On the edge of lithics

A chaîne opératoire analysis of quartzite assemblages from two Mesolithic sites at Rena in Hedmark, Norway

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Cover illustration: Refitted core seen with striking platform upwards, Bjørkeli, Åmot, Hedmark. See refit group 3. Photo by author.

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1. Intro: The role of non-flint lithics in a flint-sparse region

As a fresh archaeology student, the first material that I was introduced to in Stone Age archaeology was flint. This is normally the case for every new archaeology student, and for many of those who choose not to specialise in the field, flint artefacts is virtually all they know. Indeed, for most archaeology students, 'flintknapping' and 'knapping' are largely synonymous; in flint-rich parts of the world, even specialists can - hypothetically speaking - limit themselves to flint and flint alone without really impairing their archaeological investigations. While this is not a bad thing in its own right, but in cases where flint becomes largely irrelevant as a raw material, how does this affect the way we interpret lithic technology? There are no indigenous flint-bearing deposits in Norway, and yet the archaeological discourse for the Stone Age is dominated by retouched tools made from this material. While flint material is far from uncommon on Stone Age sites in Norway despite its scarcity, there exists a plethora of lithic raw material alternatives to it. This rings especially true at sites in the East Norwegian interior, far away from the shores of South Norway, where beach nodules and pebbles of flint were available, although to a significantly lesser extent than in regions with flint deposits.

The Scandinavian Stone Age discourse is characterised by a heavy bias towards flint (Eigeland 2007; Knutsson 1998). This paradox is partially a result of inheriting research traditions from flint-heavy regions (Eigeland 2007a: 40-42), and Norway's position on the margins compared to for example Danish Mesolithic research. Although the use of on flint-centred methodology has been sufficient for interpreting coastal assemblages where beach flint is readily available, interpreting flint-sparse localities in the East Norwegian interior presents a range of issues to investigators reliant on methodological frameworks adapted to flint technology.

Lithic materials which form a sizeable percentage of a site assemblage such as quartzite and jasper have received minimal attention over the years, and despite occasional papers and conferences (e.g. Eigeland 2007a, 2009; Falkenström 2009; Manninen and Knutsson 2014; Lindgren 1998; Staffén 1998; Taffinder 1998) the flint bias remains. The literature is still primarily flint based, flint artefacts remain as the go-to chronological markers, and generally receive the lion's share of analysis.

As the procurement, knapping, treatment and usage of non-flint lithics are interpreted by comparison with flint in the material record, methodology and theory dealing with such material will not develop; the material might not conform to the criteria we are used to when dealing with flint, and so technological aspects of prehistoric life risk neglect in the face of arbitrary standards. To begin to address this, the following study will concentrate on one under-represented material, quartzite, with case studies from recently excavated Stone Age sites. By analysing lithic objects within the framework of *chaîne opératoire*, we may infer what a knapper intended to achieve. 'Tools' that are not retouched are often called 'informal'. If the s*chema opératoire* is standardised and not haphazard, is such a term accurate? If the definition of 'tool' depends on retouch rather than intent and usage in prehistory, does the definition become inadequate when describing objects that were for all intents and purposes knapped with a specific manual task in mind?

In an attempt to address these questions, I will analyse quartzite debitage from the two sites of Bjørkeli and Stene Terrace from the OVAS project at Rena, Hedmark in Norway. The analysis will be carried out in the context of non-flint raw material usage, and will draw comparisons to earlier studies on flint alternatives from the sites in question and others. The methodological framework will be *chaîne opératoire*, with refitting as my main research technique. This will be framed in a greater context of the East Norwegian Interior archaeological record, and I will discuss how qualitative studies on lithic raw material usage can be of use in future research on the Mesolithic populations of the Scandinavian interior.

These sites are interesting in this context, since the lithic assemblages from the sites are dominated by quartzite and jasper debitage rather than flint. As such, if formal flint technology is essential for a knapping operation to be successful, we can reasonably expect debitage from a skilled knapper to contain formal retouched tools, even in the case of non-flint material.

Research questions

How did the knappers utilise quartzite at the selected sites, and what methods characterise the knapping sequences? What were the end products? Is it possible to infer site and/or work organisation by way of distributional refit maps, including hearth locations?

Identifying burnt lithic objects on the sites could potentially assist with issues regarding temporality on the site in this regard. Identifying burnt lithics is not necessarily a straightforward process with regard to exotic raw materials that falls outside the conventional scope of flintknapping experts, since such materials do not exhibit the same macroscopic signs of heat alteration as flint.

Finally, how do the results from the lithic analysis compare to previous studies, and how relevant are raw material categories in the effort of understanding lithic technology?

2. Methodology and theory

As mentioned, Norway has no indigenous flint-bearing deposits. The closest flint-bearing deposits to anywhere in Norway by land route is Kinnekulle in Sweden and the Skåne coast (Stene et. al. 2010: 505), so knappers have had to utilise beach flint or imported flint. This raw material situation separates Norwegian archaeology from continental European archaeological setting where flint is readily available, and so has influenced the greater European research milieu in a considerable way. Eigeland (2007b) argues that there is a divide between the Norwegian research milieu and the greater lithic research community on five levels:

> 1. Archaeologists with a long lithic tradition and archaeologists lacking such a tradition.
> 2. A collective lithic milieu and single archaeologists.
> 3. A lithic terminology and classification system based on raw materials of high quality and a potentially new and improved terminology and classification system based on a diversity of raw materials.
> 4. Flint-rich regions and marginal regions.
> 5. A distorted lithic prehistory and a potentially undiscovered lithic prehistory. (Eigeland 2007a: 41)

Although some of Eigeland's assertions are open for question, her main point is that the Norwegian research milieu does not have a long tradition of technological studies. Although technological studies have seen a surge of interest since Eigeland described 'the divide', typology-centred methodology is still the default approach in Norwegian archaeological undertakings. While typology and purely morphological studies are useful in their own right, in order to truly understand the fundamentals of technology, one has to look not at the 'what' of artefacts, but beyond. *Chaîne opératoire* concerns the how and why of artefact usage, and while such studies are arguably more time-consuming and labour-intensive, *Chaîne opératoire* research has the potential to explore aspects of technology that typological investigations cannot uncover.

Chaîne opératoire and refitting

The methodological framework of the present study is c*haîne opératoire*. Jacques Pelegrin (1990) describes the process of lithic production within the *chaîne opératoire* framework in the following way:

> [Knapping]—based on raw material which is never standard, and with gestures of percussion which are never perfectly delivered—cannot be reduced to an elementary repetition of gestures, or to the application of immutable sequences (as a machine would do). On the contrary, the realisation of elaborate knapping activities necessitates a critical monitoring of the situation and of the decisions adopted all through the process. If this is the case, then the capacity to mentally evoke the precise desired product is necessary for successful knapping, but it is not sufficient. The knapper has in mind successive goals, that is, a series of intermediary stages and geometric 'cues.' It is in respecting these, and with experience, that the anticipated result may be reached. These intermediary stages form a chain of intentions organized in a 'conceptual schema opératoire'. They are defined through certain geometric parameters, and they may represent the moment when a particular operation or technique changes to another […]. Between these stages, the actual and the real situation is compared with the corresponding concept and diverse action modalities are evoked in order to correct a given state or to progress in the chaîne opératoire. Using experience, the knapper chooses the (most) adapted action modality—the one which is both possible and desirable (Pelegrin 1990: 117).

The aim of the methodology is to reconstruct artefact 'lifespans', and describe the human intentions and actions that resulted in the artefacts themselves (Edmonds 1990: 56-57)Eriksen 2000: 75-76; Andrefsky 2005: 38). This includes the processes of raw material, production – or as in the case of knapping, 'reduction' –, usage, repair and recycling, and finally discarding. The strength of such studies lies in the accumulation of data, since each study on aspects of technical traditions within individual societies add to the greater understanding of lithic technology as a whole (Soressi and Geneste 2011: 340). *Chaîne opératoire* is a methodology concerned with human actions and thought processes in relation to technology (Eriksen 2000: 76) that in and of itself is not exclusively applicable to archaeology (Tostevin 2011: 352); in an archaeological context, however, site formation and taphonomical concerns will have to be integrated into analyses, since artefacts will also be influenced by taphonomical forces post-deposition. Because of this, *chaîne opératoire* analyses on lithic tool production serve to inform not only technology studies, but can inform archaeological site formation as well (Edmonds 1990: 5; e.g. Baales 2001; Dibble et. al. 1997; Staurset and Coulson 2014).

Chaîne opératoire as a methodology presents an alternative to pure typology; rather than describing artefact morphologies of end products, the research praxis is occupied with not only the techniques behind a given object's manufacture, but how those techniques were applied in the face of material and cultural constraints all throughout the artefact's microhistory of human interaction, from procurement to deposition. Refitting as a technique lets the archaeologist review the different stages of an artefact's formation process, and interpret the intentions of the knapper in light of material realities. The method has its limitation in terms of representativeness, contemporaneity, and completeness that necessitate varying degrees of interpretation (Geneste & Soressi 2011: 341).

The present study's main methodological approach is refitting. Although by no means new, refitting as a research practise is far from standardised or formalised, and every research practise will have to be adjusted to needs of the individual user and investigation. To this date, there is no standard treatise or manual on the practise of refitting. The method relies heavily on tutor guidance, and necessitates an understanding of knapping techniques, fracture patterns, material knowledge, and patience. In the case of technology studies on lithic tool production, refitting allows a researcher to explore a lithic assemblage by reverse-engineering the process that led to its creation. The process is based on macroscopic examination of lithic assemblages, subjecting debitage to intense examination, or 'reading' (Inizan et. al. 1992: 13, 27-31). After the assemblage has been selected, the investigator decides which objects are most viable for refitting and which one are not, and ensure every piece can be identified with archaeological context for later use in spatial analysis. Subsequently, the lithic objects are organised and examined until a match between two fitting objects can be found. Conjoined objects form a 'refit group'. This step is then repeated either until refit groups can no longer be found within a reasonable timeframe, or the refit groups that have been discovered will answer the research questions posed by the study.

While refitting has been a key method in a number of European lithic studies in the Norwegian research milieu researchers since the 1980s (e.g. Coulson 1986; Skar and Coulson 1986; Mikkelsen et. al. 1999; Boon 2006; Eigeland 2006; Fuglestvedt 1998; 2007, 2010; Kræmer 2007; Koxvold 2011; Myhre 2011; Kotthaus 2013; Arangua 2014; Staurset and Coulson 2014), the method is still not widely used. To attain the best results, a practically total excavation lays the groundwork for refitting, and a systematic and proper record of the excavated materials is necessary for accurate distributional map. A refit analysis is only as good as the recording regimen of the material's excavation. In addition to refitting, I will depend on a general macroscopic analysis of the pieces of the assemblages that are not refitted, and discuss the quartzite assemblages from the selected sites in terms of technological traits and spatial distribution.

3. Research history: The Mesolithic in the interior of South-East Norway

The sites presented in this study are located at Rena in Hedmark, Norway. They were part of the excavation subdivision OV[1]AS within the Gråfjell project, an archaeological excavation project with field seasons between 2003 and 2007. Sites at Rena were surveyed and registered in 2004 and 2005, and excavated during in the span of two field seasons in 2006 and 2007. The localities are situated in the geographic context of the Norwegian, and by extension Scandinavian interior.

[1] Norwegian military acronym of '*anlegg for oversetting over vassdrag'* and project name for the regulation of the Rena river area. In this study, OVAS refers to the geographically separated part of the Gråfjell project that took place at Rena 2006-2007, in accordance with the nomenclature used in the reports (Stene 2010: 1-4).

The research history of the Mesolithic Stone Age in the South-East Norwegian interior can be divided into three periods: the culture-historical phase, the dam regulation phase, research-driven investigation phase, and the military regulation phase (Boaz 1997: 11-15; Persson 2010: 31-32). The Gråfjell project is part of the latter.

In South-East Norway, little attention was given to the area beyond the coast before the advent of hydroelectric dam projects. The culture-historical phase of archaeological investigation in the region was led by Anathon Bjørn (1934) and Anders Hagen (1946), based largely on typological stray finds, and did not find much evidence for settlement in Hedmark prehistory before the Late Neolithic. Differences between Neolithic material in northern and southern Hedmark was interpreted as signatures of different ethnic groups; the northern material characterised by slate arrowheads and flint axes typical of hunter-gatherer populations, but lacked enough characteristic features evident of Mesolithic cultures based on material patterns from coastal areas to prove Mesolithic settlements(Boaz 1997: 11). In other words, the research was at this point severely restricted by the lack of data from excavations.

This would soon change however, as excavations initiated by hydroelectric dam regulation projects in the 1960s and forward uncovered evidence of Mesolithic activity in the lower forested interior, with Erik Mikkelsen(1978) interpreting the populations as migratory between coastal and inland areas according to the seasons, while not excluding the possibility of permanent settlements (Boaz 1998a: 32). The Dokkfløy excavations led to more evidence of exploitation of the interior (Boaz 1994, 1998), including intensification during the early Nøstvet phase in the form of seasonal coastal-mountainous populations (Boaz 1998: 333). Still, one should note that the area has not extensive excavation, and most of the investigations in the area have been carried out in the form of rescue archaeology; the number of Mesolithic excavations and surveys in the region is generally low (Boaz 1998a: 326).

The excavations of Dokkfløy suggest the area was initially settled 8000 BP Boaz

Another aspect that sets archaeology in the East Norwegian interior apart from coastal areas is the raw material diversity between sites, as mountain sites tend to have lower raw material diversity and more flint, and forest sites tend to have a lower rate of flint and more non-flint lithics such as quartzite and jasper (Boaz 1997: 13; Amundsen 2007: 21; Persson 2010a: 31). As early as 1963, Anders Hagen interpreted the reliance on quartz and quartzite as a sign of *stedsegenhet,* or local traditions (Hagen 1963: 112-115). Hagen struggled to date what he considers archaic artefacts in relation to South Scandinavian typological criteria, especially in the absence of period-diagnostic axes (Hagen 1963: 115-117). Boaz in turn argues that past failures to establish useful chronologies in the Norwegian Mesolithic interior comes down to South Scandinavian bias on the ideal Mesolithic lithic inventory (Boaz 1998a: 40). Markers that separated East Norwegian finds from the default Southern Scandinavian Mesolithic standard were dismissed as anomalies rather than considered independent (Boaz 1998a: 38-42). Flint assemblages have long been the dominant material in the development of methodologies in Stone Age research, which creates certain challenges when adapting the methodology for use on non-flint lithics. Terminology and knapping concepts have to be adjusted to other raw material situations, just as the knappers in their time must have adjusted their techniques for use on raw materials with different properties than flint in order to work the materials. In the case of Norwegian interior sites, where non-flint markers such as Nøstvet axes are almost completely absent (Boaz 1998: 332-333), this issue becomes even more relevant.

Research archaeology projects at Svevollen (Mikkelsen 1989; Fuglestvedt 1992), Osensjøen (Boaz 1998b) and the Flendalen Jasper quarry (Sjurseike 1994) brought to the fore new evidence of Late Mesolithic inhabitation in the region, including permanent or semi-permanent dwelling features at Svevollen dating to the Late Mesolithic (Fuglestvedt (1992) and Mikkelsen (1989) drew slightly different conclusions from their studies at Svevollen. While Mikkelsen interpreted the structures as winter settlements, Fuglestvedt did not exclude the possibility of year-round settlement. Regardless of the differing opinions on this point, the investigations marked a clear change from the previous ideas of occasional forays by coastal populations. Boaz (1997) found corresponding evidence of Late Mesolithic settlements at Rødsmoen, further strengthening the evidence for substantial settlement of Hedmark during the Late Mesolithic. Lastly, following the Gråfjell project, Stine Melvold (2011) suggested ideas based on raw material provenience and environmental research of a population network in the Scandinavian interior, spanning an inland river network rather than being based on the south-eastern Norwegian coast.

4. Material selection: Sites at Rena, part of the Gråfjell project

For this study, quartzite material from Bjørkeli and Stene Terrace was selected because of its prominence compared to finds of flint, which made up a marginal number of total finds at both sites. Other sites from OVAS were also considered, but were unfortunately not available for study.

The sites were chosen based on the meticulous records, rich lithic inventories, in addition to the use of a lithic raw material categorisation system, the latter being seen as an interesting subject for testing; would it hold up to investigation, or would pieces refit across the parameters of the classification system?

This is not the first formal attempt at refitting material from Bjørkeli and Stene Terrace. A similar study was completed by Claudia Gonzáles Arangua (2014) on the jasper material from these sites. Obviously, it would be beneficial to the analysis if its results could be presented in light of the Arangua's own finding on the jasper material. Other studies relating to the sites and material from these include Joachim Åkerström's experimental studies on heat-altered lithic material from nearby sites at Rena (Åkerstrøm 2012).

The greater excavation area: OVAS, Gråfjell

Located near Åmot in Hedmark, Norway (see figure 1), the Rena River excavation project of 2006 and 2007, known as OVAS, was started as a consequence of regulation of a portion of the Rena River for military purposes. Originally planned as an integral and contemporaneous part of the Gråfjell excavation project in 2004 and 2005, the field seasons were delayed due to cuts in military spending. Because of this, the excavation seasons took place years after the most of the Gråfjell project had finished. As the name suggests, the area excavated is situated along the Rena River, with sites located along both riverbanks. The topography of the river terraces has no clear hallmarks of possible sites, such as bays, promontories, or streams. Recognition of sites and delineation of individual sites was therefore a challenging task. The choice was made to survey the entire area with test pits in order to better get a sense of archaeological activity (Damlien 2010d: 232).

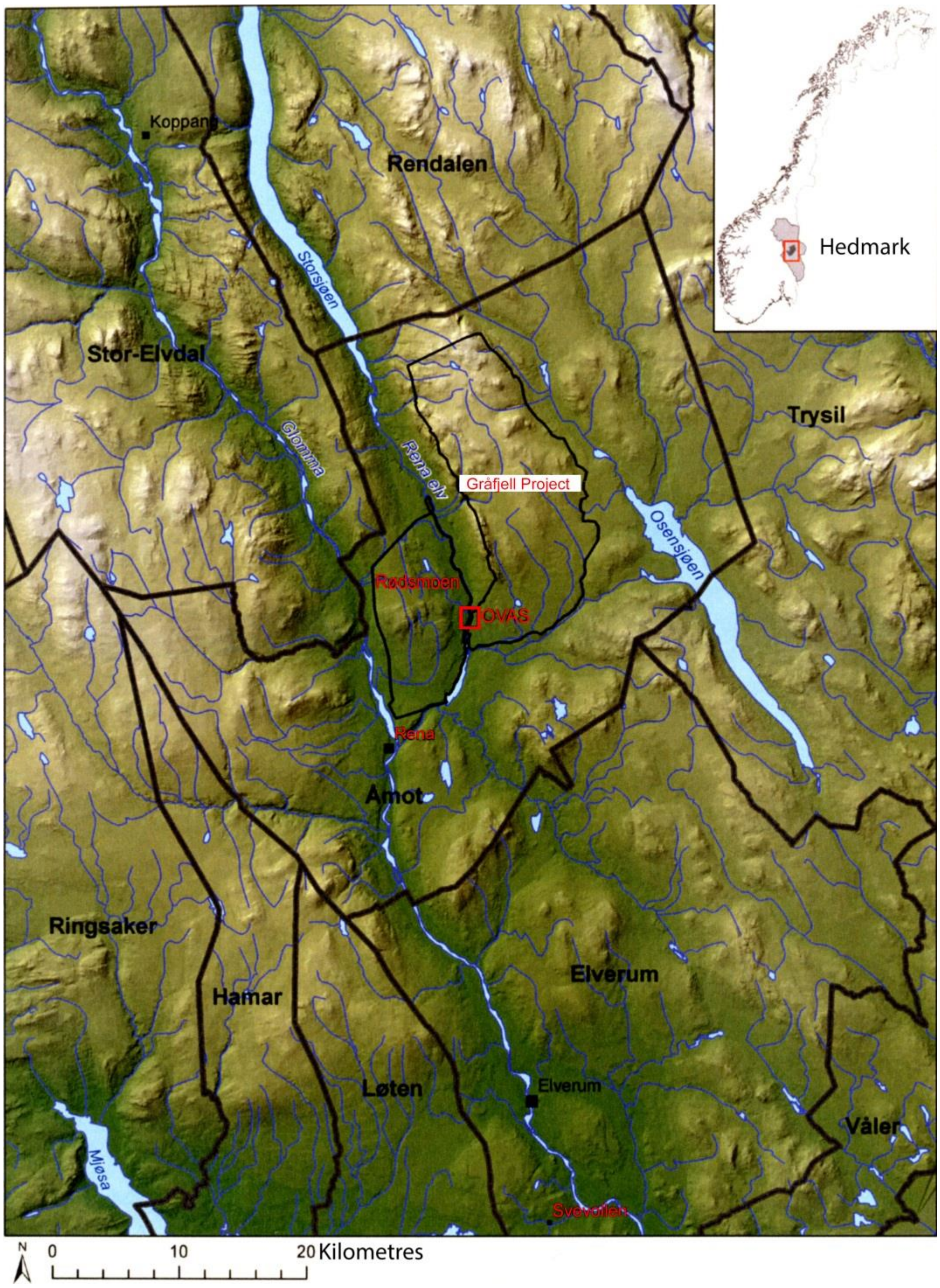


Figure 1: OVAS project area in relation to the Norwegian interior, including the Gråfjell and Rødsmoen project areas. Illustration by Damlien (2011: 32), translated and modified by author.

The excavations at Rena have uncovered a great variety of lithic raw materials, tools, sites dating to periods ranging from the Middle Mesolithic to the Bronze Age, and occasional traces of Iron Age activity. Both sites presented in the present study are located on the East bank of Rena (see figure 2), within 100 metres of each other. The following subsections of this chapter contain descriptions of the chosen localities (Damlien 2010b, 2010c). A short comment on research questions with regard to the sites themselves is included as a paragraph that the end of each site description.

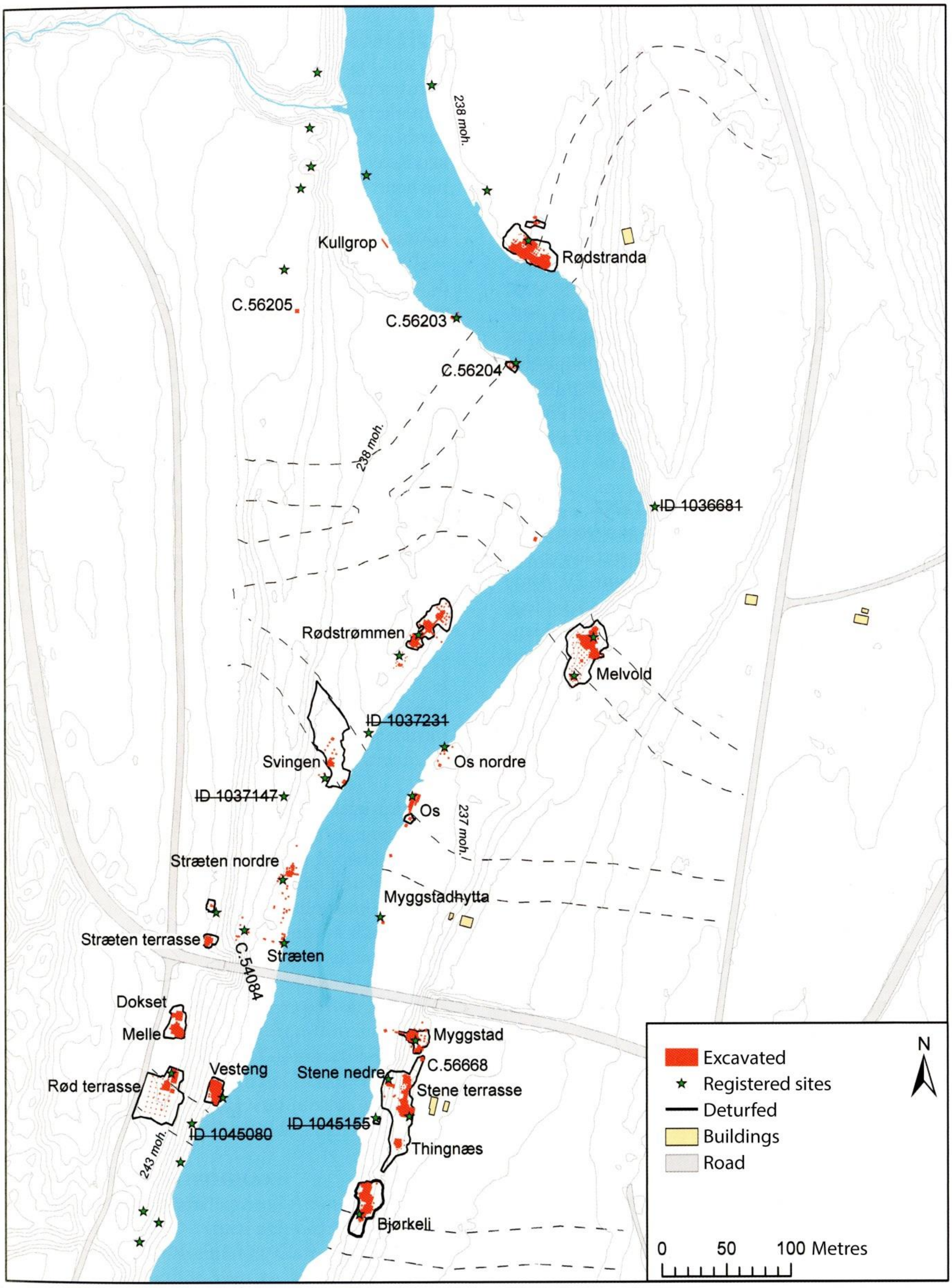


Figure 2: Rena River, Åmot, Hedmark. Map of the OVAS sites. Illustration by Stene (2010: 9), translated and modified by author.

Bjørkeli, Åmot, Hedmark

The site of Bjørkeli was chosen based on the high rate of quartzite finds, along with a Middle Mesolithic dating; if the dating is correct, the site was visited not long after the glaciers retreated from the area (Damlien 2010b: 251). This makes the site an interesting case to study in the context of raw material usage, since the landscape – and its lithic resources - had just recently opened for exploitation.

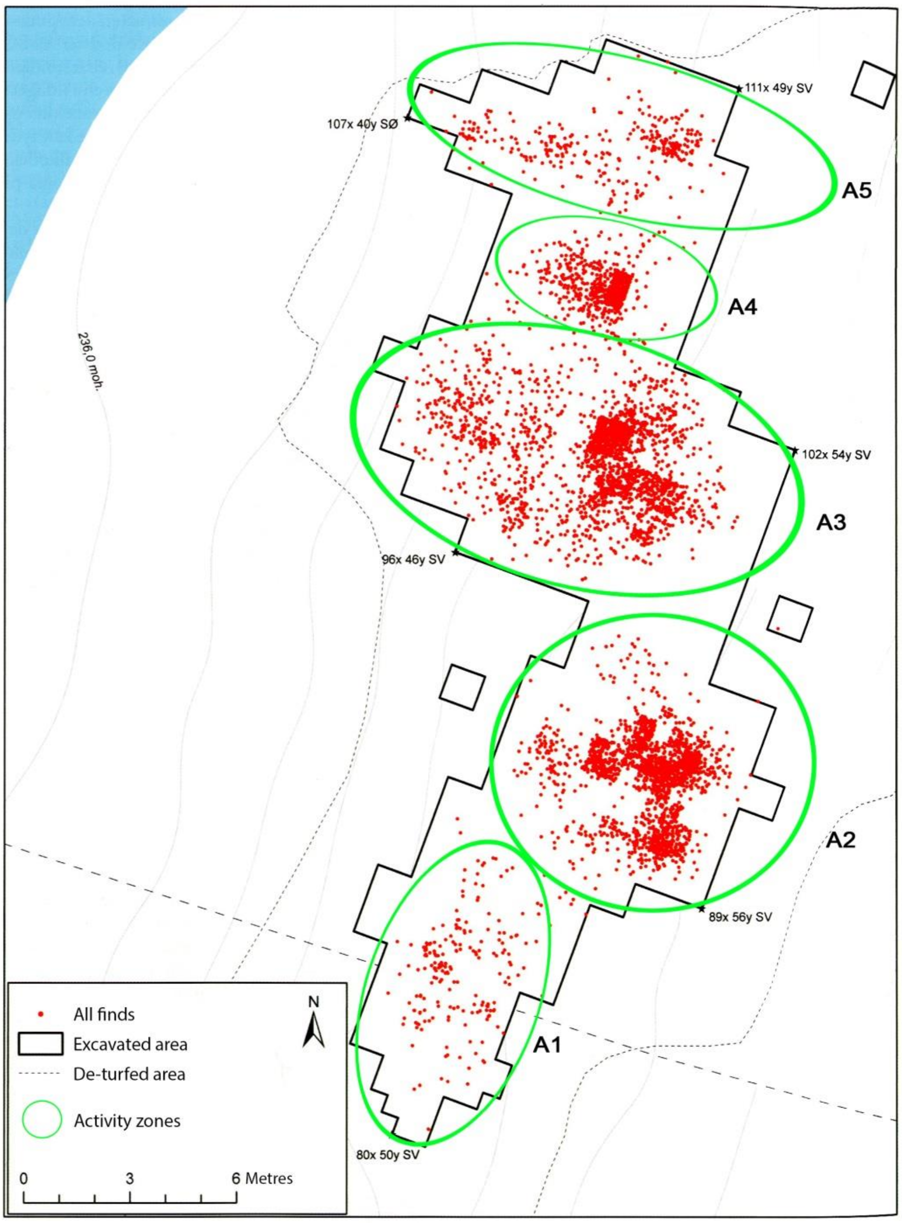


Figure 3: Bjørkeli, Åmot, Hedmark. Finds distribution and activity zones at Bjørkeli. Illustration by Damlien (2010b: 254), modified and translated by the author.

Positioned on the eastern river terrace at Rena (see fig. 2 and 3), Bjørkeli is a site surrounded by forest, located along the river with terrain sloping slightly north-south. There are no natural topographical boundaries toward north and south, but the terrain east of the site rises toward a river terrace and marshlands. At the time of excavation, the site was situated approximately 3 m above the river's normal water level, 239 metres above sea level. The vegetation mostly consists of thick mixed coniferous forest of birch and spruce, with forest floor consisting of grass, shrub and moss (Damlien 2010b: 236).

The turf topsoil at the site was 5-10 cm deep. The soil consisted of podsol with varying widths of alluvium and illuvial deposits. The alluvial horizon beneath the turf is described as 20-30 cm of light grey gravel and sand with numerous rock inclusions. The illuvial horizon is described as dark orange gravel and sand, also with plenty of rock inclusions, with a width of 50-60 cm, gradually fading over to yellow brown gravel at the bottom of the layer. The subsoil masses were composed of gravel and larger rocks, the rocks dispersed across the entire site varied in size from 10 to 50 cm. The soil also consisted of several natural masses as a result of disturbance attributed to root activity and windfalls (Damlien 2010b: 238).

Topsoil was removed by machine in an area of 660 m². The excavated area spanned 210 m², and was dug according to conventional Norwegian stone age excavation standards: a horizontal grid of 100 cm² squares divided into quadrants of 50cm², which were dug out and recorded in mechanical layers of 10 cm. Exceptions were made in the case of squares with finds of burnt bone, where mechanical layers were dug in 5cm layers. The soil was wet-sieved through a 4 mm mesh screen. Four mechanical layers were excavated on the locality, with the majority of finds in the first 15 cm. The site was considered completely excavated, although the report also states most of the site excavation was limited to 10 cm, with 65,5 m² excavated to 20 cm depth and 13,5 cm² to 30 cm depth, and 7 m² to 40cm depth (Damlien 2010b: 238-239).

Of the two sites presented in this investigation, Bjørkeli contain the largest amount of finds. The artefacts recovered at Bjørkeli comprise 5200 lithic artefacts of assorted raw materials and 0,1 g burnt bone. Of environmental samples, a sample was taken of fire-cracked stone, soil, one charcoal sample and 88 soil samples. Of the lithic raw materials at Bjørkeli, quartzite makes up the greatest percentage of all lithic finds, 65 %, followed by 17 % jasper, 11,5 % quartz, 6,5% flint and 0,1% slate (see table 1; Damlien 2010b: 239). Of the 5200 lithic objects, 136 were considered retouched, comprising 2,6 % of the total lithic inventory. Of the remaining inventory were 70 cores, of which 53 were bipolar cores. Only one flint microblade core was located by the excavation.

Table 1: Lithic finds from Bjørkeli by raw material (Damlien 2010b: 239). Translation by author.

Raw Material	Finds	Percentage
Flint	341	6,6 %
Jasper	908	17,5 %
Quartzite	3373	64,9 %
Milky quartz	560	10,8 %
Rock crystal	16	0,3 %
Slate	2	0,0 %
Total	5200	100,0 %

The features on the locality are not clearly defined. Thin concentrations of fire-cracked stone overlap the lithic scatters in several places, thought to represent fireplaces. The remains of these hearths seem to be heavily eroded, and only two radiometric dates based from the potential hearths were established.

The site was dated with several methods, including typology, raw material trends, ^{14}C and optically stimulated luminescence dating. While the ^{14}C sample turned out to be from an Iron Age hearth, the OSL dating resulted in BC 9270+-710. The presence of glacial sheets in the area up to 8000 BC makes it likely that the site is dated to around this time, 7900-8000 BC, which is plausibly within the standard deviation of the OSL analysis (Damlien 2010b: 252). Artefact typology seems to confirm the OSL results, dating Bjørkeli to the Middle Mesolithic.

Stene Terrace, Åmot, Hedmark

Stene Terrace is a flat river terrace situated on the east bank of the Rena River. It is situated approximately 5 metres above the river's normal water level, approximately 240 metres above sea level. The site is naturally bounded to the north and northwest by a steep slope leading down to the river, with no natural topographical boundaries towards south and east. The local vegetation was mixed coniferous forest of birch, pine, and spruce. The forest floor consisted of common juniper, shrub and moss.

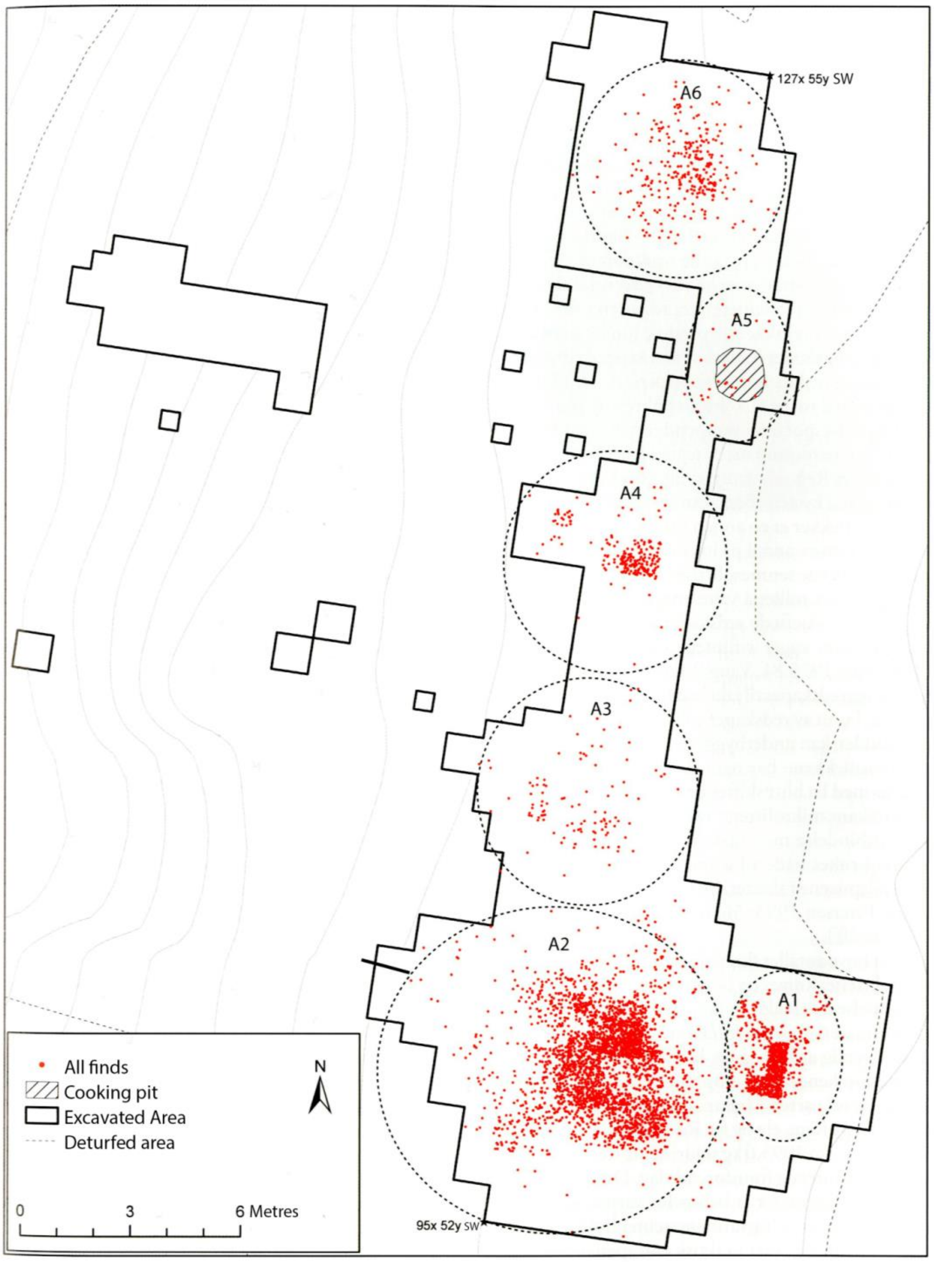


Figure 4: Stene Terrace, Åmot, Hedmark. Finds distribution and activity zones. Map by Damlien (2010c: 297), modified and translated by author.

The turf topsoil at the site was 5-10 cm deep. The soil masses consisted of podsol with varying widths of soil horizon. The alluvial horizon beneath the turf is described as 20-30 cm of light grey gravel and sand with plenty of rock inclusions. The illuvial horizon is described as dark orange gravel and sand, also with plenty of rock inclusions. At the south end of the site, the illuvial deposit had solidified into a compact hardpan, obstructing deeper excavation. At the deep end of the deposit, the illuvial soil masses gradually faded over to light yellow brown gravel. The subsoil masses were composed of gravel and larger rocks, the rocks dispersed across the site and varied in size from 10 to 50 cm. Despite the presence of a nearby modern cabin, soil profiles remain largely intact and undisturbed across most of the site. Disturbance interpreted as windfall was documented in some places (Damlien 2010c: 276-277).

The excavation of Stene Terrace was carried out over two seasons, with the southern half excavated in 2006 and the northern half excavated in 2007. The two halves were initially registered as different archaeological units, and later consolidated into one unit named *Stene Terasse,* Stene Terrace. Topsoil was removed by machine in an area of 1359 m². The excavated area spanned 200 m², and was dug according to conventional Norwegian stone age excavation standards: a horizontal grid of 100 cm² squares divided into quadrants of 50 cm², which were dug out and recorded in mechanical layers of 10 cm. Exceptions were made in the case of squares with finds of burnt bone, where the mechanical layers were dug in 5cm layers. The soil was wet-sieved through a 4 mm mesh screen. 3 mechanical layers were dug at most on the site, with the majority of finds in the first 15 cm (Damlien 2010c: 276-277). Environmental samples taken include charcoal samples and fire-cracked stone from the site features for the purpose of OSL and ^{14}C analysis.

The artefacts recovered at Stene Terrace comprise 4203 lithic artefacts of assorted raw materials and 42 g burnt bone. Of the lithic raw materials at Stene Terrace, quartzite makes up the greatest percentage of all lithic finds, 67,5 %, followed by 14,3 % quartz, 9,4 % flint and 8,8 % jasper (Damlien 2010c: 282). Of the 4203 lithic objects, 113 were considered retouched, comprising 2,7 % of the total lithic inventory. Of the remaining inventory were 48 cores, of which 24 were bipolar cores. One microblade core in jasper and a microblade core fragment in flint was found among the material, and Arangua describes pressure technique microblade production as the overarching theme in the jasper material (Arangua 2014: 51-53). Pressure blade technique is a characteristic of Post-Swiderian culture, dating the A2 activity zone to the Middle Mesolithic. Activity zones A3 and A4 were considered of Middle Mesolithic dating on the basis of triangular microliths (Damlien 2010c: 302-304). Activity zone A1 is characterised by lithic primary reduction of yellow-mottled quartzite, and along with A3 it has no diagnostic features such as triangular microliths or microblade production (Damlien 2010c: 299-302). The remaining activity zones, A5 and A6 were considered to be Late Mesolithic Phase 3 (Damlien 2010c: 304).

Raw material selection

Quartzite

As stated in the methodology chapter, results of refitting efforts depend substantially on the quality of the excavation from where the material originates, and without extensive and well-recorded excavation data one cannot unlock the full potential of *chaîne opératoire* research. In this case, the choice of Bjørkeli and Stene Terrace were made based on the fact that a refit link between the two sites was noted in the excavation report (Damlien 2010b: 233), later confirmed by Arangua (2014). The material was extensive and well-recorded, a similar study had been made on jasper material from the same sites, and finally that the material was available for study in Oslo at the time. The initial selection process involved use of the OVAS project's raw material classification system (Damlien 2010a) to evaluate the potential of the material, and for selecting individual categories. Some quartzite raw material categories were excluded from the study based on lithic qualities which rendered them unsuitable for refitting.

Quartzite as a knapping material category is not a particularly useful one, at least from a utilitarian viewpoint; the description, quartzite-silica matrices of metamorphosed quartzite sandstone, is perhaps more useful to a geologist than an archaeologist or knapper. Quartzite can be divided into four different categories; Orthoquartzite Type 1 through 3, as well as metaquartzite. Orthoquartzite types represent different stages of maturity in regards of transformative process of diagenesis, while metaquartzite is a truly metamorphosed quartz sandstone. Some types of orthoquartzite undergo a low degree of diagenesis, and so retain the same properties as sandstone that renders it practically useless as a knapping raw material (Ebright 1987: 30; Eigeland 2007b). More mature specimens of quartzite are more homogenous and compact.

The quartzite known as Ringsaker quartzite is a heterogeneous, often coarse hard-grained rock that shares some knapping qualities with flint. Its remarkable hardness affords its flakes a sharp cutting edge, and Lotte Eigeland (2007b: 345) concludes through experimentation that Ringsaker quartzite is equally technologically effective as flint. However, the hardness of Ringsaker quartzite makes it unsuitable for blade production, and its tendency to shatter makes it difficult to apply retouch.

It seems every category of quartzite studied in this thesis has its own flair, and in its time presented its own set of opportunities and limitations to the respective knapper. It is therefore hard to draw comparisons to other studies on quartzite materials in general, since the wide spectrum of knapping properties presented by quartzite lithics serves better to confuse than elucidate as a knapping material sub-category. The material selection for this thesis was based on the assumption that quartzite was a useful categorisation for a refit study, which turned out to be an imperfect assumption; however, the option was to assume blindly that the OVAS project had sorted the lithic material without flaws, which posed the risk of miscategorised material or misguided material categories, the result of which would be an impossible endeavour.

Excluded material

A significant portion of the quartzite material from the excavations was so-called *melert kvartsitt,* or 'mottled quartzite' type 3/E, a presumed local poor-quality lithic that had degraded notably, described in the reports as weathered. The weathered quartzite, when broken into pieces, reveals raw material that is said to resemble Ringsaker Quartzite (Persson 2010b: 322), although there is not much evidence to confirm that the material is actually transformed Ringsaker Quartzite. Based on examination of the raw material, I am not convinced on this point. On the other hand, the possibility cannot be completely dismissed. It would certainly explain the absence of numerous pieces in the refit groups, which would otherwise be attributed to other factors; without further analysis however, this remains speculation. While analysis into the composition and origin of this raw material could potentially yield valuable information on the properties of quartzite, the task would undoubtedly require destructive analysis of the kind that would not be possible within the framework of the present study. As far as speculation goes, it is not impossible that quartzite subcategory 3/E at least partially consists of Ringsaker Quartzite relating to refit groups presented earlier; the raw material might have been made vulnerable to some long-term weathering process as a result of heat alteration (Purdy and Clark 1978).

This decision to exclude the white mottled quartzite was not taken lightly, since white mottled quartzite made up a substantial amount of material from the localities (1911 objects at Bjørkeli and 1474 objects at Stene Terrace); the problematic surface raw material properties of this quartzite, combined with the sheer amount of the material would make any serious refitting analysis an arduous task, and it remains unclear exactly how the material was used in its time because of its post-depositional decay. The artefacts were also rendered brittle by the deterioration, so that refitting risked damaging the artefacts.

Suffice it to say, the risk outweighed the rewards significantly in terms of effort made to sort, label and analyse this particular material. Mottled quartzite was therefore, after much consideration, excluded from the analysis. Additionally, the remaining mottled quartzite categories were excluded since they were potentially part of the same raw material as the weathered variant, and therefore unsuitable for refitting as well.

About lithic raw material classification

One issue that became apparent while working with such a diverse selection of lithic material, is the various interpretations and inconsistencies between works of different authors in their descriptions of lithic material types. While the OVAS excavation project produce an extensive reference catalogue of rock types that made the treatment of lithic material consistent and internally coherent, the descriptions of certain kinds of raw materials do not match those of other archaeologists. The OVAs project’s classification includes broad geological categories such as ‘quartzite’ and ‘quartz’, but utilises archaeological terms on subtypes not narrowly defined by strictly geological terms. This is a potential source of confusion, since some of the subtypes seem to be accepted geological subtypes, while others are not; for example, *Nasjonal Berggrunnsdatabase* lists Ringsaker quartzite as a geologically defined rock, while *flammekvartsitt* seems to be an archaeologically defined material category. Furthermore, some archaeological terms seem especially vague and confusing, such as the term *tektonisk breksje*, translated as tectonic breccia. Although the terminology within a given excavation project is likely to be internally consistent, the lack of any kind of overarching archaeological lithic classification system throughout the past decades of Norwegian Mesolithic research makes it difficult to compare lithic technology from different sites in terms of raw material selection and treatment.

Of particular interest were some categories of Ringsaker quartzite that were prolific at the selected sites. Although Ringsaker quartzite was made a priority from the onset of the investigation, I opted for a wide material selection based on the presumption that raw material classification systems such as these are prone to flaws either in the sorting process, or the underpinnings of the classification system itself. As such, the specific material categories have been included as metadata in the study, but are not relied upon as basis for individual artefact selection; throughout the selection and labelling phase, every lithic finds bag from the sites was inspected for labelling errors. Additionally, the selection included some quartz finds that looked somewhat similar to quartzite, just in case there was any confusion of the material.

Ringsaker quartzite

The exact sources of Ringsaker quartzite is not possible to determine, as there are no practical means of determining the exact provenience of quartzite at the time of writing known to the author. The closest known source of Ringsaker quartzite to Rena appears to be the area surrounding Osensjøen, 14 km away by air, and 19 away by today's river network (see: http://www.ngu.no/no/hm/Kart-og-data/). There are also natural deposits of Ringsaker further south, going by the Rena river. Moraine deposits may also be a source of Ringsaker quartzite (Damlien 2010a: 54). The excavation reports lists Ringsaker quartzite as 'local' (Damlien 2010a: 64-65). This interpretation is based on the observation that the debitage often has a cortex-like surface. It thus follows that the classification is based on the theory that knappers will remove natural surface during primary production, an assumption steeped in flint knapping bias; while knappers will indeed remove cortex from flint unless under considerable material scarcity constraints, one should not assume this is the case with all lithic materials. Ringsaker quartzite does not have cortex, and the assumption that its natural surface is detrimental to the end product may be incorrect.

The most conspicuous type of Ringsaker quartzite was one classified as 13/H in the OVAS lithic classification system. It can be described as dark grey, almost black, with colour specks ranging from crimson red to mid-brown, possibly a result of thermal colour alteration. Most of the refits were made with this material.

My selection process will inevitably be imperfect in the sense that some material will be excluded from the refitting investigation, either by erroneous design or simple mistakes during the sorting process. However, the option of including every single piece of stone from the sites would render the task insurmountable, and the benefit of excluding material such as the weathered quartzite by far outweighs the risk of wasting time on dubious material. The refitting resulted in a grand total of 27 refit groups comprising 78 individual pieces (see table 4 below). While this number is quite small compared to the total amount of material selected, one should keep in mind that the material selection was designed to be as wide as possible to avoid pitfalls. Most of the quartzite material seems not to have any refit potential at all, being the result of production stages.

5. Lithic analysis

The lithic assemblages chosen for this study were presented in preceding chapters, Stene Terrace and Bjørkeli. The sites have notable quantities of non-flint lithic material, in particular quartzite and jasper. A previous study by Claudia Arangua (2014) encompassed a lithic refit study of the jasper artefacts from these same sites. In an effort to expand on that analysis, the quartzite was chosen for this study. By expanding the range of analysed lithic artefacts at the sites, I intend to provide a more complete picture of lithic artefacts production and usage at Rena, and in turn add to our understanding of the role of quartzite usage in the Norwegian Late Mesolithic.

Stene Terrace and Bjørkeli were extensively excavated and well-recorded, providing a good opportunity for refitting, as evident from the previously mentioned study (Arangua 2014). The production process of quartzite is not well understood, so for my own technology-oriented investigation it was preferable to opt for a refit-centred *chaîne opératoire* approach to quartzite. As a starting point, some key analytical research questions were apparent from the early onset: How did the knappers utilise quartzite, and what methods characterise local knapping sequences? Is it possible to infer site and/or work organisation by way of distributional refit maps? Overarching questions would become significant; how do the results from the lithic analysis look in comparison to previous studies, and how relevant are archaeological lithic raw material categories in the effort of understanding Mesolithic technology? In this chapter, I will present the process leading up to and throughout the *chaîne opératoire* analysis, as well as describe the material and present the refit groups from the different sites.

Investigation process

The analysis consisted of several stages, all of which are described in the following pages. After the initial pre-selection phase, in which the sites and raw material categories were chosen, a digital database was created to keep record of the examination and refitting stages. Subsequently followed an artefact selection and labelling stage, where individual pieces considered unsuitable for refitting were omitted from the study (See following description for details). Afterwards, the artefacts were organised into groups in order to best facilitate macroscopic study and refitting.

Each piece from the quartzite inventories was assigned an individual 'Refit ID' in the form of a unique number in a Microsoft Access database. The database itself was designed to be an easy-to-use register of all the examined artefacts that allows the user to easily quantify lithic pieces by attributes. Although the Microsoft Access database was more complicated and therefore more time-consuming to set up compared to a simple handwritten record or computer spreadsheet, it had the advantage of allowing cross-referencing individual lithic artefacts with data retrieved from the Museum of Cultural History excavation database (see figure 5). The artefacts' Refit ID numbers were tied to artefact numbers in the Museum of Cultural History's artefact database, which meant that information from the OVAS project could be consulted at will. For instance, when a refit group was established, a relation was created between two cells in the database representing the individual pieces; the system would then display the relevant information from the reports in regard to the refitted pieces, including raw material codes (see table 4). The data retrieved from the OVAS project was edited and corrected as part of the investigation.

Table 2: Overview of all selected pieces in the study broken down by OVAS raw material subcategories and colour descriptions (Damlien 2010a). The summary includes all labelled and examined material in this investigation from Bjørkeli and Stene Terrace. Names and descriptions of raw materials translated by the author.

Quartzite subcategory	Colour description	OVAS Raw material code (colour/subcategory)	Sum	Percentage
Ringsaker quartzite	Dark grey	13/H	263	21,70 %
Flame quartzite	Grey, specks of red, yellow and green	10/F	257	21,20 %
Ringsaker quartzite	Light grey	14/H	204	16,83 %
Ringsaker quartzite	White	17/H	148	12,21 %
Quartz-banded quartzite	Purple, homogenous with veins of quartz	4/D	114	9,41 %
Quartz-banded quartzite	White, matte, homogenous with black quartz bands	2/D	60	4,95 %
Quartz-banded quartzite	Green, heterogeneous with veins of quartz	5/D	38	3,14 %
Ringsaker quartzite	Light Brown	16/H	28	2,31 %
Flame quartzite	White, specks of yellow	11/F	23	1,90 %
Quartz/Quartzite	50/50 % quartz and quartzite, ranging from to grey.	24/L	23	1,90 %
Miscellaneous quartzite	brown-mottled with white quartz veins	20/J	16	1,32 %
Milky quartz	White with thin, black bands	3/C	8	0,66 %
Mostein-red quartzite	Ranging from rust red to orange	12/G	7	0,58 %
Quartz-banded quartzite	White, matte, homogenous with black quartz bands	1/D	5	0,41 %
Ringsaker quartzite	Ranging from light grey to brown, with white veins	15/H	5	0,41 %
Quartzite sandstone	Brown grey with black mineral grains	22/K	4	0,33 %
Quartzite sandstone	Grey with black mineral grains	23/K	4	0,33 %
Quartz-banded quartzite	Brown, heterogeneous with quartz veins	6/D	3	0,25 %
Quartz-banded quartzite	Pink, heterogeneous with red/purple mineral grains	7/D	1	0,08 %
Unidentified	-	-	1	0,08 %
TOTAL	-	-	1212	100,00 %

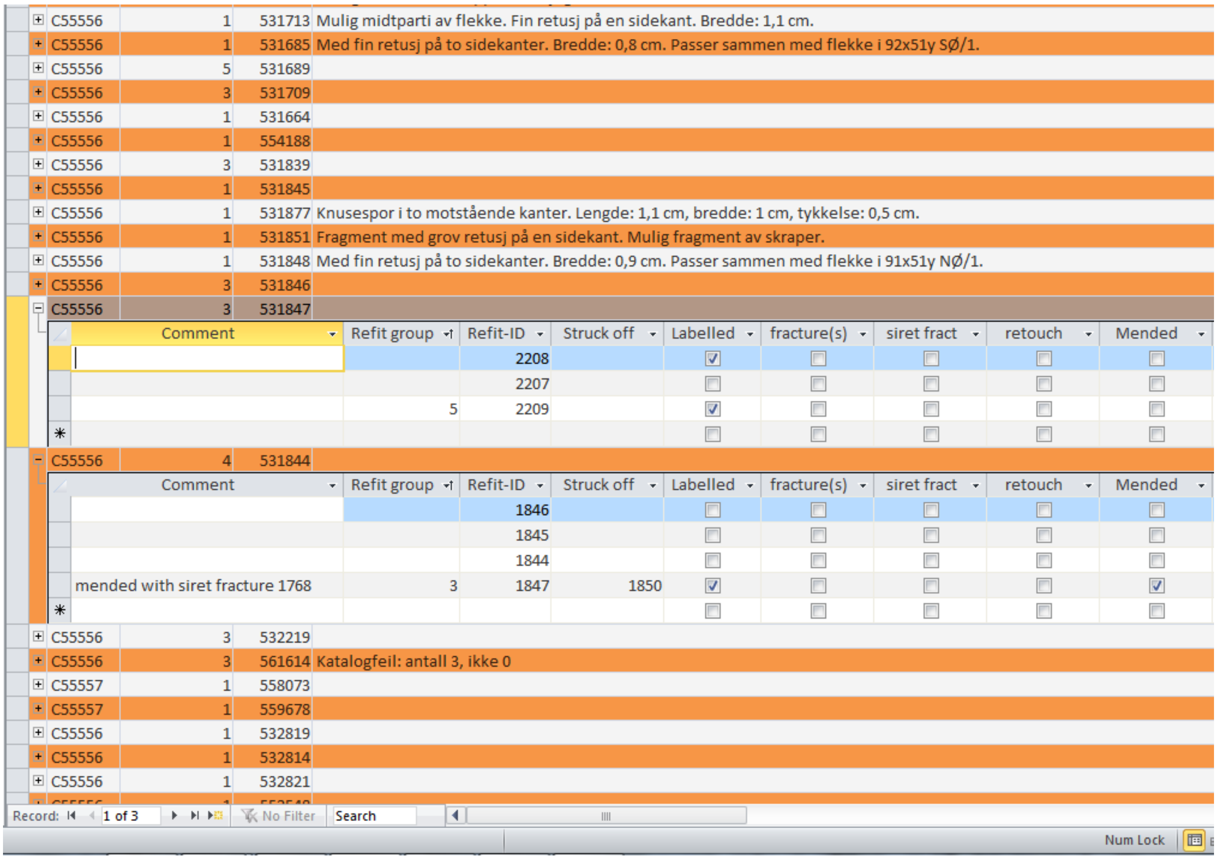


Figure 5: Screenshot example of the Microsoft Access database created and used during the lithic analysis. Data cells displaying comments and attributes are shown here embedded with their respective counterparts from the Museum of Cultural History database. The museum codes for Bjørkeli and Stene Terrace are C55556 and C55557. Illustration by author.

A grand total of 2598 lithic artefacts were examined during the investigation (see table 3). Of these, 1212 pieces were selected for analysis. Artefacts measuring less than 10 mm were excluded from the investigation, although exceptions from this rule were made for a few specimens. For example, some pieces had unusual shapes that might have left recognisable negative scars despite their size. 1352 artefacts were excluded on the basis of being too small, i.e. <10 mm. The remaining 34 artefacts were not available for examination. Each artefact label displayed the respective artefact's Refit ID number. Artefacts that fell within the initial material selection but were upon inspection deemed not refitable were assigned 'Refit ID' numbers, but not physically labelled. Remaining unlabelled artefacts were returned to their respective finds bag, and not examined further. This selection phase was carried out between September 10 and October 8, 2014.

Table 3: Selection rate of quartzite suitable for refitting analysis by site. Selection based on size, with pieces smaller than 10 mm excluded from the analysis.

Selected artefacts by site			
Artefacts	**Site**	**Selected and labelled**	**Percentage of site total**
775	Bjørkeli	No	53,2 %
683	Bjørkeli	Yes	46,8 %
611	Stene Terasse	No	53,6 %
529	Stene Terasse	Yes	46,4 %
2598	Total	-	-

During the second season of excavation at Stene Terrace, when the northern part of the locality was excavated, this part was named Stene North – a temporary site name for what would later be consolidated with the first season and then simply called Stene Terrace in reports. As a result of the temporary site name, debitage from this part of Stene Terrace was boxed and labelled as Stene North, separate from the remainder of the Stene Terrace. I mistakenly assumed Stene North was a separate site altogether when sorting through the artefacts, and so the northern end of the site was unintentionally excluded from the study. Unfortunately, when the mistake was discovered, it was too late to easily correct, since it would require restarting the whole process of refitting. The omitted material that would have been included in the pre-selection stage numbered approximately 260 pieces. Estimated based on the rate of selected artefacts in the rest of the material, 120 artefacts would have made it into the study.

Table 4: General overview of all quartzite refit groups from Bjørkeli and Stene Terrace. Refit groups have been assigned running numbers in ascending order at time of refitting, i.e. Refit Group 1 was the first refit group identified during the investigation. Note that group 1 was later found to be a broken flake from within the same context, and thus considered a mended artefact. Therefore, the two pieces were not assigned individual Refit-IDs. Refit-ID is a unique running number labelled onto each artefact in the study. OVAS Lithic Raw material codes represent lithic raw material interpretations used in the OVAS excavation project and its reports (Damlien 2010a), and consist of a two- or three-letter abbreviated texture description, a number representing a colour description, and finally a single letter for archaeological raw material subtype. See earlier pages for a more comprehensive discussion on the subject of raw material descriptions.

Refit group (RG)	Refit-ID (R-ID)	Struck from	Retouch	Siret fracture	Step fracture	Hinged	Plunging fracture	OVAS Lithic Raw Material Codes	Raw Material description (Colour code / subtype code)
1	1264							KF2/D	Banded quartzite or Tectonic Breccia
2	1633			Yes				KM13/H	Dark grey Ringsaker quartzite
2	1632			Yes				KM13/H	Dark grey Ringsaker quartzite
3	1850	1646			Yes	Yes		KM13/H	Dark grey Ringsaker quartzite
3	1646	1860						KM13/H	Dark grey Ringsaker quartzite
3	1686	2587			Yes	Yes		KM13/H	Dark grey Ringsaker quartzite
3	1768	1850		Yes	Yes			KM13/H	Dark grey Ringsaker quartzite
3	1860	2587						KM13/H	Dark grey Ringsaker quartzite
3	1847	1850			Yes			KM13/H	Dark grey Ringsaker quartzite
3	1840	1839						KM13/H	Dark grey Ringsaker quartzite
3	2587							KG13/H	Dark grey Ringsaker quartzite
3	1839	2587						KM13/H	Dark grey Ringsaker quartzite
3	1763	1860						KM13/H	Dark grey Ringsaker quartzite
3	1823	1768				Yes		KM13/H	Dark grey Ringsaker quartzite
3	1822	1768				Yes		KM13/H	Dark grey Ringsaker quartzite
3	1713	2587						KM13/H	Dark grey Ringsaker quartzite
4	2155	2156		Yes				KM14/H	Light grey Ringsaker quartzite
4	2154	2156		Yes				KM14/H	Light grey Ringsaker quartzite
4	2156							KM14/H	Light grey Ringsaker quartzite
5	2209							KK14/H	Light grey Ringsaker quartzite
5	2267							KK14/H	Light grey Ringsaker quartzite
6	2547	2544	Yes					KF14/H	Light grey Ringsaker quartzite
6	2544		Yes					KF14/H	Light grey Ringsaker quartzite
7	2611							KVG3/C	Milky quartz
7	2610							KVG3/C	Milky quartz
7	2605							KVG3/C	Milky quartz
8	711							KM13/H	Dark grey Ringsaker quartzite
8	715							KM13/H	Dark grey Ringsaker quartzite
9	645							KM13/H	Dark grey Ringsaker quartzite
9	640	650						KM13/H	Dark grey Ringsaker quartzite
9	650	645						KM13/H	Dark grey Ringsaker quartzite
10	1925						Yes	KM13/H	Dark grey Ringsaker quartzite
10	1695	2588						KM13/H	Dark grey Ringsaker quartzite
10	1940	2588						KM13/H	Dark grey Ringsaker quartzite
10	2588	1945						KM13/H	Dark grey Ringsaker quartzite
10	1838	1695						KM13/H	Dark grey Ringsaker quartzite
10	1942	1925						KM13/H	Dark grey Ringsaker quartzite
10	1785	1838						KM13/H	Dark grey Ringsaker quartzite
11	1656	1828						KM13/H	Dark grey Ringsaker quartzite
11	1765	1656						KM13/H	Dark grey Ringsaker quartzite
11	1828						Yes	KM13/H	Dark grey Ringsaker quartzite
11	2543	1828						KM13/H	Dark grey Ringsaker quartzite
11	1764	2543	Yes					KM13/H	Dark grey Ringsaker quartzite
12	7							SKM23/K	Quartzite sandstone
12	32							SKM23/K	Quartzite sandstone

13	1389							KF4/D	Banded quartzite or Tectonic Breccia
13	1341							KF4/D	Banded quartzite or Tectonic Breccia
14	1404							KF4/D	Banded quartzite or Tectonic Breccia
14	1405							KF4/D	Banded quartzite or Tectonic Breccia
15	1346		Yes	Yes				KF4/D	Banded quartzite or Tectonic Breccia
15	1199		Yes	Yes				KF4/D	Banded quartzite or Tectonic Breccia
16	165							KM10/F	Flame quartzite
16	1015							KF10/F	Flame quartzite
17	1310	2589						KG16/H	Light brown Ringsaker quartzite
17	2589							KG16/H	Light brown Ringsaker quartzite
18	2244		Yes					KF14/H	Light grey Ringsaker quartzite
18	2551	2244	Yes			Yes		KF14/H	Light grey Ringsaker quartzite
19	2518	2517	Yes					KF14/H	Light grey Ringsaker quartzite
19	2517		Yes					KF14/H	Light grey Ringsaker quartzite
20	685							KM13/H	Dark grey Ringsaker quartzite
20	684							KM13/H	Dark grey Ringsaker quartzite
21	1662	1687						KM13/H	Dark grey Ringsaker quartzite
21	1687	1694						KM13/H	Dark grey Ringsaker quartzite
21	1694							KM13/H	Dark grey Ringsaker quartzite
22	1945							KM13/H	Dark grey Ringsaker quartzite
22	1953							KM13/H	Dark grey Ringsaker quartzite
23	708			Yes				KM13/H	Dark grey Ringsaker quartzite
23	703			Yes				KM13/H	Dark grey Ringsaker quartzite
24	44		Yes					KM10/F	Flame quartzite
24	390							KK10/F	Flame quartzite
25	2560		Yes					KF14/H	Light grey Ringsaker quartzite
25	2559		Yes					KK14/H	Light grey Ringsaker quartzite
25	1196		Yes					KK14/H	Light grey Ringsaker quartzite
26	41		Yes					KK10/F	Flame quartzite
26	23		Yes					KK10/F	Flame quartzite
27	1824							KM13/H	Dark grey Ringsaker quartzite
27	1926							KM13/H	Dark grey Ringsaker quartzite
27	1862							KM13/H	Dark grey Ringsaker quartzite
28	2245			Yes				KF14/H	Light grey Ringsaker quartzite
28	2270			Yes				KF14/H	Light grey Ringsaker quartzite

Procedure

The material was intensely studied for the purpose of refitting debitage over a period of 13 weeks. Some additional refits were made when the material was re-examined during the recording process. All of the selected artefacts were spread across two desks on paper sheets and sorted principally by hand specimen characteristics or raw material properties; for example, artefacts with similar grain texture and colours were sorted into groups irrespective of OVAS project lithic classifications.

The pieces were then sorted into technological subcategories of flakes, blades, cores, fragments, aligned with ventral surface face down, distal ends upward. Proximal and distal fragments were laid out in opposite positions, with the broken end centre-oriented, so that the potentially matching pieces would face each other. This arrangement of the inventory was particularly useful with quartzite, since it tends to shatter during knapping (Knutsson 1998: 75; Eigeland 2007b: 339). For the same reason, siret fractured flakes – flakes broken along the strike axis (Inizan 1999: 34) – were positioned on the right and left sides, with the fracture line facing towards the middle. The pieces were then examined and refitted, with recurrent sorting into subgroups whenever the refitting progress stalled.

Throughout the investigation, the artefacts would be arranged by shape and size, knapping attributes such as hinged and step-fractured flakes, and finally according to characteristic raw material inclusions. As the study progressed, smaller pieces were gradually included until all of the selected material had been thoroughly examined. A total of 27 refit groups varying in size from 2 to 13 pieces were established; 7 refit groups originated from Stene Terrace and 19 from Bjørkeli, in addition to 1 refit group connecting both sites (see table 4, figure 18). A total 78 lithic artefacts were refitted, 6,4 % of the selected artefacts and 3 % of the total pre-selected lithic inventory from the chosen sites.

After refitting, the refit groups were examined and interpreted in relation to each other, spatial distribution on the chosen sites, and the remaining debitage. Refit groups that were interpreted as related to the same reduction sequences without direct evidence from refitting were then classified as associated refit groups, and interpreted as such. Although artefact classifications and interpretations from the reports were taken into consideration, the interpretations presented here are my own, and may diverge from those of excavation reports.

In the following section, the refit groups will be presented within the context of the respective site, followed by interpretations of the spatial distribution and, thermal alteration and interpretations of production sequences. After the presentation of site analyses, a short summary follows before the final discussion of this study's results.

Bjørkeli

The lithic material from Bjørkeli is dominated by quartzite, with a significant quantity of jasper (Damlien 2010b: 239). Bjørkeli consists of several activity zones, with most of the Refit groups concentrated in A2 (see figure 18). No refit groups connect A2 with other activity zones within Bjørkeli, although there is one quartzite refit group consisting of a broken blade connecting Bjørkeli to A2 at Stene Terrace (see figure 18 and figure 26). A quartzite refit group at Stene Terrace connects activity zone A2 with A3 (see figure 26), further strengthening the evidence for contemporaneity of the two sites beyond a single activity zone. Additionally, Arangua (2014) refitted two jasper pieces connecting both sites.

The quartzite raw material from Bjørkeli is diverse, with unique raw materials ranging from cryptocrystalline fine-grained retouched tools to coarse-grained primary debitage. Most of the lithic material at Bjørkeli stems from primary reduction of medium coarse grey Ringsaker quartzite. The remaining refit groups consist of broken debitage, broken tools, limited primary reduction, and scraper recycling.

Table 5: Raw material diversity among selected pieces from Bjørkeli according the OVAS raw material classification. See table 2 on raw material classification for fuller description.

Lithic pieces from Bjørkeli	Raw Material	%
180	14/H	26,4 %
179	13/H	26,2 %
127	17/H	18,6 %
74	4/D	10,8 %
34	2/D	5,0 %
21	16/H	3,1 %
16	5/D	2,3 %
15	24/L	2,2 %
8	3/C	1,2 %
6	10/F	0,9 %
6	12/G	0,9 %
5	1/D	0,7 %
5	15/H	0,7 %
4	22/K	0,6 %
3	23/K	0,4 %
683	**Total**	100,0 %

Refit groups

A total of 20 refit groups were assembled from the lithic material of Bjørkeli. The refit groups can be divided into four categories: debitage from primary reduction, broken pieces, broken scrapers, and recycled broken scrapers. A majority of the refit groups consist of groups of 3 pieces or less.

Table 6: Refit groups at Bjørkeli by raw material code. See table 2 on raw material classification for fuller description.

Refit Group	Lithic pieces	Raw Material
2	2	13/H
3	13	13/H
4	3	14/H
5	2	14/H
6	2	14/H
7	3	3/C
10	7	13/H
11	5	13/H
12	1	23/K
13	2	4/D
14	2	4/D
15	2	4/D
17	2	16/H
18	2	14/H
19	2	14/H
21	3	13/H
22	2	13/H
25	3	14/H
27	3	13/H
28	2	14/H

The three most complete refit groups where all composed of the same raw material, and these were the only refit groups from Bjørkeli consisting of more than 3 pieces (see table 6). Descriptions of the main refit groups, RG3, 10 and 11, and a short description of the minor refit groups are presented below.

Primary Reduction

Refit group 3

Group 3 consists of 13 individual lithic objects, all flakes or flake fragments joined with a core of dark grey Ringsaker quartzite with red discolouration. The shape of the refit group can be described as a semi-cubic block, with an abraded surface visible on three sides, including the main platform. The texture of the individual pieces varies within the group, but mostly has a medium-coarse grain, with numerous inclusions in the grain. The flakes are relatively thin compared to other refit groups of the same raw material, some no more than 2 mm thick. There are several traces of knapping errors in the refit groups: hinged flakes, step-struck flakes and a negative hinge flake (see figure 6). The core itself measures 6 cm long, 7,4 cm wide, an 6,3 cm deep. The refit group has three platforms in total.

Figure 6: Refit group 3, A2, Bjørkeli. This illustration shows signs of knapping errors, including a negative hinge flake and step-struck flakes. Photo by author.

The primary strike platform is a plain weathered surface with a striped pattern of red discolouration. Most flakes have been struck off this platform. The platform seems to have been given up after a series of step fracture, hinged and plunge fracture strikes.

The secondary platform is on the opposite side of the primary platform. It has a weathered, red, plane surface. 1713 is the only recovered flake refitted to be struck off this platform, seemingly to remove the hinge left by a previous knapping error.

Finally, there are several ‘tertiary platform’ removals made perpendicular to the primary and secondary platforms after exhaustion. The weathered surface, which forms the dorsal side of the flakes knapped at this stage, make for naturally sharp edges. These removals mark the end of the knapping phase, since the main platforms are rendered useless by this stage of production.

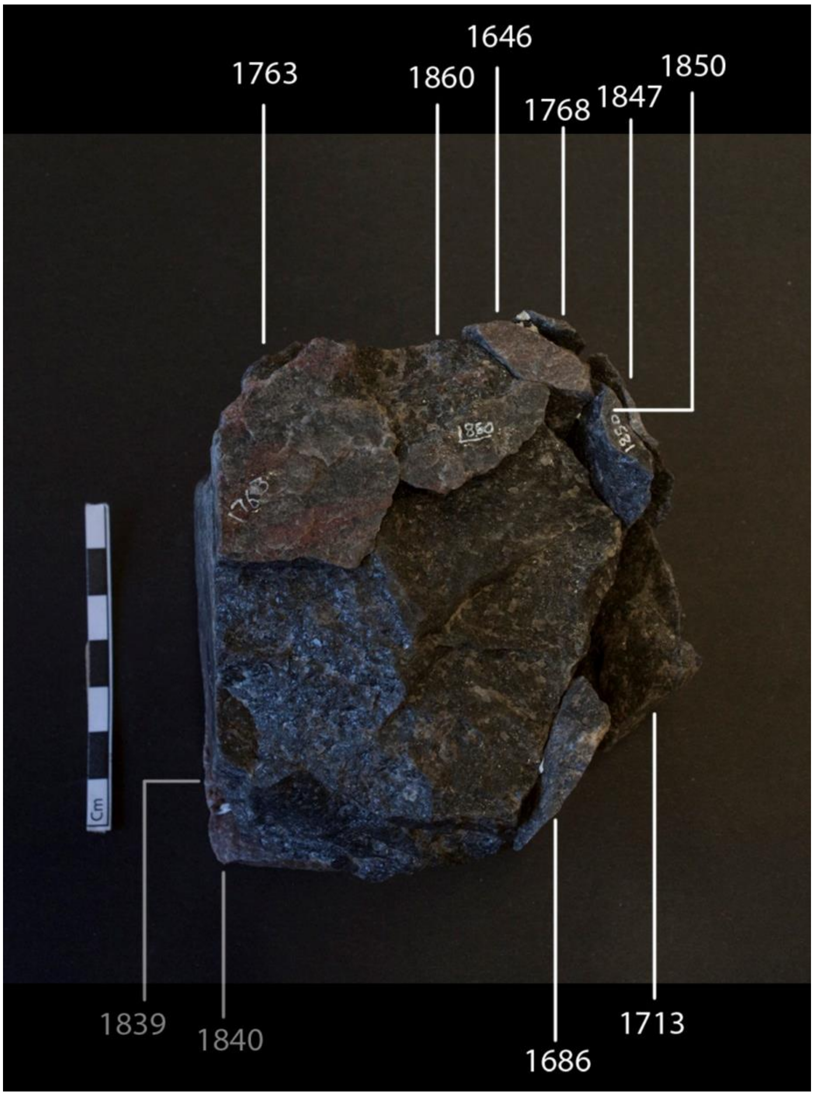


Figure 7: Refit group 3, A2, Bjørkeli. View of main strike platform. For more photos, see appendix. Photo by author.

Based on these characteristics, I infer the following: the numerous knapping errors apparent on the core, along with the destruction of the main knapping platform is evidence of a terminal knapping sequence. The negative hinge flake 1713, most likely the initial flake in the sequence of this particular refit group, was the last attempt of the knapper to correct mistakes on the core; after successive flake removals failed with hinged and step-struck flakes as a result, the scheme of the knapper was abandoned in favour of expedient reduction of the core. Turning the core 90 degrees, the knapper proceeded to remove at least 6 flakes directly off the main strike platform, along with one flake off the opposite platform. The core, now completely exhausted, was then discarded.

Refit group 10

Refit group 10 consists of 7 pieces, all flakes connected ventral-dorsal. The raw material is identical to Refit group 3. Smaller gaps between the flakes indicate platform preparation. Overall, the flakes are significantly larger than the ones in group 3.

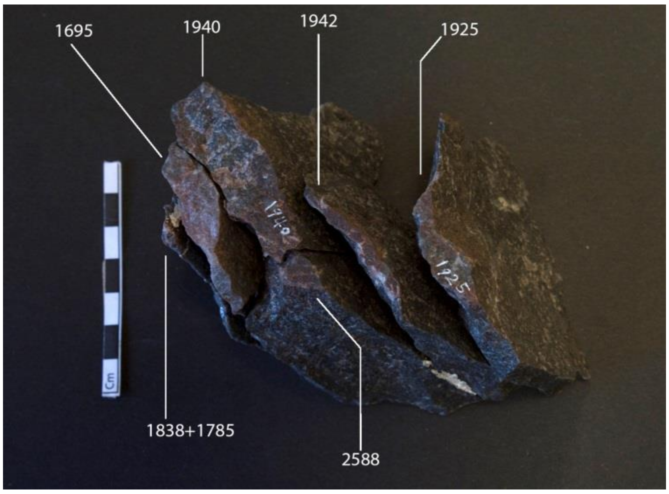


Figure 8: Refit group 10, A2, seen here with striking platform uppermost. Photo by author.

The first flake in the sequence, 1838 and 1785, is a broken thin feather flake with the negative scar of a preceding similar feather flake half the length of this one (see figure 9). The follow-up flake, 1695, is a hinged flake. Following these three knapping errors follow two following flakes which are substantially larger. The first one, 2588, has been struck with such force that the point of impact shattered. These flakes can only have been the result of forceful blows delivered with direct hard percussion technique. The grain is notably coarser in the first removals than in the last one.

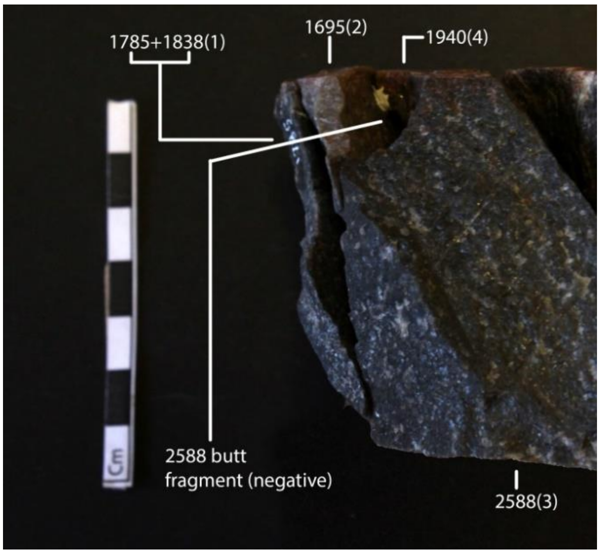


Figure 9: Detail of Refit group 10, A2, Bjørkeli. Close-up photo of the four initial removals in the refit group. Photo taken with striking platform facing upwards. Photo by author.

The latter two flakes in the refit group are interrupted by gaps, and only connect on the right side of the dorsal surface. The raw material is dark grey has a medium-coarse grain, with several visible inclusions such as quartz veins and nodules. The refit group has two abraded surfaces on each end, one of which has been used as a striking platform.

Refit group 11

The group consists of a core fragment and several flakes or fragments of flakes. Some of the pieces may be fragments from breakage rather than flakes, but this is unclear (see figure 10).

The raw material is identical to group 10 and 3, with two exceptions: it is notably discoloured, with red discolouration covering all of the pieces, apart from object 1828 which has mostly yellow discolouration; all of the pieces are also significantly paler. One of the pieces, 1764, is retouched, and resembles an end scraper (see object 2543, figure 10). While the piece was catalogued as a scraper during the excavation, the exact classification of this piece will be discussed later.

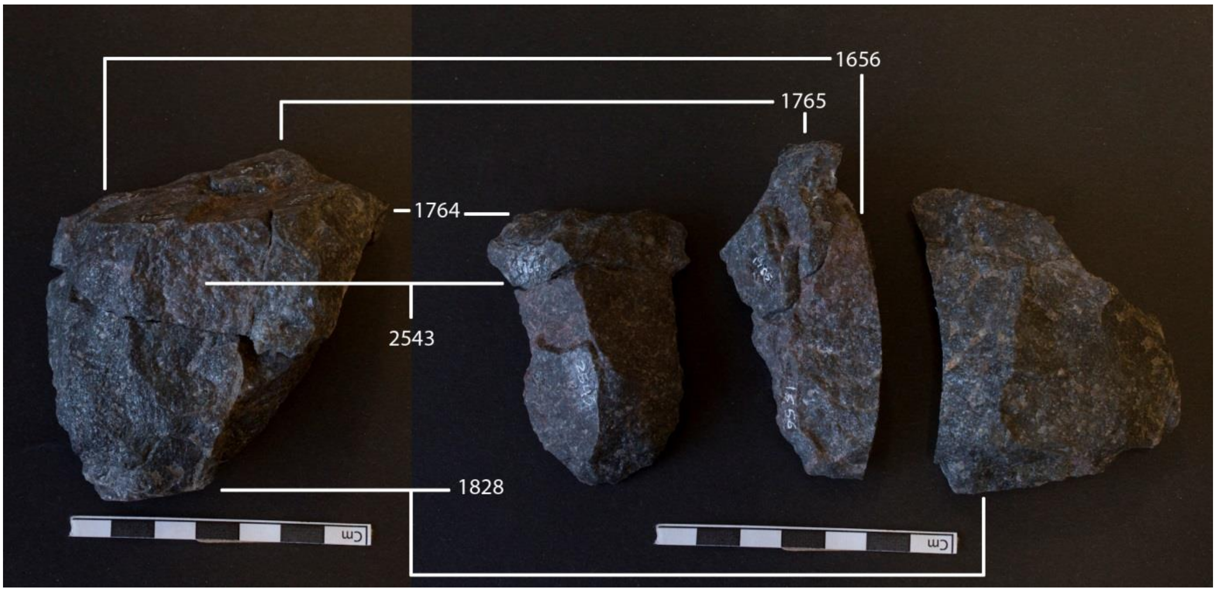


Figure 10: Refit group 11, A2, Bjørkeli. From left to right: assembled refit group, seen from dorsal surface with two strike platforms, facing down (1828) and to the right (2543); partially exploded view of Refit group 11. Photos by author.

Strike direction on flake 1765 is unclear, since clear percussion marks are absent from the piece. It could possibly be a fragment of 1656 (see figure 10). It is clear, however, that the pieces were removed independently of the strike platform from which the core fragment 1828 was knapped.

Refit Group 27

Refit group 27 consists of two hinged flakes connected to a larger flake. The raw material is identical to the previous three refit groups, with no colour bleaching. Abraded surface similar to the other main refit groups can be seen on the distal end of Piece 1926 (see figure

11). Negative scars suggest a third and a fourth step-struck flake preceding the two ones in this refit group. The larger flake could be an attempt to rectify these mistakes.

Figure 11: Refit group 27, Bjørkeli. Seen from dorsal surface.

Remaining refit groups: Broken scrapers, recycled scrapers and other broken pieces

The remainder of the refit groups consist of two to three individual pieces. Some of these were broken debitage of varying nature, others were limited refit groups from early stages of reduction. Among the refit groups are several tools.

Figure 12: Refit group 6 and 19, Bjørkeli. These refit groups consist of recycled scrapers. Photos by author.

Two of the refit groups, Refit group 6 and 19, consist of recycled broken scrapers. In the case of group 6, the broken distal end of a larger scraper has been fashioned into a new scraper after breaking (see figure 12). In the case of RG19, a scraper has broken on the medial section, only to be efficiently retouched into two smaller scrapers.

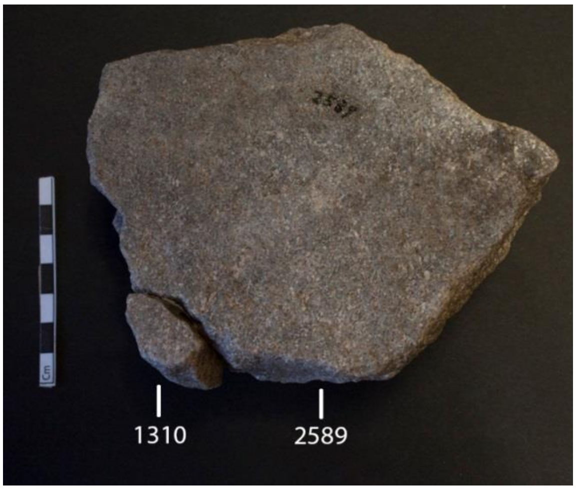


Figure 13: Refit Group 17, Bjørkeli. Seen here with striking platform uppermost. Photo by author.

RG 17 consists of a core with a single flake removal. The core still has a workable striking platform and potential for several more removals, unlike the core in RG 3. Compared to other primary reduction sequences, the number of pieces of raw material that matches RG 17 is very low: 21 pieces according to the OVAS classification (see table 2). The core has been left largely unexploited, and seems to have been discarded without much reduction at all. RG 4 and RG21 seem to be flakes from initial reduction, since abraded surface is dominant on both groups.

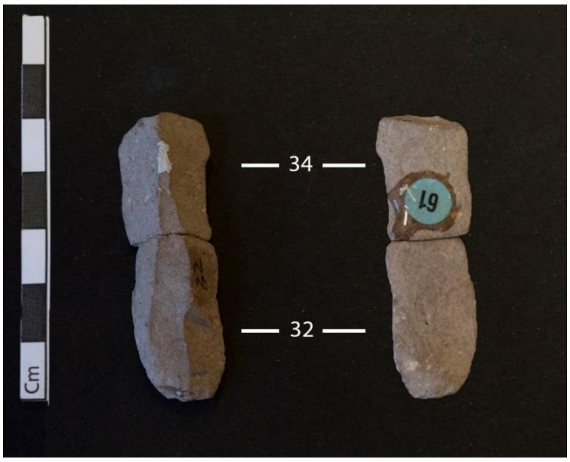


Figure 14: Refit group 12, Bjørkeli. Photo by author.

RG12 is the refit group in the study that connects Bjørkeli and Stene Terrace, consisting of a broken blade in a brittle, fine-grained quartzite sandstone raw material. The extreme distal end is either broken off or hinged. Although there is no clear retouch on the pieces, the edges are worn down to the point where one can safely assume that any fine retouch present before deposition would have been erased by edge damage.

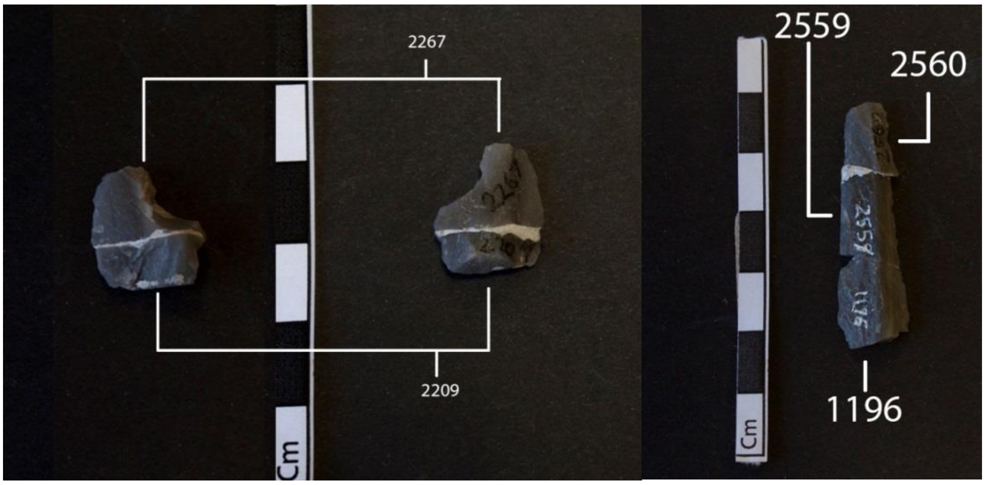


Figure 15: Refit group 5 and 25, Bjørkeli. RG 5 is a broken fine-grained quartzite burin, seen from dorsal and ventral surface. RG 25 is a broken backed blade with possible use damage. Photo by author.

Refit group 5 consists of a broken burin in fine-grained quartzite, with an absent distal end. RG 25 is made of a similar raw material. Though classified as Ringsaker quartzite in the reports, it bears little resemblance to the previously described Ringsaker Quartzite raw materials. RG 25 is a backed blade that has been broken at the proximal, medial and distal section. The extreme proximal and distal ends have not been recovered. The blade is characterised by considerable damage on the left edge, and fine abrupt retouch on the right edge. The breakage and edge damage could be the result of cutting action. The remaining refit groups are variations of broken debitage.

Spatial distribution of Bjørkeli Refit groups

As to vertical distribution, all of the refitted pieces were located in the top two layers on the site, and have not been given much attention. No clear pattern could be seen in this distribution, and post-depositional disturbance is assumed have moved the finds beyond the point of any meaningful analysis of vertical distribution.

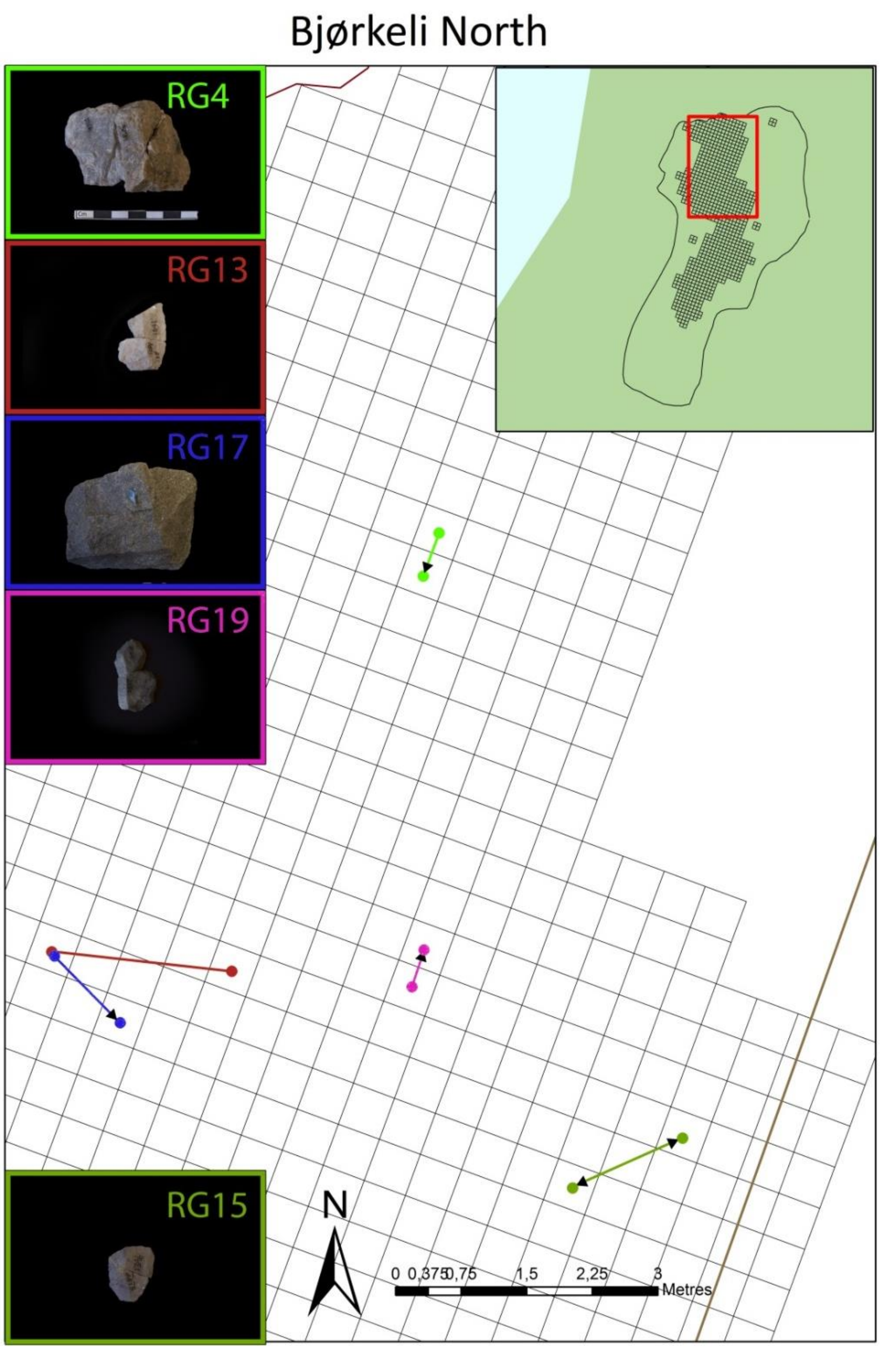


Figure 16: Bjørkeli, Åmot, Hedmark. Horizontal distribution of the refit groups at northern Bjørkeli. Every grid square is 50x50cm. Note that single-square context refits are not shown. Illustration and photos by author.

In the northern part of Bjørkeli, few refit groups have been established. The results from refitting here demonstrate use and recycling of fine-grained quartzite scrapers, in addition to limited primary reduction of a quartzite core. The refit groups are too few and limited to draw any significant conclusions on site organisation, although the activity at this part of the site appears similar to the activity at Southern Bjørkeli, albeit less intensive. As far as quartzite refits go, there is evidence of limited primary reduction. Refit Group 13 and 15, although consisting of broken flakes, are located at least 1 metre apart in the case of RG 15 and at least 2,5 metres in the case of RG13, suggest considerable post-depositional disturbance at this part of the locality.

Most of the refit groups at Bjørkeli are located in activity zone A2 at the southern part of Bjørkeli (see figure 18). The most completed refit groups were located in the middle of soil disturbance according to the site reports (see figure 17). The site is significantly affected by soil disturbance, presumably due to frost heaving and river floods. While the refit groups from the northern end of Bjørkeli are too few and small to draw conclusions from spatial distribution patterns, the situation at the southern activity zone A2 has more potential. At A2, the refit groups are largely debitage from primary reduction and scraper repair. Post-depositional site disturbance makes it hard to draw conclusions regarding spatial distribution, but a few facts seem worth noting at this juncture:

1) The Core in RG3 is positioned further southwest than any other connecting piece.
2) Similar nearby refit groups that are likely to originate from the same block are also fanned out within 3 metres north and west from said core.

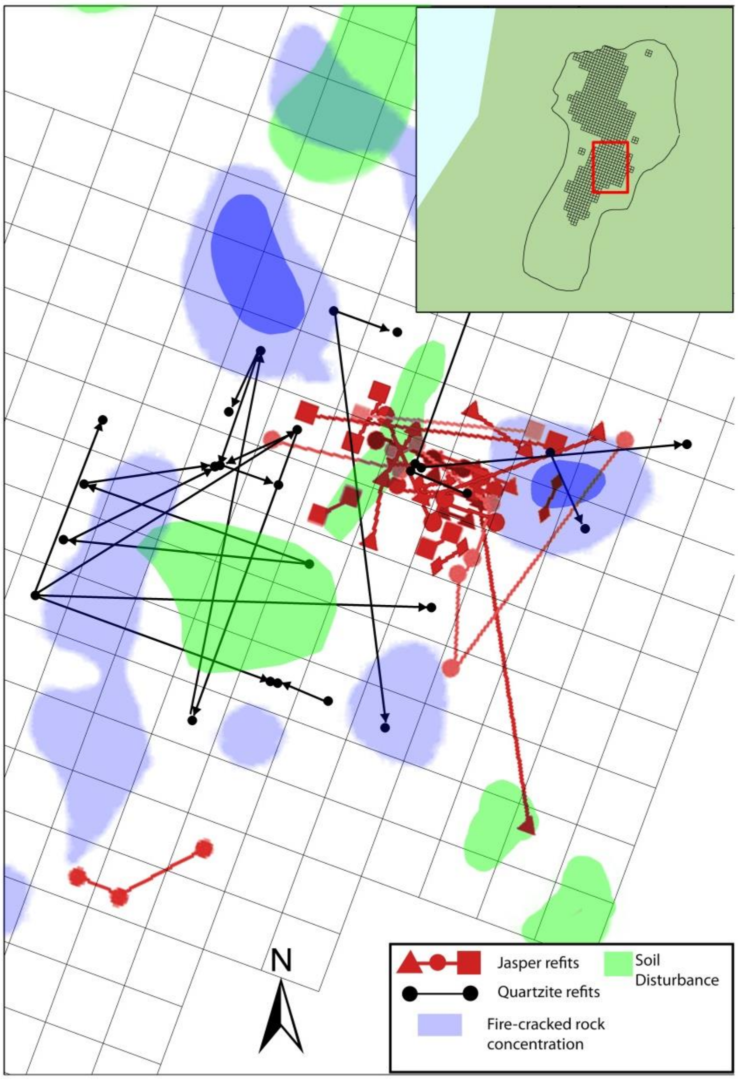


Figure 17: Zone A2, Bjørkeli, Åmot, Hedmark. Refit group distribution of quartzite and jasper (Arangua 2014: 45). Black arrows and dots represent Quartzite refits, red lines and figures represent jasper refits. Patches of green indicate soil disturbance, while blue indicates contrentrations of fire-cracked rock. Illustration by author, partially based on maps from previous works (Damlien 2010b: 237, 258; Arangua 2015: 45).

In the excavation report for Bjørkeli, Damlien (2010b) interprets zone A2 as a hearth-centred activity zone characterised by scraper production, tool usage and primary reduction of locally sourced raw materials (Damlien 2010b: 259). On the basis of spatial analysis, Damlien suggests the finds are centred in a semicircle around one of the possible hearths (Damlien 2010b: 261). Based on the horizontal distribution of the refitted artefacts, fire-cracked rock concentrations and evidence of heat alteration of quartzite artefacts, it seems more likely that there has been more than just one hearth. However, erosion and other taphonomical forces have affected the site, rendering it impossible pinpoint the exact locations of these hearths.

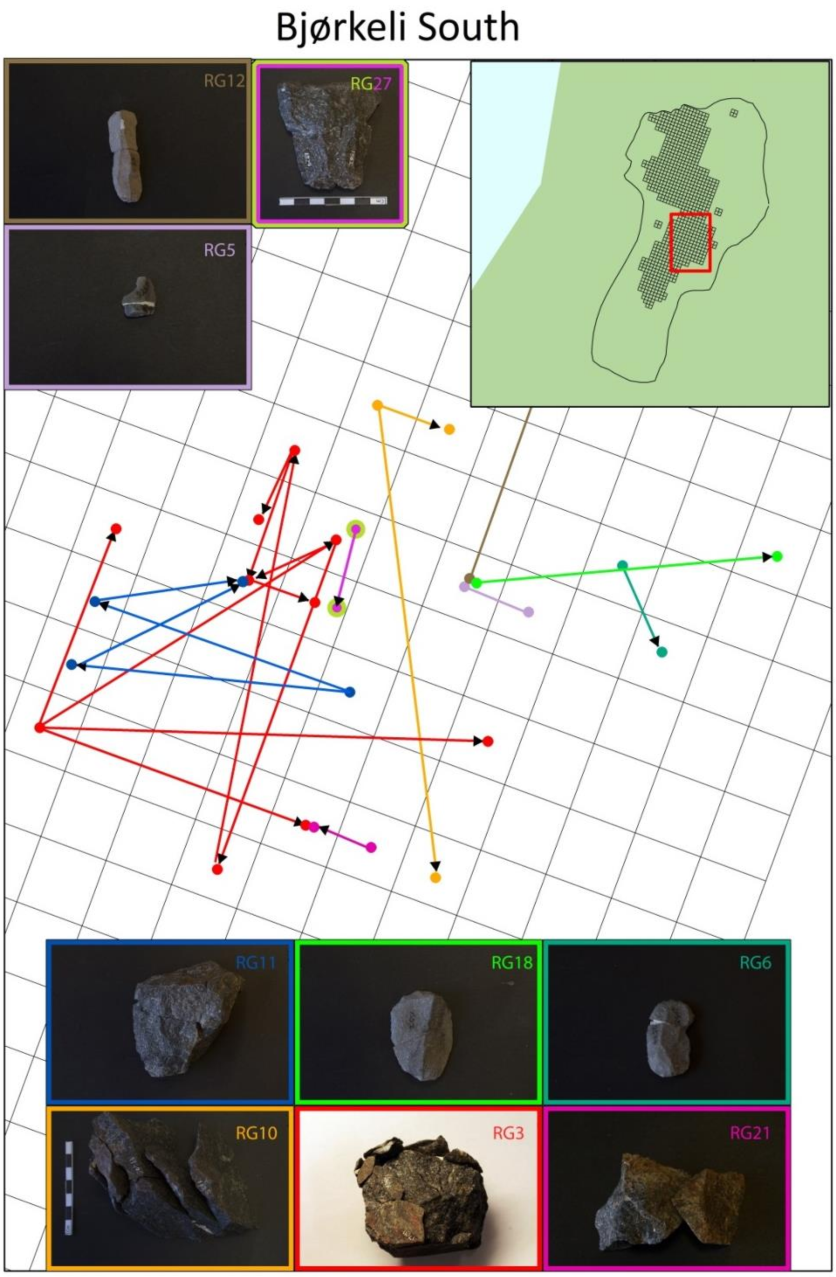


Figure 18: A2, Bjørkeli, Åmot, Hedmark. Horizontal site distribution of the refit groups at southern Bjørkeli. Only Refit group 12 connects with Stene Terrace (see figure 26). Every grid square is 50x50cm. Single-square context refits are not shown. Illustration and photos by author.

Overall, the artefact distribution on A2 seems to be somewhat disturbed, with significant gaps in artefact spread. The find scatter along with the connecting refit lines are difficult to interpret conclusively. The horizontal distribution of the primary reduction refit groups 3, 10, 11, 21 and 27 imply some kind of activity organisation separate from the other artefact concentration. The connecting lines of jasper and quartzite form a pattern, as they fan out in opposing triangles, with some overlap between the finer-grainer quartzite and jasper.

Most likely, the scattered refit groups have been moved away from the original workplace and possibly redeposited at zone A2, forming a fan-shaped midden next the jasper concentration (see figure 17). This would explain how the core in refit group 3, the biggest and heaviest among all the primary reduction refit groups at Bjørkeli South is at least 1 metre away from the rest of the flakes.

Either way, the spatial separation suggests the knapping episodes are separate, resulting in the primary reduction refit groups and the more fine-grained refit groups, including the jasper refit groups of Arangua (2014). One could interpret this as the work of two contemporaneous knappers working in parallel, one working on primary reduction on Ringsaker quartzite, and the other knapping finer-grained materials of a wide variety, each facing separate campfires. Optionally, the two episodes are separated by time, and represent separate occupations. Since there is no evidence of blanks from the primary reduction refit groups being retouched in the knapping episode associated with jasper and fine-grained quartzite, this remains an open question.

Interpretation of production sequences

All refitted pieces of Ringsaker quartzite subtype 13 from Bjørkeli are derived from three blocks at the most. If not for artefact #1921, Group 2, Group 21, I would argue for a single block. It is possible that all the dark grey Ringsaker Quartzite at Bjørkeli is derived from one block of material, but the shape and texture of some of the debitage is so different from the rest that additional blocks cannot be ruled out. Here follows a detailed interpretation of the dark grey Ringsaker quartzite assemblage from Bjørkeli. It is my opinion, based on technique, raw material features, blank morphology and spatial distribution, that RG3, RG10, G11, and RG27 were all part of the same block and schema opératoire. These groups were not refitted to one group because physical evidence from intermediate stages in the form of connecting flakes was not recovered on the site. The original blank would have been a decent-sized thick slab of dark grey Ringsaker quartzite.

Main refit groups: One block, four refit groups

The excavation reports indicated a single tool made of the dark grey Ringsaker quartzite in what I will call 'associated refit group A', by far the most completely refitted material in the assemblage. These groups exhibit features that in my opinion make it highly likely they originate from a single block of raw material, and are part of the same schema opératoire.

The distal end of 2543 in refit group 11 (see figure 21), originally classified as a scraper, was not retouched; rather, the retouch-like removals on the distal end had been produced on the flake prior to the action that removed the flake from the core. Although the apparent morphology is not dissimilar to that of a hefty scraper, the distal end of the piece is not retouched at all. The artefact is more likely a flake or scraper with the proximal end of the flake fragmented due to inclusions when the flake was retouched to a scraper on opposite end (see figure 21).

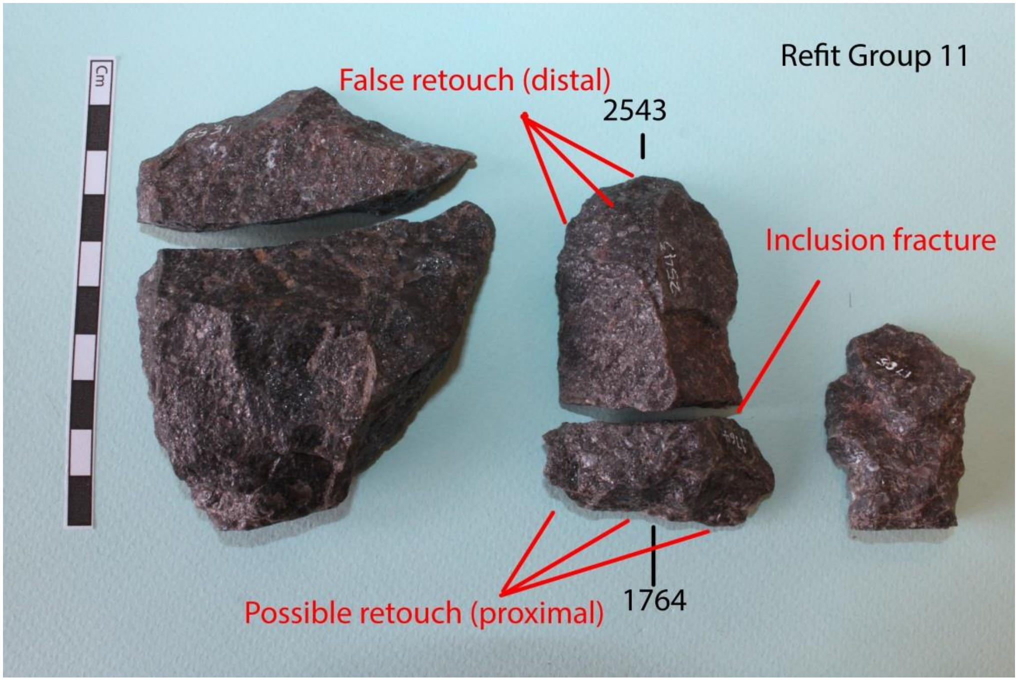


Figure 19: Refit Group 11, A2, Bjørkeli. Shown here disassembled, see Appendix for photo of Refit group 11 assembled. Photo by Author.

The erroneously ascribed retouch marks are negative scars. Piece 2543 and 1763 made up a single flake which was struck off a core fragment, retouched two or three times, before the last retouch attempt broke off the proximal end. It was then discarded on-site by a presumably displeased knapper. The problems of applying retouch to Ringsaker quartzite has been demonstrated by Ove Olstad through experimental knapping (Coulson, private correspondence), similar to the results seen on the piece.

Alternately, the ‘retouch’ marks on the proximal end can be interpreted as the result of some other process that merely resembles retouch, although there is no evidence present in the material to make such a positive identification. To summarize, the retouched tool in Refit group 11 is either a failed attempt at a scraper, or not retouched at all. Either way, this demonstrates the raw material’s limited capacity for formal tool manufacture due to its hardness and tendency to shatter.

Through analysis of the refitted stone artefacts, the interpretation of the artefact in question changed in an unexpected way: while the classification remained intact, the scraper turned out to be upside-down. This object, if it is indeed a scraper, is the sole remaining tool from what I interpret to be associated refit groups. Scraper production is consistent with the overall tool production at Bjørkeli, and seems to have been the main product in the rest of the assemblage, although a single broken scraper is an insufficient basis, especially seeing how it’s uncertain exactly how refit group 11 relates to refit group 10 and 3. So what were the end products for the knapping sequences that produced the associated refit groups?

One option is flakes that were used without further modification. The material might not require retouch in order to produce effective cutting tools. Use-wear analysis performed on flakes from Rena suggest a number of unretouched flakes were used as cutting tools (Knutsson and Knutsson 2010), and the hardness of Ringsaker Quartzite means the material was suited for such a purpose. If the flakes that form the primary reduction refit groups at Bjørkeli have been retouched into other tools than the broken scraper, we are not left with any solid evidence of it on the site.

In other words, seeking out direct evidence of tool manufacture in the traditional sense has not produced sufficient basis to describe the production sequence and the intentions behind them when it comes to the primary reduction groups at A1, Bjørkeli. However, by interpreting the refit groups in relation to each other and the larger assemblage we can reconstruct knapping sequences, and see how the technical gestures can be interpreted as pointing toward certain objectives.

Schema opératoire of Refit groups 3, 10, 11, and 27

As mentioned, I interpret refit groups 3, 10, 11 and 27 to be parts of the same raw material block and production sequence. Here follows my interpretation of the schema opératoire of these refit groups, starting with raw material procurement and ending with deposition.

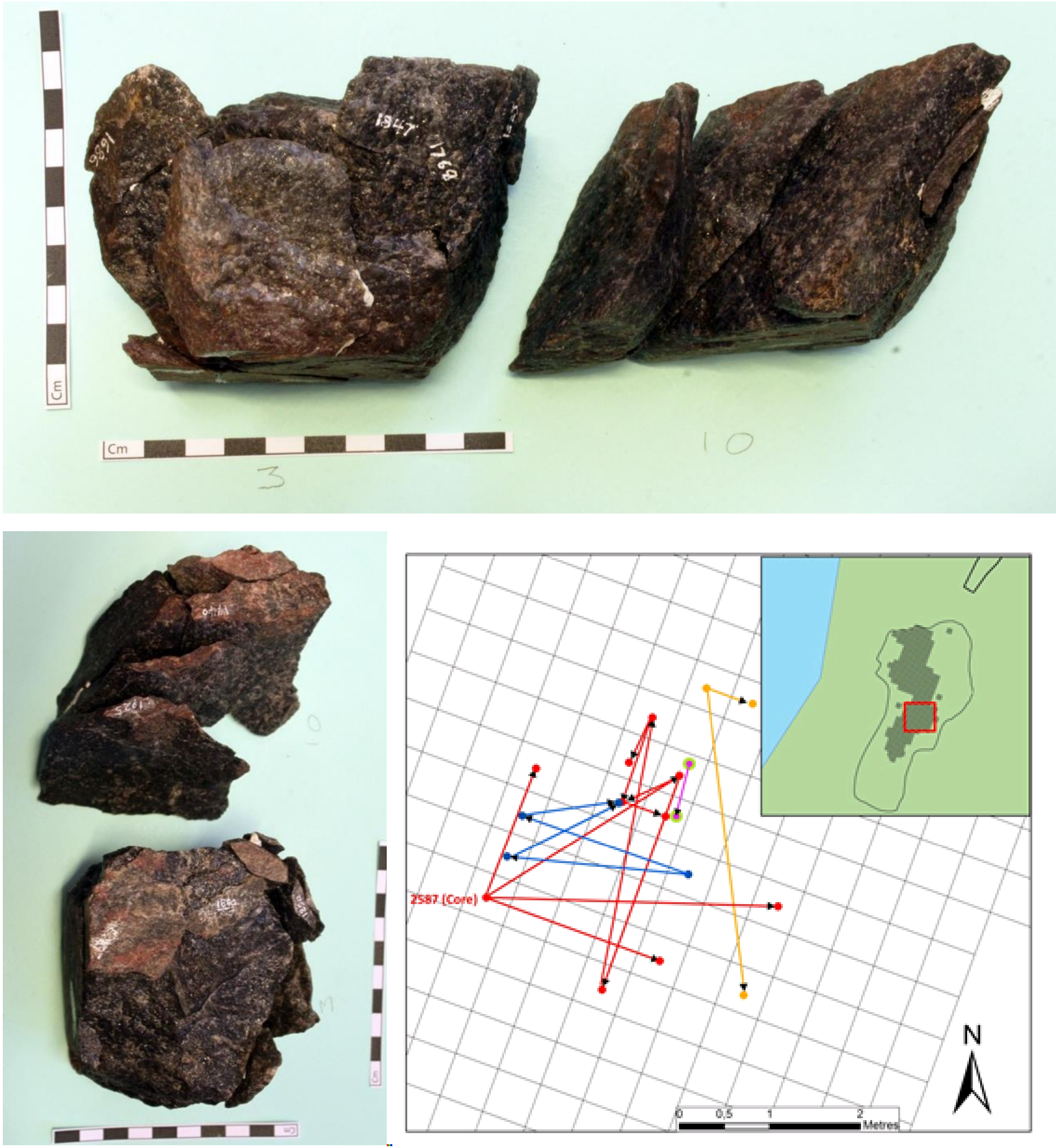


Figure 20: Photo of Refit Group 3 and Refit Group 10, A2, Bjørkeli. Placed in positional relation according to interpretation by the author, along with horizontal distribution of Refit Group 3 and associated refit groups. Although the refit groups were not refitted, it is overwhelmingly likely that these groups were part of the same block. The red lines on the distribution map represent Refit Group 3, and the yellow-orange lines represent Refit Group 10. Illustration and photos by author.

There are no macroscopic traits on the lithic artefacts to suggest that the block is a river nodule. Ringsaker quartzite is not found locally in the bedrock, so it has most likely been transported to the site from the area surrounding the Osensjøen lake or even farther away. This makes it likely that the block has been transported some kilometres, either as moraine deposits or by human interaction.

Refit group 10 represents an early stage of block reduction, with large flakes and a high rate of inclusions and coarse-grained raw material. Refit group 11, as discussed above, represents a divergent step from the main process, where a core fragment has been struck off from the main block in order to produce a rough scraper. Retouch gestures failed, and broke the blank, resulting in a broken scraper. Refit group 27 represents the knapper's attempt to strike slimmer pieces off the core, resulting in hinged flakes and more removal of flawed raw material. Refit group 3 consists of a core and the latter stage of flake removal. The core had three weathered surfaces; all used as platforms, although most removals seem to have been performed on one platform (see figure 6, 7, and 22).

Only one tool has been identified of this particular raw material – Ringsaker quartzite subtype 13, dark grey variant – this suggests that either the knapping operation was not particularly successful, or that unmodified sharp flakes were the primary goal of the operation. I would posit that we are left with enough evidence to describe the schema opératoire of this lithic tool production sequence. Similar assemblages of Ringsaker quartzite have been identified and analysed at Dokka (Boaz 1997: 487-588), of which the overall lithic tool production process coincides with the material from Bjørkeli, although the technical gesture sequence differs slightly, perhaps owing to knapper's technological repertoire and preferences, and – itself arguably a matter of knapper preference through procurement - tabular shape of the block.

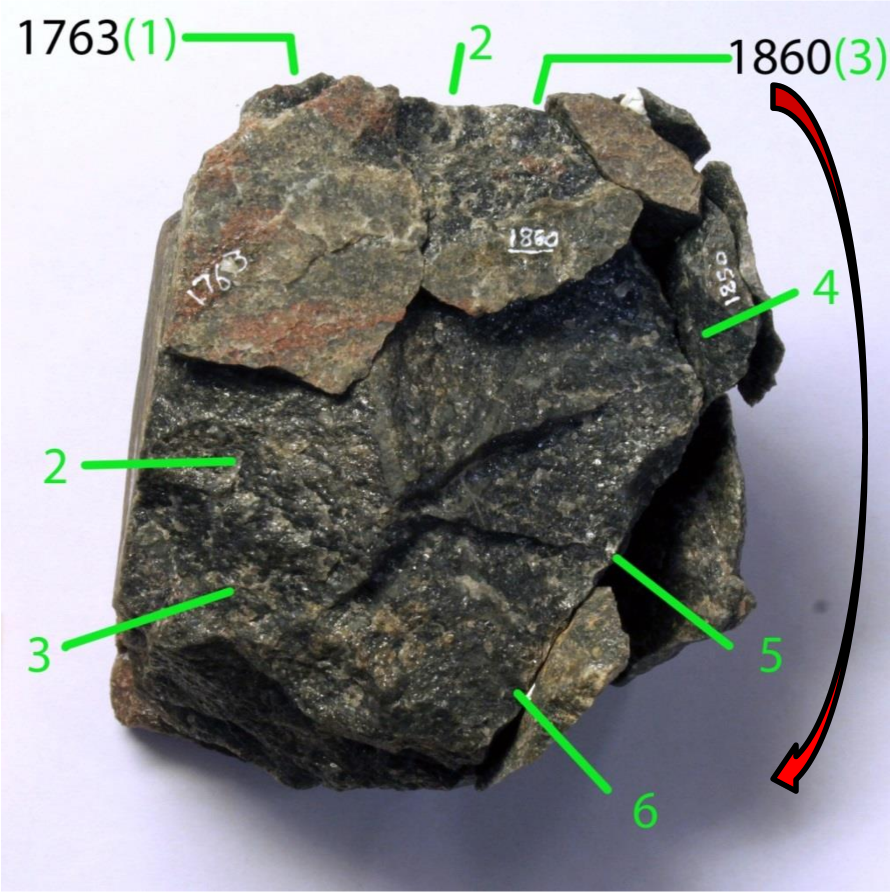
1. 

Figure 21: Refit group 3, A2, Bjørkeli. Photo of core with main Platform uppermost, with arrow indicating the relative sequence the last removals. Photo by author.

Following selection, procurement and transport to the knapping site, five distinct stages of production can be inferred.

2. In the initial stage of removal, flake removals have been struck off the sides of the block, exploiting the natural abraded surface of the block to create an effective cutting edge. All that remains from this stage of production is negative scars on the flakes removed in subsequent stages (See figure 22). None of these initial flakes have been recovered despite the fact that they would have been easily identifiable due to the abraded surface. Either this stage has been performed elsewhere, or these removals where later removed. It seems unlikely, although not impossible, that this first stage was all performed on-site, since this would seem to imply that all of the removals where taken off-site as finished tools.
3. After most of the natural weathered surface platforms on the block were exhausted, thin flakes were removed until the knapper experienced knapping errors due to inclusion in the block. Much of the block was removed in the form of relatively big

flakes, likely because the inclusions and coarseness rendered the material less than ideal. This stage is evident in refit group 10 and 27.

4. The removal of thin flakes. At this point, the knapper has removed the coarse-grained part of the block, leaving a core consisting of a material matrix with fewer inclusions that may disrupt flake removal. While these flakes have not been recovered, the critical end to this stage of production has; thin flake removals on the core in refit group 3 that resulted in several knapping errors, some of them directly successive. After abandoning this phase, the knapper seems to have made one last effort to exploit the core in Refit Group 3.
5. An expedient final repetition of the first stage brings the process full circle; the primary strike platform is destroyed by reducing the remaining weathered block surface. The natural abraded surface is exploited by strikes perpendicular to it, resulting in short flakes with a plain surface dorsal side. The margins of these pieces must have made fine, sharp edges. Some of the artefacts from this last stage have been recovered and refitted; others have not been recovered (see figure 23 above).
6. Once all the useful strike platforms had been rendered useless, the core was discarded.

Throughout the knapping phases, the knapper seems to have met problems of raw material inclusions. In RG10, large flakes have been removed with hard-hitting direct blows. This is a response to the numerous inclusions in the raw material and coarse-grained matrix, causing the knapper to remove large pieces of unwanted raw material in order to reach more apt material. It would seem that the effort succeeded, since there is a gap between the refit groups, where the blanks have presumably been carried elsewhere for either use or retouch. Only the latter part of this stage has been recovered, in refit group 3, where very thin flakes have been taken off the core. Only flawed specimens of these flakes have remained, but it would be hard to mistake the marked difference between debitage from these two stages as anything but intentional. In between the flakes are traces of platform preparation, resulting in a myriad of tiny dark grey Ringsaker quartzite fragments that were not refitted. Producing these thin flakes must have required a familiarity with the material, and skilled precision strikes in order to hit in just the right spot to remove thin flakes, and even then with enough force to break off the flakes; the material is very hard, requiring significant force compared to flint. A careful application of strength and precision seems to have failed at the latter stage, since the variety of knapping errors indicate not enough force was applied, or applied in a wrong angle.

Scraper recycling

In addition to core refitting, some results were achieved refitting broken scrapers. The artefacts, which make up Refit Group 6 and 19, imply not only scraper production on site; these are evidence of scraper recycling as well. Several broken scrapers with similar breakage, two of them recycled into smaller scrapers, extending the artefact lifespan significantly. In the activities that went on at Bjørkeli, the scrapers must have been essential tools.

Limited primary reduction

RG 17 and RG4 at Northern Bjørkeli (see figure16) indicates primary reduction at activity zone A4. The refit groups are either very limited in the number of pieces, as in the case of RG17, or limited to pieces with abraded surface, as in the case of RG4. Refit group 17 was discarded with much exploitation at all, in stark contrast to the main refit groups 3, 10, 11, and 27.

Figure 22: From left to right, Refit Groups 4 and 17, A4, Bjørkeli. RG4 is seen from dorsal surface and proximal end (upper photo). RG17 is seen with platform facing viewer. Photos by author.

I interpret these groups as raw material tests by the knappers, brief reduction sequences to test the blanks knapping qualities. In the case of RG4, the raw material was found favourable, and taken elsewhere for further work. In the case of RG17, the raw material was not considered favourable and discarded on site without much reduction at all. The raw material of RG17 does not appear in any great quantity overall, and the excavation reports sets the total number of its raw material subcategory to 22 (see table 4).

Thermal alteration at Bjørkeli

During the excavation at Bjørkeli it was not apparent where the hearths had been located, due to erosion and site disturbance (see figure 17). Locating heat altered quartzite may indicate contemporary hearths on the locality. The heterogeneous nature of quartzite makes it difficult to apply a universal model of heat alteration traits; since quartzite can be broadly classified as four different raw material classes that each present different grain structures (Ebright 1987: 30-32), chemical reactions associated with frost and heat alteration will manifest in different ways.

Heat alteration on quartzite is difficult to interpret without directly comparing burnt and unburnt material in the assemblage; no pot lids can be observed on the material despite considerable evidence for heat alteration, such as discolouration and bleaching (Inizan et. al. 1999: 92; Ebright 1987). Pot lids tend to occur in fine-grained materials (Purdy 1975), so it would not be unexpected to not see it occur in the more coarse-grained quartzite material. Without pot lids, identifying burnt material necessitates comparative analysis within refit groups to find signs of thermal damage and/or alteration.

Through experimentation, discolouration has been commonly observed in quartzite material heated in a wide range from 200-800 degrees Celsius in a wide range of hues, most commonly yellow, pink, and red (Ebright 1987: 32-34). Discolouration in its own right is, however, not a reliable indicator of heat alteration in its own right, since such changes could arguably be attributed to other chemical processes such as frost alteration and staining.

Joachim Åkerström (2012) conducted a series of experiments on lithic raw materials from Rena in order identify signs of thermal discolouration on said materials (Åkerstrøm 2012). Åkerström's conclusions on thermal alteration on jasper were questioned by Arangua (2014), who described discolouration attributed to heat alteration on several jasper artefacts despite Åkerström's assertion that jasper artefacts do not exhibit lasting thermal discolouration from fire.

It is unclear how much of the discolouration of this material can be attributed to heat, but the similarity between the results of Åkerström's experiments on dark grey Ringsaker quartzite and the colour variation in the dark grey Ringsaker quartzite at Bjørkeli is worth noting. While the apparent thermal alteration on jasper does raise questions in regard to the methodology used in the experiments, colour variation within quartzite refit groups 10 and 11 at Bjørkeli suggests thermal alteration consistent with the descriptions of the results from Åkerström's experiments on Ringsaker quartzite, especially in relation to bleached objects. Although Åkerström's results differ from those of Arangua, I will use his findings on experimental heat alteration of dark grey Ringsaker as a source for comparison when discussing heat alteration since the raw material used in his dissertation is identical to the one that is central in the present study, namely dark grey Ringsaker quartzite (see figure 19). This could prove useful in locating hearths at Bjørkeli, of which traces are otherwise heavily eroded.

In the absence of pot lids, identification of burnt material has to be made on more subtle features, such as discolouration and bleaching. Three different discolouration features are observed on dark grey Ringsaker quartzite material from Bjørkeli: Firstly, colour blotches of rust red are commonly observed on parts of some artefacts. These resemble Åkerström's descriptions of rust discolouration (Åkerström 2012: 54); Secondly, red discolouration that cover the entire object, with certain or probable bleaching of the material. Here I say probable, since the raw material seems to occur in naturally in several shades of grey within a single block of raw material. Only in a few instances can bleached material be observed with certainty.

Thirdly, an anomalous discolouration feature with Refit Group 11, specifically on piece number 1828, is similar to the second category, but mostly yellow instead of red. Yellow discolouration on Ringsaker quartzite is not mentioned by Åkerström (2012). Seeing that only one part of the refit group has been affected, this raises two possibilities: either yellow discolouration occurs under thermal conditions not covered by Åkerström's experiments, or the discolouration is caused by something other than thermal alteration. It could potentially be an ochre stain. The discolouration explanation is complicated by the fact no differentiated bleaching of refit group 11 can be observed; this would suggest a similar degree of heat alteration on all pieces within refit group 11, since Ringsaker quartzite bleaching occurs over 600 degrees Celsius (Åkerström 2012: 48-51). Comparison to other artefacts within the yellow piece's context would have been interesting, but 1828 was the sole lithic object within the present study located in its excavation square.

My interpretation of the differential discolouration is fire-cracking: Ebright (1987) notes that quartzite starts cracking at 800 degrees Celsius. Such a temperature is high, but plausibly attainable by campfire. Refit group 11 appears to have strange fragmentation in large flakes which is not easily explained by regular shattering, as most of the large broken quartzite flakes in the assemblage shatter at the proximal, and not the distal end; thinner, smaller flakes are more likely to shatter than thicker, heftier flakes. And while diagnostic markers are commonly more difficult to identify in coarse-grained quartzite flakes, some of the pieces in refit group 11 could easily be fragmented by fire-cracking rather than knapped. Most likely, piece 1828 and 1656 are fire-cracked fragments of a single flake, which would explain the differential discolouration; while in the fire, the heat-induced explosion moved piece 1656 away from piece 1828, and away from the more intense heat. The only positively identified heat-bleached artefact is piece number 1695 in refit group 10, located in a light concentration of fire-cracked rock at Bjørkeli (see fig. 17 distribution map).

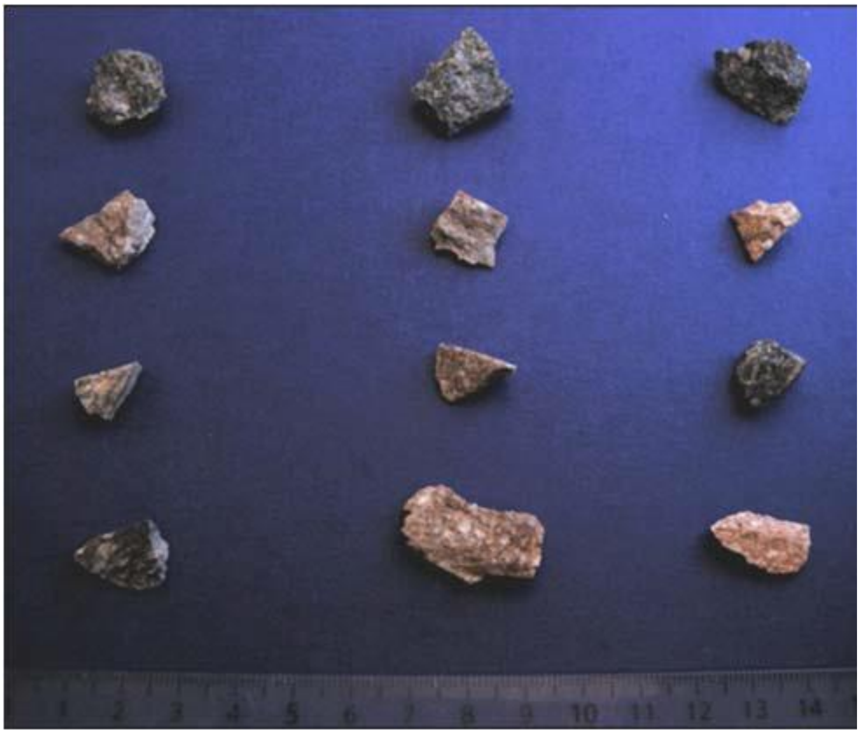


Figure 23: Experimentally heat altered coarse-grained dark grey Ringsaker quartzite, raw material code 13/H. Discolouration seen in experiments with heating over 600 degrees Celsius is identical to some of the material included in the present study. Photo by Åkerström (2012: 103).

Asserting thermal alteration by using macroscopic analysis on Ringsaker quartzite is problematic: using the experimental results of Åkerström leaves room for doubt in most cases. It is thus possible to identify signs of fire in some of the material, but not in others. Bleaching is here considered a sure sign of intense heat alteration on the quartzite material, and while thermal alteration cannot be ruled out as a cause for discolouration on much of the material, it is impossible to prove heat alteration on the basis of discolouration alone. More research on how post-depositional processes affects lithics in general and quartzite specifically could prove useful in determining heat alteration in future projects, especially frost alteration, which remains poorly understood.

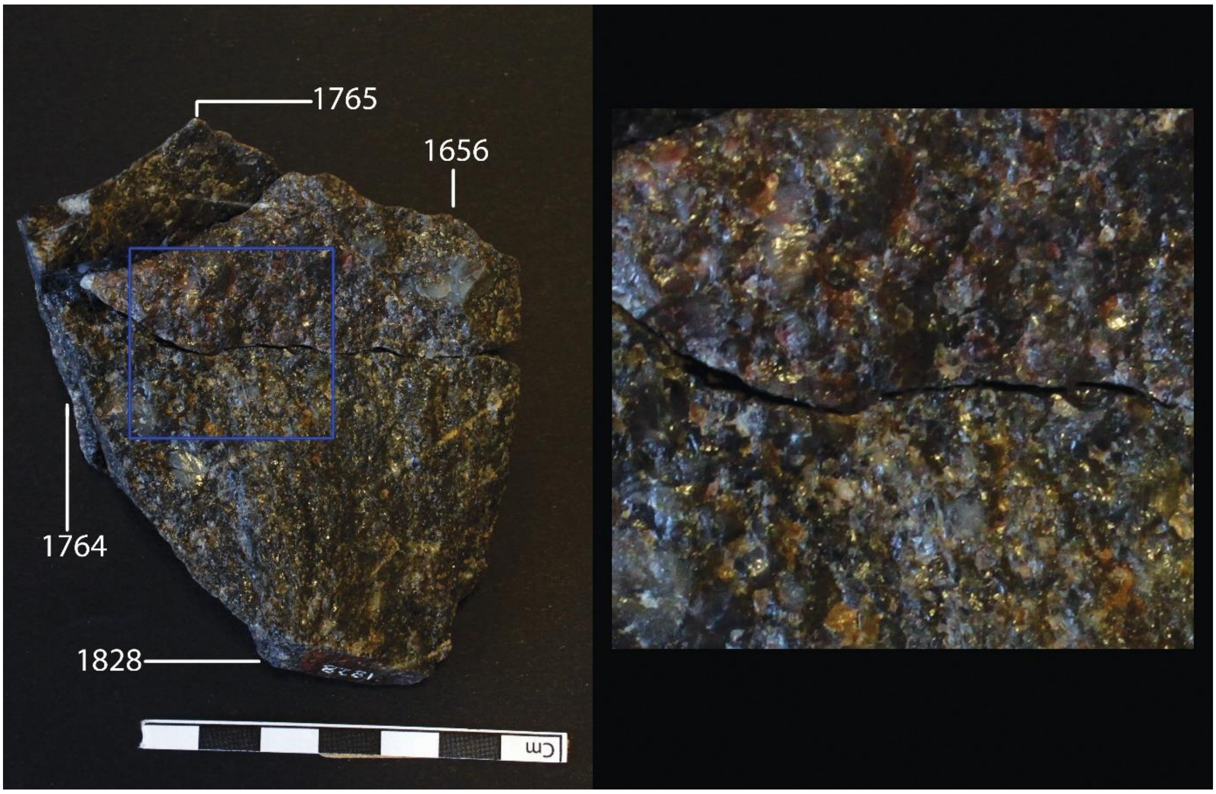


Figure 24: Refit group 11, A2, Bjørkeli. Ventral surface. There are marked differences in discolouration of this Ringsaker quartzite within the refit group: While the rest of the group has a red tint, 1828 is tinted yellow. Photos by author.

In refit group 10, evidence of heat alteration on the Ringsaker quartzite is only conclusively present on piece number 1695, located in a slight concentration of fire-cracked stone at Bjørkeli (see figure 17). The burnt piece is located at least 2,7 meters from the rest of the refit group, well beyond what can be attributed to cryoturbation. Why was this piece found far from the rest of the material in the refit group? The separation of the burnt piece from the rest of the group could indicate the location of a campfire, but could just be a coincidence. The rest of the refit group does not exhibit definite signs of heat alteration, despite the location of these lithic objects and others overlapping with an area of higher concentration of fire-cracked stone. Alternately, the thermal alteration could be resultant of a later occupation.

Summary of Bjørkeli

The quartzite assemblage of Bjørkeli is characterised by primary reduction of coarse-grained Ringsaker quartzite and tool production of more fine-grained quartzite. The site can be divided into activity zones, with a clear relation between A2 at Bjørkeli and A2 at Stene Terrace. This relation, however, does not seem to involve the primary reduction. I have reconstructed significant parts of the primary reduction sequences in the form of what I interpret as clearly associated refit groups, and inferred from analysis the whole knapping sequence of this particular block. The debitage is distributed horizontally in a pattern that suggests it was redeposited after the knapping sequences had been carried out elsewhere.

In addition to the refitted primary reduction debitage of dark grey Ringsaker quartzite, there is evidence of scraper use and recycling on the site, closely associated with the scatters of jasper in the same activity zone.

Stene Terrace

The quartzite raw material at Stene Terrace is dominated by a medium-to-fine-grained material referred to in the reports as ‘Flame quartzite’ due to the colourful appearance of the debitage. Flame quartzite makes up 47% of the total debitage at Stene, but resulted in just two refit groups despite extensive study.

Table 7: Selected material at Stene Terrace by raw material category

Raw material	Lithic pieces	%
10/F	251	47,4 %
13/H	84	15,9 %
4/D	40	7,6 %
2/D	26	4,9 %
14/H	24	4,5 %
11/F	23	4,3 %
5/D	22	4,2 %
17/H	21	4,0 %
20/J	16	3,0 %
24/L	8	1,5 %
16/H	7	1,3 %
6/D	3	0,6 %
12/G	1	0,2 %
23/K	1	0,2 %
7/D	1	0,2 %
unknown	1	0,2 %
Total	529	100,0 %

Refit groups

The refit groups at Stene Terrace are limited to one production

Table 8: Summary of Stene Terrace refit groups Stene Terrace.

Refit Group	Lithic pieces	Raw Material
8	2	13/H
9	3	13/H
12	1	23/K
16	2	10/F
20	2	13/H
23	2	13/H
24	2	10/F
26	2	10/F

Refit group 8, 9, 20 and 23

Refit group 9 consists of three flakes struck off the negative imprint of a possibly keel-shaped core, with negative scars from several hinged flakes. Unlike the similar dark grey Ringsaker quartzite at Bjørkeli, the raw material has remarkably few inclusions and has a much finer grain. The raw material, though somewhat similar, has likely no relation to the block of raw material from which the main refit groups at Bjørkeli were knapped. Refit group 8, 20 and 23 are broken flakes of the same material.

Minor refit groups

The remaining refit groups consist largely of mended flakes and a broken end scraper in the case of Refit Group 26, as well as a contentious tool in the case of RG24. The pieces of RG24 are noted in the reports to be a scraper or possibly a burin with a missing distal end. The retouch, however, is irregular and could just be damage.

Figure 25: Refit group 26 and 24, Stene Terrace. Broken end scraper and possible broken scraper/burin tools. Photos by author.

Debitage interpretation

Compared to Bjørkeli, the refitting at Stene Terrace resulted in few refit groups. The dominant raw material referred to in the report as 'Flame Quartzite' was difficult to interpret conclusively. Even though there were substantial amounts of the raw material present on the site, only two refit groups was established. Although the refitting was not exhaustive, considerable time was spent on this particular raw material. A core and a core fragment was identified, but no knapping sequences could be identified by refitting. As the name suggests, all of this raw material has clear indications of heat alteration: discolouration ranging from yellow to red, with some greenish features on occasion.

All of the material is probably derived from the same raw material source. This could possibly be a result of heat treatment to make the raw material more workable (Ebright 1987: 32-34; Moody 1976). An outer cortex-like abraded surface was observed on many pieces, and the pieces mostly ranged in size from 10 cm and smaller, with a few specimens up to 15 cm in length. The original blank seems rounded judging by the surface, probably a river nodule. It has been exhaustively worked, exploiting the fine-grained material to the last bit. The flame quartzite keel core was given up after a series of hinged flakes. It seems likely that a considerable amount of the removals between the first stage and the last stage of knapping have not been recovered at Stene Terrace.

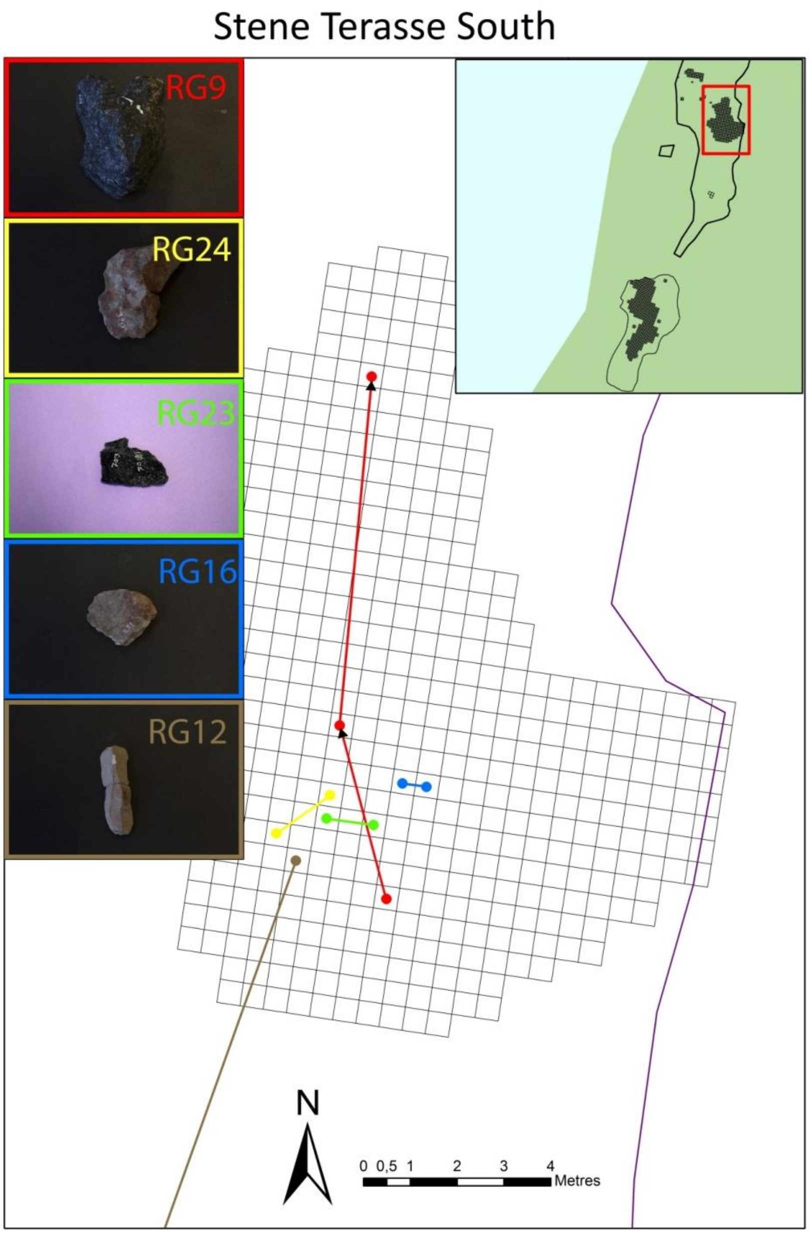


Figure 26: Stene Terrace, Åmot, Hedmark. Horizontal distribution of the refit groups at Stene Terrace South. Every grid square is 50x50cm. Note that single-square context refits are not shown. Illustration by author.

My interpretation of this absence of material is that most of the primary knapping of the flame quartzite has happened somewhere else, and the debitage present at A2 represents retouch of blanks produced elsewhere, as well as a final reduction stage of the core. This would explain the large number of pieces and the two small cores present in the assemblage. The cores been completely exhausted, one of the cores have negative scars from hinged flakes on every side.

As with the rest of the material from Stene Terrace, the flame quartzite indicates maximisation of the finer raw materials. Several broken scrapers have been refitted at the site, indicating heavy use.

Spatial distribution

Although the refit groups from Stene Terrace are few, Refit group 9 is of interest since it connects zone A2 with A3, a zone with no preceding refits. The refit group seems to overlap with the jasper material, and is likely part of the same knapping event. Since the two zones are contemporaneous, this would imply that the Southern half of Stene terrace represents a contemporaneous Middle Mesolithic occupation, while the two northernmost activity zones represent a Late Mesolithic occupation.

In activity zone A2, a few refit groups were found, with one group, RG9, connecting A2 and A3. The piece that is located in A3, 640, is a distal fragment of a bladelike flake, the last in the refit group to be removed. Given the amount of retouch debris and high degree of retouched artefacts at A3, it seems likely that it was transported along with other blanks for retouching, and forms the distal end of another artefact that was not recovered from Stene Terrace. As to why it was brought there, it is unclear, although considering that 12 % of the total lithic material at A3 consists of knives and scrapers (Damlien 2010c: 302), it is not unlikely that the piece is waste material from scraper production.

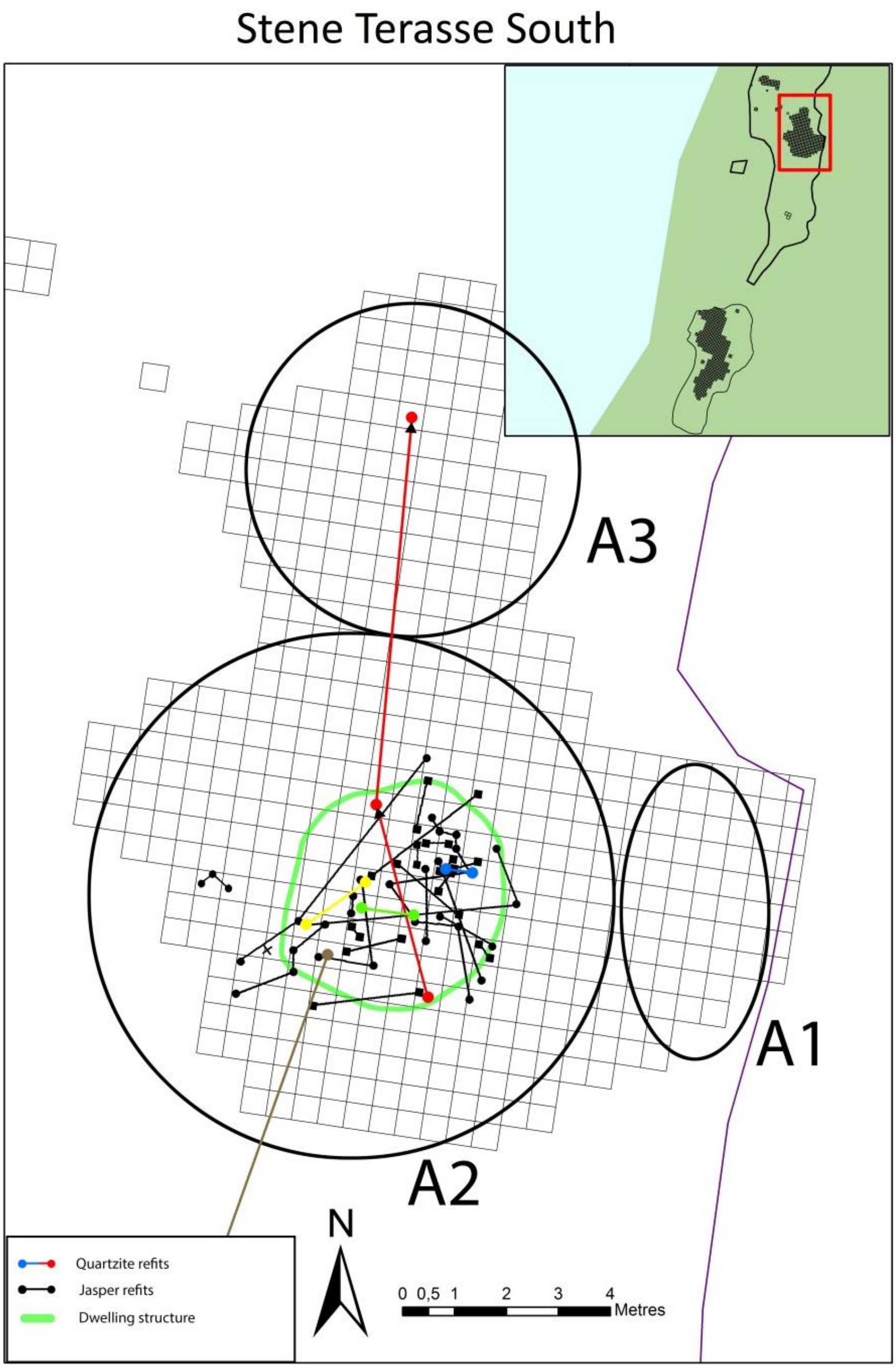


Figure 27: Stene Terrace, Åmot, Hedmark. Spatial refit distribution at southern Stene Terrace, seen together with outline of dwelling structure and jasper refits. Illustration by author, with additional information from Damlien (2010c: 278) and Arangua (2014: 28).

Relating to the dwelling structure at Stene Terrace, the quartzite refits follow largely the same pattern as the jasper material, all being located roughly within the semi-circular pattern interpreted as a dwelling structure. The results at Stene Terrace can be seen to largely confirm the previous findings at Stene Terrace, and confirms contemporality between A2 and A3. Seen together with the rest of the chronology on site, the evidence suggests that we are looking at two occupations at Stene Terrace, one Late Mesolithic Phase 3 in the two northernmost activity zones, and one Middle Mesolithic in the ones to its south connected with A2 at Bjørkeli.

Summary

A grand total of 2598 lithic artefacts were examined during the investigation (see table 3). Of these, 1212 pieces were selected for analysis A total of 27 refit groups varying in size from 2 to 13 pieces were established. The material from Bjørkeli contains several tools and otherwise retouched artefacts, in addition to debitage from primary reduction stages.

The material as a whole is best described by categorisation: some of the material, notably dark grey Ringsaker quartzite, had mostly been knapped on site and resulted in a relatively high rate of refits. Other, more fine-grained quartzite debitage mostly consisted of blades, and scrapers and retouch debris.

The assemblages from Bjørkeli and Stene Terrace are clearly connected by one part of the assemblage, the finer quartzite and the jasper, while the refit groups I have presented here as the major primary reduction refit groups appear to be separate from the rest. There are no connections between these refit groups at Bjørkeli and Stene Terrace, while there are two connecting refit groups amongst the fine-grained retouch knapping assemblage, including one quartzite blade and a jasper refit group (Arangua 2014). At northern Bjørkeli, a few refit groups indicate scraper use, scraper recycling and limited primary reduction sequences. At southern Bjørkeli, extensive primary reduction sequences have been presented as well as scraper knapping, utilisation, and recycling.

I have presented my interpretation of the production sequences that led to the deposition of the refit groups 3, 10, 11 and 27, which I consider to be from a single block of material and representing one schema opératoire.

Stene Terrace resulted in fewer, less extensive refit groups. There is evidence of tool production associated with jasper refit groups of Arangua (2014), connected to activities at A2 at Bjørkeli. One refit group connects A2 at Stene Terrace with A3.

6. Discussion and conclusion

Fine-grained quartzite was, along with jasper, used to knap scrapers. Additionally, primary reduction of coarse-grained quartzite took place at both Bjørkeli and Stene Terrace.

There is no conclusive evidence on the intentions behind the dark grey Ringsaker quartzite *schema opératoires* in the form of completed tools. Although there is some evidence suggesting the knapper attempted to make a scraper, the evidence is not conclusive; the retouch on the piece is rough, and could be the result something else entirely, such as edge damage. One would have to look elsewhere for indications of intent.

Quartzite as knapping material

Some general observations were made throughout the macroscopic examination phase. While all of the raw materials had conchoidal fracture patterns, classic knapping features that are easily observed on flint are less prominent and harder to read in much of the quartzite material. Direction of striking could be difficult to establish with certainty, and the apparent difference between siret-fractured flakes and step-fractured flakes were negligible at best without clear percussion marks, which were often absent due to fracturing near the point of impact. This holds especially true for Ringsaker quartzite, and complicates lithic analysis.

The diversity seen in the quartzite raw materials is considerably greater than the jasper material from the same site. While Arangua (2014: 51) concluded that different jasper raw material categories were sometimes a result of discolouration from leaching and thermal alteration, no such phenomenon could be observed in the quartzite materials. In spite of a blind approach to the different OVAS raw material categories from the onset of the investigation, every refit group in the study conformed to the raw material colour code categories, although some variation in colour tones was observed in the material. However, this may be attributable to the level of experience of the refitter. Of 78 refitted artefacts, 11 were siret fractured, confirming Eigeland's results from experimental knapping with Ringsaker quartzite (Eigeland 2007b: 339).

The analysis also confirms Ringsaker quartzite as a material ill-suited for blade production, microliths or retouched tools. This limits the utility of the material to unmodified flakes and rough macrotools; and as seen with the scraper example in refit group 11 (see figure 10), such production can easily fail.

Thermal alteration on quartzite

Positive detection of thermal alteration in quartzite raw materials remains problematic; identification of burning is not as clear as in jasper and flint materials, at least in the case of coarse-grained materials since such materials would not produce pot lids; although bleaching may occur as a result of firing, it is not conclusively evident from Åkerström's work that bleaching will necessarily manifest as a result of it. Even so, detecting fire-bleached material in quartzite is not a straight-forward task, since colour variation within similar materials of unfired material may be confused with bleaching. Similarly, assigning thermal alteration solely due to discolouration is also ill-advised, since it could also be resultant of other chemical processes such as staining or frost alteration. In short, the reading of thermal alteration in Ringsaker quartzite in particular and by extension other quartzite in general remains a difficult task that can only be positively attributed through refitting, or at least comparison of material that can be attributed to the same raw material blocks through some other means.

Reconstructing intention: Comparison to DR-85, DR-89, DR-291, Dokkfløy

In order to interpret the results of the analysis, I will draw comparisons similar refit groups from another excavation: The Ringsaker Quartzite refits of Dokkfløy, from the Dokka Project (Boaz 1994; Boaz 1998). The refit groups are from the sites DR-85, DR-89 and DR-291.

Figure 28: Refitted core from DR-85 and DR-89, Dokkfløy. Ringsaker quartzite refit group from Dokkfløy. Photo by Coulson (private correspondence).

DR-85, DR-89 and DR-291 are river sites from the interior of South-East Norway, 81 kilometres west of Rena. The sites of the assemblages has numerous things in common with those at the Rena River: the quartzite raw material is virtually identical, although slightly more fine-grained overall to that of the main refit groups in the present study (see figure 28, 29 and 30); the sites are dated to the Mesolithic, albeit Nøstvet Phase rather than Early Mesolithic. Ringsaker quartzite is found locally in the bedrock at Dokkfløy, while at Bjørkeli it was found only as moraine blocks.

Table 9: DR-89, Dokkfløy. Overview of artefact types by raw material. The local quartzite is Ringsaker quartzite.

	Chip	Flake	Knapping. Frag	Debris	Micro-blade	Blade	Total
Local Quartzite	346	781	1568	6058	0	0	8753
Flint	441	383	65	0	30	4	923
Rock Crystal	198	173	170	0	17	0	558
Quartzite	202	151	39	0	41	1	434
Quartz	156	146	91	0	13	0	406
Tectonic Brechia	133	90	5	0	21	0	249
Chert	84	73	9	0	13	0	179
Mudstone	32	81	5	0	1	0	119
Slate	2	8	7	0	0	0	17
Other	4	8	24	0	0	0	36
Total	1598	1894	1983	6058	136	5	11674

Table 10: DR-291, Dokkfløy. Overview of artefact types by raw material. The local quartzite is Ringsaker quartzite.

	Chip	Flake	Knapping Frag.	Debris	Micro-blade	Blade	Total
Quartzite	571	586	66	0	183	64	1470
Mudstone	390	434	13	0	220	35	1092
Flint	364	473	50	0	144	52	1083
Chert	162	273	2	0	108	29	574
Local Quartzite	75	258	23	61	0	0	417
Meta Arkose	58	272	37	0	0	0	367
Tectonic Brechia	99	192	9	0	39	11	350
Quartzose Sandstone	33	211	9	0	4	8	265
Quartz	27	27	22	0	0	0	76
Rock Crystal	27	27	9	0	0	0	63
Milky Quartzite	6	13	1	0	0	2	22
Sandstone	0	11	2	0	0	0	13
Volcanic	0	3	0	0	0	9	12
Other	61	83	25	0	77	15	261
Total	1873	2863	268	61	775	225	6065

Table 11: DR-85, Dokkfløy. Overview of artefact types by raw material. The local quartzite is Ringsaker quartzite.

	Flint	Local Quartzite	Slate	Rock Crystal	Chert	Quartzite	Other	Total
Microburin	2	0	0	0	0	0	0	2
Microlith	5	0	0	0	0	0	0	5
Backed bladelet	6	0	0	3	0	0	0	9
Single Edged Point	1	0	0	0	0	0	0	1
Tanged Point	1	0	0	0	0	0	0	1
Transverse Point	2	0	0	0	0	0	0	2
Convex Scraper	6	0	0	0	2	0	3	11
Concave Scraper	3	0	0	1	0	1	0	5
Convergent Scraper	1	0	0	0	1	0	3	5
Straight Scraper	5	0	0	0	0	1	0	6
Scraper Frag.	1	0	0	0	0	0	0	1
Scraper Resharpening Flake	3	0	0	0	0	0	0	3
Retouched Debitage	35	0	0	1	4	1	3	44
Conical Core	0	0	0	0	0	0	1	1
Single Platform Core	1	0	0	0	0	0	1	2
Amorphous Core	3	13	0	0	1	0	1	18
Bipolar Core	4	0	0	6	2	0	0	12
Core	0	4	0	0	0	2	0	6
Core Frag.	4	0	0	1	2	0	0	7
Crested Blade	3	0	0	0	0	0	0	3
Piece with Hole	0	0	2	0	0	0	0	2
Point	0	0	1	0	0	0	0	1
Point Frag.	0	0	6	0	0	0	0	6
Ground Artifact	0	0	7	0	0	0	0	7
Sandstone Whetstone	0	0	0	0	0	0	1	1
Whetstone Frag.	0	0	0	0	0	1	0	1
Hammerstone	0	0	0	0	0	1	0	1
Polished Axe Frag.	1	0	0	0	0	0	0	1
Other	3	18	2	1	1	4	1	30
Total	90	35	18	13	13	11	14	194

By examining the refit groups and the quantification of assemblages from the sites, a similar overall production scheme becomes apparent: the refit groups consist of large removals of impure raw material as well as a series of thin flake removals. No blades, microblades or retouched flakes have been identified in this raw material at any of these sites (e.g. table 7, table 8, and table 9). The schema opératoire is virtually identical to the one associated with my own refit groups from the primary reduction debitage at zone A2, Bjørkeli. Use-wear analysis on quartzite flakes from Bjørkeli suggests some of the non-retouched flakes from the sites have been used, although certain difficulties with the material makes it difficult to interpret quartzite in use-wear analysis (Knutsson and Knutsson 2010: 581-583).

Figure 29: Refitted core 4168, DR-291, Dokka. Ringsaker quartzite refit group from Dokkfløy. Photo by Coulson (private correspondence).

All this implies that complicated knapping sequences were undertaken at Dokkfløy and Bjørkeli for no apparent reason, that they were all disrupted before completion, or that the main product of these knapping operations were in fact unmodified flakes. I find the latter option to be the only believable alternative. The naturally sharp edges of Ringsaker quartzite are very robust, more so than flint (Eigeland 2007b: 345), so this would by all indications be a most effective use of the raw material.

The similarities between the material at the Dokkfløy sites and Bjørkeli can be explained in a number of ways. The respective knappers could be working with the same technological traditions, exploiting the material with the same overall goals for this reason; or, this is simply be the best way to exploit this particular raw material, regardless of tradition.

Figure 30: Refit group from D-89, Dokkfløy. Ringsaker quartzite refit group from Dokkfløy. Photo by Coulson (private correspondence).

Interpretation of production sequence

Here follows an interpretation of the primary reduction debitage from Bjørkeli. As noted earlier, we are left with an incomplete puzzle in the case of the associated refit groups from Bjørkeli. Several stages of the production seem to be missing. This can largely be attributed to incomplete excavation and taphonomical forces, in addition to prehistoric use. Still, I would argue, we are left with enough clues to interpret the sequences leading up to the deposition of the material.

The process observed through the refit groups reveals a knapper who, frustrated with impurities and inclusions in the raw materials, strikes powerful blows to remove unwanted chunks of quartzite off the core to get access to a part of the block with fewer inclusions. The knapping technique that were applied to this particular material, as demonstrated in previous experiments (Eigeland 2007), predictably resulted in substantial shattering and siret fractures. On the other extreme, the under-application of force led to a number of hinged flakes as well. The overall impression left from the refit groups is that of a knapper struggling to find the correct amount of force to apply to the material. However, a number of the flake removals were successful as well, and at one point the knapper skilfully removed a negative hinge flake in what must have been an awkward strike angle. Following one particularly large flake removal (see figure 10), the knapper used this flake as a platform to remove a large scraper blank. During the application of direct regular retouch to the proximal end, the proximal end broke off at the fourth or fifth retouch strike. When this stage ends, he switches back to his original scheme, chipping away thin flakes until the strikes start to hinge and step-fracture the removals. At this point, there is not much left of the core, and so the knapper expediently struck flakes from several platforms instead of just the primary platform until the core had been completely exhausted.

The spatial distribution of the primary reduction refit groups are clustered at zone A2 at Bjørkeli in manner that I interpret as a fan-shaped midden, the result of redeposition. It is possible that the jasper material is too, considering the symmetry of the refit group distribution patterns (see figure 17).

The knapping episode that produced the more fine-grained debitage associated with the jasper debitage is probably largely separate from the primary reduction episode of the dark grey Ringsaker quartzite. The eroded hearths at zone A2 at Bjørkeli seem to support the idea of multiple occupations. I have found no trace of this material at Stene Terrace, and so I find it unlikely that these knapping sequences originate from the same occupation. Considering the similarities to the Dokkfløy debitage the primary reduction refit groups could be from the Nøstvet Phase rather than the Middle Mesolithic, but this remains speculation.

Concluding thoughts

Throughout this study, I have investigated an often overlooked raw material in the Norwegian Stone Age discourse. By refitting quartzite debitage from Bjørkeli and Stene Terrace, I have brought to light aspects of quartzite that are not commonly investigated in Norwegian Stone Age research. Further research into non-flint lithic technology might present archaeologists with new ways of interpreting sites when conventional technological markers associated with flint are absent. With more research on the use of flint-alternatives in the Norwegian interior, we might find new chronological markers for the region.

As demonstrated by refitting debitage from Bjørkeli and Stene, retouched tools may not be the be-all and end-all of lithic production. If non-retouch knapping was a common occurrence on Stone Age sites, and the ease of producing such objects would imply that it very well could be, it is an overlooked one. Even though the end results of such knapping operations may not be artisanal knapping masterworks, they are part of the prehistoric material reality we seek to uncover. The excavations in the Norwegian interior have largely been rescue operations, and only in the recent decades have lithic technology studies been part of such investigations. It is not unlikely that the remains of such knapping operations could have been overlooked, in part because quartzite does not always leave diagnostic markers associated with knapping visible on the objects. By pressing a flint-oriented mould onto non-flint materials, archaeologists risk overlooking central technological features in assemblages. Future archaeological investigations in flint-sparse regions should be designed with this point in mind.

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8. Appendix: Refit groups

Group 1

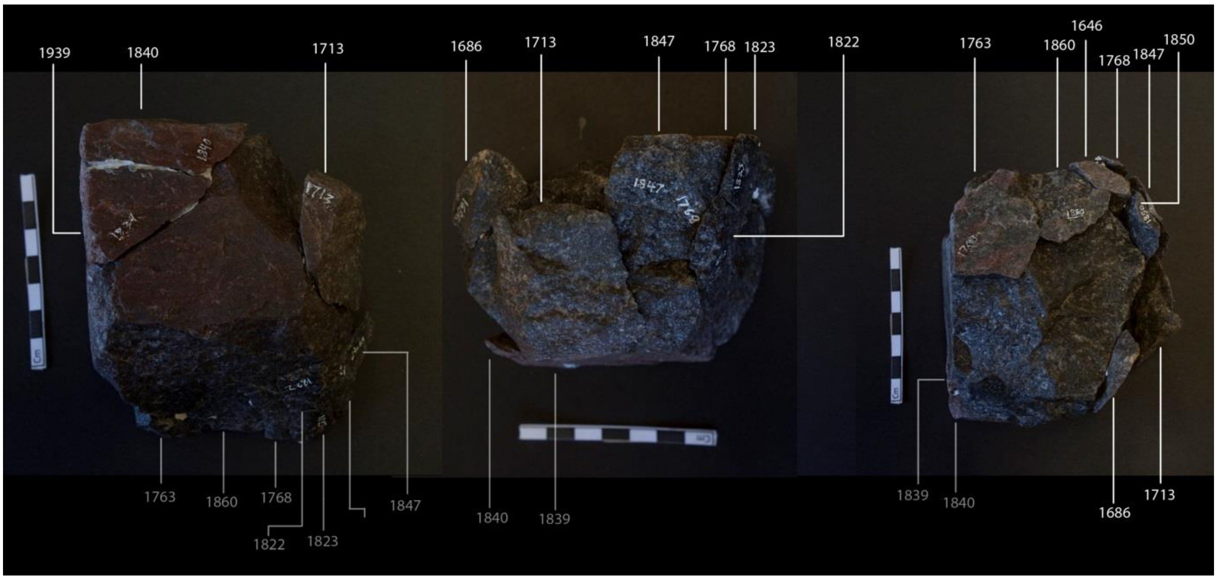
Not pictured. Two pieces were refitted that turned out to share context, probably post-knapping damage.

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
1	1264	no	no	no	no	no	KF2/D	104	47	SW	1	Bjørkeli

Group 2

Refit group	Refit -ID	step-struc k	Plunge d	Fractur e	Siret fract .	Retouc h	Raw mat. Code	X	Y	Quadr .	Vertica l unit	Localit y
2	1633	no	no	no	Yes	no	KM13/ H	102	50	NW	3	Bjørkeli
2	1632	no	no	no	Yes	no	KM13/ H	102	50	NW	3	Bjørkeli

Group 3



Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
3	1839	no	no	no	no	no	KM13/H	91	53	SE	1	Bjørkeli
3	1768	Yes	no	no	Yes	no	KM13/H	91	51	NE	1	Bjørkeli
3	1646	no	no	no	no	no	KM13/H	89	52	NW	2	Bjørkeli
3	1763	no	no	no	no	no	KM13/H	91	51	NE	1	Bjørkeli
3	1686	Yes	no	no	no	no	KM13/H	90	52	SE	2	Bjørkeli
3	1822	no	no	no	no	no	KM13/H	91	52	NW	1	Bjørkeli
3	1823	no	no	no	no	no	KM13/H	91	52	NW	1	Bjørkeli
3	1860	no	no	no	no	no	KM13/H	92	52	SW	1	Bjørkeli
3	2587	no	no	no	no	no	KG13/H	90	50	SE	1	Bjørkeli
3	1850	Yes	no	no	no	no	KM13/H	92	51	NE	1	Bjørkeli
3	1847	Yes	no	no	Yes	no	KM13/H	92	51	SE	1	Bjørkeli
3	1840	no	no	no	no	no	KM13/H	91	53	SE	1	Bjørkeli
3	1713	no	no	no	no	no	KM13/H	91	50	NE	1	Bjørkeli

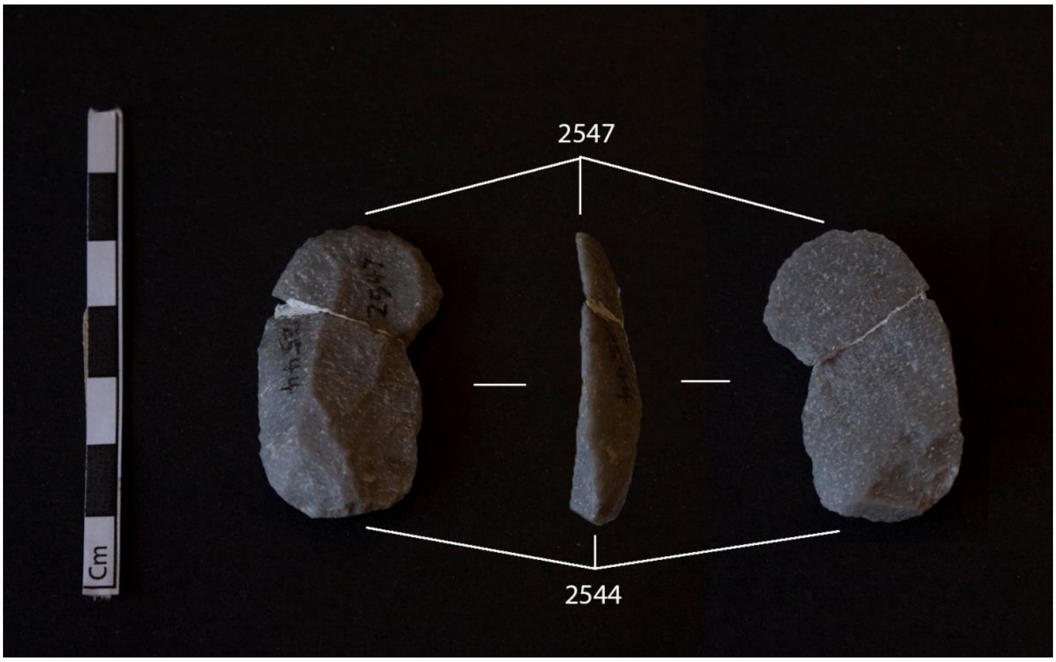
Group 4

Refit group	Refit -ID	step-struc k	Plunge d	Fractur e	Siret fract .	Retouc h	Raw mat. Code	X	Y	Quadr .	Vertica l unit	Localit y
4	2156	no	no	no	no	no	KM14/ H	105	47	NW	2	Bjørkeli
4	2154	no	no	no	Yes	no	KM14/ H	105	47	SW	2	Bjørkeli
4	2155	no	no	no	Yes	no	KM14/ H	105	47	SW	2	Bjørkeli

Group 5

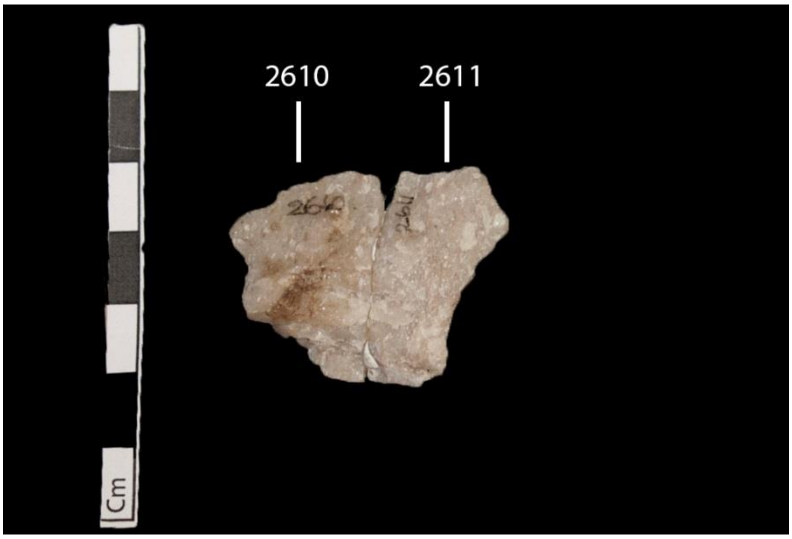
Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
5	2209	no	no	no	no	no	KK14/H	92	51	SE	1	Bjørkeli
5	2267	no	no	no	no	no	KK14/H	92	53	SE	3	Bjørkeli

Group 6



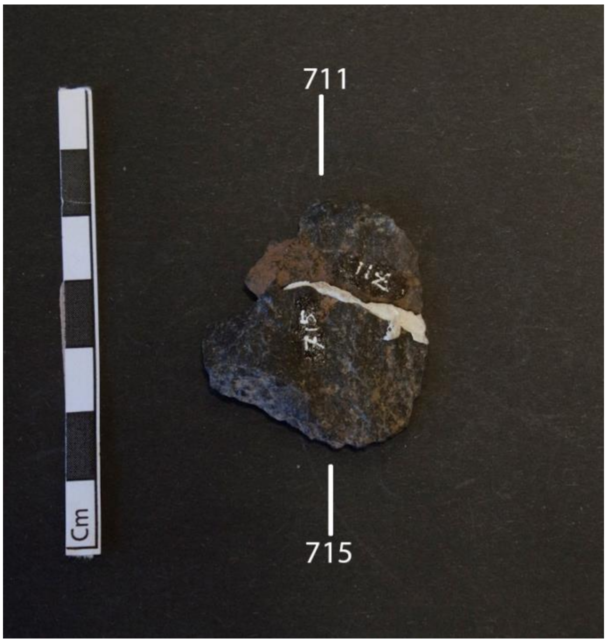
Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
6	2544	no	no	no	no	Yes	KF14/H	92	54	NW	1	Bjørkeli
6	2547	no	no	no	no	Yes	KF14/H	92	54	SE	1	Bjørkeli

Group 7



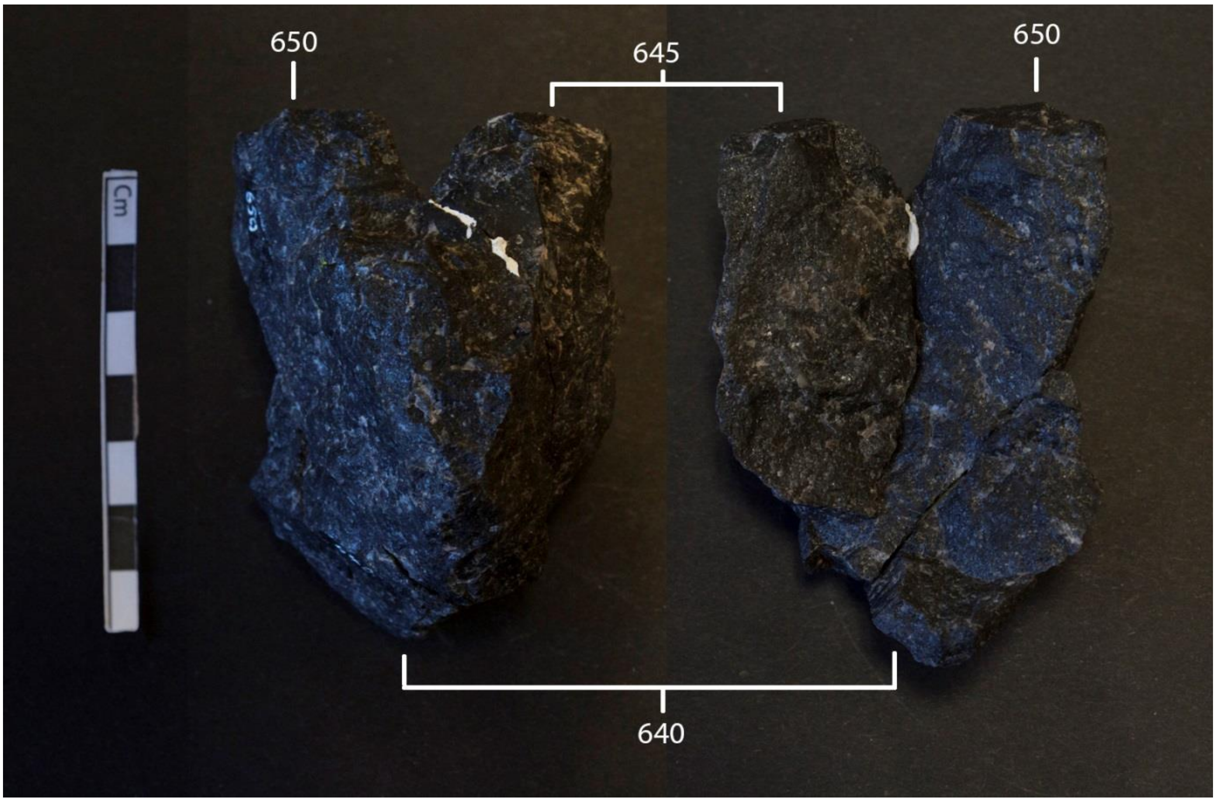
Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
7	2611	no	no	no	no	no	KVG3/C	88	49	SE	1	Bjørkeli
7	2610	no	no	no	no	no	KVG3/C	88	49	SE	1	Bjørkeli

Group 8



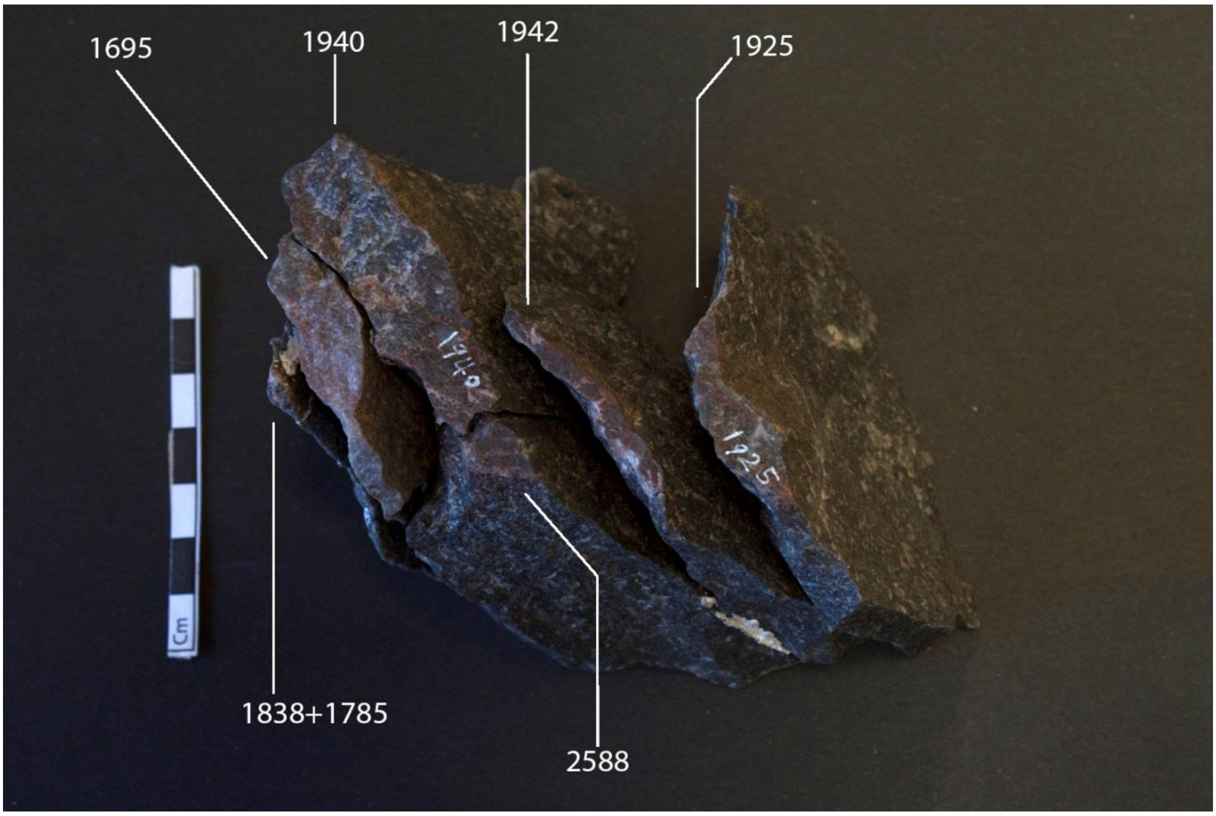
Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
8	715	no	no	Yes	no	no	KM13/H	99	54	SW	1	Stene T.
8	711	no	no	Yes	no	no	KM13/H	99	54	SW	2	Stene T.

Group 9



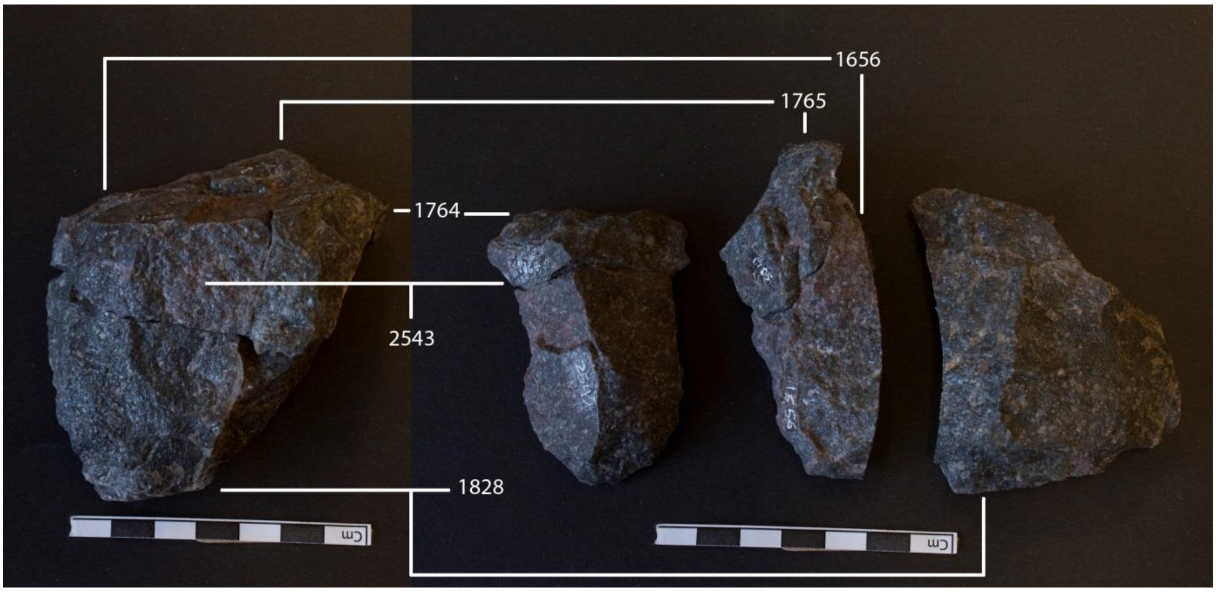
Refit group	Refit -ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
9	650	no	no	no	no	no	KM13/H	101	53	SE	1	Stene T.
9	645	no	no	no	no	no	KM13/H	97	55	NW	2	Stene T.
9	640	no	no	no	no	no	KM13/H	108	53	NW	1	Stene T.

Group 10



Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
10	1785	no	no	Yes	no	no	KM13/H	91	52	NW	2	Bjørkeli
10	1838	no	no	Yes	no	no	KM13/H	91	53	SE	1	Bjørkeli
10	1695	no	no	no	no	no	KM13/H	90	53	SE	1	Bjørkeli
10	1925	no	Yes	no	no	no	KM13/H	93	52	SW	1	Bjørkeli
10	2588	no	no	no	no	no	KM13/H	93	52	SW	1	Bjørkeli
10	1940	no	no	no	no	no	KM13/H	93	52	SE	1	Bjørkeli
10	1942	no	no	no	no	no	KM13/H	93	52	SE	1	Bjørkeli

Group 11



Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
11	1828	no	Yes	no	no	no	KM13/H	91	52	SE	1	Bjørkeli
11	1764	no	no	no	no	no	KM13/H	91	51	NE	1	Bjørkeli
11	2543	no	no	no	no	no	KM13/H	91	50	SE	1	Bjørkeli
11	1765	no	no	no	no	no	KM13/H	91	51	NE	1	Bjørkeli
11	1656	no	no	no	no	no	KM13/H	90	50	NE	1	Bjørkeli

Group 12

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
12	32	no	no	no	no	no	SKM23/K	92	53	SW	1	Bjørkeli
12	7	no	no	no	no	no	SKM23/K	98	53	SW	1	Stene T.

Group 13

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
13	1389	no	no	no	no	no	KF4/D	99	44	NE	1	Bjørkeli
13	1341	no	no	no	no	no	KF4/D	100	46	SE	1	Bjørkeli

Group 14

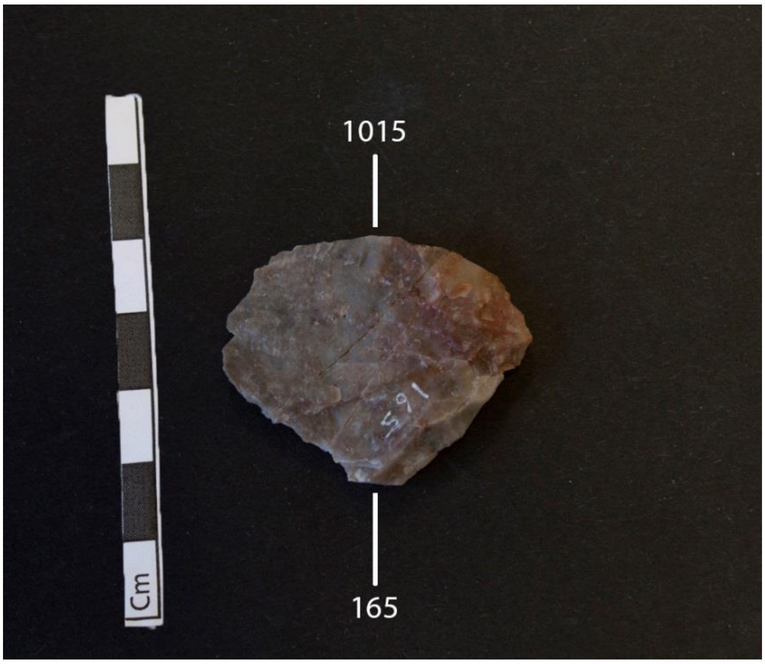
Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality

14	1405	no	no	no	no	no	KF4/D	99	50	NW	1	Bjørkeli
14	1404	no	no	no	no	no	KF4/D	99	50	NW	1	Bjørkeli

Group 15

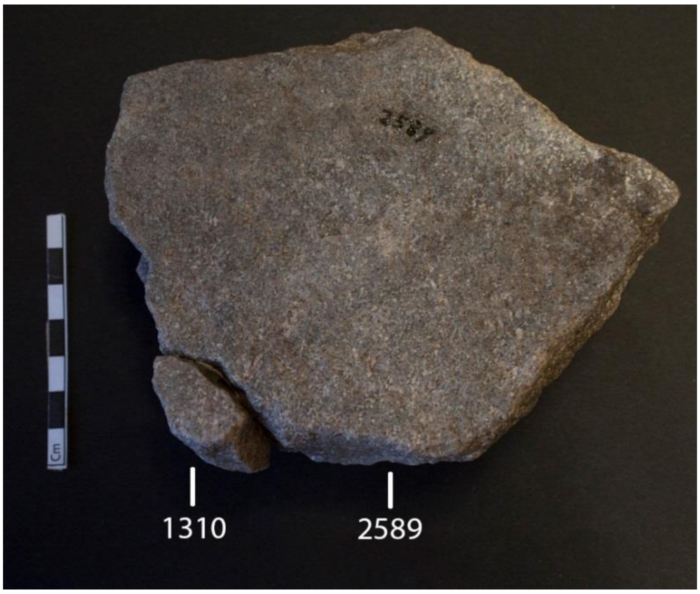
Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
15	1346	no	no	no	Yes	Yes	KF4/D	100	52	SW	1	Bjørkeli
15	1199	no	no	no	Yes	Yes	KF4/D	99	51	SW	1	Bjørkeli

Group 16



Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
16	1015	no	no	no	no	no	KF10/F	100	55	SE	1	Stene T.
16	165	no	no	no	no	no	KM10/F	100	55	SW	1	Stene T.

Group 17



Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
17	2589	no	no	no	no	no	KG16/H	99	44	NE	1	Bjørkeli
17	1310	no	no	no	no	no	KG16/H	99	45	SE	1	Bjørkeli

Group 18

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
18	2551	no	no	no	no	Yes	KF14/H	93	55	SW	1	Bjørkeli
18	2244	no	no	no	no	Yes	KF14/H	92	53	SW	1	Bjørkeli

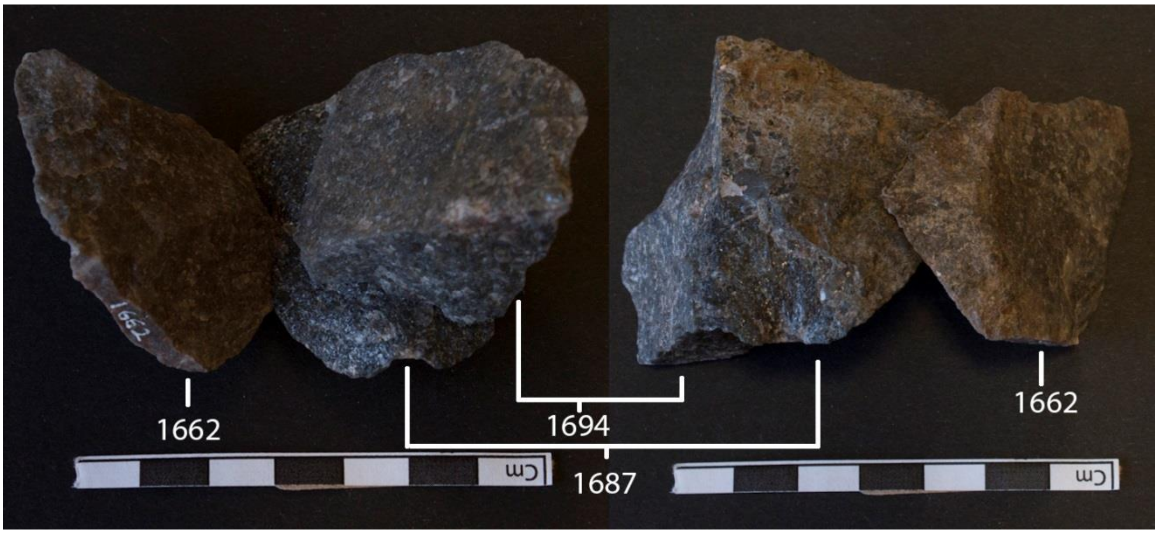
Group 19

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
19	2518	no	no	no	no	Yes	KF14/H	101	48	SE	4	Bjørkeli
19	2517	no	no	no	no	Yes	KF14/H	100	48	NE	2	Bjørkeli

Group 20

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
20	685	no	no	no	no	no	KM13/H	98	54	NW	1	Stene T.
20	684	no	no	no	no	no	KM13/H	98	54	NW	1	Stene T.

Group 21

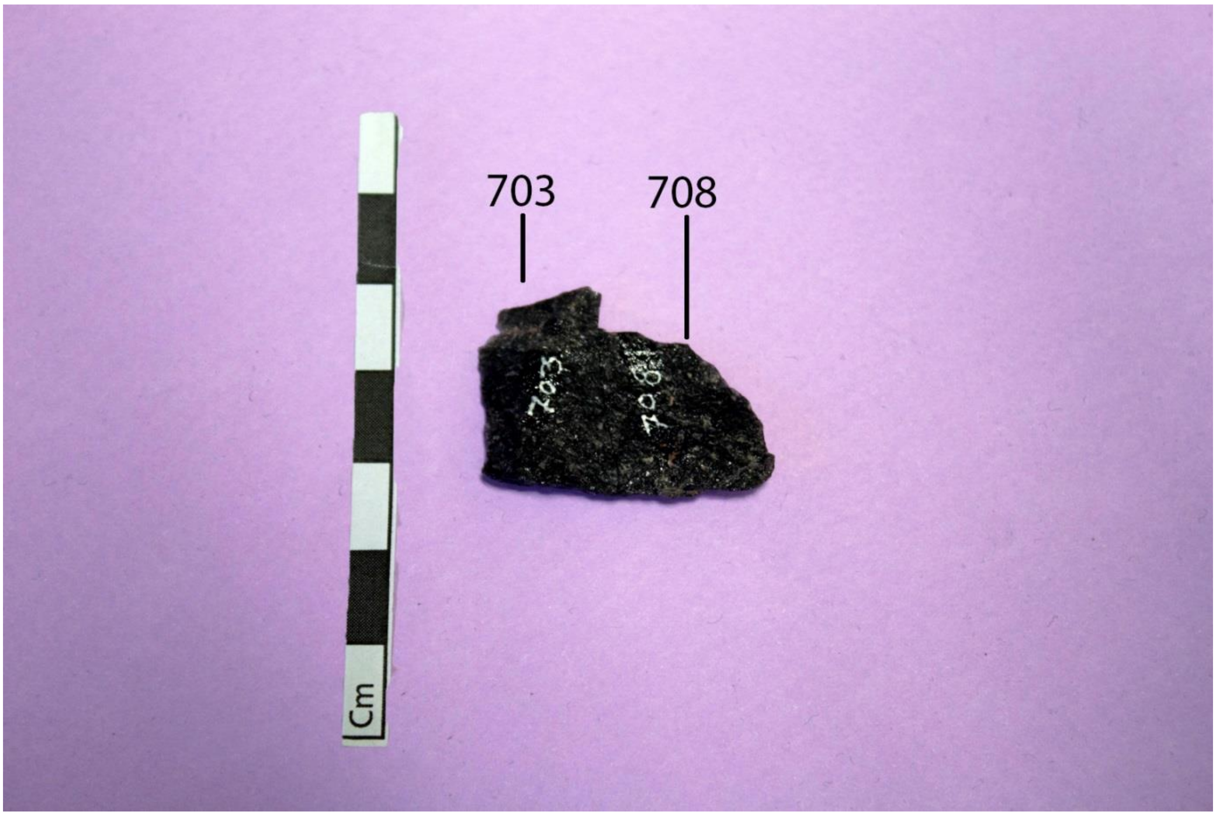


Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
21	1687	no	no	no	no	no	KM13/H	90	52	SE	2	Bjørkeli
21	1694	no	no	no	no	no	KM13/H	90	53	SW	1	Bjørkeli
21	1662	no	no	no	no	no	KM13/H	90	52	SE	1	Bjørkeli

Group 22

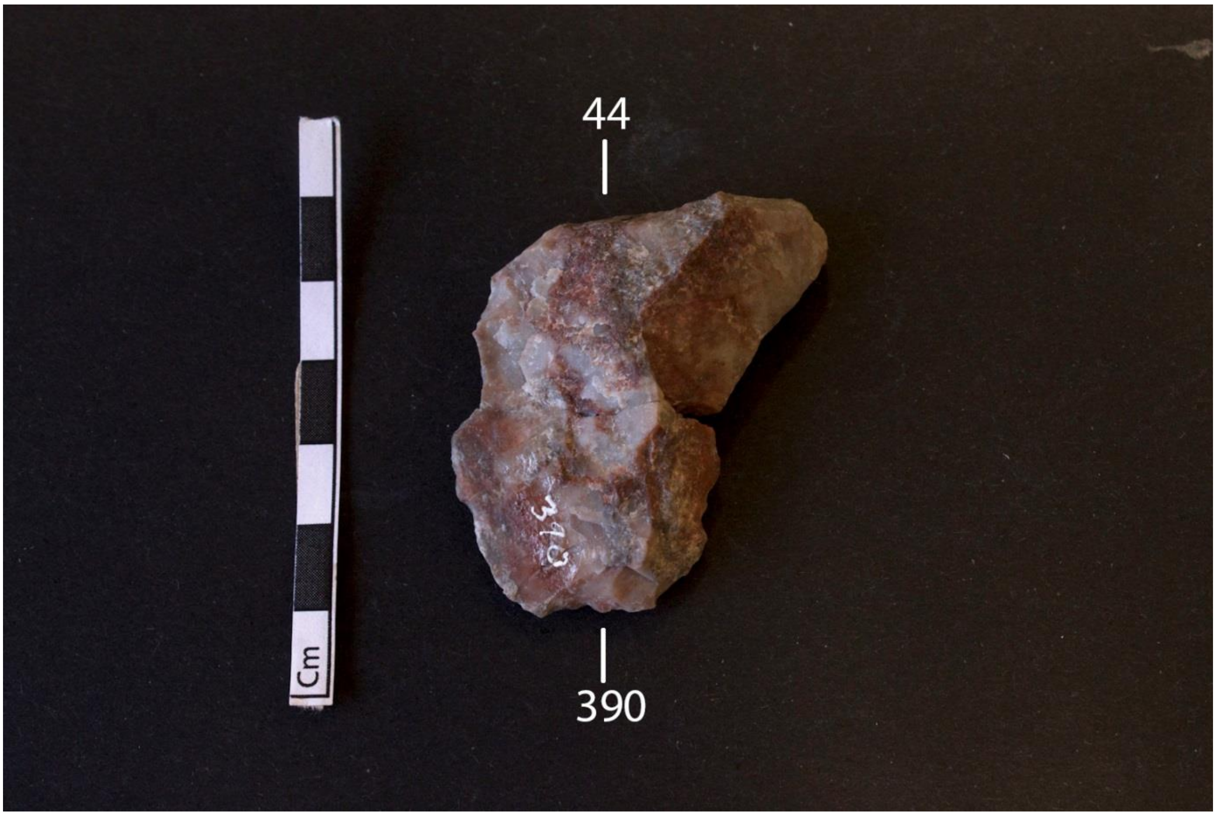
Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
22	1953	no	no	no	no	no	KM13/H	93	52	SE	1	Bjørkeli
22	1945	no	no	no	no	no	KM13/H	93	52	SE	1	Bjørkeli

Group 23



Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
23	708	no	no	no	Yes	no	KM13/H	99	54	SE	1	Stene T.
23	703	no	no	no	Yes	no	KM13/H	99	53	SE	2	Stene T.

Group 24



Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
24	44	no	no	no	no	Yes	KM10/F	98	52	NE	2	Stene T.
24	390	no	no	no	no	no	KK10/F	99	53	NE	2	Stene T.

Group 25

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
25	1196	no	no	no	no	Yes	KK14/H	91	51	SE	1	Bjørkeli
25	2560	no	no	no	no	Yes	KF14/H	91	51	NE	1	Bjørkeli
25	2559	no	no	Yes	no	Yes	KK14/H	92	51	SE	1	Bjørkeli

Group 26

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
26	41	no	no	no	no	Yes	KK10/F	97	52	SE	1	Stene T.
26	23	no	no	no	no	Yes	KK10/F	97	53	SW	1	Stene T.

Group 27

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
27	1862	no	no	no	no	no	KM13/H	92	52	SW	1	Bjørkeli
27	1824	no	no	no	no	no	KM13/H	91	52	NW	1	Bjørkeli
27	1926	no	no	no	no	no	KM13/H	93	52	SW	1	Bjørkeli

Group 28

Refit group	Refit-ID	step-struck	Plunged	Fracture	Siret fract.	Retouch	Raw mat. Code	X	Y	Quadr.	Vertical unit	Locality
28	2245	no	no	no	no	no	KF14/H	92	53	SW	1	Bjørkeli
28	2270	no	no	Yes	Yes	no	KF14/H	92	53	SW	2	Bjørkeli