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Soapstone production through Norwegian history: geology, properties, quarrying, and use

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Abstract Based on literature and studies of old soapstone quarries, artifacts, and buildings throughout the country, this paper gives an overview of the history, quarrying, and use of soapstone in Norway from prehistoric times until today. It also discusses the geological preconditions for the thriving soapstone industry. The paper focuses on soapstone for various vessels and as a building material and includes three case studies of quarries in central Norway to show the typical exploitation of the stone.

INTRODUCTION

Soapstone has been quarried, used, and appreciated since the dawn of civilization. This talc-rich metamorphic rock is very soft, heat resistant, and dense. In ancient times these properties made soapstone a perfect material for vessels, cooking pots, all kinds of small utensils, and sculpture. In some countries soapstone was used in architecture, mostly for decoration. Norway may perhaps be the only country in the world where it was also used for structural purposes in the Middle Ages and later.

In addition to describing the occurrence, formation, and petrography of soapstone, and its useful properties in the service of man, this paper follows the Norwegian soapstone "industry" from the Stone Age, through the Bronze and Iron Ages, and into the Middle Ages and modern times. It also includes brief case studies of three quarries in central Norway.

Contrary to what is often stated in Norway, soapstone is not a particular "Norwegian" material. Soapstone occurs in orogenic provinces throughout the world and consequently has been used virtually everywhere since the earliest times. In this connection we could mention large parts of Scandinavia, parts of the Americas, Canada, Greenland, East Africa, India, and the Middle East (Helland, 1893; Rütimeyer, 1924; Wiik, 1953; Allen *et al.*, 1984; Nelund 1985; Hallett, 1990). Large concentrations of quarries are found in Switzerland, North Italy, and Egypt as well as in Norway.

The Swiss and north Italian material has been studied since before the beginning of the 20th century (Rütimeyer, 1924). The working of soapstone for vessels and other utensils was especially intensive in the Roman period, for instance in the region around Plurs/Chiavenna. The products were not only used locally but also exported to present Germany and France. A peculiarity is that many vessels were not carved, but cut on turning lathes in simple workshops (see also Lurati, 1970). This highly specialized technology was so well adapted that it remained virtually unchanged until the 20th century. It should also be noted that Swiss soapstone has been extensively used for stoves and less extensively for architectural decoration since the Middle Ages (Hugger, 1976; de Quervain, 1969, 1972).

Although the Arabic material has already been mentioned by early European authors (e.g. Helland, 1893; Rütimeyer, 1924), it is relatively unknown to us. However, after receiving directions from geologist James Harrell of the University of Toledo, USA – who recently discovered several large, ancient soapstone quarries in the Eastern Desert of Egypt – we ourselves have seen the enormous extent of these quarries. The quarries must have been used for producing huge amounts of vessels, probably throughout several periods of time.

A BRIEF NOTE ON TERMINOLOGY AND PROPERTIES

Geologically speaking, the term "soapstone" is derived from the "soapy" or "fatty" surface of the stone due to its high content of talc. Surely the name "soapstone" is also used because the stone is so easy to carve. When talc takes a massive form and its content in soapstone approaches 100%, the terms "steatite" or simply "talc" are used. The term "soapstone" may also have been used for other kinds of soft rocks, such as talcschist and serpentinite with high talc content (see also Bates and Jackson, 1984).

In Norway, as elsewhere, the terminology of soapstone is closely linked to its use. The most common Norwegian term *kleberstein*, is, for instance, derived from its use as loomweights (No: *kljaastein*, *kliberg*). Another important name, *grötstein* or *grytestein*, is derived from the Old Norse collective word for stone *grjót* (or *grýta*), which was also the old name for vessels and pots made from stone (Skjølsvold, 1961; Solhaug, 2001). In Sweden the most common term is

täljsten ("stone which is easily carved"), while in Denmark it is termed *fedtsten* ("fatty stone"), which is also the most common name in German-speaking countries (*Speckstein*, also *Seifenstein*). In multilingual Switzerland there are numerous terms, for instance *Lavezstein* ("stone vessel"), *Topfstein* ("pot-stone") and *Ofenstein* ("stove-stone") (Rütimeyer, 1924; de Quervain, 1972).

Although there are enormous variations in quality, even within one single deposit, the most characteristic properties of soapstone are readily understood from the terms mentioned above. It is heat resistant, has a high heat capacity, and is very easy to work, even with wood-carving tools. However, due to the fact that large parts of many soapstone deposits are foliated, veined, and cracked, it was only the more massive areas that could be used as material for cooking pots and sculpture. The quality variations are also reflected in the color; it may vary from dull gray, to bluish, greenish, and brownish or reddish. The latter color often stems from oxidation of trace amounts of iron in the carbonates. Last, but not least it should be noted that when used as cooking pots, soapstone is supposed to produce excellent food, presumably due to the even heat dispersion and because it is a rather inert material (cf. Rütimeyer, 1924).

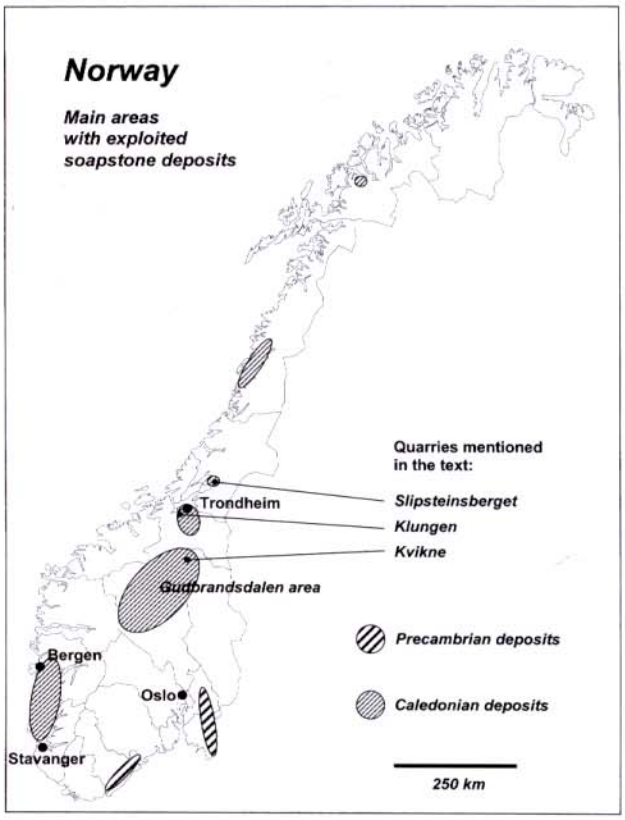

Figure 1 Map of Norway showing main areas with soapstone deposits and quarries mentioned in the text. Hatched areas do not necessarily correspond with geological provinces.

GEOLOGY OF NORWEGIAN SOAPSTONE DEPOSITS

Soapstone originates from metamorphic alteration of various magnesium-rich rocks, such as peridotites and dolomitic carbonates. The softness and excellent workability of soapstone are given by soft, flaky minerals, of which talc is the most important constituent. Other common minerals in soapstone are chlorite and carbonates (calcite, dolomite, and magnesite-breunnerite), while amphiboles, such as tremolite-actinolite, occur in some deposits. Common opaque minerals are magnetite, pyrite, and pyrrhotite. In deposits where the transition from olivine, pyroxene, and serpentine is incomplete, relics of these minerals may be found.

Peridotite bodies are common both in the Precambrian basement and in the Caledonides in Scandinavia. Many of these bodies are altered to serpentine-talc rocks, due to various episodes of regional metamorphism and, regarding ophiolites, to hydrothermal sea-floor alteration. The multistage process of serpentinization, talc-formation, and deserpentinization may be very complex (Wiik, 1953; O'Hanley, 1996) and will not be discussed further in this paper.

Soapstone is found at a large number of locations in Norway (Fig. 1). It occurs essentially in the marginal part of peridotite bodies and/or in shear zones in the internal parts. Since the most important mineral source for the formation of serpentine-talc-carbonate from peridotites is olivine and/or pyroxene, the best protolyths for the formation of soapstone would be metamorphic hartzburgite, dunite, and orthopyroxenite.

Such rocks are found in various geological settings in Norway. In the Precambrian basement, solitary ultramafic bodies of unknown origin as well as layered mafic-ultramafic intrusions are commonly known to bear soapstone deposits (Fig. 2). Solitary serpentinites also occur in Proterozoic to early Paleozoic schists within the Caledonian thrust nappes.

Ordovician ophiolite fragments are also of great importance. They are tectonically displaced to different tectonostratigraphic levels within the Caledonian Mountain belt. Here, soapstones are connected to mantle-derived hartzburgitic tectonites, layered ultramafics, and ultramafic bodies within gabbros.

Additionally, these primary sources may have been eroded in Middle Ordovician time, forming huge deposits of serpentine conglomerate and sandstone, which later have been partly or completely transformed to soapstone (Strand, 1951; Sturt *et al.*, 1991). Thus, in a number of soapstone deposits, especially in the Gudbrandsdalen area (eastern part of Norway), sedimentary structures can be recognized.

Only one soapstone deposit derived from dolomite is yet known in Norway (the Nordland quarry, southwest Norway; Mortensen, 1945). Such deposits generally contain coarse-grained, pure talc rather than soapstone "proper."

In addition to the primary source of the soapstone, metamorphic grade and deformational history strongly influence the characteristics of the deposits. The mineralogy and grain size change with metamorphic grade, and deformation contributes to more or less penetrating foliation, shear

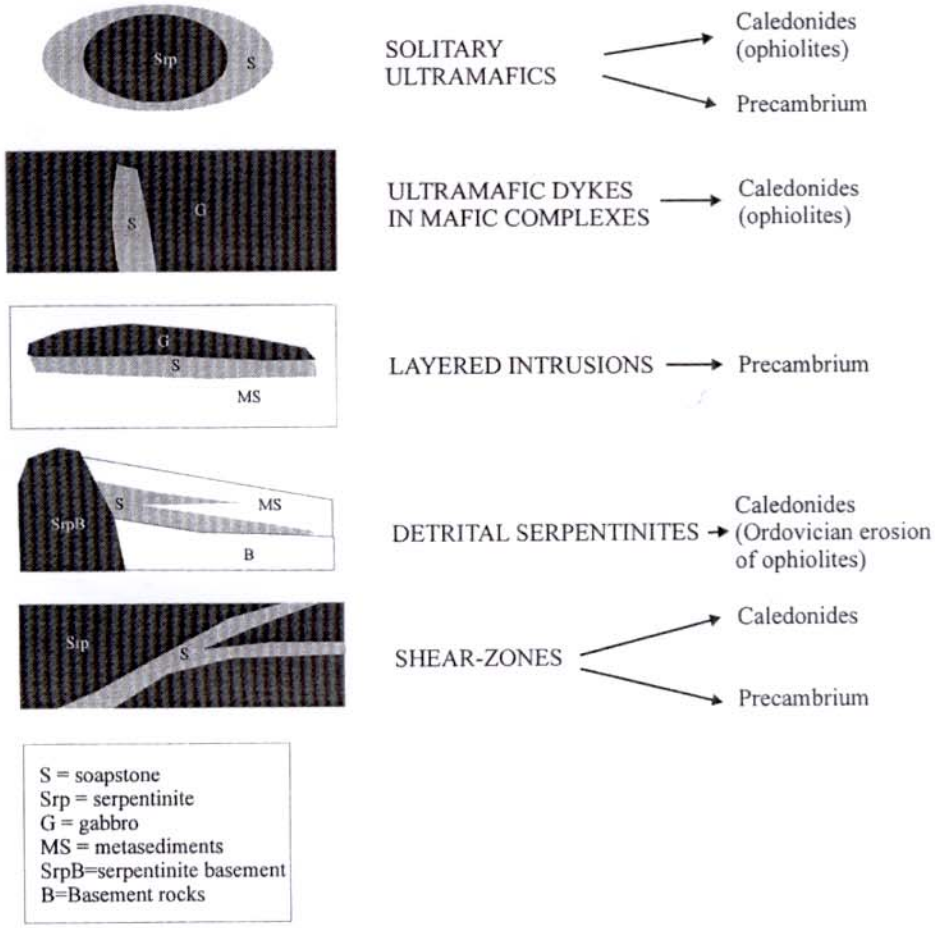

Figure 2 The various geological settings of Norwegian soapstone deposits.

zones, and other structures. For instance, stretched long-limb areas of folds are strongly foliated and have different workability than the more massive fold hinges.

In Figure 2 the various geological settings of Norwegian soapstone deposits are shown schematically. It has not yet been possible to recognize any preference for the one or the other in historical use, and, as mentioned above, the internal variations of quality within a single deposit may be greater than the differences between deposit types. Far more important have been the availability, proximity, and size of the deposits. However, the nature of deformation clearly played a major role in selecting relevant parts of the deposits for different uses. Generally, strongly foliated parts could only be used for architecture (especially ashlars) and baking plates, while more massive parts had to be found for larger vessels and sculpture. For small utensils and other small objects it was normally possible to find usable material throughout most of the deposits.

THE USE OF NORWEGIAN SOAPSTONE THROUGH HISTORY

The use of soapstone through Norwegian history can perhaps best be divided into the period before the Middle Ages and the period from the Middle Ages onwards, the reason being that the introduction of Christianity to Norway ca. AD 1000 simultaneously introduced the art of stone building (Ekroll, 1997), in which the use of soapstone became an important component.

FROM THE STONE AGE TO THE LATE IRON AGE (>1500 BC–AD 1000)

The Stone Age peoples of Norway, especially in the south-western part of the country, utilized soapstone for tools like clubs, picks, and adzes. Small animal and bird sculptures have also been found, but it is not yet known whether Stone Age peoples used soapstone for vessels and cooking pots (Skjølsvold, 1961).

With the introduction of bronze (from 1500 BC, essentially in the southern part of Norway), soapstone became an

important material for molds (axes, knives, sickles, spearheads etc.), just as in other parts of the world (e.g. Switzerland and Egypt). Since there was no production of copper and tin in Norway, Rønne (1996) suggests that bronze came via Denmark from countries further south of Norway, and that the Norwegians in exchange provided soapstone to the Danes. Many Bronze Age soapstone molds have also been found in Denmark, but since provenance studies remain to be undertaken, one cannot say for certain whether the soapstone originates in Norway or elsewhere, for instance in present-day Sweden. It should also be underlined that bronze was imported from Russia to Norway in the Bronze Age (Bakka, 1976). However, a connection with soapstone trade is uncertain.

No certain finds of Bronze Age soapstone vessels have been made in Norway (Skjølsvold, 1961), and it is not before the pre-Roman Iron Age (500–0 BC) that such items turn up on a larger scale (Fig. 4). Earlier it was believed that the production of soapstone vessels flourished only during the Viking Age (Late Iron Age, AD 800–1000). However, the discovery of the Kvikne soapstone quarry in a desolated mountain area in the middle part of Norway in the 1960s put an end to these beliefs. According to C-14 dates of wooden tools found in the quarry, it was established that the main exploitation period had to be between 500 and 200 BC. Calculations have revealed that as many as 4–6,000 vessels, mostly with forms similar to contemporary funerary urns, were produced from the quarry, a number indicating "export" to rather well-off markets – probably other regions of Norway. The discovery of the quarry was important for the understanding of the Early Iron Age in Norway, a period traditionally thought of – contrary to the prosperous Bronze Age – as being characterized by depopulation due to radical climatic change (Skjølsvold, 1969; Hagen, 1977).

Although vessels from the pre-Roman Iron Age have been found during excavations, no quarries other than Kvikne have yet been dated to the same period. The same is true for the different periods prior to the Viking Age (AD 800–1000). In the Viking Age, however, the use of soapstone for pots and vessels virtually exploded and almost completely expelled the former pottery tradition (Skjølsvold, 1961). Almost a thousand vessels (or fragments of vessels) have been found throughout Norway, and Viking Age quarries are widely distributed, although they are concentrated in the southeastern, southwestern, and middle parts of the country – and perhaps as far north as Nordland county (Berglund, 1995) (Figs 1 and 5).

Soapstone pots (and other items) were not only used in Norway during the Viking Age but probably also exported

Figure 3 Extraction marks of small and large Viking Age vessels at Tandseterstyggeberget quarry in Oppland county. Some vessels have been removed.

Figure 4 Typical form of soapstone vessels produced in the pre-Roman Iron Age (after Skjølsvold, 1961).

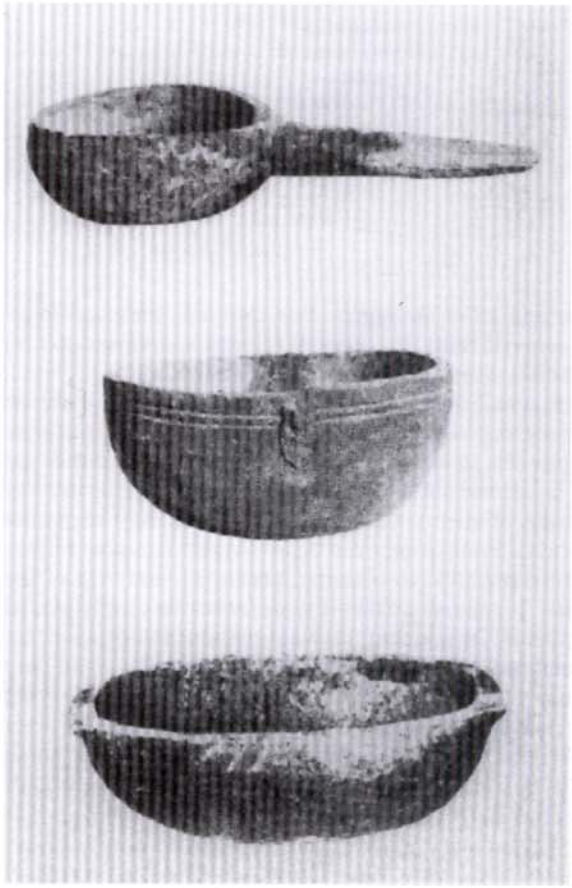

Figure 5 Typical forms of soapstone vessels produced in the Viking Age (after Skjølsvold, 1961).

to Denmark/Germany and possibly Iceland (Skjølsvold, 1961). In the north German trading town Hedeby, to which the Vikings had intimate connections, hundreds of soapstone pots and other soapstone items have been found (Resi, 1979). According to provenance studies based on trace element analyses, Alfsen and Christie (1979) suggest that the sources may have been quarries in the southeastern part of Norway and along the Swedish west coast.

So far we have only discussed soapstone vessels, but throughout the Iron Age soapstone was also used for several types of small items, such as loom-weights, spinning whorls, sinkers, molds etc. (see e.g. Tuastad, 1949).

FROM THE MIDDLE AGES ONWARDS

Cooking pots, vessels, and other artifacts continued to be produced through the Middle Ages and into modern times. In the Middle Ages, however, came the second "explosion" in the use of soapstone, namely for architecture. Almost 200 stone churches and a number of secular stone buildings were erected in the period from ca. AD 1050 to the Black Death in 1349–50, most of which included the use of soapstone in one form or another (Ekroll, 1997).

There are large regional variations, though, with regard both to the types of stone used, and the size and decoration of the buildings. Perhaps due to English and Continental influence, the earliest stone used in the Romanesque building phases at the cathedrals of Trondheim (Fig. 6) and Stavanger was local greenschist (or chlorite schist), whereas soapstone from local or regional quarries took over in the Gothic period (Storemyr, 1996, 1997). In the southeastern part of Norway, several traditions existed almost side by side. Partly due to close connections with Denmark, a lot of small country churches have decorations of granite and other hard stones (Brendalsmo and Sörensen, 1995). In other parts of the region local limestone was of great importance, together with soapstone, which was mostly used for decoration. Along the coast from the southern part of the country to the Bergen-Hordaland area, the use of different varieties of soapstone was almost universal, while along the northwestern coast the use of local and regional coarse-grained, white marble seems to reflect a somewhat different building tradition (Ekroll, 1997).

It must be emphasized that only a few of the most important and largest churches were completely or almost completely built of soapstone (ashlars). In small country churches the walls were usually made of local fieldstone or hewn coursed rubble, while quoins, portals, windows, and sculpture were made of the more valuable and less available soapstone (Fig. 7). Most of the ca. 200 Medieval baptismal fonts in Norway were also made of soapstone (Solhaug, 2001).

In conclusion and according to present knowledge, the selection of stone during the Medieval building boom was essentially dependent on availability and proximity, and perhaps to a lesser extent on cultural traditions and impulses from other parts of Europe.

Although soapstone continued to be used for vessels and utensils, and decoration on fortresses, manor houses, and a

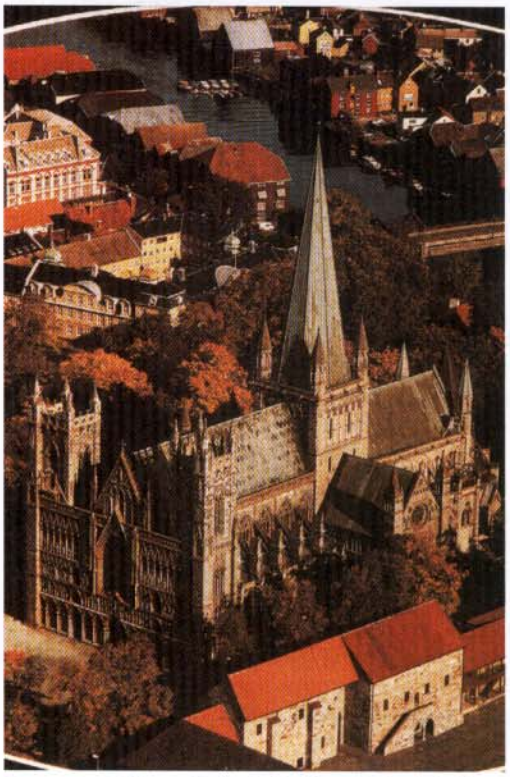

Figure 6 Nidaros Cathedral in Trondheim is built essentially from soapstone and chlorite schist. (Photo: The Restoration Workshop of Nidaros Cathedral.)

Figure 7 Small Norwegian Medieval country churches typically have soapstone in quoins, portals, and other decoration. Example from Byneset church near Trondheim.

few churches, its use in the post-Reformation period (after 1537) is strongly connected to the manufacturing of fireplaces and stoves – obviously because the stone is heat resistant and has a high heat capacity. In the 17th century and later this industry boomed especially in the Gudbrandsdalen area in the eastern part of Norway (Krekling *et al.*, 1995). Even today quite a lot of people in Gudbrandsdalen are involved in the production of modern fireplaces and stoves for domestic use and worldwide export. As the industrial revolution got a foothold, soapstone from Gudbrandsdalen was also produced for the use as linings in furnaces.

A little known, but perhaps quite significant, use of soapstone was also as "linings" for the shafts in windmills (and other mills) – not in Norway, but in north European countries such as Holland, Germany, and Denmark (Stüve, 1998). The question that remains to be answered is whether this soapstone was exported from Norway.

With regard to the quantity of soapstone quarried, one of the most intense phases of use occurred from the late 19th century until about 1915. During this period Norway experienced a general building boom, when, as elsewhere in Europe, most of the large Medieval monuments were also restored. Naturally, a lot of soapstone was needed for the restorations, for instance at the national monument, Nidaros Cathedral in Trondheim (Storemyr, 1997). Furthermore, soapstone was used for quite a few facades on new buildings (e.g. in Oslo) and as architectural decoration on buildings essentially built of other stones (see also Ringbom, 1987). Soapstone as a facade material can also be found in the USA and Finland (Bowles, 1939; Ringbom, 1987).

SOAPSTONE PRODUCTION AT THREE CENTRAL NORWEGIAN QUARRIES

Three Central Norwegian quarries used in different periods and for different purposes will be briefly presented. The extensive traces of former exploitation in these quarries provide important information on quarrying methods and treatment of the raw material.

THE KVIKNE QUARRY: VESSELS IN THE PRE-ROMAN IRON AGE (500–200 BC)

The Kvikne quarry is situated in a desolated and barren mountain area nearly 1000 m above sea level and about 120 km south of Trondheim (see also above). The dusty gray, massive, very homogeneous, and easily workable soapstone occurs in the marginal part of an egg-shaped serpentinite body with a maximum diameter of 40–50 m, surrounded by mica schists and amphibolites of Proterozoic to early Paleozoic age (Fig. 8; Frigstad, 1973; 1974).

Only the soft soapstone was worked in the pre-Roman Iron Age. Following excavations in the 1960s and later, it could be established that the quarry was worked as an open pit, much as in the later Viking Age (Figs 9 and 10). The outer shape of the vessel (diameter 13–23 cm) to be extracted was roughly hewn into the rock, and the half-finished item was subsequently loosened after a groove had been cut along the lowermost part. It is reasonable to suggest that the vessels were finished or nearly finished in the quarry, especially considering the desolated location (reduction of weight/transportation). According to fragments found, at least two types of vessels were produced in the quarry. One was relatively tall and narrow; the other looked more like a low bowl (Skjølsvold, 1969).

No metal tools have been found in the quarry, but according to tool marks it is likely that either some kind of slightly curved adze or relatively broad, slightly curved chisel was commonly applied (Fig. 11). Some marks resembling the use of picks have also been found. Generally, the tools must have had very sharp edges, which perhaps points to the use of bronze rather than iron. At such an early stage in the Iron Age, bronze tools may have been more reliable than iron tools (Skjølsvold, 1969), but since iron production started very early in central Norway (Stenvik, 1997), this hypothesis should be tested further. Another question to be answered is why this desolated quarry was exploited in the first place. Was it because of the excellent workability of the stone, a population distribution completely different from later periods, or other reasons?

The excellently preserved tool marks were buried until the 1950s when the Restoration Workshop of Nidaros

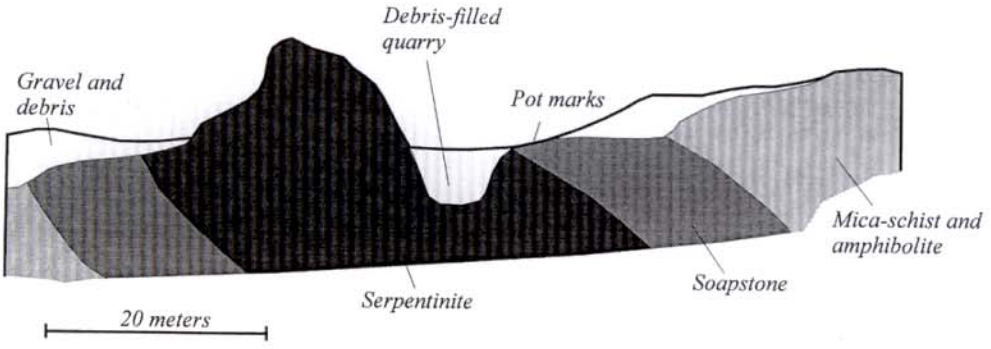

Figure 8 Geology of the Kvikne serpentinite and soapstone deposit. Cross-section (after Frigstad, 1973; 1974).

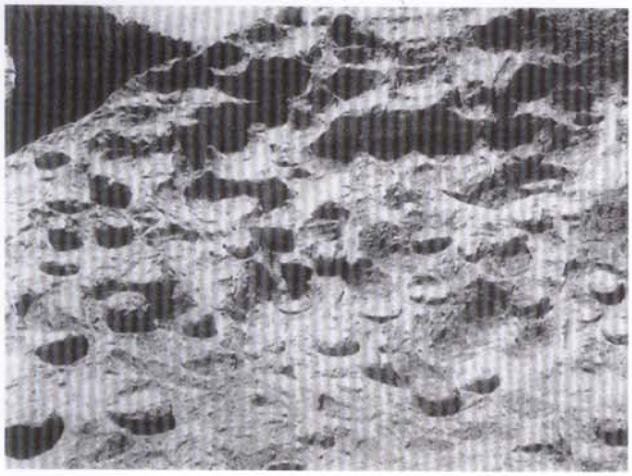

Figure 9 View of the Kvikne soapstone quarry showing vessels worked in the pre-Roman Iron Age (after Skjølsvold, 1969).

Figure 10 Kvikne soapstone quarry, pre-Roman Iron Age. Close-up of a vessel to be extracted.

Figure 11 Kvikne soapstone quarry, pre-Roman Iron Age. Close-up of a blank in which a vessel has been extracted. Note the excellently preserved tool marks.

Cathedral started excavations and quarrying in a part of the deposit. Until the old quarry was reburied some years later, many tool marks had weathered away. Kvikne is in fact one of the few soapstones in Norway that cannot resist surface weathering (Storemyr, 1997).

THE SLIPSTEINSBERGET QUARRY: VIKING AGE VESSELS AND MEDIEVAL BUILDING STONE (AD 800–1300)

Contrary to the Kvikne quarry and to many Viking Age quarries, the Slipsteinsberget quarry already lay close to a prosperous agricultural district, some 100 km north of present Trondheim. The soapstone occurs – principally as at Kvikne – in the marginal part of an almost 200 m long and 150 m wide serpentinite body, enveloped by Proterozoic to early Paleozoic schists (Fig. 12). However, Slipsteinsberget is a brecciated deposit, implying that the soapstone is more heterogeneous than is the case at Kvikne. Six to seven optically distinguishable types of soapstone can be followed from the schistose outer rim of the deposit, through very talc-rich areas, and to the veined (magnesite) mixture between soapstone and serpentinite towards the interior (Mortenson, 1973).

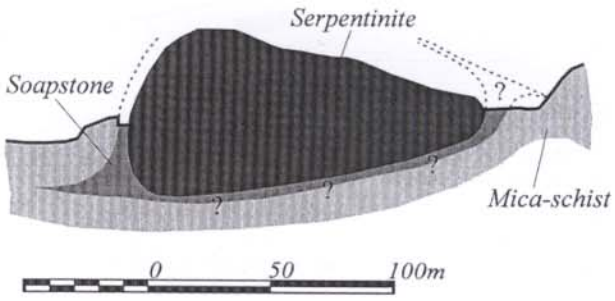

Figure 12 Geology of the Slipsteinsberget serpentinite and soapstone deposit. Cross-section (after Mortenson, 1973).

The quarry has a long history. It was perhaps worked before the Viking Age, most likely throughout the Viking Age and the Middle Ages, and probably even later. In modern times the deposit has briefly been exploited as a talc mine, and in the last decades as a natural stone quarry (Mortenson, 1973; Stenvik, 1996). The brecciated serpentinite that is quarried resembles Italian *verde antico*.

It has been calculated that 9,000–18,000 pots with forms like bowls and buckets may have been quarried along the soapstone zone (Mortensen, 1973; Stenvik, 1996). The quarry was mostly worked as an open pit (like Kvikne, and with similar methods) (Fig. 13), but at some places there are adits reaching depths of 8–10 m. Underground operations were obviously intended at following the most homogeneous and easily workable soapstone. Some authors have, however, generally suggested that underground work also took place because soapstone – like most other stones – is easier to work when thoroughly quarry-moist (cf. Skjølsvold, 1961).

At a few places there are definitive traces of extraction of building stone, and a recent study shows that the soapstone must have been used for quoins and decoration at several Medieval churches in the region. At some churches, e.g.

Figure 13 View of the Slipsteinsberget soapstone quarry, Viking Age. Typical form of a rock face from where vessels have been extracted.

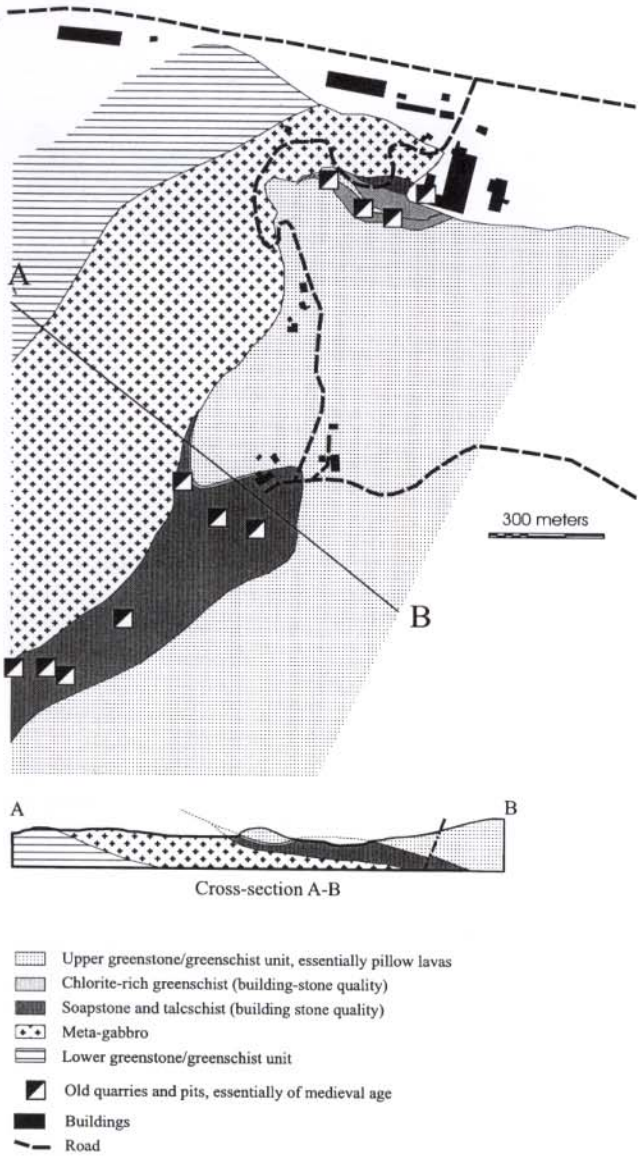

Figure 14 Geology of the Klungen soapstone and chlorite schist deposits.

Stiklestad, one can in fact observe all six to seven types of soapstone found in the quarry. It should be added that the quarry is presently subject to archaeological investigations aiming at studying its history, extraction techniques, and use (Österaas, 1999).

THE KLUNGEN QUARRY: MEDIEVAL BUILDING STONE (AD 1050–1350)

The Klungen deposits about 15 km south of Trondheim appear to have been used essentially for building stone. This is easily understood for two reasons: first, the deposits are generally schistose and not suitable for vessels and secondly, if vessels indeed were made, production marks have mostly disappeared because the deposits were a main source of material for the building of Nidaros Cathedral (1050–1300).

The soapstone at Klungen occurs as lenticular shaped deposits, trapped between underlying metagabbro and overlying greenschist. The latter unit rests with a thrust contact on top of the soapstone (Fig. 14). These rocks are correlated with the early Ordovician Løkken ophiolite (Grenne, 1989) further to the west. The soapstone is characterized by intercalating soft carbonate-rich and relatively hard, carbonate-poor soapstone. Both of these types were used in the Middle Ages, but the soft one was usually preferred (Storemyr, 1997; Heldal and Storemyr, 1997).

Along the thrust zone, a phyllonitic schist is developed, which, due to a high content of chlorite, is almost as soft and workable as soapstone. This phyllonite (or chlorite schist) was also extensively exploited in the Middle Ages, especially in the 12th century (Storemyr, 1996).

The Klungen quarry (area) is large and is one of the very few industrial-sized Medieval quarries in Norway (Fig. 15). This should imply that it had a well-developed infrastructure and perhaps employed several types of workers. It is at least possible to state that a large portion of the finishing of the stones took place in the quarry – as evidenced by the huge waste piles nearby, but not directly beside, the rock faces. The Medieval organization of the quarries is one of the themes currently being investigated in an archaeological project (Berg, 1999; Storemyr, 2000).

Figure 15 One of the Medieval quarries at Klungen recently archaeologically excavated.

Quarrying methods are also under investigation. Although parts of the quarries have been affected by 19th-century exploitation, it is still possible to observe several variations over the typical Medieval extraction method (Fig. 16). Generally, this method involved the use of different picks and chisels to carve conical grooves, always perpendicular to the foliation, around the desired blocks. By using wedges the blocks were subsequently loosened along the foliation. As it is difficult to quarry the stone selectively by modern means, it seems that a modification of the above method has to be applied in present work aiming at reopening a part of the deposit for restoration purposes. In this connection it is interesting to note that a similar manual technique was in use at Klungen in the 19th century (Storemyr, 1996; Heldal and Storemyr, 1997) and even until the 1950s in soapstone quarries in the Gudbrandsdalen area (Fig. 17; Voldheim, 1995).

Figure 16 Klungen soapstone and greenschist deposits, Middle Ages. Typical form of a rock face from which building stone has been extracted.

Figure 17 Quarrymen extracting soapstone blocks in the Gudbrandsdalen area in 1932. The work was undertaken almost as in the Middle Ages (after Voldheim, 1995).

CONCLUDING REMARKS AND RESEARCH PERSPECTIVES

In this paper it has been shown that the use of Norwegian soapstone for various purposes has a tradition dating back to the Stone Age. The most important aspects of this tradition – Iron Age vessel production and Medieval architecture – have been elucidated by examples. Although many studies have been made of Norwegian soapstone since the first great empirical investigation of Amund Helland in 1893, it is only the work of Arne Skjølsvold (1961) on the Viking Age vessel "industry" that may be regarded as a comprehensive scientific study. Thus, the time has come to evaluate the old studies and look for future research perspectives.

PRODUCTION PATTERNS THROUGHOUT TIME

The major production centers for vessels and building stone in the Viking Age and the Middle Ages, respectively, are reasonably well known, while smaller sites and earlier production areas are still largely unknown. One difficulty is the dating of quarries that have been used for hundreds of years and even into modern times, while another is distinguishing between quarries used for local purposes only and those operated on a more "industrial" scale. The question is raised of how the large quarries, especially those used for building stone, were worked: year-round, on a seasonal basis, with special quarrymen, or a local workforce of farmers? Moreover, who were the owners of such quarries? Since few written sources exist, the only way to study such questions is through extensive archaeological fieldwork, combined with scientific analyses and geological investigations, in order to sort out the relationships between stone quality and extraction techniques.

SOURCING SOAPSTONE OBJECTS

Although there are some gaps to be filled in, the origin of soapstone used for building purposes in the Middle Ages is fairly well known, but the origin of vessels throughout time is much more difficult to sort out. Except for export to Denmark, north Germany, and possibly Iceland and Shetland in the Viking Age, we have relatively little knowledge of both internal and external trade in soapstone. Sourcing soapstone objects or undertaking provenance studies is a very complex subject, made more difficult by the tremendous internal variations within each deposit. A small

number of deposit types may be recognized by special mineral assemblages or texture. Furthermore, it should be possible to distinguish between major deposit groups, such as clastic and non-clastic soapstone, based on hand specimens and thin sections. We are still uncertain, however, whether and how geochemical techniques for provenance determination can be used. An important subject will be to investigate isotopic signatures, trace element signatures, and rare earth element (REE) patterns in a limited number of deposits from different geological settings (cf. Allen *et al.*, 1984; Alfsen and Christie, 1979). Later, it might be possible to establish a database of fingerprints for Norwegian soapstone deposits.

CROSS-CULTURAL "SOAPSTONE CONTACT"

In Norway it is often said that early use of soapstone was a domestic "invention." Is that really so? Given the worldwide production and use of soapstone, as well as contact and trade between peoples since the earliest times, perhaps this assertion should be investigated more closely by combined archaeological, historical, geological, and analytical efforts.

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REFERENCES

Alfsen, B.E. and Christie, O.H.J. 1979. Massenspektrometrische Analysen von Specksteinfunden aus Haithabu und wikingerzeitlichen Specksteinbrüchen in Skandinavien. In H.G. Resi (ed.), *Die Specksteinfunde aus Haithabu*: 170–83. Neumünster: Karl Wachholtz Verlag.

Allen, R., Hamroush, H., Nagle, C., and Fitzhugh, W. 1984. Use of rare earth element analysis to study the utilization and procurement of soapstone along the Labrador Coast. *Archaeological Chemistry* III: 3–18.

Bakka, E. (1976). Arktisk og nordisk i bronsjealderen i Nordskandinavia. *Miscellania* 27: 7–47. (Trondheim: Det Kgl. norske videnskabers selskab).

Bates, R.L. and Jackson, J.A. (eds) 1984. *Dictionary of Geological Terms*. 3rd edn. New York: Anchor Press/Doubleday.

Berg, A.1999. Ny aktivitet i gammelt steinbrudd. *Spor* 2: 20–22.

Berglund, B. 1995. Tjøtta-riket. *Ph.d. thesis*. Trondheim: Norwegian University of Science and Technology.

Bowles, O. 1939. *The Stone Industries. Dimension Stone. Crushed Stone. Geology. Technology. Distribution. Utilization.* 2nd edn. New York and London: McGraw-Hill.

Brendalsmo, A.J. and Sørensen, R. 1995. Håndverksmessige og geologiske forutsetninger for bygging av steinkirker i Vestfold i tidlig middelalder. *Hikuin* 22: 77–94.

Ekroll, Ö. 1997. *Med Kleber og Kalk*. Oslo: Det Norske Samlaget.

Frigstad, O.F. 1973. Undersøkelse av klebersteinsforekomst, Bubakk, Tynset kommune, Hedmark. *Norwegian Geological Survey, Report,* no. 1211.

Frigstad, O.F. 1974. Diamantboring av klebersteinsforekomst, Bubakk, Tynset kommune, Hedmark. *Norwegian Geological Survey, Report*, no. 1312.

Grenne, T. 1989. Sea-floor hydrothermalism and related magmatic processes exemplified by the Løkken Ophiolite, Central Norway. *Papers for Dr. Techn.* Trondheim: Norwegian University of Science and Technology.

Hagen, A. 1977. *Norges Oldtid*. Oslo: Cappelen.

Hallett, J. 1990. The Early Islamic Soft-Stone Industry. Master thesis, Oxford University.

Heldal, T. and Storemyr, P. 1997. Geologisk undersøkelse og arkeologisk registrering av de middelalderske steinbruddene ved Øye, Klungen og Huseby i Sør-Trøndelag. *Norwegian Geological Survey, Report*, no. 97: 149.

Helland, A. 1893. Takskifre, heller og vekstene. *Norwegian Geological Survey (NGU)* 10.

Hugger, P. (ed.) 1976. *Altes Handwerk IV*. Schweizerische Gesellschaft für Volkskunde. Abteilung Film 31–40: 3–29.

Krekling, K. *et al.* (eds) 1995. *Det mjuke Berget - Kleberstein i Gudbrandsdalen*. Lillehammer: De Sandvigske Samlinger.

Lurati, O. 1970. L'ultimo laveggiaio di Val Malenco. *Società svizzera delle tradizioni popolari. Vecchi artigianati. Sezione Film* 24.

Mortensen, O. 1945. Vannholdige magnesiasilikater dannet ved metasomatose av dolomitiske kalkstener. *Norsk Geologisk Ttidsskrift* 25: 266–84.

Mortenson, M. 1973. Talk-serpentinforekomster i Sparbu, Nord-Trøndelag. *Norwegian Geological Survey Skrifter* 290: 1–16.

Nelund, C. 1985. *Fedtsten*. Herning: Herning Papirforretning.

O'Hanley, D.S. 1996. *Serpentinites: Records of Tectonic and Petrological History*. New York: Oxford University Press.

Österaas, B. 1999. Eit klebersteinsbrot fortel si historie. *Spor* 2: 23–5.

de Quervain, F. 1969. *Die Nutzbaren Gesteine der Schweiz*. Bern: Kümmerley & Frey.

de Quervain, F. 1972. Herkunft und Beschaffenheit des steinernen Werkstoffes kulturhistorisch bedeutsamer Bau- und Bildwerke in Graubünden. *Schriftenreihe des Rätischen Museums Chur* 13.

Resi, H.G. 1979. *Die Specksteinfunde aus Haithabu*. Neumünster: Karl Wachholtz Verlag.

Ringbom, S. 1987. Stone, style and truth: the vogue for natural stone in Nordic architecture 1880–1910. *Finska Fornminnesföreningens Tidsskrift* 91 (Helsinki).

Rütimeyer, L. 1924. *Ur-Ethnographie der Schweiz*. Basel: Schweiz. Gesellschaft für Volkskunde/Helbing & Lichtenhahn.

Rønne, P. 1996. Bronse for kleber. *Spor* 1: 14–17.

Skjølsvold, A. 1961. *Klebersteinsindustrien i Vikingetiden*. Oslo: Universitetsforlaget.

Skjølsvold, A. 1969. Et keltertids klebersteinsbrudd fra Kvikne. *Viking* 33: 201–38.

Solhaug, M. 2001. Middelalderens døpefonter i Norge. *Acta Humaniora* 89 (Ph.D. thesis, University of Oslo). Oslo: Unipub, 1999.

Stenvik, L.F. 1996. Slipsteinsberget i Sparbu – gammel steinindustri i et kleberbrudd. *Spor* 1: 10–13.

Stenvik, L.F. 1997. Ironproduction in Mid-Norway, an answer to local demand? *Studien zur Sachsenforschung* 10: 253–64.

Storemyr, P. 1996. A study on the weathering of Norwegian greenschist. In J. Riederer (ed.), *8th International Congress on Deterioration and Conservation of Stone: Proceedings*, I: 185–200. Berlin.

Storemyr, P. 1997. The Stones of Nidaros: An Applied Weather-

ing Study of Europe's Northernmost Medieval Cathedral. Ph.D. thesis 92. Trondheim: Norwegian University of Science and Technology.

Storemyr, P. 2000. Attempt at reopening Klungen Medieval Soapstone Quarry for modern use at Nidaros Cathedral. In: *Summary of Investigations and Research Carried Out 1999–2000*. Report 2000/1, The Raphael Programme, European Heritage Laboratories, Nidaros Cathedral Restoration, Trondheim: The Restoration Workshop of Nidaros Cathedral.

Strand, T. 1951. The Sel and Vågå map areas. *Norwegian Geological Survey* 178.

Sturt, B., Ramsay, D.M., and Neuman, R.B. 1991. The Otta conglomerate, the Vågåmo Ophiolite – further indications of early Ordovician orogenesis in the Scandinavian Caledonides. *Norsk Geologisk Tidsskrift* 71: 107–15.

Stüve, E. 1998. Personal communication.

Tuastad, N.H. 1949. Tolgesteinsbrota ved Haugesund. Garnstein eller vevlodd? *Stavanger Museum Årbok* 47–68.

Voldheim, K.R. 1995. 1000 år med stein: Utvinning av kleber i Sel kommune. In K. Krekling *et al.* (eds), *Det mjuke Berget–Kleberstein i Gudbrandsdalen*: 8–17. Lillehammer: De Sandvigske Samlinger.

Wiik, H.B. 1953. Composition and origin of soapstone. *Bull. Comm. Geol. Finl.* 165: 1–57.

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