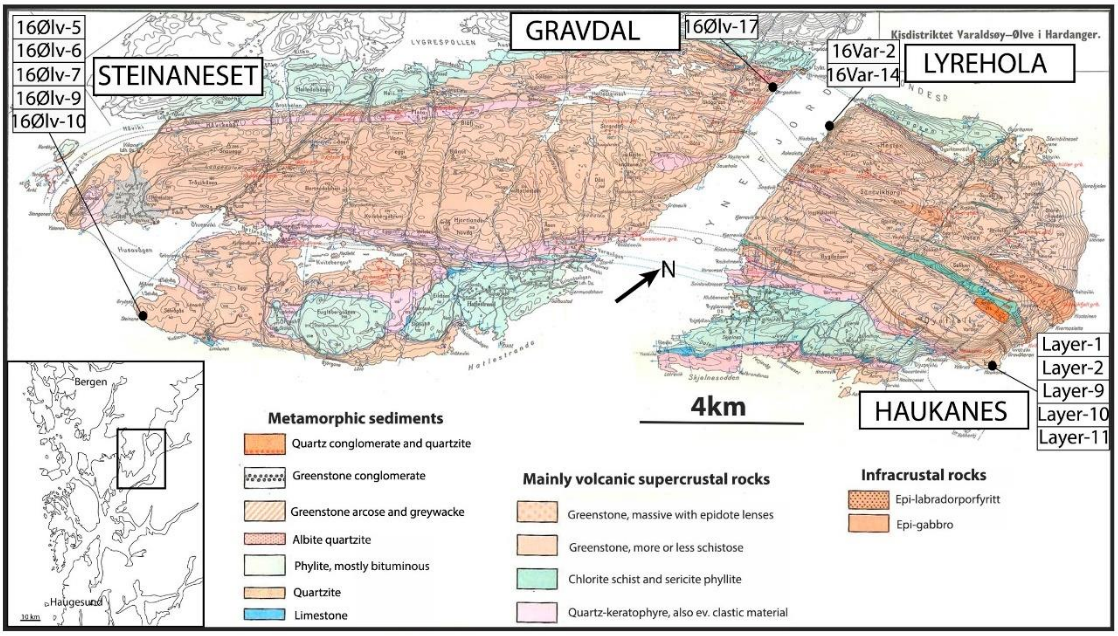

Figure 5.1: Geological map showing the different localities used for further investigations during the fieldwork in 2016. Four localities were sampled. Gravdal and Lyrehola represents the greenstones, whereas Steinaneset and Haukanes is interpreted to represent volcanogenic sediments. Modified from Foslie (1955).

The Gravdal locality

Gravdal is located on the western side of Øynefjorden (Fig. 5.1). A little south of Gravdal, an old talc mine and a soapstone quarry is found. Just south of this mine, rocks with a clear volcanic origin crop out (Fig. 5.2). The rocks have the characteristics of a pillow-breccia or a glass-breccia. It is very fragmented, containing holes that appear to have formed by weathering of carbonate-rich sediments. The volcanic fragments are extremely vesicular. Some larger cavities may represent drain-out structures, whereas some areas are enriched in epidote. The layers and structures exhibit different patterns. The more massive layers are fading and interfingering with one another.

One representative sample from this area was analyzed (16Ølv-17). The sample is fine-grained, and has a grey to green colour. In hand specimen, only plagioclase and epidote can be identified. The composition is basanitic (Fig. 5.6) with SiO_2 content of 44.05%, Na_2O+K_2O of 4.40%, intermediate MgO (4.84%) and high CaO/Na_2O ratio.

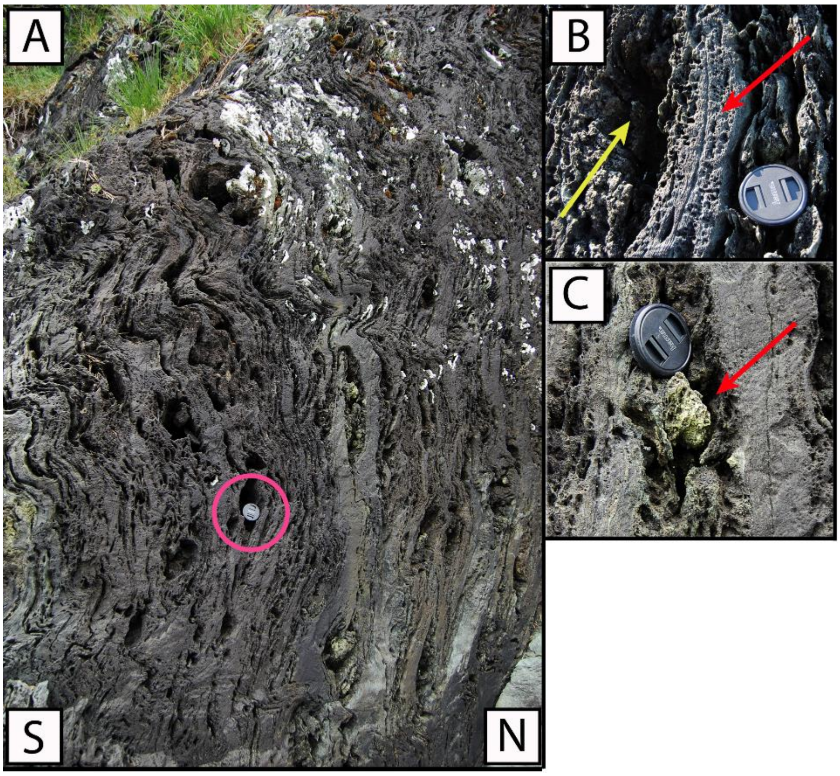

Figure 5.2: Pillow breccia south of Gravdal. **A)** Illustrates the whole Gravdal outcrop. Brecciated and fragmented areas, with more massive areas interfingering in different directions. Lens cap for scale. **B**) Close-up picture of possible drain-out structure (yellow arrow), and vesicular and fragmented areas (red arrow). **C)** Epidote in cavity.

The Lyrehola locality

This locality is located just across the fjord from the previous one, on the Varaldsøy side of Øynefjorden (Fig. 5.1). A 50 meter high, steep cliff defines this shoreline. The cliff is dominated by greenstones with abundant epidote segregations that vary in size from single crystals to large segregations that can be 50 cm across (Fig. 5.3B). Pillow lavas are not common, but pillow-like structures are locally observed (Fig. 5.3D). Together with the epidote segregations, the greenstone typically defines an irregular pattern (Fig. 5.3C). Quartz and carbonate are associated with the epidote.

Two samples were collected for analyses from this locality (16Var-2 and 16Var-14). Both samples are very fine-grained, with a grey and green colour. They consist of a very fine-grained grey matrix, with larger green crystals of epidote. Major element composition is basaltic for the 16Var-14 sample (SiO_2 of 45.51% and total alkali of 4.37%), whereas the 16Var-2 sample plots on the line between basanite and picro-basalt (SiO_2 of 42.97% and total alkali of 3.03%) (Fig. 5.6). Both samples show intermediate MgO content and high CaO/Na_2O ratio.

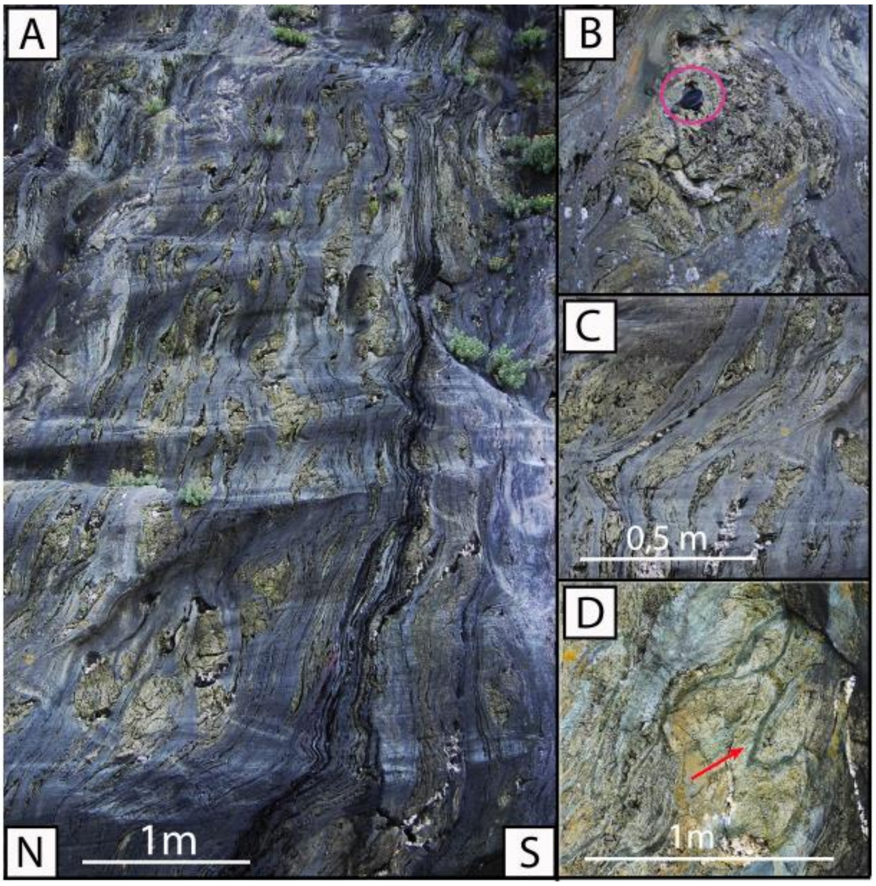

Figure 5.3: Locality at Lyrehola. **A)** Overview of the locality, showing epidote segregations surrounded by massive greenstone. **B)** Close-up picture of one of the largest epidote segregations. Lens cap for scale. **C)** Typical irregular pattern between the epidote and greenstone. **D)** Pillow-like structures (red arrow).

The Steinaneset locality

Steinaneset is a location at the southern part of Ølve (Fig. 5.1). The area is dominated by presumed volcanogenic sedimentary rocks. The rock types are well exposed in a huge cliff that is approximately 50 meters high. Large blocks that clearly have fallen from the cliff provide an opportunity for detailed sampling of this widespread lithology. One particularly large block, with an approximate size of 3*6*5 meters, was selected for detailed studies. The block is laminated, with many distinct layers. The layers vary from coarse- to fine-grained, with a green and grey colour. Some brown, very fine-grained layers are also present. Systematic sampling of the characteristic layers was done for this block, and five of these samples were chosen for further analyses (Fig. 5.4).

Sample 16Ølv-5 is from one of the most distinctive layers in the boulder. It is massive, very fine-grained and has a recognizable brown colour with a shiny lustre (Fig. 5.4B). The layer varies in thickness from 2-15 cm. This layer appears to comprise heavily altered volcanic ash. The major element analysis of the sample show SiO_2 content of 74.8%, low CaO/Na_2O ratio, and a Na_2O+K_2O content of 6.2%. This is consistent with a rhyolitic composition (Fig. 5.6).

Sample 16Ølv-6 is taken from one of the many layers of greenstone in the boulder. The layer is one of the thickest with a width of about 50 cm. The layer is medium-grained and finely laminated with minor internal variations (Fig. 5.4C). The composition of the layer is basaltic (Fig. 5.6) with SiO2 content of 50.75%, intermediate MgO content (5.26%), high CaO/Na_2O ratio and low Na_2O+K_2O.

Sample 16Ølv-7 is sampled from a continuous, 10 cm thick layer spanning the length of the boulder. It is a massive layer of greenstone (Fig. 5.4D). The colour is a bit darker than the rest of the layers, with a shinier lustre. The layer is encircled by a lot of precipitated quartz. It is a fine-grained sample, with less internal quartz veins than the other greenstone samples. The sample composition is dacitic (Fig. 5.6) with SiO_2 content of 67.40%, total alkali content of 5.92% and low CaO/Na_2O ratio.

Sample 16Ølv-9 is taken from the brightest coloured layer in the boulder. It is a massive layer with a grey to green colour (Fig 5.4E). The layer is the most distinct one, even with a thickness of only 5 cm. Small white bands and crystals of pyrite are observed in a very fine-grained matrix. The major element composition reveals a rhyolitic composition (Fig 5.6) with SiO_2 content of 72.38%, total alkali of 5.66% and low CaO/Na_2O ratio.

Sample 16Ølv-10 is a non-continuous layer through the boulder, with a thickness of 2 cm. It is a hard, massive and fine-grained layer, that may represent volcanic ash (Fig. 5.4F). It looks similar to the 16Ølv-5 sample, but is slightly coarser-grained and has a lighter brown colour. This layer appears to be less resistant to weathering than other samples, especially 16Ølv-5 and 16Ølv-9, as it occurs slightly between the other protruding layers. The composition is rhyolitic with a silica content of 75.73%, total alkali of 6.70% and low CaO/Na_2O ratio (Fig. 5.6).

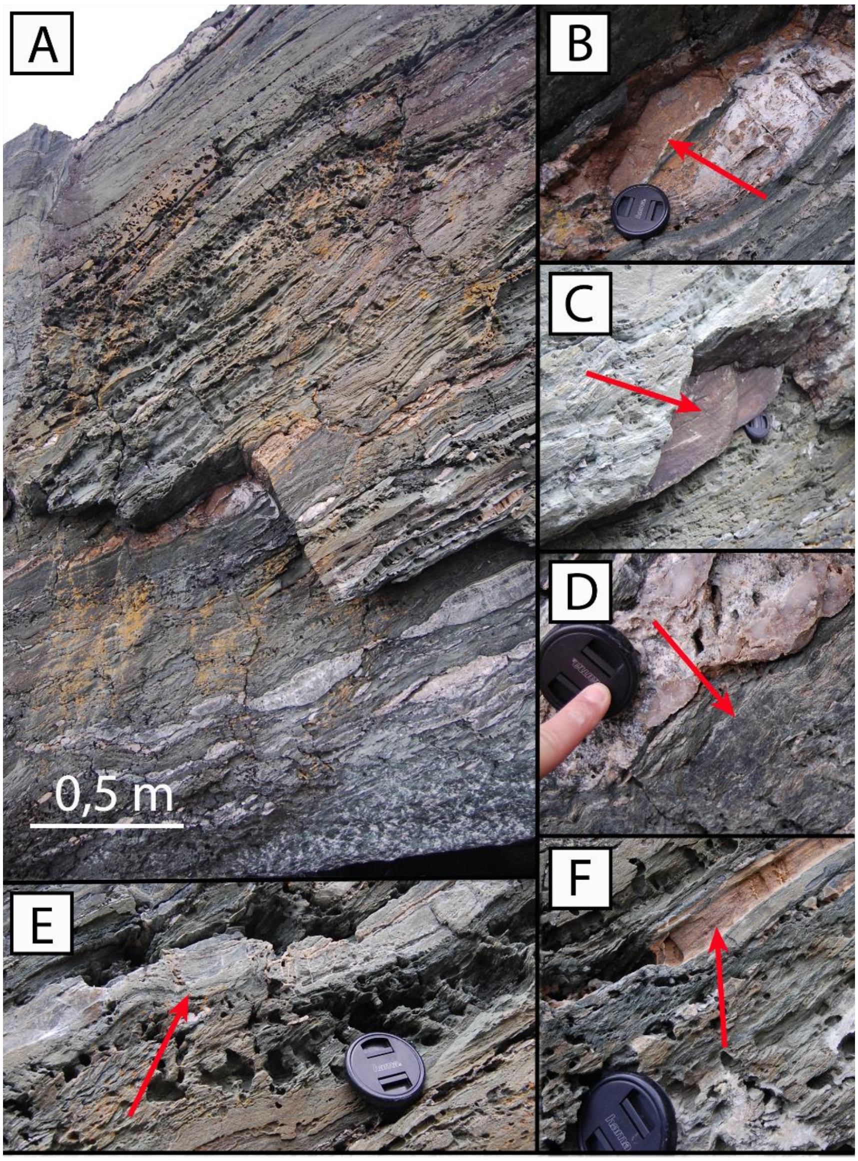

Figure 5.4: Picture showing the sampled boulder from Steinaneset, in addition to individual pictures of all the layers that were sampled. **A)** Representative part of the boulder. **B)** Sample 16Ølv-5 (red arrow). **C)** Sample 16Ølv-6 (red arrow). **D)** Sample 16Ølv-7 (red arrow). **E)** Light grey layer, sample 16Ølv-9 (red arrow). **F)** Recognizable brown layer, sample 16Ølv-10 (red arrow). Lens cap used for scale inn all pictures for each sampled layer.

The Haukanes locality

This locality is found on the eastern side of Varaldsøy (Fig. 5.1). The outcrop shows similarities to the rest of the eastern side of Varaldsøy, indicating a possible volcanic/volcanogenic origin. The outcrop shows a great variety of green, grey and light-coloured schist (Fig. 5.5A). A clear layering is observed, and this is defined by layers with distinctly different appearances. Similar lithologies are seen at the Steinaneset locality, with different schistose layers. Eleven of the different layers were sampled, and five of the most distinctive layers were selected for further investigation (Layer-1, Layer-2, Layer-9, Layer-10 and Layer-11).

Layer-1 is a 2 m thick dark green layer, with clear schistosity (Fig. 5.5B). The layer shows some internal variations, such as very thin light-coloured bands. Major element composition corresponds to basaltic trachyandesite with SiO_2 of 50.81%, total alkali of 6.23%, intermediate MgO and low CaO/Na_2O ratio (Fig. 5.6).

Layer-2 is more massive, and shows no marked schistosity. It has a lighter colour, pale grey to white, with some protruding bands (Fig. 5.5C). The layer is approximately 20 cm thick. The major elements reveal a rhyolitic composition (Fig. 5.6) with SiO_2 of 76.03%, total alkali of 5.65% and low CaO/Na_2O ratio.

Layer-9 is about 15 cm thick and seems to be more resistant to weathering than the rest of the outcrop (Fig. 5.5D). The whole layer is finely laminated with thin bands of different colours and hardness. The composition corresponds to a basaltic andesite (Fig. 5.6) with SiO_2 of 54.08%, total alkali of 1.43% and high CaO/Na_2O ratio.

Layer-10 is a meter-thick layer, and comprises grey and green massive rock. The layer shows some internal variations in the form of darker and lighter bands (Fig. 5.5E). Epidote-rich bands are present, and larger accumulations occur particularly in the upper part of this layer. Thin sections reveal that these areas are associated with carbonates as well. The major element composition reveals SiO_2 of 36.39%, total alkali of 2.42%, very high CaO/Na_2O ratio and high LOI. This composition is consistent with the high epidote and carbonate content. The layer may be of sedimentary origin, or it may have been exposed to more intense hydrothermal alteration.

Layer-11 is 15 cm thick, and is the brightest coloured layer in the whole sequence, with a pale grey to white colour. The layer is coarse-grained, and in its lower part amphibole can be identified as black and elongated crystals (Fig. 5.5F). Major elements reveal a rhyolitic composition with SiO_2 of 72.95%, total alkali of 5.90% and low CaO/Na_2O ratio (Fig. 5.6).

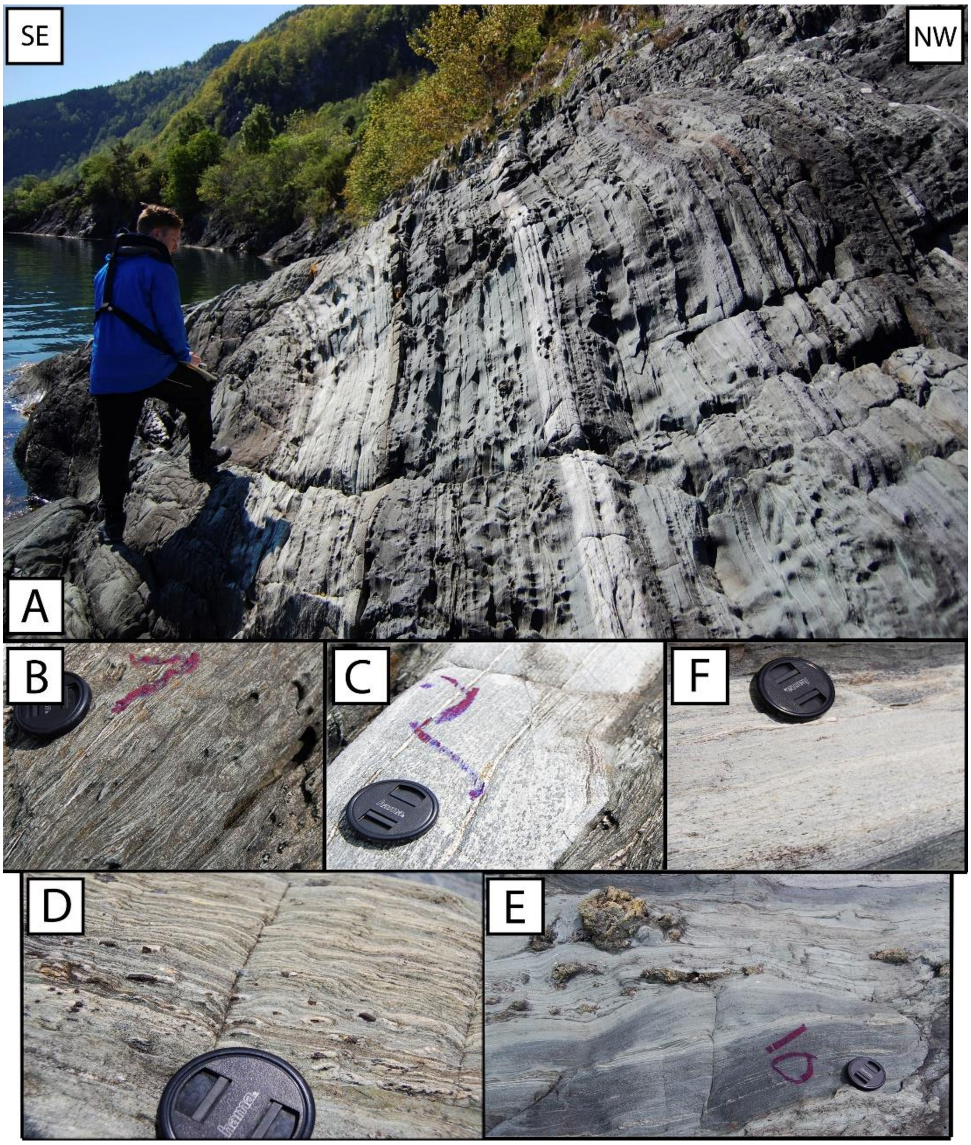

Figure 5.5: Haukanes locality. **A)** Overview of the entire outcrop showing variations through different layers. **B)** Layer-1 **C)** Layer-2 **D)** Layer-9. Pronounced internal banding is seen. **E)** Layer-10. Bulbs of epidote are seen in variable sizes. F) Layer-11.

All the samples from the Varaldsøy-Ølve Complex have been classified based on the SiO_2 vs total alkali diagram, which generally is used for the classification of volcanic rocks (Fig. 5.6). It should be noted that all the samples in this study are metamorphosed, and since sodium and potassium may be mobilized during metamorphism, their present composition may not accurately reflect the original composition.

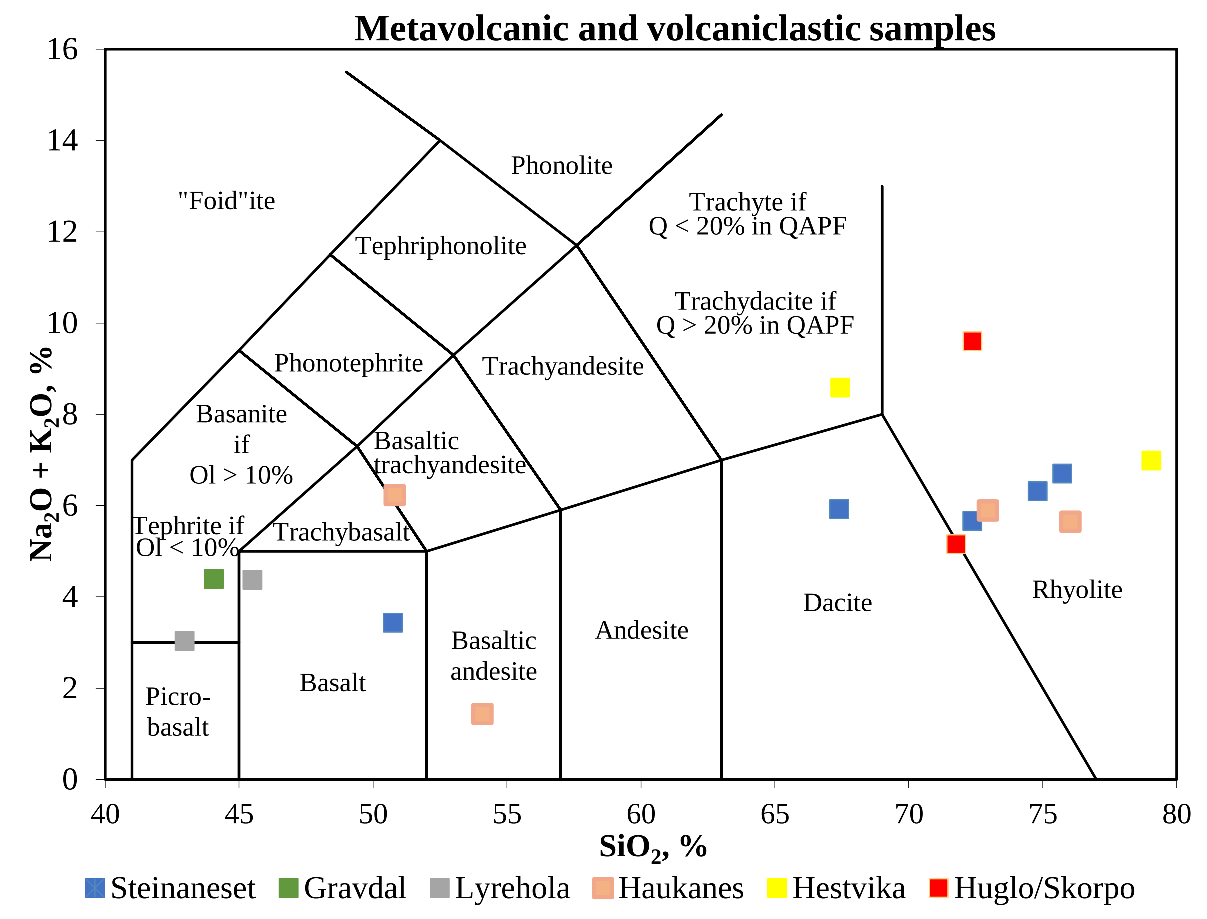

Figure 5.6: Geochemical classification based on silica versus total alkali content. The samples from the four main localities within the Varaldsøy-Ølve Complex are shown together with the volcaniclastics (Hestvika) and acid volcanics (Huglo/Skorpo). Based on Le Bas et al. (1986).

5.2 Geochemistry of the Varaldsøy-Ølve Complex

The major- and trace elements of the analyzed samples are given in Table 5.1. Since the major element compositions have been commented on in the previous sample descriptions, this section will focus on the trace element compositions.

Table 5.1: Geochemical data for the Varaldsøy-Ølve Complex. Major- and trace element composition for the samples from the four different localities.

Locality:			**Steinaneset**			**Gravdal**	**Lyrehola**				**Haukanes**		
Sample:	**16Ølv-5**	**16Ølv-6**	**16Ølv-7**	**16Ølv-9**	**16Ølv-10**	**16Ølv-17**	**16Var-2**	**16Var-14**	**Lag-1**	**Lag-2**	**Lag-9**	**Lag-10**	**Lag-11**
%													
SiO_2	74.81	50.75	67.40	72.38	75.73	44.05	42.97	45.51	50.81	76.03	54.08	36.39	72.95
TiO_2	0.26	0.78	0.46	0.29	0.27	0.55	0.68	0.89	1.35	0.26	1.13	0.52	0.43
Al_2O_3	11.20	16.07	13.65	12.26	11.48	14.73	15.28	17.79	15.27	11.14	14.97	15.11	12.30
Fe_2O_3	3.24	11.96	6.28	4.72	3.19	10.07	9.88	11.29	13.87	4.07	12.41	9.73	5.05
MnO	0.09	0.16	0.09	0.07	0.10	0.10	0.15	0.15	0.21	0.06	0.21	0.27	0.09
MgO	0.57	5.26	2.01	1.84	0.82	4.84	4.79	5.97	4.76	1.34	4.33	3.14	1.01
CaO	1.95	8.32	1.89	1.24	0.67	14.18	16.74	9.04	5.28	0.52	8.28	21.88	1.42
Na_2O	6.02	3.23	5.25	5.49	6.40	3.92	2.95	4.26	6.05	5.57	1.24	2.35	5.69
K_2O	0.30	0.20	0.67	0.17	0.30	0.48	0.08	0.11	0.18	0.08	0.19	0.08	0.20
P_2O_5	0.04	0.07	0.05	0.03	0.05	0.03	0.09	0.09	0.11	0.04	0.11	0.03	0.09
LOI	1.46	3.15	2.24	1.43	0.97	6.96	6.37	4.79	2.07	0.89	3.00	10.37	0.77
Total	99.94	99.95	99.99	99.92	93.18	99.81	99.98	99.89	99.96	100.00	96.95	99.87	99.80
ppm													
Li	1.93	15.91	9.4	7.83	11.62	21.53	10.95	25.9	10.4	4.68	12.3	8.17	5.16
Sc	13.02	43.46	19.07	15.7	10.16	46.35	31.6	42.58	37.55	12.9	39.18	26.92	14.09
Ti	1309	4834	2693	1496	1412	3467	4369	5629	8745	1305	7234	3258	2387
V	21.44	355.9	63.01	38.48	16.01	268.4	313.8	273.9	410.1	21.31	374.2	348.3	7.7
Cr	0.767	38.46	4.58	5.18	3.41	825.6	476.1	717.6	5.35	0.796	2.58	28.86	1.68
Mn	654.8	1287	711.7	521.1	694.9	828.2	1242	1211	1622	383.6	1634	2185	637.6
Co	4.73	37.97	11.38	6.5	3.14	37.56	34.86	58.48	61.33	0.85	35.9	22.86	3.6
Ni	1.84	23.41	4.46	4.25	1.34	191.08	141.85	254.73	10.17	0.35	6.84	17.87	0.75
Cu	30.47	135.9	39.89	52.31	15.85	89.36	46.78	79.72	119.4	22.59	15.08	51.02	8.22
Zn	21.12	67.98	98.32	98.88	29.12	69.6	62.66	98.54	107.6	125.3	100.1	44.51	76.25
Rb	2.3	3.72	9.15	1.93	2.03	11.44	0.76	1.24	0.894	0.623	3.87	0.959	3.46
Sr	53.79	195.1	37.21	70.87	32.03	121.4	245.3	77.55	101.2	35.9	340.6	517.5	109.4
Y	44.73	18.73	34.68	44.59	36.79	11.27	17.39	20.14	27.55	38.2	28.7	14.9	43.48
Zr	73.09	23.93	48.07	47.29	49.89	17.58	20.6	23.95	22.3	40	19.23	14.96	43.59
Nb	1.76	0.735	1.23	1.83	1.77	0.274	0.33	0.395	0.919	1.29	0.915	0.44	1.58
Cs	0.121	0.311	0.363	0.222	0.281	1.17	0.028	0.048	0.051	0.033	0.246	0.061	0.247
Ba	35.43	23.79	54.41	28.09	32.57	20.47	15.23	15.78	7.63	5.5	26.12	6.85	35.52
Hf	2.63	0.897	1.79	1.74	1.78	0.685	0.8	0.941	0.774	1.47	0.745	0.497	1.57
Ta	0.119	0.051	0.089	0.125	0.122	0.025	0.026	0.03	0.061	0.106	0.068	0.037	0.112
Pb	1.88	4.71	3.27	4.21	1.49	2.4	2.11	4.15	3.38	5.44	7.74	12.88	14.28
Th	1.66	0.866	1.26	1.76	1.6	0.461	0.762	0.989	0.518	1.46	0.507	0.204	1.4
U	0.789	0.382	0.928	0.932	0.669	0.114	0.22	0.298	0.296	0.662	0.339	0.2	0.651
La	6.66	3.55	4.45	6.97	5.62	1.44	5.26	5.29	3.78	4.94	4.16	1.89	6.13
Ce	15.82	8.44	11.22	16.98	14.38	4.15	10.44	12.24	10.02	13.21	10.02	4.53	15.96
Pr	2.46	1.29	1.68	2.69	2.29	0.67	1.64	1.89	1.73	2.14	1.63	0.77	2.60
Nd	12.15	6.03	8.32	12.74	10.85	3.38	8.23	9.71	9.13	10.65	8.27	3.86	12.77
Sm	3.96	1.88	2.76	4.10	3.51	1.17	2.34	2.82	3.02	3.55	2.77	1.30	4.19
Eu	0.99	0.74	0.85	1.13	0.91	0.47	0.91	1.00	1.13	0.98	1.10	0.65	1.23
Gd	5.58	2.59	3.94	5.67	4.87	1.64	2.94	3.52	4.28	4.92	3.93	1.95	5.77
Tb	1.02	0.46	0.74	1.06	0.93	0.30	0.53	0.64	0.77	0.93	0.71	0.36	1.05
Dy	7.14	3.36	5.32	7.78	6.69	2.13	3.46	4.06	5.29	6.66	5.00	2.58	7.53
Ho	1.55	0.72	1.18	1.69	1.45	0.45	0.74	0.86	1.13	1.43	1.07	0.57	1.63
Er	4.74	2.13	3.64	5.11	4.48	1.34	2.22	2.53	3.35	4.47	3.19	1.72	4.94
Tm	0.70	0.32	0.56	0.74	0.67	0.20	0.32	0.36	0.49	0.66	0.47	0.26	0.73
Yb	4.52	2.14	3.71	4.80	4.47	1.29	2.02	2.21	3.27	4.22	3.11	1.72	4.71
Lu	0.67	0.32	0.56	0.67	0.62	0.19	0.30	0.32	0.49	0.58	0.45	0.27	0.67

Pillow breccia at Gravdal: The REE plot (Fig. 5.7A) reveals a weak depletion in the most incompatible of the LREE from La to Sm. From Eu through all the HREE, the pattern is rather flat with values slightly below 10 times chondrite. The sample is slightly depleted in the heaviest of the HREE, such as Yb and Lu, compared to the rest of these elements. This pattern is overall similar to that of N-type MORB (Sun and McDonough, 1989). This is inconsistent with the SiO2 vs. alkali composition, which classifies the sample as a basanite rather than a basalt (Fig. 5.6). The low SiO2 content of the sample is therefore probably reflecting alteration.

The extended MORB-normalized trace element plot (Fig. 5.7B) shows decreasing values from Ce to U, with a clear negative anomaly for Ta and Nb, which is a characteristic feature of supra-subduction zone magmatism (Pearce et al., 1984). From there on the values increase to a peak at Pb, before the concentrations starts to decrease again. The least incompatible elements show an almost flat trend from Hf to Lu with values below that of average MORB.

Basaltic samples at the Lyrehola locality: Both samples are slightly enriched in the LREE, compared to the HREE, and have REE patterns that are typical for E-type MORB (Sun and McDonough, 1989) (Fig. 5.7C). 16Var-2 shows a weak positive Eu anomaly, whereas 16Var-14 shows a weak negative Eu-anomaly indicating, plagioclase accumulation and fractionation respectively. The spider diagram (Fig. 5.7D) for these two samples, show clear negative anomalies for Ta, Nd and Zr, whilst a positive anomaly for Pb dominates the plot, clearly indicating subduction influence.

Volcaniclastics and pyroclastics from the Steinaneset locality: The locality seems to represent volcanoclastic or pyroclastic materials that vary from basaltic to rhyolitic compositions (Fig. 5.6). The samples of dacitic to rhyolitic compositions show similar trace element patterns. These are characterized by a relatively flat REE pattern at up to 20 times chondrite, by a weak LREE enrichment, and by a marked negative Eu anomaly that indicates extensive plagioclase fractionation (Fig. 5.7E). The basaltic sample reveal a flat REE pattern with values around 10 times chondrite.

The extended spider diagram for these samples show similar trends (Fig. 5.7F), with positive anomalies for Th, U and Pb. Except for the basaltic sample (16Ølv-6), all the samples show a marked negative Ti-anomaly. This negative Ti-anomaly probably reflects fractionation of Ti-rich minerals like ilmenite and titanite. All the samples show clear negative anomalies for Ta and Nb indicating subduction influence.

Volcaniclastics and pyroclastics from the Haukanes locality: Except for one sample that has an anomalous major element composition (Layer-10), the samples from this location range from being basaltic-andesitic to rhyolitic in composition (Fig. 5.6). The samples share many of their characteristics with the samples from the Steinaneset locality. They are characterized by relatively high REE contents (20 times chondrite), slight depletion in the LREE, and by marked negative Eu anomalies in the rhyolitic samples (Fig. 5.7G).

The extended trace-element diagram (Fig. 5.7H) also displays patterns similar to the samples from the Steinaneset locality. All the samples are enriched in mobile trace elements with marked positive anomalies for Th and U. All the samples show negative Ta and Nb anomalies and positive Pb anomalies, indicating a subduction influence (Pearce et al., 1984). Like at Steinaneset, the rhyolitic samples display marked negative anomalies for Ti, suggesting fractionation of minerals such as ilmenite and titanite.

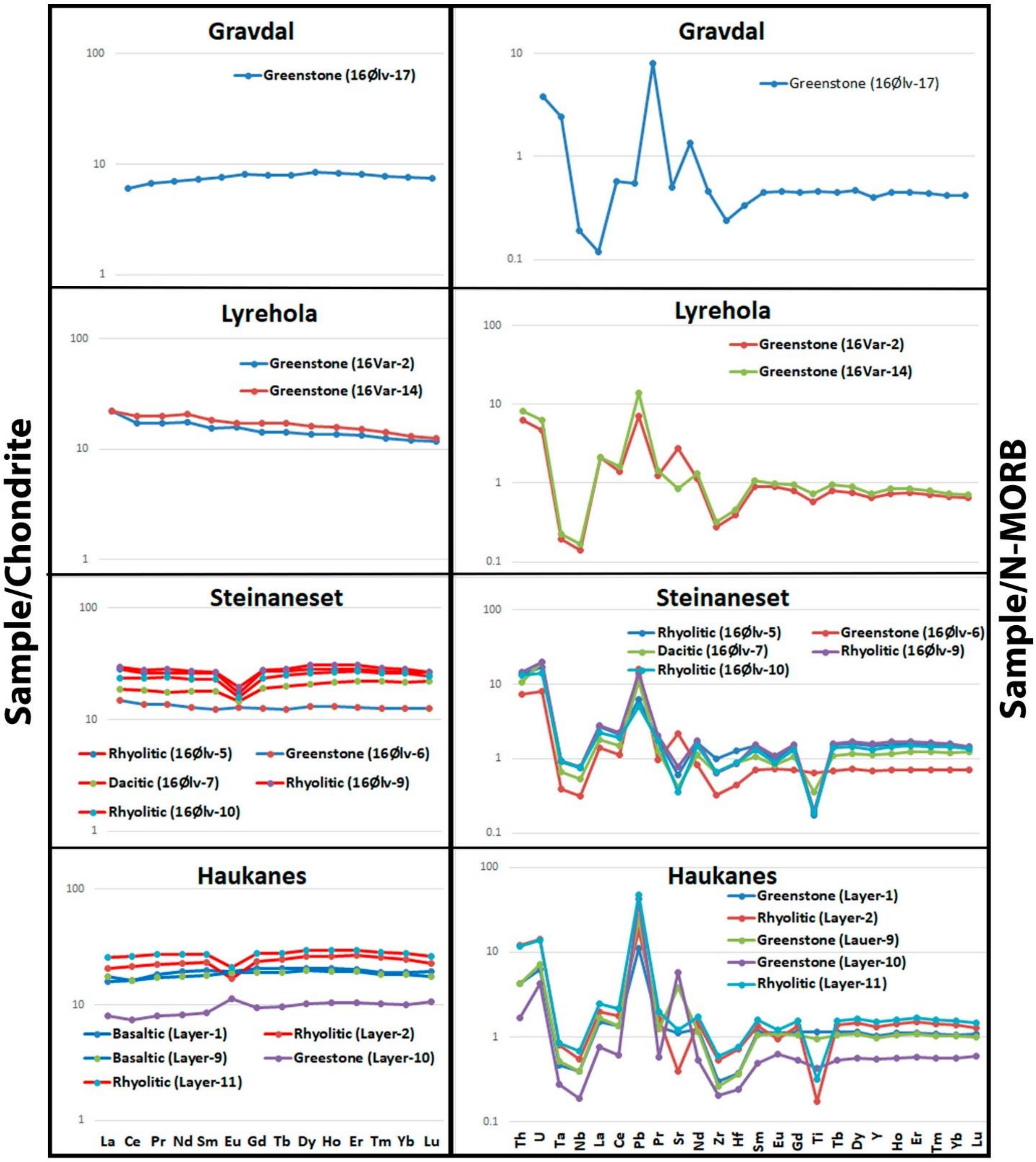

Figure 5.7: Chondrite normalized REE plots to the left and N-MORB normalized spider diagrams to the right for the samples from the four localities. Normalization values from Sun and McDonough (1989).

5.3 Quartzites and acid volcanic rocks

The origin of the “quartz-keratophyres” in the Ølve/Varaldsøy area is still an unsolved mystery with regards to the geological understanding of the Hardangerfjord area. The earliest interpretation of these rocks was done by Foslie (1955), who suggested that it mainly represents volcanic supracrustal rocks, possibly with some clastic material. Foslie (1955) separated the unit into two different rock types. The dominant lithology is the “quartz-keratophyre” exposed in the southern parts of Ølve and Varaldsøy. A small band of albite-quartzite is mapped from Flugedalen on Varaldsøy, across Ølve and all the way to Nordøya outside the Ølve peninsula. However, both Færseth (1982) and Andersen and Andresen (1994) suggested this to represent the same unit, arguing that the “quartz-keratophyres” represent lava flows, possibly originating from the Siggjo or Kattnakken Volcanics. The Geological survey of Norway (NGU) interpreted these rocks to represent Early Ordovician island arc lavas, classified as metadacites and metarhyolites (Ragnhildstveit and Helliksen, 1997).

The “quartz-keratophyres” and quartzites are interpreted to represent the uppermost part of the Varaldsøy-Ølve Complex, as they rest on top of the greenstones (Andersen and Andresen, 1994). The map by Foslie (1955) indicate that these “quartz-keratophyres” are covered in limestones throughout the Ølve-Varaldsøy area.

Seven samples of “quartz-keratophyres” and quartzites from the Ølve-Varaldsøy area, and two samples of “quartz-keratophyre” from Huglo and Skorpo (see Figs. 5.8 and 5.9 for locations) were analyzed with respect to major- and trace-element compositions. In addition, U-Pb zircon dating was carried out on four of the samples from Ølve/Varaldsøy (15Ølv-2, 15Ølv-3, 15Ølv-4, 15Ølv-7) and on the samples from Huglo and Skorpo (16Hug-3, 16Sko-3).

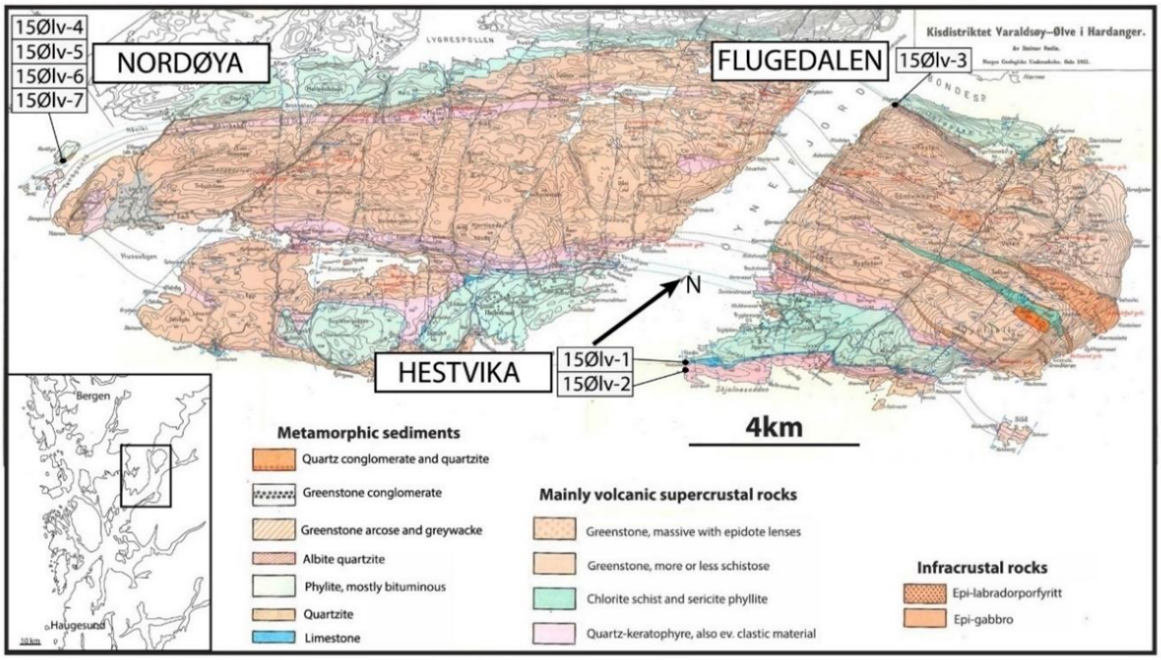

Figure 5.8: Geological map showing sample localities for all the “quartz-keratophyre” and quartzite samples in the Ølve-Varaldsøy area. Modified from Foslie (1955).

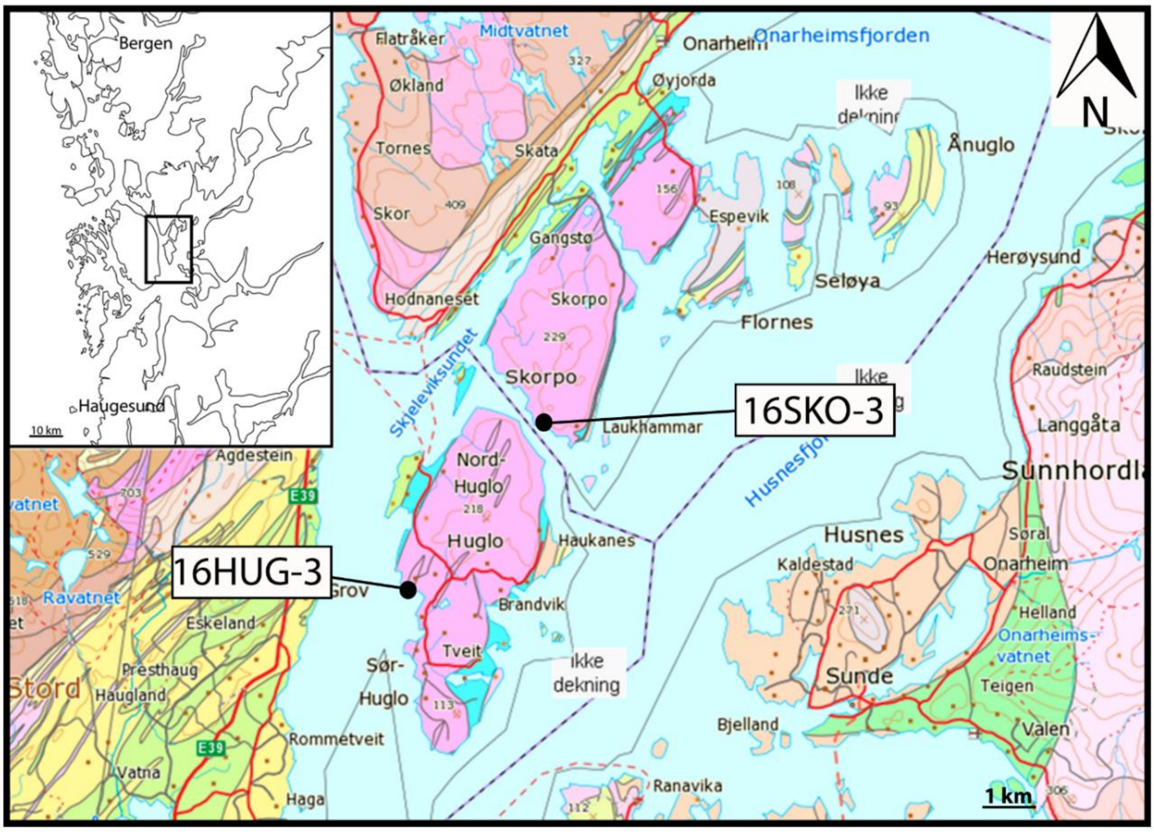

Figure 5.9: Sampled unit on Huglo and Skorpo. Both samples were collected from the “quartz-keratophyre” (pink), which is overlain by limestones (pale-blue). Modified map generated from NGU, 2017 (http://geo.ngu.no/kart/berggrunn_mobil/).

Description of key localities and samples

The Hestvika locality:

This location is dominated by exposures of "quartz-keratophyres". The "quartz-keratophyres" look slightly different on each side of the Hestvika on the southern part of Varaldsøy (Fig. 5.8). On the northern side, the rocks are fine-grained, well stratified and have clear schistosity. The southern side of Hestvika exposes a more massive rock unit with no marked schistosity. Greenstones from the underlying unit are not exposed. The locality shows a gradual transition between the "quartz-keratophyres" and the overlaying carbonates.

Sample 15Ølv-1 is a “quartz-keratophyre” taken on the north-western side of Hestvika (Fig 5.8). Sample locality is seen in Fig. 5.10. It is taken just below the carbonate-rich layers. The sampled unit is light grey, with white and pink areas. It is a fine-grained, well stratified rock with clear schistosity. The sample consists of quartz, micas and some pyrite. It shows small internal variations in terms of light and dark bands. Small quartz veins are observed. The major elements reveal a rhyolitic composition with SiO_2 of 79.05% and total alkali of 6.99% (Fig. 5.6).

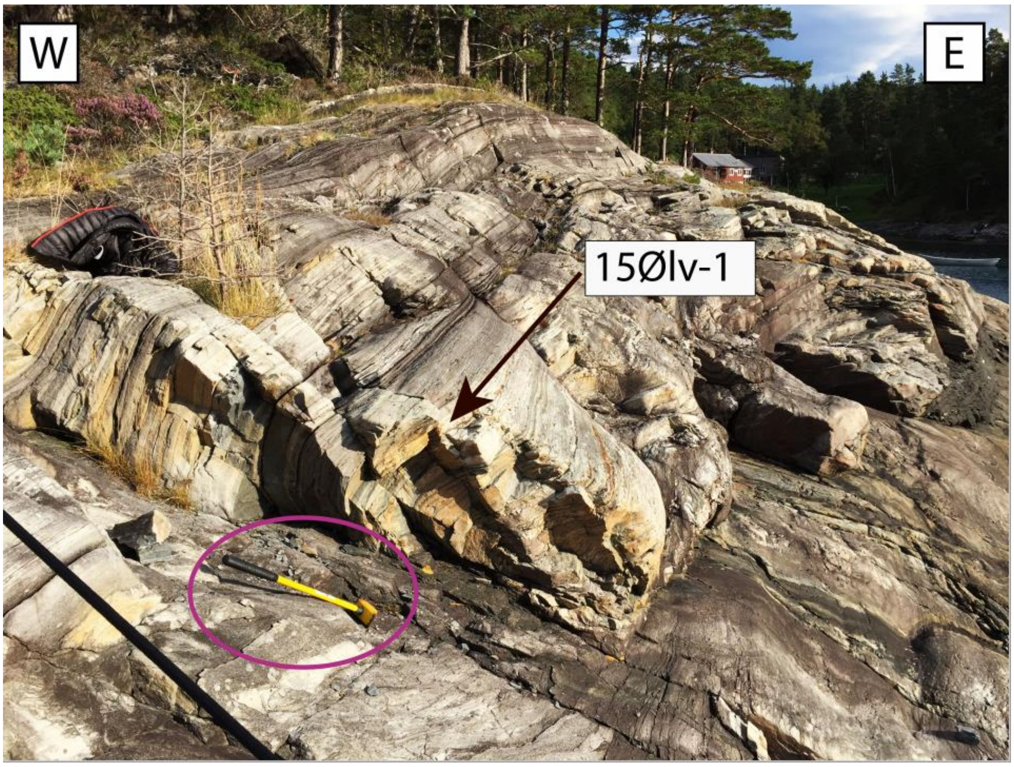

Figure 5.10: Sample location for the volcaniclastic (15Ølv-1) sample north-west of Hestvika. Black arrow pointing to the sampled area. Hammer for scale. Photo: R.B. Pedersen.

Sample 15Ølv-2 is taken on the southern side of Hestvika (Fig. 5.8). The sample is collected from the "quartz-keratophyre" approximately 50 meters below the carbonates. The rock unit here is thick and massive (Fig. 5.11). It is darker than the 15Ølv-1 unit, but still grey and white. This unit is not schistose, but shows internal compositional layers that are defined by varying proportions of light and dark minerals. In hand specimen, the rock is medium-grained, with clear feldspar crystals surrounded by quartz and micas.

In thin section, quartz, feldspar and micas dominate the sample. The micas are represented by muscovite and a few grains of biotite. It is a poorly sorted sample, with grains of different sizes. Quartz and micas occur as fine- to medium-grained, whereas the feldspars occur as larger crystals of variable sizes. Lamellar twinning reveals that the crystals are a type of plagioclase. By applying the method described by Michel-Levy (1895) on these grains, an approximate composition of 45% anorthite was determined. This composition corresponds to andesine. All the andesine crystals in this sample are heavily altered because of sericitization. Major elements reveal a dacitic composition with SiO_2 content of 67.44%, total alkali of 8.59% and low CaO/Na_2O ratio (Fig. 5.6).

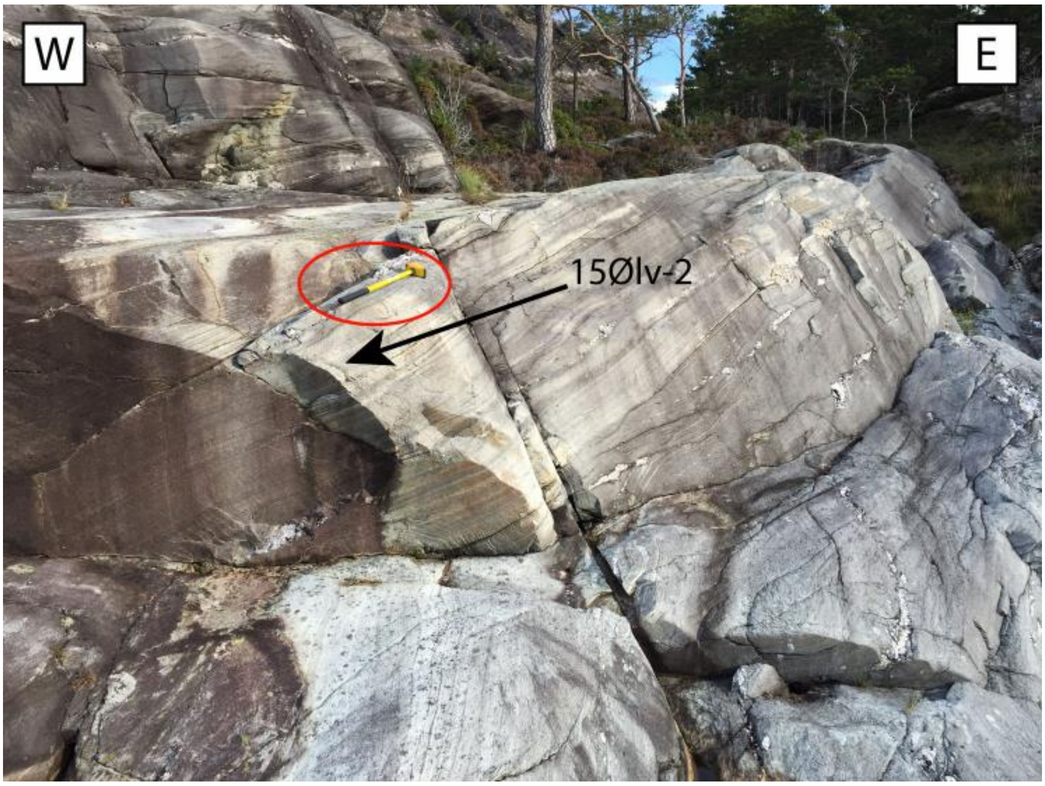

Figure 5.11: Sample locality south of Hestvika. Black arrow pointing at the volcaniclastic sample location (15Ølv-2). A clear layering is seen within the unit. Hammer for scale. Photo: R.B. Pedersen.

The Flugedalen locality:

Flugedalen is located at the northern part of Varaldsøy (Fig. 5.8). The location shows conglomerates and quartzites above the underlying sequence of greenstone. The conglomerate layer contains clasts of greenstone, some more acidic volcanics, epidosite and chert. Above the conglomeratic layer rests a thick quartz-rich unit that was mapped by Foslie (1955) as an albite-quartzite. This unit is overlain by the limestone that is representative for the whole area.

Sample 15Ølv-3 is taken approximately 20 meters above the conglomerates (Fig. 5.12). The quartzite is grey, massive and fine-grained. In hand specimen, quartz, chlorite and pyrite are observed. A clear quartz vein crosscuts the sample. Thin section observations reveal that the sample is dominated by quartz (ca. 85%). Small grains of mica, mostly muscovite, are present in between the quartz grains. Only a few grains of albite are present. The sample is fine-grained, apart from some more coarse-grained layers or veins. Major element composition reveals SiO_2 content of 88.83% and total alkali of 2.12%. The sample is therefore classified as a quartzite.

Figure 5.12: Flugedalen locality. Black arrow pointing towards the quartzite sample (15Ølv-3). Photo: R.B. Pedersen.

Nordøya:

Nordøya is a small island located just outside the southern part of the Ølve peninsula (Fig. 5.8). The island is composed of two units, where the lowest unit is made of strongly deformed greenschist that probably belongs to the Varaldsøy-Ølve Complex. This unit is overlain by a less deformed and more stratified upper unit that at the base is defined by a several meter-thick quartz-rich unit that was mapped as an albite quartzite by Foslie (1955). This is overlain by well layered carbonate-rich sediments that grade upwards into metasediments that are sandy and quartz-rich. As pointed out earlier, these carbonates represent a stratigraphic horizon which has been mapped and correlated across the Ølve and Varaldsøy (Foslie, 1955) (see Fig. 5.8), and the Nordøya locality therefore seems to represent the same overall stratigraphic level as the Hestvika and Flugedalen areas described above (i.e. the base of the Mundheim Group).

Samples 15Ølv-4 and 15Ølv-5 were collected from the quartzite at the base of the upper unit (Fig. 5.13), just above the more strongly deformed greenschist. Both samples look the same, with a white and green colour. It is a massive and fine-grained unit, dominated by quartz. Thin sections reveal that both samples are dominated by quartz (80%) with some micas. The 15Ølv-4 sample is slightly richer in mica. The sample is poorly sorted with a grain size varying from fine- to coarse-grained. Major element composition of 15Ølv-4 reveals a rhyolitic composition with SiO_2 of 76.66% and total alkali of 5.8%. The 15Ølv-5 sample is composed of 92.31% SiO_2 and a total alkali content of 1.8%. Both samples are regarded as quartzites.

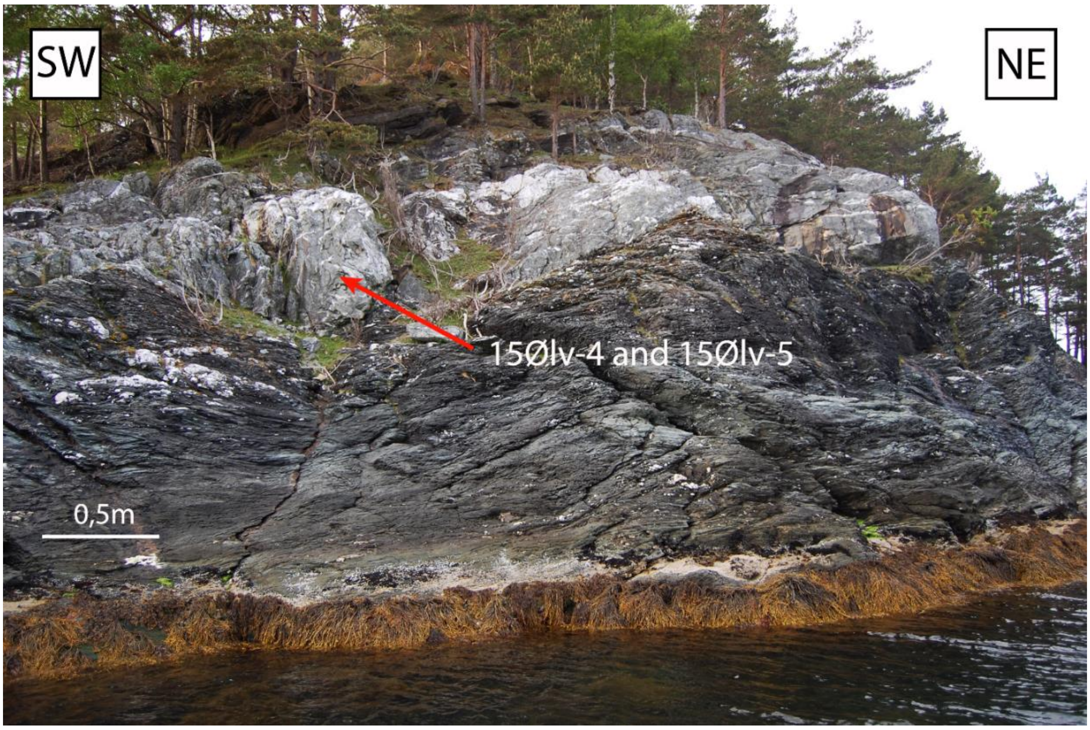

Figure 5.13: Locality at Nordøya. A clear contact between the greenstone at the bottom, and the quartzite above is seen. The red arrow points at the quartzite unit for the two samples (15Ølv-4 and 15Ølv-5). Photo: R.B. Pedersen.

Sample 5Ølv-6 and 15Ølv-7 were collected ca.10 meters above the carbonate horizon (Fig. 5.14). The two samples have similar characteristics; they are fine-grained with internal banding of light and dark layers consisting of quartz and micas, with a clear orientation. Some very quartz-rich areas or veins are observed, with bigger crystals of quartz. These areas are also associated with crystals of calcite suggesting a carbonate-rich sediment source. Thin sections reveal that both samples are dominated by quartz, mica and calcite. 15Ølv-6 is more calcite-rich than the other sample, whereas 15Ølv-7 contains more micas. The 15Ølv-6 sample contain 65.65% SiO_2, total alkali of 3.18% and high CaO/Na_2O ratio, whereas the other sample (15Ølv-7) is composed of 69.63% silica, total alkali of 2.63% and high CaO/Na_2O ratio. Based on thin section observations and major elements both samples are classified as carbonate-rich metasandstones.

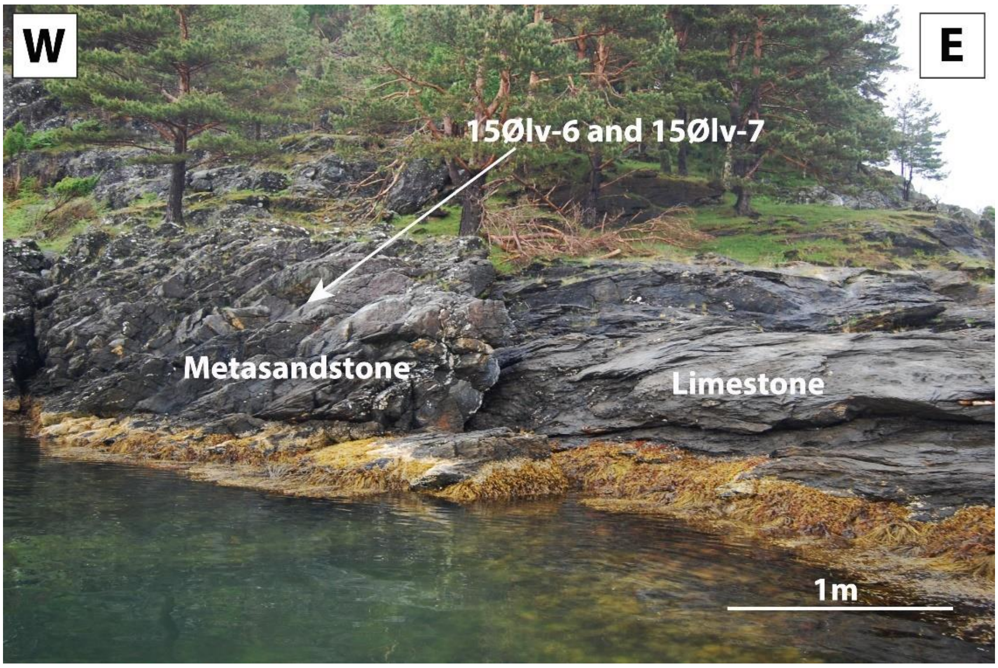

Figure 5.14: Shows the sampled unit of metasandstone (15Ølv-6 and 15Ølv-7). This is the uppermost unit of metasediments on the island, located above the limestone.

Huglo and Skorpo:

The islands of Huglo and Skorpo are located east of Stord, just south-west of Ølve and Varaldsøy. The area is dominated by the "quartz-keratophyres" of the Huglo Formation that were suggested to represent distal lava flows that overlie the greenstones of the VØC (Færseth, 1982). A thick pile of limestones cover the "quartz-keratophyre", with a thin layer of conglomerate in-between. Black shales and phyllites overlie the limestones in the area.

Sample 16Hug-3 is collected from the south-western side of Huglo (Fig 5.9). The location shows a massive unit of "quartz-keratophyre", with no other lithologies exposed (Fig. 5.15). The sample taken from the location is massive, white to pink, with a medium grain size. All the grains have a similar size, and no phenocrysts are present. Thin section reveal that the sample is dominated by microcrystalline quartz. Some coarser quartz-veins are observed. A few highly altered crystals of plagioclase can be seen. The sample has a more volcanic character than the quartzites sampled in the Ølve-Varaldsøy area. Major elements reveal a dacitic to rhyolitic composition with SiO_2 of 71.77%, total alkali of 5.16% and low CaO/Na_2O ratio (Fig. 5.6).

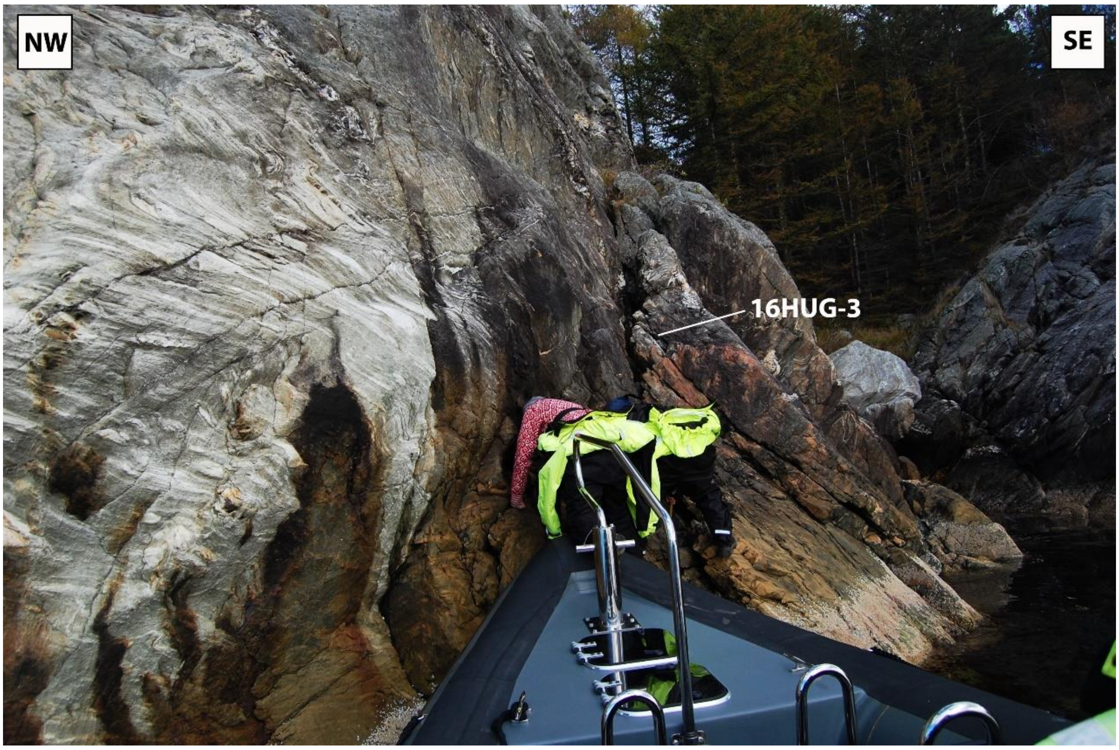

Figure 5.15: The sampled unit on Huglo (16Hug-3). People wearing coveralls for scale.

The 16Sko-3 sample is collected from the southern part of Skorpo (Fig 5.9). The location comprises only a massive unit of "quartz-keratophyre" (Fig. 5.16). It is dominated by a laminated "quartz-keratophyre" with a pink colour. The sample is composed of fine-grained quartz, with bigger phenocrysts of feldspar. Thin sections reveal a dominance of microcrystalline quartz, with large phenocrysts of feldspar (up to 5mm). Some of the phenocrysts show primary magmatic textures. Major elements reveal a SiO_2 content of 72.37%, total alkali of 9.61% and low CaO/Na_2O ratio. The sample is therefore classified as a rhyolite (Fig. 5.6). This sample differs from the one collected from Huglo by its very high K_2O content (7.64%). The high amount of sodium is consistent with the predominance of feldspar phenocrysts. A marked variation in sodium content of the “quartz-keratophyres” on Huglo and Skorpo is documented by Foslie (1955).

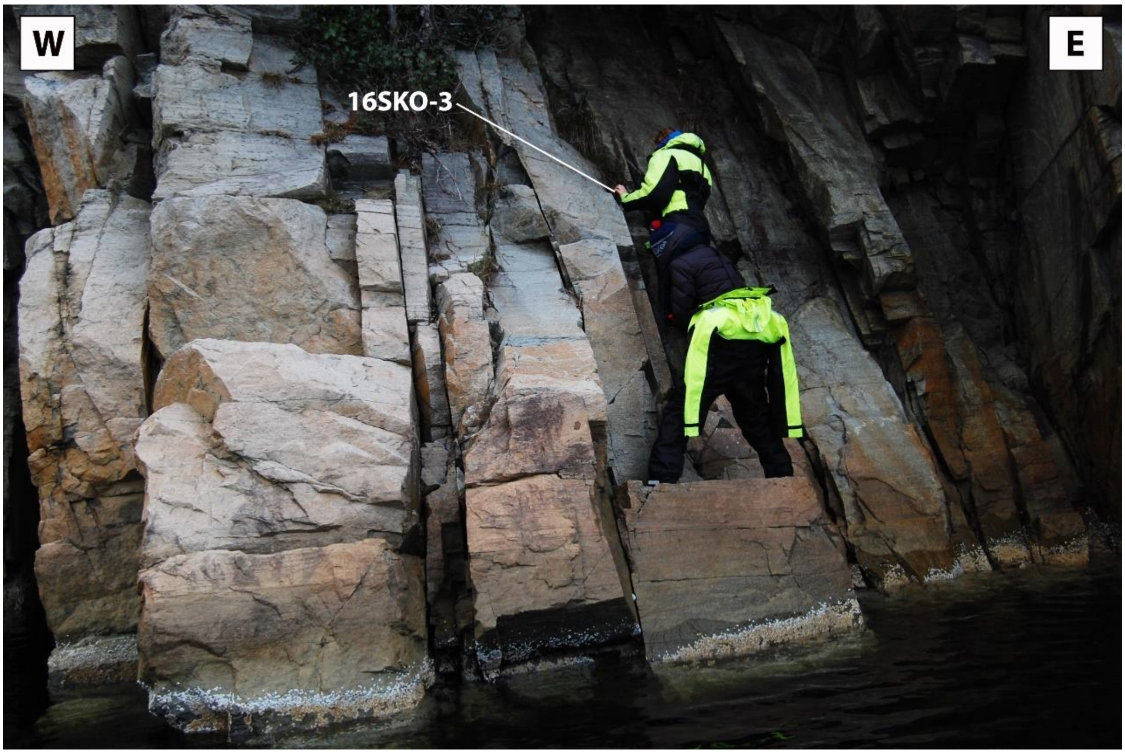

Figure 5.16: The sampled rhyolite on Skorpo (16Sko-3). People wearing coveralls for scale.

Geochemistry of the quartzites, volcaniclastics and acid volcanic rocks

The geochemical results, major- and trace elements, for the “quartz-keratophyres” and quartzites are reported in Table 5.2. Since the major element compositions have been commented on in the previous sample descriptions, this section will focus on the trace element compositions.

Table 5.2: Major- and trace element composition of the quartzites, volcaniclastics and acid volcanic rocks from the different locations on Ølve/Varaldsøy, Huglo and Skorpo.

Locality	Hestvika		Flugedalen		Nordøya			Huglo	Skorpo
Sample:	15Ølv-1	15Ølv-2	15Ølv-3	15Ølv-4	15Ølv-5	15Ølv-6	15Ølv-7	16Hug-3	16Sko-3
%									
SiO_2	79.05	67.44	88.83	76.77	92.31	65.65	69.63	71.77	72.37
TiO_2	0.27	0.34	0.33	0.81	0.34	0.47	0.42	0.32	0.23
Al_2O_3	9.96	14.50	4.41	11.20	3.67	7.86	7.21	10.51	13.04
Fe_2O_3	2.13	2.56	1.56	2.60	0.97	2.94	2.60	1.71	1.58
MnO	0.02	0.06	0.03	0.02	0.01	0.06	0.06	0.08	0.02
MgO	0.71	1.22	0.37	0.63	0.17	2.55	1.74	0.25	0.35
CaO	0.25	2.23	1.00	0.77	0.25	8.03	7.93	2.29	0.27
Na_2O	0.79	3.32	1.28	2.57	0.71	1.44	1.01	3.80	1.97
K_2O	6.20	5.27	0.84	3.23	1.09	1.74	1.62	1.36	7.64
P_2O_5	0.03	0.08	0.07	0.13	0.02	0.08	0.08	0.06	0.07
LOI	0.58	2.95	1.15	1.20	0.43	8.91	7.59	1.06	0.50
Total	99.99	99.97	99.87	99.93	99.97	99.73	99.89	93.19	98.05
ppm									
Li	10.25	12.20	7.37	11.86	4.31	24.77	21.22	-	-
Sc	2.83	6.55	2.69	10.8	2.25	7.22	6.55	4	2.72
Ti	1389	1922	1726	4905	1680	2964	2368	1877	1120
V	17.08	55.67	21.95	67.08	14.43	48.73	42.21	19.38	15.96
Cr	88.1	6.63	40.91	759.7	119.7	70.81	49.88	0.62	1.75
Mn	96.90	455.7	219.5	107.8	47.16	458.8	424.8	681.8	135.7
Co	1.63	6.14	3.32	3.59	1.50	5.17	6.11	1.41	1.11
Ni	4.69	5.7	16.72	45.1	10.57	18.73	19.66	0.36	0.87
Cu	6.03	3.12	8.56	6.66	4.61	12.66	6.83	5.41	3.16
Zn	15.73	13.71	21.06	25.81	8.93	35.15	35.00	21.81	15.99
Rb	109.8	148.7	21.76	67.2	21.04	76.64	64.14	46.49	152.4
Sr	42.86	91.03	16.75	29.75	6.80	142.9	100.7	556.1	61.85
Y	12.84	16.50	8.53	25.84	8.11	19.18	18.57	21.53	16.19
Zr	163.6	99.89	32.75	71.66	37.58	67.18	51.57	162.7	86.79
Nb	9.49	19.51	8.02	16.39	6.37	8.56	6.81	13.37	15.15
Cs	1.26	1.08	0.533	2.11	0.686	2.59	2.27	0.82	0.98
Ba	1283	1209	126.9	563.8	208.6	253.2	226.0	649.2	1299
Hf	3.97	3.09	0.994	2.32	1.15	2.16	1.66	4.4	3.05
Ta	0.663	1.92	0.563	1.19	0.431	0.642	0.501	0.97	1.18
Pb	6.35	6.72	4.35	3.64	2.30	11.11	9.73	15.87	12.68
Th	19.51	32.86	3.36	7.77	3.05	7.87	5.98	27.89	43.29
U	3.97	5.08	0.757	1.60	0.78	1.44	1.02	8.56	7.92
La	49.55	57.09	10.57	26.45	10.14	25.18	19.09	66.51	73.58
Ce	80.69	93.22	21.55	53.47	19.25	50.54	38.48	112.67	125.12
Pr	8.91	9.41	2.77	6.70	2.37	6.40	4.86	11.59	12.3
Nd	30.10	27.99	10.28	24.92	8.47	23.53	18.17	37.91	38.23
Sm	4.43	3.99	2.16	4.86	1.54	4.52	3.55	5.76	5.52
Eu	1.30	0.88	0.49	1.21	0.36	0.93	0.77	1.32	0.88
Gd	3.24	3.02	1.96	4.57	1.40	3.99	3.41	4.6	3.87
Tb	0.48	0.42	0.30	0.74	0.23	0.60	0.54	0.69	0.59
Dy	2.67	2.58	1.76	4.68	1.45	3.66	3.32	4.11	3.33
Ho	0.53	0.52	0.32	0.96	0.30	0.71	0.66	0.85	0.65
Er	1.75	1.66	0.90	2.87	0.89	2.10	1.96	2.66	2.00
Tm	0.27	0.25	0.13	0.42	0.13	0.31	0.29	0.39	0.29
Yb	1.88	1.81	0.83	2.68	0.89	2.06	1.88	2.78	2.03
Lu	0.29	0.29	0.12	0.37	0.13	0.31	0.28	0.42	0.31

Trace elements and REE patterns:

The REE patterns from all samples show similar trends with strong enrichment in the LREE relative to the HREE, and small negative Eu anomalies (Fig. 5.17). Even though all the samples show overall similar trends, they can be separated into two different groups based on their REE values. The samples from Huglo (16Hug-3), Skorpo (16Sko-3) and Hestvika (15Ølv-1 and 15Ølv-2) show markedly higher values compared to the other samples, especially in terms of the LREE that have concentrations of up to 200 times chondrite (Fig. 5.17). These samples are the ones that based on petrography and major element composition have been classified as dacitic and rhyolitic volcaniclastics and volcanic rocks. The quartzites and metasandstones generally show lower values, especially for the LREE.

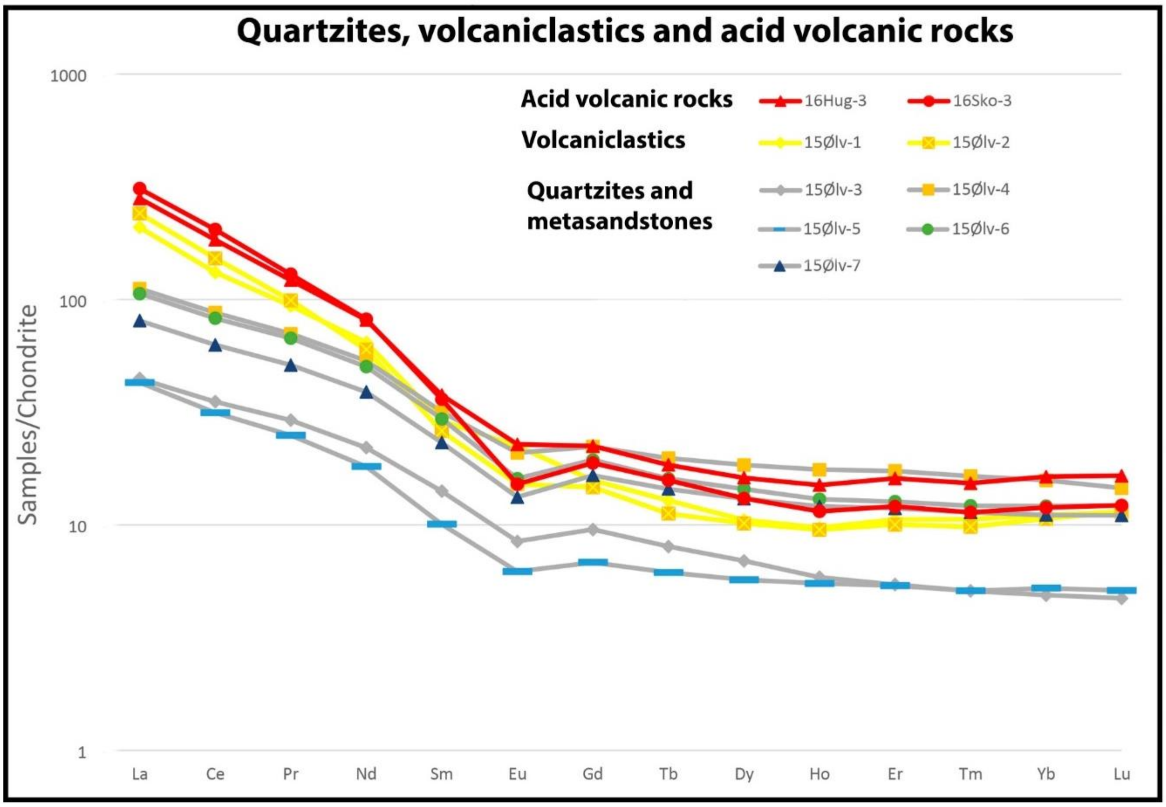

Figure 5.17: Rare earth element (REE) patterns for quartzites, volcaniclastics and acid volcanic rocks. The samples conform to a similar pattern. The REE values separate the samples into two groups based on their volcanic or sedimentary origin. The upper red plots show the volcanic samples (rhyolites from Huglo and Skorpo) whereas the yellow lines represent the volcaniclastics (from Hestvika). The other grey lines illustrate the quartzites and metasandstones (from Flugedalen and Nordøya). Normalization values from Sun and McDonough (1989).

In the extended spider diagram (Fig. 5.18), additional trace elements are plotted together with all the REE. The diagram shows that all samples are enriched in the most mobile and incompatible elements, with a decreasing trend towards less incompatible elements. A few clear anomalies are observed. A significant negative anomaly is observed for Sr, and Ti. Ta and Nb show a small negative anomaly in all samples. Positive anomalies are seen for both La and Pb. The samples classified as dacitic and rhyolitic volcaniclastic and volcanic rocks can be distinguished from the quartzite and sandstone samples by having higher Th and U concentrations.

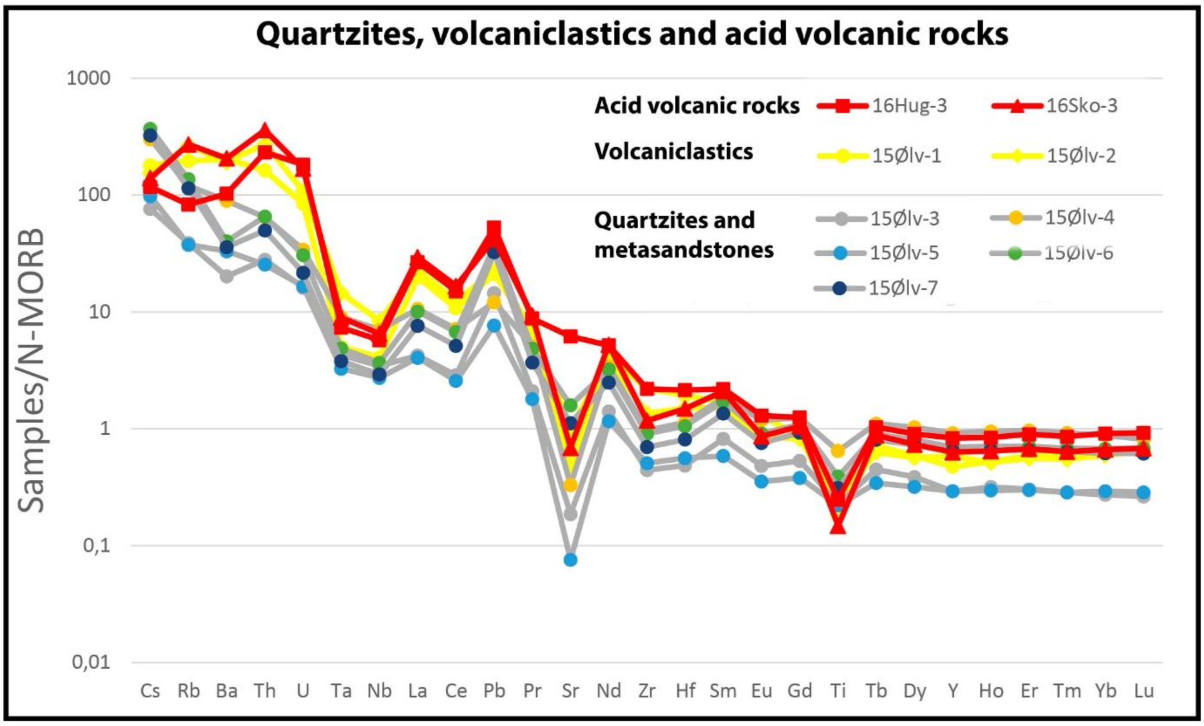

Figure 5.18: Extended spider diagram for trace elements from the quartzite, volcaniclastic and volcanic samples. The upper red plots show the volcanic samples (rhyolites from Huglo and Skorpo) whereas the yellow lines represent the volcaniclastics (from Hestvika). The other grey lines illustrate the quartzites and metasandstones (from Flugedalen and Nordøya). Normalized against N-MORB using values from Sun and McDonough (1989).

5.4 Zircon geochronology of volcaniclastics, quartzites and acid volcanic rocks

Volcaniclastics from Hestvika

Sample 15Ølv-2: A total of 237 zircon grains were analyzed from this sample, of which 214 were <10% concordant. The grains vary in size from 50-200 µm on the longest axis (Fig. 5.19). Most of the grains generally have the same size of approximately 100 µm, but some grains stand out as particularly big. Most of these outliers are angular to subangular. A few of the grains can be classified as subrounded. Several of the grains seem to have been broken or eroded, whereas some retain a primary prismatic crystal shape. The grains show different internal structures. Most of the grains exhibit oscillatory zoning.

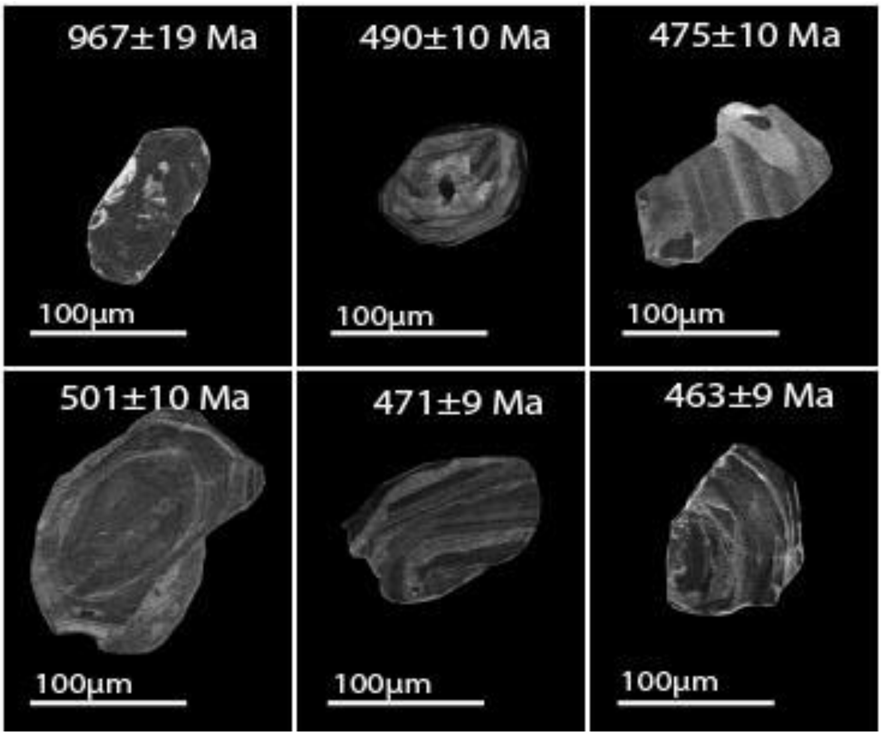

Figure 5.19: CL-pictures showing a representative selection of the zircon population from the volcaniclastic sample (15Ølv-2). The figure shows grains of different sizes and shapes. Most of the grains have measured ages from 460-500 Ma. Only one older grain (976 Ma) was dated, and is seen in the first quadrant (976 Ma).

All the obtained data from this analysis is presented in Fig. 5.20. Concordia diagrams are given for all the data, and for the grains that are less than 10% discordant. The concordia diagram shows a major concordant age population around 475 Ma. This sample shows a concentration of ages with a major peak around 470 Ma in the probability density plot (Fig. 5.21A). Besides one single grain dated at 976 Ma, all the analyses gave ages from 420-540 Ma. This young population was filtered with regards to the degree of discordance. A subpopulation of the most concordant grains (less than 1% discordant) shows a mean $^{206}Pb/^{238}U$ age of 474±1.9 Ma, with a confidence of 95% (Fig. 5.21B).

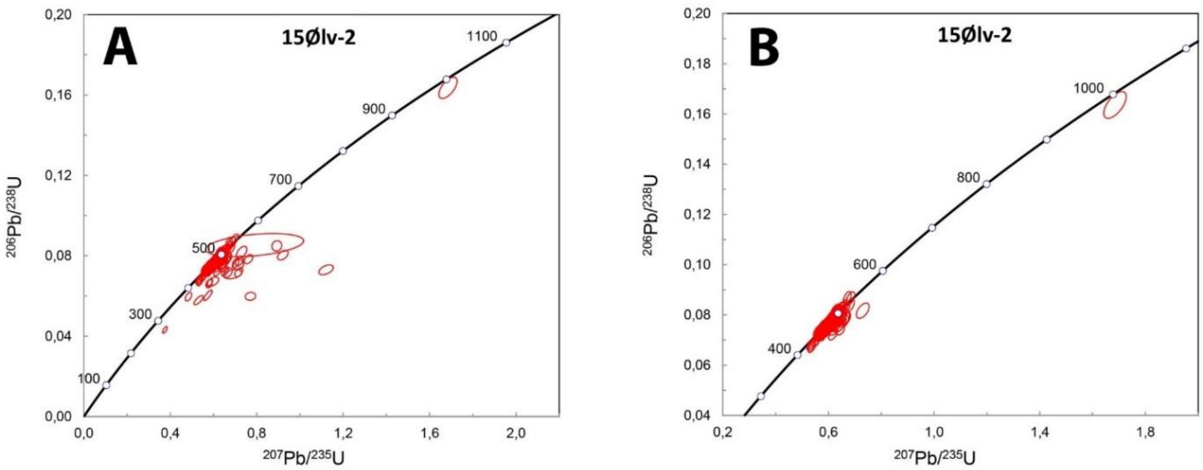

Figure 5.20: Concordia diagrams for the volcaniclastic sample from Hestvika (15Ølv-2). **A)** All the analyzed grains. **B)** Only the grains that were let through the different stages of filtration are illustrated.

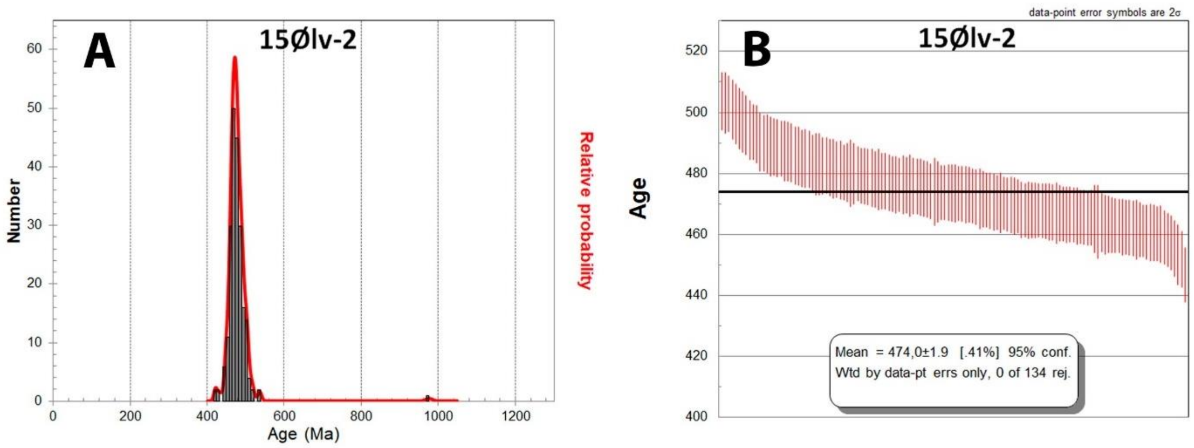

Figure 5.21: A) Probability density plot for the volcaniclastic sample from Hestvika (15Ølv-2). Black columns show actual age and number of grains. The red line is the calculated relative probability. The dominant peak is located around 470 Ma. **B)** Weighted average plot generated from the youngest grains of the population. The plot give a mean age of 474±1.9 Ma for all the selected grains in the sample.

Quartzite from Flugedalen

15Ølv-3: The bulk of sampled grains have an approximate size ranging between 100-200 µm. A few aberrant grains, however, have been found to be significantly smaller (50 µm) (Fig. 5.22). Most of the grains are angular to subangular, with some subrounded ones. All the grains seem to have low sphericity. Some elongated grains are present. Most of the grains show zoning of different character, and some of the grains also have dark inclusions. Other grains seem to contain both core and rim, whereas some grains show no signs of internal features.

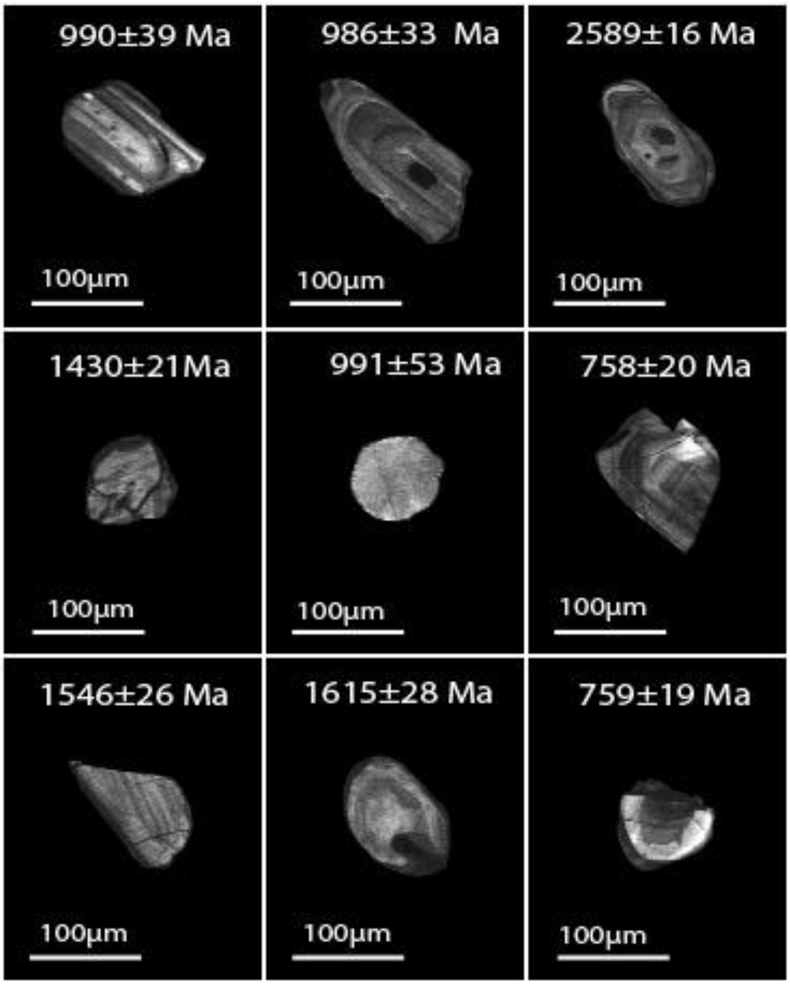

Figure 5.22: CL-pictures of representative grains from the quartzite sample (15Ølv-3), showing differences in sizes and shapes as well as in terms of ages. Grains from all the different age populations have been selected.

A total amount of 224 grains were analyzed in this sample. Of these, 184 are less than 10% discordant. All data, as well as the filtered grains are illustrated in concordia diagrams (Fig. 5.23). The total data set indicates a significant portion of discordant grains far off the concordia line. Some of the grains seem to follow certain trends with Proterozoic-Archean upper intercept ages and Paleozoic lower intercept ages.

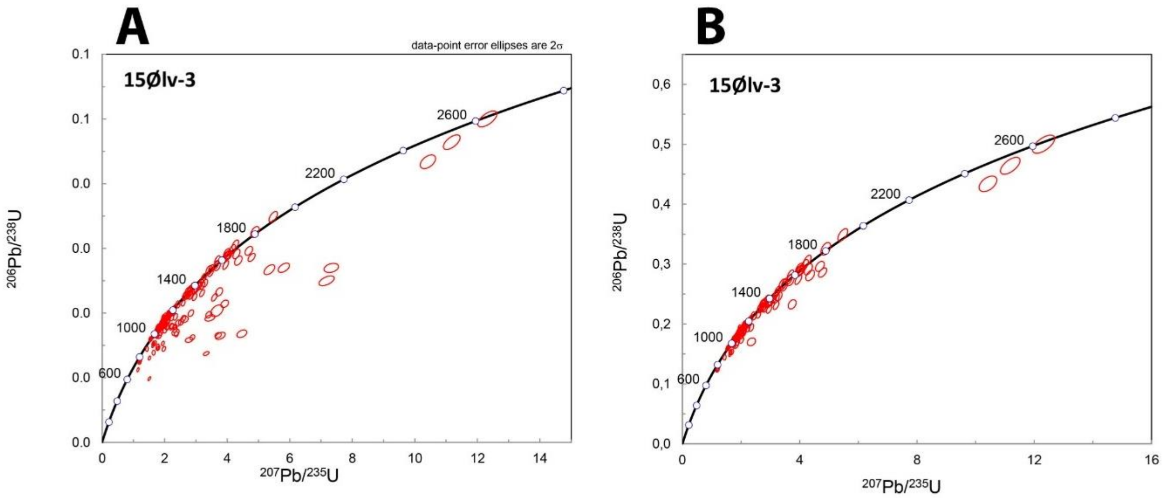

Figure 5.23: Concordia diagrams for the quartzite from Flugedalen (15Ølv-3). **A)** All data retrieved from the analysis. Only grains with common lead contamination are removed, as they show unrealistically high upper intercept. Several discordant grains following certain trends are present. **B)** Only the accepted data is illustrated (<10% discordant).

The concordant grains in this sample show distinctly different age distributions compared to the presumed volcaniclastic sample from Hestvika (15Ølv-2). Whereas the sample from Hestvika is dominated by Ordovician grains with an average age of 474 Ma, the near concordant zircon grains of this quartzite sample are all of Precambrian age (Fig. 5.23B). The larger part of the zircons show ages of around 1000 Ma (approximately 100 grains have ages between 900 Ma to 1100 Ma). The probability density plot (Fig. 5.24) also shows a minor peak around 1500 Ma (approximately 25 grains show ages ranging from 1400-1650 Ma), and a few grains give ages between 1700-2000 Ma. From the analyzed grains, three grains revealed an Archean age of around 2600 Ma.

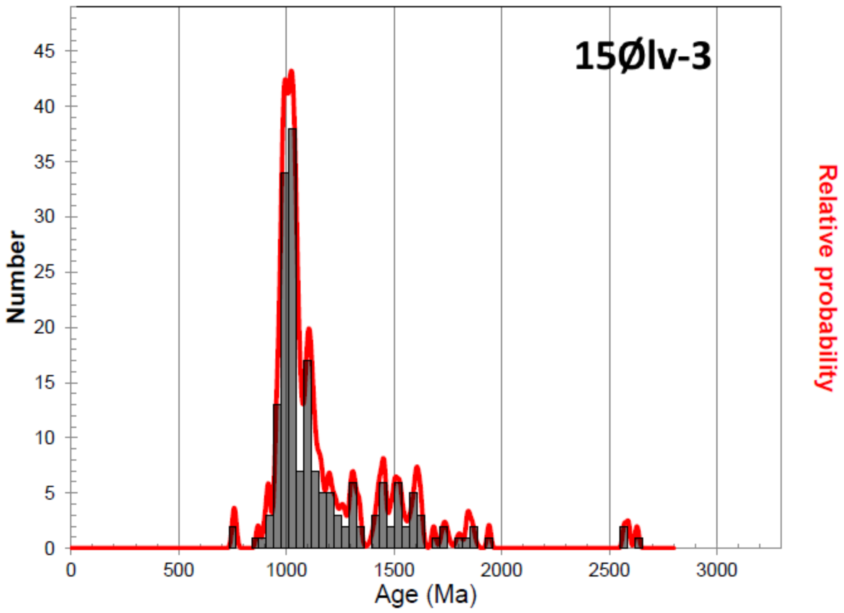

Figure 5.24: Probability density plot for the accepted data obtained from the quartzite (15Ølv-3). A widespread range of ages are illustrated, with a major peak at about 1000 Ma. A few Archean grains are present.

Quartzites and metasandstones from Nordøya

15Ølv-4: A total amount of 178 grains were analyzed, and 139 of these were less than 10% discordant. The grains exhibit differences in both size and shape. The size varies from less than 50 µm to around 200 µm on the longest axis (Fig 5.25). The grains show a variety of shapes, from angular to rounded with sphericity ranging from high to elongated. Subrounded grains with low to moderate sphericity are the dominant type. About half of the grains reveal zoning, whereas the other half shows no internal structures on the CL-images (Fig. 5.25).

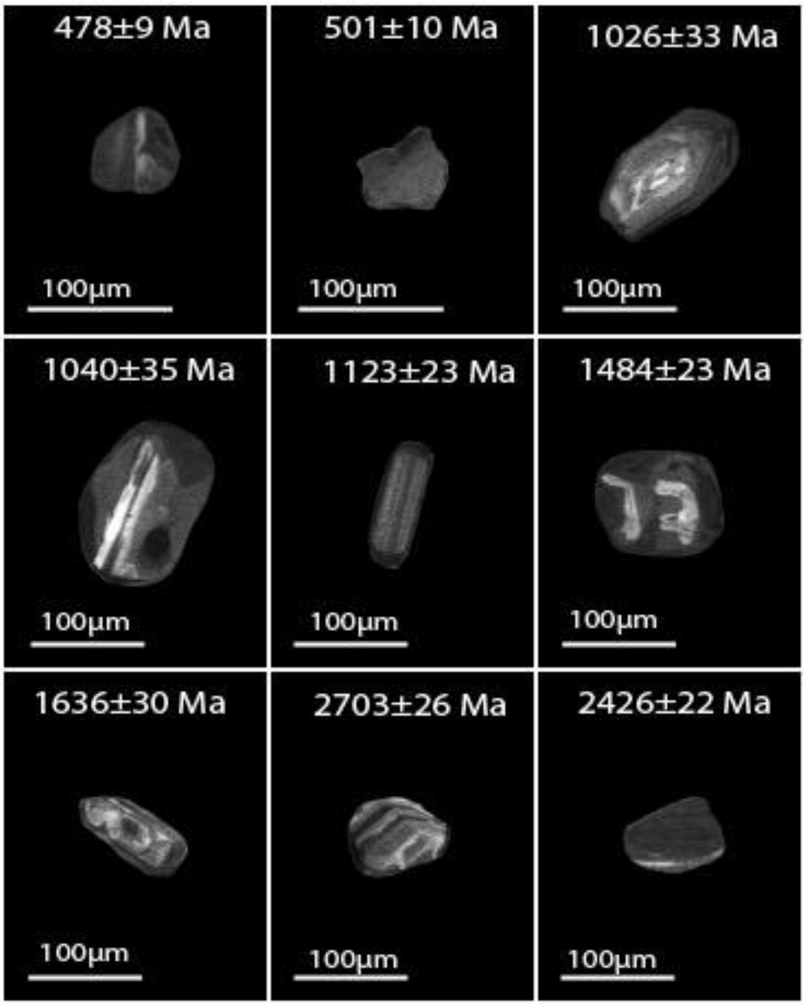

Figure 5.25: CL-pictures of selected grains from the quartzite sample from Nordøya (15Ølv-4). The grains revealed ages ranging from below 500 Ma all the way up to almost 3000 Ma.

Obtained data from the entire analysis is shown in Fig. 5.26. The concordia diagrams show all the data, as well as the filtered data of grains with less than 10% discordance. The unfiltered data reveals some discordant grains similar to the Flugedalen sample (15Ølv-3), which conform to trends associated with Paleozoic lower intercept ages (Fig. 5.26A).

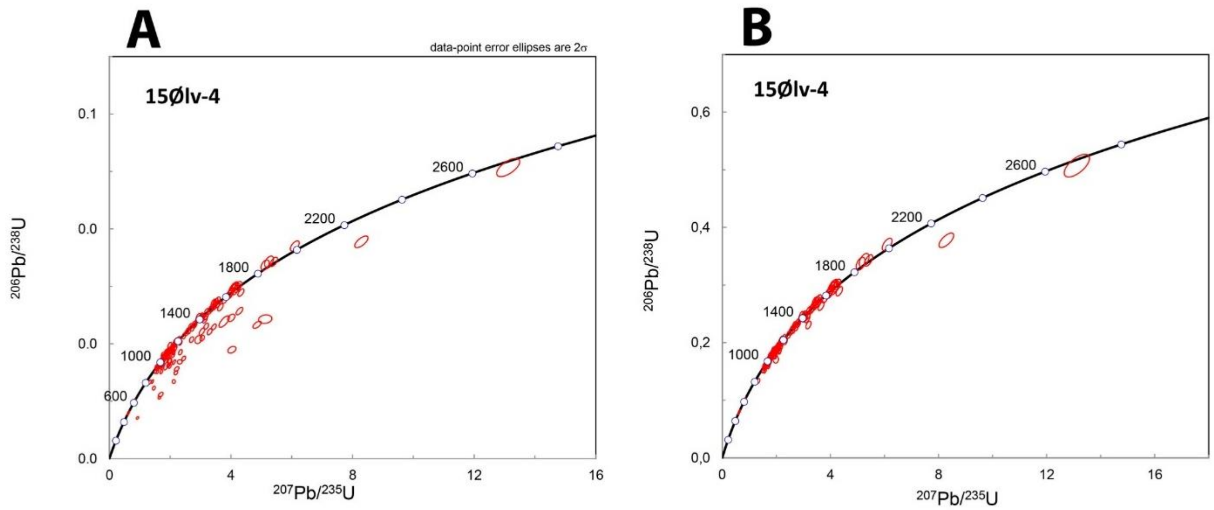

Figure 5.26: Concordia diagrams for the quartzite from Nordøya (15Ølv-4). **A)** All the data is plotted, except grains with common lead contamination. **B)** Only edited data with concordant ages are presented.

Overall, this analysis exhibit a similar age distribution as the quartzite from Flugedalen (15Ølv-3). However, where the Flugedalen sample only shows Precambrian ages, this sample includes two grains of early Paleozoic age (480-500 Ma). The Precambrian population includes a few grains with ages between 600-900 Ma. Most of the grains show ages around 1000 Ma, represented by a major peak in the probability density plot (Fig. 5.27). Approximately 75 grains give ages from 900-1150 Ma. The plot also reveals a minor peak around 1460 Ma and 1600 Ma. Only 6 grains show ages from the 1600 Ma peak and up to 2500 Ma. This sample also includes one grain with an Archean age of approximately 2700 Ma.

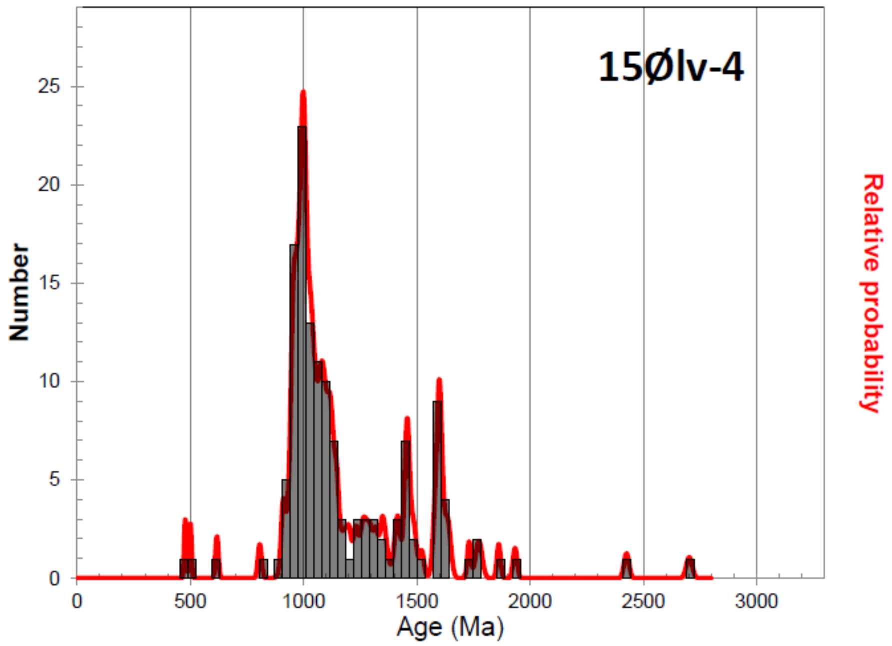

Figure 5.27: Probability density plot for the quartzite from Nordøya (15Ølv-4). Great variations in ages are seen, with a major peak at approximately 1000 Ma.

15Ølv-7: Both a sample of the general zircon population, and a selection of only prismatic grains were analyzed for this sample. In total, 170 grains were included in the general analysis, and of these, 126 were less than 10% discordant (Fig. 5.29). These grains revealed ages ranging from 470-3500 Ma. The grains exhibit a large variety in sizes, from approximately 50-200 µm (Fig. 5.28). Most of the grains are subangular to subrounded. Only a few seems to be angular, and this seems to be caused by breakup of the grains. Some of the grains are elongated, but the majority seems to have low to moderate sphericity. Only very few show sign of a prismatic crystal shape. Most of the grains exhibit little or no sign of zonation. Some of the grains seems to contain an older core with new crystal growth around.

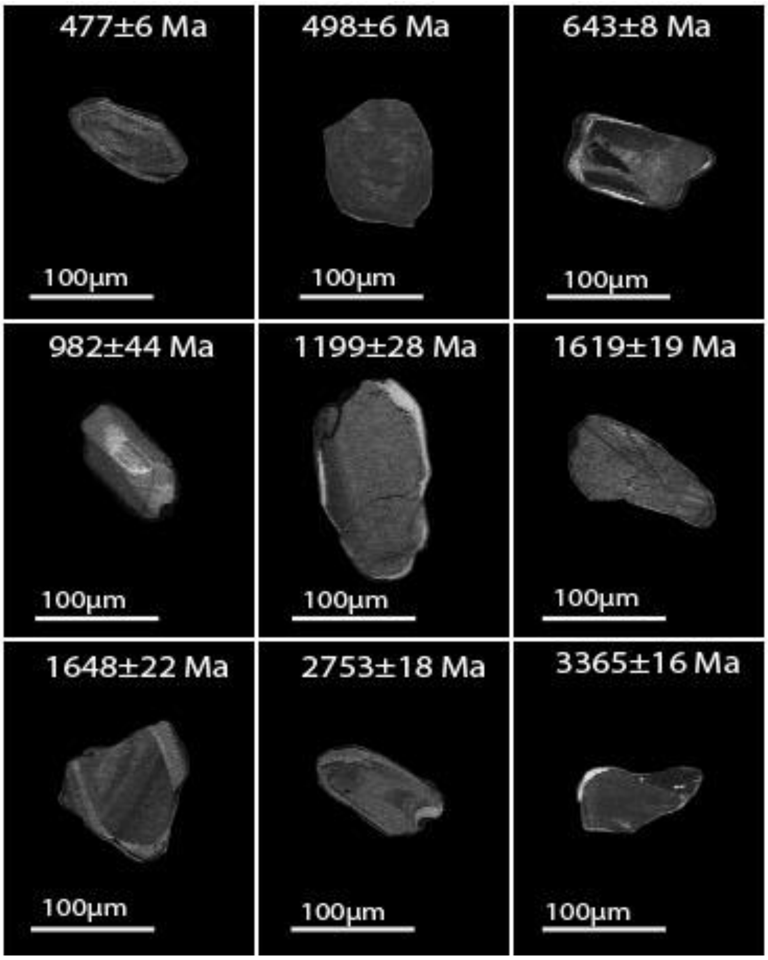

Figure 5.28: CL-pictures of a representative amount of the dated grains in the metasandstone from Nordøya (15Ølv-7). The grains show differences in shape and size. Obtained ages range from about 470 Ma to almost 3500 Ma.

The concordia diagrams show several concordant age populations, dominated by Precambrian ages (Fig. 5.29B). In the unfiltered data, several discordant grains are seen (Fig. 5.29A). These grains reveal lower Paleozoic intercepts. This is a result of mixed ages due to analysing of both core and rims.

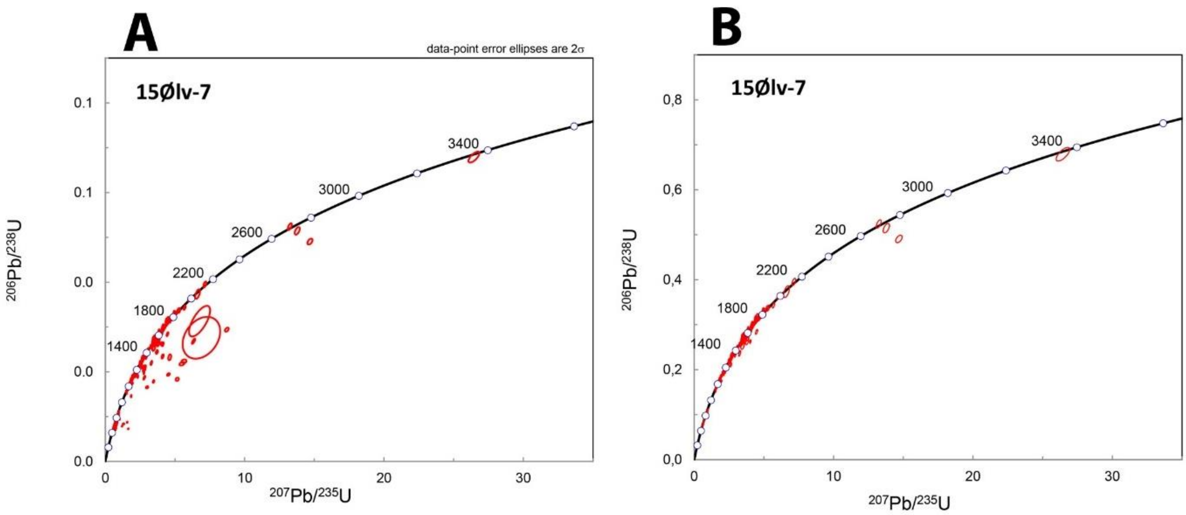

Figure 5.29: Concordia diagrams for the metasandstone from Nordøya (15Ølv-7). **A)** All the data are presented. Only grains containing common lead has been removed. The results reveal a widespread range of ages from around 475 Ma to old Archean grains. **B)** Only concordant ages are presented.

The probability density plot (Fig. 5.30) shows four major peaks. A small population (10 grains) define a peak at 500 Ma, and 6 grains with ages around 650 Ma. The major part of the analyzed grains gave ages from 1000 Ma to 2000 Ma, with two major peaks at 995 Ma and 1625 Ma. Two separate grains gave ages slightly above 2000 Ma, and four grains yielded Archean ages from 2600-3400 Ma.

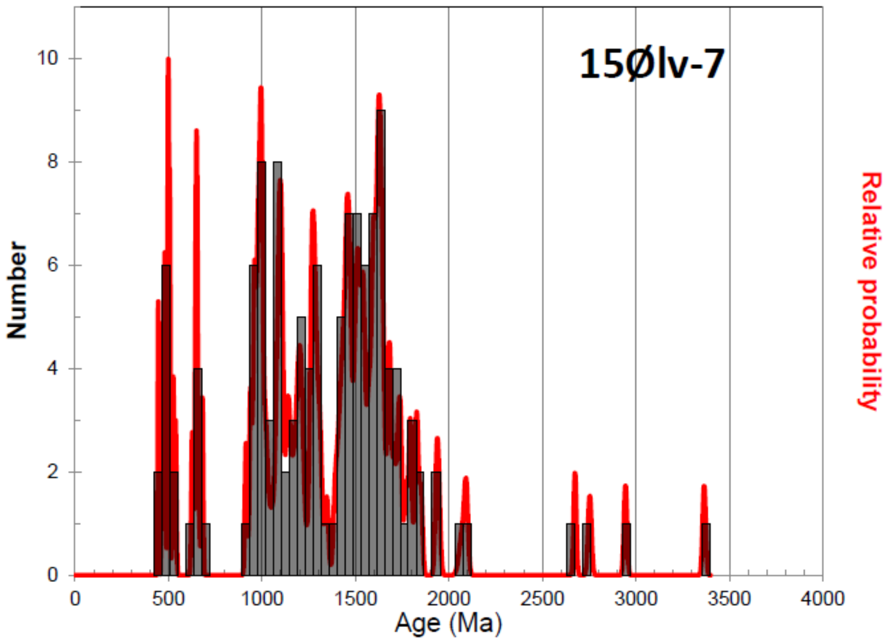

Figure 5.30: Probability density plot for the metasandstone from Nordøya (15Ølv-7) revealing a large variety in obtained ages, ranging from Ordovician to Archean with three major populations.

Forty grains were selected based on prismatic and euhedral crystal shape. The CL pictures reveals differences in internal structures, such as zoning. Some grains show a clear and intense zoning through the whole grain, while others show no sign of zoning. Some grains are composed of rounded cores with a more prismatic rim (Fig. 5.31). The grains exhibit some variation in terms of size, with width and length varying from 50-100 µm and 100-250 µm, respectively. For some of the grains, the prismatic shape has been rounded at the edges, and these tend to show the oldest ages. A few of the grains reveal near perfect prismatic crystal shape, and this population yield the youngest ages.

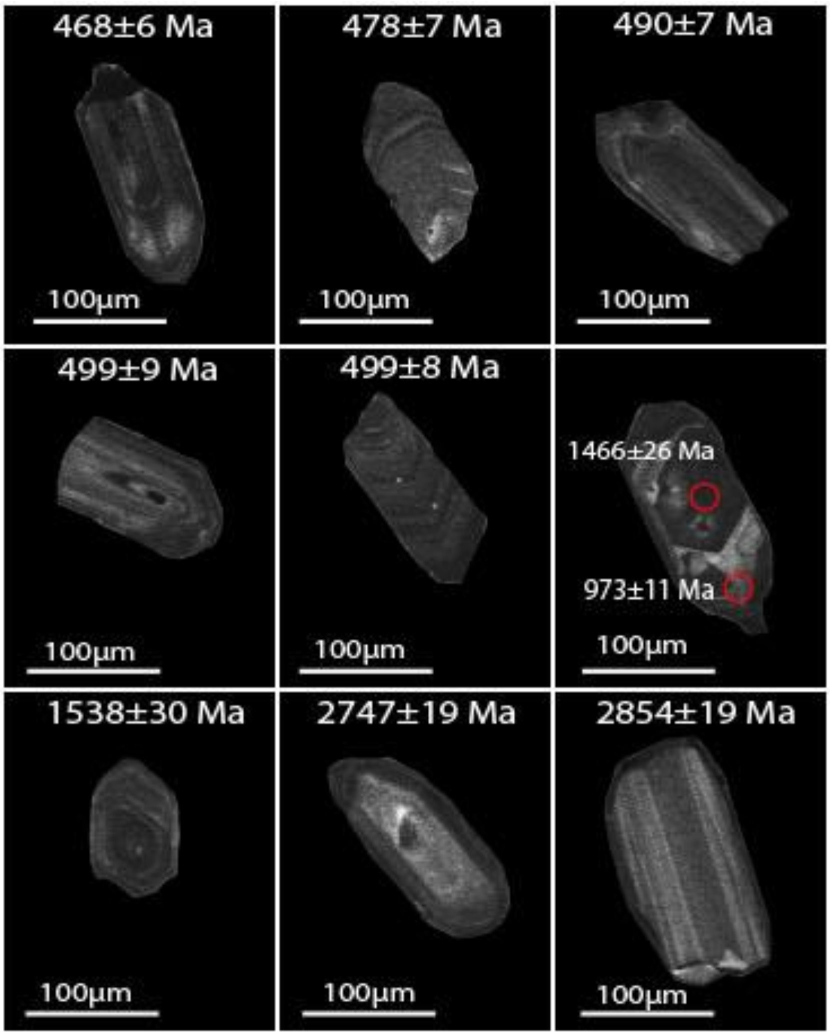

Figure 5.31: CL-pictures illustrating the selectively picked prismatic grains from the metasandstone from Nordøya. One grain revealed differences in terms of ages between core and rim. This is illustrated as red circles in the middle right quadrant.

The concordia diagrams reveal near concordant ages for all the grains (Fig. 5.32). This subset of prismatic grains is dominated by early Paleozoic ages with an average age of 495 Ma seen as the major peak in the probability density plot (Fig. 5.33). The rest of the grains show ages that range from 1000 Ma and 1500 Ma, and in addition, two grains revealed Archean ages of 2750-2850 Ma.

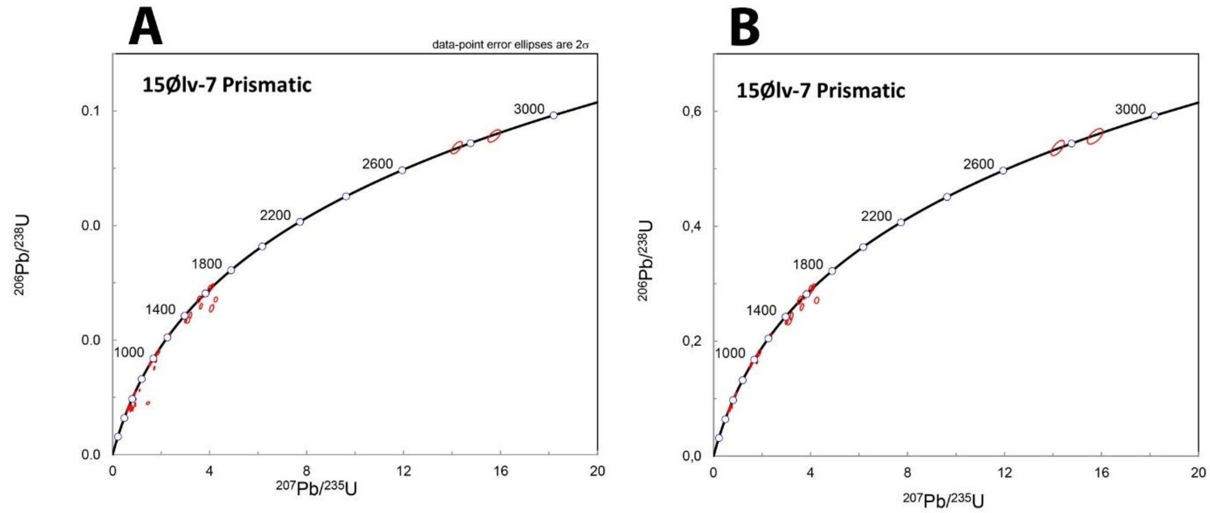

Figure 5.32: Concordia diagrams for the prismatic grains from the metasandstone from Nordøya (15Ølv-7 Prismatic). **A)** All the analyses are illustrated with a widespread range in terms of ages. **B)** Only the most concordant analyses are presented.

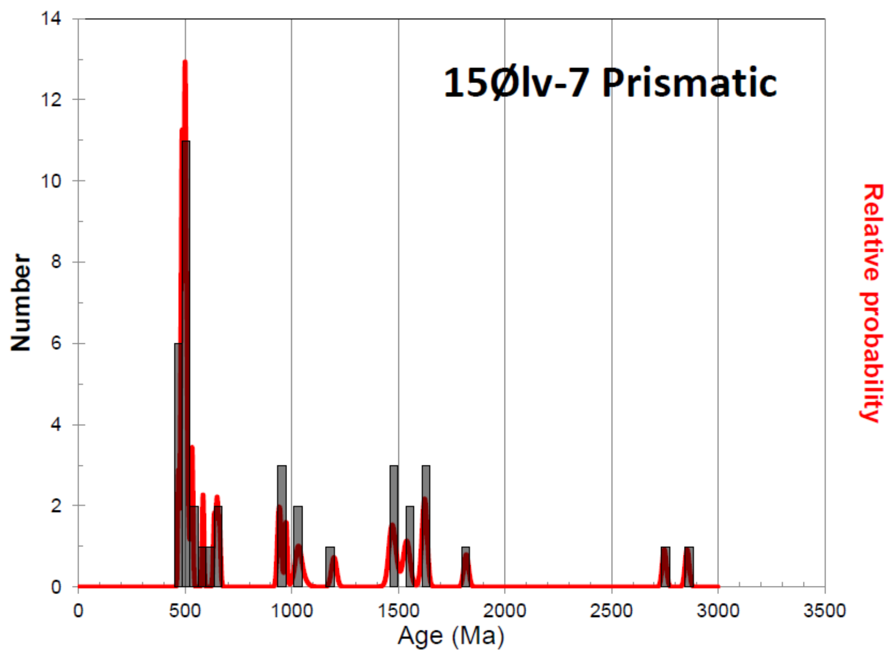

Figure 5.33: Probability density plot for the prismatic grains from the metasandstone at Nordøya (15Ølv-7 Prismatic). A major peak is seen at 495 Ma, followed by fewer grains ranging all the way up to Archean ages.

Rhyolites from Huglo and Skorpo

The rhyolite from Huglo (16Hug-3), yielded abundant zircons varying in size from 50-200 µm. Most of the grains are between 50-100 µm. The zircon population is dominated by grains of low to moderate sphericity with an angular to subrounded shape. Some elongated grains are present representing a primary magmatic texture. All the grains are heavily zoned. Of these, 181 grains were analyzed with 122 being less than 10% discordant. The concordant ages are seen as a major population around 470 Ma in the concordia diagram (Fig. 5.34A).

A large fraction of 50-150 µm zircons were extracted from the rhyolitic sample from Skorpo (16Sko-3). The grains vary a lot in terms of shape. Subangular and angular grains are the dominant type. Several near euhedral grains are seen, indicating a primary magmatic texture. All the grains show clear oscillatory zoning. A total of 153 zircons were analyzed, and 115 of these yielded near concordant ages. The results are presented in the concordia diagram in Fig. 5.34B.

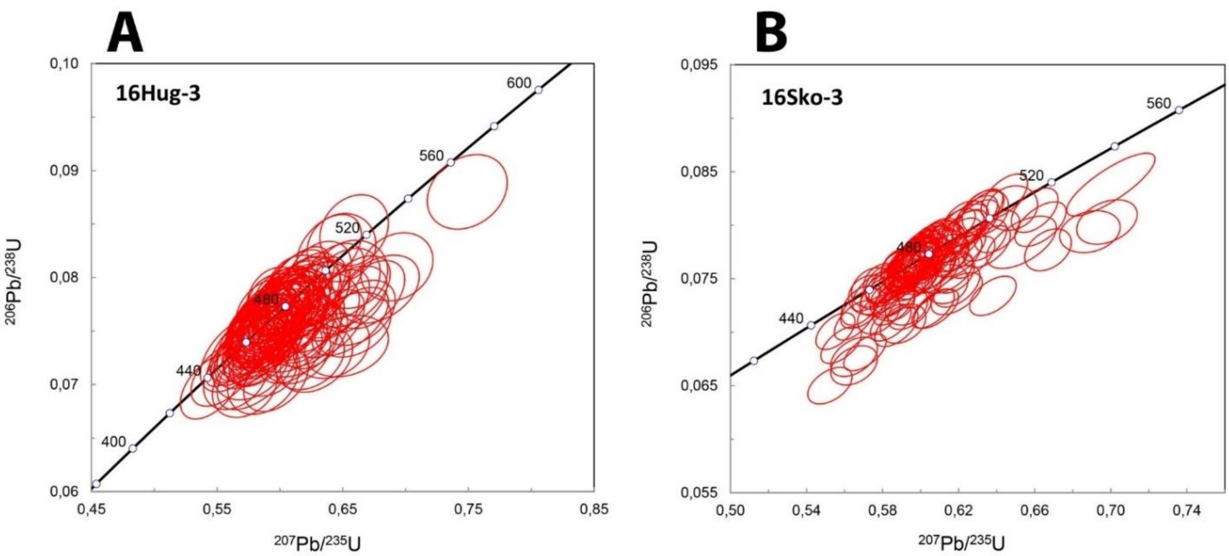

Figure 5.34: Concordia diagrams for the less than 10% discordant grains extracted from the metavolcanics on Huglo and Skorpo. **A)** A major population of concordant ages is seen around 470 Ma for the rhyolite from Huglo (16Hug-3). No older grains are present. **B)** The analyzed grains reveal a concordant population around 470 Ma for the rhyolite from Skorpo (16Sko-3) as well. No older grains are present in the sample.

The probability density plots for the two metavolcanic samples, reveal similar results (Fig. 5.35). Most of the zircon grains gave ages ranging from 450-500 Ma, and both samples show a peak at approximately 475 Ma. No older grains, or discordant trends, are present in any of the samples.

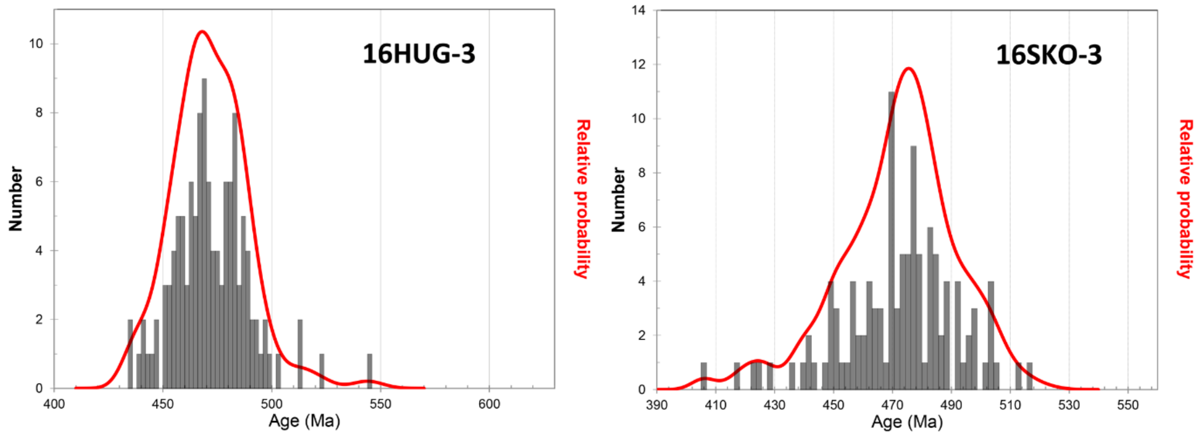

Figure 5.35: Probability density plots for the rhyolites from Huglo (16Hug-3) and Skorpo (16Sko-3). Both samples revealed similar trends with a major peak at approximately 475 Ma.

By using the most concordant ages (less than 1% discordant) a mean age of 473±3.0 Ma and 474±2.2 Ma was obtained for the two samples, respectively (Fig 5.36). Apart from these populations, no older zircon grains are found in any of the samples.

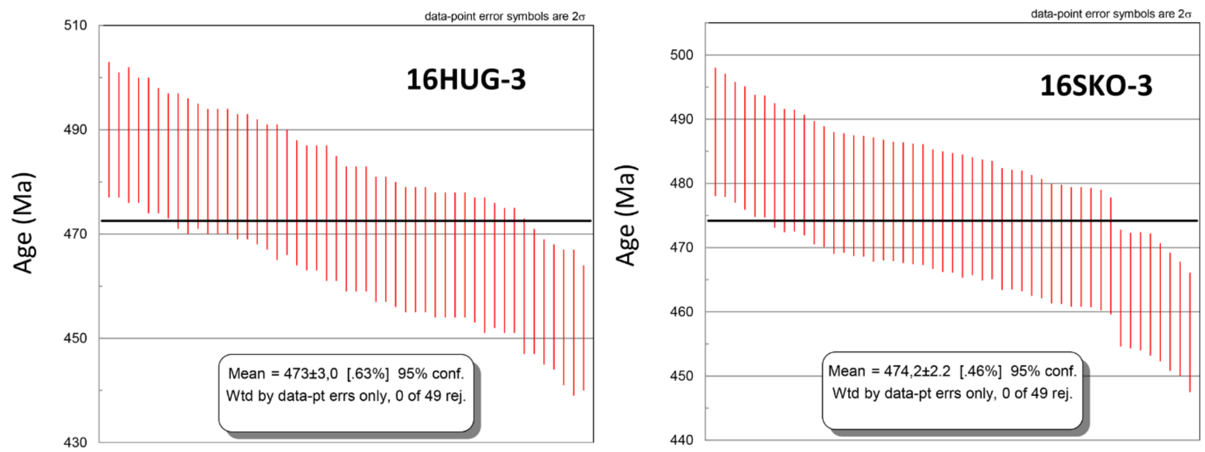

Figure 5.36: Weighted average plots for the rhyolites from Huglo (16Hug-3) and Skorpo (16Sko-3) generating a mean age for the most concordant grains in the zircon population of 473±3.0 Ma for the Huglo sample and 474±2.2 Ma for the Skorpo sample.

5.5 Limestones in the Hardangerfjord area

Two separate units of limestone are mapped in the Hardangerfjord area. Ashgillian limestone comprises the Limbuvik Formation representing the upper limestone unit (Færseth, 1982). The lowest unit is the Haukanes Formation that is dominated by limestone with thin layers of pelite and psammite (Færseth, 1982). Only poorly preserved crinoid fragments occur at different localities, and the age of this unit is yet unknown (Andersen and Andresen, 1994). This unit of limestone rests unconformably on top of the rhyolites on Huglo and Skorpo. A local layer of conglomerate occurs at the base of the limestone on Huglo containing fragments from the underlying acid volcanics (Færseth, 1982; Ragnhildstveit et al., 1998). Phyllites and mica schist cover the limestone. The limestones can be traced to Ølve and Varaldsøy where it conformably covers, and intercalates with, the volcaniclastics and quartzites/metasandstones.

Different samples of limestone from the Haukanes Formation were collected from various locations throughout the outer Hardangerfjord area (Ølve, Huglo and Skorpo) (Fig. 5.37). The objective was to determine the age of this key stratigraphic horizon and thereby the age of the base of the Mundheim Group.

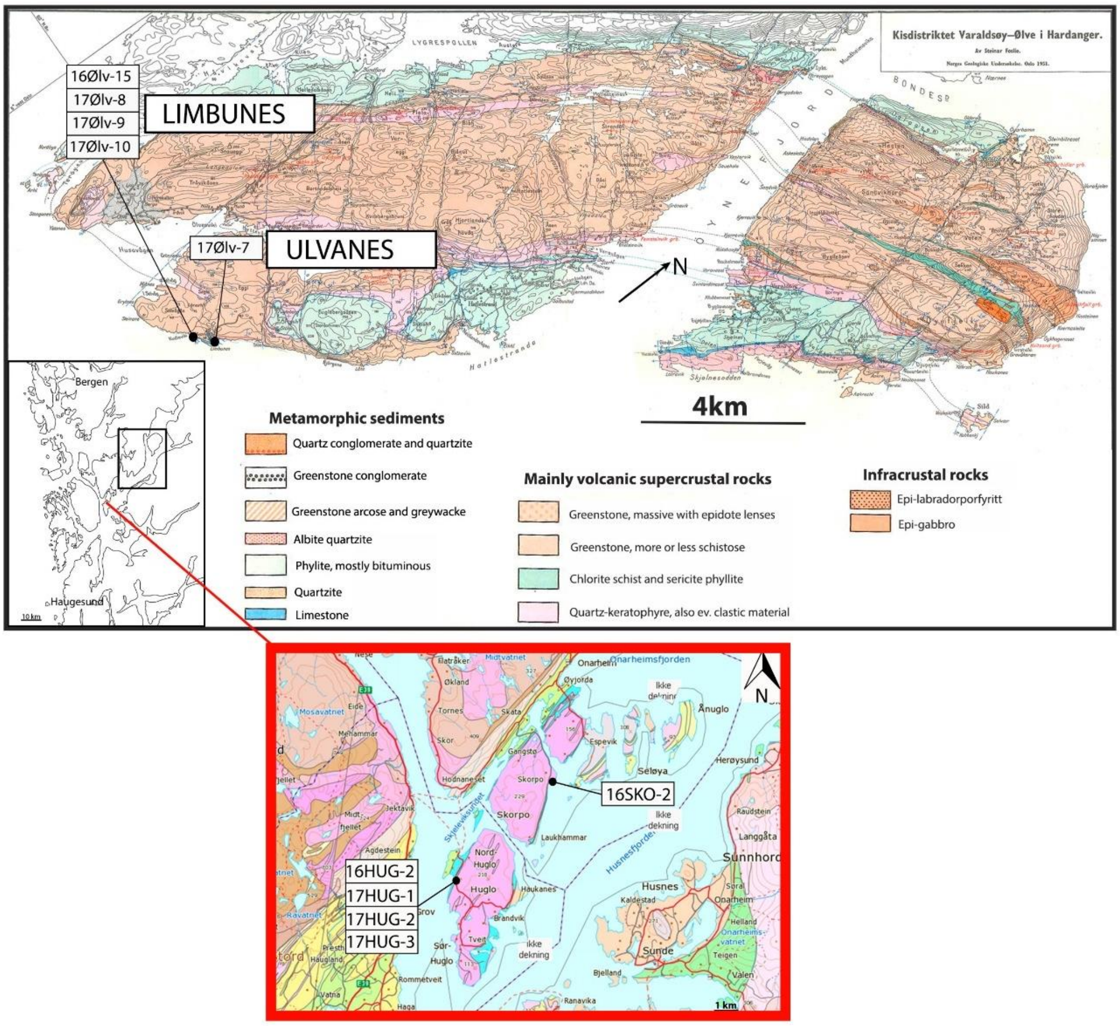

Figure 5.37: Geological maps of the sampled locations. The uppermost map, modified from Foslie (1955), show the two different locations in Ølve. The lower map (red) illustrates the sampled areas on the islands of Huglo and Skorpo. The map from Huglo and Skorpo is modified based on the generated map from NGU, 2017 (http://geo.ngu.no/kart/berggrunn_mobil/).

Sampled locations

Ølve:

Five different samples were collected from the Ulvanes and Limbunes area in Ølve (Fig. 5.37). Four of the samples were collected on the same location (Limbunes). Samples were collected from the base of the unit (16Ølv-15), and from thin pure carbonate layers present within the unit (17Ølv-8, 17Ølv-9 and 17Ølv-10) (Fig. 5.38). The last sample (17-Ølv-7) was collected a few hundred meters further north at Ulvanes. Unlike the other massive samples, this sample is porous and fragile.

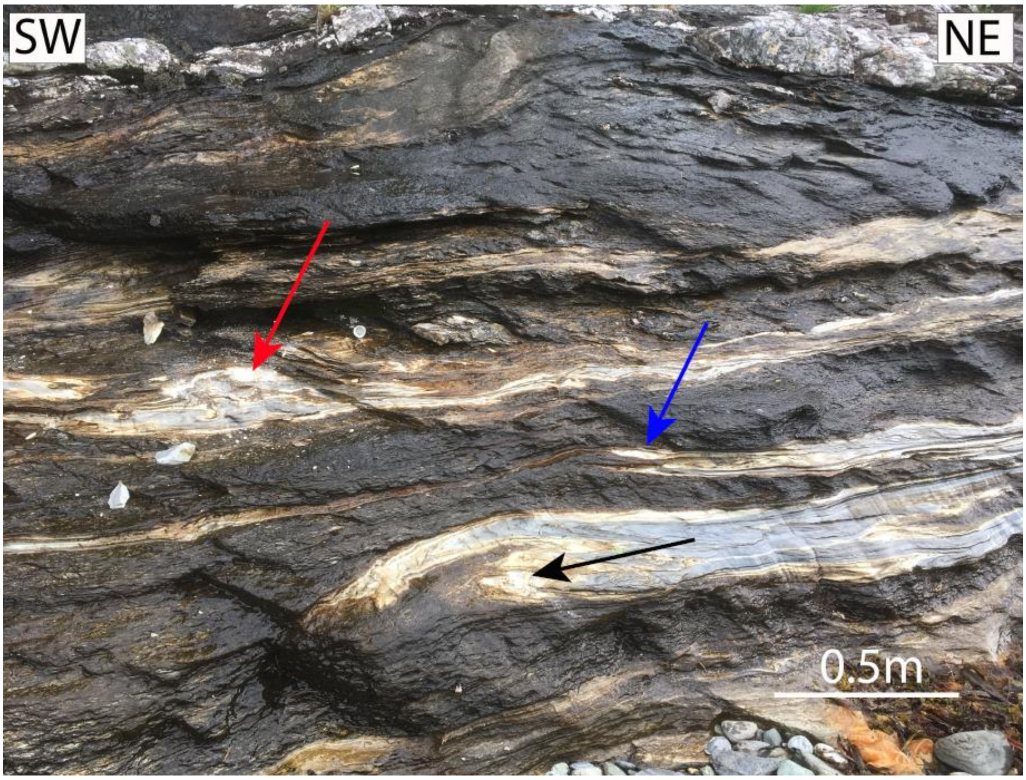

Figure 5.38: The sampled area for the limestones at Limbunes. The blue arrow points to the sampled 17Ølv-8. Black arrow indicated 17Ølv-9, and the red points at the sampled layer for 17Ølv-10. 16Ølv-15 were sampled approximately 10 meter south-west of this picture, at the base of the unit.

Huglo and Skorpo:

At the islands of Huglo and Skorpo the limestone sequence lies directly on a massive unit of rhyolite. The limestones are here up to 100 m thick and it is overlain by phyllites with layers of black shale. Samples of limestones were taken from two different locations (Fig. 5.37). Four samples were collected from the north-western part of Huglo (Fig. 5.39). The samples were selected from different areas within the outcrop. One sample were collected on the north-eastern part of Skorpo (Fig. 5.40), taken just above the rhyolite.

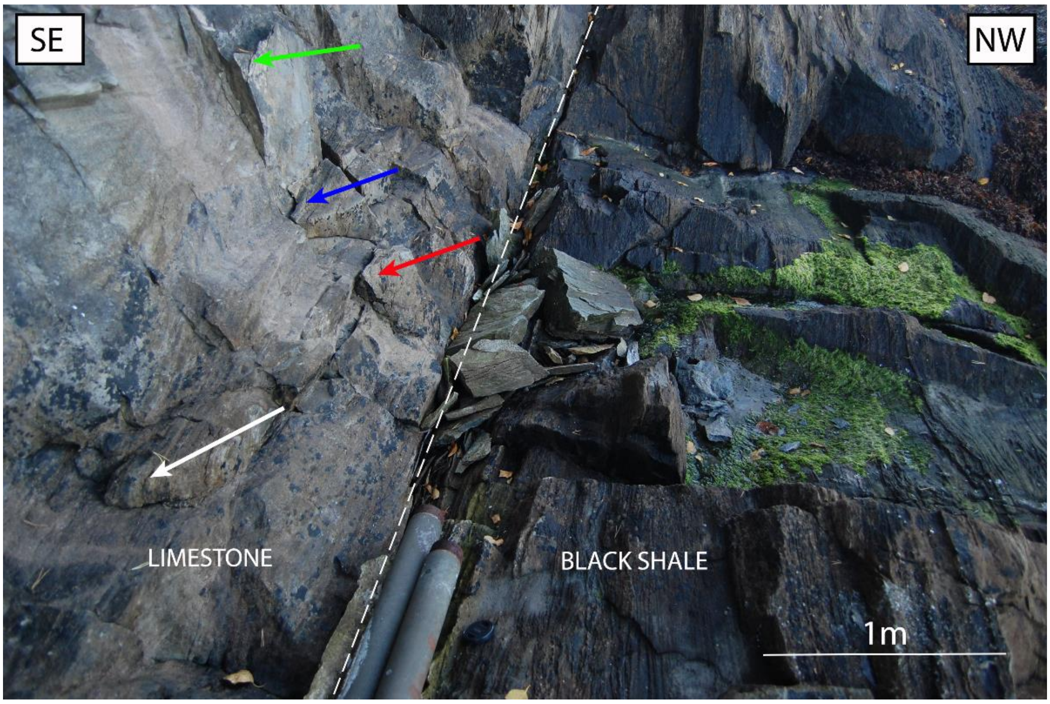

Figure 5.39: The picture shows the sampled location on Huglo, where the limestone is in contact with a layer of black shale. The white arrow points to the 16Hug-2 sample. The coloured arrows point to the other samples, respectively 17Hug-1 (green), 17Hug-2 (blue) and 17Hug-3 (red).

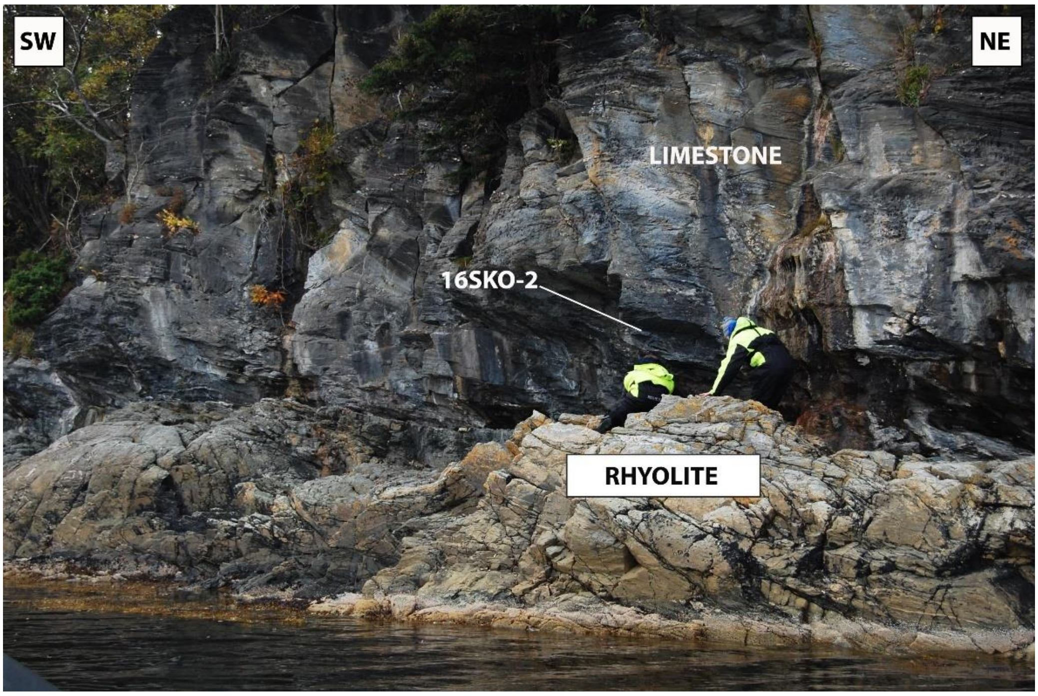

Figure 5.40: Picture showing the sampled area on Skorpo. The sample was collected from the limestone unit just above the rhyolite. People wearing coveralls for scale.

Sr-isotopic data

The results from the Sr isotopic analyses of the limestones are reported in Table 5.3, where both the data from the acetic acid and the nitric acid leaching steps are given. Concentrations for both rubidium and strontium are reported for all the samples as well. The Sr-ratios from the HNO_3 acid are slightly lower in all the samples. Marine $^{87}Sr/^{86}Sr$ changes through time, and the isotopic record can be used for dating and correlation of marine sediments. McArthur et al. (2001) compiled $^{87}Sr/^{86}Sr$ data and constructed a curve with a given numerical age (from 0 to 509 Ma) corresponding to a certain $^{87}Sr/^{86}Sr$ ratio. By comparing the ratios from the different samples to the given ratios in the seawater curve, it is possible to determine the age of the deposition (Smalley et al., 1994). However, as the seawater Sr-isotopic value has been fluctuating up and down through time, a given value may have several ages solutions. It is therefore imperative to know the approximate time of deposition.

The seawater Sr-isotope curve for the Cambro-Silurian reaches a maximum $^{87}Sr/^{86}Sr$ value of 0.7094 at around 500 Ma. From there on the $^{87}Sr/^{86}Sr$ ratio decreases steadily through the Ordovician to a minimum of 0.7078 at 440 Ma. From thereon it increases through most of the Silurian and reaches a maximum value of 0.7088 at 410 Ma. Since the $^{87}Sr/^{86}Sr$ value has a minimum at 440 Ma (close to the transition from the Ordovician to the Silurian periods), Sr-isotope dating of marine carbonates formed between around 463 and 410 Ma give two possible ages - one Ordovician and one Silurian. Within this time interval a single age solution can only be obtained if additional geological information can be used to constrain if the carbonates formed in the Ordovician or in the Silurian. In Table 5.3 both these ages are reported. A few of the samples yielded values far above the ones reported from McArthur et al. (2001), and no ages are therefore given.

Table 5.3: The table shows the obtained Sr-data from the limestone samples. Values from both leaching steps are reported, with generally lower values for the analyzed HNO_3 acid. The reported ages are retrieved from McArthur et al. (2001). Concentrations for Rb and Sr, in ppm, are reported for each sample as well.

Locality	Sample	Acid	87/86Sr	2S error	Lower age (Ma)	Upper age (Ma)	Rb (ppm)	Sr (ppm)
Huglo	16Hug-2	1% acetic acid	0.708180	0.000009	429.0	454.8	10.99	297.5
	17Hug-1	1% acetic acid	0.708190	0.000009	428.7	454.9	5.62	231.8
	17Hug-2A	1% acetic acid	0.708243	0.000010	427.5	455.7	11.65	267.0
	17Hug-2B	1% acetic acid	0.708205	0.000010	428.4	455.1		
	17Hug-3	1% acetic acid	0.708077	0.000009	431.4	452.8	14.73	293.1
Skorpo	16Sko-2	1% acetic acid	0.708417	0.000009	422.5	458.2	9.67	426.7
Ulvanes	17Ølv-7	1% acetic acid	0.707971	0.000009	434.1	450.0	0.04	563.5
Limbunes	16Ølv-16	1% acetic acid	0.709636	0.000009	-	-	11.03	418.1
	17Ølv-8	1% acetic acid	0.709093	0.000012	-	493.0	46.38	138.7
	17Ølv-9	1% acetic acid	0.708605	0.000009	417.9	460.8	13.28	448.5
	17Ølv-10	1% acetic acid	0.709837	0.000009	-	-	35.86	142.6
Huglo	16Hug-2	3N HNO3	0.708094	0.000007	431.0	453.1	10.99	297.5
	17Hug-1	3N HNO3	0.708124	0.000008	430.2	453.7	5.62	231.8
	17Hug-2A	3N HNO3	0.708207	0.000008	428.4	455.2	11.65	267.0
	17Hug-2B	3N HNO3	0.708111	0.000009	430.6	453.4		
	17Hug-3	3N HNO3	0.707967	0.000009	434.3	449.9	14.73	293.1
Skorpo	16Sko-2	3N HNO3	0.708310	0.000009	425.6	456.7	9.67	426.7
Ulvanes	17Ølv-7	3N HNO3	0.707881	0.000007	437.7	444.7	0.04	563.5
Limbunes	16Ølv-16	3N HNO3	0.709551	0.000008	-	-	11.03	418.1
	17Ølv-8	3N HNO3	0.708578	0.000008	418.6	460.4	46.38	138.7
	17Ølv-9	3N HNO3	0.708538	0.000008	419.6	459.8	13.28	448.5
	17Ølv-10	3N HNO3	0.709591	0.000008	-	-	35.86	142.6

Chapter 6: Discussion

6.1 Geochemistry of volcanic rocks from the Varaldsøy-Ølve Complex

Basaltic lavas

Basaltic lavas are exposed as greenstones on several locations in the Ølve/Varaldsøy area and constitutes the lowermost part of the Varaldsøy-Ølve Complex. The REE pattern for the basaltic pillow breccia collected from Gravdal in the Ølve area has been compared to known REE values for N-MORB in Fig. 6.1A. Both the pillow breccia and the N-MORB signature show a clear depletion in the LREE compared to the HREE. This indicates that the pillow breccia originated from a depleted MORB-like source. The pillow breccia shows generally slightly lower values for all the REE compared to the N-MORB signature. The REE values of both greenstone samples from Lyrehola at Varaldsøy are compared to known values for E-MORB in Fig. 6.1B. Both samples show similar patterns as the E-MORB signature with slightly higher values for the LREE relative to the HREE, indicating a more enriched source. The overall trace element pattern (Fig. 6.3) for the basaltic lavas exhibit subduction related signatures. Clear positive anomalies for Th, U and Pb are present together with negative anomalies for Ta and Nb.

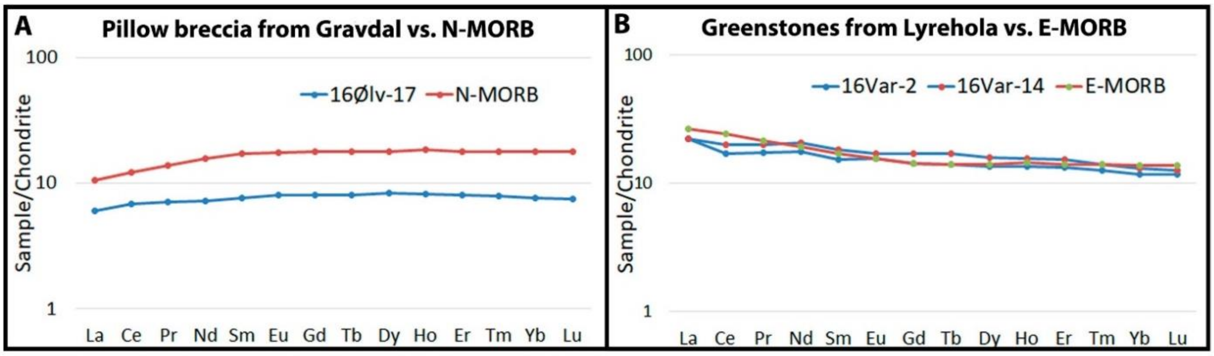

Figure 6.1: A) Chondrite normalized REE pattern for the basaltic pillow breccia from Gravdal compared to values for N-MORB from Sun and McDonough (1989). **B)** Chondrite normalized REE pattern for greenstones from Lyrehola compared to known values for E-MORB from Sun and McDonough (1989).

Layered volcanogenic sequence

The layered volcanogenic sedimentary sequence is seen on Steinaneset in the Ølve area and at Haukanes on Varaldsøy. This sequence represents the upper part of the Varaldsøy-Ølve Complex and rests on top of the basaltic lavas. The sequence indicates bimodal volcanic eruption as the rhyolitic layers occur in between more basaltic units.

Samples of the basaltic layers show flat MORB-like REE patterns in Fig. 6.2, with values from 10-20 times chondrite. The heavily altered Layer-10 from Haukanes differs from the other basaltic samples, with generally lower values for all the REE and a positive Eu anomaly. The basaltic sample from Steinaneset shows an enrichment in the LREE compared to the HREE, and lower values for all the REE compared to the Haukanes samples. The extended spider diagram in Fig. 6.3 reveals that the basaltic samples exhibit a typical subduction influence with positive Th, U and Pb anomalies and negative anomalies for Ta and Nb. These layered volcanogenic samples contain generally higher trace element concentrations than the underlying basaltic lavas.

Samples from the rhyolitic layers are characterized by flat MORB-like REE patterns (Fig. 6.2). A weak enrichment is seen in the lightest of the REE and a clear Eu anomaly is present in all the samples, indicating plagioclase fractionation. The REE pattern for the layered volcanogenic rocks of the Varaldsøy-Ølve Complex has been compared to a plagiogranite from the Geitung Unit on Bømlo. The plagiogranite shows a flat pattern for the HREE, with a slight enrichment in LREE compared to the samples from Ølve and Varaldsøy. A negative Eu anomaly is present. Pedersen and Malpas (1984) suggested that the plagiogranite originates from an immature and depleted source. The close similarities with the rhyolitic layers from the Varaldsøy-Ølve Complex indicate a formation in a similar environment.

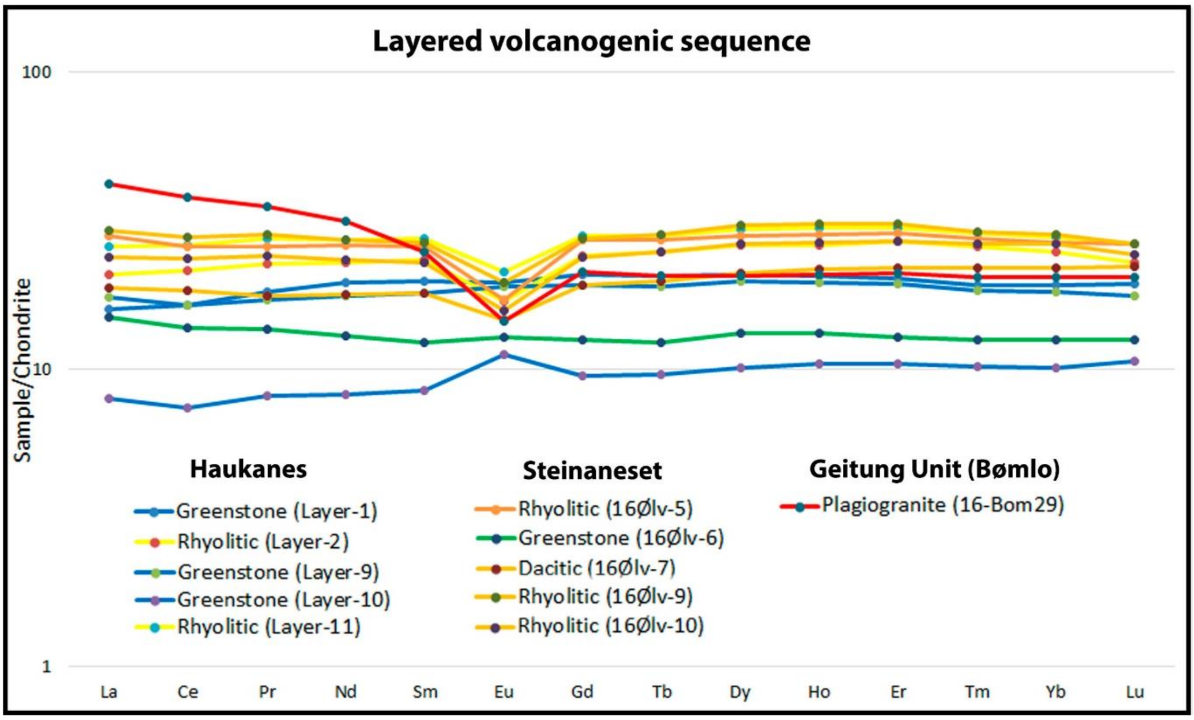

Figure 6.2: REE patterns for the layered volcanogenic sequence from the Varaldsøy-Ølve Complex compared to a plagiogranite from the Geitung Unit on Bømlo (16-Bom29). Data from Geitung Unit from Viken (2017).

The extended spider diagram (Fig. 6.3) shows that samples exhibit clear positive anomalies for Th, U and Pb and negative anomalies for Ta and Nb. This is a typical trace element pattern of immature island arc tholeiitic (IAT) volcanics (Brekke et al., 1984; Pedersen and Dunning, 1997).

Basaltic lavas and layered volcanogenic rocks from the Varaldsøy-Ølve Complex are compared to pillow lavas from the Geitung Unit on Bømlo and the Visnes Unit on Karmøy in Fig. 6.3. Both of these units are interpreted to represent fragments of an ophiolite complex formed in a spreading centre located above a subduction zone (Pedersen and Dunning, 1997). Pearce et al. (1984) termed such complexes supra-subduction zone (SSZ) ophiolites. Such complexes hold the geochemical characteristics of an island arc and the structure of an oceanic crust (Pearce et al., 1984). Typical trace element patterns for such complexes show an enrichment of Sr, K, Rb, Ba, Th ± Ce ± Sm and lack of enrichment in others, such as Ta, Nb, Hf, Zr, Ti, Y and Yb (Pearce et al., 1984). The samples from the Varaldsøy-Ølve Complex show similar trace element patterns which suggest a formation in a similar environment.

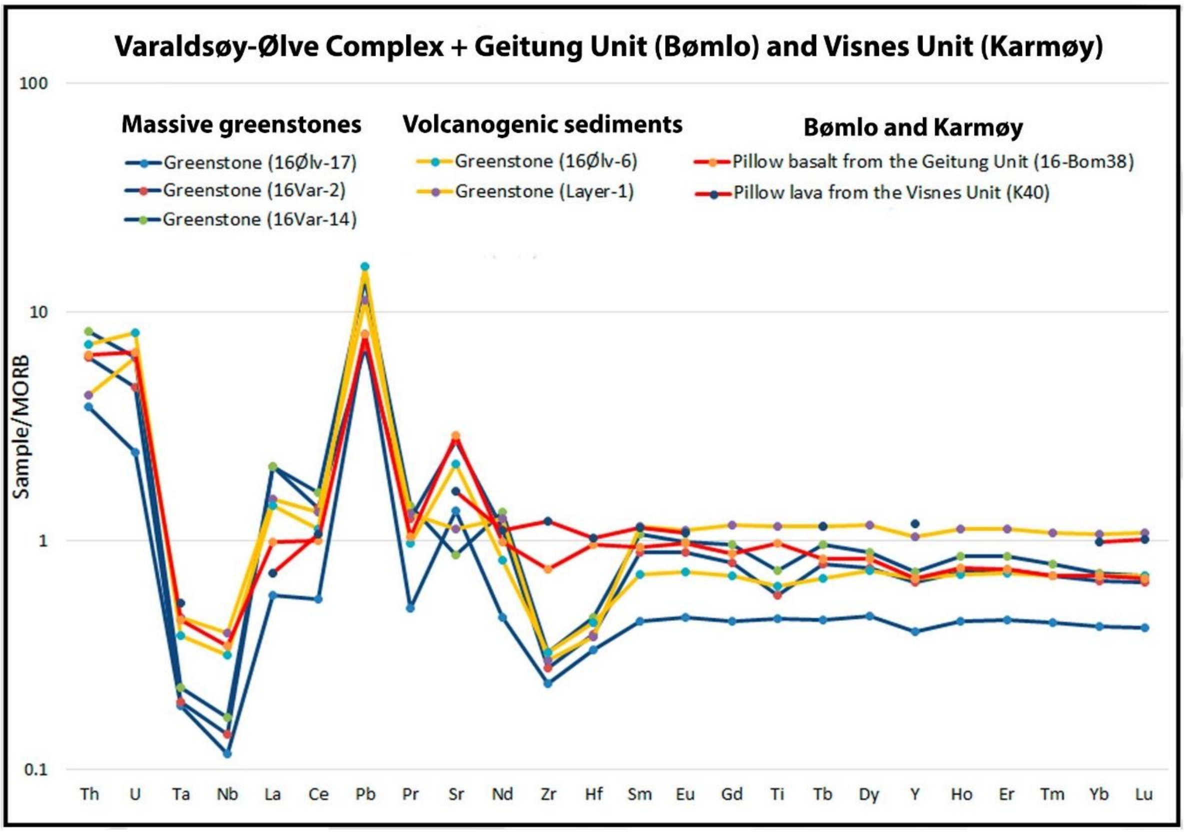

Figure 6.3: Trace element patterns for five representative greenstones and layered volcanogenic samples from each main locality on Ølve and Varaldsøy. Massive greenstone from Gravdal (16Ølv-16) and from Lyrehola (16Var-2 and 16Var-14) are compared with layered volcanogenic rocks from Steinaneset (16Ølv-6) and from Haukanes (Layer-1). These samples are compared with one sample of pillow basalt from the Geitung Unit on Bømlo (16-Bom38) and one from the Visnes Unit on Karmøy (K40). Data from Bømlo from Viken (2017) and Karmøy from Furnes et al. (1980).

Rhyolites from Huglo and Skorpo

On top of the basaltic lavas and the layered volcanogenic sequence of the Varaldsøy-Ølve Complex rest a unit of rhyolite, exposed on Huglo and Skorpo. This sequence was classified as "quartz-keratophyres" by Færseth (1982). The rhyolites show an enrichment in the LREE relative to the HREE. A negative Eu anomaly is present. These samples have been compared with two rhyolites from the Siggjo Complex on Bømlo in Fig. 6.4. The volcanics from Siggjo show an enrichment in the LREE, with concentrations up to 200 times chondrite, and a clear negative Eu. A depletion in the HREE relative to the LREE is present. The Siggjo Complex contain generally higher values for all the REE than the analyzed samples from Huglo and Skorpo. Brekke et al. (1984) suggested that the Siggjo Complex represent a mature island arc. The similarities with the rhyolites on Huglo and Skorpo suggest that these formed in a similar environment.

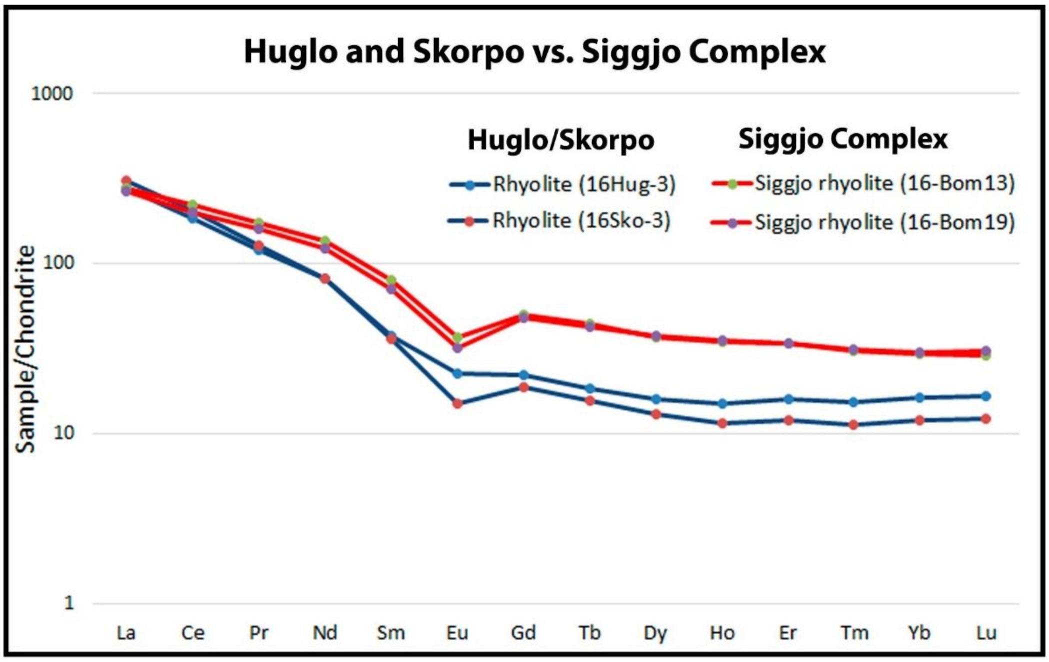

Figure 6.4: REE pattern for rhyolites from Huglo and Skorpo compared to rhyolites from the Siggjo Complex on Bømlo. Data from the Siggjo Complex from Viken (2017).

Acid volcaniclastic rocks on Varaldsøy

On top of the greenstones and layered volcanogenic sequence of the Varaldsøy-Ølve Complex rest a unit of acid volcaniclastics. This unit is exposed on the southern part of Varaldsøy (Hestvika) and was mapped as “quartz-keratophyres” by Foslie (1955).

The trace element patterns of the volcaniclastics rocks have been compared with rhyolites from Huglo, Skorpo and Siggjo as well as acid volcanogenic rocks from the lower part of the Varaldsøy-Ølve Complex (Fig. 6.5). The volcaniclastics from Hestvika show the same major trends for all the trace elements as the rhyolites from Huglo and Skorpo. A high Th/Ta ratio, positive Pb anomaly and negative anomalies for Sr and Ti are present. The volcaniclastics show generally lower values, especially in terms of the least incompatible elements compared to the Siggjo Complex.

The volcaniclastics from Hestvika show clear differences from the rhyolitic rocks in the underlying layered volcanogenic sequence. A very high Th/Ta ratio is present in the layered sequence, indicating subduction influence (Pearce et al., 1984). The rhyolitic layers show significantly lower values for the most incompatible elements and generally higher values for the least incompatible elements compared to the Hestvika and the Huglo/Skorpo samples. These differences suggest a development from an immature island arc to a mature island arc.

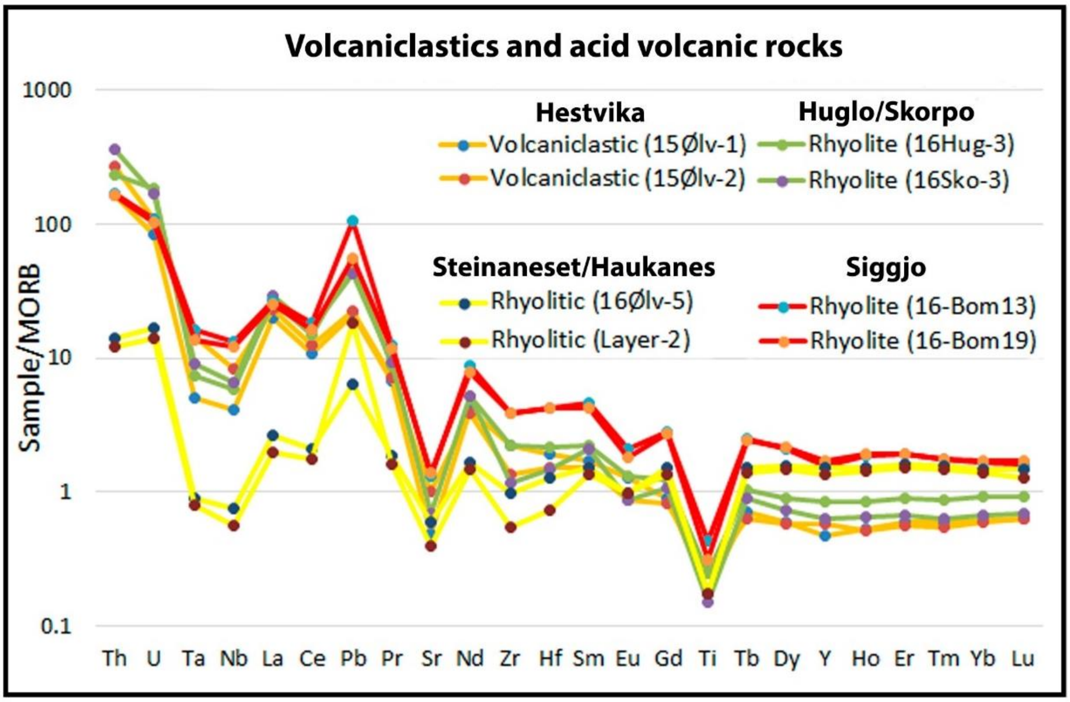

Figure 6.5: Spider diagram for the volcaniclastics (Hestvika) and acid volcanic rocks (Huglo and Skorpo) compared with rhyolitic volcanogenic rocks from the Varaldsøy-Ølve Complex (Steinaneset and Haukanes) and rhyolites from Siggjo. Data from the Siggjo Complex from Viken (2017).

6.2 Geochronology

U-Pb dating of volcanic rocks

The two rhyolite samples collected from Huglo and Skorpo have been dated by U-Pb zircon geochronology. The zircon analyses that are less than 1% discordant give mean ages of 473±3 Ma and 474±2 Ma for the Huglo and the Skorpo samples, respectively (Fig. 6.6). No older zircon populations are present in any of the sample. The obtained ages are similar to the Siggjo and Kattnakken Volcanics that have been dated to 473±2 Ma and 476±4 Ma, respectively (Pedersen and Dunning, 1997).

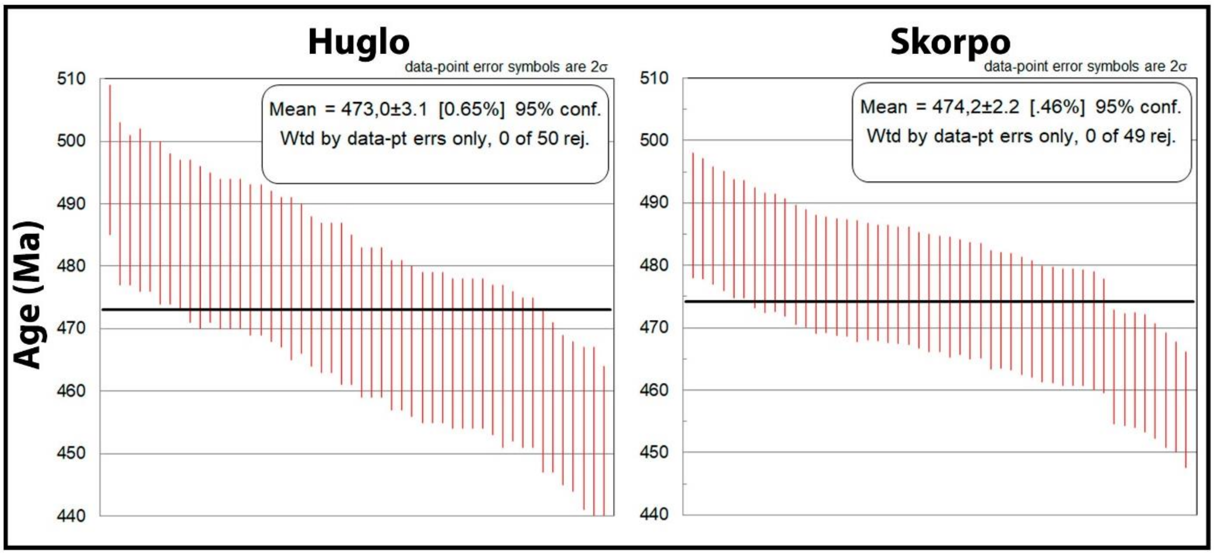

Figure 6.6: Mean ages obtained for both rhyolites from Huglo and Skorpo. The Huglo sample revealed a mean age of 473±3 Ma and 474±2 Ma for the Skorpo sample.

Provenance of sedimentary rocks

The sample from Hestvika on Varaldsøy is classified as a volcaniclastic sample. It is located above the basaltic lavas and the layered volcanogenic sequence, and is intercalating with the overlying limestones. The rock unit was classified as “quartz-keratophyre” by Foslie (1955). The analyzed sample shows one major zircon population with single zircon ages ranging from 420 Ma to 520 Ma (Fig. 6.7A). The weighted average plot of the most concordant grains in the population (analyses less than 1% discordant) revealed a mean age of 474±2 Ma (Fig. 6.7B). This mean age is similar to the acid volcanic sequences in the Hardangerfjord area (Huglo, Skorpo, Siggjo and Kattnakken). In addition to the Ordovician zircon population, one Precambrian grain with an age of 976 Ma was analyzed (Fig. 6.7A). The U-Pb results are consistent with the conclusion that this rock sequence has a volcaniclastic origin, as suggested by field observations, petrography and geochemistry.

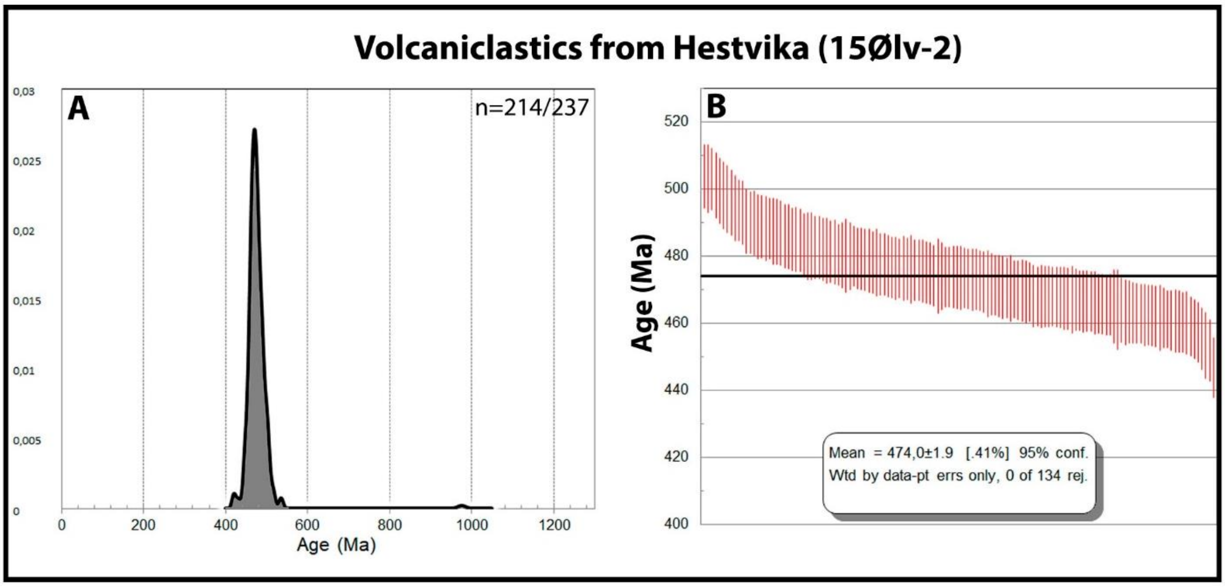

Figure 6.7: A) Probability density plot for the dated volcaniclastic sample from Hestvika (15Ølv-2). A major age population is seen at around 475 Ma. Only one older grain is present in the sample, with an age of 976 Ma. **B)** Weighted average plot for the most concordant grains in the population revealing a mean age of 474±2 Ma.

The other four sedimentary samples represent a coherent rock unit on the northern side of the Varaldsøy-Ølve Complex. The rock unit was classified as albite-quartzite and suggested to represent the similar stratigraphic level as the volcaniclastics in the Hestvika area on Varaldsøy (Foslie, 1955). These samples display polymodal age distributions, indicating several sediment sources (Fig. 6.8). The samples are dominated by a prominent peak of Meso/Neoproterozoic age of 1000 Ma. However, a minor assemblage is seen at around 1500 Ma, whereas this peak is more dominant in the metasandstone from Nordøya near Ølve (15Ølv-7). Only a few grains in each sample are older than 2500 Ma, indicating a minor influence of an Archean source in all the samples.

The metasandstones from Nordøya show a widespread range of ages with three major populations at 500 Ma, 1000 Ma and 1500 Ma. A few Archean grains are present. The Paleozoic peaks are seen at 475 Ma and 493 Ma, suggesting a source from the underlying island arc and ophiolite, respectively. The prismatic zircons extracted from the metasandstone from Nordøya (15Ølv-7 Prismatic) are dominated by Paleozoic ages compared to the other samples. This is because the grains have been picked selectively based on their prismatic shape, suggesting short sediment transport. The Paleozoic peaks are seen at 482 Ma and 496 Ma for the prismatic grains. This indicates that the source of detritus may be the underlying ophiolite and immature island arc, that have been dated to 494 Ma and 485 Ma by Pedersen and Dunning (1997).

The quartzite samples from Nordøya (15Ølv-4) and Flugedalen on Varaldsøy (15Ølv-3) are almost identical in terms of ages, with a major population around 1000 Ma. A small population is seen around 1500 Ma and a few Archean grains are present in both samples. No Paleozoic ages are reported in the sample from Flugedalen. Several discordant ages are seen in Fig. 6.9, with a lower intercept at Paleozoic ages. This indicates that both core and younger rim may have been analyzed, resulting in mixed ages. A few grains of Paleozoic age are present in the quartzite from Nordøya (15Ølv-4).

This polymodal age distribution of mainly Precambrian ages clearly show detritus of the underlying ophiolite and island arc sequences, as well as a continental source.

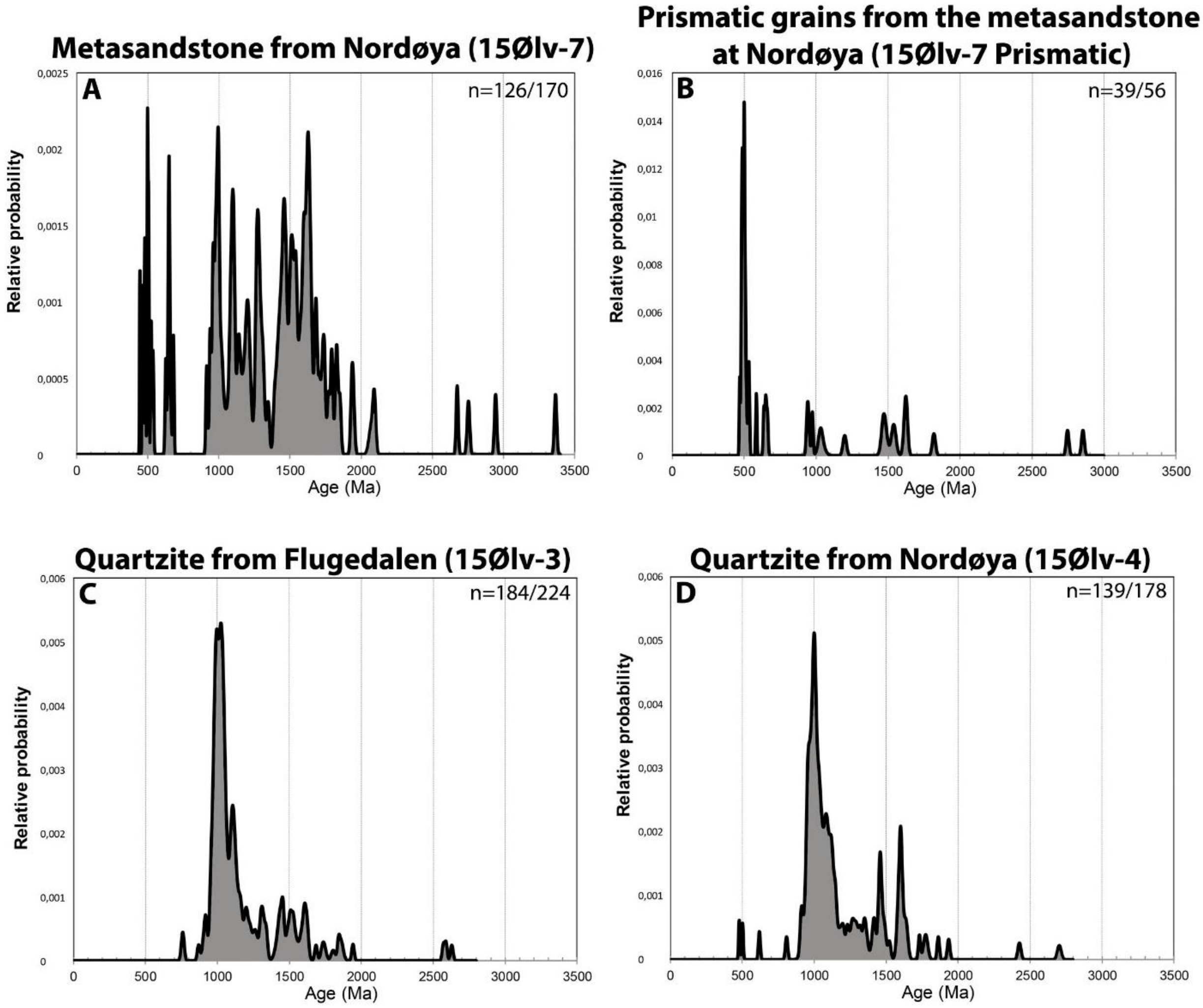

Figure 6.8: Probability density plots showing polymodal age distribution for the different quartzite and metasandstone samples from Flugedalen and Nordøya.

Similarities with the sediments from the Vikafjord Group on Bømlo

The quartzites and metasandstones from the Mundheim Group contain discordant zircon populations (Fig. 6.9). These discordant ages seem to follow two different discordancy trends. One population shows Ordovician lower intercept ages and upper intercepts of Proterozoic and Archean ages. The other yields lower intercepts at Meso-/Neoproterozoic ages around 1000 Ma and upper intercepts of old Archean ages (close to 4000 Ma).

The discordant zircon populations from the sedimentary rocks of the Mundheim Group have been compared against two sandstone samples from the Vikafjord Group on Bømlo (Viken, 2017) (Fig. 6.9E&F). The Vikafjord Group show discordant zircon populations that also have Ordovician lower intercept ages and Proterozoic and Archean upper intercept ages. As for the Mundheim Group, the distinct Ordovician zircon population yield an average age of around 475 Ma. For both groups these zircon populations are most likely derived from the ophiolitic basement, which contain volcanic, granitic and migmatitic rock complexes of this age (i.e. the andesitic to rhyolitic volcanic sequences present on Siggjo/Kattnakken/Huglo; S-type granites of the West Karmøy Igneous Complex; Bremnes Migmatite Complex; Vardafjell Gabbro). Viken (2017) suggested that these discordant trends represent partly resetting, or directly overgrowth of the grains due to subduction of continental margin sediments below the island arc complex, and that the Bremnes Migmatite Complex and/or the S-type granites of the West Karmøy Igneous Complex are a potential source of these zircons.

The Archean populations are more prominent in the Vikafjord samples than in the samples from the Mundheim Group. The samples from the Vikafjord Group contain very old zircon population with ages reaching up to 3983±83 Ma (Fig. 6.9E). Such Paleo- and Eoarchean zircon ages have also been obtained from the Bremnes Migmatite (R.B. Pedersen, pers. comm., 2017) Some of the discordant zircons from the Mundheim Group seem to project towards similarly old ages (Fig. 6.9). Due to the very old ages and the high amount of Archean grains in the samples from Vikafjord, Viken (2017) argues that these sandstones represent sediments with a Laurentian source.

Based on the above similarities in U-Pb zircon systematics and stratigraphic considerations (see chapter 6.3) it seems reasonable to correlate the Mundheim Group with the Vikafjord Group.

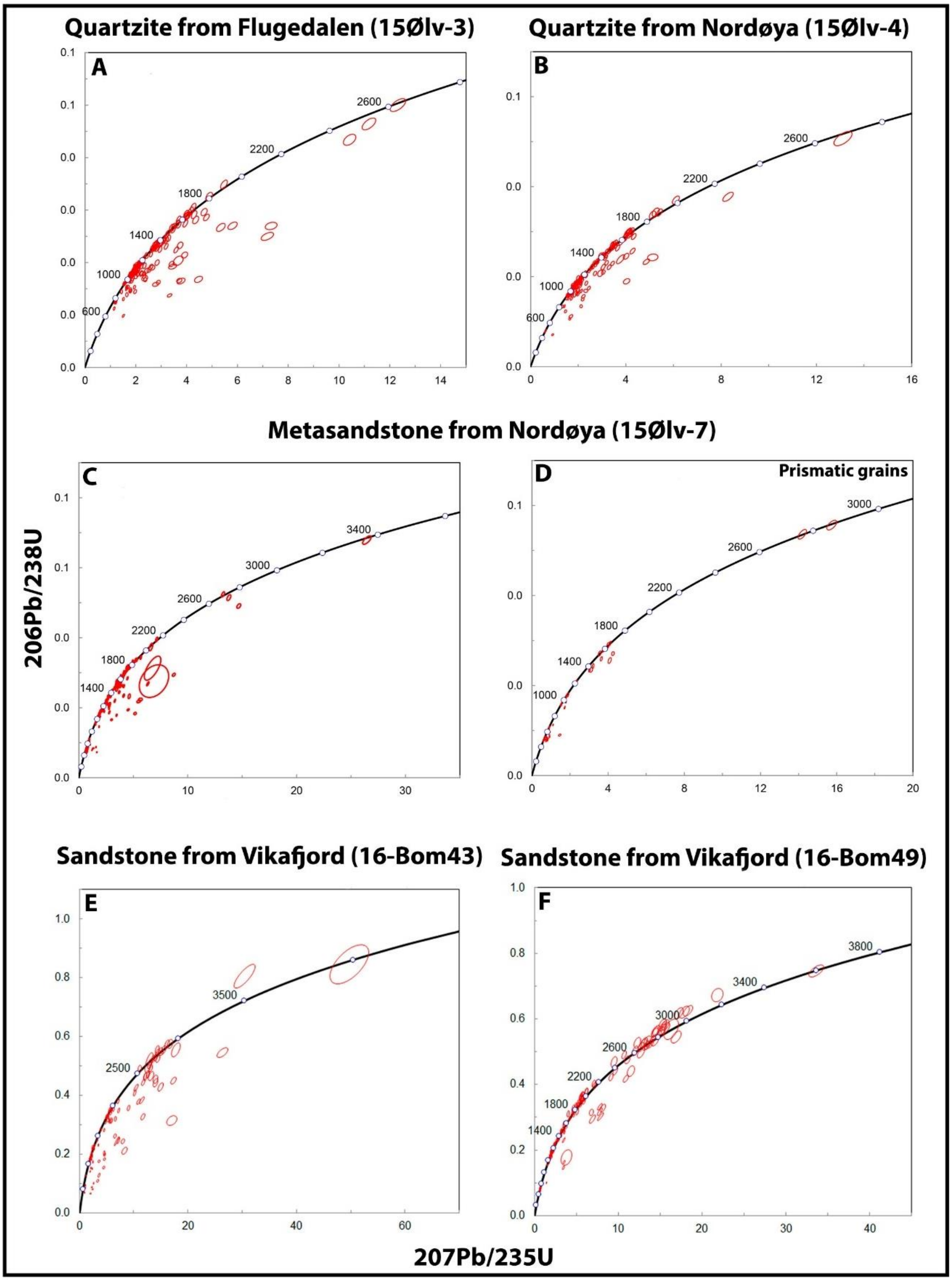

Figure 6.9: Concordia diagrams for the zircon grains from the quartzites (Flugedalen and Nordøya) (A&B) and the metasandstones (Nordøya) (C&D). Only grains with common lead contamination have been removed. Concordia diagrams for two sandstones from the Vikafjord Group on Bømlo shown for comparison (E&F). Data from the Vikafjord Group from Viken (2017).

Sr-isotopic ages of the overlying limestones

Two separate units of limestone are present in the Hardangerfjord area. The upper one is the Ashgillian limestone of the Limbuvik Formation at the base of the Dyvikvågen Group (Færseth, 1982). This is similar to the Silurian limestone unit overlying the Gullfjellet Ophiolite Complex (Thon, 1985b, and references therein). The lower limestone unit defines the Haukanes Formation, of yet unknown age. On Huglo, a thick pile of this limestone rests unconformably on top of the rhyolites from the Huglo Formation, that here has been dated to 473 Ma. In the Varaldsøy/Ølve area this limestone constitutes the lower part of the Mundheim Group. It conformably overlay and intercalates with the quartzites and metasandstones that were analyzed for zircon provenance in this study (see previous sections).

As this unit of limestone occurs stratigraphically below the lower Silurian (Ashgillian) Limbuvik Formation, and since it rests on volcanic rocks now dated to 473 Ma, the limestones of the Haukanes Formation must be of Ordovician age. Based on this overall age constraint, the $^{87}Sr/^{86}Sr$ ratios of these limestones point towards a Late Ordovician deposition age of 445 Ma to 460 Ma (Fig. 6.10).

The samples contain Rb of different concentrations, varying from 0.04-46.38 ppm (Table 5.3). The lowest age of 445 Ma (for the 17Ølv-7 sample) is obtained from the sample with the lowest Rb concentration (0.04 ppm), and this is consistent with petrographic observation showing that this is a very pure limestone. As ^{87}Rb breaks down to ^{87}Sr by radioactive decay over time, the presence of rubidium in the sample would lead to a higher strontium isotopic ratio (Veizer, 1989). The higher ages of the more impure limestone samples that were analysed in this study may therefore be related to breakdown of Rb present in clay or in other Rb-rich silicate minerals present in the samples. Sr may be mobilized by hydrothermal processes, as circulating water has the ability to exchange elements with the surrounding rocks leading to disturbance of the isotopic ratios (Hart et al., 1974). Other processes such as dolomitization and metamorphism may also lead to alteration of the isotopic composition in the limestones (Jacobsen and Kaufman, 1999). The Sr-isotopic ages of metamorphic limestones should therefore be treated with caution.

A calculation of the maximum effect that the decay of Rb may have had on the $^{87}Sr/^{86}Sr$ ratios shows that a Rb concentration of 0.04 ppm, as seen in the most pure limestone sample (17Ølv-7), only will have an insignificant effect on the Sr isotopic ratio, and on the derived age. For the samples with a Rb concentration of around 10 ppm, radioactive decay of ^{87}Rb to ^{87}Sr could potentially increase the age by 10 Ma. Assuming that there has been insignificant Sr-exchange with the surrounding rocks, it is concluded that the 445 Ma age obtained from the sample with the lowest Rb concentration is the most reliable age estimate for the limestones of the Haukanes Formation and for the lower part of the Mundheim Group.

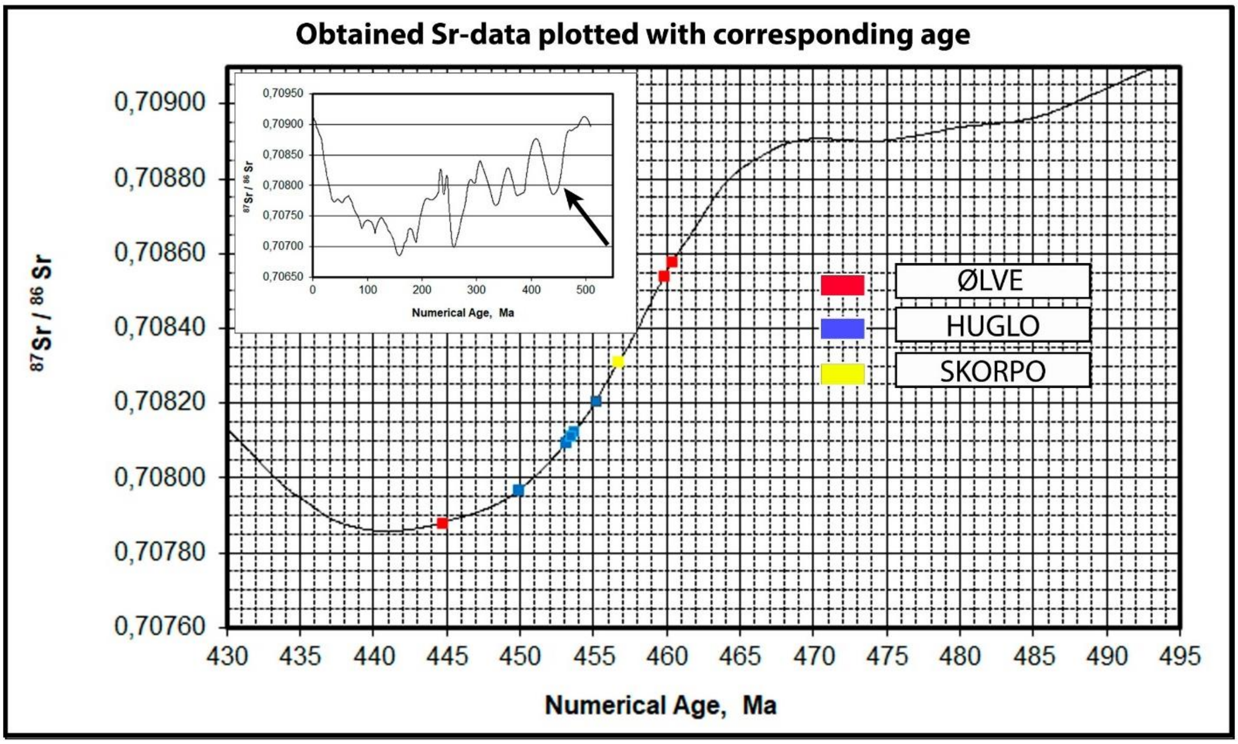

Figure 6.10: Sr seawater-curve modified from McArthur et al. (2001). Data retrieved from the HNO_3 acid are shown for all the samples. The picture in the upper left corner illustrates the Sr seawater-curve from 0-509 Ma. The main picture is zoomed in on the Ordovician, as all the samples are located within this time interval. The samples from Ølve correspond to the lowest age of 445 Ma and two with higher ages around 460 Ma (red dots). The Huglo samples are all concentrated from 450-455 Ma (blue dots). The one sample from Skorpo suggest a deposition age of 457 Ma (yellow dot).

6.3 Stratigraphic relationships in the outer Hardangerfjord area

The following part aims to clarify the stratigraphy in the outer Hardangerfjord area based on the obtained data from this study.

The stratigraphy of the Hardangerfjord area is described by Færseth (1982), who suggested a stratigraphy containing three major units; the Hardangerfjorden Group, the Sunnhordland Igneous Complex and the Dyvikvågen Group. Each of these major groups are further subdivided into several formations (Fig. 6.11A). The Hardangerfjorden Group comprise the oldest rocks in the area (Færseth, 1982). It is made up by the Ølve-Varaldsøy greenstone, that is overlain by the rhyolites of the Huglo Formation. The Haukanes Formation comprises limestones that are deposited on top of the rhyolites of the Huglo Formation. These limestones are again overlain by the pelites of the Ådland Formation and the psammite and semi-pelites from the Agdestein Formation. The uppermost unit within the Hardangerfjorden Group is, according to Færseth (1982), the Sagvågen Formation that consists of a mixture of sediments and basic volcanics. Andersen and Andresen (1994) divided the Hardangerfjorden Group into two main units; the Varaldsøy-Ølve Complex (VØC) and the Mundheim Group (6.11B).

Færseth (1982) concluded that the arc type volcanics of the Siggjo and Kattnakken sequences are placed on top of the Hardangerfjorden Group stratigraphically. These volcanic rocks have later been dated to 473±2 Ma and 476±4 Ma (Pedersen and Dunning, 1997). The findings from this study suggest also that the stratigraphy for the outer Hardangerfjord area needs revision as with regards to the relations between the Varaldsøy-Ølve Complex (VØC), the Huglo Formation and the Mundheim Group.

A revised stratigraphy that is based on the new data from this study is shown in Fig. 6.11C. The Varaldsøy-Ølve Complex (VØC) clearly represents the lowest unit in the area. This complex includes greenstones and volcanogenic sediments of basaltic to rhyolitic compositions. The analyzed samples reveal trace element patterns typical of that found in modern island arc volcanics. The geochemistry of these rocks is similar to the oldest parts of the ophiolite complexes on Bømlo and Karmøy that formed around 490 Ma.

On top of the Varaldsøy-Ølve Complex rests the rhyolitic rocks of the Huglo Formation that in this study have been dated to 473 Ma. The close similarities with the volcanic rocks present on Siggjo and Kattnakken, in terms of geochemical signature and absolute ages, suggest that these units can be correlated. On Bømlo, a 20 Ma gap has been documented between the immature island arc volcanics of the Geitung Unit and the mature island arc volcanics of the Siggjo Complex (Pedersen and Dunning, 1997). A similar history in terms of age and affinity seems to exist between the Varaldsøy-Ølve Complex and the Huglo Formation.

Above the rhyolites of the Huglo Formation occurs a layer of basal conglomerate with pebbles of the underlying rhyolites, indicating uplift and erosion (Ragnhildstveit and Helliksen, 1997). Above this, rests the limestones the Haukanes Formation. The Sr isotopic compositions obtained from these limestones as part of this study, indicate a Late Ordovician deposition age of around 445-460 Ma.

This limestone unit can be followed from Huglo to the Ølve-Varaldsøy area, where it forms a distinct horizon that has been mapped on both the northern and the southern side of the

Varaldsøy-Ølve Complex (Fig. 2.6). Below, and interlayered with these limestones, are sandstones, quartzites and more massive beds classified as "quartz-keratophyres" by Foslie (1955). The latter seems also to represent sedimentary rocks, but to be dominated by detritus derived from a volcanic source with similar age and affinity as the rhyolites of the Huglo Formation. On the northern side of the Varaldsøy-Ølve Complex, this stratigraphic level rests on a greenstone conglomerate that occurs on top of the greenstones of the Varaldsøy-Ølve Complex (Foslie, 1955). Also in this area, there is therefore field evidence for a hiatus below the limestones of the Haukanes Formation.

It is therefore solid evidence that the Mundheim Group was deposited uncomfortably on a basement that incorporated the greenstones of the Varaldsøy-Ølve Complex as well as the rhyolites of the Huglo Formation, here dated to 473 Ma. The Mundheim Group shares therefore the same overall stratigraphic position as the Vikafjord Group on Bømlo, which also lay unconformably on 473 Ma old rhyolitic rocks (i.e. the Siggjo Complex). This correlation is further supported by the two groups also having comparable U-Pb zircon systematics.

The upper part of the Mundheim Group is composed of phyllites (Ådland Formation), greywackes, black shales and metasandstone (Agdestein Formation), suggesting a gradual deepening of this Late Ordovician basin. The stratigraphy of the outer Hardangerfjord area ends with the Grånut Formation that comprise quartzite conglomerate, quartzites and mica-rich phyllites that were deposited unconformably on the Mundheim Group (Andersen and Andresen, 1994) (Fig. 6.11). This group, which has not been investigated as part of this study, is correlated with the Dyvikvågen Group on Stord (Andersen and Andresen, 1994).

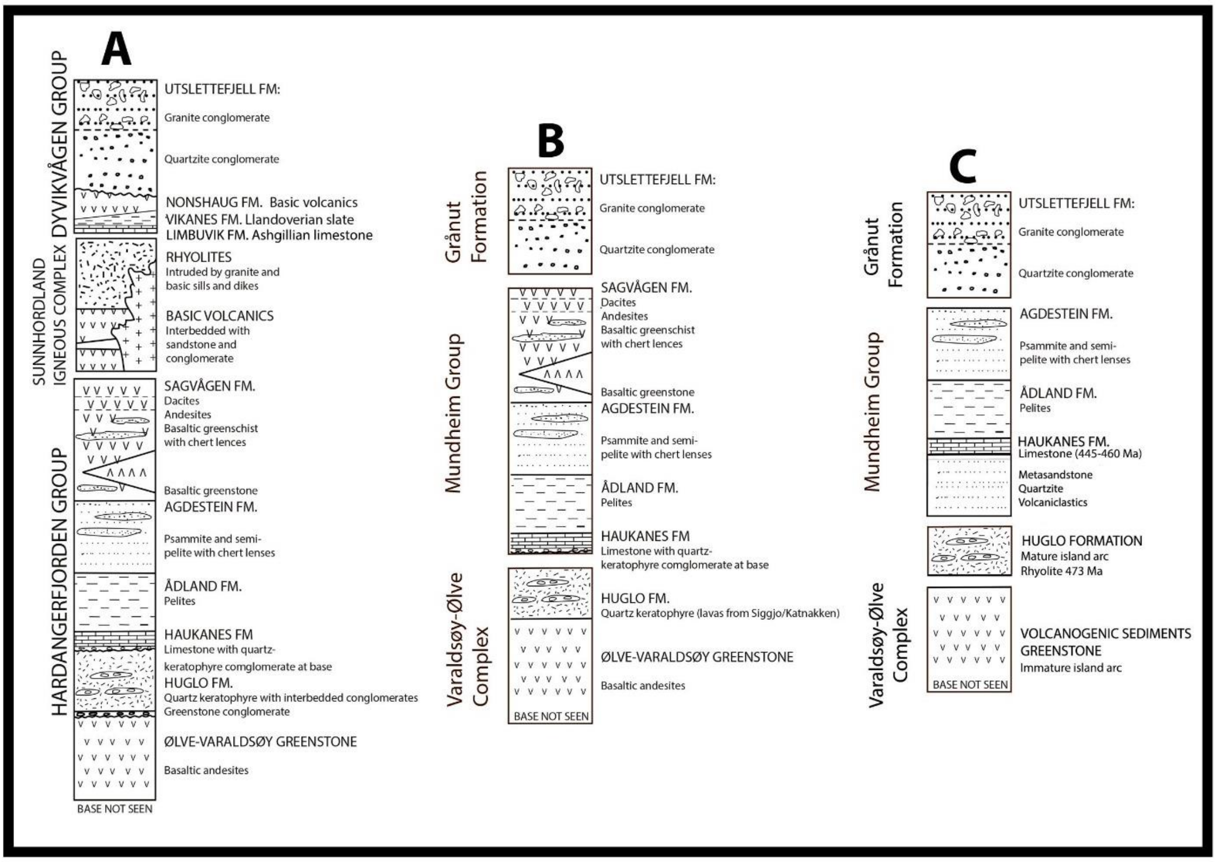

Figure 6.11: A) Stratigraphic column for the Hardangerfjord area, comprising three major lithological units; Hardangerfjorden Group, Sunnhordland Igneous Complex and Dyvikvågen Group. Sunnhordland Igneous Complex is today regarded as the Siggjo and Kattnakken Volcanics. The three groups are further subdivided into different formations. Redrawn and slightly modified after Færseth (1982). **B)** Stratigraphic column for the Ølve/Varaldsøy area based on the described stratigraphic units from Andersen and Andresen (1994) who divided the Hardangerfjorden Group into two units; the Varaldsøy-Ølve Complex and the Mundheim Group. The uppermost unit is the Grånut Formation similar to the Dyvikvågen Group with the Utslettefjell Formation on top. **C)** Revised stratigraphy based on the findings from this study.

6.4 Tectonic evolution of the outer Hardangerfjord area

Based on previous knowledge about the ophiolitic terrane in SW Norway and the findings of this study, a three-step tectonic model is proposed to describe the geological evolution of the outer Hardangerfjord area (Fig. 6.12).

A. Formation of immature island arc crust that is represented in the Hardangerfjord area by the greenstones and the volcanogenic sediments of the Varaldsøy-Ølve Complex. This is correlated with the ophiolite complexes and the immature island arc sequences on Karmøy and Bømlo that formed around 494-485 Ma.
B. Development of a mature island arc complex that is represented by the rhyolites of the Huglo Formation that is dated to 473 Ma. This is correlated with the Siggjo and Kattnakken Volcanics on Bømlo and on Stord. This occurred simultaneously to the intrusion of S-type granites of the West Karmøy Igneous Complex and the formation of the Bremnes Migmatite Complex, presumably due to the subduction of Laurentian derived sediments below the island arc (Pedersen and Dunning, 1997; Fonneland, 2002).
C. Formation of a marginal basin with the deposition of a transgressive sequence that make up the Mundheim Group. Sr-isotopic dating of a unit of limestones present at the base of this group suggests that this sequence formed around 445 Ma. Later deposition of a sequence of pelagic and intercalated sandy sediments reflects a deepening of the basin. It can be questioned if this progressive evolution of a marginal basin somehow is linked to the Late Ordovician back-arc spreading event that is recorded by the Solund-Stavfjord and the Sulitjelma ophiolite complexes (e.g. Pedersen et al., 1992).

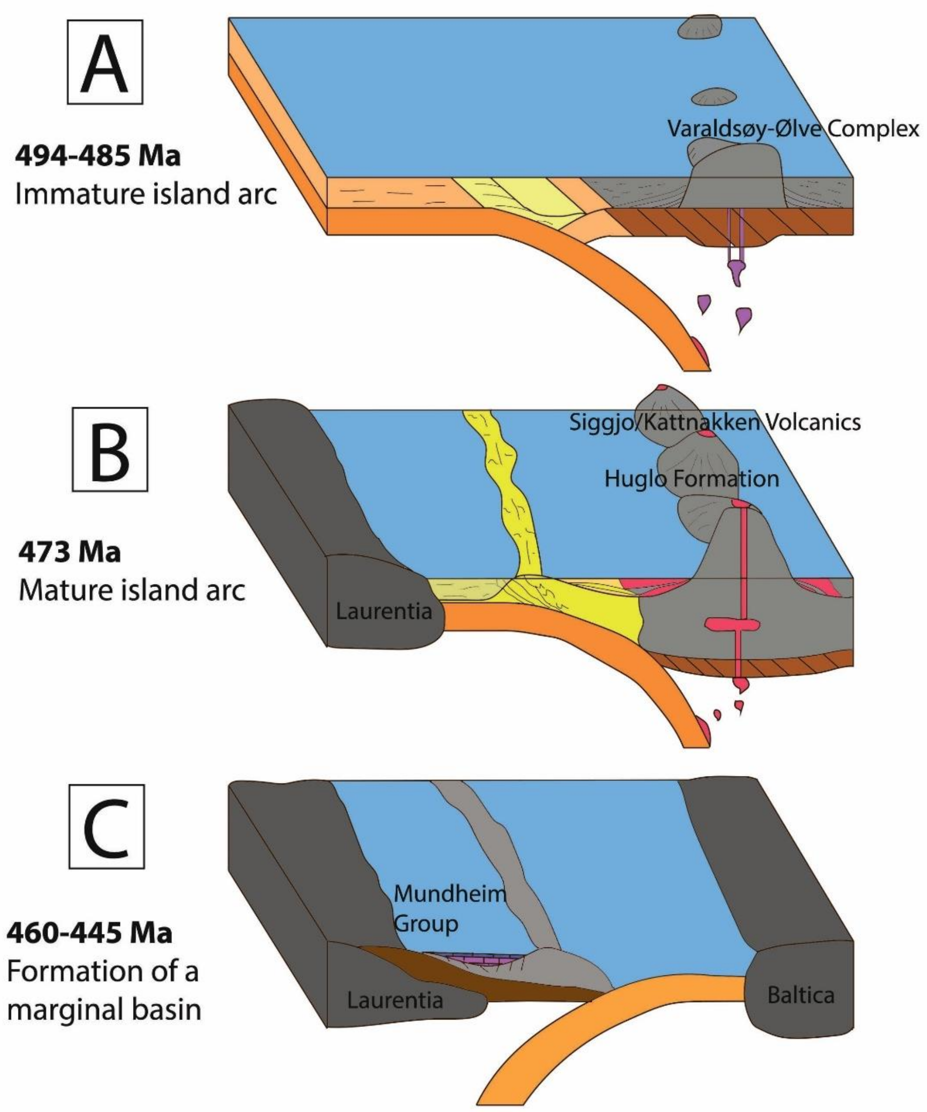

Figure 6.12: Three-step tectonic evolution of the outer Hardangerfjord area. **A)** Formation of the greenstones of the Varaldsøy-Ølve Complex at an immature island arc. **B)** Mature island arc volcanics represented by the Siggjo, Kattnakken and Huglo volcanics formed around 473 Ma. **C)** Rifting of the Laurentic margin after the ophiolitic terrane became accreted to the continent. This lead to the formation of a marginal basin with deposition of a transgressive sequence.

Chapter 7: Conclusion

The different results from this study has given a better understanding of the outer Hardangerfjord area, especially in terms of the Varaldsøy-Ølve Complex, the Huglo Formation and the Mundheim Group. The following main conclusions can be presented from the study:

- The previously suggestions that the basaltic greenstones of the Varaldsøy-Ølve Complex can be correlated with the ophiolitic and island arc sequences on Bømlo and Karmøy seems to be correct. Geochemical analyses have documented trace element patterns typical of SSZ ophiolite complexes, and that show similarities with the Karmøy- and the Lykling Ophiolite/Geitung Unit on Bømlo. The geochemical patterns reveal a transition from an immature island arc to a mature island arc system.
- This study has documented that the "quartz-keratophyres" of the Huglo Formation represent rhyolitic lavas from a mature island arc formed around 473 Ma, which is comparable with the Siggjo and Kattnakken Volcanics.
- It is suggested that the volcaniclastics and quartzites/metasandstones on Ølve and Varaldsøy represent the same stratigraphic level, constituting the base of the Mundheim Group. The Mundheim Group is suggested to represent similar deposits as the Vikafjord Group on Bømlo. These metasediments are suggested to have been deposited in a marginal basin formed by rifting of the Laurentic margin. Rock complexes on Varaldsøy that was earlier mapped as "quartz-keratophyres" represent volcaniclastics derived from the rhyolitic lavas of the Huglo Formation, or other volcanic sources with similar age and affinity. The quartzites and metasandstones on Ølve and Varaldsøy indicate multiple source of sediments with a continental input, dominated by Proterozoic grains.
- The lowest limestone unit (Haukanes Formation) in the Hardangerfjord area has Sr compositions suggesting a deposition age of 445-460 Ma. It is suggested to have been deposited directly on top of the quartzites and metasandstones. The limestones are covered in phyllites and mica-schist deposited at reducing conditions as the basin developed through time. These pelagic sediments represent the upper part of the Mundheim Group.
- Taking all the new findings into account, a renewed stratigraphy is suggested for the outer Hardangerfjord area together with a geological evolution.

Chapter 8: Future work

The outer Hardangerfjord area comprise a complex geology. Even though this study has improved our understanding of the region, there are still a lot of work to be done.

Trace element composition has reveal that the greenstones of the Varaldsøy-Ølve Complex represent ophiolitic and island arc sequences formed at a supra-subduction zone. It would be useful to try and date these sequences, as this has not been done before. This may be possible by extracting zircons from the rhyolitic layers at Steinaneset or Haukanes.

This study has conducted provenance studies on the volcaniclastics, quartzites and metasandstones in the area, and dated the overlying limestones. Further up in the stratigraphy rests phyllites, mica-schists and other pelagic sediments. It would be interesting to investigate the provenance signatures of these sediments, and compare them to the obtained results from the lower units. On top of the metasediments of the Mundheim Group rest a unit of mafic volcanics. Geochemical analyses of these volcanics could reveal ifs affinity and make a possible correlation with other units in the area.

The unconformable Grånut Formation is presumed to represent mature Lower Silurian sediments. Provenance of this formation could reveal an age of deposition as well as a source area. This would make it possible to correlate the unit with other known sediments of Lower Silurian age, such as Utslettefjell Formation (on Bømlo) and Ulven Group (in Os).

References:

Adolfsen, K., 1997, En strukturgeologisk og litostratigrafisk utvikling på sørlig del av Varaldsøy, Hardanger: Cand. Scient. Thesis, Universitetet i Oslo, Norge.

Amaliksen, K., 1983, The geology of the Lykling Ophiolitic Complex, Bømlo, SW Norway: Unpubl. Cand. Real. thesis, University of Bergen, Norway.

Andersen, T., 2002, Correction of common lead in U–Pb analyses that do not report 204 Pb: Chemical geology, v. 192, p. 59-79.

Andersen, T. B., and Jansen, Ø. J., 1987, The Sunnhordland Batholith, W. Norway: regional setting and internal structure, with emphasis on the granitoid plutons: Norsk geologisk tidsskrift, v. 67, p. 159-183.

Andersen, T. B., and Andresen, A., 1994, Stratigraphy, tectonostratigraphy and the accretion of outboard terranes in the Caledonides of Sunnhordland, W. Norway: Elsevier, v. 231, p. 71-84.

Andersen, T. B., 1998, Extensional tectonics in the Caledonides of southern Norway, an overview: Tectonophysics, v. 285, p. 333-351.

Andresen, A., and Færseth, R., 1982, An evolutionary model for the southwest Norwegian Caledonides: American Journal of Science, v. 282, p. 756-782.

Barnes, C. G., Frost, C. D., Yoshinobu, A. S., McArthur, K., Barnes, M. A., Allen, C. M., Nordgulen, Ø., and Prestvik, T., 2007, Timing of sedimentation, metamorphism, and plutonism in the Helgeland Nappe Complex, north-central Norwegian Caledonides: Geosphere, v. 3, p. 683-703.

Bockelie, J., and Nystuen, J., 1985, The southeastern part of the Scandinavian Caledonides: The Caledonide orogen–Scandinavia and related areas, v. 1, p. 69-88.

Brekke, H., 1983, The Caledonian Geological patterns of Moster and southern Bømlo. Evidence for Lower Palaeozoic Mag matic Are Development: Unpublished Cand. Real. Thesis. University of Bergen, Norway.

Brekke, H., Furnes, H., Nordås, J., and Hertogen, J., 1984, Lower Palaeozoic convergent plate margin volcanism on Bømlo, SW Norway, and its bearing on the tectonic environments of the Norwegian Caledonides: Journal of the Geological Society, v. 141, p. 1015-1032.

Corfu, F., Roberts, R. J., Torsvik, T. H., Ashwal, L. D., and Ramsay, D. M., 2007, Peri-Gondwanan elements in the Caledonian Nappes of Finnmark, Northern Norway: Implications for the paleogeographic framework of the Scandinavian Caledonides: American Journal of Science, v. 307, p. 434-458.

Davis, D. W., Krogh, T. E., and Williams, I. S., 2003, Historical development of zircon geochronology: Reviews in mineralogy and geochemistry, v. 53, p. 145-181.

Dunning, G., and Pedersen, R. B., 1988, U/Pb ages of ophiolites and arc-related plutons of the Norwegian Caledonides: implications for the development of Iapetus: Contributions to Mineralogy and Petrology, v. 98, p. 13-23.

Fedo, C. M., Sircombe, K. N., and Rainbird, R. H., 2003, Detrital zircon analysis of the sedimentary record: Reviews in Mineralogy and Geochemistry, v. 53, p. 277-303.

Fonneland, H. C., 2002, Radiogenic isotope systematics of clastic sedimentary rocks-with emphasis on detrital zircon geochronology: PhD Thesis, University of Bergen, Norway

Foslie, S., 1955, Kisdistriktet Varaldsøy-Ølve i Hardanger og bergverksdriftens historie: Norges Geologiske Undersøkelse, v. 147, p. 1-106

Fossen, H., and Austrheim, H., 1988, Age of the Krossnes granite, west Norway: Norges Geologiske Undersøkelse Bulletin, v. 413, p. 61-65.

Fossen, H., 1992, The role of extensional tectonics in the Caledonides of south Norway: Journal of structural geology, v. 14, p. 1033-1046.

Fossen, H., and Hurich, C. A., 2005, The Hardangerfjord Shear Zone in SW Norway and the North Sea: a large-scale low-angle shear zone in the Caledonian crust: Journal of the Geological Society, v. 162, p. 675-687.

Franklin, J. M., Gibson, H. L., Galley, A. G., and Jonasson, I. R., 2005, Volcanogenic Massive Sulfide Deposits: Economic Geology 100th Anniversary, v. Society of Economic Geologists, Littleton, p. 523-560.

Furnes, H., Roberts, D., Sturt, B., Thon, A., and Gale, G., Ophiolite fragments in the Scandinavian Caledonides, in Proceedings Ophiolites—Proceedings of the International Ophiolite Symposium, Cyprus1979, p. 582-599.

Furnes, H., Sturt, B., and Griffin, W., 1980, Trace element geochemistry of metabasalts from the Karmøy ophiolite, southwest Norwegian Caledonides: Earth and Planetary Science Letters, v. 50, p. 75-91.

Furnes, H., Ryan, P., Grenne, T., Roberts, D., Sturt, B., and Prestvik, T., 1985, Geological and geochemical classification of the ophiolite fragments in the Scandinavian Caledonides: The Caledonide orogen—Scandinavia and related areas, John Wiley & Sons, Chichester, p. 657-670.

Furnes, H., Brekke, H., Nordås, J., and Hertogen, J., 1986, Lower Palaeozoic convergent plate margin volcanism on Bømlo, southwest Norwegian Caledonides: geochemistry and petrogenesis: Geological Magazine, v. 123, p. 123-142.

Furnes, H., Skjerlie, K., Pedersen, R., Andersen, T., Stillman, C. J., Suthren, R., Tysseland, M., and Garmann, L., 1990, The Solund–Stavfjord Ophiolite Complex and associated rocks, west Norwegian Caledonides: geology, geochemistry and tectonic environment: Geological Magazine, v. 127, p. 209-224.

Færseth, R., 1982, Geology of southern Stord and adjacent islands, Southwest Norwegian Caledonides: Norges Geologiske Undersøkelse Bulletin, v. 371, p. 57-112.

Hannington, M., 2014, Volcanogenic massive sulfide deposits: Treatise on Geochemistry 2nd Edition. Edited by HD Holland, and Turekian, KK Elsevier Ltd, p. 319-350.

Hart, S., Erlank, A., and Kable, E., 1974, Sea floor basalt alteration: some chemical and Sr isotopic effects: Contributions to Mineralogy and Petrology, v. 44, p. 219-230.

Hossack, J., and Cooper, M., 1986, Collision tectonics in the Scandinavian Caledonides: Geological Society, London, Special Publications, v. 19, p. 285-304.

Jacobsen, S. B., and Kaufman, A. J., 1999, The Sr, C and O isotopic evolution of Neoproterozoic seawater: Chemical Geology, v. 161, p. 37-57.

Le Bas, M. J., Le Maitre, R., Streckeisen, A., and Zanettin, B., 1986, A chemical classification of volcanic rocks based on the total alkali-silica diagram: Journal of petrology, v. 27, p. 745-750.

Lee, J. K., Williams, I. S., and Ellis, D. J., 1997, Pb, U and Th diffusion in natural zircon: Nature, v. 390, p. 159-162.

Ludwig, K., 2008, Manual for isoplot 3.7: Berkeley Geochronology Center Special Publication, v. 4, p. 77.
McArthur, J., Howarth, R., and Bailey, T., 2001, Strontium isotope stratigraphy: LOWESS version 3: best fit to the marine Sr-isotope curve for 0–509 Ma and accompanying look-up table for deriving numerical age: The Journal of Geology, v. 109, p. 155-170.
Michel-Levy, A., 1895, Recherche des axes optiques daus usu mineral powvant etre considre comme um mélange de deux mineraux determines: Bull. Soc. Min, fr, v. 18, p. 79-94.
Morel, M., Nebel, O., Nebel-Jacobsen, Y., Miller, J., and Vroon, P., 2008, Hafnium isotope characterization of the GJ-1 zircon reference material by solution and laser-ablation MC-ICPMS: Chemical Geology, v. 255, p. 231-235.
Morton, A. C., 1991, Geochemical studies of detrital heavy minerals and their application to provenance research: Geological Society, London, Special Publications, v. 57, p. 31-45.
Mæland, A., 1996, Strukturelle og stratigrafiske undersøkelser av de nordlige deler av Varaldsøy, Hardanger: Cand. Scient. Thesis, Universitetet i Oslo, Norge
Nordås, J., Amaliksen, K., Brekke, H., Suthren, R., Furnes, H., Sturt, B., and Robins, B., 1985, Lithostratigraphy and petrochemistry of Caledonian rocks on Bømlo, SW Norway: The Caledonide Orogen—Scandinavia and Related Areas: New York, John Wiley & Sons Ltd, p. 679-692.
Ohmoto, H., 1996, Formation of volcanogenic massive sulfide deposits: the Kuroko perspective: Ore geology reviews, v. 10, p. 135-177.
Osmundsen, P., 1996, Late-orogenic structural geology and Devonian Basin formation in Western Norway: a study from the hanging-wall of the Nordfjord-Sogn Detachment in the Sunnfjord region: Unpubl. Dr Scient Thesis, University of Oslo, Norway
Osmundsen, P., Andersen, T., and Markussen, S., 1998, Tectonics and sedimentation in the hangingwall of a major extensional detachment: the Devonian Kvamshesten Basin, western Norway: Basin Research, v. 10, p. 213-234.
Pearce, J. A., Lippard, S., and Roberts, S., 1984, Characteristics and tectonic significance of supra-subduction zone ophiolites: Geological Society, London, Special Publications, v. 16, p. 77-94.
Pedersen, R. B., Furnes, H., and Dunning, G., 1991, AU/Pb age for the Sulitjelma Gabbro, North Norway: further evidence for the development of a Caledonian: Geol. Mag, v. 128, p. 141-153.
Pedersen, R. B., and Dunning, G., 1993, Provenance of turbiditic cover to the Caledonian Solund–Stavfjord ophiolite from U-Pb single zircon dating: Journal of the Geological Society, v. 150, p. 673-676.
Pedersen, R. B., and Malpas, J., 1984, The origin of oceanic plagiogranites from the Karmoy ophiolite, Western Norway: Contributions to Mineralogy and Petrology, v. 88, p. 36-52.
Pedersen, R. B., Furnes, H., and Dunning, G., 1988, Some Norwegian ophiolite complexes reconsidered: Norges Geologiske Undersøkelse Special Publication, v. 3, p. 80-85.
Pedersen, R. B., and Hertogen, J., 1990, Magmatic evolution of the Karmøy Ophiolite Complex, SW Norway: relationships between MORB-IAT-boninitic-calc-alkaline and alkaline magmatism: Contributions to Mineralogy and Petrology, v. 104, p. 277-293.

Pedersen, R. B., Bruton, D., and Furnes, H., 1992, Ordovician faunas, island arcs and ophiolites in the Scandinavian Caledonides: Terra Nova, v. 4, p. 217-222.

Pedersen, R. B., and Dunning, G. R., 1997, Evolution of arc crust and relations between contrasting sources: U-Pb (age), Nd and Sr isotope systematics of the ophiolitic terrain of SW Norway: Contributions to Mineralogy and Petrology, v. 128, p. 1-15.

Ragnhildstveit, J., and Helliksen, D., 1997, Geologisk kart over Norge, berggrunnskart Bergen–M 1: 250.000: Norges Geologiske Undersøkelse, Trondheim.

Ragnhildstveit, J., Naterstad, J., Jorde, K., and Egeland, B., 1998, Geologisk kart over Noreg; Berggrunnskart Haugesund-M 1: 250.000: Norges geolologiske undersøkelse, Trondheim

Roberts, D., and Gee, D. G., 1985, An introduction to the structure of the Scandinavian Caledonides: The Caledonide orogen–Scandinavia and related areas, v. 1, p. 55-68.

Roberts, D., Melezhik, V., and Heldal, T., 2002, Carbonate formations and early NW-directed thrusting in the highest allochthons of the Norwegian Caledonides: evidence of a Laurentian ancestry: Journal of the Geological Society, v. 159, p. 117-120.

Roberts, D., 2003, The Scandinavian Caledonides: event chronology, palaeogeographic settings and likely modern analogues: Tectonophysics, v. 365, p. 283-299.

Roberts, D., Nordgulen, Ø., and Melezhik, V., 2007, The Uppermost Allochthon in the Scandinavian Caledonides: From a Laurentian ancestry through Taconian orogeny to Scandian crustal growth on Baltica: Geological Society of America Memoirs, v. 200, p. 357-377.

Schermerhorn, L., 1973, What is keratophyre?: Lithos, v. 6, p. 1-11.

Scott, S., 1997, Submarine hydrothermal systems and deposits: In: Barnes, H.K., (ed.) Geochemistry of hydrothermal ore deposits (third edition), John Wiley, New York, 797-876.

Slagstad, T., Roberts, N. M., Marker, M., Røhr, T. S., and Schiellerup, H., 2013, A non-collisional, accretionary Sveconorwegian orogen: Terra Nova, v. 25, p. 30-37.

Slama, J., and Pedersen, R. B., 2015, Zircon provenance of SW Caledonian phyllites reveals a distand Timanian sediment source: Journal of the Geological Society, v. 172, p. 465-478.

Sláma, J., Košler, J., Condon, D. J., Crowley, J. L., Gerdes, A., Hanchar, J. M., Horstwood, M. S., Morris, G. A., Nasdala, L., and Norberg, N., 2008, Plešovice zircon—a new natural reference material for U–Pb and Hf isotopic microanalysis: Chemical Geology, v. 249 p. 1-35.

Smalley, P., Higgins, A., Howarth, R., Nicholson, H., Jones, C., Swinburne, N., and Bessa, J., 1994, Seawater Sr isotope variations through time: a procedure for constructing a reference curve to date and correlate marine sedimentary rocks: Geology, v. 22, p. 431-434.

Starmer, I., 1996, Oblique terrane assembly in the late Paleoproterozoic during the Labradorian-Gothian Orogeny in southern Scandinavia: The Journal of Geology, v. 104, p. 341-350.

Starmer, I. C., 1993, The Sveconorwegian orogeny in southern Norway, relative to deep crustal structures and events in the North Atlantic Proterozoic supercontinent: Norsk Geologisk Tidsskrift, v. 73, p. 109-132.

Stephens, M., Furnes, H., Robins, B., and Sturt, B., 1985, Igneous activity within the Scandinavian Caledonides: The Caledonide orogen—Scandinavia and related areas, v. 2, p. 623-656.

Sturt, B., 1984, The accretion of ophiolitic terrains in the Scandinavian Caledonides: Geologie en Mijnbouw, v. 63, p. 201-212.

Sturt, B. A., and Thon, A., 1978, An ophiolite complex of probable early Caledonian age discovered on Karmøy: Nature, v. 275, p. 538-539.

Sun, S.-S., and McDonough, W.-s., 1989, Chemical and isotopic systematics of oceanic basalts: implications for mantle composition and processes: Geological Society, London, Special Publications, v. 42, p. 313-345.

Thon, A., 1985a, The Gullfjellet ophiolite complex and the structural evolution of the major Bergen arc, west Norwegian Caledonides: The Caledonide Orogen: Scandinavia and related areas, p. 671-677.

Thon, A., 1985b, Late Ordovician and early Silurian cover sequences to the west Norwegian ophiolite fragments: stratigraphy and structural evolution: Gee, DG, Sturt, BA (Eds.), The Caledonide Orogen-Scandinavia and Related Areas, p. 407-415.

Tornos, F., 2006, Environment of formation and styles of volcanogenic massive sulfides: the Iberian Pyrite Belt: Ore Geology Reviews, v. 28, p. 259-307.

Veizer, J., 1989, Strontium isotopes in seawater through time: Annual Review of Earth and Planetary Sciences, v. 17, p. 141-167.

Viken, A. L., 2017, Accretionary history of Lower Ordovician island arc complexes on Bømlo: evidence from detrital zircon dating and geochemical data: Master Thesis, University of Bergen, Norway

Wiedenbeck, M., Alle, P., Corfu, F., Griffin, W., Meier, M., Oberli, F., Quadt, A. v., Roddick, J., and Spiegel, W., 1995, Three natural zircon standards for U-Th-Pb, Lu-Hf, trace element and REE analyses: Geostandards newsletter, v. 19, p. 1-23.

Wulff, P. W., 1993, En klassifikation af mineraliseringer på Bømlo, Sunnhordland, SV-Norge: Stud. Scient Thesis, Københavns Universitet, Danmark.

Online Resources:

NGU, 2017, Berggrunnskart N50, http://geo.ngu.no/kart/berggrunn_mobil/

(accessed 03.06.2017)

Appendix

Appendix 1 – Sample localities

Sample	Locality	Lithology	Stratigraphic unit	GPS-coordinates
15Ølv-1	Hestvika	Rhyolitic volcaniclastic	Mundheim Group	60.069806, 5.968638
15Ølv-2	Hestvika	Rhyolitic volcaniclastic	Mundheim Group	60.068855, 5.971059
15Ølv-3	Flugedalen	Quartzite	Mundheim Group	60.136639, 5.930922
15Ølv-4	Nordøya	Quartzite	Mundheim Group	59.986359, 5.747078
15Ølv-5	Nordøya	Quartzite	Mundheim Group	59.986359, 5.747078
15Ølv-6	Nordøya	Quartzite	Mundheim Group	59.986359, 5.747078
15Ølv-7	Nordøya	Quartzite	Mundheim Group	59.986359, 5.747078
16Hug-3	Huglo	Rhyolite	Huglo Formation	59.843449, 5.562510
16Sko-3	Skorpo	Rhyolite	Huglo Formation	59.875488, 5.603468
16Ølv-5	Steinaneset	Volcanic sediments	Varaldsøy-Ølve Complex	59.981903, 5.822112
16Ølv-6	Steinaneset	Volcanic sediments	Varaldsøy-Ølve Complex	59.981903, 5.822112
16Ølv-7	Steinaneset	Volcanic sediments	Varaldsøy-Ølve Complex	59.981903, 5.822112
16Ølv-9	Steinaneset	Volcanic sediments	Varaldsøy-Ølve Complex	59.981903, 5.822112
16Ølv-10	Steinaneset	Volcanic sediments	Varaldsøy-Ølve Complex	59.981903, 5.822112
16Ølv-17	Gravdal	Pillow breccia	Varaldsøy-Ølve Complex	60.119911, 5.907825
16Var-2	Lyrehola	Greenstone with epidote	Varaldsøy-Ølve Complex	60.129089, 5.931888
16Var-14	Lyrehola	Greenstone with epidote	Varaldsøy-Ølve Complex	60.129021, 5.931939
Layer-1	Haukanes	Volcanic sediments	Varaldsøy-Ølve Complex	60.124805, 6.055808
Layer-2	Haukanes	Volcanic sediments	Varaldsøy-Ølve Complex	60.124805, 6.055808
Layer-9	Haukanes	Volcanic sediments	Varaldsøy-Ølve Complex	60.124805, 6.055808
Layer-10	Haukanes	Volcanic sediments	Varaldsøy-Ølve Complex	60.124805, 6.055808
Layer-11	Haukanes	Volcanic sediments	Varaldsøy-Ølve Complex	60.124805, 6.055808

16Ølv-16	Limbunes	Limestone	Mundheim Group	59.989044, 5.845796
17Ølv-7	Ulvanes	Limestone	Mundheim Group	59.990494, 5.851858
17Ølv-8	Limbunes	Limestone	Mundheim Group	59.989044, 5.845796
17Ølv-9	Limbunes	Limestone	Mundheim Group	59.989044, 5.845796
17Ølv-10	Limbunes	Limestone	Mundheim Group	59.989044, 5.845796
16Sko-2	Skorpo	Limestone	Mundheim Group	59.899128, 5.650077
16Hug-2	Huglo	Limestone	Mundheim Group	59.854546, 5.561202
17Hug-1	Huglo	Limestone	Mundheim Group	59.854546, 5.561202
17Hug-2	Huglo	Limestone	Mundheim Group	59.854546, 5.561202
17Hug-3	Huglo	Limestone	Mundheim Group	59.854546, 5.561202

Appendix 2 – LA-ICP-MS results

Sample 15Ølv-2														
	Isotopic Ratios							Calculated ages (Ma)						
ID	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Rho	$^{207/206}Pb$	2σ	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	$^{207/206}Pb$	2σ	Disc.
15Ølv-2 - 1	0.615	0.012	0.0756	0.0016	0.53508	0.05815	0.00066	485	7.4	469.7	9.3	512	24	-3.3
15Ølv-2 - 2	0.633	0.013	0.0803	0.0017	0.56347	0.05643	0.00077	496	7.7	497	10	442	30	0.2
15Ølv-2 - 3	0.586	0.01	0.0745	0.0016	0.47099	0.05673	0.00049	467.4	6.5	463.2	9.8	466	19	-0.9
15Ølv-2 - 4	0.5839	0.0099	0.0741	0.0015	0.56204	0.0568	0.0006	465.8	6.4	460.4	9	455	24	-1.2
15Ølv-2 - 5	0.73	0.016	0.0817	0.002	0.5276	0.06404	0.0007	553.3	8.9	506	12	710	24	-9.3
15Ølv-2 - 6	0.702	0.01	0.0763	0.0015	0.46585	0.06607	0.00055	539.6	6.2	474.2	8.7	795	17	-13.8
15Ølv-2 - 7	0.617	0.01	0.0769	0.0015	0.41845	0.05777	0.00063	486.8	6.4	477.7	9.2	493	24	-1.9
15Ølv-2 - 8	0.663	0.011	0.0787	0.0017	0.39044	0.06057	0.00076	515.2	7.1	488	10	609	28	-5.6
15Ølv-2 - 9	0.667	0.013	0.0716	0.0016	0.44165	0.0666	0.00099	516.3	7.9	445.4	9.7	806	34	-15.9
15Ølv-2 - 10	0.574	0.013	0.0603	0.0017	0.80528	0.07058	0.00096	458	8.1	376	10	912	28	-21.8
15Ølv-2 - 11	0.762	0.013	0.0783	0.0015	0.44799	0.07012	0.00077	573.1	7.2	485.8	9.2	903	23	-18.0
15Ølv-2 - 12	0.5798	0.0085	0.0724	0.0014	0.45144	0.05768	0.00047	463.8	5.5	451	8.2	500	18	-2.8
15Ølv-2 - 13	0.619	0.011	0.079	0.0016	0.52683	0.05628	0.00059	488.1	6.7	490.2	9.6	445	24	0.4
15Ølv-2 - 14	0.5904	0.0091	0.0753	0.0015	0.54541	0.05626	0.00048	470.3	5.8	467.9	8.8	451	19	-0.5
15Ølv-2 - 15	0.576	0.0094	0.0731	0.0014	0.46778	0.05694	0.00062	461	6.1	454.8	8.7	462	24	-1.4
15Ølv-2 - 16	0.612	0.011	0.0788	0.0016	0.54797	0.05585	0.00061	482.9	6.6	489.1	9.4	423	24	1.3
15Ølv-2 - 17	0.66	0.011	0.0836	0.0016	0.50724	0.05711	0.00059	514	6.6	517.4	9.7	471	23	0.7
15Ølv-2 - 18	0.598	0.011	0.0759	0.0016	0.36382	0.05709	0.00086	475.2	7.2	471.7	9.9	470	34	-0.7
15Ølv-2 - 19	0.5983	0.0096	0.0766	0.0015	0.55231	0.05636	0.00053	474.8	6.1	475.8	9.1	442	21	0.2
15Ølv-2 - 20	0.598	0.017	0.0672	0.0015	0.43915	0.0642	0.0012	473	10	418.7	8.9	710	35	-13.0
15Ølv-2 - 21	0.617	0.013	0.0777	0.0017	0.48973	0.0573	0.00092	486.4	8.1	483	10	473	35	-0.7
15Ølv-2 - 22	0.534	0.011	0.0684	0.0015	0.76433	0.05619	0.00055	432.7	7.2	426	9.2	442	22	-1.6
15Ølv-2 - 23	1.685	0.028	0.1636	0.0035	0.62315	0.07445	0.00076	1001	10	976	19	1041	21	-2.6
15Ølv-2 - 24	0.62	0.01	0.0795	0.0016	0.41609	0.05635	0.00062	488.3	6.4	492.9	9.5	442	24	0.9
15Ølv-2 - 25	0.6019	0.0097	0.0772	0.0015	0.55622	0.05615	0.0005	477.6	6.1	479.2	9.1	440	20	0.3
15Ølv-2 - 26	0.715	0.016	0.0755	0.0017	0.19055	0.0698	0.0015	543.5	9	469	10	843	46	-15.9
15Ølv-2 - 27	0.645	0.013	0.0826	0.0018	0.60776	0.05627	0.00073	503.7	7.8	512	11	441	29	1.6
15Ølv-2 - 28	0.592	0.011	0.0752	0.0017	0.53052	0.05706	0.0008	471.2	7.3	467	10	473	31	-0.9
15Ølv-2 - 29	0.6453	0.009	0.0798	0.0015	0.39523	0.05838	0.00046	505.2	5.6	494.9	9.1	527	17	-2.1
15Ølv-2 - 30	0.5766	0.0098	0.0733	0.0015	0.58615	0.05672	0.0006	461.2	6.3	456.3	9.1	456	23	-1.1
15Ølv-2 - 31	0.5876	0.0096	0.0753	0.0015	0.47496	0.05649	0.00061	468	6.2	467.9	9	443	24	0.0
15Ølv-2 - 32	0.6568	0.0099	0.0804	0.0016	0.50917	0.05902	0.0005	511.6	6.1	498	9.2	551	18	-2.7
15Ølv-2 - 33	0.921	0.016	0.0803	0.0016	0.46902	0.08244	0.00096	660.3	8.3	497.4	9.5	1234	22	-32.8
15Ølv-2 - 34	0.6003	0.0096	0.075	0.0015	0.58206	0.0578	0.00051	476.8	6.1	465.8	8.9	504	20	-2.4
15Ølv-2 - 35	0.564	0.011	0.0728	0.0017	0.43036	0.05639	0.00086	453.3	6.9	453.4	9.9	439	34	0.0
15Ølv-2 - 36	0.6	0.01	0.0765	0.0015	0.38957	0.05672	0.00068	476.3	6.5	475.1	9.2	449	27	-0.3
15Ølv-2 - 37	0.613	0.01	0.0785	0.0016	0.48589	0.05626	0.00062	484.5	6.4	487.1	9.7	443	25	0.5
15Ølv-2 - 38	0.6284	0.0092	0.081	0.0016	0.56002	0.05589	0.00042	494.6	5.8	502	9.4	434	17	1.5
15Ølv-2 - 39	0.5964	0.0095	0.0763	0.0015	0.49422	0.05642	0.00055	474.1	6.1	473.7	9	446	22	-0.1
15Ølv-2 - 40	0.601	0.01	0.0759	0.0015	0.33105	0.05704	0.00068	476.1	6.5	471.3	9.2	459	25	-1.0
15Ølv-2 - 41	0.621	0.011	0.0769	0.0016	0.51497	0.05834	0.00066	489	6.7	477.3	9.4	513	24	-2.5
15Ølv-2 - 42	0.615	0.01	0.0785	0.0016	0.55753	0.05647	0.0006	485.4	6.6	486.8	9.6	447	23	0.3
15Ølv-2 - 43	0.5953	0.0088	0.0744	0.0014	0.50559	0.05768	0.00047	473.6	5.6	462.5	8.6	501	18	-2.4
15Ølv-2 - 44	0.667	0.011	0.0787	0.0016	0.45962	0.06132	0.00068	517.4	6.6	487.9	9.6	621	24	-6.0
15Ølv-2 - 45	0.5814	0.0097	0.0744	0.0015	0.4517	0.05633	0.00064	464.6	6.3	462.4	9.2	440	25	-0.5
15Ølv-2 - 46	0.562	0.011	0.0709	0.0016	0.6453	0.05719	0.00072	451.7	7.2	441	9.7	470	28	-2.4
15Ølv-2 - 47	0.601	0.01	0.0771	0.0016	0.52489	0.05606	0.00061	476.2	6.5	478.5	9.4	430	24	0.5
15Ølv-2 - 48	0.606	0.01	0.0781	0.0016	0.41376	0.05614	0.00065	480.1	6.5	484.6	9.3	429	25	0.9
15Ølv-2 - 49	0.618	0.011	0.0786	0.0017	0.45475	0.05664	0.00073	488.5	7	487.4	9.9	457	29	-0.2
15Ølv-2 - 50	0.62	0.011	0.0788	0.0016	0.45038	0.05645	0.00068	487.7	6.8	488.8	9.6	446	27	0.2
15Ølv-2 - 51	0.604	0.01	0.0764	0.0016	0.51128	0.057	0.00062	479	6.5	474.2	9.3	470	24	-1.0
15Ølv-2 - 52	0.618	0.011	0.0794	0.0016	0.36809	0.05617	0.00069	486.8	6.6	492	9.5	424	27	1.1
15Ølv-2 - 53	0.5757	0.0095	0.074	0.0015	0.50618	0.0563	0.00059	460.5	6.1	460.1	8.9	436	23	-0.1
15Ølv-2 - 54	0.719	0.012	0.0774	0.0016	0.43142	0.06742	0.0008	548.7	7.2	480.5	9.5	821	25	-14.2
15Ølv-2 - 55	0.6102	0.0095	0.079	0.0016	0.48231	0.05577	0.00043	483	5.8	489.9	9.7	427	17	1.4
15Ølv-2 - 56	0.5506	0.0093	0.0694	0.0014	0.37066	0.05722	0.00064	444.3	6.2	432.3	8.3	477	25	-2.8
15Ølv-2 - 57	0.5901	0.0097	0.0757	0.0016	0.47631	0.05617	0.00068	470.1	6.2	470.4	9.8	439	27	0.1
15Ølv-2 - 58	0.5845	0.0096	0.0753	0.0015	0.49163	0.05599	0.00057	465.9	6.1	467.9	8.9	427	23	0.4
15Ølv-2 - 59	0.596	0.011	0.0763	0.0017	0.41563	0.05643	0.00085	473.3	7.3	474	10	450	33	0.1
15Ølv-2 - 60	0.531	0.014	0.0579	0.0015	0.74751	0.06572	0.00085	430.7	9.1	362.3	8.9	762	27	-18.9
15Ølv-2 - 61	0.616	0.012	0.0766	0.0016	0.51301	0.05785	0.0008	485.8	7.6	476.1	9.9	493	30	-2.0
15Ølv-2 - 62	0.642	0.01	0.0796	0.0016	0.53382	0.0581	0.00051	502.3	6.2	493.8	9.3	516	19	-1.7
15Ølv-2 - 63	0.5728	0.0098	0.074	0.0016	0.38337	0.05602	0.00072	459.1	6.3	460	9.3	429	28	0.2
15Ølv-2 - 64	0.5785	0.0086	0.0718	0.0014	0.46939	0.05793	0.00052	462.7	5.7	446.7	8.3	511	20	-3.6
15Ølv-2 - 65	0.609	0.011	0.0776	0.0015	0.14582	0.0568	0.00072	481.9	6.6	481.2	9.2	458	24	-0.1
15Ølv-2 - 66	0.5838	0.0091	0.075	0.0015	0.53931	0.05609	0.00051	465.8	5.8	465.7	8.8	434	20	0.0
15Ølv-2 - 67	0.594	0.011	0.0768	0.0016	0.40778	0.05572	0.00072	471.9	6.8	476.7	9.4	412	28	1.0
15Ølv-2 - 68	0.636	0.011	0.0805	0.0016	0.53048	0.0568	0.00063	498.4	6.8	499.4	9.8	460	24	0.2
15Ølv-2 - 69	0.6133	0.0094	0.0782	0.0015	0.49276	0.05665	0.00053	485.4	5.9	484.9	9.2	457	21	-0.1
15Ølv-2 - 70	0.63	0.013	0.0808	0.0019	0.58439	0.05601	0.00082	494.4	8.1	501	11	431	32	1.3
15Ølv-2 - 71	0.604	0.01	0.0774	0.0016	0.56723	0.05628	0.0006	477.8	6.5	480.3	9.7	437	23	0.5
15Ølv-2 - 72	0.687	0.019	0.0869	0.0026	0.77766	0.05712	0.00093	526	12	536	15	464	36	1.9
15Ølv-2 - 73	0.628	0.013	0.0816	0.0018	0.51561	0.05543	0.00089	493.1	8.3	505	11	402	36	2.4
15Ølv-2 - 74	0.5934	0.0084	0.0752	0.0014	0.41047	0.05671	0.00045	472.6	5.3	467.5	8.6	466	17	-1.1
15Ølv-2 - 75	0.593	0.011	0.0748	0.0015	0.32766	0.05692	0.00077	470.9	6.8	465	9	452	29	-1.3
15Ølv-2 - 76	0.5366	0.009	0.067	0.0013	0.56186	0.05752	0.00053	435.7	6.2	418.4	8.2	494	21	-4.1

15Ølv-2 - 77	0.589	0.01	0.0752	0.0015	0.54372	0.05606	0.00061	468.7	6.5	467.9	9.2	435	24	-0.2
15Ølv-2 - 78	0.599	0.011	0.0767	0.0016	0.34353	0.05631	0.00072	476.1	6.9	476.3	9.4	431	28	0.0
15Ølv-2 - 79	0.637	0.011	0.0816	0.0017	0.36804	0.05637	0.00076	499.2	7.2	505	10	430	30	1.1
15Ølv-2 - 80	0.5607	0.0095	0.0718	0.0014	0.51418	0.05613	0.0006	450.7	6.2	446.7	8.8	432	24	-0.9
15Ølv-2 - 81	0.5911	0.0098	0.075	0.0015	0.40636	0.05662	0.00065	470.7	6.2	466	9.1	453	25	-1.0
15Ølv-2 - 82	0.664	0.011	0.0828	0.0016	0.46639	0.05752	0.00057	515.5	6.4	512.9	9.8	492	22	-0.5
15Ølv-2 - 83	0.771	0.016	0.0598	0.0013	0.10434	0.0927	0.0012	579	8.8	374.1	7.7	1456	24	-54.8
15Ølv-2 - 84	0.683	0.011	0.0866	0.0017	0.59269	0.05682	0.00057	527.7	7	535	10	466	22	1.4
15Ølv-2 - 85	0.632	0.011	0.0778	0.0016	0.43939	0.0585	0.00073	495.7	6.9	483.6	9.7	516	27	-2.5
15Ølv-2 - 86	0.599	0.01	0.0767	0.0016	0.43677	0.05653	0.00068	475.7	6.5	476.3	9.5	440	26	0.1
15Ølv-2 - 87	0.717	0.012	0.0718	0.0015	0.48855	0.07164	0.00086	547.5	7.1	447.6	8.8	963	24	-22.3
15Ølv-2 - 88	0.612	0.01	0.0787	0.0016	0.46424	0.05599	0.00059	484.4	6.3	488.2	9.5	430	23	0.8
15Ølv-2 - 89	0.579	0.014	0.0747	0.0021	0.43294	0.05615	0.00087	462.9	8.5	464	12	430	34	0.2
15Ølv-2 - 90	0.586	0.0098	0.0753	0.0015	0.44138	0.05629	0.00064	467.6	6.4	467.9	9	432	25	0.1
15Ølv-2 - 91	0.5839	0.0099	0.0752	0.0016	0.45982	0.05583	0.00066	465.3	6.3	467.3	9.3	419	26	0.4
15Ølv-2 - 92	0.624	0.01	0.0809	0.0016	0.53568	0.05564	0.00061	491	6.5	500.9	9.7	413	24	2.0
15Ølv-2 - 93	0.637	0.011	0.0812	0.0017	0.52718	0.05662	0.00071	498.1	7	503	10	444	28	1.0
15Ølv-2 - 94	0.612	0.011	0.0779	0.0016	0.43666	0.05657	0.00064	485.1	6.7	483.2	9.4	449	25	-0.4
15Ølv-2 - 95	0.603	0.011	0.0771	0.0017	0.43923	0.05673	0.00056	478.1	6.7	478	10	456	22	0.0
15Ølv-2 - 96	0.603	0.012	0.0767	0.0017	0.46353	0.05643	0.00085	478.2	7.7	476	10	443	33	-0.5
15Ølv-2 - 97	0.6169	0.0094	0.0788	0.0016	0.33715	0.05641	0.00052	486.6	5.8	488.8	9.3	444	20	0.5
15Ølv-2 - 98	0.585	0.0087	0.0756	0.0015	0.3882	0.05583	0.00051	466.9	5.6	469.8	8.8	425	20	0.6
15Ølv-2 - 99	0.59	0.0094	0.0756	0.0015	0.51028	0.05646	0.00059	469.7	6	469.7	9.1	448	23	0.0
15Ølv-2 - 100	0.5833	0.0098	0.0751	0.0015	0.43631	0.05616	0.00064	464.9	6.3	466.5	9	430	25	0.3
15Ølv-2 - 101	0.59	0.01	0.0757	0.0016	0.44897	0.05668	0.00068	469.8	6.5	470.6	9.3	447	27	0.2
15Ølv-2 - 102	0.5791	0.0091	0.0757	0.0015	0.45504	0.05527	0.00055	463	5.8	470.4	9.1	406	23	1.6
15Ølv-2 - 103	0.5979	0.0099	0.0762	0.0015	0.45991	0.05676	0.00062	474.6	6.3	473	9.2	457	24	-0.3
15Ølv-2 - 104	0.5826	0.0099	0.0744	0.0015	0.49836	0.05656	0.00061	464.6	6.3	462.3	8.9	448	24	-0.5
15Ølv-2 - 105	0.5823	0.0097	0.0754	0.0015	0.46722	0.05589	0.00057	465.3	6.2	468.1	9.2	427	23	0.6
15Ølv-2 - 106	0.613	0.01	0.0791	0.0016	0.51467	0.05616	0.00059	484.3	6.4	490.2	9.5	437	23	1.2
15Ølv-2 - 107	0.5962	0.0097	0.077	0.0015	0.52271	0.05602	0.00058	473.7	6.2	478.1	9.2	428	23	0.9
15Ølv-2 - 108	0.597	0.01	0.0763	0.0015	0.42802	0.05668	0.00067	473.7	6.4	473.6	9.2	446	26	0.0
15Ølv-2 - 109	0.608	0.011	0.0783	0.0016	0.45593	0.05608	0.00068	481.1	6.7	485.7	9.6	428	26	0.9
15Ølv-2 - 110	0.563	0.013	0.0735	0.0017	0.5434	0.0554	0.0009	452.3	8.1	457	10	402	36	1.0
15Ølv-2 - 111	0.592	0.011	0.0736	0.0016	0.47658	0.05831	0.00083	471.9	7.2	457.7	9.7	513	31	-3.1
15Ølv-2 - 112	0.6115	0.0099	0.0783	0.0016	0.4609	0.05642	0.00061	483.7	6.2	485.8	9.5	446	24	0.4
15Ølv-2 - 113	0.5847	0.0098	0.0751	0.0015	0.32757	0.05614	0.00061	465.9	6.2	466.6	8.9	428	24	0.2
15Ølv-2 - 114	0.6082	0.0091	0.0791	0.0015	0.5285	0.05549	0.00049	481.7	5.7	490.7	9.2	415	19	1.8
15Ølv-2 - 115	0.595	0.01	0.076	0.0015	0.44732	0.05653	0.00066	472.4	6.5	471.6	9.1	443	26	-0.2
15Ølv-2 - 116	0.59	0.0099	0.0752	0.0015	0.44174	0.05668	0.00064	469.5	6.4	467	9.1	453	25	-0.5
15Ølv-2 - 117	0.6343	0.0099	0.0817	0.0016	0.50667	0.05597	0.00053	498.1	6.1	505.7	9.5	437	21	1.5
15Ølv-2 - 118	0.603	0.012	0.0763	0.0018	0.49521	0.05714	0.00083	478	7.4	474	11	475	34	-0.8
15Ølv-2 - 119	0.591	0.01	0.0734	0.0015	0.41158	0.05831	0.00065	471.1	6.2	456.1	8.9	520	23	-3.3
15Ølv-2 - 120	0.619	0.01	0.0761	0.0015	0.46377	0.05901	0.00062	488.6	6.3	472.7	9.2	540	23	-3.4
15Ølv-2 - 121	0.58	0.011	0.0747	0.0016	0.47816	0.05602	0.00061	463.4	6.6	463.9	9.6	432	24	0.1
15Ølv-2 - 122	0.5909	0.0084	0.0757	0.0014	0.47339	0.05615	0.00042	470.9	5.3	470.1	8.6	442	17	-0.2
15Ølv-2 - 123	0.621	0.011	0.0742	0.0015	0.51018	0.06067	0.00089	489.5	6.8	461	9.1	596	30	-6.2
15Ølv-2 - 124	0.578	0.01	0.0745	0.0015	0.42937	0.05606	0.00067	462.3	6.5	463.1	9.1	427	27	0.2
15Ølv-2 - 125	0.5749	0.0094	0.0738	0.0015	0.4346	0.05627	0.00061	460.2	6.1	458.9	8.8	437	24	-0.3
15Ølv-2 - 126	0.569	0.01	0.0741	0.0016	0.42309	0.05528	0.0006	456.7	6.4	460.6	9.4	404	24	0.8
15Ølv-2 - 127	0.6264	0.0097	0.0811	0.0016	0.51903	0.05564	0.0005	493.1	6.1	502.4	9.5	420	20	1.9
15Ølv-2 - 128	0.625	0.01	0.0805	0.0016	0.34374	0.05602	0.00061	491.4	6.5	498.8	9.8	424	24	1.5
15Ølv-2 - 129	0.604	0.012	0.0778	0.0017	0.52792	0.05547	0.00079	478.2	7.7	483	10	410	32	1.0
15Ølv-2 - 130	0.688	0.028	0.0708	0.0015	0.31723	0.0701	0.0021	529	15	440.5	8.9	858	50	-20.1
15Ølv-2 - 131	0.63	0.011	0.0778	0.0018	0.51013	0.05808	0.00062	494.6	6.9	482	10	509	24	-2.6
15Ølv-2 - 132	0.5941	0.0091	0.0763	0.0015	0.41597	0.05592	0.00052	472.5	5.8	473.7	8.9	432	21	0.3
15Ølv-2 - 133	0.588	0.01	0.075	0.0015	0.48355	0.05618	0.00066	467.8	6.5	466.5	9.2	432	26	-0.3
15Ølv-2 - 134	0.5988	0.0092	0.0766	0.0015	0.46953	0.05612	0.00053	475.4	5.8	475.7	9	435	21	0.1
15Ølv-2 - 135	0.5824	0.0093	0.0749	0.0015	0.51694	0.05575	0.00052	465.2	5.9	465.6	8.8	426	21	0.1
15Ølv-2 - 136	0.578	0.011	0.0736	0.0015	0.23538	0.05699	0.00069	461.4	7.2	457.3	8.9	449	26	-0.9
15Ølv-2 - 137	0.5988	0.0096	0.0765	0.0015	0.46053	0.05614	0.00056	475.4	6.1	474.8	9.1	437	22	-0.1
15Ølv-2 - 138	0.649	0.0098	0.0813	0.0016	0.55959	0.05747	0.00047	507.3	6	503.6	9.5	493	18	-0.7
15Ølv-2 - 139	0.623	0.011	0.0767	0.0018	0.46466	0.0582	0.0012	490.2	7	477	11	510	36	-2.8
15Ølv-2 - 140	0.585	0.011	0.0749	0.0015	0.3182	0.05624	0.00078	466.3	6.8	465.4	9	420	30	-0.2
15Ølv-2 - 141	0.5847	0.0096	0.0749	0.0015	0.45369	0.05612	0.0006	466.5	6.2	465.4	8.9	433	24	-0.2
15Ølv-2 - 142	0.79	0.15	0.0853	0.0038	0.3659	0.0667	0.0052	590	43	527	21	782	78	-12.0
15Ølv-2 - 143	0.5794	0.0098	0.0661	0.0014	0.37107	0.06322	0.0008	462.8	6.3	412.6	8.5	680	28	-12.2
15Ølv-2 - 144	0.6343	0.009	0.0812	0.0015	0.51493	0.05611	0.00043	498.1	5.6	502.8	9.2	441	17	0.9
15Ølv-2 - 145	0.5642	0.0094	0.0717	0.0014	0.44337	0.05623	0.00064	452.7	6.1	446.5	8.6	436	24	-1.4
15Ølv-2 - 146	0.593	0.0092	0.0757	0.0015	0.44252	0.05621	0.00054	472.3	5.9	470.4	8.9	438	21	-0.4
15Ølv-2 - 147	0.5922	0.0098	0.0753	0.0015	0.42779	0.05655	0.00063	471.2	6.3	467.6	9	448	24	-0.8
15Ølv-2 - 148	0.5994	0.0093	0.0762	0.0015	0.52408	0.05637	0.00051	475.9	5.9	473.2	9	448	20	-0.6
15Ølv-2 - 149	0.616	0.01	0.0775	0.0016	0.53292	0.05692	0.0006	485.7	6.4	481.1	9.6	464	23	-1.0
15Ølv-2 - 150	0.653	0.011	0.0722	0.0015	0.53159	0.06488	0.00066	510.1	6.6	449	8.7	752	22	-13.6
15Ølv-2 - 151	0.627	0.012	0.0799	0.0018	0.51831	0.05617	0.00078	492.6	7.5	495	11	436	31	0.5
15Ølv-2 - 152	0.6014	0.0098	0.0767	0.0015	0.50144	0.05632	0.00058	476.8	6.2	476.2	9.2	442	23	-0.1
15Ølv-2 - 153	0.627	0.011	0.0756	0.0015	0.43872	0.05937	0.00071	492.8	7	469.8	9.2	549	27	-4.9
15Ølv-2 - 154	0.6011	0.0096	0.076	0.0015	0.42052	0.05674	0.00059	476.5	6.1	471.7	8.9	453	23	-1.0
15Ølv-2 - 155	0.5822	0.0091	0.0666	0.0013	0.51873	0.06287	0.00062	464.9	5.9	415.5	7.9	681	21	-11.9
15Ølv-2 - 156	0.576	0.0094	0.0737	0.0015	0.495	0.05617	0.00059	460.5	6.1	458.2	8.8	432	23	-0.5

15Ølv-2 - 157	0.637	0.011	0.0805	0.0017	0.53899	0.05711	0.00072	499.7	7.1	498	10	471	28	-0.3
15Ølv-2 - 158	0.649	0.011	0.078	0.0016	0.48453	0.05988	0.00067	506.3	6.7	483.6	9.4	571	25	-4.7
15Ølv-2 - 159	0.5808	0.0081	0.0741	0.0014	0.42315	0.05617	0.00041	464.6	5.2	461.2	8.5	446	16	-0.7
15Ølv-2 - 160	0.645	0.01	0.0757	0.0015	0.54966	0.06149	0.00067	504.9	6.2	470.2	9	635	22	-7.4
15Ølv-2 - 161	0.6057	0.0098	0.0777	0.0016	0.50217	0.0561	0.00056	479.4	6.1	482	9.3	436	22	0.5
15Ølv-2 - 162	0.615	0.011	0.0787	0.0015	0.22854	0.05612	0.00064	485	6.6	488.1	9.1	428	25	0.6
15Ølv-2 - 163	0.607	0.011	0.0776	0.0016	0.44573	0.05615	0.00073	480.2	6.9	481.5	9.7	436	29	0.3
15Ølv-2 - 164	0.582	0.011	0.0738	0.0017	0.5112	0.0569	0.00085	464.8	7.2	458.4	9.9	463	33	-1.4
15Ølv-2 - 165	0.893	0.015	0.0849	0.0017	0.10565	0.07631	0.00092	645.6	8.1	525	10	1062	25	-23.0
15Ølv-2 - 166	0.5886	0.0096	0.0752	0.0015	0.43318	0.05635	0.00061	469.3	6.2	467.7	8.9	439	24	-0.3
15Ølv-2 - 167	0.5796	0.0097	0.0743	0.0015	0.072805	0.05631	0.00064	462.7	6.2	461.5	8.9	436	24	-0.3
15Ølv-2 - 168	1.121	0.022	0.073	0.0016	0.47115	0.1102	0.0014	760	10	453.9	9.3	1779	23	-67.4
15Ølv-2 - 169	0.6244	0.0087	0.0796	0.0015	0.46987	0.05663	0.00041	492.1	5.4	493.5	9	461	16	0.3
15Ølv-2 - 170	0.5722	0.0097	0.0732	0.0015	0.45683	0.05635	0.00067	458.4	6.2	455.4	9.1	440	26	-0.7
15Ølv-2 - 171	0.5953	0.0094	0.0763	0.0015	0.4034	0.05634	0.0005	473.4	6	474.2	9	445	20	0.2
15Ølv-2 - 172	0.5805	0.0099	0.0738	0.0015	0.5348	0.05663	0.00062	463.8	6.4	459	9.1	455	24	-1.0
15Ølv-2 - 173	0.6697	0.0094	0.0847	0.0016	0.57601	0.05675	0.00047	519.6	5.8	523.8	9.7	464	18	0.8
15Ølv-2 - 174	0.6712	0.0097	0.0867	0.0017	0.51618	0.05578	0.00045	520.8	5.9	536	10	430	18	2.8
15Ølv-2 - 175	0.583	0.01	0.0727	0.0016	0.5408	0.05775	0.00059	465.4	6.4	452	9.5	517	23	-3.0
15Ølv-2 - 176	0.6017	0.0099	0.0772	0.0015	0.63773	0.05598	0.00053	476.9	6.2	478.9	9.2	431	21	0.4
15Ølv-2 - 177	0.5984	0.0086	0.0767	0.0015	0.46297	0.05625	0.00045	475.9	5.5	476.3	8.8	448	18	0.1
15Ølv-2 - 178	0.5803	0.0096	0.0745	0.0015	0.47486	0.05588	0.00059	463.2	6.2	463	8.9	427	24	0.0
15Ølv-2 - 179	0.6033	0.0092	0.0774	0.0015	0.44467	0.05613	0.00051	478.3	5.8	480.3	9	439	20	0.4
15Ølv-2 - 180	0.643	0.012	0.0743	0.0015	0.28549	0.06244	0.00091	502.6	7.5	461.5	8.8	644	31	-8.9
15Ølv-2 - 181	0.5809	0.0094	0.0745	0.0015	0.43404	0.05602	0.00056	463.9	6	462.8	8.7	430	22	-0.2
15Ølv-2 - 182	0.642	0.016	0.0788	0.0019	0.57247	0.0592	0.0011	502.1	9.6	488	12	529	40	-2.9
15Ølv-2 - 183	0.5353	0.0089	0.0676	0.0013	0.58204	0.05682	0.00058	434.2	6	421.4	8.1	461	23	-3.0
15Ølv-2 - 184	0.601	0.01	0.0769	0.0015	0.51945	0.05612	0.00059	476.5	6.4	477.4	9.2	430	24	0.2
15Ølv-2 - 185	0.603	0.01	0.0752	0.0015	0.37366	0.0577	0.00068	478.8	6.6	467.6	9	488	26	-2.4
15Ølv-2 - 186	0.623	0.011	0.0789	0.0016	0.49566	0.05664	0.00065	490	6.6	489.8	9.6	449	25	0.0
15Ølv-2 - 187	0.65	0.011	0.0785	0.0016	0.52535	0.05937	0.00061	507	6.5	486.6	9.3	559	22	-4.2
15Ølv-2 - 188	0.616	0.009	0.079	0.0015	0.45784	0.05604	0.00047	486.6	5.6	489.9	9.2	436	19	0.7
15Ølv-2 - 189	0.607	0.013	0.0773	0.0017	0.60777	0.05631	0.00081	480.4	7.9	480	11	441	31	-0.1
15Ølv-2 - 190	0.609	0.01	0.0782	0.0016	0.52788	0.05607	0.0006	481.6	6.4	484.9	9.6	427	24	0.7
15Ølv-2 - 191	0.595	0.01	0.0756	0.0016	0.34878	0.0564	0.0007	472.5	6.5	469.3	9.3	441	28	-0.7
15Ølv-2 - 192	0.603	0.011	0.0763	0.0016	0.4618	0.057	0.00072	477.7	6.7	473.5	9.4	459	28	-0.9
15Ølv-2 - 193	0.618	0.011	0.0723	0.0015	0.59817	0.06154	0.00073	486.6	7.2	449.3	9.2	630	26	-8.3
15Ølv-2 - 194	0.5654	0.0097	0.0727	0.0015	0.53	0.05599	0.00064	453.5	6.3	451.8	9.1	426	26	-0.4
15Ølv-2 - 195	0.606	0.01	0.0777	0.0016	0.47818	0.05607	0.0006	479.5	6.4	482.5	9.4	431	24	0.6
15Ølv-2 - 196	0.632	0.011	0.0797	0.0016	0.52363	0.0569	0.00062	496.4	6.6	494.2	9.7	460	24	-0.4
15Ølv-2 - 197	0.5924	0.0094	0.0759	0.0015	0.4843	0.05605	0.00054	471.1	6	471.3	9	432	22	0.0
15Ølv-2 - 198	0.578	0.01	0.0743	0.0015	0.45745	0.05598	0.00066	461.9	6.4	461.9	9.1	419	26	0.0
15Ølv-2 - 199	0.5863	0.0099	0.0758	0.0015	0.44249	0.05577	0.00064	467.2	6.3	470.9	9.2	414	25	0.8
15Ølv-2 - 200	0.5836	0.0099	0.0744	0.0015	0.47304	0.05624	0.00063	465.5	6.4	462.2	9	442	25	-0.7
15Ølv-2 - 201	0.681	0.011	0.0837	0.0017	0.55386	0.05869	0.00064	526.2	6.9	518	10	531	24	-1.6
15Ølv-2 - 202	0.598	0.01	0.0765	0.0016	0.39972	0.0562	0.00069	474.6	6.6	475.5	9.3	432	27	0.2
15Ølv-2 - 203	0.3755	0.0072	0.0431	0.0011	0.69265	0.06477	0.00097	322.3	5.3	271.6	7	717	31	-18.7
15Ølv-2 - 204	0.5653	0.0087	0.0719	0.0014	0.46253	0.05654	0.00054	454.3	5.6	447.5	8.5	462	21	-1.5
15Ølv-2 - 205	0.5917	0.0095	0.0762	0.0015	0.4948	0.05605	0.00057	471.1	6.1	473.4	9	431	22	0.5
15Ølv-2 - 206	0.6053	0.0095	0.0778	0.0015	0.50171	0.05611	0.00053	479.5	6	482.5	9.2	439	21	0.6
15Ølv-2 - 207	0.5944	0.0092	0.0762	0.0015	0.065884	0.05634	0.0006	472.1	5.6	473	9	440	22	0.2
15Ølv-2 - 208	0.5841	0.0088	0.0756	0.0015	0.49187	0.05578	0.00049	466.4	5.6	469.3	8.8	427	20	0.6
15Ølv-2 - 209	0.601	0.011	0.0778	0.0017	0.56041	0.05578	0.00065	476.2	6.8	482.9	9.9	423	26	1.4
15Ølv-2 - 210	0.5913	0.0093	0.076	0.0015	0.45963	0.05615	0.00056	470.9	6	472.2	9.1	439	22	0.3
15Ølv-2 - 211	0.652	0.011	0.0793	0.0016	0.51664	0.05941	0.00067	507.6	6.9	491.8	9.7	552	25	-3.2
15Ølv-2 - 212	0.5814	0.0097	0.075	0.0015	0.3962	0.05612	0.00064	464.3	6.3	466	9.2	430	25	0.4
15Ølv-2 - 213	0.643	0.01	0.0809	0.0016	0.50045	0.05775	0.00059	503.1	6.3	501	9.7	497	22	-0.4
15Ølv-2 - 214	0.5923	0.0099	0.0762	0.0016	0.47929	0.05646	0.00064	471.2	6.3	473.6	9.4	443	25	0.5
15Ølv-2 - 215	0.611	0.01	0.0767	0.0015	0.53029	0.05785	0.00061	483	6.5	475.8	9.2	497	23	-1.5
15Ølv-2 - 216	0.658	0.012	0.0776	0.0016	0.36707	0.06171	0.00083	511.3	7.1	481.4	9.4	626	29	-6.2
15Ølv-2 - 217	0.5722	0.0094	0.0727	0.0015	0.54168	0.0575	0.00075	458	6.2	451.9	8.9	484	27	-1.3
15Ølv-2 - 218	0.607	0.012	0.0773	0.0017	0.51561	0.05672	0.00083	480.1	7.8	480	10	450	32	0.0
15Ølv-2 - 219	0.627	0.011	0.08	0.0016	0.54265	0.0567	0.00063	492.6	6.6	495.9	9.7	453	25	0.7
15Ølv-2 - 220	0.5985	0.0089	0.0768	0.0015	0.47859	0.0565	0.0005	475.4	5.6	476.6	9	454	20	0.3
15Ølv-2 - 221	0.484	0.01	0.0596	0.0014	0.49716	0.05877	0.00062	399.7	7.2	373.1	8.5	531	23	-7.1
15Ølv-2 - 222	0.5911	0.009	0.076	0.0015	0.47066	0.05623	0.00052	470.6	5.7	472.6	9	441	21	0.4
15Ølv-2 - 223	0.6005	0.0089	0.0773	0.0015	0.4177	0.05622	0.00051	477.2	5.7	479.9	9	444	20	0.6
15Ølv-2 - 224	0.575	0.013	0.0745	0.0016	0.46994	0.0557	0.00078	460.3	8	463.2	9.3	420	28	0.6
15Ølv-2 - 225	0.6092	0.0095	0.0772	0.0015	0.4643	0.05709	0.00057	481.9	6	479	9.2	472	22	-0.6
15Ølv-2 - 226	0.5859	0.0097	0.0751	0.0015	0.41939	0.05649	0.00062	467.5	6.2	466.3	8.9	445	24	-0.3
15Ølv-2 - 227	0.597	0.01	0.0769	0.0015	0.37295	0.05614	0.00068	474.2	6.5	477.4	9.2	429	27	0.7
15Ølv-2 - 228	0.578	0.011	0.0741	0.0015	0.40882	0.05636	0.00074	462.2	6.7	460.4	9.2	438	28	-0.4
15Ølv-2 - 229	0.6018	0.0096	0.0768	0.0015	0.5129	0.0567	0.00056	477.3	6.1	476.9	9.2	460	22	-0.1
15Ølv-2 - 230	0.5611	0.0095	0.0716	0.0014	0.52859	0.05639	0.0006	450.8	6.2	446	8.6	443	24	-1.1
15Ølv-2 - 231	0.625	0.011	0.08	0.0016	0.35899	0.05653	0.0007	491	6.6	496.2	9.7	437	27	1.0
15Ølv-2 - 232	0.585	0.011	0.0752	0.0015	0.43932	0.05629	0.00072	465.7	6.8	467.2	9.1	427	28	0.3
15Ølv-2 - 233	0.5803	0.0095	0.0742	0.0015	0.45725	0.05645	0.0006	463.5	6.1	460.8	8.9	450	24	-0.6
15Ølv-2 - 234	0.576	0.012	0.0743	0.0016	0.52766	0.05564	0.00079	460.2	7.4	461.6	9.8	419	32	0.3
15Ølv-2 - 235	0.585	0.011	0.0749	0.0018	0.40791	0.05668	0.00096	466.8	7.4	465	11	450	37	-0.4
15Ølv-2 - 236	0.643	0.016	0.0763	0.0019	0.53406	0.0606	0.0011	501.9	9.5	474	12	603	40	-5.9
15Ølv-2 - 237	0.5794	0.0099	0.0728	0.0015	0.42015	0.0573	0.00068	462.4	6.4	452.8	8.8	472	26	-2.1
15Ølv-2 - 238	0.633	0.014	0.0785	0.0019	0.42218	0.05796	0.0007	496.7	8.3	487	11	502	26	-2.0

Sample 15Ølv-3

	Isotopic Ratios							Calculated ages (Ma)						
ID	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Rho	$^{207/206}Pb$	2σ	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	$^{207/206}Pb$	2σ	Disc.
15Ølv-3 - 1	1.906	0.043	0.1793	0.0037	0.44875	0.0771	0.0012	1077	15	1062	20	1074	32	-0.3
15Ølv-3 - 2	1.773	0.04	0.1474	0.0038	0.50131	0.0878	0.0016	1032	15	886	22	1349	36	-16.5
15Ølv-3 - 3	1.795	0.058	0.1774	0.0045	0.22248	0.0755	0.0023	1024	22	1048	24	911	64	-12.4
15Ølv-3 - 4	1.809	0.045	0.1761	0.0038	0.35645	0.074	0.0014	1036	17	1044	21	977	40	-6.0
15Ølv-3 - 5	1.667	0.038	0.1656	0.0035	0.46601	0.0729	0.0011	989	15	986	19	965	33	-0.3
15Ølv-3 - 6	1.864	0.044	0.1814	0.0038	0.39641	0.0744	0.0013	1060	16	1072	21	993	36	-6.7
15Ølv-3 - 7	1.932	0.045	0.183	0.0039	0.37872	0.0764	0.0013	1084	16	1081	21	1047	35	-3.5
15Ølv-3 - 8	2.073	0.044	0.1931	0.0039	0.48515	0.0773	0.001	1134	14	1136	21	1097	27	-3.4
15Ølv-3 - 9	1.614	0.033	0.1632	0.0032	0.50613	0.07142	0.00083	972	13	973	18	946	24	0.1
15Ølv-3 - 10	1.758	0.04	0.171	0.0037	0.061534	0.0746	0.0011	1021	14	1015	20	1008	30	-1.3
15Ølv-3 - 11	1.767	0.04	0.1744	0.0037	0.38575	0.0736	0.0012	1026	15	1034	20	974	35	-5.3
15Ølv-3 - 12	1.437	0.035	0.1445	0.0032	0.058326	0.0723	0.0014	900	14	869	18	950	40	-3.6
15Ølv-3 - 13	2.243	0.045	0.1994	0.0039	0.58627	0.08069	0.00085	1190	14	1172	21	1198	21	0.7
15Ølv-3 - 14	2.13	0.047	0.1901	0.0041	0.56907	0.0812	0.0011	1154	15	1120	22	1206	25	4.3
15Ølv-3 - 15	1.936	0.041	0.1852	0.0037	0.51058	0.07574	0.00099	1092	15	1093	20	1060	26	-3.0
15Ølv-3 - 16	3.953	0.078	0.2742	0.0055	0.66568	0.104	0.001	1621	16	1563	28	1685	18	3.8
15Ølv-3 - 17	1.871	0.038	0.1812	0.0036	0.43286	0.07477	0.00093	1068	14	1072	19	1029	25	-3.8
15Ølv-3 - 18	1.892	0.044	0.1809	0.0038	0.39465	0.076	0.0013	1070	16	1070	21	1036	36	-3.3
15Ølv-3 - 19	1.882	0.043	0.1829	0.0039	0.37766	0.0748	0.0013	1069	15	1081	21	1010	35	-5.8
15Ølv-3 - 20	3.196	0.063	0.2307	0.0045	0.60574	0.09984	0.00096	1452	15	1336	23	1607	18	9.6
15Ølv-3 - 21	3.154	0.062	0.2473	0.0049	0.63339	0.0922	0.00088	1443	15	1425	25	1455	18	0.8
15Ølv-3 - 22	1.83	0.04	0.178	0.0037	0.57146	0.075	0.0011	1049	14	1053	20	1025	29	-2.3
15Ølv-3 - 23	1.836	0.042	0.1783	0.0039	0.52562	0.0748	0.0011	1052	15	1058	22	1035	31	-1.6
15Ølv-3 - 24	3.92	0.1	0.2143	0.0046	0.33802	0.1341	0.0029	1598	21	1251	24	2074	40	23.0
15Ølv-3 - 25	2.039	0.041	0.1917	0.0038	0.53625	0.07715	0.00085	1124	14	1129	20	1104	22	-1.8
15Ølv-3 - 26	1.866	0.043	0.1806	0.0038	0.40728	0.0753	0.0012	1060	15	1068	21	1025	34	-3.4
15Ølv-3 - 27	1.956	0.044	0.1878	0.0038	0.41817	0.0759	0.0012	1093	15	1108	20	1040	31	-5.1
15Ølv-3 - 28	1.912	0.055	0.185	0.0043	0.2848	0.0769	0.002	1070	20	1091	23	991	53	-8.0
15Ølv-3 - 29	4.295	0.091	0.2912	0.0062	0.52091	0.1074	0.0015	1687	17	1643	31	1731	25	2.5
15Ølv-3 - 30	1.76	0.035	0.175	0.0034	0.56965	0.07285	0.00078	1027	13	1038	18	993	21	-3.4
15Ølv-3 - 31	3.289	0.07	0.246	0.005	0.43784	0.0976	0.0013	1470	16	1415	26	1546	26	4.9
15Ølv-3 - 32	1.648	0.041	0.1387	0.0031	0.066702	0.0873	0.0016	975	14	835	17	1298	35	-16.8
15Ølv-3 - 33	1.186	0.033	0.1252	0.0035	0.56982	0.0698	0.0014	787	15	758	20	888	44	-3.8
15Ølv-3 - 34	1.752	0.035	0.1731	0.0034	0.57799	0.07341	0.00075	1026	13	1027	18	1012	21	-1.4
15Ølv-3 - 35	1.858	0.041	0.1811	0.0038	0.45979	0.0754	0.0011	1061	14	1071	21	1039	30	-2.1
15Ølv-3 - 36	3.983	0.086	0.2881	0.006	0.43532	0.1012	0.0015	1622	18	1629	30	1615	28	-0.4
15Ølv-3 - 37	5.74	0.24	0.2162	0.0047	0.65281	0.1879	0.0058	1866	35	1258	25	2595	51	28.1
15Ølv-3 - 38	1.691	0.038	0.1685	0.0036	0.33182	0.0739	0.0011	1001	15	1001	20	995	31	-0.6
15Ølv-3 - 39	2.108	0.049	0.1966	0.0041	0.45835	0.079	0.0013	1146	16	1154	22	1114	34	-2.9
15Ølv-3 - 40	2.059	0.045	0.1932	0.0039	0.038129	0.0779	0.0011	1127	15	1136	21	1091	29	-3.3
15Ølv-3 - 41	2.239	0.05	0.203	0.0042	0.45215	0.0804	0.0012	1187	16	1189	23	1174	30	-1.1
15Ølv-3 - 42	1.146	0.028	0.1124	0.0026	0.48722	0.0748	0.0013	770	13	686	15	1019	36	-12.2
15Ølv-3 - 43	1.642	0.036	0.1667	0.0034	0.48327	0.0722	0.001	980	14	992	19	948	30	1.2
15Ølv-3 - 44	1.894	0.047	0.1838	0.0041	0.38195	0.0762	0.0015	1070	17	1084	22	1030	41	-3.9
15Ølv-3 - 45	1.771	0.04	0.1719	0.0035	0.35885	0.0758	0.0012	1029	15	1022	20	1040	33	1.1
15Ølv-3 - 46	1.755	0.035	0.1761	0.0034	0.45117	0.07252	0.00085	1026	13	1045	19	983	24	-4.4
15Ølv-3 - 47	2.112	0.051	0.199	0.0042	0.38639	0.0777	0.0014	1143	17	1169	23	1085	35	-5.3
15Ølv-3 - 48	2.967	0.062	0.2356	0.0049	0.67019	0.0915	0.00099	1394	16	1363	26	1439	21	3.1
15Ølv-3 - 49	1.86	0.04	0.182	0.0037	0.40117	0.0749	0.0011	1063	15	1075	20	1027	30	-3.5
15Ølv-3 - 50	1.752	0.036	0.1729	0.0035	0.58557	0.07378	0.00087	1025	14	1026	19	1012	24	-1.3
15Ølv-3 - 51	4.69	0.1	0.2961	0.0056	0.43698	0.1151	0.0016	1761	18	1670	28	1860	25	5.3
15Ølv-3 - 52	3.486	0.07	0.2682	0.0054	0.60567	0.0948	0.001	1519	16	1529	27	1508	20	-0.7
15Ølv-3 - 53	1.709	0.035	0.1717	0.0034	0.48678	0.07232	0.0009	1007	13	1020	19	970	25	-3.8
15Ølv-3 - 54	1.94	0.043	0.1898	0.0039	0.44029	0.0747	0.0011	1087	15	1118	21	1010	32	-7.6
15Ølv-3 - 55	3.678	0.087	0.2731	0.0061	0.38192	0.0986	0.0018	1557	19	1553	31	1557	34	0.0
15Ølv-3 - 56	3.106	0.062	0.241	0.0047	0.54212	0.09357	0.00097	1431	16	1389	24	1482	20	3.4
15Ølv-3 - 57	3.203	0.066	0.2426	0.005	0.55226	0.0961	0.0012	1453	16	1397	26	1529	22	5.0
15Ølv-3 - 58	1.817	0.041	0.1768	0.0036	0.43905	0.0743	0.0011	1046	15	1048	20	1014	31	-3.2
15Ølv-3 - 59	1.962	0.046	0.1874	0.004	0.37938	0.0766	0.0014	1093	16	1105	22	1043	37	-4.8
15Ølv-3 - 60	1.934	0.044	0.1866	0.004	0.51875	0.0752	0.0011	1088	15	1101	22	1044	29	-4.2
15Ølv-3 - 61	1.818	0.041	0.1791	0.0037	0.42287	0.0736	0.0012	1045	15	1061	20	987	33	-5.9
15Ølv-3 - 62	3.688	0.073	0.2817	0.0056	0.56382	0.09452	0.0009	1562	16	1596	28	1505	18	-3.8
15Ølv-3 - 63	1.895	0.038	0.1853	0.0037	0.51288	0.07424	0.00088	1076	14	1095	20	1022	25	-5.3
15Ølv-3 - 64	2.175	0.054	0.1978	0.0043	0.39821	0.0802	0.0016	1161	18	1162	23	1126	40	-3.1
15Ølv-3 - 65	2.74	0.071	0.2329	0.0054	0.38145	0.0861	0.0018	1323	19	1344	28	1263	42	-4.8
15Ølv-3 - 66	1.924	0.046	0.1856	0.0039	0.41316	0.0749	0.0013	1080	16	1096	21	1020	34	-5.9
15Ølv-3 - 67	2.141	0.05	0.1962	0.0042	0.39358	0.0794	0.0014	1154	17	1153	22	1133	35	-1.9
15Ølv-3 - 68	1.735	0.038	0.1718	0.0036	0.46232	0.073	0.0011	1017	14	1020	20	975	31	-4.3
15Ølv-3 - 69	4.89	0.11	0.3254	0.0069	0.46398	0.109	0.0017	1790	19	1811	33	1744	28	-2.6
15Ølv-3 - 70	2.351	0.094	0.1702	0.0043	0.24669	0.0997	0.0035	1200	27	1012	24	1506	65	20.3
15Ølv-3 - 71	1.974	0.048	0.1828	0.004	0.43126	0.0777	0.0013	1102	16	1081	22	1117	34	1.3
15Ølv-3 - 72	2.426	0.053	0.2134	0.0044	0.12917	0.082	0.0012	1243	15	1245	23	1211	29	-2.6
15Ølv-3 - 73	2.105	0.041	0.1851	0.0034	0.47066	0.08174	0.00082	1147	13	1093	19	1227	20	6.5
15Ølv-3 - 74	2.091	0.058	0.1888	0.0044	0.26198	0.0814	0.002	1129	20	1111	24	1109	51	-1.8
15Ølv-3 - 75	1.914	0.041	0.1825	0.0037	0.37689	0.0755	0.0011	1081	14	1081	20	1047	31	-3.2
15Ølv-3 - 76	2.001	0.044	0.1869	0.0039	0.51254	0.0775	0.0011	1110	15	1103	21	1100	29	-0.9

15Ølv-3 - 76	2.001	0.044	0.1869	0.0039	0.51254	0.0775	0.0011	1110	15	1103	21	1100	29	-0.9
15Ølv-3 - 77	1.974	0.048	0.1446	0.0032	0.43204	0.0989	0.0018	1097	16	869	18	1558	34	-26.2
15Ølv-3 - 78	2.138	0.046	0.1991	0.004	0.41899	0.0778	0.0011	1155	15	1168	22	1105	29	-4.5
15Ølv-3 - 79	1.961	0.042	0.1922	0.0041	0.050233	0.07372	0.00098	1096	14	1130	21	1003	27	-9.3
15Ølv-3 - 80	2.228	0.049	0.1925	0.0039	0.35582	0.0837	0.0013	1183	15	1133	21	1251	31	5.4
15Ølv-3 - 81	2.045	0.04	0.1872	0.0037	0.52248	0.07933	0.00088	1128	14	1105	20	1158	22	2.6
15Ølv-3 - 82	2.597	0.063	0.1915	0.0042	0.44754	0.0981	0.0017	1290	18	1127	23	1550	34	16.8
15Ølv-3 - 83	1.221	0.033	0.1249	0.0033	0.53445	0.0713	0.0015	803	15	759	19	914	44	-5.8
15Ølv-3 - 84	2.947	0.066	0.236	0.0057	0.42515	0.0901	0.0015	1389	17	1363	30	1406	33	1.2
15Ølv-3 - 85	1.885	0.039	0.1817	0.0036	0.43998	0.07478	0.00095	1072	14	1074	20	1030	26	-4.1
15Ølv-3 - 86	1.993	0.045	0.1887	0.004	0.46928	0.0764	0.0012	1105	16	1111	22	1061	31	-4.1
15Ølv-3 - 87	1.867	0.04	0.1798	0.0037	0.45308	0.0745	0.001	1064	14	1068	20	1026	29	-3.7
15Ølv-3 - 88	1.91	0.041	0.1842	0.0039	0.49836	0.0754	0.0011	1078	14	1087	21	1048	28	-2.9
15Ølv-3 - 89	2.138	0.045	0.1986	0.004	0.49446	0.07744	0.00098	1156	15	1166	21	1103	26	-4.8
15Ølv-3 - 90	1.963	0.048	0.187	0.0041	0.34902	0.0765	0.0014	1090	16	1103	22	1024	39	-6.4
15Ølv-3 - 91	1.899	0.053	0.1838	0.0042	0.31905	0.0751	0.0018	1067	19	1085	23	974	49	-9.5
15Ølv-3 - 92	2.268	0.045	0.206	0.0041	0.55043	0.07921	0.00085	1199	14	1205	22	1158	22	-3.5
15Ølv-3 - 93	2.424	0.072	0.1843	0.0042	0.34884	0.0955	0.0024	1229	21	1087	23	1428	50	13.9
15Ølv-3 - 94	2.145	0.049	0.1942	0.0041	0.43468	0.0799	0.0013	1154	16	1141	22	1142	33	-1.1
15Ølv-3 - 95	1.892	0.04	0.1822	0.0037	0.5002	0.07511	0.00096	1072	14	1078	20	1037	26	-3.4
15Ølv-3 - 96	1.84	0.053	0.1776	0.0042	0.70887	0.0749	0.0017	1040	19	1049	22	983	47	-5.8
15Ølv-3 - 97	1.803	0.04	0.1752	0.0036	0.5083	0.0739	0.001	1041	15	1038	20	1008	29	-3.3
15Ølv-3 - 98	1.788	0.038	0.1758	0.0035	0.47563	0.07292	0.00095	1035	14	1043	19	988	26	-4.8
15Ølv-3 - 99	1.753	0.047	0.1738	0.0038	0.067577	0.0733	0.0017	1015	17	1032	21	924	48	-9.8
15Ølv-3 - 100	1.863	0.042	0.1785	0.0037	0.38224	0.0753	0.0012	1063	15	1057	20	1036	33	-2.6
15Ølv-3 - 101	2.841	0.07	0.1998	0.0042	0.39087	0.1027	0.0019	1352	18	1171	22	1609	35	16.0
15Ølv-3 - 102	3.021	0.062	0.2388	0.0048	0.59243	0.0911	0.001	1408	16	1378	25	1430	21	1.5
15Ølv-3 - 103	1.897	0.046	0.1821	0.0039	0.35834	0.0754	0.0014	1071	16	1076	21	1020	38	-5.0
15Ølv-3 - 104	1.859	0.043	0.1763	0.0041	0.65775	0.0759	0.0011	1062	15	1046	23	1078	28	1.5
15Ølv-3 - 105	1.999	0.044	0.1834	0.0038	0.47726	0.0787	0.0011	1109	15	1084	21	1124	29	1.3
15Ølv-3 - 106	4.034	0.082	0.2906	0.0057	0.50212	0.0994	0.0012	1636	17	1643	29	1589	22	-3.0
15Ølv-3 - 107	3.25	0.074	0.2546	0.0056	0.60391	0.092	0.0013	1458	17	1458	29	1437	26	-1.5
15Ølv-3 - 108	3.02	0.061	0.2369	0.0049	0.53909	0.0917	0.001	1408	15	1368	25	1452	22	3.0
15Ølv-3 - 109	2.087	0.041	0.1933	0.0037	0.17806	0.07735	0.00085	1139	13	1137	20	1102	21	-3.4
15Ølv-3 - 110	1.682	0.035	0.168	0.0034	0.59796	0.07186	0.00085	996	13	999	19	959	23	0.3
15Ølv-3 - 111	3.33	0.074	0.1374	0.0026	0.50999	0.1734	0.0023	1477	17	830	15	2562	22	-78.0
15Ølv-3 - 112	2.741	0.066	0.2279	0.0052	0.32418	0.0875	0.0017	1329	18	1320	27	1314	39	-1.1
15Ølv-3 - 113	1.923	0.039	0.1835	0.0036	0.15835	0.07526	0.0009	1083	13	1084	20	1045	24	-3.6
15Ølv-3 - 114	1.988	0.051	0.1878	0.0041	0.35103	0.0768	0.0016	1098	17	1107	22	1026	43	-7.0
15Ølv-3 - 115	10.42	0.2	0.4339	0.0086	0.47887	0.1728	0.0018	2467	18	2317	38	2571	17	4.0
15Ølv-3 - 116	1.564	0.034	0.1599	0.0032	0.45923	0.0703	0.001	952	14	956	18	892	30	0.4
15Ølv-3 - 117	2.162	0.045	0.1997	0.004	0.53175	0.0778	0.001	1165	15	1171	22	1117	26	-4.3
15Ølv-3 - 118	1.852	0.041	0.1764	0.0036	0.35322	0.0756	0.0012	1057	15	1046	20	1033	34	-2.3
15Ølv-3 - 119	1.869	0.046	0.1781	0.0038	0.33258	0.0757	0.0014	1062	17	1055	20	1032	39	-2.9
15Ølv-3 - 120	1.513	0.033	0.1304	0.0026	0.39597	0.0832	0.0012	933	14	789	15	1247	29	-18.3
15Ølv-3 - 121	1.944	0.038	0.153	0.0029	0.38961	0.0908	0.001	1094	13	917	16	1429	21	-19.3
15Ølv-3 - 122	1.864	0.039	0.1811	0.0038	0.61983	0.07407	0.00081	1066	14	1070	20	1025	23	-4.0
15Ølv-3 - 123	1.914	0.036	0.1825	0.0035	0.4709	0.07539	0.00069	1084	13	1079	19	1067	19	-1.6
15Ølv-3 - 124	2.344	0.056	0.194	0.0042	0.4286	0.0875	0.0015	1214	17	1140	23	1319	34	8.0
15Ølv-3 - 125	2.01	0.046	0.1951	0.0041	0.44203	0.0742	0.0012	1110	16	1148	22	997	33	-11.3
15Ølv-3 - 126	1.768	0.039	0.1645	0.0033	0.37729	0.0768	0.0011	1029	14	981	18	1079	30	-4.9
15Ølv-3 - 127	2.042	0.042	0.181	0.0037	0.54659	0.0812	0.00098	1125	14	1071	20	1196	24	5.9
15Ølv-3 - 128	1.791	0.042	0.173	0.0036	0.12186	0.0744	0.0013	1031	15	1027	20	981	33	-5.1
15Ølv-3 - 129	2.955	0.059	0.2246	0.0045	0.55376	0.0942	0.001	1391	15	1305	23	1493	21	6.8
15Ølv-3 - 130	2.337	0.049	0.209	0.0042	0.51112	0.0803	0.001	1218	15	1221	22	1170	26	-4.1
15Ølv-3 - 131	1.881	0.047	0.1699	0.0037	0.39711	0.0799	0.0015	1064	17	1010	21	1142	40	6.8
15Ølv-3 - 132	2.021	0.068	0.1905	0.0061	0.55583	0.0766	0.002	1111	23	1120	33	1050	57	-5.8
15Ølv-3 - 133	1.884	0.039	0.185	0.0037	0.53478	0.0734	0.00088	1073	14	1092	20	997	25	-7.6
15Ølv-3 - 134	3.71	0.083	0.1657	0.0034	0.26067	0.161	0.0027	1566	18	988	19	2437	29	-58.5
15Ølv-3 - 135	1.735	0.037	0.1722	0.0034	0.50129	0.07277	0.00099	1018	14	1023	19	967	28	-5.3
15Ølv-3 - 136	1.792	0.039	0.1763	0.0037	0.46958	0.0735	0.0011	1038	14	1046	20	986	30	-5.3
15Ølv-3 - 137	1.682	0.043	0.1531	0.0032	0.36802	0.0794	0.0015	993	16	917	18	1113	39	-8.3
15Ølv-3 - 138	1.754	0.043	0.172	0.0037	0.37138	0.0741	0.0014	1019	16	1021	21	977	39	-4.3
15Ølv-3 - 139	4.019	0.085	0.2893	0.0059	0.55728	0.1005	0.0013	1631	17	1635	30	1604	24	-1.7
15Ølv-3 - 140	1.838	0.04	0.1762	0.0035	0.51418	0.0749	0.00098	1053	14	1045	20	1041	26	-1.2
15Ølv-3 - 141	3.423	0.083	0.2662	0.0058	0.44762	0.0936	0.0017	1498	19	1518	30	1454	35	-3.0
15Ølv-3 - 142	1.833	0.039	0.1794	0.0036	0.48009	0.07411	0.00097	1052	14	1064	19	1020	27	-3.1
15Ølv-3 - 143	2.325	0.049	0.1784	0.0035	0.46735	0.0941	0.0012	1215	15	1057	19	1489	25	18.4
15Ølv-3 - 144	2.278	0.057	0.2013	0.0043	0.33766	0.0823	0.0016	1192	18	1181	23	1173	41	-1.6
15Ølv-3 - 145	2.217	0.048	0.1802	0.0033	0.28828	0.0893	0.0013	1180	15	1067	18	1368	29	13.7
15Ølv-3 - 146	11.18	0.22	0.4641	0.0093	0.61943	0.1745	0.0017	2535	18	2453	41	2589	16	2.1
15Ølv-3 - 147	1.798	0.039	0.1457	0.003	0.50587	0.0894	0.0013	1041	14	877	17	1393	27	-18.7
15Ølv-3 - 148	2.332	0.052	0.1741	0.0035	0.48391	0.0968	0.0014	1214	16	1033	19	1534	27	20.9
15Ølv-3 - 149	2.835	0.059	0.227	0.0049	0.60216	0.0908	0.0012	1361	16	1316	26	1418	25	4.0
15Ølv-3 - 150	1.894	0.046	0.1822	0.0038	0.12511	0.076	0.0015	1067	16	1077	21	1015	39	-5.1
15Ølv-3 - 151	1.854	0.043	0.181	0.0038	0.48103	0.0744	0.0012	1057	15	1071	20	1003	33	-5.4
15Ølv-3 - 152	2.522	0.064	0.1861	0.004	0.31032	0.0981	0.0019	1265	18	1097	22	1542	38	18.0
15Ølv-3 - 153	1.906	0.048	0.181	0.0038	0.27517	0.0772	0.0016	1072	17	1070	21	1046	41	-2.5
15Ølv-3 - 154	1.633	0.031	0.1531	0.0029	0.48802	0.07757	0.00081	982	12	918	16	1118	21	-7.0
15Ølv-3 - 155	2.161	0.053	0.1989	0.0043	0.35344	0.0792	0.0015	1158	17	1167	23	1108	38	-4.5

15Ølv-3 - 155	2.161	0.053	0.1989	0.0043	0.35344	0.0792	0.0015	1158	17	1167	23	1108	38	-4.5
15Ølv-3 - 156	7.18	0.2	0.2499	0.0062	0.55047	0.2086	0.0041	2104	26	1432	32	2853	33	26.3
15Ølv-3 - 157	3.41	0.08	0.1974	0.0042	0.37648	0.1278	0.0023	1501	19	1159	22	2025	32	25.9
15Ølv-3 - 158	1.531	0.032	0.1597	0.0031	0.45032	0.06975	0.00089	938	13	954	17	894	27	1.7
15Ølv-3 - 159	1.511	0.036	0.0986	0.0025	0.69472	0.1111	0.0016	930	15	605	15	1805	27	-53.7
15Ølv-3 - 160	5.81	0.15	0.27	0.0058	0.50554	0.1558	0.0028	1933	22	1539	29	2376	30	18.6
15Ølv-3 - 161	1.867	0.043	0.1816	0.0037	0.37461	0.0747	0.0012	1060	15	1073	20	1006	34	-5.4
15Ølv-3 - 162	3.45	0.13	0.1925	0.004	0.40778	0.1273	0.0036	1490	28	1134	22	2008	49	25.8
15Ølv-3 - 163	1.782	0.036	0.1677	0.0033	0.48714	0.07722	0.00096	1034	13	999	18	1095	25	-3.5
15Ølv-3 - 164	3.469	0.075	0.2632	0.0055	0.4976	0.0963	0.0013	1514	17	1504	28	1519	26	0.3
15Ølv-3 - 165	2.9	0.064	0.2409	0.005	0.38385	0.0876	0.0014	1372	17	1388	26	1331	30	-3.1
15Ølv-3 - 166	2.64	0.06	0.2273	0.005	0.66421	0.0838	0.001	1303	17	1317	26	1267	25	-2.8
15Ølv-3 - 167	1.707	0.037	0.17	0.0036	0.44041	0.0734	0.0011	1007	14	1012	20	984	31	-2.3
15Ølv-3 - 168	1.871	0.048	0.1806	0.0038	0.4034	0.0753	0.0014	1063	17	1068	21	1010	39	-5.2
15Ølv-3 - 169	1.814	0.036	0.1776	0.0034	0.5629	0.07368	0.00074	1049	13	1053	19	1016	21	-3.2
15Ølv-3 - 170	1.778	0.048	0.1736	0.0038	0.34129	0.074	0.0016	1022	18	1029	21	949	46	-7.7
15Ølv-3 - 171	2.594	0.049	0.2152	0.0038	0.44823	0.08665	0.00077	1296	14	1255	20	1340	17	3.3
15Ølv-3 - 172	1.787	0.037	0.1758	0.0035	0.50679	0.07316	0.0009	1036	13	1042	19	992	26	-4.4
15Ølv-3 - 173	1.887	0.041	0.1814	0.0036	0.44752	0.0749	0.001	1072	14	1073	20	1029	28	-4.2
15Ølv-3 - 174	1.832	0.057	0.1655	0.0041	0.38257	0.0806	0.0022	1041	21	986	23	1125	54	-5.6
15Ølv-3 - 175	2.78	0.076	0.231	0.0057	0.31082	0.0879	0.0021	1332	21	1336	30	1297	48	-2.7
15Ølv-3 - 176	1.88	0.037	0.1752	0.0033	0.52551	0.07757	0.00079	1071	13	1040	18	1119	21	4.3
15Ølv-3 - 177	2.227	0.057	0.1788	0.0041	0.50883	0.09	0.0017	1183	18	1060	23	1389	36	14.8
15Ølv-3 - 178	2.119	0.046	0.1965	0.0041	0.41235	0.0781	0.0012	1149	15	1154	22	1105	31	-4.0
15Ølv-3 - 179	1.767	0.037	0.1755	0.0035	0.42576	0.07313	0.00096	1029	14	1041	19	983	27	-4.7
15Ølv-3 - 180	1.883	0.039	0.1822	0.0036	0.52124	0.07426	0.00092	1070	14	1078	19	1023	26	-4.6
15Ølv-3 - 181	2.204	0.05	0.2026	0.0041	0.37891	0.0786	0.0012	1175	16	1188	22	1129	32	-4.1
15Ølv-3 - 182	1.723	0.035	0.1719	0.0033	0.50056	0.07208	0.0008	1014	13	1022	18	962	24	-5.4
15Ølv-3 - 183	2.664	0.068	0.2264	0.005	0.39929	0.0852	0.0017	1303	19	1312	26	1244	40	-4.7
15Ølv-3 - 184	2.197	0.046	0.2015	0.0041	0.28426	0.0791	0.001	1173	14	1181	22	1138	25	-3.1
15Ølv-3 - 185	1.776	0.044	0.1733	0.0038	0.37572	0.0745	0.0014	1026	16	1028	21	990	39	-3.6
15Ølv-3 - 186	1.919	0.053	0.1806	0.0041	0.34457	0.078	0.0018	1070	19	1067	22	1043	49	-2.6
15Ølv-3 - 187	1.74	0.04	0.1718	0.0036	0.33367	0.0739	0.0012	1017	15	1020	19	986	33	-3.1
15Ølv-3 - 188	2.007	0.052	0.1736	0.0038	0.27913	0.0845	0.0019	1107	18	1029	21	1211	44	8.6
15Ølv-3 - 189	1.959	0.049	0.1851	0.0041	0.37269	0.0767	0.0015	1088	17	1092	22	1035	42	-5.1
15Ølv-3 - 190	3.78	0.13	0.1648	0.0045	0.43724	0.1666	0.005	1571	29	982	25	2465	52	-60.0
15Ølv-3 - 191	3.208	0.063	0.2506	0.0049	0.5985	0.09216	0.00086	1455	15	1440	25	1456	18	0.1
15Ølv-3 - 192	2.058	0.041	0.1921	0.0038	0.51104	0.07715	0.00089	1132	14	1132	21	1105	24	-2.4
15Ølv-3 - 193	1.898	0.039	0.1831	0.0037	0.47722	0.07485	0.00093	1075	14	1082	20	1047	26	-2.7
15Ølv-3 - 194	4.357	0.097	0.281	0.0058	0.4772	0.1122	0.0017	1698	19	1593	29	1804	27	5.9
15Ølv-3 - 195	10.03	0.36	0.1532	0.0034	0.63591	0.464	0.012	2390	33	917	19	4073	37	-160.6
15Ølv-3 - 196	2.077	0.043	0.1775	0.0033	0.18633	0.0846	0.0011	1134	14	1053	18	1271	26	10.8
15Ølv-3 - 197	3.743	0.089	0.2328	0.0051	0.34958	0.1166	0.0022	1569	19	1348	27	1860	35	15.6
15Ølv-3 - 198	1.626	0.037	0.1662	0.0036	0.47509	0.0711	0.0011	974	14	991	20	908	33	1.7
15Ølv-3 - 199	2.786	0.059	0.2359	0.0051	0.54681	0.086	0.0011	1346	16	1364	27	1309	26	-2.8
15Ølv-3 - 200	5.35	0.14	0.267	0.0062	0.53493	0.1459	0.0027	1869	23	1521	31	2269	32	17.6
15Ølv-3 - 201	2.888	0.062	0.1624	0.0032	0.28991	0.1292	0.0019	1373	16	969	18	2057	27	-41.7
15Ølv-3 - 202	2.796	0.056	0.2351	0.0046	0.47275	0.0859	0.001	1351	15	1359	24	1314	23	-2.8
15Ølv-3 - 203	5.41	0.17	0.1743	0.0036	0.58184	0.2204	0.005	1846	28	1034	20	2915	38	36.7
15Ølv-3 - 204	5.47	0.11	0.3488	0.0068	0.60003	0.1131	0.0011	1893	17	1926	32	1842	17	-2.8
15Ølv-3 - 205	6.58	0.23	0.1299	0.0032	0.57441	0.3604	0.0094	2032	32	786	18	3711	41	-158.5
15Ølv-3 - 206	3.646	0.071	0.2748	0.0055	0.63287	0.09569	0.00093	1557	16	1561	27	1525	19	-2.1
15Ølv-3 - 207	4.157	0.088	0.2976	0.0066	0.63617	0.101	0.0013	1661	17	1675	33	1625	24	-2.2
15Ølv-3 - 208	7.33	0.19	0.2697	0.0057	0.30111	0.196	0.004	2139	23	1538	29	2754	33	22.3
15Ølv-3 - 209	3.983	0.084	0.2922	0.0061	0.58091	0.0983	0.0012	1623	17	1650	30	1578	23	-2.9
15Ølv-3 - 210	4.47	0.13	0.168	0.0048	0.3845	0.1934	0.0052	1714	24	1003	27	2738	44	37.4
15Ølv-3 - 211	1.639	0.037	0.1506	0.0034	0.73509	0.0785	0.00089	981	14	902	19	1138	23	-8.8
15Ølv-3 - 212	1.982	0.061	0.1809	0.0042	0.20649	0.0803	0.0023	1089	21	1068	23	1059	58	-2.8
15Ølv-3 - 213	3.67	0.16	0.2035	0.0074	0.40593	0.1415	0.0067	1486	40	1178	40	1920	93	22.6
15Ølv-3 - 214	2.64	0.092	0.1901	0.004	0.26544	0.1009	0.0031	1295	24	1120	22	1548	53	16.3
15Ølv-3 - 215	4.063	0.08	0.2894	0.0057	0.6156	0.10056	0.00098	1642	16	1636	28	1623	18	-1.2
15Ølv-3 - 216	4.26	0.086	0.3057	0.006	0.58391	0.0999	0.0011	1681	16	1716	30	1602	21	-4.9
15Ølv-3 - 217	3.586	0.074	0.2242	0.0048	0.61053	0.1159	0.0012	1538	17	1303	25	1878	19	18.1
15Ølv-3 - 218	12.32	0.25	0.5	0.01	0.63193	0.1778	0.0019	2623	19	2605	44	2629	18	0.2
15Ølv-3 - 219	2.78	0.1	0.1585	0.0032	0.31349	0.1265	0.0039	1326	26	947	18	1940	54	-40.0
15Ølv-3 - 220	1.848	0.036	0.1734	0.0032	0.49653	0.07635	0.00076	1059	13	1030	18	1087	20	2.6
15Ølv-3 - 221	4.779	0.094	0.2859	0.0051	0.55587	0.1199	0.0012	1776	16	1619	26	1942	17	8.5
15Ølv-3 - 222	2.703	0.053	0.2278	0.0046	0.69357	0.08512	0.00081	1325	15	1320	24	1301	19	-1.8
15Ølv-3 - 223	2.376	0.051	0.1673	0.0032	0.15225	0.1022	0.0016	1232	16	997	18	1639	30	-23.6
15Ølv-3 - 224	1.858	0.052	0.1781	0.004	0.30522	0.0761	0.0018	1051	19	1053	22	974	50	-7.9

Sample 15Ølv-4

	Isotopic Ratios							Calculated ages (Ma)						
ID	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Rho	$^{207/206}Pb$	2σ	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	$^{207/206}Pb$	2σ	Disc.
15Ølv-4 - 1	2.927	0.093	0.2073	0.0057	0.28985	0.101	0.0029	1379	24	1212	30	1603	54	14.0
15Ølv-4 - 2	4.03	0.11	0.1896	0.0047	0.37129	0.1526	0.0036	1631	23	1117	25	2341	40	30.3
15Ølv-4 - 3	4.01	0.097	0.2452	0.0053	0.45224	0.1171	0.002	1625	20	1411	27	1881	31	13.6
15Ølv-4 - 4	1.891	0.039	0.1801	0.0035	0.43244	0.07522	0.00094	1073	14	1067	19	1045	26	-2.7
15Ølv-4 - 5	1.982	0.044	0.1844	0.0039	0.44471	0.0772	0.0011	1103	15	1090	21	1086	30	-1.6
15Ølv-4 - 6	1.644	0.035	0.1063	0.002	0.20014	0.111	0.0018	985	14	651	12	1788	30	-51.3
15Ølv-4 - 7	1.779	0.035	0.1675	0.0031	0.47134	0.07585	0.00079	1035	13	998	17	1070	21	-3.7
15Ølv-4 - 8	2.178	0.04	0.1977	0.0035	0.44816	0.07853	0.00064	1171	13	1162	19	1147	16	-2.1
15Ølv-4 - 9	2.315	0.066	0.1685	0.003	0.036541	0.0981	0.0025	1203	19	1005	17	1518	43	20.8
15Ølv-4 - 10	1.338	0.034	0.1336	0.0028	0.39315	0.0714	0.0013	858	14	807	16	935	39	-6.3
15Ølv-4 - 11	2.124	0.044	0.1679	0.0035	0.71375	0.09072	0.00097	1154	14	1000	19	1428	20	19.2
15Ølv-4 - 12	1.643	0.041	0.1609	0.0034	0.42405	0.0732	0.0013	978	16	960	19	949	38	-1.9
15Ølv-4 - 13	13.41	0.83	0.327	0.016	0.48864	0.303	0.018	2610	62	1816	82	3340	97	21.9
15Ølv-4 - 14	4.098	0.082	0.2971	0.0059	0.54877	0.0991	0.0011	1647	16	1672	29	1589	21	-3.7
15Ølv-4 - 15	3.177	0.059	0.2471	0.0046	0.62183	0.0922	0.00076	1448	15	1421	24	1459	16	0.8
15Ølv-4 - 16	3.657	0.073	0.2635	0.0052	0.62017	0.1001	0.001	1558	16	1505	27	1608	18	3.1
15Ølv-4 - 17	3.437	0.068	0.2292	0.0042	0.56003	0.1074	0.0011	1509	15	1329	22	1738	18	13.2
15Ølv-4 - 18	2.927	0.057	0.247	0.0047	0.53185	0.08499	0.00085	1384	15	1420	24	1298	20	-6.6
15Ølv-4 - 19	1.887	0.038	0.1824	0.0035	0.50197	0.07407	0.00082	1071	13	1079	19	1021	23	-4.9
15Ølv-4 - 20	1.967	0.037	0.19	0.0035	0.56849	0.07429	0.00066	1101	13	1121	19	1033	18	-6.6
15Ølv-4 - 21	1.799	0.038	0.1726	0.0033	0.27591	0.0748	0.0011	1040	14	1025	18	1025	30	-1.5
15Ølv-4 - 22	1.869	0.063	0.1616	0.0058	0.60966	0.0839	0.0023	1063	23	963	32	1256	54	-10.4
15Ølv-4 - 23	1.525	0.04	0.1522	0.0033	0.50938	0.0718	0.0013	934	16	913	18	939	37	-2.3
15Ølv-4 - 24	3.189	0.062	0.2306	0.0044	0.48242	0.0993	0.001	1452	15	1336	23	1598	19	9.1
15Ølv-4 - 25	1.998	0.042	0.1894	0.0039	0.59197	0.07612	0.00089	1109	14	1116	21	1073	23	-3.4
15Ølv-4 - 26	1.742	0.036	0.1623	0.0032	0.62728	0.07747	0.00082	1020	13	968	18	1114	21	-5.4
15Ølv-4 - 27	1.768	0.05	0.1803	0.004	0.23998	0.0723	0.0018	1018	19	1067	22	868	52	-17.3
15Ølv-4 - 28	2.049	0.049	0.1886	0.0044	0.56991	0.0787	0.0013	1128	16	1112	24	1127	33	-0.1
15Ølv-4 - 29	2.1	0.043	0.1809	0.0039	0.54496	0.0842	0.0011	1146	14	1070	21	1279	25	10.4
15Ølv-4 - 30	0.646	0.016	0.0808	0.0017	0.43658	0.058	0.001	503.8	9.6	501	10	482	38	-0.6
15Ølv-4 - 31	1.69	0.066	0.1115	0.0033	0.52478	0.109	0.0033	977	25	680	19	1680	57	-43.7
15Ølv-4 - 32	6.1	0.12	0.3703	0.0072	0.58824	0.1196	0.0012	1986	17	2028	34	1934	18	-2.7
15Ølv-4 - 33	1.747	0.035	0.166	0.0032	0.48244	0.07592	0.00084	1023	13	990	18	1073	23	-3.3
15Ølv-4 - 34	2.073	0.052	0.1939	0.0043	0.14903	0.078	0.0013	1126	17	1140	23	1079	35	-4.4
15Ølv-4 - 35	1.855	0.037	0.1785	0.0034	0.52356	0.07521	0.00079	1061	13	1057	18	1054	21	-0.7
15Ølv-4 - 36	0.596	0.014	0.0771	0.0015	0.38789	0.05639	0.00089	471.6	8.6	478.2	9.2	423	34	1.4
15Ølv-4 - 37	4.143	0.083	0.3007	0.006	0.51407	0.0999	0.0011	1658	16	1691	30	1610	21	-3.0
15Ølv-4 - 38	2.033	0.044	0.1923	0.0038	0.47894	0.0765	0.001	1120	15	1132	21	1075	28	-4.2
15Ølv-4 - 39	3.78	0.14	0.2388	0.0082	0.72247	0.1153	0.0026	1572	28	1375	42	1864	41	15.7
15Ølv-4 - 40	1.572	0.036	0.1606	0.0033	0.46267	0.071	0.0011	953	14	959	19	914	32	0.6
15Ølv-4 - 41	2.671	0.054	0.2296	0.0047	0.44313	0.0849	0.001	1316	15	1331	24	1284	24	-2.5
15Ølv-4 - 42	3.018	0.061	0.2478	0.0049	0.54647	0.0885	0.001	1407	16	1424	25	1366	22	-3.0
15Ølv-4 - 43	2.816	0.054	0.2327	0.0045	0.57984	0.08746	0.00086	1356	14	1347	24	1353	19	-0.2
15Ølv-4 - 44	2.786	0.057	0.2341	0.0047	0.51064	0.0864	0.001	1346	15	1354	25	1323	24	-1.7
15Ølv-4 - 45	3.366	0.073	0.2621	0.0054	0.45756	0.0932	0.0013	1489	17	1497	28	1464	27	-1.7
15Ølv-4 - 46	1.42	0.029	0.1342	0.0027	0.62303	0.07664	0.00078	894	12	811	15	1088	20	-10.2
15Ølv-4 - 47	3.144	0.065	0.242	0.0049	0.55601	0.0941	0.0011	1439	16	1396	25	1484	23	3.0
15Ølv-4 - 48	2.279	0.052	0.2074	0.0044	0.42557	0.08	0.0013	1198	16	1213	24	1144	33	-4.7
15Ølv-4 - 49	2.133	0.042	0.1976	0.0039	0.54148	0.078	0.00088	1156	14	1160	21	1124	23	-2.8
15Ølv-4 - 50	1.773	0.045	0.1772	0.0039	0.0088377	0.0734	0.0015	1021	16	1048	21	922	43	-10.7
15Ølv-4 - 51	1.8	0.051	0.1776	0.0043	0.13827	0.0746	0.0019	1029	19	1047	22	941	53	-9.4
15Ølv-4 - 52	2.101	0.042	0.1965	0.0039	0.58507	0.07726	0.0008	1147	14	1156	21	1110	21	-3.3
15Ølv-4 - 53	1.759	0.034	0.1725	0.0033	0.58278	0.07348	0.00072	1028	13	1025	18	1006	20	-2.2
15Ølv-4 - 54	1.616	0.039	0.1642	0.0034	0.37249	0.0712	0.0012	967	15	978	19	900	37	1.1
15Ølv-4 - 55	1.643	0.038	0.1681	0.0034	0.34255	0.0709	0.0012	979	15	999	19	898	35	2.0
15Ølv-4 - 56	2.215	0.061	0.1562	0.0034	0.48177	0.1021	0.002	1169	18	934	19	1617	35	-25.2
15Ølv-4 - 57	3.458	0.071	0.2654	0.0055	0.56464	0.0943	0.0011	1513	16	1514	28	1492	22	-1.4
15Ølv-4 - 58	3.555	0.076	0.2746	0.0057	0.57281	0.0934	0.0011	1531	17	1561	28	1468	23	-4.3
15Ølv-4 - 59	5.25	0.12	0.3432	0.0077	0.49898	0.1109	0.0018	1847	20	1893	36	1772	30	-4.2
15Ølv-4 - 60	5.12	0.11	0.337	0.0073	0.4532	0.1103	0.0017	1831	20	1866	35	1776	28	-3.1
15Ølv-4 - 61	2.705	0.056	0.2073	0.004	0.38812	0.0938	0.0012	1326	15	1214	22	1484	25	10.6
15Ølv-4 - 62	3.312	0.07	0.2586	0.0055	0.52228	0.0925	0.0012	1478	17	1478	28	1453	26	-1.7
15Ølv-4 - 63	1.573	0.049	0.1581	0.0038	0.29395	0.0723	0.002	942	19	944	21	875	58	0.2
15Ølv-4 - 64	4.008	0.079	0.2909	0.0058	0.44329	0.0995	0.0011	1631	16	1642	29	1594	20	-2.3
15Ølv-4 - 65	2.035	0.045	0.1927	0.0041	0.44117	0.077	0.0011	1121	15	1130	21	1077	30	-4.1
15Ølv-4 - 66	3.999	0.081	0.2887	0.0058	0.55174	0.0998	0.0011	1630	17	1631	29	1605	21	-1.6
15Ølv-4 - 67	1.838	0.04	0.1785	0.0037	0.53389	0.07456	0.00099	1052	14	1057	20	1024	27	-2.7
15Ølv-4 - 68	1.724	0.035	0.1709	0.0033	0.48051	0.07234	0.00084	1014	13	1017	18	975	24	-4.0
15Ølv-4 - 69	1.846	0.042	0.1816	0.0038	0.33419	0.074	0.0013	1055	15	1074	20	979	35	-7.8
15Ølv-4 - 70	3.948	0.082	0.2856	0.0059	0.37768	0.1002	0.0012	1618	17	1612	28	1604	23	-0.9
15Ølv-4 - 71	4.86	0.11	0.2332	0.0051	0.59517	0.1499	0.002	1791	18	1349	26	2331	23	23.2
15Ølv-4 - 72	2.113	0.046	0.1872	0.0037	0.07094	0.0815	0.0012	1144	14	1104	20	1186	29	3.5
15Ølv-4 - 73	4.28	0.09	0.257	0.0052	0.63873	0.1201	0.0013	1683	17	1470	27	1938	20	13.2
15Ølv-4 - 74	1.908	0.04	0.1826	0.0036	0.50424	0.07555	0.00095	1081	14	1079	19	1053	26	-2.7
15Ølv-4 - 75	1.873	0.042	0.1829	0.0038	0.24735	0.0743	0.0011	1061	14	1081	21	1003	28	-5.8
15Ølv-4 - 76	3.298	0.065	0.2574	0.005	0.59208	0.09262	0.0009	1476	15	1473	26	1460	19	-1.1

15Ølv-4 - 76	3.298	0.065	0.2574	0.005	0.59208	0.09262	0.0009	1476	15	1473	26	1460	19	-1.1
15Ølv-4 - 77	3.56	0.071	0.2691	0.0054	0.58174	0.0957	0.0011	1535	16	1532	27	1522	20	-0.9
15Ølv-4 - 78	2.717	0.054	0.2274	0.0045	0.069556	0.08627	0.00092	1327	15	1320	24	1318	21	-0.7
15Ølv-4 - 79	2.015	0.04	0.1871	0.0037	0.47704	0.07785	0.00092	1118	14	1105	20	1119	24	0.1
15Ølv-4 - 80	1.91	0.04	0.1807	0.0036	0.53143	0.0762	0.0009	1081	14	1071	20	1084	24	0.3
15Ølv-4 - 81	5.99	0.37	0.194	0.0058	0.68155	0.217	0.01	1893	55	1140	31	2826	81	33.0
15Ølv-4 - 82	1.693	0.033	0.1678	0.0033	0.52779	0.07322	0.00078	1005	13	999	18	994	22	-0.6
15Ølv-4 - 83	2.186	0.049	0.1496	0.003	0.3104	0.1064	0.0018	1170	16	898	17	1710	31	-30.3
15Ølv-4 - 84	3.064	0.062	0.2454	0.005	0.058527	0.0908	0.0011	1417	16	1412	26	1412	23	-0.4
15Ølv-4 - 85	1.896	0.043	0.1832	0.0039	0.40557	0.0756	0.0012	1071	15	1082	21	1026	33	-4.4
15Ølv-4 - 86	1.957	0.042	0.1766	0.0034	0.35044	0.0806	0.0012	1097	15	1048	19	1183	30	7.3
15Ølv-4 - 87	2.087	0.043	0.1965	0.0039	0.45968	0.07707	0.00095	1139	14	1155	21	1101	25	-3.5
15Ølv-4 - 88	1.817	0.035	0.1797	0.0034	0.58035	0.07325	0.0007	1048	13	1064	19	1007	20	-4.1
15Ølv-4 - 89	2.121	0.05	0.197	0.0042	0.34919	0.0789	0.0014	1146	17	1158	22	1118	36	-2.5
15Ølv-4 - 90	2.043	0.045	0.1925	0.0039	0.36086	0.0774	0.0012	1124	15	1133	21	1092	32	-2.9
15Ølv-4 - 91	2.604	0.056	0.2225	0.0044	0.07733	0.0852	0.0012	1291	15	1293	23	1278	26	-1.0
15Ølv-4 - 92	1.913	0.039	0.1845	0.0036	0.41853	0.07549	0.00098	1082	14	1091	20	1055	27	-2.6
15Ølv-4 - 93	1.737	0.038	0.1731	0.0034	0.42732	0.0733	0.001	1016	14	1028	19	980	30	-3.7
15Ølv-4 - 94	3.432	0.069	0.2712	0.0054	0.54922	0.09206	0.00095	1505	16	1543	27	1449	20	-3.9
15Ølv-4 - 95	1.686	0.044	0.167	0.0037	0.32029	0.074	0.0016	992	17	993	20	951	45	0.1
15Ølv-4 - 96	1.716	0.042	0.1713	0.0036	0.22521	0.073	0.0015	1006	16	1019	20	940	42	-7.0
15Ølv-4 - 97	13.12	0.31	0.507	0.013	0.64573	0.1877	0.0029	2676	22	2630	54	2703	26	1.0
15Ølv-4 - 98	3.05	0.075	0.2215	0.0054	0.63483	0.0992	0.0016	1415	19	1288	28	1596	31	11.3
15Ølv-4 - 99	1.764	0.038	0.1744	0.0036	0.49704	0.0737	0.001	1028	14	1035	20	994	29	-3.4
15Ølv-4 - 100	1.752	0.039	0.1702	0.0035	0.43009	0.0746	0.0011	1021	14	1012	19	1011	31	-1.0
15Ølv-4 - 101	1.753	0.039	0.1773	0.0037	0.51116	0.072	0.0011	1025	15	1050	20	943	31	-8.7
15Ølv-4 - 102	1.762	0.049	0.1729	0.004	0.22254	0.0755	0.0019	1018	19	1025	22	956	53	-6.5
15Ølv-4 - 103	1.72	0.046	0.1679	0.004	0.41115	0.0732	0.0015	1011	17	999	22	990	45	-1.2
15Ølv-4 - 104	1.746	0.04	0.1709	0.0035	0.41618	0.0741	0.0012	1017	15	1016	19	993	33	-2.4
15Ølv-4 - 105	1.745	0.039	0.1689	0.0034	0.38496	0.0747	0.0012	1018	15	1005	19	1012	32	-0.6
15Ølv-4 - 106	1.76	0.037	0.1738	0.0035	0.45194	0.073	0.001	1027	14	1031	19	976	29	-5.2
15Ølv-4 - 107	1.751	0.039	0.1738	0.0034	0.37563	0.0728	0.0011	1022	15	1031	19	962	31	-6.2
15Ølv-4 - 108	4.251	0.089	0.3011	0.006	0.47261	0.1014	0.0013	1677	17	1694	30	1631	24	-2.8
15Ølv-4 - 109	1.65	0.04	0.1603	0.0035	0.50387	0.0739	0.0012	981	15	956	19	990	34	-2.6
15Ølv-4 - 110	1.782	0.042	0.1727	0.0038	0.38021	0.0749	0.0014	1031	15	1024	21	997	38	-3.4
15Ølv-4 - 111	2.454	0.048	0.2137	0.0041	0.3154	0.08217	0.00087	1254	14	1247	22	1227	20	-2.2
15Ølv-4 - 112	1.705	0.04	0.1636	0.0036	0.47629	0.0744	0.0011	1003	15	974	20	1016	32	-3.0
15Ølv-4 - 113	2.012	0.047	0.1859	0.0039	0.451	0.0778	0.0013	1113	16	1097	21	1089	34	-2.2
15Ølv-4 - 114	1.728	0.034	0.17	0.0033	0.46967	0.07299	0.00084	1016	13	1011	18	990	24	-2.6
15Ølv-4 - 115	2.337	0.05	0.1854	0.0039	0.43643	0.091	0.0013	1217	15	1094	21	1415	28	14.0
15Ølv-4 - 116	1.765	0.059	0.1728	0.0042	0.19688	0.0744	0.0023	1008	22	1023	23	886	64	-13.8
15Ølv-4 - 117	1.831	0.057	0.179	0.0042	0.18691	0.0749	0.0022	1034	21	1058	23	902	61	-14.6
15Ølv-4 - 118	1.866	0.046	0.1799	0.0039	0.33503	0.0751	0.0015	1058	17	1063	21	992	40	-6.7
15Ølv-4 - 119	2.232	0.05	0.2042	0.0043	0.47907	0.0789	0.0012	1183	16	1196	23	1118	31	-5.8
15Ølv-4 - 120	2.012	0.042	0.1893	0.0039	0.54442	0.07627	0.00093	1114	14	1115	21	1075	25	-3.6
15Ølv-4 - 121	3.302	0.07	0.2212	0.0045	0.5707	0.1065	0.0013	1474	16	1285	24	1719	23	14.3
15Ølv-4 - 122	4.327	0.08	0.2891	0.0053	0.58467	0.10653	0.00087	1695	15	1635	27	1731	15	2.1
15Ølv-4 - 123	0.852	0.024	0.1008	0.0022	0.16048	0.0612	0.0015	617	13	618	13	544	53	0.2
15Ølv-4 - 124	1.877	0.046	0.1808	0.0037	0.30991	0.0748	0.0014	1063	16	1069	20	998	38	-6.5
15Ølv-4 - 125	1.857	0.044	0.1773	0.0039	0.444	0.0757	0.0013	1060	16	1051	22	1040	35	-1.9
15Ølv-4 - 126	1.864	0.046	0.1783	0.0039	0.34273	0.0757	0.0015	1057	17	1056	21	1002	42	-5.5
15Ølv-4 - 127	3.487	0.069	0.2722	0.0055	0.60621	0.0923	0.00096	1520	16	1549	28	1454	20	-4.5
15Ølv-4 - 128	2.177	0.041	0.1926	0.0034	0.48501	0.08095	0.00076	1171	13	1135	19	1203	19	2.7
15Ølv-4 - 129	2.073	0.048	0.189	0.0042	0.51973	0.079	0.0012	1138	16	1114	23	1150	32	1.0
15Ølv-4 - 130	2.129	0.043	0.1971	0.0039	0.5129	0.07769	0.00089	1154	14	1158	21	1122	23	-2.9
15Ølv-4 - 131	1.466	0.039	0.1229	0.0027	0.31846	0.0865	0.0019	905	17	746	16	1265	46	-21.3
15Ølv-4 - 132	4.15	0.095	0.2939	0.0071	0.59166	0.1022	0.0016	1657	19	1655	35	1636	30	-1.3
15Ølv-4 - 133	0.927	0.033	0.0709	0.0018	0.43277	0.0949	0.0027	663	17	441	11	1463	54	-50.3
15Ølv-4 - 134	2.546	0.056	0.2197	0.0045	0.43009	0.0838	0.0012	1278	16	1278	24	1257	29	-1.7
15Ølv-4 - 135	1.583	0.033	0.1516	0.003	0.4717	0.07565	0.00098	959	13	908	17	1055	26	-5.6
15Ølv-4 - 136	1.983	0.041	0.1703	0.0034	0.33392	0.0849	0.0012	1105	14	1012	19	1271	28	13.1
15Ølv-4 - 137	1.939	0.041	0.1626	0.0032	0.3864	0.0859	0.0012	1092	14	971	18	1311	28	-12.5
15Ølv-4 - 138	2.449	0.053	0.1746	0.0034	0.44681	0.1011	0.0014	1250	16	1036	18	1614	25	22.6
15Ølv-4 - 139	2.114	0.042	0.1855	0.0037	0.19813	0.08264	0.00095	1150	14	1095	20	1235	23	6.9
15Ølv-4 - 140	2.152	0.043	0.2031	0.004	0.53689	0.07675	0.00085	1161	14	1190	22	1092	22	-6.3
15Ølv-4 - 141	1.891	0.041	0.1823	0.0038	0.41421	0.0751	0.0011	1072	15	1079	21	1033	31	-3.8
15Ølv-4 - 142	1.922	0.039	0.1857	0.0036	0.54988	0.07458	0.00083	1085	14	1097	20	1039	23	-4.4
15Ølv-4 - 143	1.839	0.042	0.1764	0.0036	0.31215	0.076	0.0013	1052	15	1045	20	1033	35	-1.8
15Ølv-4 - 144	1.983	0.042	0.1612	0.0031	0.33539	0.0891	0.0013	1103	14	963	17	1367	28	-14.5
15Ølv-4 - 145	3.054	0.061	0.2098	0.004	0.39933	0.1052	0.0013	1418	15	1226	21	1701	22	16.6
15Ølv-4 - 146	2.336	0.047	0.2021	0.0037	0.48963	0.08363	0.00093	1220	15	1186	20	1262	21	3.3
15Ølv-4 - 147	3.029	0.067	0.2433	0.005	0.40333	0.0906	0.0014	1408	17	1401	26	1406	30	-0.1
15Ølv-4 - 148	1.869	0.039	0.1827	0.0036	0.47669	0.07383	0.00094	1065	14	1081	20	1007	26	-5.8
15Ølv-4 - 149	1.979	0.066	0.1708	0.0042	0.024675	0.0844	0.0024	1083	22	1013	23	1159	59	6.6
15Ølv-4 - 150	2.091	0.049	0.1899	0.0039	0.27949	0.08	0.0013	1136	16	1119	21	1139	33	0.3
15Ølv-4 - 151	4.104	0.088	0.2991	0.0061	0.45177	0.0997	0.0014	1645	17	1684	31	1580	27	-4.1
15Ølv-4 - 152	1.736	0.035	0.1727	0.0034	0.55409	0.07274	0.0008	1018	13	1026	19	985	23	-3.4
15Ølv-4 - 153	1.887	0.039	0.1849	0.0035	0.48329	0.07373	0.00086	1072	14	1093	19	1008	24	-6.3
15Ølv-4 - 154	2.118	0.043	0.1342	0.0026	0.0052111	0.1139	0.0014	1151	14	811	15	1842	22	-41.9
15Ølv-4 - 155	1.866	0.039	0.1806	0.0036	0.44281	0.07478	0.00097	1064	14	1068	19	1032	27	-3.1

15Ølv-4 - 156	4.211	0.09	0.297	0.006	0.51412	0.1027	0.0014	1667	17	1673	30	1641	25	-1.6
15Ølv-4 - 157	1.988	0.051	0.1968	0.0046	0.44142	0.0734	0.0014	1099	17	1154	25	974	38	-12.8
15Ølv-4 - 158	1.714	0.036	0.1594	0.003	0.39225	0.0777	0.001	1009	14	952	17	1110	27	-6.0
15Ølv-4 - 159	1.897	0.066	0.1784	0.0044	0.20654	0.079	0.0025	1051	24	1056	24	967	69	-8.7
15Ølv-4 - 160	1.741	0.038	0.1734	0.0035	0.40154	0.0729	0.0011	1017	14	1029	19	966	31	-5.3
15Ølv-4 - 161	1.867	0.042	0.1794	0.0038	0.4647	0.0756	0.0011	1065	15	1061	21	1052	30	-1.2
15Ølv-4 - 162	3.19	0.064	0.2552	0.0051	0.64361	0.09046	0.00093	1450	16	1461	26	1420	20	-2.1
15Ølv-4 - 163	1.871	0.037	0.1842	0.0036	0.51931	0.07345	0.00082	1068	13	1089	20	1009	23	-5.8
15Ølv-4 - 164	1.712	0.038	0.1514	0.003	0.57791	0.0816	0.001	1010	14	909	17	1211	25	-11.1
15Ølv-4 - 165	1.819	0.044	0.1745	0.0037	0.36262	0.076	0.0014	1044	16	1035	20	1024	39	-2.0
15Ølv-4 - 166	1.992	0.053	0.1887	0.0042	0.37002	0.0774	0.0017	1100	18	1112	23	1039	46	-5.9
15Ølv-4 - 167	1.869	0.05	0.1849	0.0044	0.34619	0.0743	0.0016	1058	18	1089	24	951	47	-11.3
15Ølv-4 - 168	2.181	0.048	0.2046	0.0043	0.49286	0.0776	0.0011	1169	15	1197	23	1103	29	-6.0
15Ølv-4 - 169	5.13	0.18	0.2429	0.0061	0.14075	0.1544	0.0053	1813	30	1400	31	2296	60	21.0
15Ølv-4 - 170	1.905	0.057	0.1862	0.0044	0.26573	0.0756	0.002	1072	20	1098	24	976	55	-9.8
15Ølv-4 - 171	1.533	0.03	0.1595	0.003	0.59385	0.06938	0.00067	941	12	953	17	889	21	1.3
15Ølv-4 - 172	4.034	0.083	0.2959	0.0061	0.63234	0.0988	0.0011	1636	17	1669	30	1581	20	-3.5
15Ølv-4 - 173	3.797	0.069	0.2762	0.0049	0.57857	0.09912	0.00075	1590	15	1570	25	1599	14	0.6
15Ølv-4 - 174	2.042	0.045	0.1929	0.004	0.46902	0.0769	0.0011	1125	15	1135	22	1078	30	-4.4
15Ølv-4 - 175	5.41	0.1	0.3426	0.0066	0.6124	0.1148	0.0011	1882	16	1898	32	1862	16	-1.1
15Ølv-4 - 176	1.825	0.054	0.1783	0.0041	0.26021	0.0758	0.0019	1039	20	1056	23	958	54	-8.5
15Ølv-4 - 177	2.899	0.058	0.2417	0.0048	0.67039	0.08697	0.00082	1377	15	1392	25	1344	18	-2.5
15Ølv-4 - 178	8.29	0.18	0.3776	0.0083	0.6804	0.1585	0.002	2258	20	2061	39	2426	22	6.9

Sample 15Ølv-7

	Isotopic Ratios							Calculated ages (Ma)						
ID	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Rho	$^{207/206}Pb$	2σ	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	$^{207/206}Pb$	2σ	Disc.
15Ølv-7 - 1	3.566	0.039	0.2711	0.0036	0.56669	0.0946	0.0011	1536.9	8.9	1544	18	1503	21	-2.3
15Ølv-7 - 2	0.697	0.013	0.087	0.0016	0.62174	0.05785	0.00094	534.8	8.2	536.7	9.2	484	35	0.4
15Ølv-7 - 3	3.61	0.044	0.2759	0.004	0.55755	0.0949	0.0011	1545.5	9.8	1566	20	1503	23	-2.8
15Ølv-7 - 4	3.574	0.046	0.2776	0.0042	0.60448	0.0921	0.0011	1536	10	1578	21	1455	23	-5.6
15Ølv-7 - 5	2.856	0.045	0.2098	0.0037	0.65952	0.0983	0.0013	1365	12	1225	20	1574	26	13.3
15Ølv-7 - 6	4.659	0.052	0.3146	0.0042	0.56573	0.1075	0.0012	1754.6	9.2	1758	21	1730	21	-1.4
15Ølv-7 - 7	0.893	0.011	0.1064	0.0014	0.11357	0.06072	0.00076	645.1	5.9	651.7	8	590	27	1.0
15Ølv-7 - 8	3.659	0.037	0.2746	0.0035	0.64579	0.09622	0.00087	1558.4	8.2	1561	18	1540	17	-1.2
15Ølv-7 - 9	18.18	0.68	0.3604	0.0073	0.62356	0.3481	0.0088	2902	35	1967	33	3607	40	19.5
15Ølv-7 - 10	3.486	0.04	0.2763	0.0036	0.58737	0.09056	0.00095	1519.3	9	1571	18	1426	20	-6.5
15Ølv-7 - 11	0.8699	0.0094	0.08684	0.001	0.49624	0.07199	0.00074	633.9	5.1	536.6	5.8	971	21	-18.1
15Ølv-7 - 12	1.731	0.024	0.1731	0.0024	0.11116	0.07242	0.00099	1013.2	8.8	1027	13	953	28	-6.3
15Ølv-7 - 13	2.682	0.059	0.2315	0.0041	0.32174	0.0853	0.002	1309	17	1338	22	1214	48	-7.8
15Ølv-7 - 14	5.5	0.15	0.218	0.0031	0.40607	0.1812	0.0044	1883	24	1270	16	2617	40	28.0
15Ølv-7 - 15	1.794	0.03	0.178	0.0027	0.46621	0.073	0.0012	1036	11	1054	15	973	32	-6.5
15Ølv-7 - 16	2.831	0.03	0.2384	0.0029	0.43971	0.08555	0.00085	1361.3	7.7	1376	15	1309	20	-4.0
15Ølv-7 - 17	3.591	0.059	0.2688	0.0049	0.58409	0.0968	0.0015	1539	13	1529	25	1546	28	0.5
15Ølv-7 - 18	4.432	0.045	0.3077	0.0039	0.63983	0.10385	0.00094	1717.1	8.6	1725	19	1679	17	-2.3
15Ølv-7 - 19	2.497	0.044	0.2186	0.0036	0.50817	0.082	0.0013	1260	13	1272	19	1197	33	-5.3
15Ølv-7 - 20	0.816	0.017	0.0817	0.0012	0.35521	0.0718	0.0014	599.3	9.3	505.4	7.4	923	41	-18.6
15Ølv-7 - 21	1.66	0.019	0.1669	0.0022	0.43217	0.07169	0.00082	990	7.1	994	12	956	23	0.4
15Ølv-7 - 22	3.428	0.053	0.2685	0.0042	0.50585	0.0926	0.0014	1500	12	1529	22	1445	28	-3.8
15Ølv-7 - 23	1.725	0.034	0.1735	0.0028	0.31534	0.0722	0.0015	1005	13	1029	15	900	45	-11.7
15Ølv-7 - 24	13.78	0.15	0.5145	0.0069	0.56025	0.1928	0.0021	2728	11	2668	29	2753	18	0.9
15Ølv-7 - 25	0.883	0.011	0.1061	0.0014	0.41115	0.06017	0.0008	639.3	6	649.2	8	572	29	1.5
15Ølv-7 - 26	0.635	0.012	0.0814	0.0012	0.25723	0.0564	0.0012	496.6	7.7	503.8	6.9	405	44	1.4
15Ølv-7 - 27	3.442	0.039	0.274	0.0033	0.09003	0.0906	0.001	1508.4	8.8	1558	17	1414	22	-6.7
15Ølv-7 - 28	1.654	0.021	0.168	0.0022	0.5357	0.07077	0.00086	987	8	999	12	924	25	1.2
15Ølv-7 - 29	4.456	0.046	0.3094	0.0038	0.54226	0.104	0.0011	1718.9	8.7	1735	19	1682	19	-2.2
15Ølv-7 - 30	5.687	0.056	0.3432	0.0041	0.59862	0.1196	0.0011	1925	8.6	1898	20	1934	17	0.5
15Ølv-7 - 31	4.513	0.056	0.3123	0.0043	0.56742	0.1048	0.0013	1727	10	1747	21	1688	22	-2.3
15Ølv-7 - 32	4.179	0.055	0.3009	0.0041	0.4983	0.1002	0.0013	1663	11	1693	20	1604	24	-3.7
15Ølv-7 - 33	0.954	0.02	0.1021	0.0018	0.2689	0.0684	0.0016	673	11	627	10	787	49	-7.3
15Ølv-7 - 34	4.262	0.049	0.3005	0.004	0.51765	0.1025	0.0012	1680.8	9.6	1689	20	1648	22	-2.0
15Ølv-7 - 35	3.987	0.042	0.2863	0.0036	0.55183	0.1006	0.001	1628.3	8.5	1620	18	1619	19	-0.6
15Ølv-7 - 36	2.01	0.023	0.1892	0.0024	0.5536	0.07645	0.00084	1114.7	7.9	1115	13	1091	23	-2.2
15Ølv-7 - 37	6.33	0.1	0.2682	0.0047	0.79055	0.1702	0.0018	2017	14	1530	24	2551	18	20.9
15Ølv-7 - 38	2.125	0.034	0.1911	0.0029	0.35649	0.0812	0.0014	1150	11	1124	16	1181	33	2.6
15Ølv-7 - 39	3.064	0.034	0.249	0.0033	0.55425	0.08904	0.00094	1420.2	8.4	1432	17	1391	20	-2.1
15Ølv-7 - 40	3.65	0.05	0.2775	0.004	0.50947	0.0956	0.0013	1553	11	1574	20	1513	26	-2.6
15Ølv-7 - 41	4.132	0.044	0.3014	0.0038	0.5454	0.0992	0.0011	1656.9	8.8	1697	19	1594	20	-3.9
15Ølv-7 - 42	3.531	0.034	0.2743	0.0034	0.6175	0.09279	0.00083	1530.4	7.6	1560	17	1473	17	-3.9
15Ølv-7 - 43	2.137	0.031	0.1989	0.0027	0.41012	0.0778	0.0012	1153	10	1167	14	1100	30	-4.8
15Ølv-7 - 44	5.322	0.054	0.3372	0.0042	0.61271	0.1139	0.0011	1867.1	8.7	1869	20	1850	17	-0.9
15Ølv-7 - 45	3.704	0.061	0.2443	0.0033	0.3934	0.1093	0.0017	1562	13	1407	17	1759	30	11.2
15Ølv-7 - 46	4.937	0.048	0.3315	0.0039	0.38255	0.10742	0.00095	1802.7	8.1	1842	19	1742	16	-3.5
15Ølv-7 - 47	2.101	0.027	0.1949	0.0026	0.19717	0.07728	0.00086	1141.8	8.5	1147	14	1104	22	-3.4
15Ølv-7 - 48	0.681	0.011	0.0803	0.0011	0.34731	0.0611	0.001	525.2	6.7	497.2	6.8	597	36	-5.6
15Ølv-7 - 49	3.842	0.037	0.2903	0.0036	0.57236	0.09532	0.00089	1597.7	7.8	1640	18	1521	18	-5.0
15Ølv-7 - 50	4.08	0.048	0.2956	0.0041	0.56275	0.0991	0.0011	1644	9.5	1667	20	1591	22	-3.3
15Ølv-7 - 51	4.656	0.046	0.3177	0.0038	0.6271	0.10539	0.00095	1755.4	8.2	1776	19	1707	17	-2.8
15Ølv-7 - 52	0.5469	0.0056	0.07149	0.0009	0.43962	0.055	0.00061	442.4	3.7	444.8	5.1	394	24	0.5
15Ølv-7 - 53	3.381	0.037	0.2631	0.0033	0.57559	0.09236	0.00093	1496	8.4	1503	17	1457	19	-2.7
15Ølv-7 - 54	3.554	0.073	0.2678	0.007	0.50667	0.0961	0.0022	1533	16	1525	35	1520	44	-0.9
15Ølv-7 - 55	3.893	0.057	0.2865	0.0042	0.34173	0.0982	0.0015	1599	12	1621	21	1546	28	-3.4
15Ølv-7 - 56	2.588	0.036	0.2202	0.0033	0.50405	0.0848	0.0012	1292	10	1281	18	1273	27	-1.5
15Ølv-7 - 57	2.486	0.034	0.2185	0.0032	0.49071	0.082	0.0011	1263	10	1275	17	1216	28	-3.9
15Ølv-7 - 58	4.187	0.043	0.2979	0.0038	0.54581	0.1011	0.001	1666.9	8.6	1676	19	1628	19	-2.4
15Ølv-7 - 59	2.173	0.027	0.1979	0.0026	0.59906	0.07852	0.00086	1167.3	8.7	1163	14	1140	22	-2.4
15Ølv-7 - 60	3.84	0.045	0.2801	0.0036	0.61433	0.0983	0.001	1596.4	9.4	1589	18	1577	20	-1.2
15Ølv-7 - 61	2.216	0.024	0.2033	0.0026	0.60201	0.07805	0.00078	1182.1	7.5	1192	14	1136	20	-4.1
15Ølv-7 - 62	2.793	0.074	0.2068	0.0065	0.51724	0.0976	0.0029	1346	20	1212	35	1543	56	12.8
15Ølv-7 - 63	3.837	0.063	0.2701	0.0045	0.7144	0.1017	0.0013	1596	13	1540	23	1642	24	2.8
15Ølv-7 - 64	2.496	0.035	0.2209	0.003	0.50507	0.0815	0.0011	1265	10	1284	16	1203	26	-5.2
15Ølv-7 - 65	3.46	0.042	0.1785	0.0025	0.45879	0.1397	0.0018	1515.1	9.8	1058	13	2205	22	31.3
15Ølv-7 - 66	0.648	0.012	0.0711	0.0015	0.10727	0.0666	0.0014	504.5	7.4	442.6	9.4	771	41	-14.0
15Ølv-7 - 67	4.621	0.084	0.2325	0.0053	0.3583	0.1443	0.0032	1746	15	1344	27	2247	40	22.3
15Ølv-7 - 68	0.712	0.01	0.0748	0.0014	0.45871	0.0685	0.0011	544.5	6.1	464.7	8.2	863	35	-17.2
15Ølv-7 - 69	1.649	0.024	0.07277	0.0009	0.4882	0.162	0.0022	986.5	9.3	452.7	5.6	2465	23	-117.9
15Ølv-7 - 70	3.477	0.086	0.2537	0.0057	0.49055	0.1002	0.0024	1504	20	1449	29	1538	48	2.2
15Ølv-7 - 71	92.8	3.6	1.039	0.039	0.42883	0.662	0.015	4503	38	4380	110	4625	37	2.6
15Ølv-7 - 72	1.829	0.02	0.1781	0.0022	0.56559	0.07399	0.00075	1052.3	7.1	1055	12	1020	21	-3.2
15Ølv-7 - 73	2.625	0.038	0.2107	0.0029	0.53611	0.0898	0.0012	1306	11	1231	16	1409	25	7.3
15Ølv-7 - 74	0.617	0.017	0.07769	0.001	0.03269	0.05643	0.00068	481.2	4.7	482	5.8	434	26	0.2
15Ølv-7 - 75	2.778	0.029	0.1977	0.0024	0.49004	0.1014	0.0011	1347.6	8.1	1161	13	1634	20	17.5

15Ølv-7 - 76	3.422	0.034	0.265	0.0031	0.16723	0.09292	0.00085	1505	7.7	1514	16	1469	18	-2.5
15Ølv-7 - 77	4.026	0.033	0.2624	0.0027	0.52874	0.11024	0.00087	1636.5	6.7	1501	14	1793	14	8.7
15Ølv-7 - 78	4.13	0.045	0.2615	0.0036	0.60856	0.1136	0.0012	1658.4	8.8	1496	19	1847	20	10.2
15Ølv-7 - 79	4.996	0.072	0.3275	0.0058	0.56852	0.1107	0.0016	1814	12	1826	28	1792	27	-1.2
15Ølv-7 - 80	4.835	0.063	0.3208	0.0051	0.76044	0.1085	0.0011	1789	11	1791	25	1769	18	-1.1
15Ølv-7 - 81	1.538	0.018	0.1524	0.002	0.56346	0.0728	0.00081	943.6	7.1	914	11	993	23	-3.2
15Ølv-7 - 82	0.7421	0.0087	0.07116	0.0008	0.45817	0.07532	0.00088	561.8	5.1	443.1	5.1	1050	24	-26.8
15Ølv-7 - 83	0.844	0.011	0.0869	0.0011	0.48738	0.06993	0.00087	620.2	6.2	536.8	6.7	905	27	-15.5
15Ølv-7 - 84	0.973	0.011	0.1114	0.0014	0.54444	0.06307	0.00067	688.8	5.4	680.7	8	693	23	-1.2
15Ølv-7 - 85	1.771	0.036	0.1739	0.0031	0.39852	0.0739	0.0015	1022	13	1031	17	976	41	-4.7
15Ølv-7 - 86	5.65	0.15	0.2234	0.0034	0.16084	0.1847	0.0048	1880	22	1297	18	2574	43	27.0
15Ølv-7 - 87	2.32	0.032	0.1898	0.0029	0.12766	0.0888	0.0011	1212	9.6	1118	16	1376	24	11.9
15Ølv-7 - 88	1.946	0.026	0.1846	0.0024	0.63446	0.07582	0.00082	1094.8	8.9	1091	13	1080	22	-1.4
15Ølv-7 - 89	3.262	0.049	0.2361	0.0041	0.68423	0.0995	0.0012	1465	12	1369	22	1599	24	8.4
15Ølv-7 - 90	1.573	0.024	0.0874	0.0012	0.41414	0.1295	0.0018	954	9.3	540.3	7.3	2067	26	-76.6
15Ølv-7 - 91	4.391	0.057	0.3141	0.0047	0.5822	0.102	0.0012	1705	11	1755	23	1640	22	-4.0
15Ølv-7 - 92	26.46	0.32	0.679	0.01	0.70766	0.282	0.0029	3358	12	3330	39	3365	16	0.2
15Ølv-7 - 93	2.463	0.028	0.214	0.0028	0.5512	0.08321	0.00088	1257.8	8.3	1248	15	1261	21	0.3
15Ølv-7 - 94	3.88	0.038	0.2811	0.0036	0.55011	0.0999	0.001	1607.8	8.1	1597	19	1611	19	0.2
15Ølv-7 - 95	1.311	0.047	0.0837	0.0011	0.21855	0.1125	0.0038	820	18	518	6.3	1681	51	-58.3
15Ølv-7 - 96	1.207	0.02	0.07884	0.0009	0.46009	0.1101	0.0015	797.6	9	488.9	5.5	1768	25	-63.1
15Ølv-7 - 97	3.357	0.042	0.2562	0.0034	0.56147	0.0949	0.0011	1489.5	9.9	1467	17	1510	21	1.4
15Ølv-7 - 98	13.24	0.12	0.5238	0.0061	0.62818	0.1833	0.0015	2692.5	8.4	2709	26	2674	14	-0.7
15Ølv-7 - 99	3.462	0.05	0.2604	0.0037	0.39667	0.097	0.0013	1509	11	1490	19	1537	25	1.8
15Ølv-7 - 100	2.219	0.041	0.1979	0.0029	0.01723	0.0819	0.0016	1175	13	1161	15	1165	41	-0.9
15Ølv-7 - 101	16.8	0.61	0.2031	0.0071	0.69565	0.621	0.018	2874	33	1177	37	4510	45	36.3
15Ølv-7 - 102	2.935	0.033	0.2323	0.003	0.55342	0.09134	0.00099	1387.3	8.4	1344	16	1437	20	3.5
15Ølv-7 - 103	0.6089	0.0086	0.0769	0.001	0.28049	0.05759	0.00083	480.7	5.3	476.7	6.2	468	31	-0.8
15Ølv-7 - 104	14.69	0.15	0.4906	0.0054	0.49899	0.2171	0.0022	2791.1	9.7	2568	23	2944	16	5.2
15Ølv-7 - 105	4.165	0.057	0.2951	0.0041	0.46671	0.1021	0.0014	1659	11	1666	20	1631	26	-1.7
15Ølv-7 - 106	0.6446	0.0073	0.0819	0.001	0.53608	0.05687	0.0006	503.8	4.5	507.1	6.2	461	23	0.7
15Ølv-7 - 107	5.161	0.096	0.1832	0.0029	0.23046	0.2034	0.0043	1837	16	1083	16	2818	36	34.8
15Ølv-7 - 108	8.72	0.11	0.2941	0.0037	0.47058	0.2132	0.0027	2303	12	1660	18	2918	20	21.1
15Ølv-7 - 109	0.5832	0.008	0.07461	0.0009	0.39661	0.05625	0.00078	464.7	5.1	463.6	5.6	431	31	-0.2
15Ølv-7 - 110	23.2	1.2	0.449	0.011	0.734	0.331	0.012	2983	54	2364	48	3400	61	12.3
15Ølv-7 - 111	4.111	0.059	0.2344	0.0038	0.52672	0.1262	0.0018	1652	12	1357	20	2033	26	18.7
15Ølv-7 - 112	2.58	0.038	0.2182	0.003	0.05428	0.0856	0.0013	1286	11	1268	16	1288	29	0.2
15Ølv-7 - 113	1.935	0.029	0.1744	0.0021	0.24407	0.0805	0.0013	1086	10	1035	12	1156	31	6.1
15Ølv-7 - 114	3.802	0.077	0.2635	0.0054	0.56155	0.1041	0.002	1582	16	1503	27	1661	35	4.8
15Ølv-7 - 115	3.351	0.038	0.2559	0.0033	0.55639	0.09371	0.00099	1488.7	8.8	1467	17	1488	20	0.0
15Ølv-7 - 116	3.702	0.036	0.273	0.0035	0.59681	0.09759	0.00094	1566.3	7.8	1553	18	1569	18	0.2
15Ølv-7 - 117	1.897	0.041	0.1833	0.0031	0.38769	0.0749	0.0016	1064	14	1082	17	982	44	-8.4
15Ølv-7 - 118	4.464	0.052	0.284	0.0035	0.6599	0.1125	0.001	1718.1	9.8	1608	18	1829	17	6.1
15Ølv-7 - 119	1.039	0.011	0.0946	0.0014	0.33907	0.0791	0.0011	721.8	5.7	582.3	8	1161	27	-24.0
15Ølv-7 - 120	0.7769	0.0099	0.07443	0.0008	0.3995	0.07471	0.00093	581.8	5.7	462.6	4.7	1033	26	-25.8
15Ølv-7 - 121	1.896	0.024	0.1782	0.0025	0.6258	0.07646	0.00084	1075.7	8.7	1056	14	1087	22	1.0
15Ølv-7 - 122	4.043	0.051	0.2867	0.0039	0.23699	0.1014	0.0011	1635.6	9.9	1621	20	1625	21	-0.7
15Ølv-7 - 123	1.897	0.028	0.1844	0.0026	0.18267	0.0742	0.0011	1071.5	9.8	1088	14	1001	30	-7.0
15Ølv-7 - 124	1.628	0.022	0.1606	0.0021	0.50186	0.07294	0.00092	978	8.7	959	11	986	26	-2.0
15Ølv-7 - 125	2.95	0.036	0.2418	0.0033	0.68795	0.08708	0.00088	1390.4	9.2	1394	17	1346	19	-3.3
15Ølv-7 - 126	0.771	0.012	0.07738	0.001	0.45721	0.0718	0.0011	577.8	6.8	480.1	5.9	931	31	-20.3
15Ølv-7 - 127	0.6371	0.0067	0.08041	0.0009	0.44281	0.05681	0.00061	498.9	4.2	498.2	5.6	462	23	-0.1
15Ølv-7 - 128	2.081	0.021	0.1944	0.0025	0.58113	0.07685	0.00075	1139.6	6.9	1144	13	1102	19	-3.4
15Ølv-7 - 129	2.062	0.024	0.1916	0.0024	0.50994	0.07711	0.00089	1133.4	8.2	1128	13	1101	23	-2.9
15Ølv-7 - 130	1.791	0.026	0.174	0.0024	0.01501	0.0742	0.0011	1034.7	9.2	1032	13	997	30	-3.8
15Ølv-7 - 131	3.439	0.051	0.2635	0.0038	0.10194	0.0942	0.0014	1501	11	1503	19	1466	28	-2.4
15Ølv-7 - 132	2.798	0.057	0.1868	0.0035	0.72274	0.1073	0.0016	1345	16	1102	19	1735	27	22.5
15Ølv-7 - 133	1.891	0.063	0.1827	0.0039	0.256	0.0756	0.0025	1042	22	1077	21	883	71	-18.0
15Ølv-7 - 134	1.792	0.031	0.1753	0.0027	0.35215	0.0745	0.0014	1035	11	1038	15	987	39	-4.9
15Ølv-7 - 135	2.999	0.07	0.1656	0.0019	0.27757	0.1298	0.003	1390	18	987	11	2034	40	-40.8
15Ølv-7 - 136	4.482	0.072	0.3168	0.0051	0.62926	0.1017	0.0014	1719	13	1771	25	1633	25	-5.3
15Ølv-7 - 137	2.655	0.033	0.2282	0.0031	0.54427	0.08366	0.00098	1310.5	9.2	1322	16	1266	24	-3.5
15Ølv-7 - 138	2.649	0.025	0.2286	0.0028	0.55821	0.08353	0.00081	1311.6	7	1325	15	1269	18	-3.4
15Ølv-7 - 139	2.213	0.032	0.1958	0.0028	0.06248	0.0817	0.0012	1177.4	9.8	1150	15	1199	28	1.8
15Ølv-7 - 140	1.963	0.05	0.189	0.0036	0.24518	0.0763	0.0021	1081	18	1111	20	970	56	-11.4
15Ølv-7 - 141	1.804	0.033	0.1774	0.0026	0.40147	0.0738	0.0014	1038	12	1050	14	968	38	-7.2
15Ølv-7 - 142	0.94	0.036	0.1072	0.0026	0.50735	0.0635	0.0023	667	18	657	16	638	75	-1.5
15Ølv-7 - 143	1.876	0.028	0.1807	0.0025	0.33339	0.0757	0.0012	1065	10	1070	14	1035	34	-2.9
15Ølv-7 - 144	5.229	0.054	0.3361	0.0042	0.39197	0.1125	0.0012	1850	8.9	1865	21	1825	18	-1.4
15Ølv-7 - 145	2.636	0.032	0.2257	0.0029	0.52457	0.0847	0.001	1306.3	8.9	1309	15	1282	23	-1.9
15Ølv-7 - 146	7.145	0.085	0.395	0.0053	0.58561	0.1303	0.0014	2124	10	2141	25	2092	19	-1.5
15Ølv-7 - 147	0.71	0.011	0.0848	0.0012	0.50282	0.06035	0.00087	542.6	6.6	524.2	7.2	586	31	-3.5
15Ølv-7 - 148	2.735	0.038	0.2295	0.003	0.41146	0.0863	0.0012	1330	11	1330	16	1313	28	-1.3
15Ølv-7 - 149	4.524	0.081	0.194	0.0023	0.47398	0.1676	0.0026	1717	15	1142	12	2496	26	31.2
15Ølv-7 - 150	1.985	0.028	0.1876	0.003	0.53595	0.077	0.0011	1106.4	9.4	1106	16	1101	27	-0.5
15Ølv-7 - 151	1.504	0.018	0.1569	0.0021	0.45486	0.06959	0.00088	928.4	7.5	938	11	889	26	1.0
15Ølv-7 - 152	4.648	0.053	0.3156	0.0044	0.56656	0.107	0.0012	1754.2	9.7	1763	21	1729	22	-1.5
15Ølv-7 - 153	6.62	0.14	0.3734	0.0087	0.59091	0.1295	0.0025	2052	19	2035	41	2072	33	1.0
15Ølv-7 - 154	3.304	0.049	0.2198	0.0036	0.61953	0.1084	0.0014	1478	12	1279	19	1761	24	16.1
15Ølv-7 - 155	6.027	0.065	0.3628	0.0047	0.57739	0.1202	0.0013	1974.3	9.4	1991	22	1944	19	-1.6

15Ølv-7 - 156	2.544	0.044	0.1771	0.0032	0.24011	0.1055	0.0018	1273	13	1047	17	1673	32	23.9
15Ølv-7 - 157	0.906	0.014	0.105	0.0014	0.16396	0.06251	0.00098	650.1	7.2	643.3	8.2	633	30	-1.1
15Ølv-7 - 158	3.258	0.04	0.2558	0.0035	0.45241	0.0918	0.0012	1464.5	9.6	1467	18	1443	24	-1.5
15Ølv-7 - 159	4.092	0.042	0.2922	0.0038	0.59672	0.1008	0.001	1647.7	8.4	1650	19	1625	19	-1.4
15Ølv-7 - 160	3.276	0.033	0.2562	0.003	0.60213	0.09223	0.00086	1470.9	8	1467	16	1456	18	-1.0
15Ølv-7 - 161	2.665	0.036	0.2255	0.0032	0.13497	0.0851	0.0012	1311.2	9.9	1308	17	1280	27	-2.4
15Ølv-7 - 162	2.047	0.03	0.1933	0.0027	0.3691	0.0765	0.0012	1124	9.9	1137	15	1061	32	-5.9
15Ølv-7 - 163	4.036	0.041	0.2906	0.0036	0.5703	0.0995	0.001	1636.9	8.2	1642	18	1597	19	-2.5
15Ølv-7 - 164	6.9	1.1	0.276	0.038	0.30657	0.241	0.047	1930	150	1530	190	2360	370	18.2
15Ølv-7 - 165	116	13	1.17	0.15	0.38587	0.722	0.054	4640	150	4660	430	4770	130	2.7
15Ølv-7 - 166	6.77	0.62	0.313	0.028	0.69521	0.169	0.011	1995	72	1730	130	2420	110	17.6
15Ølv-7 - 167	1.777	0.019	0.1765	0.0022	0.56296	0.07231	0.00073	1034.5	6.8	1046	12	981	21	-5.5
15Ølv-7 - 168	1.776	0.017	0.1752	0.002	0.59656	0.07236	0.00064	1034.4	6.4	1040	11	983	18	-5.2
15Ølv-7 - 169	2.751	0.036	0.2315	0.0031	0.41403	0.0853	0.0012	1334.9	9.7	1340	16	1287	27	-3.7
15Ølv-7 - 170	1.853	0.022	0.1456	0.002	0.30063	0.0912	0.0011	1061.7	7.7	875	11	1436	22	-21.3

Sample 15Ølv-7 Prismatic

	Isotopic Ratios							Calculated ages (Ma)						
ID	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Rho	$^{207/206}Pb$	2σ	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	$^{207/206}Pb$	2σ	Disc.
15Ølv-7 Prismatic - 1	0.788	0.014	0.0799	0.0011	0.31167	0.0711	0.0014	586.2	7.5	495.3	6.5	910	38	-18.4
15Ølv-7 Prismatic - 2	0.6536	0.0068	0.0805	0.0012	0.4303	0.05906	0.00077	509.4	4.2	498.8	6.9	534	28	-2.1
15Ølv-7 Prismatic - 3	3.016	0.037	0.2344	0.0036	0.44908	0.0934	0.0013	1407	9.3	1355	19	1466	26	4.0
15Ølv-7 Prismatic - 4	1.788	0.018	0.1632	0.0019	0.50075	0.07893	0.00078	1038.9	6.4	973	11	1159	19	-6.8
15Ølv-7 Prismatic - 5	1.72	0.023	0.1511	0.0025	0.66734	0.08254	0.00099	1009.9	8.9	905	14	1236	24	-11.6
15Ølv-7 Prismatic - 6	0.665	0.013	0.0831	0.0015	0.39207	0.0585	0.0012	512.9	8.3	514.7	9	467	45	0.3
15Ølv-7 Prismatic - 7	1.803	0.024	0.1747	0.0027	0.53411	0.07465	0.00097	1043.4	8.9	1035	15	1030	27	-1.3
15Ølv-7 Prismatic - 8	3.993	0.057	0.2892	0.0053	0.52242	0.1015	0.0014	1625	12	1626	26	1622	27	-0.2
15Ølv-7 Prismatic - 9	15.74	0.21	0.5565	0.0088	0.63542	0.2052	0.0024	2852	13	2841	36	2854	19	0.1
15Ølv-7 Prismatic - 10	0.5933	0.0086	0.0754	0.001	0.24169	0.05689	0.00083	470.1	5.4	468	6.2	444	31	-0.4
15Ølv-7 Prismatic - 11	13.39	0.62	0.298	0.0068	0.5705	0.3047	0.0097	2580	42	1668	33	3368	49	23.4
15Ølv-7 Prismatic - 12	2.345	0.033	0.2087	0.0031	0.18518	0.08138	0.00098	1215.7	9.1	1220	17	1198	24	-1.5
15Ølv-7 Prismatic - 13	0.925	0.023	0.0856	0.0011	0.37476	0.0771	0.0017	656	12	529	6.5	1042	45	-24.0
15Ølv-7 Prismatic - 14	4.099	0.05	0.2933	0.0042	0.65426	0.1011	0.0011	1646	9.8	1653	21	1626	20	-1.2
15Ølv-7 Prismatic - 15	4.082	0.071	0.2556	0.0052	0.5239	0.1168	0.002	1639	14	1460	26	1873	32	12.5
15Ølv-7 Prismatic - 16	0.891	0.013	0.1061	0.0016	0.46951	0.06112	0.00092	643.6	7.2	648.9	9.2	597	32	0.8
15Ølv-7 Prismatic - 17	0.921	0.017	0.1082	0.002	0.26794	0.0626	0.0012	657	9.3	660	11	626	42	0.5
15Ølv-7 Prismatic - 18	0.644	0.011	0.0814	0.0013	0.4295	0.05738	0.00096	501.7	6.7	503.7	7.4	473	36	0.4
15Ølv-7 Prismatic - 19	14.19	0.18	0.5362	0.0088	0.67468	0.1921	0.0022	2756	12	2758	37	2747	19	-0.3
15Ølv-7 Prismatic - 20	0.76	0.011	0.0855	0.0015	0.34654	0.0651	0.0011	571.5	6.4	528.8	9	739	35	-8.1
15Ølv-7 Prismatic - 21	0.655	0.012	0.0813	0.0015	0.49384	0.0592	0.0011	509.9	7.4	503	9.2	525	38	-1.4
15Ølv-7 Prismatic - 22	1.883	0.042	0.1795	0.0037	0.4666	0.077	0.0017	1061	15	1060	20	1038	46	-2.2
15Ølv-7 Prismatic - 23	3.11	0.12	0.1043	0.0026	0.53222	0.215	0.0069	1372	28	637	15	2792	59	-115.4
15Ølv-7 Prismatic - 24	0.782	0.015	0.0836	0.0017	0.04176	0.0678	0.0014	582.2	8.3	519	10	786	43	-12.2
15Ølv-7 Prismatic - 25	4.255	0.059	0.271	0.0036	0.24242	0.1126	0.0014	1676	11	1544	18	1818	22	7.8
15Ølv-7 Prismatic - 26	3.21	0.04	0.2434	0.0045	0.39167	0.0972	0.0016	1459	10	1399	23	1540	32	5.3
15Ølv-7 Prismatic - 27	0.633	0.012	0.0807	0.0015	0.46521	0.0573	0.0011	494.6	7.6	499.4	8.9	445	41	1.0
15Ølv-7 Prismatic - 28	0.921	0.015	0.0895	0.0014	0.43763	0.0747	0.0011	657.5	7.8	551.6	8.1	1017	31	-19.2
15Ølv-7 Prismatic - 29	3.558	0.06	0.2711	0.0046	0.50131	0.0944	0.0016	1528	13	1542	23	1477	31	-3.5
15Ølv-7 Prismatic - 30	3.642	0.047	0.2593	0.0039	0.56161	0.1011	0.0013	1550	10	1486	20	1619	24	4.3
15Ølv-7 Prismatic - 31	0.626	0.01	0.0796	0.0015	0.50863	0.0569	0.00095	491.4	6.2	493.2	9	447	36	0.4
15Ølv-7 Prismatic - 32	0.621	0.011	0.0778	0.0015	0.43807	0.0571	0.0011	488.8	7.1	482.8	8.9	467	43	-1.2
15Ølv-7 Prismatic - 33	1.109	0.015	0.1123	0.0017	0.53806	0.07119	0.00093	753.8	7.4	685	9.6	936	27	-10.0
15Ølv-7 Prismatic - 34	0.625	0.01	0.0782	0.0012	0.09885	0.0575	0.00095	489.1	6.2	485.1	7	458	34	-0.8
15Ølv-7 Prismatic - 35	0.813	0.013	0.0779	0.0012	0.22287	0.075	0.0012	600.1	7.5	483.7	6.9	1017	33	-24.1
15Ølv-7 Prismatic - 36	0.6569	0.0071	0.0821	0.0011	0.31591	0.05743	0.00068	511	4.3	508.1	6.3	477	26	-0.6
15Ølv-7 Prismatic - 37	0.833	0.01	0.0949	0.0013	0.4209	0.06332	0.00083	614	5.6	583.7	7.7	685	28	-5.2
15Ølv-7 Prismatic - 38	0.621	0.0071	0.0794	0.0011	0.35345	0.05656	0.00077	489.1	4.5	491.9	6.5	441	29	0.6
15Ølv-7 Prismatic - 39	0.6076	0.0087	0.077	0.0012	0.7687	0.05693	0.00083	479.7	5.4	477.8	7	451	32	-0.4
15Ølv-7 Prismatic - 40	0.824	0.014	0.07792	0.00084	0.40773	0.0754	0.0011	605.7	7.4	483.4	5	1035	30	-25.3
15Ølv-7 Prismatic - 41	0.64	0.01	0.0782	0.0012	0.45446	0.05902	0.00091	501.2	6.3	485.1	6.9	528	34	-3.3
15Ølv-7 Prismatic - 42	0.6915	0.0099	0.0865	0.0014	0.52008	0.0577	0.00079	530.4	5.9	533.7	8.2	484	30	0.6
15Ølv-7 Prismatic - 43	0.7283	0.0089	0.07708	0.00095	0.10167	0.06778	0.00092	553.8	5.2	478.4	5.7	828	28	-15.8
15Ølv-7 Prismatic - 44	0.6082	0.0099	0.0782	0.0013	0.43391	0.05611	0.00096	479.7	6.2	484.7	7.6	406	37	1.0
15Ølv-7 Prismatic - 45	0.6232	0.0091	0.079	0.0012	0.50539	0.05688	0.0008	489.2	5.7	489.6	7.2	452	31	0.1
15Ølv-7 Prismatic - 46	1.54	0.029	0.1584	0.0029	0.48617	0.0699	0.0013	939	11	946	16	880	38	0.7
15Ølv-7 Prismatic - 47	1.528	0.024	0.157	0.0027	0.53291	0.0702	0.0011	936.5	9.7	938	15	889	32	0.2
15Ølv-7 Prismatic - 48	0.903	0.016	0.104	0.0018	0.47354	0.0624	0.0011	648.2	8.5	637	10	635	37	-1.8
15Ølv-7 Prismatic - 49	0.953	0.01	0.0965	0.0012	0.57228	0.07071	0.00071	677.7	5.3	593.5	7.2	927	21	-14.2
15Ølv-7 Prismatic - 50	1.459	0.052	0.0899	0.002	0.43321	0.1168	0.0038	897	21	554	12	1810	63	-61.9
15Ølv-7 Prismatic - 51	0.853	0.01	0.082	0.0011	0.12195	0.0748	0.00085	625.6	5.3	507.6	6.7	1042	23	-23.2
15Ølv-7 Prismatic - 52	0.7296	0.0089	0.079	0.0012	0.55855	0.06622	0.00078	555.2	5.3	489.8	6.9	794	25	-13.4
15Ølv-7 Prismatic - 53	0.736	0.016	0.07589	0.00093	0.41952	0.0688	0.0013	553.3	8.9	471.2	5.5	825	38	-17.4
15Ølv-7 Prismatic - 54	3.106	0.066	0.2347	0.0042	0.32998	0.0962	0.0021	1417	16	1355	22	1477	44	4.1
15Ølv-7 Prismatic - 55	0.63	0.0076	0.0806	0.0013	0.40707	0.05663	0.00081	495.6	4.7	499	7.5	452	31	0.7
15Ølv-7 Prismatic - 56	3.769	0.062	0.2804	0.0048	0.52118	0.0969	0.0015	1580	13	1589	24	1538	30	-2.7
15Ølv-7 Prismatic - 57	0.6818	0.0088	0.0805	0.0012	0.48117	0.06068	0.00083	526.7	5.4	498.9	6.9	597	30	-5.6

Sample 16Hug-3

	Isotopic Ratios							Calculated ages (Ma)						
ID	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Rho	$^{207/206}Pb$	2σ	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	$^{207/206}Pb$	2σ	Disc.
16Hug-3 - 1	0.613	0.022	0.0739	0.0021	0.32108	0.0606	0.0015	483	14	459	13	596	54	-5.2
16Hug-3 - 2	1.3	0.14	0.0897	0.0098	0.44706	0.118	0.012	804	57	547	57	1690	200	-47.0
16Hug-3 - 3	0.641	0.02	0.0736	0.002	0.21448	0.063	0.0013	502	13	458	12	674	42	-9.6
16Hug-3 - 4	0.59	0.02	0.0736	0.0025	0.57776	0.0585	0.0015	470	13	458	15	517	54	-2.6
16Hug-3 - 5	0.586	0.016	0.075	0.002	0.47574	0.05652	0.00064	468	10	466	12	459	25	-0.4
16Hug-3 - 6	0.61	0.018	0.0757	0.0021	0.51485	0.05826	0.00075	483	11	470	12	524	29	-2.8
16Hug-3 - 7	0.57	0.017	0.0734	0.0021	0.55601	0.05609	0.00072	457	11	457	12	442	29	0.0
16Hug-3 - 8	0.719	0.032	0.0757	0.002	0.29094	0.069	0.0024	546	18	470	12	823	63	-16.2
16Hug-3 - 9	0.565	0.017	0.0707	0.002	0.33944	0.0585	0.001	455	11	440	12	517	38	-3.4
16Hug-3 - 10	0.61	0.018	0.0763	0.0021	0.31762	0.05812	0.00093	482	11	474	12	503	34	-1.7
16Hug-3 - 11	0.582	0.021	0.0713	0.0024	0.56509	0.0593	0.0013	464	13	444	14	548	48	-4.5
16Hug-3 - 12	1.245	0.063	0.0774	0.0023	0.46659	0.1152	0.0046	801	29	480	13	1752	79	-66.9
16Hug-3 - 13	0.545	0.016	0.0698	0.002	0.50864	0.05669	0.00076	442	10	435	12	469	31	-1.6
16Hug-3 - 14	0.866	0.038	0.0749	0.0023	0.073812	0.0837	0.0031	626	20	466	14	1200	74	-34.3
16Hug-3 - 15	0.718	0.024	0.0728	0.0022	0.37173	0.0715	0.0015	547	14	453	13	949	43	-20.8
16Hug-3 - 16	0.62	0.019	0.075	0.0022	0.30496	0.0598	0.001	488	12	466	13	568	38	-4.7
16Hug-3 - 17	0.644	0.018	0.0774	0.0022	0.51163	0.06041	0.0008	504	12	480	13	603	30	-5.0
16Hug-3 - 18	0.583	0.016	0.0754	0.002	0.48938	0.05575	0.0006	466	10	469	12	427	25	0.6
16Hug-3 - 19	0.887	0.026	0.0698	0.0019	0.50407	0.0917	0.0013	642	14	435	12	1444	26	-47.6
16Hug-3 - 20	0.593	0.017	0.0759	0.002	0.22862	0.05653	0.00082	471	11	471	12	446	33	0.0
16Hug-3 - 21	0.655	0.02	0.0779	0.0021	0.43382	0.0612	0.00097	510	12	483	12	618	34	-5.6
16Hug-3 - 22	0.577	0.02	0.0719	0.0022	0.30579	0.0579	0.0014	463	12	447	13	514	53	-3.6
16Hug-3 - 23	1.142	0.055	0.0763	0.0021	0.50444	0.1067	0.004	753	27	474	13	1588	82	-58.9
16Hug-3 - 24	0.616	0.018	0.079	0.0022	0.66873	0.05626	0.00065	486	11	490	13	444	26	0.8
16Hug-3 - 25	0.659	0.019	0.0787	0.0022	0.49656	0.06043	0.00084	512	12	488	13	601	31	-4.9
16Hug-3 - 26	0.613	0.018	0.0731	0.002	0.24509	0.061	0.001	486	12	455	12	606	35	-6.8
16Hug-3 - 27	0.657	0.019	0.0803	0.0021	0.12404	0.05919	0.00093	511	12	498	13	552	35	-2.6
16Hug-3 - 28	0.782	0.022	0.076	0.002	0.44934	0.07446	0.00087	584	12	472	12	1025	24	-23.7
16Hug-3 - 29	0.677	0.019	0.0763	0.0021	0.34007	0.06438	0.0009	523	12	474	12	724	30	-10.3
16Hug-3 - 30	0.579	0.016	0.0731	0.002	0.42225	0.05749	0.00075	464	10	454	12	491	28	-2.2
16Hug-3 - 31	0.586	0.016	0.0752	0.002	0.3362	0.05639	0.00058	467	10	467	12	448	22	0.0
16Hug-3 - 32	0.599	0.017	0.0765	0.002	0.32687	0.05694	0.00067	475	10	475	12	465	26	0.0
16Hug-3 - 33	0.574	0.016	0.0734	0.002	0.59572	0.05668	0.00059	460	10	456	12	462	23	-0.9
16Hug-3 - 34	0.931	0.04	0.0766	0.0021	0.10549	0.088	0.0031	656	21	476	12	1243	72	-37.8
16Hug-3 - 35	0.591	0.017	0.0745	0.002	0.48383	0.05738	0.00066	471	11	463	12	488	25	-1.7
16Hug-3 - 36	0.609	0.017	0.0754	0.0021	0.50777	0.05844	0.00068	482	11	468	12	533	26	-3.0
16Hug-3 - 37	0.583	0.017	0.0747	0.0021	0.49934	0.05648	0.00073	466	11	464	12	449	28	-0.4
16Hug-3 - 38	0.71	0.029	0.0746	0.002	0.33896	0.0688	0.002	537	16	464	12	788	51	-15.7
16Hug-3 - 39	0.754	0.035	0.0802	0.0022	0.31969	0.0677	0.0024	565	19	497	13	759	63	-13.7
16Hug-3 - 40	0.678	0.021	0.0745	0.0021	0.52355	0.06586	0.00099	524	13	463	13	786	32	-13.2
16Hug-3 - 41	0.733	0.03	0.0753	0.002	0.45017	0.0701	0.002	552	17	468	12	837	58	-17.9
16Hug-3 - 42	0.625	0.018	0.0786	0.0022	0.60573	0.05737	0.00066	491	11	487	13	491	26	-0.8
16Hug-3 - 43	0.594	0.017	0.0754	0.002	0.45175	0.05721	0.00073	473	11	468	12	475	29	-1.1
16Hug-3 - 44	0.555	0.017	0.071	0.002	0.52915	0.05641	0.00085	447	11	442	12	445	33	-1.1
16Hug-3 - 45	0.738	0.03	0.078	0.0021	0.047365	0.0686	0.0023	553	17	484	12	758	62	-14.3
16Hug-3 - 46	1.034	0.042	0.0785	0.0021	0.3063	0.0948	0.0029	709	20	487	13	1417	54	-45.6
16Hug-3 - 47	0.587	0.019	0.0707	0.0023	0.29489	0.0607	0.0015	469	13	440	14	590	55	-6.6
16Hug-3 - 48	0.577	0.018	0.074	0.0022	0.49494	0.0567	0.001	461	11	460	13	455	40	-0.2
16Hug-3 - 49	1.9	0.093	0.0898	0.0028	0.75056	0.1465	0.0046	1031	34	553	16	2148	65	-86.4
16Hug-3 - 50	0.819	0.028	0.0767	0.002	0.18598	0.0771	0.0017	602	15	476	12	1053	43	-26.5
16Hug-3 - 51	0.746	0.025	0.0728	0.002	0.25603	0.0741	0.0016	562	14	453	12	972	45	-24.1
16Hug-3 - 52	0.585	0.016	0.0746	0.002	0.55376	0.05675	0.00063	467	10	463	12	461	25	-0.9
16Hug-3 - 53	0.616	0.017	0.078	0.0021	0.52548	0.05715	0.00062	486	11	484	13	483	24	-0.4
16Hug-3 - 54	0.658	0.02	0.0756	0.002	0.29197	0.0626	0.001	511	12	469	12	663	34	-9.0
16Hug-3 - 55	0.584	0.017	0.0741	0.0021	0.49031	0.0571	0.00085	466	11	461	13	473	33	-1.1
16Hug-3 - 56	0.604	0.017	0.0765	0.0021	0.53476	0.05716	0.00066	478	11	475	12	476	26	-0.6
16Hug-3 - 57	0.588	0.018	0.0747	0.0021	0.53086	0.05714	0.00088	468	11	464	13	472	34	-0.9
16Hug-3 - 58	0.586	0.016	0.0751	0.002	0.54667	0.05637	0.00046	468	10	467	12	451	18	-0.2
16Hug-3 - 59	0.629	0.019	0.0723	0.002	0.35246	0.063	0.0012	494	12	450	12	680	38	-9.8
16Hug-3 - 60	0.587	0.017	0.0758	0.0021	0.43618	0.05635	0.0008	468	11	471	12	444	32	0.6
16Hug-3 - 61	0.624	0.018	0.0724	0.0019	0.32108	0.06261	0.00089	491	11	450	11	655	29	-9.1
16Hug-3 - 62	0.593	0.018	0.0742	0.002	0.4867	0.05774	0.00085	471	11	461	12	493	31	-2.2
16Hug-3 - 63	0.611	0.017	0.0769	0.002	0.32317	0.0577	0.00067	483	11	478	12	495	26	-1.0
16Hug-3 - 64	0.588	0.017	0.0738	0.002	0.40279	0.05778	0.00081	469	11	459	12	500	31	-2.2
16Hug-3 - 65	0.578	0.016	0.0739	0.002	0.56909	0.05671	0.00057	462	10	459	12	460	22	-0.7
16Hug-3 - 66	0.605	0.02	0.0756	0.0022	0.35178	0.0583	0.0012	479	13	469	13	510	46	-2.1
16Hug-3 - 67	0.649	0.018	0.0828	0.0021	0.101	0.05673	0.00057	507	11	513	13	456	22	1.2
16Hug-3 - 68	0.597	0.017	0.0705	0.002	0.39541	0.06145	0.00087	474	11	439	12	634	30	-8.0
16Hug-3 - 69	0.624	0.018	0.076	0.002	0.38319	0.05932	0.00076	491	11	472	12	559	27	-4.0
16Hug-3 - 70	0.604	0.017	0.0773	0.002	0.33726	0.05644	0.0007	478	11	480	12	446	27	0.4
16Hug-3 - 71	0.828	0.035	0.0788	0.0021	0.28534	0.0755	0.0024	601	18	489	13	960	61	-22.9
16Hug-3 - 72	0.585	0.016	0.0762	0.0021	0.53431	0.05579	0.00064	467	11	473	12	423	26	1.3
16Hug-3 - 73	0.594	0.016	0.0755	0.002	0.22951	0.05681	0.00063	472	10	469	12	462	25	-0.6
16Hug-3 - 74	0.833	0.023	0.0774	0.002	0.48275	0.07783	0.00071	614	13	480	12	1131	18	-27.9
16Hug-3 - 75	0.571	0.017	0.0731	0.0021	0.59164	0.05665	0.00076	457	11	454	13	461	30	-0.7
16Hug-3 - 76	0.564	0.018	0.0728	0.0023	0.52713	0.0562	0.0011	455	12	453	14	446	45	-0.4

16Hug-3 - 77	1.044	0.033	0.0819	0.0024	0.33153	0.0931	0.0015	725	15	507	14	1468	30	-43.0
16Hug-3 - 78	0.606	0.017	0.0777	0.0021	0.54856	0.05629	0.00056	480	11	482	12	452	22	0.4
16Hug-3 - 79	0.656	0.02	0.0759	0.0021	0.58105	0.06243	0.00093	510	12	471	13	674	32	-8.3
16Hug-3 - 80	0.651	0.019	0.0794	0.0022	0.35736	0.05946	0.00074	507	12	492	13	558	26	-3.0
16Hug-3 - 81	0.679	0.021	0.0789	0.0021	0.37487	0.0623	0.001	523	13	490	13	646	35	-6.7
16Hug-3 - 82	0.698	0.024	0.074	0.0021	0.38713	0.0689	0.0015	536	14	460	12	836	43	-16.5
16Hug-3 - 83	0.589	0.016	0.0753	0.002	0.54703	0.05686	0.00062	470	11	468	12	470	24	-0.4
16Hug-3 - 84	0.596	0.018	0.0763	0.0022	0.44222	0.05676	0.00091	474	11	474	13	457	35	0.0
16Hug-3 - 85	2.879	0.082	0.096	0.0027	0.40723	0.2175	0.0032	1374	22	591	16	2951	23	-132.5
16Hug-3 - 86	0.64	0.018	0.0757	0.0021	0.50472	0.06134	0.00069	501	11	470	12	630	25	-6.6
16Hug-3 - 87	0.586	0.016	0.0749	0.002	0.30549	0.05693	0.00053	468	10	465	12	469	20	-0.6
16Hug-3 - 88	0.727	0.023	0.0764	0.002	0.29286	0.0693	0.0012	551	13	475	12	845	34	-16.0
16Hug-3 - 89	0.607	0.017	0.0769	0.0021	0.49656	0.05734	0.00067	481	11	478	13	485	26	-0.6
16Hug-3 - 90	0.592	0.017	0.0744	0.0021	0.45976	0.0579	0.00072	472	11	462	12	513	28	-2.2
16Hug-3 - 91	0.6	0.016	0.0769	0.002	0.57351	0.05634	0.00048	476	10	478	12	452	19	0.4
16Hug-3 - 92	0.617	0.018	0.0778	0.0021	0.0031018	0.05759	0.00083	486	11	483	13	482	31	-0.6
16Hug-3 - 93	0.659	0.018	0.0844	0.0022	0.20991	0.05651	0.00054	512	11	522	13	452	21	1.9
16Hug-3 - 94	0.934	0.028	0.0769	0.0021	0.12246	0.0883	0.0014	666	14	477	12	1352	30	-39.6
16Hug-3 - 95	0.583	0.016	0.0734	0.0019	0.33148	0.05753	0.00054	466	10	457	11	496	21	-2.0
16Hug-3 - 96	0.6	0.016	0.0779	0.0021	0.56673	0.05572	0.00053	476	10	484	12	426	21	1.7
16Hug-3 - 97	0.581	0.016	0.0749	0.002	0.31167	0.05636	0.00065	464	10	466	12	439	25	0.4
16Hug-3 - 98	0.589	0.016	0.0768	0.002	0.3206	0.05566	0.00053	470	10	477	12	417	21	1.5
16Hug-3 - 99	0.612	0.017	0.0794	0.0021	0.54005	0.05604	0.00053	484	10	492	13	435	21	1.6
16Hug-3 - 100	0.584	0.016	0.0762	0.002	0.60507	0.05564	0.00044	466	10	473	12	425	18	1.5
16Hug-3 - 101	0.631	0.017	0.0802	0.0021	0.32575	0.05706	0.00058	496	11	497	12	467	22	0.2
16Hug-3 - 102	0.611	0.017	0.0781	0.0021	0.59818	0.0567	0.00054	483	11	485	12	464	21	0.4
16Hug-3 - 103	0.596	0.016	0.0746	0.002	0.565	0.05792	0.00052	474	10	464	12	514	20	-2.2
16Hug-3 - 104	0.609	0.017	0.0784	0.0021	0.58363	0.05627	0.00055	482	10	486	12	443	21	0.8
16Hug-3 - 105	0.571	0.015	0.0725	0.0019	0.34355	0.05715	0.00051	458	9.9	451	11	479	20	-1.6
16Hug-3 - 106	0.878	0.026	0.0703	0.002	0.47944	0.0912	0.0014	639	14	438	12	1440	28	-45.9
16Hug-3 - 107	0.622	0.017	0.0788	0.0021	0.36382	0.05748	0.00062	490	11	489	12	488	24	-0.2
16Hug-3 - 108	0.607	0.016	0.0775	0.002	0.59535	0.05692	0.00047	481	10	481	12	473	18	0.0
16Hug-3 - 109	0.582	0.016	0.075	0.0019	0.33646	0.0562	0.00053	465	10	466	12	444	21	0.2
16Hug-3 - 110	0.564	0.015	0.0727	0.0019	0.70786	0.05627	0.00051	453.2	9.9	452	12	450	20	-0.3
16Hug-3 - 111	2.13	0.088	0.0829	0.0023	0.41132	0.1856	0.0054	1140	27	513	14	2641	46	-122.2
16Hug-3 - 112	0.695	0.02	0.0746	0.0019	0.12374	0.06769	0.00095	535	12	464	12	823	28	-15.3
16Hug-3 - 113	0.708	0.021	0.0718	0.002	0.37935	0.0718	0.0012	543	13	448	12	962	33	-21.2
16Hug-3 - 114	0.599	0.016	0.0772	0.002	0.61934	0.05611	0.0005	476	10	479	12	443	20	0.6
16Hug-3 - 115	0.603	0.016	0.0775	0.002	0.32817	0.05653	0.00055	478	10	481	12	453	21	0.6
16Hug-3 - 116	0.717	0.021	0.0731	0.0019	0.20419	0.0714	0.0011	547	12	455	11	923	32	-20.2
16Hug-3 - 117	0.587	0.016	0.0752	0.002	0.22294	0.05659	0.00068	468	10	467	12	455	26	-0.2
16Hug-3 - 118	0.592	0.016	0.0745	0.002	0.53566	0.05767	0.00056	471	10	463	12	498	22	-1.7
16Hug-3 - 119	0.63	0.017	0.0785	0.002	0.42538	0.05824	0.00049	495	10	487	12	522	18	-1.6
16Hug-3 - 120	0.614	0.017	0.0778	0.002	0.29086	0.05707	0.00053	485	10	483	12	473	20	-0.4
16Hug-3 - 121	0.639	0.017	0.0827	0.0021	0.41298	0.05611	0.00058	501	11	512	13	433	23	2.1
16Hug-3 - 122	0.812	0.024	0.0752	0.002	0.33003	0.0786	0.0011	601	13	467	12	1134	28	-28.7
16Hug-3 - 123	0.672	0.018	0.0784	0.0021	0.44793	0.06228	0.00066	521	11	487	12	665	23	-7.0
16Hug-3 - 124	0.612	0.017	0.0749	0.0019	0.13245	0.05933	0.00069	484	11	465	12	553	25	-4.1
16Hug-3 - 125	0.72	0.02	0.0764	0.002	0.56017	0.06842	0.00072	549	12	475	12	870	22	-15.6
16Hug-3 - 126	0.593	0.016	0.0762	0.002	0.33197	0.05647	0.0005	472	10	473	12	451	20	0.2
16Hug-3 - 127	0.614	0.017	0.0771	0.002	0.41027	0.05791	0.00065	485	11	479	12	500	25	-1.3
16Hug-3 - 128	0.598	0.016	0.0778	0.0021	0.13292	0.05591	0.0005	475	10	483	12	430	20	1.7
16Hug-3 - 129	0.595	0.017	0.0771	0.0021	0.56659	0.05593	0.00059	473	11	478	12	432	23	1.0
16Hug-3 - 130	0.591	0.016	0.0759	0.002	0.5861	0.05656	0.00055	470	10	471	12	454	22	0.2
16Hug-3 - 131	0.68	0.019	0.0743	0.0019	0.31376	0.06653	0.00076	526	11	462	12	808	24	-13.9
16Hug-3 - 132	0.613	0.017	0.0797	0.0021	0.63739	0.05577	0.00055	485	11	494	13	432	22	1.8
16Hug-3 - 133	0.582	0.016	0.075	0.0019	0.39827	0.05627	0.00053	465	10	466	12	444	21	0.2
16Hug-3 - 134	0.581	0.016	0.0744	0.002	0.66835	0.05674	0.00052	464	10	463	12	460	21	-0.2
16Hug-3 - 135	0.598	0.016	0.0773	0.002	0.082079	0.05629	0.00063	475	10	480	12	440	23	1.0
16Hug-3 - 136	0.629	0.017	0.0784	0.002	0.37671	0.05814	0.00062	495	11	486	12	514	24	-1.9
16Hug-3 - 137	0.655	0.023	0.0732	0.0021	0.3838	0.0651	0.0014	509	14	455	12	734	46	-11.9
16Hug-3 - 138	0.596	0.016	0.0766	0.002	0.38101	0.05657	0.00048	474	10	476	12	456	19	0.4
16Hug-3 - 139	0.782	0.027	0.0829	0.0022	0.1626	0.0688	0.0017	583	15	513	13	836	46	-13.6
16Hug-3 - 140	0.663	0.019	0.0767	0.002	0.40183	0.06289	0.0008	515	12	476	12	681	28	-8.2
16Hug-3 - 141	0.924	0.028	0.0736	0.0019	0.20726	0.091	0.0014	660	15	458	11	1405	30	-44.1
16Hug-3 - 142	0.628	0.017	0.0745	0.002	0.43451	0.0614	0.00067	494	11	463	12	638	24	-6.7
16Hug-3 - 143	0.749	0.021	0.088	0.0023	0.2455	0.06166	0.00087	566	12	544	14	640	31	-4.0
16Hug-3 - 144	0.603	0.017	0.0776	0.0021	0.58673	0.05636	0.00057	479	11	482	12	455	23	0.6
16Hug-3 - 145	1.001	0.048	0.0724	0.0023	0.44158	0.1	0.0035	696	23	451	14	1577	60	-54.3
16Hug-3 - 146	1.261	0.05	0.0817	0.0023	0.33859	0.1115	0.0033	816	23	506	14	1746	56	-61.3
16Hug-3 - 147	0.979	0.043	0.078	0.0021	0.46727	0.09	0.0029	679	22	484	13	1308	61	-40.3
16Hug-3 - 148	2.66	0.11	0.0895	0.0028	0.55727	0.2124	0.0051	1302	31	552	17	2896	40	-135.9
16Hug-3 - 149	0.615	0.017	0.0789	0.0021	0.14711	0.05658	0.00054	485	11	489	13	452	20	0.8
16Hug-3 - 150	0.636	0.018	0.0774	0.002	0.1818	0.05957	0.00066	498	11	481	12	561	24	-3.5
16Hug-3 - 151	1.168	0.058	0.0782	0.0022	0.52291	0.1068	0.004	764	28	485	13	1598	75	-57.5
16Hug-3 - 152	1.433	0.07	0.0809	0.0021	0.56728	0.1259	0.0049	866	30	501	13	1830	77	-72.9
16Hug-3 - 153	1.07	0.034	0.0714	0.002	0.50356	0.1085	0.0018	736	17	444	12	1745	31	-65.8
16Hug-3 - 154	0.804	0.029	0.0765	0.002	0.056101	0.0766	0.0021	590	15	475	12	1004	48	-24.2
16Hug-3 - 155	0.641	0.017	0.08	0.0021	0.45584	0.05803	0.00045	502	11	496	13	514	17	-1.2
16Hug-3 - 156	3.18	0.16	0.0952	0.0027	0.7617	0.2384	0.0084	1424	37	586	16	3052	52	-143.0

16Hug-3 - 157	0.653	0.022	0.0736	0.0019	0.24255	0.0647	0.0015	502	12	457	12	665	37	-9.8
16Hug-3 - 158	0.693	0.019	0.081	0.0021	0.19953	0.06215	0.00078	533	12	502	13	651	27	-6.2
16Hug-3 - 159	0.701	0.025	0.0764	0.0021	0.2876	0.0663	0.0016	535	14	474	13	754	47	-12.9
16Hug-3 - 160	0.819	0.027	0.0724	0.0019	0.34132	0.082	0.0015	603	15	450	11	1187	38	-34.0
16Hug-3 - 161	0.623	0.017	0.0787	0.0021	0.19725	0.05765	0.00073	490	11	488	12	488	27	-0.4
16Hug-3 - 162	1.39	0.075	0.0822	0.0022	0.6461	0.1183	0.0049	831	28	509	13	1643	68	-63.3
16Hug-3 - 163	0.579	0.016	0.0728	0.0019	0.29096	0.05783	0.0007	464	10	453	11	498	27	-2.4
16Hug-3 - 164	1.709	0.09	0.0753	0.0021	0.1753	0.1639	0.0071	988	32	468	13	2397	68	-111.1
16Hug-3 - 165	0.58	0.016	0.0733	0.002	0.5759	0.05752	0.0006	463	10	456	12	492	23	-1.5
16Hug-3 - 166	0.602	0.016	0.0778	0.002	0.26766	0.05625	0.00065	477	10	483	12	436	25	1.2
16Hug-3 - 167	5.64	0.3	0.1176	0.004	0.90159	0.3272	0.0099	1824	52	715	23	3515	57	-155.1
16Hug-3 - 168	1.058	0.041	0.081	0.0022	0.45693	0.0943	0.0026	720	20	502	13	1384	53	-43.4
16Hug-3 - 169	0.692	0.02	0.0754	0.002	0.45838	0.06662	0.00086	534	12	469	12	799	27	-13.9
16Hug-3 - 170	0.61	0.016	0.0777	0.002	0.32094	0.05672	0.00046	483	10	482	12	468	18	-0.2
16Hug-3 - 171	0.619	0.017	0.0753	0.002	0.47958	0.05934	0.0005	488	10	468	12	564	19	-4.3
16Hug-3 - 172	0.608	0.017	0.073	0.0019	0.38002	0.06026	0.00069	481	11	454	12	590	25	-5.9
16Hug-3 - 173	0.572	0.017	0.0698	0.0019	0.25958	0.05913	0.00096	458	11	435	11	546	36	-5.3
16Hug-3 - 174	2.54	0.13	0.1033	0.003	0.61233	0.1749	0.0065	1238	35	633	18	2480	59	-95.6
16Hug-3 - 175	0.606	0.024	0.0754	0.0028	0.20915	0.0596	0.0019	477	15	468	17	520	63	-1.9
16Hug-3 - 176	0.588	0.017	0.0718	0.0019	0.11182	0.05929	0.0008	468	11	447	12	550	28	-4.7
16Hug-3 - 177	0.7	0.024	0.0577	0.0019	0.64327	0.0872	0.0017	535	14	361	11	1351	38	-48.2
16Hug-3 - 178	0.879	0.031	0.0723	0.0023	0.23612	0.0886	0.0025	636	17	450	14	1334	55	-41.3
16Hug-3 - 179	0.817	0.037	0.0765	0.0021	0.47635	0.0767	0.0025	594	20	475	13	984	64	-25.1
16Hug-3 - 180	0.807	0.025	0.0789	0.0021	0.4184	0.0736	0.0012	598	14	489	12	1003	34	-22.3
16Hug-3 - 181	1.043	0.042	0.0763	0.002	0.25012	0.0984	0.0029	712	21	474	12	1467	62	-50.2

Sample 16Sko-3

	Isotopic Ratios							Calculated ages (Ma)						
ID	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Rho	$^{207/206}Pb$	2σ	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	$^{207/206}Pb$	2σ	Disc.
16Sko-3 - 1	0.6061	0.009	0.078	0.0016	0.4572	0.05633	0.00038	480.9	5.7	484.2	9.5	458	15	0.7
16Sko-3 - 2	0.6026	0.0092	0.0773	0.0016	0.65212	0.05637	0.0004	478.6	5.9	480.1	9.6	463	16	0.3
16Sko-3 - 3	0.6082	0.0096	0.0722	0.0015	0.60121	0.06108	0.00048	481.8	6.1	449.5	9.1	634	17	-7.2
16Sko-3 - 4	0.795	0.014	0.0768	0.0016	0.50524	0.07483	0.00078	593.4	7.7	477.2	9.7	1055	22	-24.4
16Sko-3 - 5	0.6138	0.0095	0.0703	0.0015	0.58499	0.06325	0.00051	485.4	6	437.8	8.8	709	17	-10.9
16Sko-3 - 6	0.698	0.013	0.0803	0.0017	0.34427	0.06273	0.00081	537.1	8	498	10	698	28	-7.9
16Sko-3 - 7	2.227	0.055	0.0799	0.0017	0.59144	0.2003	0.0035	1179	17	496	10	2802	28	-137.7
16Sko-3 - 8	0.688	0.011	0.0773	0.0016	0.50369	0.0643	0.00058	530.2	6.8	479.9	9.8	742	19	-10.5
16Sko-3 - 9	0.6272	0.0097	0.077	0.0016	0.59639	0.05896	0.00045	494.1	6	478.1	9.4	559	16	-3.3
16Sko-3 - 10	0.66	0.01	0.0814	0.0017	0.4898	0.05883	0.00048	514.4	6.2	504	10	553	17	-2.1
16Sko-3 - 11	0.68	0.015	0.0754	0.0016	0.43366	0.0655	0.0011	525.4	8.9	468.5	9.6	771	32	-12.1
16Sko-3 - 12	0.5898	0.0091	0.0749	0.0015	0.67293	0.05706	0.0004	470.4	5.9	465.5	9.2	486	15	-1.1
16Sko-3 - 13	0.5843	0.0088	0.0709	0.0014	0.56563	0.05968	0.00044	466.9	5.7	441.2	8.7	582	16	-5.8
16Sko-3 - 14	0.6034	0.0093	0.0769	0.0016	0.649	0.05682	0.0004	479.1	5.9	477.4	9.4	477	16	-0.4
16Sko-3 - 15	0.648	0.011	0.0816	0.0017	0.16092	0.05747	0.00055	506.7	6.5	506	10	495	21	-0.1
16Sko-3 - 16	0.644	0.01	0.0827	0.0017	0.58939	0.05633	0.00044	503.9	6.2	512	10	456	17	1.6
16Sko-3 - 17	0.619	0.01	0.0743	0.0016	0.5022	0.06029	0.00054	488.2	6.2	462	9.4	603	20	-5.7
16Sko-3 - 18	0.902	0.016	0.0739	0.0016	0.57977	0.08856	0.00086	651.2	8.3	459.5	9.7	1381	19	-41.7
16Sko-3 - 19	0.5967	0.0093	0.0757	0.0016	0.20936	0.05712	0.00045	474.6	5.9	470.1	9.3	486	17	-1.0
16Sko-3 - 20	0.622	0.01	0.0777	0.0016	0.61928	0.05809	0.00049	490.5	6.4	482.1	9.6	521	18	-1.7
16Sko-3 - 21	0.606	0.0089	0.078	0.0016	0.30053	0.05632	0.00036	480.8	5.7	484.3	9.5	457	14	0.7
16Sko-3 - 22	0.88	0.015	0.0787	0.0016	0.37303	0.08091	0.0008	638.9	7.9	488.2	9.4	1199	20	-30.9
16Sko-3 - 23	0.5985	0.0095	0.0749	0.0015	0.59307	0.05779	0.00044	475.9	6	465.6	9.3	517	17	-2.2
16Sko-3 - 24	0.6233	0.0095	0.0795	0.0016	0.55007	0.05675	0.00042	491.4	5.9	492.8	9.7	475	17	0.3
16Sko-3 - 25	0.722	0.012	0.0754	0.0016	0.58942	0.06929	0.00062	551	7.1	468.4	9.4	894	19	-17.6
16Sko-3 - 26	0.6135	0.0093	0.0745	0.0015	0.18584	0.05984	0.00038	485.5	5.7	463	9.2	588	13	-4.9
16Sko-3 - 27	0.7	0.019	0.0838	0.0024	0.81371	0.06077	0.00083	528.9	9.7	517	13	596	25	-2.3
16Sko-3 - 28	0.667	0.01	0.0777	0.0016	0.35845	0.06225	0.00048	518.6	6.1	482.3	9.5	674	17	-7.5
16Sko-3 - 29	0.633	0.01	0.0786	0.0016	0.49395	0.05841	0.00046	497.6	6.2	487.9	9.5	539	17	-2.0
16Sko-3 - 30	0.689	0.013	0.0794	0.0016	0.21735	0.06297	0.00085	531.5	7.5	492.9	9.9	694	28	-7.8
16Sko-3 - 31	0.5696	0.0095	0.0722	0.0015	0.54427	0.05719	0.00054	457.1	6.1	449.5	9.1	491	21	-1.7
16Sko-3 - 32	0.72	0.016	0.0786	0.0017	0.42382	0.0666	0.0011	548.4	9.2	488	10	805	35	-12.4
16Sko-3 - 33	0.862	0.017	0.0749	0.0016	0.623	0.08359	0.00096	629.3	8.9	465.4	9.7	1271	23	-35.2
16Sko-3 - 34	0.6115	0.0096	0.0782	0.0016	0.37444	0.05675	0.00043	483.9	6	485.5	9.6	472	17	0.3
16Sko-3 - 35	0.638	0.01	0.0734	0.0015	0.52897	0.06291	0.00056	500.2	6.4	456.7	9.3	698	19	-9.5
16Sko-3 - 36	0.6137	0.0092	0.0772	0.0016	0.39693	0.05784	0.00042	485.5	5.8	479.2	9.4	515	16	-1.3
16Sko-3 - 37	0.5973	0.0093	0.0755	0.0016	0.20653	0.05747	0.00048	475	5.9	469.3	9.5	502	17	-1.2
16Sko-3 - 38	0.62	0.01	0.0786	0.0017	0.56106	0.05722	0.00056	489.1	6.6	488	10	487	21	-0.2
16Sko-3 - 39	0.5925	0.0091	0.0725	0.0015	0.2251	0.05944	0.00045	472.1	5.7	450.9	8.9	572	16	-4.7
16Sko-3 - 40	0.6171	0.0092	0.0755	0.0015	0.36297	0.05936	0.0004	487.4	5.8	469	9.2	572	15	-3.9
16Sko-3 - 41	1.72	0.028	0.0832	0.0017	0.62081	0.15	0.0012	1015	10	515	10	2343	14	-97.1
16Sko-3 - 42	0.755	0.02	0.0698	0.0015	0.29821	0.0786	0.0017	565	11	435.3	8.9	1081	44	-29.8
16Sko-3 - 43	1.217	0.022	0.0714	0.0015	0.40333	0.1249	0.0016	807	10	444.2	9.2	2005	23	-81.7
16Sko-3 - 44	0.718	0.016	0.0736	0.0015	0.44462	0.0707	0.0011	546.7	9.1	457.8	9.2	911	31	-19.4
16Sko-3 - 45	0.5582	0.0087	0.0688	0.0014	0.58484	0.05881	0.00044	450.2	5.7	428.6	8.5	557	16	-5.0
16Sko-3 - 46	0.68	0.011	0.0691	0.0014	0.3255	0.07182	0.00074	526.1	6.5	430.7	8.8	967	21	-22.1
16Sko-3 - 47	0.5863	0.0091	0.0732	0.0015	0.56884	0.05818	0.00045	467.9	5.8	455.4	9.1	527	17	-2.7
16Sko-3 - 48	0.5894	0.0091	0.0756	0.0016	0.59582	0.05661	0.00043	470.1	5.8	469.6	9.4	470	17	-0.1
16Sko-3 - 49	0.806	0.045	0.0699	0.0033	0.3981	0.0845	0.0043	576	21	434	19	1167	90	-32.7
16Sko-3 - 50	0.5707	0.0091	0.0681	0.0014	0.60746	0.06086	0.00049	458.4	5.9	425	8.5	627	18	-7.9
16Sko-3 - 51	0.966	0.018	0.0546	0.0012	0.32463	0.129	0.0014	684.5	9.1	342.4	7.5	2067	19	-99.9
16Sko-3 - 52	0.981	0.021	0.08	0.0018	0.52459	0.0891	0.0012	691	10	496	11	1390	25	-39.3
16Sko-3 - 53	0.631	0.01	0.0813	0.0017	0.61061	0.05642	0.00048	496.2	6.5	504	10	459	19	1.5
16Sko-3 - 54	0.6024	0.0098	0.0781	0.0017	0.62384	0.05612	0.00047	478.2	6.2	485	10	450	18	1.4
16Sko-3 - 55	0.684	0.012	0.0771	0.0016	0.59326	0.06423	0.00062	528.4	7.1	478.9	9.6	741	21	-10.3
16Sko-3 - 56	0.6076	0.0095	0.0778	0.0016	0.5696	0.05666	0.00045	481.6	6	482.8	9.7	473	17	0.2
16Sko-3 - 57	0.5934	0.0088	0.0761	0.0015	0.51617	0.05657	0.0004	472.9	5.7	472.8	9.3	467	16	0.0
16Sko-3 - 58	0.653	0.015	0.0784	0.002	0.56238	0.0603	0.001	509	9.4	486	12	598	38	-4.7
16Sko-3 - 59	0.5965	0.0092	0.0768	0.0016	0.56724	0.05637	0.00043	474.5	5.8	476.8	9.4	457	17	0.5
16Sko-3 - 60	0.578	0.0091	0.0717	0.0015	0.41616	0.05856	0.00046	462.6	5.9	446.3	8.9	541	17	-3.7
16Sko-3 - 61	0.663	0.011	0.0801	0.0017	0.5687	0.0601	0.00049	516.1	6.4	496.5	9.9	598	18	-3.9
16Sko-3 - 62	0.5683	0.0082	0.0725	0.0015	0.46294	0.05677	0.00035	456.6	5.3	451.2	8.7	478	13	-1.2
16Sko-3 - 63	1.15	0.021	0.081	0.0017	0.4661	0.1028	0.0012	774	10	502	9.9	1657	22	-54.2
16Sko-3 - 64	0.5813	0.0086	0.0745	0.0015	0.34013	0.05651	0.00036	464.9	5.5	463.3	9	466	14	-0.3
16Sko-3 - 65	0.642	0.01	0.0713	0.0015	0.52944	0.06534	0.00058	502.9	6.4	443.7	8.8	771	19	-13.3
16Sko-3 - 66	0.5942	0.0093	0.0721	0.0015	0.48496	0.05977	0.0005	473.1	6	448.9	9.1	589	18	-5.4
16Sko-3 - 67	0.6059	0.0099	0.0757	0.0016	0.63026	0.05794	0.00047	480.4	6.3	470	9.5	520	18	-2.2
16Sko-3 - 68	0.5652	0.0086	0.0711	0.0015	0.59929	0.05761	0.0004	454.7	5.6	443	8.8	509	15	-2.6
16Sko-3 - 69	0.5985	0.0089	0.0769	0.0016	0.37352	0.05643	0.00036	476	5.7	477.2	9.3	463	14	0.3
16Sko-3 - 70	0.5965	0.009	0.077	0.0016	0.49643	0.05604	0.0004	474.6	5.7	478.1	9.4	447	16	0.7
16Sko-3 - 71	0.579	0.0089	0.0734	0.0015	0.53024	0.0571	0.00044	464	5.7	457	9.2	489	17	-1.5
16Sko-3 - 72	0.5552	0.0084	0.0701	0.0014	0.53185	0.05738	0.0004	448.1	5.5	436.4	8.5	499	15	-2.7
16Sko-3 - 73	0.5976	0.0089	0.0765	0.0016	0.57314	0.05643	0.00037	475.3	5.7	475.4	9.3	463	15	0.0
16Sko-3 - 74	0.818	0.018	0.079	0.0016	0.36895	0.0748	0.0012	603.2	9.7	489.8	9.7	1019	31	-23.2
16Sko-3 - 75	0.5846	0.0097	0.0744	0.0016	0.5136	0.0568	0.00054	466.7	6.2	462.7	9.5	473	21	-0.9
16Sko-3 - 76	0.6136	0.0096	0.0776	0.0016	0.1416	0.05698	0.00042	484.6	5.6	482	9.6	478	16	-0.5

16Sko-3 - 76	0.6136	0.0096	0.0776	0.0016	0.1416	0.05698	0.00042	484.6	5.6	482	9.6	478	16	-0.5
16Sko-3 - 77	0.684	0.015	0.0757	0.0015	0.27606	0.0653	0.0011	526.2	8.8	470.5	9.3	733	33	-11.8
16Sko-3 - 78	1.346	0.036	0.0812	0.0017	0.47221	0.1193	0.0025	857	15	503	10	1901	37	-70.4
16Sko-3 - 79	0.81	0.014	0.072	0.0015	0.32306	0.08143	0.00095	601.1	8.1	448.4	8.9	1210	24	-34.1
16Sko-3 - 80	0.705	0.012	0.0705	0.0016	0.60859	0.07234	0.0007	540.6	7.2	439.2	9.4	985	20	-23.1
16Sko-3 - 81	0.5873	0.0093	0.0705	0.0015	0.55983	0.06015	0.0005	468.7	5.9	438.9	8.9	602	18	-6.8
16Sko-3 - 82	0.5942	0.009	0.0757	0.0015	0.54786	0.05678	0.00041	473.5	5.7	470.1	9.3	476	16	-0.7
16Sko-3 - 83	0.6066	0.0091	0.0722	0.0015	0.64005	0.06063	0.00039	481	5.8	449.6	8.9	618	14	-7.0
16Sko-3 - 84	0.666	0.015	0.0752	0.0016	0.21699	0.0639	0.001	516.1	8.5	467.2	9.3	699	33	-10.5
16Sko-3 - 85	0.894	0.015	0.0776	0.0016	0.37456	0.08314	0.00069	647.8	7.8	482.1	9.6	1264	17	-34.4
16Sko-3 - 86	0.594	0.0088	0.0764	0.0015	0.60181	0.05616	0.00036	473.2	5.6	474.9	9.2	453	14	0.4
16Sko-3 - 87	0.565	0.01	0.0677	0.0015	0.4341	0.06064	0.00071	454.6	6.7	421.9	9.1	616	26	-7.8
16Sko-3 - 88	0.642	0.01	0.0732	0.0015	0.51221	0.06345	0.00054	502.9	6.4	455.3	9.1	715	18	-10.5
16Sko-3 - 89	0.827	0.013	0.0727	0.0015	0.46533	0.08224	0.00066	611.4	7.1	452.1	8.9	1245	16	-35.2
16Sko-3 - 90	0.649	0.01	0.074	0.0016	0.52035	0.06346	0.00053	507.5	6.4	460.3	9.3	716	18	-10.3
16Sko-3 - 91	0.565	0.01	0.0669	0.0015	0.34753	0.06112	0.00075	454.2	6.6	417.7	8.9	632	26	-8.7
16Sko-3 - 92	0.5798	0.0094	0.0668	0.0014	0.54527	0.06269	0.00055	463.9	6	417.1	8.5	690	19	-11.2
16Sko-3 - 93	1.733	0.039	0.0808	0.0017	0.21161	0.1562	0.0029	1011	15	500.8	9.9	2355	34	-101.9
16Sko-3 - 94	0.5998	0.0093	0.0741	0.0015	0.52978	0.05881	0.00046	476.9	5.9	460.7	9.2	550	17	-3.5
16Sko-3 - 95	0.619	0.011	0.0736	0.0016	0.55039	0.06105	0.00061	488.3	6.6	457.8	9.6	623	22	-6.7
16Sko-3 - 96	0.592	0.0087	0.0754	0.0015	0.47953	0.05684	0.00037	471.7	5.5	468.7	9.1	479	15	-0.6
16Sko-3 - 97	0.6402	0.0097	0.0794	0.0016	0.45711	0.05842	0.00042	501.9	6	492.5	9.6	537	16	-1.9
16Sko-3 - 98	0.786	0.013	0.0735	0.0015	0.56153	0.07763	0.0007	588.4	7.3	456.9	9.3	1128	18	-28.8
16Sko-3 - 99	0.693	0.015	0.0733	0.0018	0.49925	0.0689	0.0011	533	9.3	456	11	875	34	-16.9
16Sko-3 - 100	0.5925	0.0097	0.0761	0.0016	0.61406	0.0565	0.00047	472.1	6.2	472.9	9.5	463	19	0.2
16Sko-3 - 101	0.5908	0.0098	0.0708	0.0015	0.34017	0.06065	0.00058	470.6	6.2	440.7	9	611	21	-6.8
16Sko-3 - 102	0.5932	0.0089	0.0763	0.0016	0.5552	0.05634	0.00039	472.8	5.7	474.3	9.2	459	15	0.3
16Sko-3 - 103	0.614	0.011	0.0756	0.0016	0.4886	0.05878	0.00064	485.1	7	469.6	9.6	546	24	-3.3
16Sko-3 - 104	0.5988	0.009	0.077	0.0016	0.65035	0.05646	0.00037	476.2	5.7	478	9.4	464	15	0.4
16Sko-3 - 105	0.635	0.01	0.078	0.0016	0.5455	0.05908	0.00049	498.7	6.3	483.8	9.6	558	18	-3.1
16Sko-3 - 106	0.5821	0.009	0.0745	0.0015	0.55413	0.05677	0.00043	465.4	5.8	463.2	9.2	473	17	-0.5
16Sko-3 - 107	0.5992	0.009	0.0776	0.0016	0.54323	0.05604	0.00038	476.5	5.6	481.9	9.4	446	15	1.1
16Sko-3 - 108	0.622	0.011	0.0799	0.0017	0.57761	0.05657	0.00055	490.6	6.7	496	10	463	22	1.1
16Sko-3 - 109	0.5744	0.0085	0.0738	0.0015	0.62486	0.05648	0.00036	460.7	5.5	458.9	8.9	465	14	-0.4
16Sko-3 - 110	0.5968	0.0097	0.0769	0.0016	0.57626	0.05626	0.0005	474.8	6.2	477.5	9.7	452	20	0.6
16Sko-3 - 111	0.5523	0.0095	0.065	0.0014	0.47065	0.06155	0.00064	446	6.2	406	8.3	648	22	-9.9
16Sko-3 - 112	0.6007	0.0091	0.0764	0.0016	0.35415	0.05707	0.0004	477.2	5.8	474.3	9.4	487	15	-0.6
16Sko-3 - 113	0.5852	0.0096	0.0729	0.0015	0.19069	0.05819	0.00051	467.2	6	453.3	9.1	525	18	-3.1
16Sko-3 - 114	0.62	0.01	0.0771	0.0016	0.57109	0.0585	0.0005	489.2	6.3	478.7	9.7	541	19	-2.2
16Sko-3 - 115	0.6226	0.0092	0.0716	0.0014	0.50233	0.06313	0.00043	491.1	5.8	445.8	8.7	705	15	-10.2
16Sko-3 - 116	0.587	0.0087	0.0734	0.0015	0.53278	0.05814	0.00038	468.7	5.5	456.3	8.9	528	14	-2.7
16Sko-3 - 117	0.5736	0.0094	0.0735	0.0015	0.15963	0.05657	0.0005	459.5	6	456.8	9.3	461	20	-0.6
16Sko-3 - 118	0.929	0.02	0.0901	0.0022	0.42321	0.07458	0.0009	664	11	556	13	1042	25	-19.4
16Sko-3 - 119	0.739	0.013	0.0726	0.0015	0.20109	0.07399	0.00073	560.7	7.5	451.8	9.1	1027	20	-24.1
16Sko-3 - 120	0.5936	0.0093	0.076	0.0016	0.29865	0.05683	0.00044	472.3	5.9	471.9	9.4	472	17	-0.1
16Sko-3 - 121	0.6053	0.0092	0.0777	0.0016	0.55465	0.05664	0.00041	480.2	5.9	482	9.5	470	16	0.4
16Sko-3 - 122	0.6055	0.0094	0.0768	0.0016	0.52781	0.05716	0.00044	480.1	6	477	9.4	490	17	-0.6
16Sko-3 - 123	0.5979	0.0088	0.0771	0.0016	0.54342	0.0564	0.00037	475.8	5.6	478.5	9.3	460	15	0.6
16Sko-3 - 124	0.5903	0.0091	0.0759	0.0016	0.22225	0.05649	0.0004	470.7	5.7	471.4	9.3	461	16	0.1
16Sko-3 - 125	0.5957	0.009	0.0766	0.0016	0.5181	0.0564	0.0004	474.2	5.7	476	9.3	460	16	0.4
16Sko-3 - 126	0.6088	0.0096	0.0787	0.0016	0.48894	0.05631	0.00048	482.2	6	488	9.8	454	19	1.2
16Sko-3 - 127	0.5745	0.0089	0.0742	0.0015	0.29431	0.05627	0.00041	460.7	5.6	461.5	9.2	454	16	0.2
16Sko-3 - 128	0.6072	0.0093	0.076	0.0016	0.48589	0.0582	0.00045	482	6	472	9.3	528	16	-2.1
16Sko-3 - 129	0.5931	0.0099	0.0749	0.0016	0.32074	0.05755	0.00055	472.4	6.3	465.5	9.6	505	21	-1.5
16Sko-3 - 130	0.5903	0.0091	0.0757	0.0016	0.13606	0.05666	0.00045	470.9	5.6	470.6	9.3	469	17	-0.1
16Sko-3 - 131	0.5979	0.0096	0.0765	0.0016	0.37159	0.05683	0.00049	475.4	6.1	474.9	9.6	476	19	-0.1
16Sko-3 - 132	0.6082	0.0098	0.0755	0.0015	0.58554	0.05849	0.00048	481.5	6.1	469.2	9.3	536	18	-2.6
16Sko-3 - 133	0.5995	0.0094	0.0765	0.0016	0.59191	0.05692	0.00045	476.4	6	475.6	9.4	482	17	-0.2
16Sko-3 - 134	0.5903	0.0091	0.0756	0.0016	0.10148	0.05668	0.00044	470.6	5.8	470	9.3	469	17	-0.1
16Sko-3 - 135	0.621	0.01	0.0793	0.0017	0.63417	0.05689	0.00046	490.1	6.3	491.8	9.9	477	18	0.3
16Sko-3 - 136	0.586	0.009	0.0725	0.0015	0.61756	0.05873	0.00043	467.8	5.8	451.3	8.9	547	16	-3.7
16Sko-3 - 137	0.6003	0.009	0.0775	0.0016	0.51003	0.05612	0.00039	477.2	5.7	481.3	9.4	452	16	0.9
16Sko-3 - 138	0.5806	0.0087	0.0746	0.0015	0.19166	0.05651	0.00038	464.7	5.4	463.7	9.1	463	15	-0.2
16Sko-3 - 139	0.634	0.01	0.0812	0.0017	0.28593	0.05659	0.00047	497.7	6.3	503	10	464	18	1.1
16Sko-3 - 140	0.6018	0.0093	0.0771	0.0016	0.046012	0.05651	0.00044	477.7	5.9	478.5	9.5	464	16	0.2
16Sko-3 - 141	0.6237	0.0099	0.0802	0.0017	0.34799	0.05634	0.00042	490.9	6	497.2	9.9	455	17	1.3
16Sko-3 - 142	0.6289	0.0094	0.0808	0.0016	0.56627	0.05639	0.00038	494.9	5.9	500.9	9.8	460	15	1.2
16Sko-3 - 143	0.6125	0.0093	0.0785	0.0016	0.10748	0.05651	0.0004	484.5	5.8	487.5	9.6	462	16	0.6
16Sko-3 - 144	0.5799	0.0093	0.074	0.0015	0.59193	0.05676	0.00045	463.7	5.9	460	9.2	471	18	-0.8
16Sko-3 - 145	0.769	0.014	0.0828	0.0018	0.65077	0.06717	0.00071	577.8	8.3	512	11	829	22	-12.9
16Sko-3 - 146	0.5961	0.0091	0.0761	0.0016	0.55011	0.05676	0.00043	474.2	5.8	472.6	9.4	473	17	-0.3
16Sko-3 - 147	0.6106	0.0088	0.0784	0.0016	0.48878	0.05639	0.00034	483.7	5.5	486.4	9.4	461	13	0.6
16Sko-3 - 148	0.6168	0.0098	0.0796	0.0016	0.65502	0.05613	0.00043	487.4	6.2	493.5	9.8	448	17	1.2
16Sko-3 - 149	0.5975	0.0089	0.0772	0.0016	0.5707	0.056	0.00037	475.7	5.7	479.5	9.4	443	15	0.8
16Sko-3 - 150	0.6016	0.0092	0.0768	0.0016	0.3715	0.05662	0.00041	477.7	5.8	476.7	9.4	466	16	-0.2
16Sko-3 - 151	0.629	0.01	0.0803	0.0017	0.56331	0.0566	0.00047	494.7	6.3	497.6	9.9	463	18	0.6
16Sko-3 - 152	0.6318	0.0098	0.0811	0.0017	0.6049	0.0563	0.0004	496.8	6.1	503	10	459	16	1.2
16Sko-3 - 153	0.5928	0.0092	0.0757	0.0016	0.64387	0.0565	0.00042	472.2	5.8	470.5	9.3	463	17	-0.4