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Making rock images

Experimental Archaeology as a Method for understanding Prehistoric Rock Art Production

Rock art has been widely studied within archaeology, typically with a particular emphasis on their iconographical expression and potential narrative meaning. By contrast, scholars have shown less interest in the processes underlying their creation. For example, the preparations for rock art production such as the selection of appropriate panels, selection of production tools, what material the tools were made of and where they came from. The present article seeks to cast light on such processes, with a focus on how the practical work of making figurative images in panels and surfaces of different rock types and geological characteristics are done.

In the area around the town of Alta, at the head of the Alta fjord, in Northern Norway, we find Northern Europe's largest concentration of prehistoric rock art made by hunter-fisher-gatherers, consisting of both painted and pecked rock art. It has been argued by several researchers that the different rock art images were originally pecked into rock surfaces in the vicinity of past shorelines. After the figures were made, post-glacial land upheaval gradually raised them to various altitudes, ranging from 8.5 to 26.5 metres above sea level, with the older figures being higher up. Because of their argued past connection to shorelines, this has been used to date the panels by on the one hand referring to geologically dated shorelines and by referring to various rock art styles and associated chronological phases (Gjerde 2010; Helskog 1983; 1988). The dating of rock art and the phase divisions are subject to constant reevaluation, but on the basis of the current shoreline dating the figures have been dated to somewhere between 5200 BC and AD 300 (Arntzen 2007; Gjerde 2010; Helskog 2012, 2021; Tansem 2020). That is, from the Late Mesolithic to the Late Metal period.

The geology in Alta varies between the different rock art sites and panels. Because of this variation, as well as the different properties of the rocks themselves, it seems likely that the rock art makers of the past needed to differentiate the choice and selection of tools involved in the rock art production. The difference between sites makes it natural to assume that the handling of the different tools would also have been quite dissimilar. It is common knowledge within the archaeological field that the most common methods for rock art production has either been by striking the rock surface directly, with a stone hammer, or chisel or alternatively indirectly, applying a mallet to strike a stone chisel. We know less about what materials that were involved for mallets and chisels, and there were probably regional variations based on what materials were at hand locally. Obviously, there might have been other considerations that perhaps were dealt with in terms of tradition and even cosmology, that has also been suggested (eg. Lødøen 2015).

Research associated with the rock art of Alta has focused only limited on the production of the images, the tools and materials involved in this production. Professor Knut Helskog has worked extensively on research and documentation of rock art in Alta. In his research (Helskog 1988), he suggested that the rock art in Alta may have been created

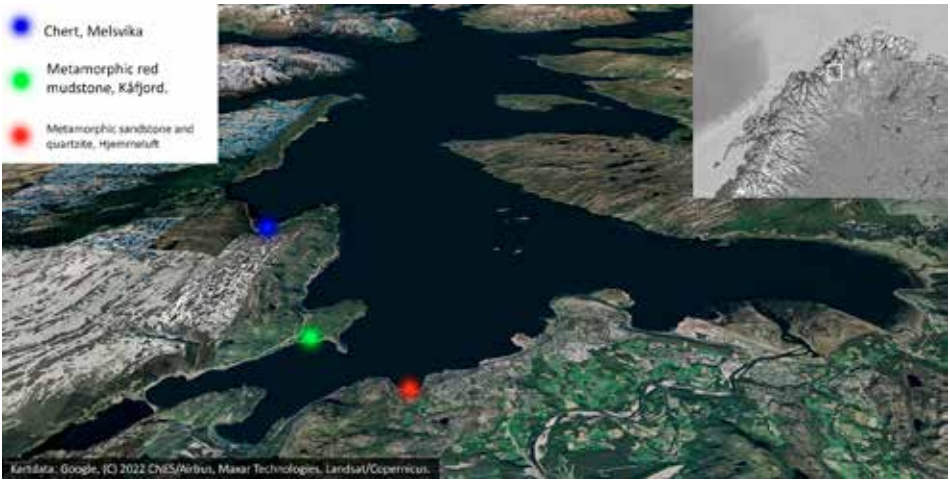
using indirect blows with chisels of quartzite and chert. As both a raw material and a tool in itself, chert and quartzite have been documented at Stone Age settlements throughout the northwestern Fennoscandian Peninsula and were critically important raw materials for carving, scraping, and other purposes (Hood 1992; Niemi 2019, Olsen 1994). Might quartzite and chert have been used for the chisels needed to produce the Alta rock carvings? To answer this question, I myself will experiment by using these two materials as chisels on two different rock types that we know were used as substrates for Stone Age rock art, namely the metamorphic sandstone in Hjemmeluft and the metamorphic red mudstone in Kåfjord (fig. 1). The article will also discuss the following auxiliary questions: Are quartzite and chert well-suited for use as chisels involved in rock art production? Do their edges make appropriate peckmarks, what shape do such peckmarks take, and do they resemble the peckmarks made during the Stone Age?

The first part of the article will discuss previous research related to experimental archaeology associated with rock art production, with a particular focus on the practical side of making rock art. The second part will then describe the methodology and materials I used in my experiment. The outcome of my experimental rock art production will then be studied and discussed in relation to and comparative to the actual Stone Age rock art in Alta.

Rock art research

Consisting of over 6,000 registered figures, the rock art in Alta contains large scenes depicting people and animals engaged in various activities, understood by several scholars as hunting, trapping, fishing, rituals, and collaboration. Many different types of figures are depicted, including humans, reindeer, elk, bears, dogs/wolves, birds, boats, tools, and other artefacts. There are also depictions of various geometric patterns and figures (Helskog 1984). Previous research into these figures has focused on understanding the meaning and purpose of the depicted scenes (see e.g. Gjerde 2010; Helskog 1984; 1999; 2012; Tansem 2022; Tansem & Johansen 2008). The rock arts' setting along the argued vicinity of prehistoric shorelines and their proximity to water has inspired to a number of interpretations (Arntzen 2007; Gjerde 2010; Helskog 1999).

Fig. 1. The Alta fjord with rocks and raw material sites. Map: Google Earth. Ill. Rune Normann, World Heritage Rock Art Center - Alta Museum IKS.



Rock art sites found elsewhere in the vicinity of rivers and freshwater have also been studied by scholars (see e.g. Gjessing 1945; Simonsen 1979; 2000), such as the finds at Vingen in Western Norway (see e.g. Lødøen and Mandt 2012), Chalmi Varre on the Kola Peninsula (Gurina 1980; Shumkin 1990) and Lake Onega in Karelia (Ravdonikas 1936), both in modern-day Russia. At some of these sites, wind causes nearby water to wash over the figures, while at other sites the rock art becomes inundated in pace with rising water levels during the spring. Knut Helskog (1999:73–74) contends that since so many rock images are associated with water, water must be one of the explanations for where they were placed.

Several scholars have argued for a connection between water and fertility (see e.g. Gjessing 1945; Helskog 1999), while others refer to ethnographic data from the Arctic regions of Europe showing that water is associated with a cosmic world, and in particular the underworld (Helskog 1999:73–94). Parallels have been drawn with the pre-Christian Sami religion, where the world was divided into three spheres: sky (the upper world), land (this world), and water (the lower world). Knut Helskog proposes that the figures may have been deliberately at the shore as a form of communication between these various worlds (Helskog 1999:75–79; 2004:283–285). Trond Lødøen (2017) suggest that in past societies, whales, deer and seabirds might have held significant cosmological importance and helped people understand the relationship between the two cosmological levels (Lødøen 2017:141-142, 149).

Previous studies typically devote little space to the actual production of the rock art, that is the physical acts of the human creator, without interpreting the resulting art as having to mean something more than merely this physical act. By moving away from all such layers of interpretation, this article will come closer to my own field of interest, where the focus is squarely on the practicalities of making rock art.

The practical aspects related to making rock images have been discussed by other authors. Knut Helskog (1999:74) points out that although the seashore may have been a ritual site, the choice of the seashore may also have been necessitated by practical considerations, given that this was an area where the rock surfaces were free of vegetation and hence well-suited for making figures in the rock surface.

Other theories have also been posited as to why the rock art in Alta was originally located in the vicinity of the shoreline. When we stand near a rock art panel in Alta today, we do not see the same that was there during the Stone Age. Today, the rock art panels have a light-grey appearance, while the rock surfaces at the seashore vary from faint orange to a deep reddish brown. As per the geochemical XRF and SEM/EDS analyses conducted by Tansem and Storemyr in 2021, the thin, external surface layer of the foreshore is inorganic and ferrous. It is likely composed of rust, in the form of iron oxyhydroxide/goethite and iron (III) oxide/ferrihydrite, which has precipitated from the metamorphic sandstone belonging to the Skoddavarre formation. According to Tansem and Storemyr, the rock surfaces in Hjemmeluft were likely reddish when the figures were made. The reddish hue may have been one of the reasons why the rock images were produced in both Kåfjord and Hjemmeluft, along with other factors. They also suggest that aesthetic judgements may have played a role in this decision (2021:314–334). Previous studies do not discuss the possibility of any practical reasons apart from the rock surfaces being lichen-free.

Within the international research community related to prehistoric rock art there has been a focus on rhythms, sounds, and aural knowledge related to the production of rock art (see e.g. Diaz-Andreau, Mattioli, & Reinsbury 2021; Goldhahn 2002; Vergara 2019). For their part, Hygen and Bengtsson (1999) cite water as a factor in such production, in their research on south tradition rock art. Although they refer to

experiments that show that it takes less time to make figures in water than on dry rock, they argue that such considerations were not decisive when placing the figures. According to Hygen and Bengtsson (1999), it was running water itself, not any notion of practicality and saving time and effort, that motivated the choice of a site for rock art. This is supported by the observation that many figures were created in the vicinity of running water and not directly in the water seepage (Hygen and Bengtsson 1999:45).

The fundamental questions being discussed in this article, concerning the specific pecking methods and materials used to produce Stone Age rock art, will be analysed in accordance with previous research on this topic. Because of the limited research on this subject in relation to the Alta material, it is necessary in the following to examine research from other parts of Europe. In studies of whether rock carvings were made by using either direct or indirect percussion, scholars in Norway and Sweden (Hygen & Bengtsson 1999) and Scotland (Jones et al. 2011) have concentrated on examining the results of direct percussion technique. For Bohuslän in Sweden and Østfold in Norway, Hygen and Bengtsson (1999) argue that peckmarks in granite were made with direct percussion by using a hammerstone made of for example quartzite or diabase. There are also examples where a mixture of different techniques have been argued to have been employed, such as at the Sagaholm barrows outside of Jönköping, Sweden, where the figure was first formed by scraping, then pecked out and partially polished. According to Hygen and Bengtssons experiments it has been demonstrated that it takes about 45 minutes to peck a cup mark, while a small figure of a ship takes a day or so. The time required varies according to the depth of the peckmark and the condition of the rock, and they argue that making rock art was not some kind of spur-of-the-moment fancy but rather a ritualistic event (Hygen & Bengtsson 1999:91). Studies from Scotland have also demonstrated that quartz hammerstones were used to make figures on epidiorite (Lamdin-Whymark 2011). Direct percussion has also been the focus of rock art research in South Africa (Sierts 1968).

Few scholars would claim that rock art was produced with indirect percussion, and some have even rejected this method (Bednarik 2007:44). Conversely, Morten Kutschera and Trond Lødøen (2010; 2015) has concentrated on the indirect technique in their analytical studies of prehistoric rock art production in Western Norway, basing their analysis on the discovery of a chisel of diabase unearthed under an archaeological excavation at the rock art site Vingen and that the recovered tool was used to make rock art at the site (Lødøen 2010:39; 2015:69). Referring to the results from their experiments, Kutschera and Lødøen concludes that the indirect technique must have been used to make the lines in the rock art at the Vingen site. The experiments demonstrated that the chisels regularly were worn down and became blunt, and just as regularly required resharpening. The resharpening also helped the chisels keep their form longer during the pecking process. Their experiments revealed that some chisels had intrinsic weaknesses and were less effective, while others worked better. Kutschera and Lødøen also studied the time it took to make rock art, noting that several of the figures took less than 30 minutes to complete. The results from their experiments also demonstrated that it took longer to prepare the chisel than to produce the individual rock art images, something that must be considered when trying to understand how rock art was produced. Kutschera and Lødøens experiment involved also several performers to investigate whether individual differences could be identified. The results showed that the figures differed in their shape according to the force of the different creators stokes s corresponding in different depths and character of the peckmarks. The time it took to complete a figure also varied between creators of rock art. Those who pecked images with a lighter hand achieved denser and smaller peckmarks than those who pecked with greater force (Lødøen 2015:67–77).

Regarding the rock art in Alta, Knut Helskog argued already in 1988, after having studied the rock art, that they must have been made with indirect percussion. According to Helskog, this would have been the only feasible way the creator could have ensured the evenness and regularity of the 3 to 15 millimetre wide lines that forms the figures. Helskog also postulated that the chisels must have been made with both hard – and soft-edged tools or chisels using either quartzite or chert. Studies of the peckmarks indicate that the chisels were both pointed and edged, and they varied in size. As recent as in 2012, Helskog continued to claim that an indirect technique must have been used to make the rock art in Alta, adding that it is easier to make images in the softer red mudstone of Kåfjord than in the compact sandstone of Hjemmeluft. (Helskog 1988:35; 2012:35–37).

Kutschera, Lødøen and Helskog therefore agree that the selected tools for production of rock art must have been sharp with a regular need for resharpening when the tools became blunt. This is also in accordance with Helskogs observations that several variants of peckmarks can be observed and documented within individual figures in Alta, suggesting that this corresponds with the gradual deforming of the pecking tool as it is worn down, changed in shape, and was then resharpened again (Helskog 1988:35–37). No artefacts have yet been found in Alta and assumed to have been used as chisels or hammerstones, but potential chopped of flakes of coarse and fine-grained (almost amorphous) quartzite and chert from production or resharpening of pecking tools have been found in cracks below the many panels with rock art (Helskog 1988:35–37). At the Bergbukten 6 site in Hjemmeluft, which lies 20–20.5 metres above sea level, flakes of coarse quartzite have been found beneath the turf (Helskog 2021:55), while many chert deposits have been found both under the turf

Fig. 2. Overview from the Kåfjord panel. Photo: M. S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

in the area in front of Bergbukten 3 and in cracks in the rock in Kåfjord (Knut Helskog, personal communication, 13 October 2023).

In her doctoral thesis, Marie Vourc'h (2013) studied the rock art in Alta and made several experimental images in sandstone. Vourc'h tested different chisels and hammerstones and used both direct and indirect percussion in order to explore the character of peckmarks in the sandstone surface, using and utilising stones in their natural, untreated form as chisels. Vourc'h tested seven types of rocks, all of which, apart from chert, may be collected from the seashore in Alta: chert, quartz, jasper, compact basaltic rock, greenstone (quartz type), coarse-grained quartzite, and fine-grained quartzite. The stones were selected on the basis of their shape, and they had at least one sharp edge even if they were rounded. Vourc'h outlined a preliminary figure in the rock surface with the striking tool before she began the pecking process. On some accasions, she attached each stone to a curved juniper handle, similar to a modern hammer with a handle. The latter provided poor control over the point of impact, and Vourc'h excluded this method (Vourc'h 2013:293–300). In her research, she has argued that most of the figures have been produced by direct percussion using chisels made from quartzite or other materials. In some cases, indirect percussion may have been used to create the outer lines, but she argues that most of the figures were made with direct percussion against the rock surface (Vourc'h 2011:476–485; 2013:293–300). (Fig. 3).

The archaeologist Morten Kutschera has extensive experience in creating rock art and preparing stone tools. Similar to Helskog, he argues that the level of precision expressed by the many rock images in Alta – in particular their thin, lines – must be the result of indirect percussion. Kutschera maintains that direct percussion would have been too imprecise, adding that direct percussion may have been used to fill in the

Fig. 3. Overview from Bergbukten 4a, Hjemmeluft, with the Alta fjord in the background. Photo: M. S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

interior surface area, since such a technique requires less precision (Kutschera, personal communication, 29 November 2022). In the summer of 2017, Kutschera, along with a team from Alta Museum of which I was a member, tried to make figures at Hjemmeluft with chisels made of diabase, an imported material. These chisels worked poorly on the sandstone in Hjemmeluft, as they splintered and even left no marks in the rock. We then tried pecking the rock surface with quartzite chisels, with much better results. The quartzite was collected from the seashore in Alta and was easily shaped into chisel-like stones that created peckmarks of a more similar character as in the original rock art at Hjemmeluft.

Given the results discussed above, I have chosen to focus on two different types of rock that occur in the areas of Stone Age rock art in the Alta area, namely sandstone and red mudstone. For the chisels part, I have chosen to use chert and quartzite.

Rocks and raw materials

When experimenting with the creation of rock carvings, I first pecked into metamorphic red mudstone from Kåfjord (see fig. 2), whose purple and white stripes and greyish and greenish hues stem from volcanic sediments that were deposited under water around two billion years ago (Bergh & Torske 1988). The rock carvings in Kåfjord are the biggest single panel in Alta, it can be dated to 7000-5000 B.P and has approximately 1,300 figures pecked into it (Tansem 2022:22) This red mudstone has not previously been explored in test carvings and experimental archaeology in Alta.

The second rock I used as a substrate in the experiment was metamorphic sandstone from Hjemmeluft (see fig. 3). It has a high magnetite content and was formed from fluvial deposits in a river delta around 1.8 billion years ago (Bergh & Torske 1986). Hjemmeluft is the largest sites in Alta. It can be dated from 7000 – 2000 B.P. and has approximately 2,300 figures pecked into it (Tansem 2022:27). Sandstone has been explored in test carvings and experimental archaeology in Alta earlier.

The chisels I used in the experiment were of quartzite and chert (see fig. 4). The quartzite was fairly coarse and was gathered from the seashore in Alta. The chert was collected from the Melsvik area in Alta, the largest chert quarry in Norway (Niemi 2019:1–4). The chert in question had been donated to Alta Museum after the archaeological excavation of the ID 138347 site in Melsvik was completed. The chert deposits in Alta are to be found in the Kvenvik formation, as well as in parts of the so-called geological window between the Altafjord and Kvænangen (Niemi 2019:9). Quartzite and chert have been important both as raw materials and tools during Stone Age settlements (Hood 1992; Niemi 2019; Olsen 1994). It is of interest to examine how they function as chisels.

The mallets involved were made of wood, and the chosen hammerstones were picked from the seashore. They were selected from a subjective, hands-on basis in relation to their shape and weight (see fig. 5). A mallet made of reindeer or elk antler was ruled out as the force when struck would have been too strong and damaged the chisel severely (Morten Kutschera, personal communication, 12 June 2022).

Making rock images

Experimental archaeology mixes observation and experimentation in an attempt to unearth new knowledge about how prehistoric activity. The discipline seeks to test archaeological hypotheses by emulating the techniques of ancient cultures, for example by using methods, techniques, and analyses based on archaeological sources (Foulds 2013). In order to gain insight into how rock art was made in prehistoric times, experimental archaeology is most valuable. Studies and practical experiences related to the production of rock art have demonstrated that there were regional differences related to what type of rock the figures were made on and what materials that were

Fig. 4. Some of the chisels used in the experiment. (a) Quartzite and (b) chert. Photos: M.S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

used as tools. These regional differences are incorporated in the analysis, because they influenced how rock art may have been made and how they were designed.

The experiment

I began the experiment by choosing the type of rock to use as a substrate. The rock substrates were selected according to their geology, suitable pecking surface and weight. The sandstone was picked from the seashore in Hjemmeluft and the mudstone from the seashore in Kåfjord. It should be noted that the tests were carried out indoor in the Alta museum workroom, and in a different setting than the original environment for rock art production, which were made outdoor, on larger rock surfaces, in a natural environment.

The next step in my experiment was to make myself a chisel. The chisels were made of stone and were shaped in a simple manner, with the stone being struck so that it split into several parts, with those having a natural "chisel shape" being selected to serve that purpose (see fig. 4). Afterwards I chose a

Fig. 5. In my experiment, I used percussion tools of wood (to the left) and of stone (to the right). Photo: M.S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

Fig. 6. Morten Kutschera makes rock carvings with a quartzite chisel on sandstone, Hjemmeluft. Photo: M.S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

mallet that had the right weight and fit well in my hand.

I then considered where to place the figure on the rock, before I started making the figures with indirect percussion using a mallet of wood and stone. Over the course of the experiment, I studied whether the given edge succeeded in making a peckmark, what form these peckmarks took on different surfaces, and whether the results were similar to the Stone Age rock art. The experiment was divided into six tests, with 11 figures being created in total. The rock art creation ended when the peckmarks in the stone were visible in both "flat" and slanting light and also tangible. Filming the experiment allowed me to retrospectively study both the technique and the results.

Finding a comfortable sitting position on the floor, as well as an apt position for the rocks I was going to peck on, proved to be challenging. The rocks needed to be placed on the floor because it provided better stability and control when I was pecking. The rocks were relatively small compared to the outdoor rock surfaces, which posed challenges in how I positioned my body relative to the rocks. I started the process by pecking the outline of the figure, using a light hand to make faint peckmarks. Soon after I began pecking, marks appeared on the rock. Sandstone is a hard material, and it took force to pierce through the outermost layer, after which the pecking process felt easier. By contrast, pecking figures into red mudstone was easier, and there was no need to strike the rock as hard to make pecking marks. In several instances, when carving on red mudstone with a quartzite chisel, I only need to use a single chisel to complete a figure.

The carving process produced stone dust, which I blew away regularly and when necessary. The amount of stone dust varied according to the given chisel and rock substrate. The largest amount of stone dust was produced when using quartzite to make images in the sandstone. Regarding both sandstone and red mudstone, I learned at a certain point that it was not

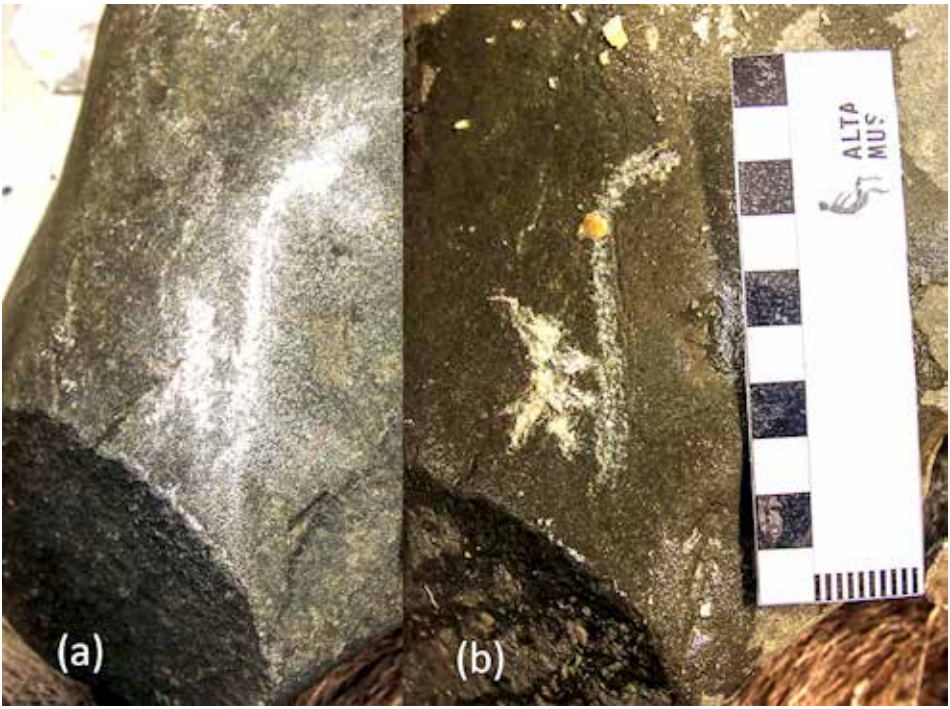


Fig. 7. (a) Shows stone dust that settles over the work area and makes it difficult to see the peckmarks. (b) The stone dust mixed with water and settled as a layer in the peckmarks. Photos: M. S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS

possible to blow away all the accumulated stone dust, and it therefore became difficult to make out the depth of the peckmarks. When I consequently used my fingers to feel the peckmarks, this obfuscated the segment I was working on, and the dust became smeared over this entire segment (see fig. 7a). This made it necessary to add water to better see the area I was working on. When I then continued to peck the rock, the stone dust and the water mixed together and settled as a layer in the peckmarks, so that the area had to be cleaned with water again (see fig. 7b). Carving with quartzite on sandstone required the greatest use of water, and it was important for the process to have it nearby.

The experiment revealed that striking the rock substrate damaged the chisels edges, something that led to the peckmarks changing shape during the creation process. The peckmarks might initially be circular, only to gradually morph into linear marks during the creation process, or vice versa. This occurred because the edges became damaged and changed their shape during use. The harder type of rock, sandstone, damaged the edges of the chisel the most, and it was the edges of chert that were damaged both most frequently and most severely, as they split and fell off as flakes; using chert also caused a burnt odour. The quartzite usually retained its shape during the image producing process, but there were also cases where the quartzite edge deteriorated and fell off as fine grains of sand.

The results from the experimental process showed that the quartzite and chert produced both linear and circular peckmarks.

Fig. 8. Rock carvings pecked on sandstone with a quartzite chisel (to the left) and chert (to the right). Photo: M. S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

The chert produced linear peckmarks more regularly and often served to create the outer lines of the figures. The peckmarks varied in size according to how the stone edges were shaped. Over the course of the image producing process, the edges gradually changed their shape. Making images into sandstone (see fig. 8) produced small peckmarks, between one and two millimetres in diameter, while carving on red mudstone (see fig. 9) produced larger peckmarks, from two to four millimetres wide, independent of which chisel was used. Quartzite chisels retained their shape longer than the chert chisels did before being worn down or damaged.

Fig. 9. Rock carvings pecked on mudstone with a quartzite chisel (to the left) and chert (to the right). Photo: M. S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

Hence, both the size and shape of the peckmarks gradually changed during the process because the chisel edges became transformed after repeatedly striking the substrate. When the chisels were shorter than five centimetres, they became harder to hold without hitting my fingers. If they were longer than five centimetres, it was also easier to observe where the chisel was placed on the rock surface.

As for the hammer tools, the wooden mallet produced both a softer blow and softer sound than the hammerstone did. The chisels caused a certain amount of damage to the wooden mallet, and pieces fell off during use. In turn, the wooden mallet did little damage to the chisels, while the hammerstone damaged them to a greater extent. The choice of percussor had no visible effect on the peckmarks, though the experiment did show that the wooden mallet worked best as it caused less chisel damage. The time it took to make a 10 cm human figure with an elkstokk ranged from 10 to 25 minutes, with pecking lines into red mudstone taking in general the shortest time. The quality of both the chisel and the substrate also impacted the production time.

Studies of Rock Art of Alta

The next step was to study peckmarks from the Stone Age and determine whether they were similar to the results from the experiment. I examined 15–20 figures from the Bergbukten 4a panel in Hjemmeluft, dated to the oldest phase in Alta, 5200–3800 BC (Arntzen 2007; Gjerde 2010; Helskog 2021). Upon inspecting these figures, I found circular, oval, and linear peckmarks of different

sizes. All of the figures included at least two different peckmark types.

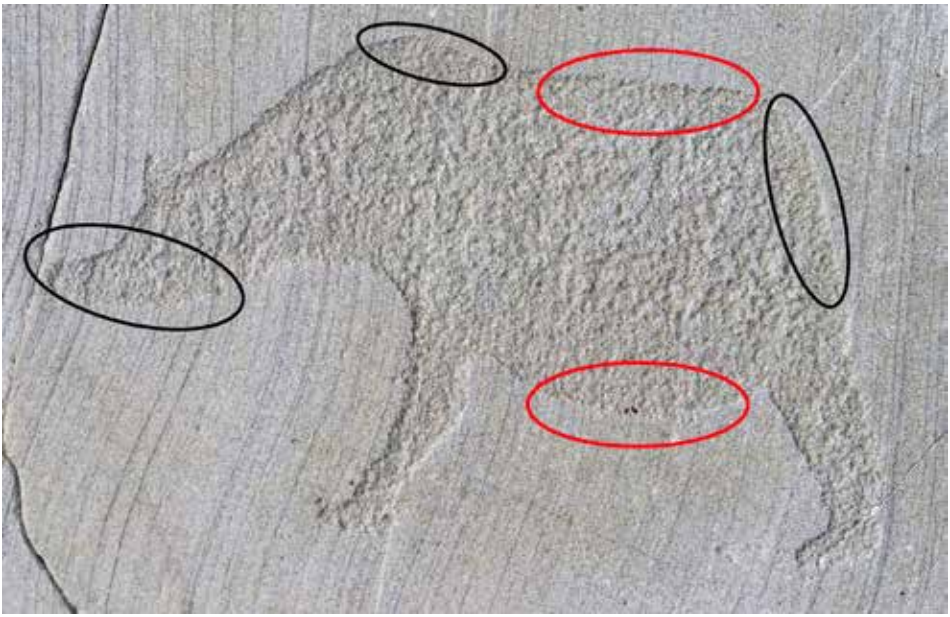
I chose to divide the figures into three groups: finely pecked, medium-coarse, and coarse. The "finely pecked" figures in group 1 are characterized by their straight outlines with small, dense peckmarks. The peckmarks here are both circular and linear and range from one to two millimetres, with some peckmarks up to four millimetres. Most of the group 1 figures are bear images, but there are also some elk, reindeer, and fringed droplet-like figures. The various figures have discernible details and realistic heads and body shapes. The figures in this group show the signs of precise craftsmanship. I observed outlines that were variously shaped by linear and circular peckmarks. As figure 10 shows, the bear's shoulders, head, and, as well as its posterior, all have an outline formed by linear peckmarks (black marking), while the outline of the animal's back and stomach was formed by circular peckmarks (red marking). The entire figure has been filled in with variously sized circular peckmarks. Similar types of peckmarks can be found on several figures in this group.

Group 2 has "medium-coarse" peckmarks that are variously circular, oval, and linear (see fig. 11). These figures do intermittently feature straight outlines, but more coarsely pecked lines are the rule. The peckmark sizes in this group range from two to three millimetres, which is slightly larger than group 1. The figures in group 2 depict reindeer, elk, and people.

Group 3 is characterized by coarser lines (see fig. 12). Straight outlines are absent, and the peckmarks are larger than in the other two groups, with circular, oval, and linear peckmarks up to five millimetres. The figures in this group mainly depict reindeer and people.

In Kåfjord, I examined the peckmarks of 15 of the oldest figures, which have been dated to around 5200–4000 BC (Gjerde 2010; Helskog 2021). The figures in ques-

Fig. 10. A bear from Bergbukten 4a from "finely pecked" group. Photo: M.S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.



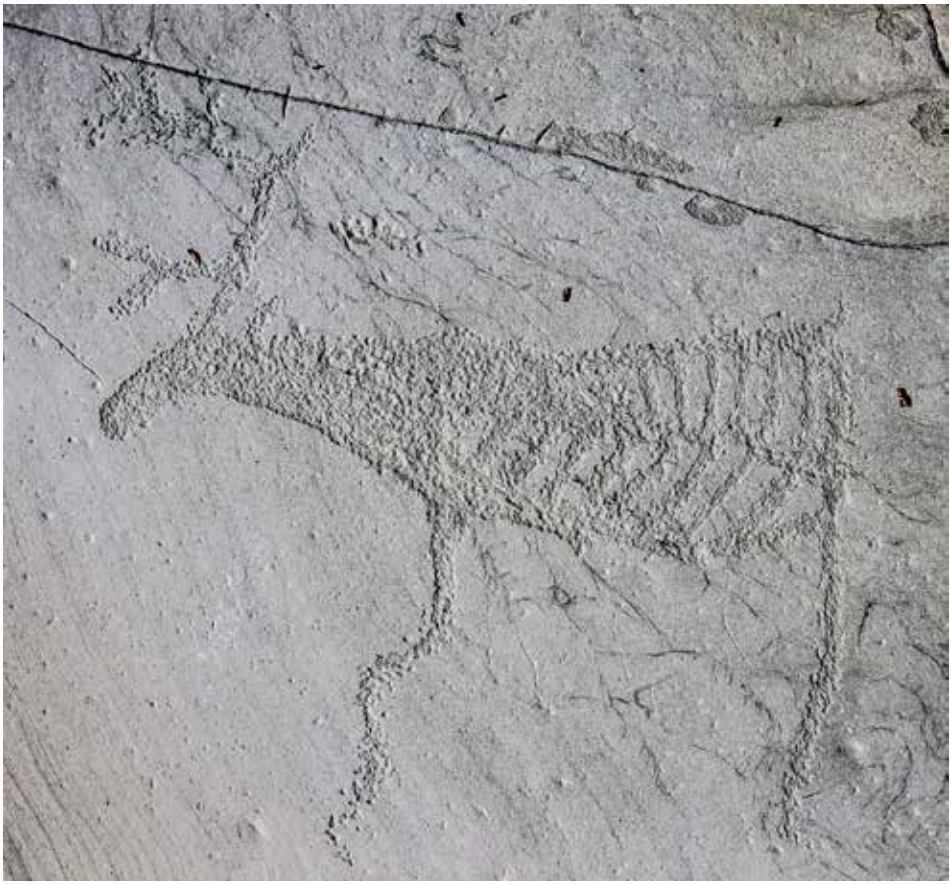


Fig. 11. An elk from Bergbukten 4a. Belongs to group 2, medium-coarse, with elements of straight edges. Photo: M.S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

Fig. 12. Two people from Bergbukten 4a. Roughly pecked with most linear and oval peckmarks. Photo: Mari S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

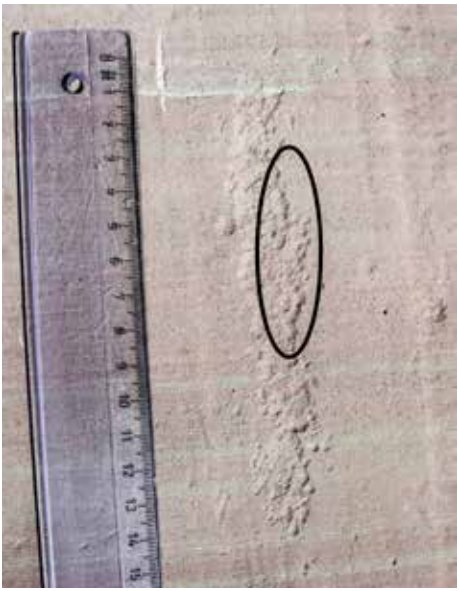


Fig. 13. Rock carving from Kåfjord, pecked on red mudstone. Photo: M. S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

Fig. 14. Pecked on mudstone with a single quartzite chisel. Photo: M. S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

tion depict elk, reindeer, and humans. The peckmarks made at this site, Kåfjord 1, are mostly circular, with the circles having a particular side that is sharper (see black marking, fig. 13). I found a few examples of linear peckmarks, but they are rare. The peckmarks vary in size from two to four millimetres wide. I did not find any straight outlines or any variation in the peckmarks' shape, as I did at Bergbukten 4a.

Conclusion

This article has focused on testing quartzite and chert as chisels for producing rock images into two different types of rock: metamorphic sandstone and metamorphic red mudstone. The findings from the experiment were then compared with observations from Stone Age rock art in the Alta area.

The sandstone in Hjemmeluft is a hard type of rock, and the experiments showed that when sandstone was struck by the chisels, the chisels' edges became damaged, thereby altering the shape of the peckmarks left in the rock surface. The producer is unable to control this, because the degradation occurs at the very moment when the chisel strikes the rock. As a result, it became difficult to plan where to make circular or linear peckmarks. I found that chert created linear peckmarks more frequently than the quartzite.

The studies of the rock art in Hjemmeluft show several instances of peckmarks varying in their form even within the same figure. This is confirmed, for example, by the studies of the character of the Bergbukten 4a images, where different peckmark types occurred randomly in the figures. Thus, it does not seem as though any planning went into where the peckmarks should be either linear or circular; rather, both types probably appeared randomly within the figures. This may suggest that the edge of the chisel that was used became misshapen or damaged during the pecking, and that the chisel was then replaced with a new one, or that the chisels were regularly sharpened,

Fig. 15. Rock carvings covered by a grey layer of stone dust made in the experiment (on the left) and rock carvings made in the Stone Age (on the right) without the grey layer. All the figures are pecked in sandstone. Photos: M.S. Arntzen, World Heritage Rock Art Center - Alta Museum IKS.

which in turn resulted in different peck marks. The experiment showed moreover that quartzite was the preferred material for chisels when making images in sandstone; however, although it suffered less reduction of the tool, quartzite did also produce more dust. By having good insight of the raw material such damages can be reduced by selecting higher quality materials. The chisels may therefore have had a short period of usability, and they must have been replaced upon becoming damaged in any case.

The figures I pecked in sandstone are most similar to those in group 1, the ones I labelled "finely pecked", typified by small peckmarks and straight outlines. In their appearance, my figures resemble the Stone Age peckmarks studied in this paper, indicating that it is conceivable that chisels made of quartzite and chert were used. On average, the Stone Age peckmarks I examined were larger than mine, which were all under 2 millimetres. This may imply that a larger chisel was used during the Stone Age, or that – given Kutschera and Lødøens abovementioned findings (2015), which showed that peckmarks vary in size and depth when made by different individuals – the Stone Age figures and peckmarks were deeper implying that they were made with greater force than those I produced during my experiment.

As for Kåfjord, the figures were made in the softer local rock that damaged the chisel edge less, resulting in less change in the shape of both the chisel and the peckmarks. The peckmarks made during the experiment resemble those from the Stone Age with their circular shape, and both chert and quartzite gave results similar to the Stone Age peckmarks. The lack of straight contour lines on the figures in Kåfjord may indicate a different design than those in Bergbukten 4a. The figures do not have the same details, and the straight lines might not have been essential to create. I did not find any variation in the peckmarks' shape, as I did at Bergbukten 4a, which may indicate that the chisel held its shape throughout the pecking process. Figure 14 that was pecked with a single quartzite chisel, and the peckmarks have held their shape

Fig. 16. The rock surface and carvings from Bergbukten 4a, Hjemmeluft, show how natural depressions collect rainwater in the immediate vicinity of the carver's work area. Next to the figure, rainwater is collected in a puddle. Photo: Heidi M Johansen, World Heritage Rock Art Center - Alta Museum IKS.

throughout the entire process. The peckmarks are circular and similar to those from the Stone Age. These findings demonstrate that these materials may have been used as chisels on red mudstone surfaces in the Stone Age as well.

Freshly pecked figures become covered by a grey layer of stone dust. Settling into all the cracks of the rock surface, this dust is impossible to clear away totally, even after being rinsed with water. The dust makes it harder to make out the peckmarks, meaning it will cause a certain margin of error when the experimental rock carvings are compared with those from the Stone Age, which do not have this layer. Figure 15 illustrate this difference.

The issue of stone dust, and the attendant need for repeated rinsing when making rock carvings, calls attention to the practical sides of rock art production. The Stone Age rock carvings were made on lichen-free rock surfaces that lay at the water's edge, and some of the surfaces have natural pits and channels where both rainwater and seawater accumulated (see fig. 16). These pits, as well as the nearby shoreline, may have served as water reservoirs that creators could use while making rock art. Given this proximity, it was not necessary to transport water to the site. The seashore was a place where rock art producers had everything they needed to make rock art: clean rock surfaces to peck figures into, quartzite for tools, and water for the production itself. The seashore may therefore have been chosen as the rock art production area for practical and time-saving reasons, in addition to other factors. When seen from this perspective, what may have been more important than the result was the very production and act of rock art creation – the choice of stone and place, the physical and repetitive motions, the weight of the stone as the peck-

Fig. 17. Morten Kutschera (on the right in the picture) is pecking figures on a loose boulder near the water's edge. Photo: Sara Orzel, World Heritage Rock Art Center - Alta Museum IKS.

ers hand is raised and lowered, the sound of the stone striking the rock, the sand dust swirling up in the air. The movements are repeated as the carver goes through and experiences the entire process.

The present study has examined only a small fraction of Alta's rock art, which encompasses nearly 6,000 figures dispersed across large area at the head of the Alta fjord and produced over the span of millennia. When studying this topic further, it would be of interest to examine peckmarks both at other rock art sites in the Alta area, from other eras, and at sites that are more remote, as this may lead to other findings and also provide greater insight into the rock art found in Fennoscandia. I have argued in this article that water is important in the process of pecking figures. In further study, it would be interesting to investigate how the pecking process is affected when done during rain. Will the stone dust accumulate as a layer over the figures, or will the rain keep the surface free of dust and make the working area easier to see? The rock art in Alta lies in a zone on the foreshore that remains snow-free during winter, giving rise to additional questions. Might colder temperatures affect the results? How does the stone dust act in frost and when it is then rinsed with water? If we focus on the various rocks in the seashore, a further line of research would be to investigate what happens when we make figures on rock surfaces rife with lichen. Is it possible to carve through the lichen and make precise figures? If not, such an experiment may help corroborate the theory that the rock images were made in the shoreline on surfaces of clean, lichen-free rock.

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