Rock Art

A guide to the Documentation, Management, Presentation and Monitoring of Norwegian Rock Art

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Preface

Through the ten year project "Protection of Rock Art" - The Rock Art Project – systematic research has been carried out on the causes for the decomposition of rock art, and the manner in which these causal factors influence one another. The project has developed methods for limiting and delaying decomposition, and for the documentation, management and presentation of rock art.

The development of knowledge in the project has been interdisciplinary in nature and undertaken by the five regional museums, the Norwegian Institute for Cultural Heritage Research (NIKU) and through the contributions of individual persons.

In order to insure the best possible communication and coordination of activities during the project, the Norwegian Working Group for Rock Art Conservation – The Conservation Group – was established towards the end of the project period.

Shortly after its creation, The Conservation Group was assigned the task of summarizing the results of the project in a "Manual for the Protection of Rock Art".

The manual presents the results of the project in a guide that will surely be useful in the continued work with protecting this important part of our cultural heritage.

The guide is written by conservator Terje Norsted, Norwegian Institute for Cultural Heritage Research (NIKU); conservator Bitten Bakke, Museum of Archaeology, Stavanger (AmS); geologist Linda Sæbø, Bergen Museum, University of Bergen; botanist Torbjørg Bjelland, University of Bergen and archaeologist Bjørn Hebba Helberg, Tromsø University Museum, University of Tromsø.

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International cooperation, particularly through the **INTERREG** projects Rock Carving in the Borderlands (Helleristninger i grensebygd) (1996-2000) and RANE – Rock Art in Northern Europe (2002-2005), has been an important source of knowledge and development. The project is partially financed by The European Union, and this has enhanced our ability to conduct experiments and exchange and disseminate knowledge.

The text is edited by Torbjørg Bjelland and Bjørn Hebba Helberg. The text was translated into English by Stephen Wickler, Tromsø University Museum. Photographs and illustrations are edited by Linda Sæbø.

The Directorate for Cultural Heritage (Riksantikvaren) would like to thank all of those who contributed for their efforts and wishes all of you who make use of this guide the best of luck with continued preservation and management efforts.

Harald Ibenholt
Riksantikvaren

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1. GENERAL INFORMATION ON THE PROTECTION OF ROCK ART

1.1 Rock Art as a Source of Knowledge

Simply put, rock art is a collective term for images and figures from the past produced by various techniques on boulders, bedrock surfaces and in caves. It represents the earliest art form we are familiar with in Scandinavia and includes rock carvings as well as rock and cave paintings.

Archaeologists have described rock art within a number of interpretive frameworks. The religious-magical-functionalistic explanatory model has been dominant since the 1930s. This model has interpreted rock carvings as a component of hunting magic to maintain and enhance access to game and kills. The motivation for those producing the carvings was obviously much more than to provide information about what was eaten and the tools used for hunting. Rock art presumably tells us about group affiliation, religious ideas and rituals, ideology and power. The images may also tell us something about the world view of prehistoric populations, including cosmology, mythology and beliefs about how the world was organized in relationships between humans, animals, vegetation, water, mountains, ethanols and gods. From about 1980 until 2000, research has focused on structuralist and post-structuralist explanatory models. Within this framework, images are seen as signs and messengers in an information system where the meaning of rock art emerges through relationships that the different signs and images have to one another. In the past few years there has been an increased focus on understanding rock art as an expression of mythology, cosmology and religion.

There is therefore no set answer regarding the interpretation of rock art. Images can be "read" over and over again in our own ideological world, and in the future one can expect totally different interpretations and narratives than those we have at present.

One of the most important functions we who work with rock art have is to maintain the transference of knowledge and information from earlier periods to the current generation. An important group in this respect is primary school children. The interpretation and presentation of rock art localities and panels should therefore also be directed towards use in primary schools. It is important to show that rock art has a place in the dissemination of knowledge and information from earlier times to today's children and youth. Increasing the awareness of children will have a preventative influence in terms of potential damage and destruction of rock art.

1.1.1 Rock Carvings

In Norway, we know of about 1100 rock art localities with at least 33,000 figures. Rock carvings in Scandinavia include two main types: hunter art (*veideristninger*) commonly associated with the hunter-gatherer economy from the Stone Age (Figure 1), and agrarian rock carvings (*jordbruksristninger*) made by Bronze Age farmers (Figure 2). In Norway, the Stone Age rock carvings are found primarily in **Western Norway**, Central Norway and North Norway. Two locations in particular stand out in relation to this type of rock carving; the localities in Alta municipality and Vingen in Bremanger municipality. Agrarian rock carvings are found for the most part from **Trøndelag** and southwards, but they are also represented in locations such as Alta.

Rock art motifs and their placement in the terrain can be summed up in one word; diversity. Stone Age rock carvings are dominated by naturalistic animal figures, hunting scenes and abstract signs. Ships are possibly the best known theme of the many figure types from the Bronze Age. Rock art is also found in many different natural settings such as bedrock faces, caves, rock slabs and both large and small boulders.

Figure 1. Stone Age rock carvings at Ausevik, Flora, Sogn og Fjordane. Photo: J. M. Gjerde.

Figure 2. Bronze Age rock carvings at Hornnes, Skjeberg, Østfold. Photo: J. M. Gjerde.

The majority of rock carvings appear to have been produced in a similar fashion. The grooves that form the actual image are pecked or hammered into the rock by one or more blows in the same place. A different type of rock carving technique is found only in Nordland county; ground rock carvings (Figure 3). As the name suggests, these images are ground or polished rather than pecked into the rock surface. All of the ground rock carvings are found on extremely hard rock types, such as gneiss and granite. The images were most likely ground into the rock surface with an object made from another hard rock or mineral. A third type of rock carving is cut or carved into the rock with the aid of a sharp or pointed object. This technique is highly restricted. One example is found at Hell in Stjørdal where a series of animal figures and a geometric pattern have been cut into the rock. There are also other examples where a boring technique has been used in the manufacture of rock carvings. It is difficult to date rock carvings directly, even with today's advanced scientific methods (see Chapter 1.1.4).

Figure 3. Ground rock art. Jo Sarsaklubben, Lødingen, Nordland. Photo: B. H. Helberg.

1.1.2 Rock Paintings

Norwegian rock paintings, as well as those from Sweden and Finland, are generally characterized by a few common traits. In addition to having a more or less close association with lakes, fjords or rivers, they have the following characteristics:

- Rock paintings are often highly visible in the landscape. They distinguish themselves in the terrain in one way or another. Some may have been positioned strategically in relation to old transport routes.
- Rocks usually face south or southwest. Their orientation towards the sun may have had an important role.
- Rocks can, as with caves, be interpreted as "portals". The portal effect is enhanced by overhangs, marked depressions, the position of cracks and small "caves". The figures are often placed between cracks, crevices and holes on relatively even surfaces of variable size.
- The surface of rocks are often totally or partially covered by a transparent, siliciferous surface coating that is henceforth referred to as "silica skin".

Apart from two localities, all of the Norwegian rock paintings are clearly red. The red pigment is iron oxide. The colour varies from warm red to dark, bluish nuances. Iron oxide appears in nature (very often in bogs) in the form of the minerals hematite and magnetite. Hematite is the most common. In prehistoric times, the raw material used may have been iron hydroxide in the form of yellow ochre (the mineral geothite) or brownish ochre (limonite). The practice of warming up (roasting) yellow and brown ochre in a fire in order to eliminate the water content and thereby obtain the desired red colour, is probably extremely ancient. This demands a temperature of about 500 °C. It is likely that the roasting method was known and used in Norway when the rock and cave paintings were made.

The pigment must initially be finely pulverized and cleaned. Finds from cultural deposits and ethnographic sources indicate that it was most commonly mixed with water and kneaded, dried and stored in lumps. Before it could be used for painting, the pigment had to be pulverized again and mixed with a liquid.

Some rock paintings are located on rock surfaces that are not effectively protected from rain (Figure 4). It is noteworthy some of the paintings on these surfaces are so well preserved considering the stress they had to endure until the silica skin was formed (see Chapter 2.2.2). This can be explained if the liquid added to the pigment in preparation for painting was an effective adhesive, possibly a fatty substance. Identification of such an adhesive is extremely difficult because the paints on the rock surface have been mineralized over time such that they have become an integral part of the rock.

Figure 4. Rock surface with rock paintings without a protective overhang. Hinna, Tingvoll, Møre og Romsdal. Photo: T. Nordsted

Provided the paintings are placed in a protected location, such as under an overhang (Figure 5), the pigments may just as well have been prepared using only water. Iron oxide is so strongly influenced by geomagnetism that this (and the surface texture) will be sufficient to keep the pigment attached to the rock surface after the water has evaporated.

Figure 5. Panel with rock paintings protected by a massive overhang. Hinna, Tingvoll, Møre og Romsdal. Photo: T. Norsted.

The repertoire of painting motifs include anthropomorphic figures and animal figures that for the most part appear to represent elk (moose), reindeer or other deer species. There are also a few motifs that resemble plants or trees as well as a number of more or less intricate geometric figures. Zigzag lines and other simple geometric patterns are common. There has also been found ca. 3 to 20 cm long parallel and nearly vertical lines that appear to have been painted with fingertips, apparently from the same hand. We have recorded figures consisting of up to 12 such parallel lines.

It can often be difficult to distinguish between painted figures and natural precipitates of iron oxide when both have approximately the same colour. Enlargement of the figures is necessary to enable distinction. Natural precipitates cover the smallest depressions in the texture of the rock surface, but the painted colour is restricted for the most part to the "high points".

It has been observed that faint figures are more visible when there is high air humidity, especially in the autumn, but also when they are covered by a thin layer of ice in the winter. A relatively thick "skin" of amorphous silicate (see Chapter 2.2.2) clarifies the paintings in the same way.

1.1.3 Cave Paintings

Nine deep caves with prehistoric paintings have been recorded in Norway[1]. The total number is low in comparison to rock carving localities, but their occurrence is significant

[1] There are an additional three that have been classified as caves, but these are more accurately classified as rock shelters. These include the "cave" at Store Hjertøya outside Bodø, "Resholet" in Indre Visten, Vevelstad, and "Simon Kranehula" near Kabelvåg in Vågan.

in light of their scarcity. These painted caves are the only ones of their type in Northern Europe. They are also erosion caves rather than solution caves[2]. This latter type is the most common context for cave paintings in the rest of the world.

The Norwegian cave paintings are spread over an area that can be divided into three units based on distinctive geographical and geological features. The two southernmost caves are in an area of Ytre Namdalen dominated by the rock types serpentinite and greenstone. The central unit is located in Salten and along the Helgeland coast where there are, respectively, one and two localities where the predominant rock type is mica schist. The northwestern unit includes four caves in outer Lofoten where the rocks are gneiss/granite.

The caves vary significantly in size and form. They also form dissimilar systems of passages and wide room formations that make each of them distinct. Lengths range from 40 to nearly 200 metres, measuring from the drip line at the entrance. The entrances also vary in shape and size, from enormous to quite narrow (Figure 6).

Figure 6. The monumental entrance to Kollhellaren, Moskenes, Nordland. Note people at entrance for size comparison. Photo: T. Norsted.

[2] Solution caves: Irregular caves formed in limestone. They are created by ground water flowing through fissure systems that dissolves the rock.

It is common for the figures to appear in groups/panels. A significant number are often located in areas where there is a transition from light to darkness. Some are placed either closer to the entrance or innermost in the cave. There are also examples of panels located in areas than can fit a large group of people. Figures are also found in extremely narrow sections with difficult access.

The paintings are usually quite simple and a majority are anthropomorphic. Their height varies from 12 to 90 cm. The majority are formed of straight lines and presented frontally. Arms and legs are spread out and the head is approximately round in form. A few figures have “antennae” on their heads and some are carrying objects. In addition to the anthropomorphic figures, there some animal figures, geometric patterns and combinations of long and short lines.

Clear drips on the floor in Solsemhula indicate that the paint was liquid when it was applied. There is no evidence that an adhesive was used. Carbonite-rich water from the interior of the rock may possibly have been added to the pigment. Only adhesives that are mixed with water will adhere to humid cave walls[3].

A majority of the figures are painted directly on to the rock surface. The remainder are placed entirely or partially upon white, cauliflower-like crusts of calcite (Figure 7). It is compelling to suggest that the figures that consist of short, thin lines, were painted with fingers. More common figures with longer, thicker lines have obviously been applied with a brush. The brush strokes are clearly visible on a large, cruciform figure in Solsemhula.

Figure 7. Two out of a number of figures that are painted on a layer of calcite on the roof of Brusteinarhula, Gildeskål, Nordland. Photo: T. Norsted.

1.1.4 Dating

[3] Water that collects in caves is **calcium-rich** and has a certain binding ability. Analyses have shown that the majority of figures in Spanish and French caves appears to be painted with pigment that is only mixed with water. Since no remains of an organic binding agent have been identified in Norwegian cave paintings, the same can be true in this country. Geomagnetism has contributed to fastening the iron-bearing pigment to the cave walls. In two French caves (Labastide and Enlène), there has been found remains of an oil-like substance in the paint.

Knowing the age of rock art contributes to increasing the awareness of their value. Therefore the desire to obtain reliable dates has been an important challenge in the study of rock art. Rock art can be dated by direct and indirect methods. Direct dating involves dating the actual rock art, for example the organic constituent parts of a rock painting. Indirect dating is based on a contextual relationship such as the dating of cultural layer(s) in close proximity to a rock art panel. Using this method, the activity associated the panel is dated rather than the rock art itself.

Stone Age rock art that consists mostly of ground and pecked motifs, has usually been dated based on its elevation relative to present sea level. As a rule of thumb, it is assumed that the higher the rock carvings lie above present day sea level, the older they are. The ground rock art in Nordland appears to be the earliest and dates to the first part of the Early Stone Age, while the pecked rock carvings generally date to the later part of the Early Stone Age, Late Stone Age and Bronze Age. The use of prehistoric shorelines as a dating method can only provide a maximum age for rock art. In principle, the rock carvings could have been made at any time after the shoreline had emerged, and were not necessarily pecked or ground into the rock when it was at the water's edge. Shoreline dating cannot be used to the same extent for agricultural rock carvings (the South Scandinavian rock carvings). Other means must be employed to date this rock art. This involves using a comparative technique that considers the similarities and differences relative to known artefact types and decoration. Artefact types that can be placed within a relatively reliable chronological framework (such as razors, lurs (horn-like wind instruments) and weapons from the Bronze Age) with rock art figures depicted on the same type of objects. Indirect dating can also be considered when the following criteria are present:

- Approximate dating of the motifs in relation to other motifs of the same type (or in the same area) that have previously been dated.
- Assessment of the amount of surface coating in the pecked grooves relative to the surrounding rock surface; "patina" is interpreted here as a surface coating that forms through a gradual change in the surface colour (usually darkening) and texture as a result of precipitation, oxidation and microbiological processes.
- Assessment of the degree of weathering in the pecked grooves relative to the rock's general resistance to weathering.
- Documentation of the degree of overlapping between the motifs; this gives an indication of relative age if a closer inspection of patina/degree of weathering can provide circumstantial evidence for a substantial age difference.

1.2 History

The fact that rock art is a particularly vulnerable and damage-prone cultural resource was already recognized by Scandinavian researchers in the 1900s. This recognition grew parallel with, and as a result of, the comprehensive and increasingly thorough documentation work that characterized the decades before and after the turn of the century. The first to document damage to rock art was Carl Georg Brunius who, in 1815, documented extensive weathering damage to rock art in the Tanum area. Both Gustaf Hallström and Johannes Bøe, who documented rock carvings at Vingen in 1913-17 and the 1920s, respectively, commented that many figures were extensively damaged by weathering. In a series of rock art monographs from the 1930s, it is pointed out that previously documented panels were so overgrown that it was difficult to find them again, and that figures were partially worn away. In addition, many carving panels were damaged or vandalized because the public had painted or incised their names or dates into and around the figures.

A measure of the degree of decomposition was obtained when Anders Hagen undertook new investigations of the Ausevik carvings in Flora municipality and Sogn og Fjordane at the start of the 1960s. The panels had been recorded by Johannes Bøe in the 1930s, and comparison of tracings and photographs from the first investigations confirmed that a number of figures had been extensively damaged or disappeared completely over the course of thirty years.

The first systematic documentation of the condition of Norwegian rock art was initiated in the mid-1970s with funding from the Arts Council Norway (*Norsk Kulturråd*) and Ministry of the Environment (*Miljøverndepartementet*). A national group led by Kristen Michelsen from what was then the Bergen Historical Museum (*Historisk museum i Bergen*)[4] produced a report on damages to rock art and recommendations for protection measures. The report concluded that the condition of rock art over the entire country was critical, and that a series of measures had to be implemented in order to save the most exposed panels. A committee appointed by the Directorate for Cultural Heritage in 1991 came to the same conclusion and emphasized that the need for protection of rock art was urgent and a national responsibility in their concluding document *Rock Art – a cultural treasure in crisis*. The poor state of preservation for rock art was confirmed through the data presented in 1995 by the Directorate for Cultural Heritage in their plan of measures for the *Preservation of rock art*. Here it is confirmed that the more than 90% of the country's rock art localities were damaged to some degree. This led the Directorate for Cultural Heritage, with financial support from the Ministry of the Environment, to place rock art preservation on the archaeological agenda through the national project *Protection of Rock Art* (*The Rock Art Project 1996-2006*). The Rock Art Project provides the starting point for the Norwegian Working Group for Rock Art Conservation (*Norsk faggruppe for bergkunstkonservering*). Members are appointed by the Directorate for Cultural Heritage and represent the regional museums and Norwegian Institute for Cultural Heritage Research (NIKU). The group has an interdisciplinary competence (see Chapter 10).

[4] From its founding in 1825 up until the creation of the University of Bergen in 1948, this institution was called Bergen's Museum, and included both cultural history and natural history. From 1948 onward, archaeology, ethnography and art history were brought together under the name Historical Museum. In 1995, the umbrella organization Bergen Museum came into being and includes both culture history and natural history departments.

Figure 8. A) Extensive weathering damage in the form of exfoliation has left only some parts of these rock art figures intact. Vingen, Bremanger, Sogn og Fjordane. Photo: L. Sæbø.

Figure 8. B) Rock art figures partially covered by lichens. Austre Åmøy, Rogaland. Photo: T.Bjelland.

1.3 Management tasks and distribution of responsibility

The Cultural Heritage Act defines *all traces of human activity in our physical environment* as cultural heritage. This is an extremely broad definition that includes everything that is humanly created in our surroundings, from the earliest archaeological evidence to modern-day structures.

Responsibility for the management of cultural heritage is divided into three management levels in descending order: the Directorate for Cultural Heritage, the counties / Sámi Parliament (*Sametinget*) and the regional archaeological museums.

Following § 11a of the Cultural Heritage Act and regulation § 1, points 1-3, the Directorate for Cultural Heritage, the counties / Sámi Parliament and the regional archaeological museums have the right to search for and record automatically protected cultural resources. The Directorate for Cultural Heritage and counties / Sámi Parliament also have the designated authority for management measures associated with such cultural resources, including those that involve direct intervention. It is emphasized that the objective of such actions is to protect, preserve and maintain cultural resources / cultural environments or to make these visible for the public.

The division of responsibility does not necessarily entail that the counties / Sámi Parliament carry out such actions themselves, but that this management level has the authority to insure that necessary management actions are initiated. When specialized tasks such as condition documentation and conservation are necessary, the regional museums (and others such as the Norwegian Institute for Cultural Heritage Research) expertise should be utilized. This assumes a close cooperation between the counties / Sámi Parliament and the regional archaeological museums in the choice of action and means employed for management and preservation. Following regulation § 3 of the Cultural Heritage Act, the three management levels (Directorate for Cultural Heritage, counties / Sámi Parliament and the regional archaeological museums) are required to keep one another informed in cases of mutual interest. However, it is a prerequisite that the regional museums and counties / Sámi Parliament concur in their priorities and level of ambition before potential management actions are carried out. The relationship to the municipalities involved, district museums and landowners must also be clarified before actions are carried out.

Actions for protection and management must be planned and implemented in relation to a previously prepared management plan that is approved by all of the involved parties.

In the Rock Art Project, the regional archaeological museums have had primary responsibility for securing Phase 1 (documentation) (Table 1). In addition, various firms with special competence have participated in tasks within areas such as conservation and photography. Phase 2 (protection plan production) has been carried out with close cooperation between the regional archaeological museums and counties since the museums produce a draft of the protection plan based on Phase 1 documentation. The counties must complete the protection plan with a financing plan and take responsibility for agreements between the involved parties. The regional archaeological museums have been responsible for the completion of Phase 3 (implementation). The counties have normally carried out the management and preparation actions within Phase 4 (follow-up), with input from the Sámi Parliament in appropriate areas.

Table 1. Protection in accordance with the Rock Art Projects definition.

Protection phase	**Definition**
Phase 1: Documentation	Documentation provides a status assessment (archaeological and technical/scientific documentation, graphic documentation and traditional background material where this is considered relevant). Protection of source material and terms for actions to be taken.
Phase 2: Management plan with management agreement	Management plan prepared along with management agreement / letter of intent. A standard template can be used to establish guidelines for both long term and short term actions, forms of cooperation and professional and economic responsibility.
Phase 3: Implementation	Potential immediate measures (emergency conservation) implemented. *When Phase 3 is completed (where it is necessary), protection is considered complete. In other cases, protection is completed when Phase 2 is finished.*
Phase 4: Follow-up	Follow-up, review and revision of the protection plan.

2. THE STATE OF ROCK ART TODAY

2.1 Decomposition processes

Weathering is a complicated interaction between different physical, chemical and biological processes, which leads to the breakdown and alteration of minerals and rocks at the earth's surface. Weathering occurs because rocks and minerals are unstable on the surface, where they are exposed to entirely different physical and chemical conditions than when they were formed. It is this difference that drives the weathering processes and leads to the breakdown and alteration of minerals and rocks to form products that are more in equilibrium with newly imposed physico-chemical conditions. These processes are thus closely linked to atmospheric, hydrospheric and biospheric conditions. Decomposition processes are divided into three main groups: (I) physical, (II) chemical and (III) biological processes. Physical weathering is decomposition of a material into smaller fragments without a change in mineralogical or chemical composition, such as jointing and fragmentation due to frost action. Chemical weathering is the dissolution of primary minerals in the rock through reaction with water, and can lead to changes of both chemical and mineralogical composition. Only in extremely cold and/or dry areas will one find physical weathering alone, since chemical weathering will also take place if water is present. Biological processes are linked to activity from, for example, plant roots, lichens and microorganisms. Biological processes include both physical and chemical processes and can **therefore be** classified under these categories. Nevertheless, one often chooses to separate these from purely inorganic processes.

I. **Physical weathering processes**
   - Frost action
   - Wave erosion
   - Wind erosion
   - Temperature variation (mainly by fire)
   - Precipitation / crystal growth
   - Pressure relief fracturing

II. **Chemical weathering processes**
   - Dissolution of minerals in reaction with water

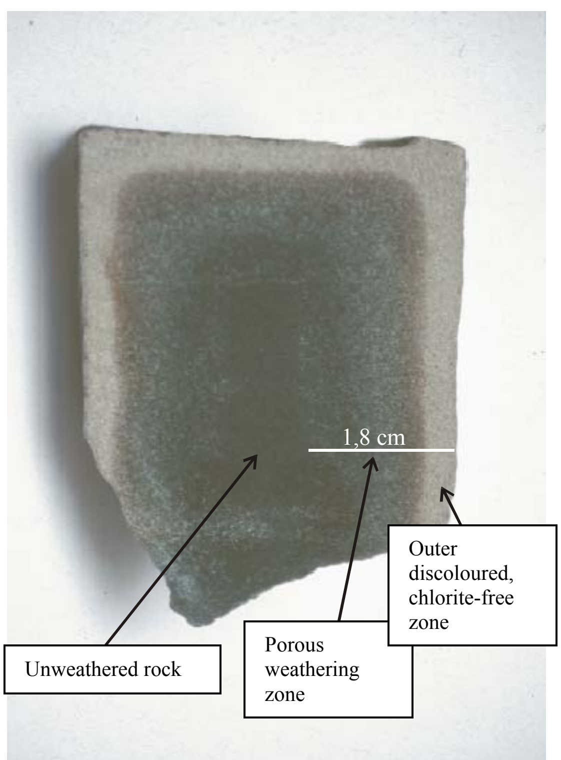
III. **Biological weathering processes**
   - Chemical: precipitation of acids (lichen, peat/soil)
   - Physical: Root action, lichen growth

Although physical and chemical weathering are different in nature, there is a close interplay between these processes, and they are often difficult to separate in practice. The speed of decomposition of rock surfaces is controlled by rock composition (different minerals have different weathering resistance dependent on chemical composition and crystalline structure) and of environment.

The most essential environmental factors for physical, chemical and biological processes are probably *water* and *temperature*, which are determined by climate. Light is also an essential factor for most biological processes and important for the establishment of pioneer organisms on the rock surfaces.

2.1.1 The general damage picture

Due to post-glacial chemical weathering, the majority of rock surfaces in Norway have developed an outer, porous, and often partially discoloured, weathering zone (Figure 9 and 10). The thickness of the weathering zone varies from a few millimetres up to two or three centimetres, dependent on, among other variables, primary porosity, grain size, mineral composition and rock type. All minerals can be chemically weathered, but are more or less resistant, and are broken down at differential rates. The degree of dissolution of each individual rock varies depending on how resistant individual minerals in the rock are to chemical weathering. Cross-sections through rock surfaces reveal an outer, weathered surface "rind" with a different character (such as colour, mineral composition, porosity and physical strength) than the inner unweathered rock. Since the chemical weathering started from the surface and therefore has had the longest effect here, the minerals in the outermost part of the weathering zone are most dissolved and porosity subsequently highest here. Porosity decreases inwards in the rock surface as a result of shorter weathering time. The degree of mineral grain dissolution is also dependent on grain size. Small grains can be completely dissolved, while larger grains of the same mineral are only partially dissolved.



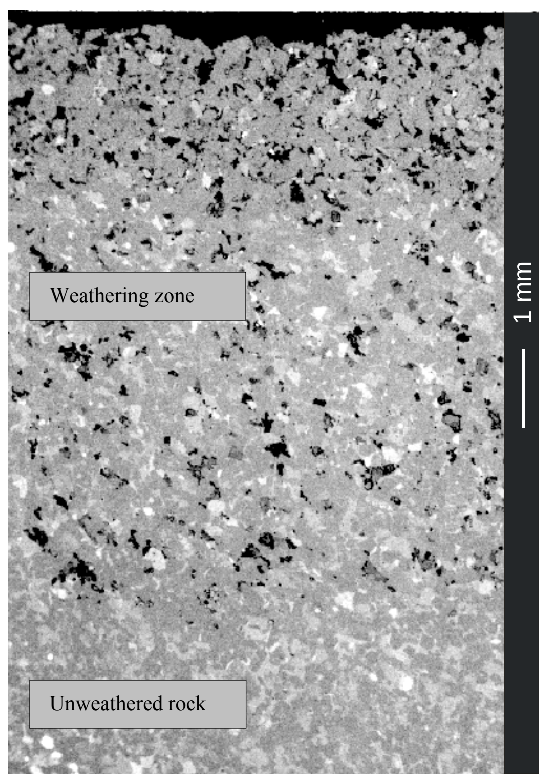


Figure 9. A) A 1,8 cm thick porous weathering zone is visible in a sandstone cross-section from the rock art locality Vingen, Sogn og Fjordane.

Figure 9. B) A SEM photograph of a similar cross-section. In the SEM, materials with different densities appear as different shades of grey. The different grey tones in the image thus represent different minerals in the rock and the black areas are voids/pores. The rock at the bottom is unaffected by weathering.

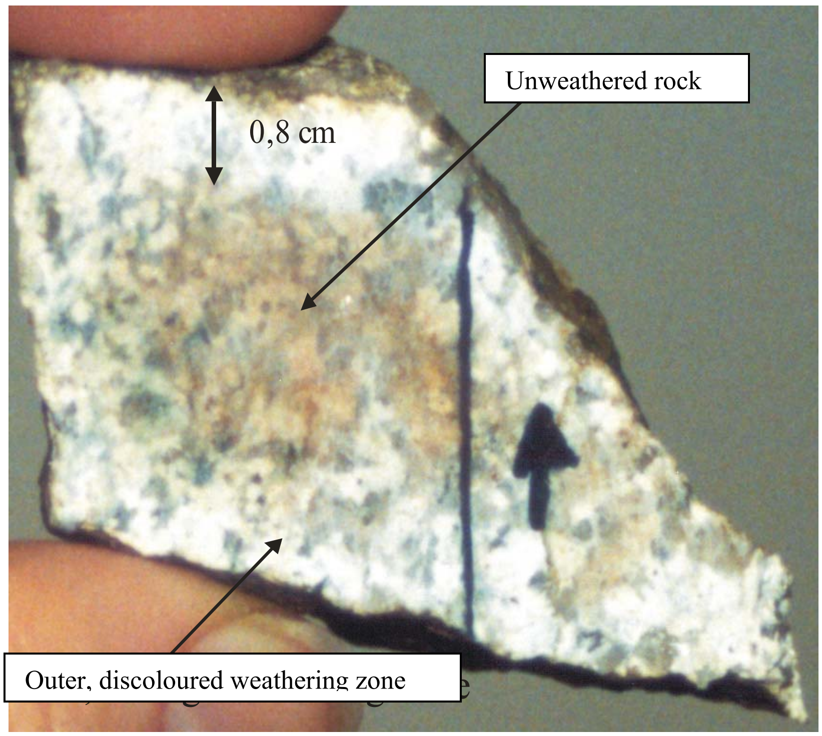


Figure 10. A 0.8 cm light discoloured weathering zone has developed in the surface portion of granite from the rock art locality Vestbøstad, Fitjar, Hordaland. Photo: L. Sæbø.

The reason that the damage to Norwegian rock art panels appears to have increased in recent years is probably because weathering has reached a critical point. Weathering is not a linear process where the surface gradually wears down. Chemical weathering leads to a loosening of grain boundaries in mineral grains so they no longer adhere to one another. The mechanical weathering which follows causes the loose grains to eventually fall off. Weathering since the last ice age has produced rock surfaces that are presently extremely porous and open both for water and biological activity. This increased surface area within and on the rock surface in turn provides the basis for increased mechanical as well as chemical decomposition. Rock surfaces are therefore extremely vulnerable and tolerate only a limited amount of mechanical stress or additional chemical dissolution before the individual mineral grains loosen and the rock surface crumbles away (granular weathering) or splinters off in flakes. It has taken thousands of years of chemical weathering to form these porous rock surfaces, but will only take a few decades of physical/biological processes before the up to 3 cm thick weathering zone crumbles / flakes off and the rock carvings disappear. When the weathering zone flakes off, fresh unweathered rock is exposed. This surface is then exposed to chemical weathering, and weathering extends further downwards into the rock surface. Peeling and exfoliation, even of thin flakes, is dramatic since carvings are often extremely shallow and parts of painted figures can be lost. Over the long term, the process of granular weathering will also have serious consequences for the rock carvings.

2.2 Weathering damage

2.2.1 Weathering damage

In this chapter, the most common types of weathering damage that affect rock art panels will be described. Most of the types of damage apply to all forms of rock art. Situations that apply specifically to rock and cave paintings, will be clarified later (see chapters 2.23 and 2.2.4). The following is an explanation of the different terms that have been used for damage documentation during the Rock Art Project. Some terms (loose grains and mineral precipitation) will probably be removed in the new damage documentation form that will appear in the National Cultural Heritage Database (*Askeladden*).

Loose grains

Loose grains are released mineral grains that form a residue layer on the surface after surrounding, less resistant rock minerals are dissolved (Figure 11). Observation of loose grains is an indication that granular weathering is active, and leads to a gradual muting of carved figures.

Figure 11. Loose grains and splintered flakes in depressions on the rock surface indicate that granular weathering is active at the locality Unneset, Askvoll, Sogn og Fjordane. Photo: K. H. Riisøen.

Exfoliation

Exfoliation is concentric thin layers that successively flake off parallel to the rock surface (Figure 12). The layers are often < 2 mm thick, but can have a circumference > 20 cm. The phenomenon is observed on a number of rock types, such as granite, sandstone and gneiss, and the problem is most pervasive in rocks where foliation/cleavage is parallel with the surface. Rock surfaces are uneven in many places due to ~2 mm high, vertical damage edges from exfoliation. Damage edges are often bounded by air pockets with and extent of many cm^2.

Exfoliation is often a problem associated with cracks. Water is retained in cracks and seeps into the weathering zone along these, thus saturating the pores. Water expands when frozen, which can easily lead to jointing and flaking of the weathering zone, as well as crack expansion. Jointing and flaking results in the exposure of fresh rock that is subsequently exposed to weathering.

Figure 12. A) Exfoliation of the surface of granitoid gneiss at the rock art locality Leirvåg, Askvoll, Sogn og Fjordane. The light section is the fresh rock surface exposed by exfoliation. Photo: L. Sæbø

Figure 12. B) Exfoliation of the surface of andesitic tuff/tuffi at the rock art locality Kåfjord, Alta, Finnmark. Photo: L. Sæbø

Granular weathering

Rock surfaces with high porosity will be exposed to granular weathering, and loose mineral grains can often be observed in depressions and cracks on these surfaces. Granular weathering will often be visible on the rock surface in the form of small light spots, where new rock surface without micro-vegetation / surface coating is exposed after sand grains have flaked off (Figure 13A). Investigation of these surfaces under an electron microscope show that the individual mineral grains are barely adhering to one another (Figure 13B). The rock surfaces are extremely vulnerable and will only tolerate a minimal amount mechanical stress or additional chemical dissolution before the individual mineral grains loosen and the rock surface crumbles. Granular weathering leads to a gradual, but eventually extremely dramatic muting of carved figures.

Figure 13. A) Granular weathering is often visible in the form of small light spots, where a new rock surface without micro-vegetation / surface coating is exposed after sand grains have flaked off. Example from Vingen, Bremanger, Sogn og Fjordane. Photo: L. Sæbø.

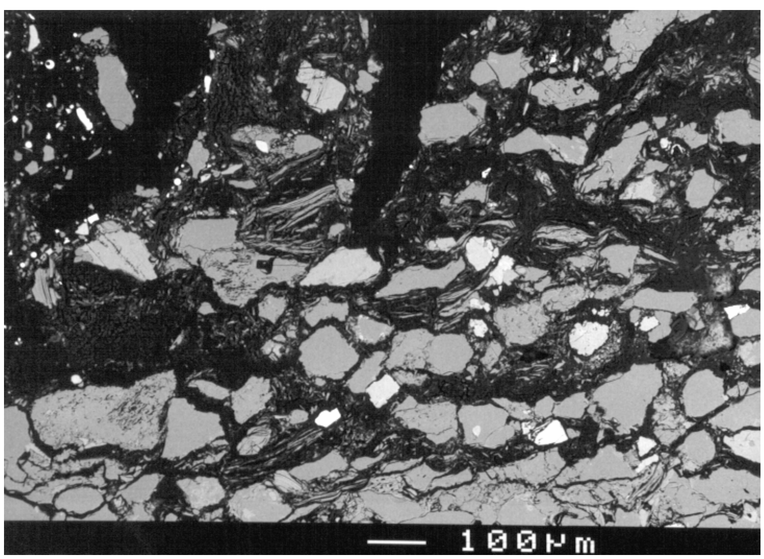


Figure 13. B) A SEM photograph of the same rock shows that the individual mineral grains are barely attached to one another in the uppermost weathering zone. Photo: I. H. Thorseth.

Air pockets

Air pockets are formed by jointing of the rock parallel with the surface without the actual rock surface flaking off. The rock section is loose, but remains in place. Air pockets are not visible on the surface, but can be discovered by the distinctive hollow sound made when one taps carefully on the loose section with a light metal object (Figure 14).

Figure 14. The circumference of the air pocket is outlined here with chalk on a rock surface in Hjemmeluft/ Jiebmaluokta, Alta, Finnmark. Photo: L. Sæbø

Chemical weathering

Layered and laminated rocks can often have layers and lamina with different resistance to chemical weathering, so that one can observe differences in relief above the surface of such rocks. Layers that are rich in more resistant minerals will last longer than layers rich in less resistant mineral grains (Figure 15A). Relief differences can also be observed in rocks with layers and lamina that have variable grain size (Figure 15B). Fine-grained layers and lamina are often more deeply eroded because it takes less time before the mineral grains are totally dissolved in such layers. Only in extremely cold and/or dry areas will one find physical weathering alone, since chemical weathering will also take place as long as water is present. Thus chemical weathering always represents a threat for the preservation of rock art.

Figure 15. A) Chemical weathering of minerals with different resistence has created a porous surface at the rock art locality Unneset, Askvoll, Sogn og Fjordane. Photo: L. Sæbø.

B) Chemical weathering causes relief differences in rocks with layers and lamina of variable grain size. This photo is of the sandstones at Vingen, Bremanger, Sogn og Fjordane. Photo: L. Sæbø.

Crack-related weathering

Cracks in rock surfaces often form depressions in the rock where water collects and vegetation is established. Crack formation and the splitting off of flakes and pieces of rock as a result of frost and root action in the cracks, is often a substantial threat to the preservation of rock art. Crack-related weathering is a significant problem where cracks with different orientations cross one another. Pieces of rock often fall out at these locations, and rock art can be partially or totally destroyed (Figure 16).

Figure 16. At the point of intersection between cracks of different orientations, sections of rock art have been lost because pieces of rock have fallen out. Photo from Hjemmeluft/ Jiebmaluokta, Alta, Finnmark. Photo: L. Sæbø.

Flake weathering

Cracking and flaking of schistose/foliated rocks occurs often, especially when the cleavage/foliation is vertical to the surface or sloping relative to it (Figure 17). Flaking is especially serious along cracks and damage edges. Freezing water or roots that grow into the cleavage planes and thereby exert a sideways pressure, will in such cases not meet any resistance and flakes are easily broken off. In this way, flaking moves inward through the rock parallel with the topographic surface. Fresh rock is exposed where the outer weathering zone flakes off. This surface is in turn exposed to weathering. The process of flaking should not be confused with exfoliation.

Figure 17. The fracturing of rock flakes often occurs where cleavage/foliation is vertical to the topographic surface as here at the rock art locality Ausevik, Flora, Sogn og Fjordane. Photo: L. Sæbø.

Mineral precipitation

In Norway the amount of rainfall is so high that mineral precipitation is extremely seldom on open rock surfaces exposed to rain. The potential formation of mineral precipitation on such rock surfaces does not lead to increased dissolution of rock, but instead to the deposition of material which is often more of an aesthetic problem than a threat to the preservation of rock art figures. Iron precipitation from water seepage has been observed at a number of rock art localities. At some locations, carbonate precipitates are present and originate from lime infilling within cracks on the rock surface. Amorphous silicates have precipitated on the rock surfaces at other rock art localities (see 2.2.2).

Mineral precipitation can, however, represent a serious threat to the preservation of rock and cave paintings found on nearly vertical rock surfaces that are protected against rainfall (see Chapter 2.2.2 and 2.2.3). Pore water (infiltration water) that moves through the rock towards its surface, brings with it dissolved salts that precipitate onto the surface when allowed by climatic conditions. Heavy soluble salts (such as carbonates) can precipitate in the pores of the weathering surface and create pressure that leads to cracking and flaking in the outermost rock surface.

2.2.2 Silica skin – a preservative environmental factor?

It is common for south facing rocks to be covered by a transparent, light reflecting layer of amorphous silicate referred to as “silica skin” or “silcrete” (Figure 18). This silica skin can vary considerably in thickness, even within the same panel. However, it is seldom more than c. 1 mm thick. As with a glossy painting varnish, silica skin of a certain thickness will reduce the painting’s colour tone significantly. Evidence indicates that the initial formation of a thin silica skin layer over the rock art figures occurs fairly rapidly. Silica skin is an important preservative environmental factor, but can also have the opposite effect. It must be recorded during condition documentation.

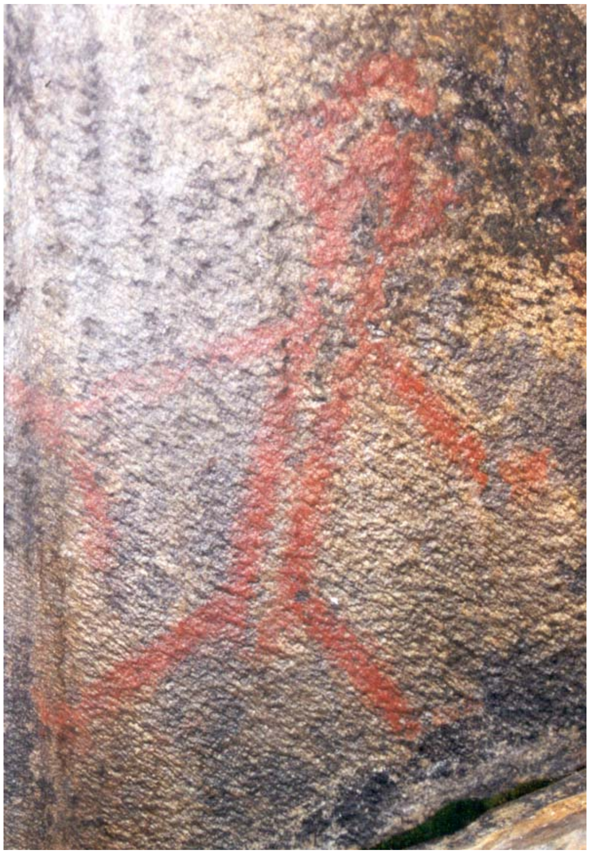


Figure 18. Rock paintings covered by amorphous silica skin, Indre Sandvik/Ruksesbákti, Porsanger, Finnmark. Photo: L. Sæbø.

A layer of silica skin probably existed on the rock surface when the paintings were applied. Silica skin is extremely resistant to chemical weathering, but eventually when it reaches a certain collective thickness, tension will lead to the formation of microscopic cracks. SEM observations demonstrate that micro-cracks extend crossways through the silica skin from the surface to the original rock surface (Figure 19). Flaking between the silica skin and rock surface occurs at the same time. This can lead to cracking and localised peeling of the silica skin. In the worst case, the painted figures can be removed when this happens.

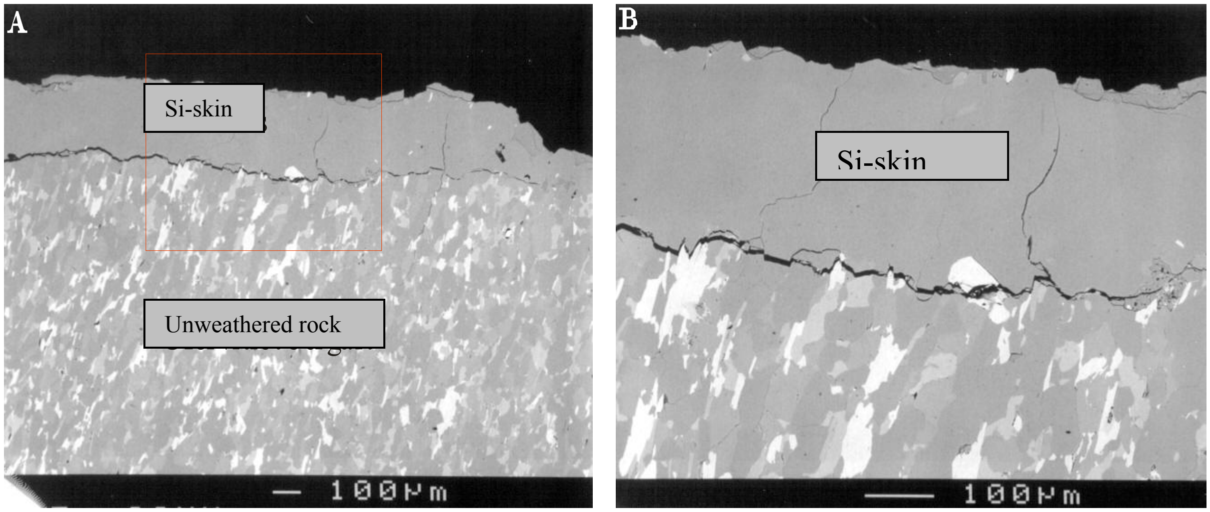


Figure 19 A) SEM photograph of a cross-section of the rock surface from the rock art locality Indre Sandvik/Ruoksesbákti, Porsanger, Finnmark. A ~ 300 μm thick layer of amorphous silicate has precipitated and formed a silica skin on the rock surface. B) A section from A (red square) shows that the silica layer has cracked off from the rock surface, and micro-cracks also extend through the silica skin. This cracking can bring about a localised flaking of the silica skin, and in the worst case the painted figures can be lost when this happens. Photo: L. Sæbø.

Silica skin is often easily observed on rock surfaces with paintings. As it increases in thickness over time, the layer will probably encase small remains of organic material. By taking samples of such remains closest to the painting surface and having them AMS dated, a relative age estimate (minimum age) for the paintings can be calculated. Sample collection is difficult and requires special expertise. The analytical results can easily be misinterpreted.

When the paintings are first covered with silica skin, they tolerate more rain. Rainfall can probably have a stabilizing effect on the silica skin. Since it is weakly water soluble, the rain will wear down and regulate the thickness of the layer. This reduces the danger that the silica skin will be exposed to cracking and flaking.

2.2.3 Destructive environmental factors for rock paintings

The presence of water is the most important destructive environmental factor for rock paintings.

There is always water present in the rock structure. This water, described as *infiltration water* or *pore water*, is in motion. The quantity and speed of infiltration water will be dependent on how much excess water is found in the terrain, but also on the rock porosity and crack system. If the water seeps out evenly and in small amounts, it can spread itself as a thin membrane on the surface. Dissolved salts in the water can precipitate out during evaporation that occurs if the temperature rises and the relative humidity sinks. This results in the formation of a thin, white veil of crystals on the surface. In the winter the water film can freeze to ice. Alternatively, when the water seeps out faster and in greater amounts after rainy weather and during snow melting, it has a tendency to seep downwards over the surfaces in a fixed channel. If this occurs often enough and in sufficient amounts, it can locally dissolve the silica skin. As a consequence, the pigment affected by the water seepage can be washed away. At the same time, crystals can form along the margins of the water channel, where it is thinner and more easily evaporated.

Surface water can have a variable impact. This is conditioned most by the form of the rock. Overhangs can provide protection, but certainly not in all cases. If the overhang's underlying surface slants sharply inward, the water will continue underneath and further downward until it eventually reaches a formation that serves as a drip formation point. It is often difficult to predict which way the rainwater will run on a strongly undulating rock surface. In the worst case, it will come in contact with painted figures and wash away the pigment (Figure 20). It is recommended that localities be observed during and after a hard rainfall to record the effect (remember to photograph the observations!).

Figure 20. Section that shows water seepage downward over a rock after rainfall. Water/frost has lead to peeling that has made the figures difficult to understand. Indre Sandvik/Ruksesbákti, Porsanger, Finnmark. Photo: T. Norsted.

Exposure to sunlight can be an effective destructive factor if the rock has a south to southwest orientation, and especially when incoming rays of light strike nearly perpendicular to the surfaces with figures. This can cause large temperature differences in the rock surface through the day and can create tension that leads to exfoliation, especially when moisture is present.

Salts and *frost* are significant causes of destruction. The effects will not be serious when the crystals form a thin layer on the surface. It is different when the crystals form just under the rock surface and cause frost and salt weathering. This can lead to the loosening of pieces of the rock surface that subsequently flake off (Figure 21). This type of damage is most widespread in cracks and other areas that retain moisture. A significant supply of moisture in the springtime will – combined with frost melting cycles – be destructive. Schistose rocks are particularly prone to frost action.

Lichens are the most important form of micro-vegetation on south facing rocks. In association with permanent water seeps, it is common to find *green algae* and *cyanobacteria*. In shady areas where a certain amount of moisture is maintained, moss also grows.

Diverse forms of *macro-vegetation* are found on and around all rocks. Humus that collects in uneven clusters, primarily on ledges and in cracks, can provide suitable growth conditions for trees and bushes. Growing roots can, together with infiltration and surface water, lead to the expansion of crack formation and cause flaking and rock falls.

Figure 21. Exfoliation of a weathering surface. One of a number of rock painting motifs that are in danger of being lost in this way at Hinna, Tingvoll, Møre og Romsdal. Photo: T. Norsted.

2.2.4 Destructive environmental factors for cave paintings

Caves constitute a distinctive environment that gives the impression of being closed. But they are always influenced by external climatic processes. The degree of influence is dependent on the size and orientation of the cave opening relative to the dominant wind direction. A cave's size and axial form are important factors affecting the influence of air currents that bring seasonal changes in climatic. Air movements also insure exchange of gases with oxygen moving in and carbon dioxide out. External influences occur according to a set, yearly pattern that in the long-term can have a destructive impact on the paintings.

Moisture is the most important destructive factor in cave environments. It appears as water vapour in the air, as condensation on surfaces and as infiltration water (pore water) in the rock.

Infiltration water is surface water that forces itself into the rock, where it seeps continuously through pores and cracks. Quantity and speed are dependent on precipitation and snow melting, potential for drainage and absorption from trees above the cave, as well as the rock's porosity and crack system. Infiltration water increases the degree of crack formation over time. This is an important reason for the loosening of blocks from the cave vault. Seismic activity and frost action in particular are contributing factors leading to such rock falls.

When infiltration water reaches surfaces in the cave, it will seep out of individual fissures and cracks. If this occurs almost continuously and in small amounts, the water will spread as a thin membrane over the rock surface. If it occurs abruptly as a result of heavy rainfall or snow melting, the water will seep down the rock surface in a fixed "channel". The water can flow over the figures and this will break down the weak bond between the pigment and the rock. This is a significant reason for the total or partial destruction of individual paintings (Figure 22).

Figure 22. An example of infiltration water that has flowed from a crack and muted large parts of a painted human figure. The left arm, a majority of the torso and a small part of the legs are visible, but the colour is weak. Bukkhammarhula in Moskenes, Nordland. Photo: T. Norsted.

Infiltration water consists, in reality, of *weak salt solutions*. Some of the salt can originate from the terrain above the cave, but is for the most part a product of geochemical reactions (ion formation) that involves water and soluble minerals in the rock. Analyses have shown that the salts consist mainly of carbonates and calcium sulphate (gypsum) [5]. When a salt solution of this type reaches the cave surface, its behaviour is dependent on climatic conditions. If the relative humidity[6] is low, the water will evaporate from the solution, which will become more and more saturated. If the saturation point is reached, the salts will *precipitate* as crystals. Heavy soluble salts have a low saturation point and will precipitate first. Carbonates are a component of these salts. If the rock is porous, as it often is in the weathering surface, a portion of the salts can recrystallize in pores *below* the surface. This creates an inner pressure in the rock surface that can lead to peeling (Figure 23). Salt action is one of the reasons for destruction of cave paintings. Frost can act in the same way and lead to a similar type of damage.

[5] Identified by XRD and SEM-EDS analysis by, respectively, the Geological Museum and Museum of Cultural History (UKM) at the University of Oslo (cf. Section 3.2.4).

[6] Relative humidity: The amount of water vapour that the air contains relative to what it *can* contain at the same temperature. The amount is indicated as a percentage. When the air is saturated with water vapour, the relative humidity is 100 %.

Figure 23. The country's most vulnerable cave paintings. The picture shows one of six figures in a panel where most of the figures are covered and lifted up by precipitates, and which will not tolerate the least amount of contact. Sandenhula, Værøy, Nordland. Photo: T. Norsted.

The white salt precipitates are a characteristic feature in cave environments. They are often concentrated along cracks. Precipitates vary considerably with respect to hardness, thickness and surface. Precipitates that are colourless and have been deposited as a protective "skin" over the paintings, are relatively scarce. Red and reddish brown precipitates of, respectively, iron oxide and rust (corroded iron = iron oxide) are, on the other hand, common. In certain cases, the precipitates can grow relatively rapidly, but as a rule take a long time to form. Old, thick crusts of calcite and gypsum can loosen over time, so that figures that are painted on them are lost.

Some precipitates are caused by *condensation*. Commonly, condensation appears when the outside temperature rises in early summer. At this time, heated air flows into the cold and moist cave. When this cold air comes in contact with the cold rock surfaces, part of its water vapour content condenses and moisten the surfaces. Since the relative humidity in the cave is usually extreme high, just a minor increase in temperature will be enough to cause condensation. The water first appears on the surfaces after some of it has been absorbed by the rock's outer layer, where it is transformed to weak salt solutions. When a salt precipitate is forced out to the surface by decreasing air humidity in the winter, a white, veil-like precipitate is often formed. These can loosen with renewed condensation, but can also become permanent and cover the figures (Figure 24). A surplus of condensation moisture often collects in drops that flow slowly downwards in the same channels year after year. Dark traces from the drops are visible in the condensation precipitates and can contribute to making the figures unclear.

Figure 24. Precipitate that partially covers two painted figures. Traces of seeping condensation drops are also visible. Troillhålet, Hamnøya in Vevelstad, Nordland. Photo: T. Norsted.

During periods with considerable condensation, the paintings will often be totally enclosed in moisture. This condensation moisture weakens the bond between the pigment and the rock surface. When the figures are in a moist condition in the summer and fall, the colour will rub off with the least amount of contact. The pigment particles will also have a tendency to separate so that they partially spread themselves over the rock surface. Condensation moisture is the most important reason that a large number of cave paintings are more or less without contours and muted (Figure 25).

Figure 25. A) Example of cave paintings with clear contours. Kollhellaren in Moskenes, Nordland. Photo: T. Norsted.

Figure 25. B) Example of cave painting with very vague contours on the eastern wall of Solsemhula, Leka, Nord-Trøndelag. The vague contours can probably be attributed to condensation moisture. Photo: T. Nordsted

2.3 Human-related damage

2.3.1 Painting

Wilful damage can include vandalism using permanent ink markers, paint, graffiti and tagging (Figure 26). Paint is more difficult to remove the longer it hardens, so it is important that it is removed as quickly as possible. Paint removal is a direct intervention and must be considered carefully. The removal methods that are used involve considerable stress on the rock surface and must be done by a conservator (see Chapter 5 and 5.2.7).

Figure 26. Graffiti on one of the rock art panels at Vingen, Bremanger, Sogn og Fjordane. Photo: L. Sæbø.

2.3.2 Mechanical wear, incising and chalking

Rock art and rock art panels can be damaged by deep and disfiguring incising (Figure 27 and 28).

Figure 27. Vandalism in the form of recent incising in the original rock art grooves. Rødøya, Alstahaug, Nordland. Photo: T. Norsted

Figure 28. Modern incising done by children. Authentic ground rock art is found on the same rock surface. Klubba, Meløy, Nordland. Photo: B. H. Helberg.

The fragile weathering surface can also be broken due to pressure from being stepped on, driving mopeds and off-road motorcycles (Figure 29), sledding with and without sleds and other forms of transportation over the rock surface. People have also attempted, with varying amounts of success, to chop loose pieces of rock with rock art.

Figure 29. Brake marks from bicycles with studded tires on carved rock art at the locality Kirkely, Tennes in Balsfjord, Troms. Photo: B. H. Helberg.

On rock paintings, scratch marks have been made by sharp rocks or knives in the silica skin (Figure 30). Vandalism also includes the use of pencils and chalk. Chalking used to clarify the figures prior to photographing and tracing, is usually associated with documentation done between 30 and 60 years ago. This chalking has often been covered by silica skin and is therefore impossible to remove without the danger of damaging the paintings (Figure 31).

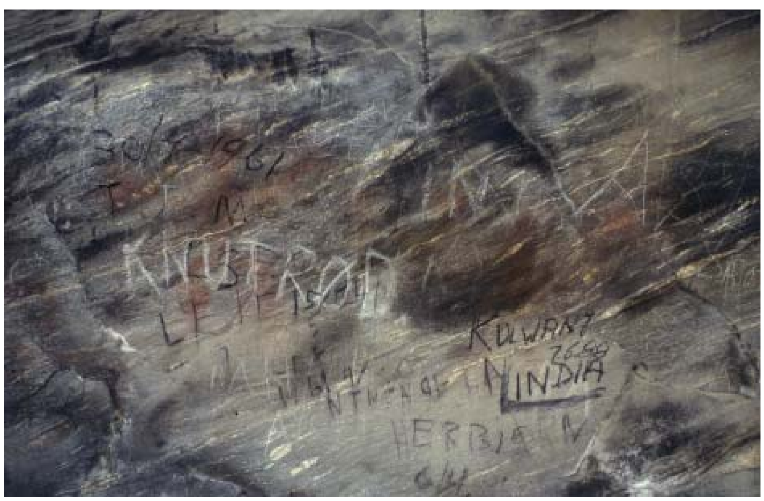


Figure 30. Tagging done with pieces of charcoal and by incising with rocks on two 90 cm high painted human figures that can barely be seen. Helvete in Trenyken, Røst, Nordland. Photo: T. Norsted.

Figure 31. A) An example illustrating why chalk must be removed as soon as possible after application. Rock paintings in Transfarelvdalen, Alta, Finnmark, were chalked during documentation work in the 1960s. The chalk was still visible when this photograph was taken in 1999. Photo: L. Sæbø.

Figure 31. B) Traces of chalk that are probably from the first documentation (1963) of Fingalshula, Nærøy, Nord- Trøndelag. Photo: T. Norsted.

2.3.3 Fire

A number of localities are destroyed because of fires, campfires and the use of disposable grills. It is important to consider if the remains of campfires can be of prehistoric age. Archaeologists must consider this before direct intervention. Where fires have occurred, the upper cm of the rock surface is often blackened, flaked and lies as course gravel on the rock surface. In some places the rock art is lost. In such instances, it can be necessary to initiate conservation measures to stop further weathering of the rock. It is important to prevent fire making and use of disposable grills on carved rock art surfaces.

2.3.4 Previous management measures

Cultural resource management organizations cannot deny that they have also been responsible for damage to rock art. For many years, harsh chemicals, stiff brushes, steel brushes and rubber-soled shoes have been used to remove moss and lichens. This has left clear traces on the rock, and one can still see discoloured panels and scrub marks (Figure 32). Another example is carvings that were painted with various types of paint or figures that were painted incorrectly. Early in the 1970s, casts were attempted using silicon at a number of rock carving panels. Remains of the silicon are still visible today and will be visible for many decades to come. Silicon that adheres to the rock is nearly impossible to remove without tearing loose pieces from the rock surface.

In some places, pressure impregnated material, galvanized iron and wrought iron have been used in presenting rock art. This has left traces in the form of discolouring from chemicals on the rock. These damages are difficult to remove. These methods were typical at the time, and one can be critical of some of our earlier colleagues' efforts. Therefore it is important that everything that is done for the future is well thought out and reversible.

Figure 32. Close-up photo of a rock surface with rock paintings as it appears after the removal of lichens using "Pingo" and scrubbing. Hinna, Tingvoll, Møre og Romsdal. Photo: T. Norsted.

3. DOCUMENTATION

The objective of documentation is to safeguard the source value through establishing the position of the locality, recording its form in relation to the terrain, all rock art present on the rock surface, and special features such as cracks, surface depressions, different weathering damage, previous management measures such as gluing and consolidation, as well as human vandalism that may be present on the figure panel.

The most important documentation methods include: Measuring, photographing, chalking, frottage, scanning and a written status documentation. All documentation done at a rock art locality, especially in connection with management work, must be carried out in accordance with the Directorate for Cultural Heritage's Documentation Standard for Rock Art (the "old field report form").

The documentation standard is a form found in both digital and printed formats (field edition), and some forms correspond with the discontinued Rock Art Database. Information in the Rock Art Database will be transferred to the National Cultural Heritage Database (*Askeladden*) beginning in 2006. The standard is built up so that it includes all important aspects regarding the rock art panel, both the historical facts documented earlier and the recording that will be done in connection with new documentation of the panel. It is extremely important that the Directorate for Cultural Heritage's Documentation Standard for Rock Art is used in connection with damage documentation of rock art. This is because a high degree of standardization and uniform treatment of the panels is desired for the entire country. This will also make it easier to assess regional differences.

The documentation that the standard includes, will from 2006 be transferred to Askeladden as rapidly as possible, so that this information will be available to cultural resource management and other professional agencies. This information will, among other things, constitute baseline material for the development of management plans for the particular rock art panels (see Chapter 4/4.1 Management/Management plans).

3.1 Photography

Photography is an important documentation method. The advantage of photography is that it is a rapid process compared to other methods. It is also considered advantageous that the image produced is for the most part detached from how we as individuals perceive the original. Photography also makes possible the use of specialized technicians that can clarify less visible motifs, traces of tool use and different types of damage.

Photo documentation can have general informative value, but also provides baseline information for research, conservation and management. These activities will often emphasize different aspects with regard to what should be photographed and how this should be done. Here we will attempt to provide a general introduction with an emphasis on the fundamental aspects.

Professional photographers seem to have very different experiences and opinions about which methods work best. The results must, at the same time, be evaluated from a number of professional viewpoints. A *complete* photo documentation of rock art should show:

1. Appearance.
2. Condition.
3. Destructive factors in the immediate environment.
4. Preventative actions.

5. Results of direct intervention[7].
6. Context of the rock art (relationship to the landscape and other cultural resources).

Photography is an important tool in monitoring and management. Since monitoring involves recording changes over time, it is important that documentation methods and factors are determined in advance so that they can be *repeated* in an identical fashion. Conducting routine repetitions is important because photographic material should serve as the basis for digital image treatment, or a GIS-program. The photographs that are taken in connection with monitoring, should also be able to be used in evaluating different management actions.

Photographic material and Askeladden

In the Rock Art Project, emphasis is placed on the *quality* and *durability* of the photographic material. There is a requirement that both recording techniques and film type provide optimal information. Photo material should also be the best suited for use in publications. The Directorate for Cultural Heritage therefore prefers the use of colour negatives and slide film in medium format (120), or 4 x 5” [8]. The use of a professional photographer and equipment is desirable. Small format slide film is regarded as supplementary material, best suited to lectures and other popular presentations, but must be used as primary documentation material if the specific objectives for the work are not presented. Digital photography techniques have reached such a high level of quality that it can be expected to dominate completely in the future, but for the time being film has a much greater durability with proper storage than digital media.

From 10 to 12 photographs from each documentation (rock art panel) should be placed in Askeladden. The photographs that are placed in Askeladden are selected by the institution that has responsibility for completing the documentation standard and entering information into the database. The photographs are chosen on the basis of their ability to illustrate localities and the special attributes of the motifs, but also destructive factors and the condition of the rock surface.

The original photographs are stored by the institution that has been responsible for the photography. Selected duplicates should be sent to the archives of the appropriate county and Directorate for Cultural Heritage. When photo documentation is done in connection with the Rock Art Project, a selection of duplicates should be sent to the Directorate for Cultural Heritage.

In collaboration with photographers, the Directorate for Cultural Heritage has developed a standard for photo documentation of rock art. For the latest updated version of the standard, see

[7] ”Intervention” is a broad term for conservators compared with its use in the Cultural Heritage Act’s §3. In this publication, it is used to designate *all* actions that intervene directly in the source material, including those that do not have a destructive or disfiguring influence. For conservators, “intervention” has a positive meaning, for example when it applies to cleaning or consolidation.
[8] Use of medium format has up to this point only been fully implemented in the documentation of rock paintings and the ground carvings in Nordland.

http://www.niku.no/index.asp?strurl=//applications/system/publish/view/showobject.asp?infoobjectid=1000742 (site visited 16.03.05).

Digital image processing

Digital image processing can be used both for individual groups of figures and panels as a whole, and require sectional photographing with overlapping. This should be done perpendicular to the rock surface and at a set distance from it. The results will be a "photo mosaic". For documentation of an entire panel, it is necessary to include as much as possible, also including areas where there are no figures. Areas with many tightly grouped figures can be divided into smaller sections. When each section is photographed in this way, measurements are made of the four sides and diagonally. Based on this information, we can fit together the sections and develop an illustration of the rock surfaces with figures correctly placed in the proper scale. If the photographic material is digitalized, the combination of sections can be done with the aid of digital image processing.

Image processing makes it possible to filter out visual "noise" so that the figures appear with greater clarity. The images used in this process must have high resolution. It is a major advantage to be able to check the originals during the stages of image processing. The results are not only dependent on the operator's skill and observational ability, but also the quality of the original photographic images. Digital image processing will not bring out more of the figures than those recorded during photographing. It can be necessary to use image processing to insert special information on things such as vandalism, weathering, micro-vegetation and various conservation interventions. These are added in the form of separate graphic image files placed in layers on top of the figure representations and the rock surface.

3.1.1 Photo documentation of rock carvings

In practice, the locality should be gone over by the archaeologist and conservator in advance, so that they can provide all of the information regarding purpose and scope to the photographer in advance of photographing.

Photographing is conducted *systematically*. The purpose is in part to obtain optimal control insuring that the most important features of the locality are recorded, and partially to standardize documentation material. It is natural to start with overview photos and work downwards to close-ups. Overview photos serve to emphasize the relationship between the landscape and rock carving, but also give an impression of size relationships, especially when a human is included for scale. Overview photos can also assist in relocating small panels in a complex landscape.

Every panel should be completely documented, using multiple angles (Figure 33). A part of these documentation must include the panels closest surroundings. The goal is to show the vegetation and other environmental factors, in order to obtain a photographic starting point for future management. In this connection, it is important to include existing presentation measures such as signage, walkways, barriers and platforms.

Recording of figure groups and individual figures should if possible be done *perpendicular* to the rock surface. If the photo documentation is part of monitoring over a number of years, one should insure that photographing occurs from the same location, and that fixed points are placed in the ground so that the location can be found again.

During photographing, a complete *photo log / photo list* must be maintained that contains the following:

- Name of locality / photo number.
- Panel number.
- Farm number and title number.
- Municipality.
- County.
- Date.
- Name and institutional affiliation of those responsible for photography.
- Compass orientation of the photograph.

Light

Correct *lighting* is the key to successful photo documentation of carved rock art. With natural lighting, the documentation of a south facing panel in direct sunlight at midday will seldom give satisfactory results. Under these conditions the light is sharp and “flat” and unsuited to defining form. The worst situation occurs when the motif is partially in sunlight and partially in the shade due to vegetation. In such situations, the film is not capable of recording fine increments between light and dark, and the carving is unevenly rendered. Sunlight at a low angle that does not cast a shadow will accentuate the texture of the rock surface, but the rendering will often be strongly effected by dramatic shadow effects. Overcast weather will record halftones better, but carvings will also be incompletely defined on the photograph. This happens because the light is too diffuse to provide a successful rendering of the rock surface texture.

Figure 33. Photographic documentation of portions of the rock art locality Hjemmeluft/Jiebmaluokta, Alta, Finnmark. Photo: B. H. Helberg.

The best conditions for photographing rock carvings in natural lighting occurs when the sun is strongly veiled by thin cloud cover, and is also so low that the light angle is from the side. This side-light should preferably *come from the left*, and be somewhat oblique from above. If the light comes from the right side, the figures will appear to be rendered in relief on the photograph. Veiled sunlight from the left will give a modelling with fine grading and a moderate light- and shadow effect. Both the contours and tool traces can be reproduced satisfactorily if they are still clearly visible in the rock surface. If the light is good, but the other conditions are less than ideal, a reflector or screen can make an improvement. Moderate dampening with water can give a more dramatic modelling, but also hamper reflection.

There are many methods for avoiding difficulties that the natural light conditions create, at least when it involves photographing smaller groups and individual figures. One of the methods involves covering oneself with a movable, tent-shaped *covering* of black plastic. This can open up on the left side so that it lets in a moderate amount of light through a crack. Smaller openings facing in other directions can soften dramatic shadows and contribute to more even lighting.

The use of *artificial light* in the half dark has also been used in photographing rock carvings. One or more effectively placed photo lamps, run by a generator or rechargeable battery, can give good results. A flash with cable connection can also be used. If this is the case, a minimum of two flashes are used, one of them providing the principal light from the left, while the other is placed at a greater distance and contributes to muting the dramatic shadows. The results of artificial light photography are not always equally predictable. As a rule, it provides poorer information on textures that show tool traces and require a good, natural lighting.

It is usually an advantage to use a *tripod* during photo work. This makes it possible to obtain maximum depth of field.

Scale

A set of photographs of figure groups, individual figures, and details should include a *scale* of at least 10 cm. Such a scale is found in the IFRAO-scale. The scale should cover 5-10% of the photo frame. It should be placed near the motif and can be used in connection with a digital colour correction program. Unfortunately, it has a reflective surface that can present problems. Since the scale also dominates the image, it can divert much of the attention away from the main motif. The IFRAO-scale is designed for painted rock art and can be replaced by a simple scale when working with carvings. Another scale used is the Qpcard (www.qpcard.se).

3.1.2 Photo documentation of painted rock art

Standard photo documentation of painted rock art includes*:*

- The landscape surrounding the rock/cave opening.
- The entire rock, viewed directly from the front and side angles.
- The rock in sections viewed directly from the front.
- The rock in sections viewed from the sides (to show the rock in profile).
- The cave in sections, viewed inward and outward.
- Each panel in the cave photographed perpendicular to the rock surface (if possible).
- The rock / cave in smaller sections, including the areas outside the figures (for digital image processing / GIS use); the sections should have good overlapping, and precision can be insured by marking with the help of a corner fixed point.
- Each figure with and without colour- and centimetre scales.
- Details that illustrate technique and damage (natural and anthropogenic).
- Potential presentation for visitors.
- Potential direct interventions (cleaning, consolidation, presentation, etc.) before and after.

Partially cloudy weather with weak sunlight provides the best conditions for photographing rock paintings. If the sun is too strong, it should be shielded, if this is possible. Additional light can be directed into shady areas with the aid of a reflector. This means that the photographer may require an assistant. Photographs should also be taken of the panels during rainy weather. Two powerful flash lamps are needed as a light source during photographic documentation of cave paintings (Figure 34).

Standard film types are medium format (120) colour negative and slide. Colour negative film has a richer colour spectrum than slide film, and is better suited to critical documentation of rock paintings.

When photographing cave paintings, good results can be obtained with cross-polarization when the surfaces are very damp. Mounting a polarizing filter on both the lens and lamps can effectively reduce reflection and provide better definition of the figures.

IR-film (film that is sensitive to reflections of long-waved infrared beams) can be used to clarify figures that are covered by thin precipitates. If it is appropriate to use artificial light, polarizing filters should be mounted on both flash lamps and the lens. This provides optimal colour saturation and contrast. Recording of reflected fluorescence from ultraviolet radiation[9] can contribute to documenting organic material (such as algae and more recent soot marks) on the panel. Since iron oxide absorbs ultraviolet and appears black in contrast to the fluorescent carbonates, UV-photography can help to define figures that are painted on top of precipitates of calcite.

A complete photographic journal/photo list should be kept that includes the locality name, panel and figure numbers, date and the name of the photographer.

Figure 34. Photo documentation of cave paintings. Arve Kjersheim in Sandenhula, Værøy, Nordland. Photo: T. Norsted.

Alternative photographic documentation

It can be necessary to document rock paintings three-dimensionally with the aid of photogrammetry or orthophotos in order to bring out the three-dimensional form of the rock surface. At present, we have little experience in the use of these methods for rock art documentation in Norway.

Three-dimensional recording can be especially relevant when it appears that the form and irregularities of the rock surface have importance for the painting's placement and content relative to one another.

[9] UV-sensitive digital cameras have also been developed.

3.2 Surveying of rock art localities

Establishing the position of a locality in the terrain is an important part of rock art documentation, as is mapping the relationship between figures and rock formation. Until recently, it has been common to locate rock art localities through levelling by taking compass measurements or by setting out traverses and thereafter placing them on economic maps. In the future, mapping locations with the aid of GPS will take over completely.

When surveying at a more detailed level, it will still be necessary to use a levelling telescope, tape measure and folding rule.

3.2.1 Rock carvings – Mapping of figures

Rock carvings are usually documented somewhat differently than painted rock art. It is not common to measure in each individual section and figure such as with documentation of figures on rocks and in caves. The reason for this is that rock carvings are for the most part documented through tracing of entire panels on large sheets of plastic film (Chapter 3.3.1), and therefore avoids measuring in individual figures.

3.2.2 Rocks and caves – Description and mapping of paintings

When surveying rocks and caves, it is important to map both the most important features of the rock face and landscape formations in the local environment (Figure 35). Both aspects can have had importance for the placement and design of the paintings. The following documentation tasks should be carried out:

- Precise survey of locality morphology. This means that all details of the physical shape of the rock face are measured in. It is especially important to document features of the rock or cave that can have had importance for the persons that made the paintings. Examples of this include peculiar rock formations, small caves or marked depressions in the rock face. The best results are obtained by producing both vertical and horizontal plan drawings so that potential overhangs will be documented.
- In cave survey it is practical to start at the drip line, so that it is included, and finish in the inner portion of the cave.
- The survey recording must be done to scale.
- All paintings must be measured in as precisely as possible and be localized on the drawings.
- The highest and lowest point of the locality/panel must be levelled in relation to the closest body of water or sea level.

The description of the locality and paintings in a professional report should include the following points:

Panel, division, numbering and goal.

- Grouping of figures in a panel. Panel is defined here as a group of figures that are separated from other groups of figures by a clear terrain-based boundary and/or marked space without figures.
- Location of the panel at the locality. In caves, it is important to establish the location in relation to the boundary between light/darkness.

- Division of the panel. If there is a marked distance between groups of figures in a panel, it is advantageous to divide the panel into sections. It can often be difficult to characterize, demarcate and record individual motifs, and the division into sections can help to maintain an overview.
- Numbering. If the paintings have been recorded earlier, the previous numbering of the panel and figures must be referred to so that the same numbering can be retained if possible. It has been shown that older documentation material can be incomplete and misleading, so that a new numbering will be necessary. The sequence generally progresses from left to right. In caves, it is common to number in sequence from the opening and inward.
- Measurement: The maximum height and width of the panels and sections are measured. The distance between the panels and sections must also be calculated. In caves, the distance from the outer panel to the drip line is measured.

Measurement of figures

- Maximum height and width. When anthropomorphic figures are involved, the height and width across the arms and legs is taken. Only what is visible is measured.
- Approximate line thickness of the figures.
- Distance to the closest figures and minimum distance to the ground/cave floor.

Figure 35. Documentation work at the rock painting locality Kjeøya, Harstad, Troms. Photo: B. H. Helberg.

3.3 Tracing

Tracing is a documentation method that has a long tradition among archaeologists that work with rock art and is used in connection with both research and management. The method involves covering the rock art panel with plastic film onto which the motifs are traced with a permanent ink marker. It is often necessary to mark the rock carvings with chalk before it is possible to trace them onto the film.

In addition to the figures, it is important to document the special features / micro-morphology of the rock surface[10]. This can include structures such as crack formations, depressions, indentations and cavities in the rock. This is because these formations are given more and more interpretive importance within rock art research.

It is just as important to document the different types of damage to the rock surface as to the rock art itself. When using the tracing technique in connection with damage documentation, it is also absolutely necessary that all significant damage to the rock surface, such as air pockets, exfoliation edges, human vandalism, previous management intervention, etc. is drawn on the tracing. It is recommended that the damage symbols shown in Chapter 3.8.1 are used in connection with damage recording.

During tracing work, it is extremely important to remember to move carefully on the rock surface so that air pockets do not break off and peeling sections expand during documentation.

3.3.1 Tracing of rock carvings

It is important to determine in advance that the rock surface can tolerate tracing. As a rule, moss and lichens must not be cleaned from the rock surface if the only objective is documentation, and no further action is planned.

1. The rock surface *must* be clean before the tracing can be done. This is done as gently as possible. Brush away old leaves, twigs, etc. For information on the removal of micro-vegetation, see Chapter 5.2.2.
2. The rock surface *must* be totally dry before the tracing can be done. If the surface is damp, condensation will form on the underside of the plastic film and it will not be possible to carry out documentation.
3. Indistinct figures and damages can be marked with quartz slurry, but only if absolutely necessary. The alternative is to use chalk slurry. This is applied with a brush. The method is extremely gentle. Chalking is used to clarify the figures for photographing and in connection with tracing (Figure 36). Yellow chalk must *never* be used because it contains oil that is difficult to remove.
4. Plastic film (glossy, Icopal moisture block: 0.10-0.15 mm) is placed over the rock surface as evenly as possible. It can be fastened along the edges as necessary with the appropriate type of tape. It is an advantage to use tape that does not leave glue residue. Such residue can be removed with ethyl acetate.
5. Figures and damage evidence are traced onto the film with a black felt tip marker. Both solid lines and dot technique can be used. The damage evidence is traced with the aid of standard symbols (see Chapter 3.8.1). Marker ink requirements: It must tolerate light and moisture, dry rapidly and not crack when it dries.
6. Remove the chalk when the tracing is finished. This should be done by spraying with water and drying with a sponge.

[10] The illustration of peeling surfaces on tracings of rock carvings was already done by Johs. Bøe in the 1920s when he documented Vingen. This practice was followed up and developed by Egil Bakka in the 1960s, including the marking of cracks, depressions in the rock surface and boundaries of the rock surface. This has since been done with the documentation of rock carvings in Bergen Museum's district. The method has also proved to be especially useful in relocating previously documented panels and figures.

The following types of damage should be documented on the tracing:

- *Weathering damage*: Loose grains, exfoliation, granular weathering, air pockets, chemical weathering, crack-related weathering, flake weathering and mineral precipitates (see Chapter 2.2.1).
- *Human-induced damage:* Mechanical wear, fire damage, graffiti, superimposed incising, other damages and damages produced by previous intervention (see Chapter 2.3).

All of the tracings produced should include the following information:

- Locality name.
- Panel number.
- Land No. and Title No.
- Municipality.
- County.
- Date.
- Name and institutional affiliation of the person/persons who have produced the tracing.
- Cardinal direction (indicated by a north arrow).
- Slope inclination.
- *Symbol list* for the types of damage recorded.

Figure 36. Figures and damage evidence are marked with school chalk before tracing rock art locality Ytre Kåfjord, Alta, Finnmark. Photo: B. H. Helberg.

Symbols used on the tracing should be consistent, whether done graphically or with colour coding.

Tracings are best stored by rolling them together and placing them in acid free, marked cardboard tubes. An alternative for large tracings is to roll them around a sufficiently large pipe. If the tracing is folded together, it should not lay like this for long because the plastic can be damaged by such treatment. Tracings should be stored in the dark. All tracings should be reduced or scanned within a certain period of time since plastic and permanent ink breaks down (see the following section on photographic reduction).

Photographic reduction / scanning of tracings
Plastic film with tracings can have very large dimensions which makes them difficult to handle. It is therefore necessary to photographically reduce the plastic tracings to a reasonable size, such as A3 format. Small tracings can be reduced at a number of institutions, but large tracings covering many square metres can probably only be reduced at *The Norwegian Museum of Science and Technology* in Oslo.
The purpose of photographic reduction is:

- Safeguarding the primary source of information.
- Use in damage recording, in that documentation of the damage situation can be added directly to the reduced tracing.

This reduced material can then be scanned and processed by different computer programs, such as Adobe Photoshop or Adobe Illustrator, and can then be used further in work within research, management and dissemination. There are also large plotters which can scan tracings directly without prior reduction (e.g. HP DesignJet 815 MFP).

3.3.2 Tracing of painted rock art

If the rock surface and paintings are covered by a protective layer of silica skin, it is possible to make a tracing of the figures without danger of damaging them.

- Use of completely transparent film that is so compliant that it follows the irregularities of the surface. We have had good results with 35 µm thick polyester film, preferably with silicon coating on one side. Thinner film is even more compliant to the underlying surface, but is easily ripped and is harder to handle/store later.

1. Each film is supplied with locality name, municipality, county, panel and figure numbers, brief recommendations, date and name of the person(s) who made the tracing.
2. The film is placed against the rock surface with perpendicular edges and the silicon coated surface against the rock. When making continuous horizontal tracing of figure groups, sufficient overlapping is necessary and indicated by register marks.
3. Tracing is done using relatively small pens with an alcohol soluble colouring agent. The best control is obtained when the tracing colour is lighter and somewhat warmer than the original colour. It is best to use diagonal hatching to indicate the figures. The lines are closely spaced where the original colour is strong and clear. Abrupt level changes, cracks, air pockets, missing fragments, precipitates and micro-vegetation are indicated with other colours and/or symbols. It is best to draw in these elements first. This provides a reference in case the film moves when tracing the figures.
4. When the figures are rendered, everything that is clearly visible through the film is traced first. Then the film is partially bent up like a blind so that the lower part of the figure is exposed. This is moistened with distilled water. This provides better visibility than when the rock is dry, especially when there

is a veil of salt on the surface (this is very common)[11]. The lower part of the tracing can then be completed. Then the film is rolled up gradually so that the process can be repeated higher up until everything is traced. This process insures that the tracing can be checked with the original continuously.

5. The tracing can be put together later on a light box for photographing. It can also be redrawn on drafting film that is easier to store.

Digital image processing and tracing can complement each other in the graphic rendering of rock paintings. The advantage of tracing over digital image processing is that with tracing one works directly from the original, while the digital method is done through photography and occurs without the presence of the original.

Figure 37 A) Rock painting of an elk (moose) at Sandhalsen (Vasstrand), Åfjord, Sør-Trøndelag. The figure is relatively unclear due to weathering and precipitates on the rock surface. Photo: T. Norsted.

[11] It is important to be aware that dampening rock surfaces covered with a thin salt precipitate has an undesirable side effect; some of the moisture will be absorbed and dissolve certain minerals. These can be brought to the surface and recrystallize, so that the previously occurring precipitates are amplified. This usually happens during dry, warm weather. Even though a single dampening will not have a visible effect, it is a reminder of the necessity for constraint and caution.

Figure 37. B) Elk (moose) figure at Sandhalsen in Åfjord, Sør-Trøndelag, completely traced. Photo: T. Norsted.

3.4 Drawing

Use of drawing techniques can often be a useful aid in the recording and documentation of cultural resources (Figure 38). This is especially true during initial recording when the archaeologist or other professional does not have access to specialized equipment. Simple, direct plan drawings where the location of archaeological site in the terrain is drawn, can be a useful aid in finding the locality. Drawing the location of the rock art motifs and their composition on the rock surface can provide an initial documentation of figure composition and potential damages.

These techniques have both benefits and drawbacks. Significant advantages can be achieved when one wishes to describe a panel with the main lines because this can be done at the site with simple equipment. The technique makes it possible to remove all unnecessary information, in contrast to photography. This has more status as a representation of "reality" since it can bring out texture, structure, the type of rock, plants, etc. But it also includes "all" types of information so that it cam be difficult to separate out the essentials. In black and white drawing, lines are almost always used but hachure and point techniques can also be used to bring out shape, depth and orientations.

Freehand drawing renders the motifs/figures based on the skill of the artist. The advantage is that information can be presented selectively and, for example, one can focus only on the motif (figure) or parts of it, size (scale), a restricted area with details, slope, curves, cracks and surfaces. Freehand drawing can also reproduce larger formations (localization), but only as main lines with a limited level of detail. Sketching with a pencil or pen and redrawing with ink (rotring) is simple to prepare for archiving/publication.

Perspective drawing can provide a good picture of form and space. It requires experience with visual judgement in order to render a reliable presentation of scale and depth. Those doing the drawing should be familiar with which techniques are used in perspective drawing.

It is important that the drawings/sketches are done to scale and that this is indicated on the drawing. All drawings must include:

- Locality name.
- Panel number.
- Land No. and Title No.
- Municipality.
- County.
- Date.
- Name and institutional affiliation of the person/persons who have produced the tracing.
- Cardinal direction (indicated by a north arrow).
- Slope inclination.

It is important that the drawings are stored rolled and not folded.

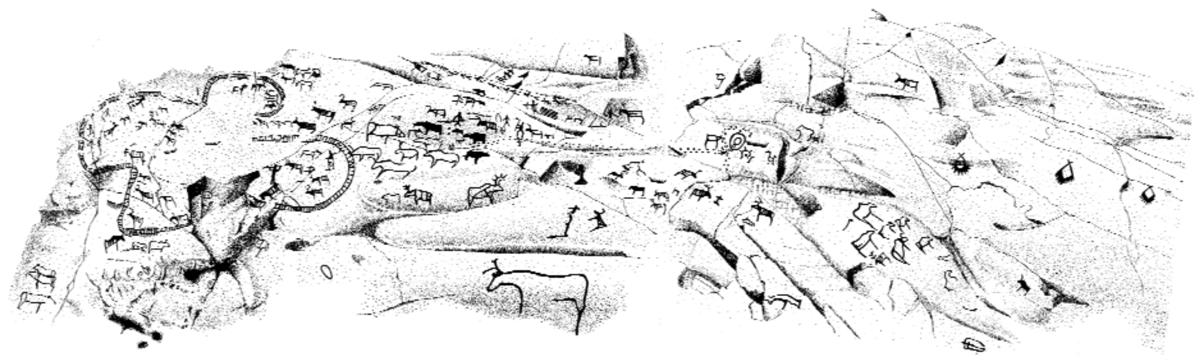


Figure 38. Drawing of rock carvings in Hjemmeluft/Jiebmaluokta, Alta, Finnmark. Photo: Ernst Høgtun.

3.4.1 Drawing painted rock art

Since the majority of painted figures are sensitive to being touched, tracing is ruled out except in the few instances where the paintings are protected by a transparent precipitate (see Chapter 2.2.2). Instead, the figures are drawn quite precisely to scale with clear indications of weak and clear colours. Details are added to the drawings, including cracks, precipitates, missing fragments and loose fragments/air pockets (Figure 39). Individual figures can be joined together afterwards to provide a graphic picture of the entire panel. When this is done, elevation differences in the rock surface are indicated. The results can in many ways resemble those obtained using photographs in image processing. The advantage of image processing is that all of the information included in the drawing can be added as separate files. However, this requires that all of this information is collected in advance, and then the drawing is important as a starting point anyway. The drawing process is also a substantial part of consciousness-raising.

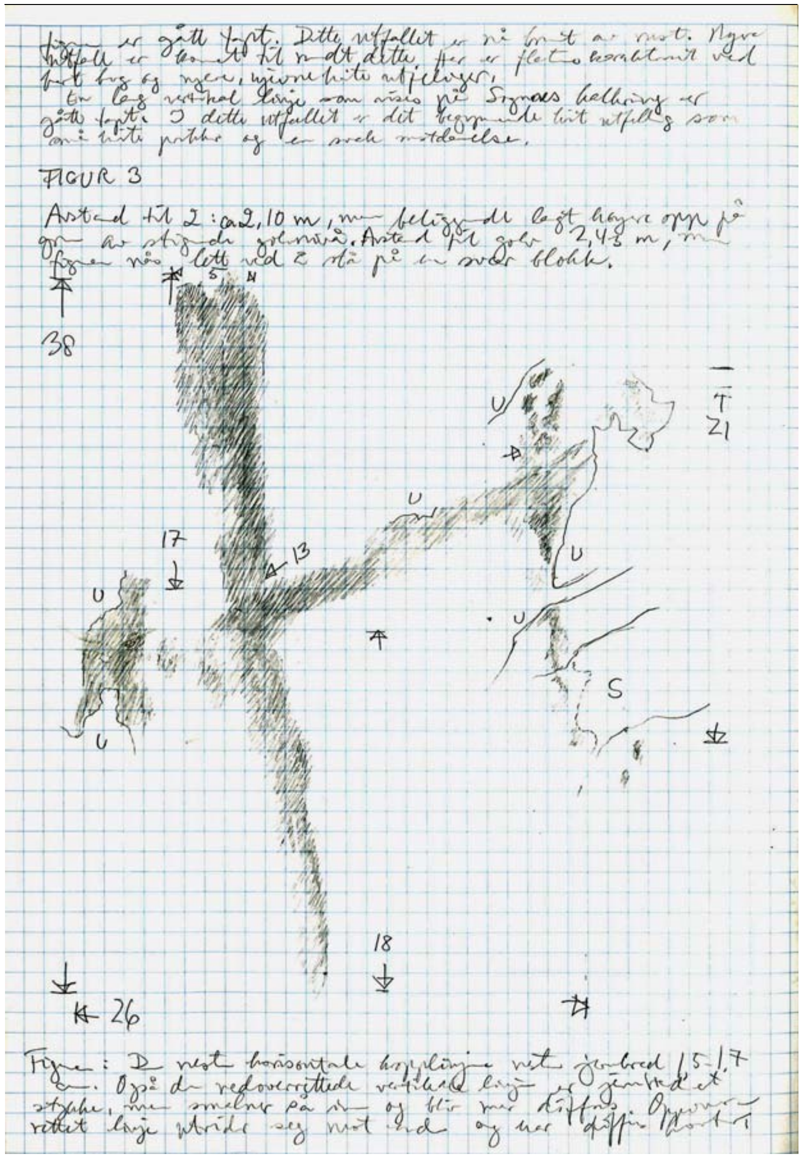


Figure 39. Field journal from a cave with drawings of painted figures to scale. Damages and other important features are included in the drawing. Figure 3 in Skåren-Monsenhula, Brønnøy, Nordland. From Terje Norsted's field journal.

3.5 Frottage

Frottage is a relatively new technique for the documentation of pecked carvings in Norway (Figure 40). It involves making a print of the carvings on paper with the aid of a rubbing technique. Special paper and carbon paper are used. This technique has an advantage over tracing in that all the textures of the rock surface are clearly visible on the frottage paper as a precise copy. This applies both to the carved figures and potential damage. The rock surface *must* be completely dry and clean when using this method. Frottage works very well for the documentation of most rock carving panels, but must *never* be used in connection with documentation of rock paintings.

Necessary equipment:

- A small towel or wool sock rolled together to form a ”sausage”.
- Carbon paper, preferably A4-size. Wrap around the towel/wool sock with the blackened surface out.
- Special paper that can be found in many sizes and on a roll (can be purchased at Tanums Hällristningsmuseum or Adorant@bigfoot.com).
- Fixing is done with fresh grass. Spray fixer can also be used.

1. The paper is fastened to the rock surface over the rock carving motif to be documented with the help of tape.
2. The rock carving is documented by rubbing the rolled carbon paper over the frottage paper. It is important to rub quite hard and in all directions, especially across the pecking traces.
3. When the carving has obtained the desired quality, a handful of grass is rubbed carefully over the paper surface, or a coat of spray fixative sprayed on (NB! Spray on the sheet of paper after it is removed from the rock carving surface).
4. Loosen the paper from the rock, roll it up and place in a storage tube.

Figure 40. Frottage is a documentation method where a copy of the carving is obtained with the help of a rubbing technique. Here frottage is being done on pecked carvings in Bohuslän, Sverige. Photo: B. H. Helberg.

3.6 3D-documentation

3D-documentation of carvings and the rock surface that the carvings are found on, can be done with the aid of scanning (Figure 41). The firm Metimur in Gothenburg has used five years to develop a method for measuring carvings (www.metimur.se).

Measuring is done using a laser that projects a 5 cm wide beam on the object. The beam is guided over the object and registers 7000 points per second. The data is visualized online on a computer screen and the object’s form can be immediately observed. This method is objective and documents different levels in the rock surface with extreme precision (2/10 millimetre) and a measuring speed of c. 10-12 m^2 per day. The documentation results become a dataset that contains many individual point measurements in a system of three dimensional (X, Y and Z) coordinates. The dataset can processed and visualized in different ways. Among other things, it can be used to present accurately formed copies. It can also be linked to other data systems, such as GIS, Fledermaus or Irfanview 3D.

The measurements can be used to monitor the decomposition of rock art as long as small fixed points are established on the rock surface during the initial measurement series. If the measurements are repeated over a given period, it is possible to measure the changes of the rock surface by comparing it with the measurement series. For good results, it is necessary for the rock surface to be completely free of micro-vegetation.

Figure 41. A) 3D-scanning carried out on carvings in Ytre Kåfjord, Alta, Finnmark. Photo: T. Norsted.

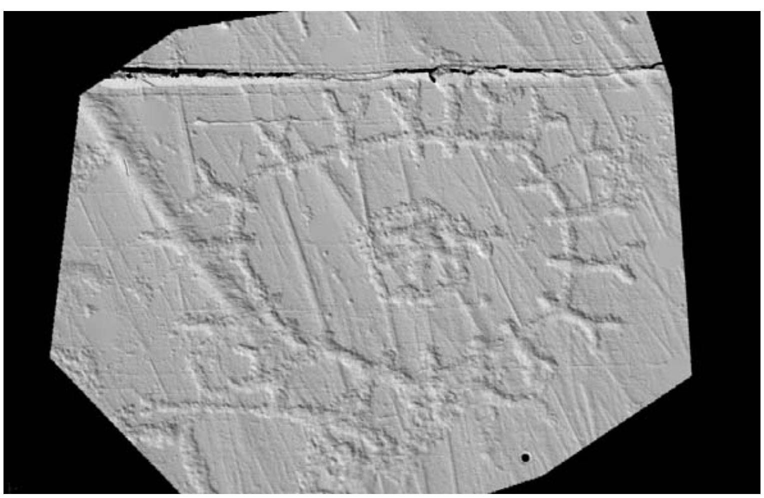


Figure 41. B) Results of scanning in Ytre Kåfjord. Details in these carved figures and the rock surface in general are extremely well visualized. Photo: Metimur.

3.7 Casting

Casting of rock art was previously used in connection with documentation, research and dissemination of information for carvings. With the aid of casting material, a cast can be made that documents/records the surface of the rock, including figures and damages to the carving panel as well as pecking technique and tool traces. This method **must no longer** be used for the documentation of rock art. The reason for this is the significant danger for damage during the process of casting and that other more effective documentation methods, such as 3D-scanning, will replace the various casting techniques that were formerly in use.

3.8 Condition documentation

Every conservation action, whether it involves preventive work or direct intervention, must build upon a basic documentation of the *physical condition of the rock art*. Such documentation, carried out at a definite point in time, is an important part of the total documentation of the rock art. It contributes to our understanding of what happened in the past and what will happen in the future. In other words, it can help us take action and decide which action should be taken. Since it is the basis for future monitoring and management, condition documentation is an important premise supplier for all conservation.

Mapping of condition comprises a majority of the Directorate for Cultural Heritage's Documentation Standard. In order for the documentation to be complete relative to the standard, the rock art panel should be investigated by an archaeologist, conservator, botanist and geologist. Mapping of this type is done at a relatively detailed level, and in many instances resources are too limited for such in-depth recording. The degree of documentation detail must be considered in each case. More resources are commonly used on localities that will receive many visitors and are also threatened with damage. The more detailed condition mapping is, the better the basis for monitoring of the locality in the future.

There are three elementary steps that must be taken in connection with condition documentation:

1. Observe, locate and record.
2. Build up knowledge about the materials (the rock, paintings, etc.), how they change over time and what this is attributed to.
3. Consider strategies that can counteract problems.

Condition has three main aspects:

1. Physical traits that can be observed → *the effect.*
2. Reasons for the effect → environmental factors (*natural and human-related*).
3. How the effect appears and develops → *the process.*

It is important to consider these three aspects, both individually and collectively. This helps us analyze *what* is occurring and *why* it occurs. Of course it is impossible to provide an approximately complete picture of decomposition factors and processes that are the reason for the current condition, since the environment consists of a large number of parameters (mutually variable factors) that make up a extremely complicated system. But we should at least seek to map the main traits. One of the difficulties is that fully visible effects often have hidden causes.

When we describe the reasons for a panel's condition, it is common to divide these into two categories: the *natural* and the *anthropogenic* (human-induced). The first category relates to the "normal", natural processes that cause the condition to change through a transformation – commonly decomposition – of the materials. These processes are expressed by the term *weathering*. The other category includes wear, vandalism and other damaging effects from visitors. In reality, the natural and anthropogenic decomposition factors can mutually influence one another. Damages due to visitors can contribute to making the locality more sensitive to natural decomposition, while the degree of weathering can contribute to determining the impact of wear from visitors. In this way a synergy effect[12] can be created that not only involves the actual rock art panel, but also its immediate surroundings.

Standard condition documentation of rock art includes:
The environment around the rock art

- Type of area (agricultural, housing area, urban environment, industrial).
- Type of terrain (valley, hilly terrain, open location, mountain, fjord, river, mountain plateau, lake, beach, ocean).
- Local vegetation (field, meadow, grazing land, grass lawn, garden, coniferous forest, deciduous forest, mixed forest, tree plantation, scrub, bog, beach vegetation, mountain vegetation).
- Highway traffic / other sources of pollution.

Rock art surfaces

- Each figure is described with consideration to motif, material and technique. Condition is characterized by explaining what is preserved and how this expresses itself: Strong or weak, clearly bounded or diffuse and indistinct, etc. It is also important to include what seems to have disappeared and the likely reason for the loss. (This is based on a visual and subjective impression. Trials have shown that it is advantageous for two persons to provide a description independent of one another. Everything is dependent on good light conditions. A halogen headlamp is essential for documentation of cave paintings.)
- Orientation (exposure and slope).
- Rock type.
- Moisture effects (rain, sea spray, periodic seepage, permanent seepage).
- Macro-vegetation.
- Micro-vegetation (type of vegetation: moss, lichen, algae, biofilm, coverage percentage).
- Weathering damage (loose grains, exfoliation, granular weathering, air pockets, chemical weathering, crack-related weathering, flake weathering, mineral precipitates, incising, graffiti, chalking, fire damage, soot from torches, wax drippings from candles).

Important factors that influence weathering processes on rock carving surfaces

- Water (infiltration water, condensation, surface water from rain and snow melting, ice formation, snow accumulation).
- Vegetation (macro and micro).
- Climatic factors (temperature, relative humidity, air currents, sun exposure).

3.8.1 Damage map

[12] Synergy effect is the increased effect through an association between to or more components. This is greater than the sum of the effects of each individual component acting alone.

The regional museums commonly document damages in the following ways: (1) by photographic documentation and (2) by illustrating the damages on reduced copies of tracings, or possibly by drawing in the damages on the rock surface at the same time as the archaeological tracings are done (Figure 42). If a panel is scanned, most damages are visible on the scanning printout, but air pockets, for example, must be drawn in afterward.

Figure 42. Completed damage map of the locality at Hjemmeluft/Jiebmaluokta, Alta, Finnmark. The different damages are marked with different colours and symbols. Photo: B. H. Helberg.

Figure 43. A) Overview photo of rock art panel Ausevik II, Flora, Sogn og Fjordane. Photo: J. M. Gjerde.

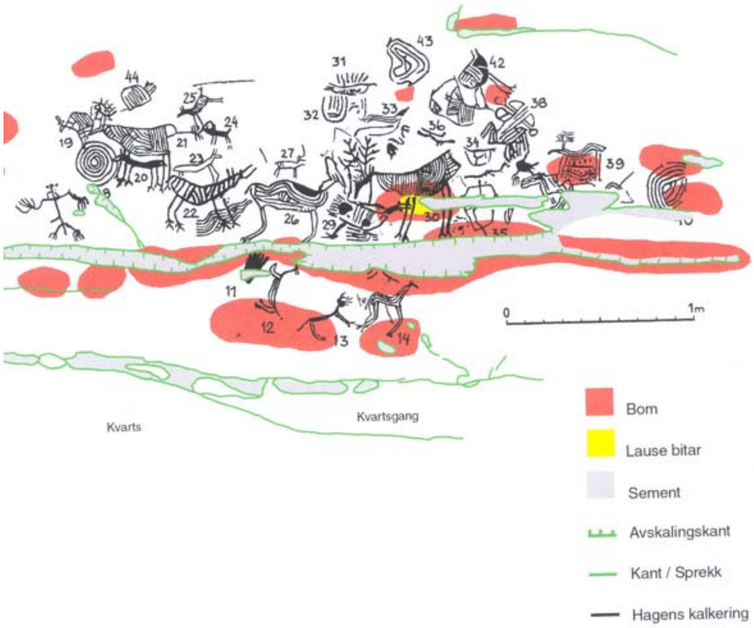


Figure 43. B) Damage tracing of the same panel at Ausevik, Flora, Sogn og Fjordane, from Gjerde and Gundersen 2000. The different types of damage are marked with different colours.

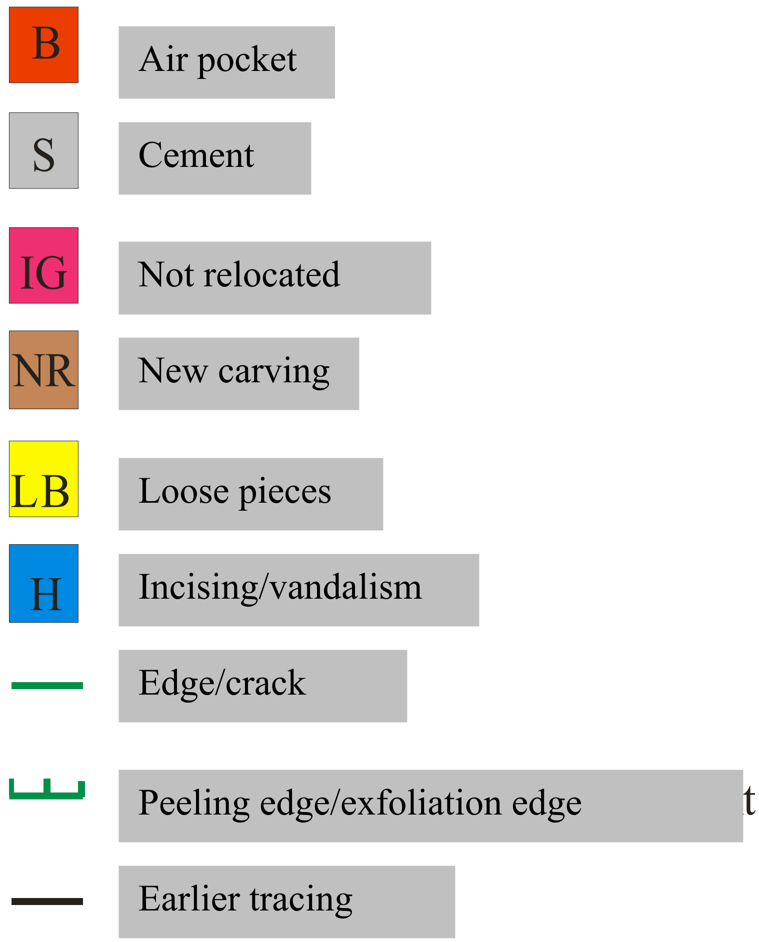


Figure 44. Symbols used when drawing a damage map.

3.9 Sample collection and analysis of rock paintings

It is necessary to apply for dispensation from the Cultural Heritage Act to take samples directly from rock paintings. One should also be aware that loose paint fragments on the cave floor are also automatically protected.

The inorganic material in the pigments of rock paintings are best analyzed by a combination of SEM-EDS (Scanning Electron Microscope Equipped with Energy Disperse X-Ray Spectrometry) and X-ray diffraction (XRD). In other countries, pigment has also been analyzed with Raman spectroscopy. The advantage of this method is that it requires very little sample material, the sample is not destroyed during analysis and both inorganic and organic material can be analyzed.

Potential organic binding agents in rock paintings are usually strongly mineralized. This makes them extremely difficult to reveal and identify. Only a few uncertain international results indicate that remains of organic binding agents are present in rock paintings. In addition to mineralization of the actual binding agent, these results can also be due to sensitive analysis methods that register many sources of error in addition. The most appropriate analysis method for organic binding agents is gas chromatography / mass spectrometry (GC-MS). If one actually succeeds in identifying probable remains of an organic binding agent in the paint, it can also be possible to obtain a direct age estimate using radiocarbon dating (AMS dating). So far this has not been possible in the analysis of Norwegian cave and rock paintings.

4. MANAGEMENT

The objective of management is to safeguard the value of rock art through physical protection of the locality/panel and its immediate environment. Management can include different types of preventive conservation actions, including maintenance and presentation, but also communication of the significance and vulnerability of the rock art. Management usually involves changes in the appearance of the rock art and its immediate surroundings. In practice, it can be difficult to distinguish between management and direct intervention because direct intervention – according to the definition provided by the Directorate for Cultural Heritage – is also a part of management[13].

Simpler forms of management – and especially measures linked to maintenance – are a continuous, and partially routine-like, process. Maintenance is an important means for guiding development and avoiding more resource demanding intervention. All forms of more intensive management and direct intervention can introduce elements of risk. These must be discovered at an early stage, so that counter measures can be implemented to correct negative developments before damages become more extensive. Monitoring should also be considered an integrated part of management.

All management actions, both planned and implemented, must be recorded in a *written management plan* that is:

1. Subject to interdisciplinary quality control (archaeologist, conservator, geologist, botanist).
2. Approved by the appropriate county, regional museum, municipality, landowner and other possible parties involved.

4.1 Management plans

Rock art has been handed down to us in a highly variable condition. The form and size of the rock, as well as its surrounding environment (terrain, vegetation, climate, distance to water, etc.) also varies significantly. This makes it very difficult to make use of standardized solutions for management of such cultural resources. Each protective measure must be tailored to the individual locality. The nature and scope of management must be viewed in relation to the degree of access and presentation. The preparation of management plans is therefore a very important part of the total protective work.

[13] Also see Directorate for Cultural Heritage, Information pamphlet 7.3.1. Skjøtsel: Vernestrategi og velferdsgode (Management – protection strategy and merit good) (1998).

Management plans should function as a tool for safeguarding rock art localities in the best manner following the completion of documentation and condition assessment. Lack of a plan can, in the worst case, mean that earlier efforts have been wasted. It is therefore necessary to have well thought out and binding management plans both for the preservation of rock art localities and their potential presentation for the public. Management plans must provide a clearly defined division of responsibility in regard to the individual actions such as inspection, maintenance and written reports at agreed times. This can apply to the division of labour between the county, regional museums, individual municipalities and possible landowners. This entails that management plans must indicate possible financial responsibility for all ongoing management, and that there are clear guidelines and routines for execution of management work. It is also important that management plans address and determine relationships with the landowner. If this is done afterwards, the delegation of responsibility is often unclear so that the completed actions are endangered and plans for future actions are difficult.

Finally, it should be pointed out that preservation, communication and presentation of rock art is a question of condition assessment, long-term planning and clarification of responsibility. Management plans are in this regard quite important. They must insure that necessary actions and responsibility are a reality. In order to achieve this, it is still a fundamental prerequisite that resources are available to insure necessary control and initiate necessary actions.

A management plan template is found on the website for the Directorate for Cultural Heritage under the Rock Art Project: http://www.riksantikvaren.no/Norsk/Fagemner/Arkeologi/Bergkunst/Bergkunstprosjektet/ and http://www.riksantikvaren.no/Norsk/Publikasjoner/Informasjonsark_og_brosjyrer/?module=Articles;action=Article.publicShow;ID=2312 (site visited 10.05.05).

In addition to the management template, the Directorate for Cultural Heritage's Information on Cultural Resources, Chapter 7.2 *Informasjon til grunneiere* (Information for landowners) and 7.3.1 *Skjøtsel - vernestrategi og velferdsgode* (Management – protection strategy and merit good) published in the fall of 1998, can be used as a basis for the production of management plans (http://www.riksantikvaren.no/Norsk/Publikasjoner/Informasjonsblader/?module=Articles;action=Article.publicShow;ID=2314) (site visited 9.08.05).

4.2 Presentation

Rock art is protected by the Cultural Heritage Act of 1978, which is the best protection available by law. However, there are still major problems related to long-term protection of cultural resources of this type. There are many reasons for this, but conditions surrounding increased outdoor recreational activity and tourism have led to significant preservation problems and caused a great deal of damage and direct vandalism. In addition, there are problems associated with the extent of the rock art surface and poor condition of the rock surface. In sum, these conditions make preservation work both extensive and costly.

Efforts involving the dissemination of rock art must be strengthened so that a change in public attitudes occurs. Visitors must be taught that they cannot walk on rock art panels and that they should not expect to be able to see everything each time. Those who are especially interested must expect multiple visits to the same panel if they wish to see everything. Professionals must be better at informing the public about the importance and content of the rock art, as well as explaining how easily individual rock art panels can be damaged.

It is also important to coordinate efforts between different research and management activities concerning the same cultural resources since various professional groups can come into conflict with one another because they play different roles. One example of this can be that in connection with management actions such as clearing of vegetation, cultural layers that occur in relation to the rock art locality are destroyed, including structural remains and artefacts that are disturbed and destroyed through edging, cleaning and draining work.

When going to the effort of presenting a rock art panel for the public, one should undertake a vulnerability assessment of the panel/locality to be adapted. In such an assessment/analysis, it will be important to confirm that the location has the necessary qualities to enable presentation. Central questions and problems to be addressed will then be:

- The value of presentation in relation to expected durability of the panel over time
- Can presentation contribute to increasing decomposition processes at the locality or panel?
- If possible, establish the tolerance limits of the panel with regard to visitor numbers and wear.
- Which communication qualities does the panel have? Does is lie by itself or as a part of a larger cultural resource area, etc.? If the panel has previously been painted, will this be important for the way one chooses to adapt the panel?

Such a total assessment should build as much as possible on the data that the Rock Art Project documentation has obtained. It is important to stress that all presentation of rock art must only take place according to a overarching plan, or a situation can rapidly develop where only the small, peripheral localities in poor condition that are not made accessible to the public. Perhaps some of the large and really impressive localities should be spared from modification / presentation.

General principles for presentation

- Adapt only what is professionally and ethically defensible.
- Be humble, patient and cautious. Think ecologically and long-term.
- Do not regard the surrounding natural and cultural landscape as a problem, but as a natural and necessary context that should increase the experience value of the rock art.
- Try to keep the technical devices to a minimum and at a good distance from the rock art.
- Use materials and installations that neither in the short or long-term can lead to damage (such as run-off) on the rock art.
- Consider the possibilities for guiding rather than physical presentation.

- A management plan with long-term follow-up and financing, as well as binding management agreements, should be designed in advance of any action.

See the Directorate for Cultural Heritage publication *Informasjon om kulturminner* (Information on Cultural Resources), Chapter 7.3.6 *Formidling og tilrettelegging* (Communication and Presentation); http://www.riksantikvaren.no/Norsk/Publikasjoner/Informasjonsark_og_brosjyrer/?module=Articles;action=Article.publicShow;ID=2308 (site visited 26.01.05).

4.2.1 Physical presentation

All presentation will constitute an intervention in the cultural resource area in one form or another, whether it occurs through signage, walkways, public ramps, etc. Therefore it is important that the physical presentation is adapted to the particular area, so that wear is minimal, and that one chooses a solution or solutions and materials that are least destructive for the panel. The Directorate for Cultural Heritage can give advice or provide contacts with others that can give advice on which solutions and materials one should use.

A goal must be set for the tolerance limit of the panel with respect to the public. The size of the presentation should be in proportion to estimated number of visitors. One must also have an aesthetic consideration that the presentation accommodates and is subordinate to the cultural landscape with regard to design and use of materials. The presentation must stand in relation to what one wishes to show, and not have such substantial dimensions that it becomes a presentation in itself that is most conspicuous (Figure 45).

In some instances, presentation actions will come into conflict with communication aspects, for example with larger coverings to remove lichens and other vegetation, as well as possible painting of the figure panel. This is an intervention that can take many years to complete, so that the work will influence public access. In the worst case, the entire area must be closed. This is a necessary process, but can have negative consequences, for example economics, because the public is denied access to the area.

Figure 45. Presentation with fencing. Åskollen, Drammen, Buskerud. Photo: T. Norsted

4.2.2 Increasing the visibility of rock carvings

In the view of the Directorate for Cultural Heritage, the painting of rock carvings should be restricted as much as possible, both for aesthetic and conservation reasons and the appreciation of rock art. One should work for a change in attitude with a greater focus on the time of day and type of light in which rock carving figures are most visible (Figure 46). It should not be assumed that everyone should be able to see the rock carving figures at any time such that we must therefore paint them in. Guided tours should be given increasing consideration as an alternative to physical presentation of localities.

The Scandinavian tradition of painting in rock carvings is about 100 years old and is partially maintained in both Norway and Sweden. The main argument for painting has been that the carvings are clarified so that people can see where they are and do not begin to paint or draw on the carvings themselves where they are weak or indistinct.

Painting rock carvings has previously been a common part of presentation in Scandinavia. Today it is the view of management authorities that carvings that have until now been unpainted, should not be painted. One should also avoid painting carvings that have previously been painted. The reasons for this are many: Possibilities for studying pecking technique are eliminated. The experience of rock carvings is oversimplified since the different interpretive possibilities are removed. The wonder and magic of the figures disappears completely because they are interpreted in advance by the one/ones that carried out the new paintings. The possibility of returning to experience the diversity of the figures is also eliminated. Painting can also damage the rock carvings because the paint can remove the mineral grains when it flakes off. Finally, within foreign research circles, painting of rock carvings is considered to be vandalism, even when it is done by professionals.

See the Directorate for Cultural Heritage's *Informasjon om kulturminner* (Information on Cultural Resources) Chapter 7.3.6 *Formidling og tilrettelegging* (Communication and Presentation); http://www.riksantikvaren.no/Norsk/Publikasjoner/Informasjonsark_og_brosjyrer/?module=Articles;action=Article.publicShow;ID=2308 (site visited 26.01.05).

Figure 46. One should work for a change in attitude with a greater focus on the time of day and type of light in which rock carving figures are most visible. One example that a good light angle can replace the marking of carvings with chalk or paint. A) Parts of the rock art locality Vestbøstad, Fitjar, Hordaland, in "poor" light.

Figure 46. B) The same area of rock surface in good light conditions. Photo: L. Sæbø.

4.2.3 Resources, maintenance and communication

Communication and maintenance should also be of central importance in presentation. The communication potential of the rock art panel should be the main reason for choosing presentation of a special panel for the public. Defining a target group for presentation of rock art will probably be impossible. The public constitutes a diverse group, ranging from those that have never seen a rock carving before to those that have seen many different types of rock art in a number of countries. However, there is one particular group of special importance, children in primary school. One of the most important functions that rock art can have is the communication of knowledge from earlier periods to the coming generation. Increased consciousness of this can have a preventative effect in relation to the damage and destruction of rock art.

It is important that presentation materials, sign types, text and brochure material have a high standard, both in terms of durability and professionalism. Signs should not have oversized text, and should be easily understood. It is also important that signs are simple to replace, because they can easily become outdated. If they can stimulate the imagination and encourage an attitude as well, this is a definite advantage. Simple solutions can often be as good as large signs with great amounts of information. It should also be obvious that presentation material left standing in a state of collapse is of little benefit to the cultural resource. When adapted areas are in poor condition and are no longer in accordance with their descriptions in tourist brochures, etc., this gives an unfortunate signal and can lead to an impression that the area and rock art are no longer particularly important. When adapted areas – following the completion of management work – lie overgrown with signage that does not function according to its intention, it is not surprising that the public, and maybe children in particular, do not see the value of taking care of the rock art. Communication and maintenance are therefore closely linked. Both aspects will have importance for how tourists and local residents take care of the area. Well maintained cultural areas are a good advertisement for the individual municipalities, while the opposite will probably be the case for areas where advertisements and tourist information do not coincide with the actual situation.

See the Directorate for Cultural Heritage's *Informasjon om kulturminner* (Information on Cultural Resources) Chapter 7.3.6 *Formidling og tilrettelegging* (Communication and Presentation); http://www.riksantikvaren.no/Norsk/Publikasjoner/Informasjonsark_og_brosjyrer/?module=Articles;action=Article.publicShow;ID=2308 and Section 7.3.4 *Skjøtsel: restaurering* (Management: Restoration) http://www.riksantikvaren.no/Norsk/Publikasjoner/Informasjonsark_og_brosjyrer/ ?module=Articles;action=Article.publicShow;ID=2310 (site visited 26.01.05).

Resources

Access to necessary resources is often a central issue in questions that have to do with conservation, communication and presentation of cultural resources. These needs must be addressed at an early point in the planning phase and before one initiates physical presentation itself. This applies both to financing sources and access to necessary professional competence. Of central importance to this problem is the question of what capacity the county and regional museum have at the actual point in time when the presentation will be undertaken.

Questions surrounding resources will of necessity affect the cooperation between the different parties, not the least between the counties and regional museums. The content of the management concept will be of central importance at this time. In practice, it is the counties and Sámi Parliament that are the proper authorities with regard to planning and implementation of management actions. But no action should be initiated without all parties, including the applicable regional museum, being informed and in agreement. It is also important that the relationship to the municipality and landowner is clarified.

It is extremely important to remember that a detailed management plan for the locality must be in place before one applies for funding and other resources.

The relationship between new actions and ongoing maintenance

During presentation, it is important to be aware of the problematic relationship between new actions and ongoing maintenance. New actions are easily carried forward by enthusiasm and job satisfaction, but who removes the routine tagging from the signs, washes off the algae and replaces them when they are worn out? Who adds new gravel when heavy rain washes out deep trenches in the parking lot, and who fastens loose planks in the platform before someone twists an ankle? Who does this job in 1,5,10 or 20 years, and where does the money come from? If one has a clear answer to these questions, there is a good basis for initiating presentation.

Presentation and delayed marketing awareness

It is also important to be aware that if one starts presentation, it takes many years before "the entire market" becomes aware of the new adapted rock art locality. By this time a tradition is established, the locality appears in guides and road books, etc., and it is *expected* that the location has been adapted. The stream of visitors will continue regardless of what happens at the locality. An adapted locality will therefore be difficult to close after a few years, if one wishes to do so. Presentation of new localities must therefore be evaluated with extreme care, and if one first commits to this solution, one must be certain that this is the correct long-term choice.

Local contact persons

The desire for presentation most often comes from the local communities. This is obviously positive, both because enhancing visibility can contribute to protection and because the local community's involvement is a prerequisite for success. However, it is important that a locality is not opened and adapted for visitors before the culture historical context is clarified and a complete documentation is carried out. Only after this is done, is it possible to consider if the locality really is appropriate for presentation. This sequence also means that a substantial part of the source value is insured in advance of potential destructive consequences from the presentation.

Place emphasis from the outset on developing a good relationship with property owners and local authorities Alert and interested locally acquainted caretakers are valuable supporters, but also insure that limits are established for what they can undertake. Avoid permitting landowners to paint in carvings, clean the rock art with high pressure washers and/or decorate along pathways with plants from their own garden.

The verbal contact with landowners and local contact persons is important. Through such conversations, one can be given important information and solve many larger and smaller problems. At the same time, verbal agreements involve a risk that the situations are misunderstood. There can also arise a danger of the situation becoming twisted in an undesirable direction. One possible precaution is to make a report following a verbal agreement that is sent to the local landowners and contact persons, and that these agreements are incorporated into the management plan for the applicable panel/locality.

Think ecologically and long-term

It is important to avoid making irreversible and polluting changes in the environment at and surrounding a rock art locality. Use ecological methods and environmentally friendly materials. After a hundred years it should be possible to remove all traces of human activity and return the locality to its natural setting. Think how a planned action can influence rock art over a very long period.

Pressure impregnated materials lead to runoff that can kill lichens and moss. This and other foreign matter can lead to chemical and biological pollution that can hinder possibilities for future scientific investigations at the localities.

Luxuriant vegetation surrounding rock art localities often necessitates considerable maintenance. This will also increase if sawed-off branches, leaves and other plant material are placed in a pile and decomposes to provide nutrients for additional growth near the panel/locality. By removing plant material, one simulates traditional agricultural harvesting methods and gradually creates a more modest vegetation that requires less management. But remember that this takes time!

4.2.4 Minimal presentation

In connection with presentation (Figure 47) it is important to ask questions. When we place rock art and its context in focus, how can we manage to minimize presentation? For example, is it correct to build high platforms that display carvings from a perspective that people in the past would not have seen them from?

- Presentation must accommodate the locality's condition, its potential as an attraction locally/regionally/nationally and estimated amount of visitors. Take into account the need for changes due to a dramatic increase in visitors, economic recession or decreased interest. Frequent visits by large groups (buses) require completely different actions than an even flow of one or two visitors.
- Make attractive public use areas (rest areas, viewpoints, etc.) some distance from the locality so that the public is spread out and both wear and tear and the risk of damage to the rock carvings is reduced.
- Adapt in accordance with the surrounding natural environment / cultural landscape and local traditions. Do not plant garden plants and ornamental trees out in nature, but instead use appropriate wild growing species. An appropriate and traditional fence from one region or area will not be equally appropriate in another area.
- Avoid having presentation create visual pollution affecting the experience of a cultural resource. Think about how a photographer would wish to photograph the locality without the interference of objects such as cars, signs, fences, etc. Provide for an adequate distance / screening between the parking lot and actual locality.
- Take into account geography, changing seasons and climate both with regard to presentation and protection. If steps and platforms are made, one also has responsibility if persons slip and injure themselves when there is ice and snow. Will a presented locality be exposed to damage by motorized vehicles with studded tires when it is covered with snow, or are physical barriers set up to hinder this?

Figure 47. A) An example of a relatively extensive presentation. Begby near Fredrikstad, Østfold. Photo: T. Norsted.

Figure 47. B) Minimal presentation that accomodates the contours of the rock with carvings. Bjørnstad, Skjeberg, Østfold. Photo: T. Norsted.

4.2.5 Use of materials

Presentation should occur in accordance with the surrounding natural environment / cultural landscape and local traditions. Presentation actions can often be most effective by using raw materials and resources found at the location.

- Instead of leading the public in the right direction by making fences and railings of impregnated materials or iron posts, one can potentially use a "living hedge". In this case, one uses locally appropriate species that are moved and planted where they are required. If there is a location where the public must not go, species such as bushes with thorns (bearberry, primrose) are more effective than fences. Instead of only using factory finished fence posts of pressure impregnated and pollutive wood, one should investigate local and more natural alternatives. Maybe the landowner in the area can deliver fence posts of juniper wood? This is even more long-lasting than pressure impregnated materials, can provide the farmer with extra income, and also foster a good relationship.
- Many rock carvings lie on flat rock surfaces, and it is not unusual for paths to cross *over* these. Experience has shown that if there is a well-adapted path, nearly all visitors will follow it. This fact must be utilized positively when making new paths so that the public is led to the rock carvings at a favourable place, and led forward *along the rock carvings* and not over them. Shortcuts across paths can be closed by planting locally appropriate bushes (possibly with thorns).
- Where there is a need for gravel for the path and parking lot, one should investigate if there is a local gravel pit that can deliver natural gravel from a local rock type. A cultural resource is presented in a much better fashion if gravel of small, local rock rather than gravel that is sieved from crushed material of a non-local rock type is used. It is unfortunate if a path with sharp, angular gravel leads all the way to the actual rock carving panel because the gravel is moved about by shoes. If the public walks on the rock surface, the gravel will act as an abrasive. Crushed rock will have more of a negative impact than natural gravel. One

alternative is to plant grass along the final portion of the path. If this is done over a base of gravel, it will not become muddy, and the grass will help to clean gravel and sand from shoe soles. Shredded bark can also be a good alternative.

4.2.6 Signs

When we plan elements of a presentation, it is natural to start with the way through the landscape and up to the rock art panels. This can be an significant part of the experience. Construction should be combined with marking and signage that encourages the public to follow the route. Marking of the path should be discrete. There is a point in forming the route so that one has an impression of approaching an important place.

The ideal is to organize the signage in two steps. If it is natural for the visitors to come by car, the first sign can be set up by the parking lot (Figure 48). One can consider the possibility of setting up small signs along the way as is common along nature paths and cultural pathways. But this arrangement can easily appear distracting or give the impression of excessive information.

Sign number two is set up at the locality. It should be placed discretely so that it does not hinder free sight over the panel/locality. The sign should not be visible when photographing. It is best to place it a little to the side of, and a certain distance from, the panel, but at the same time give the reader a good overview when it is studied. If some of the individual figures are difficult to comprehend, it is important that the sign include a graphic representation of the panel. The sign should not be so large and eye-catching that it appears as a foreign element at the location.

- Signage should be given a good deal of consideration in a presentation. Signs should be informative in a way that gives a positive message from management authorities. By spreading knowledge, the signs can contribute both to providing a meaningful experience and communicate the importance of sensitive behaviour.
- The overarching function of a sign is to give the visitor relevant information in the form of *text, drawings, maps and images*. It is preferable if a clear message can be combined with good design, but one should be warned against an outer design and construction that is so dominating that it diverts attention from the content.
- It is not possible to provide a standard recommendation on *design and use of materials*. This must be considered on the basis of the conditions and traditions of the place. A flat, open terrain demands different signage than a steep rock face within a forest. It is recommended to copy signage design and choice of materials that one has good experience with at other places, and adapt the signage to the system that is used for other cultural resources in the district. One must often choose a middle path between two extremes: Signs that are very durable and resistant to vandalism, but are expensive to produce (cast bronze, engraved text in stone or metal), and on the other hand signs that have limited durability, susceptible to vandalism, but easy to produce and cheap to replace (such as paper with sun-resistant colours sealed in plastic).
- In connection with research tasks and management actions, it can be necessary to have some equipment at or nearby a locality. Insure that the public is informed

about this with a separate *temporary sign*, and set the same requirements for orderliness that we set for the public. It is not desirable to have winter matting, drainage pipes and plastic film lying about around a locality/panel in the middle of the summer.

Figure 48. A) Information sign at Leiknes, Tysfjord, Nordland. Photo: B. H. Helberg.

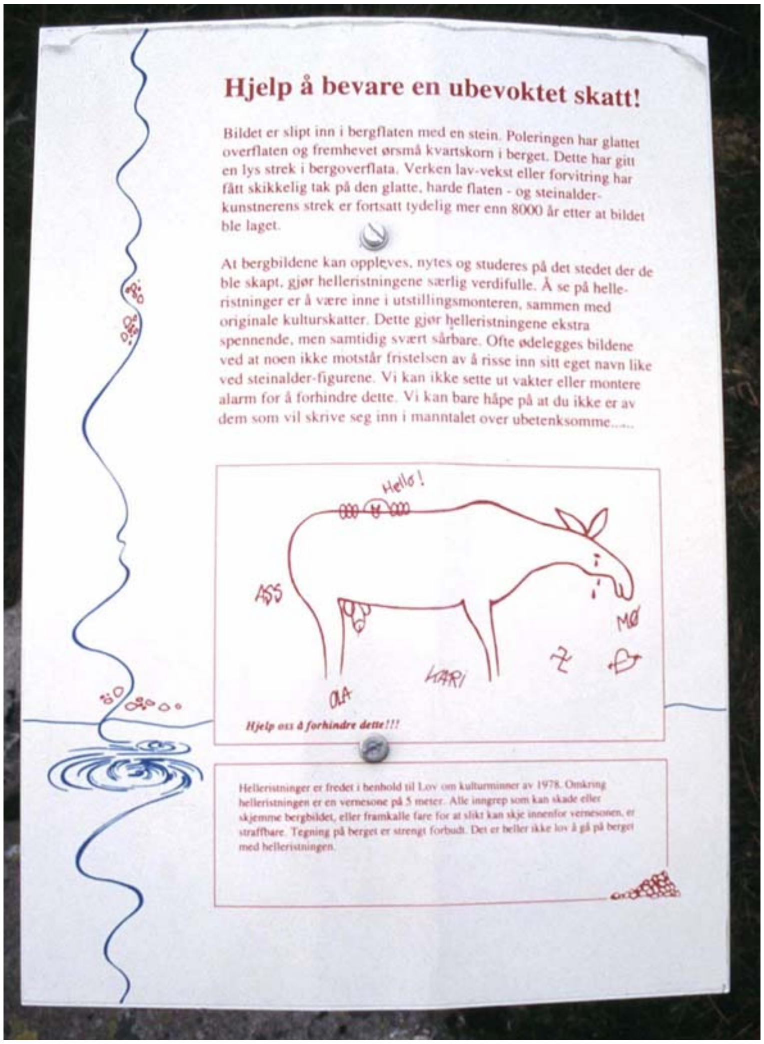


Figure 48. B) Information sign from Vågan, Bodø, Nordland. Photo: B.H. Helberg.

4.2.7 Presentation of painted rock art

The presentation of painted rock art has two goals: It should make the paintings accessible and at the same time be so informative that they provide a link to preventive conservation.

The following problems should be considered in assessing the requirements for presentation of rock and cave paintings.

- *The condition of the paintings*. Are the paintings poorly preserved? Are there indications that continued destruction will occur relatively rapidly? Is the condition in accordance with the presentation effort? Can the condition give the public such a poor impression that it creates a negative attitude? Can this attitude lead to vandalism?

- *Preventative actions*. Can we avoid setting up a barrier that hinders the visitors from touching the paintings? If this is necessary, how much will this fence – even if it is low – reduce the experience of the paintings' authentic connection with the landscape?
- *Ownership situation*. If the landowner's use of the property damaging to the locality and a possible source of conflicting interests in relation to traffic?
- *Access*. Does the locality lie within an acceptable distance in relation to a traffic artery? Is it possible to construct a parking lot?
- *Route possibilities*. Is the terrain appropriate for building up a usable route that leads from the parking lot to the locality?
- *The appeal of the locality*. Does the locality have a size and form that makes an impression on the visitors? Are the paintings clear enough to give the public a meaningful experience?
- *Condition of the rock or cave.* Is it safe to move about at and nearby the locality, or is there rockslide danger?
- *Protection of the terrain at the locality.* Will it be possible to lead the public at the locality so that wear and tear on the terrain is limited and other archaeological material is protected? Is this possible without constructing a platform (that is probably not desirable)?
- *Regular maintenance.* Is it practically possible and are there sufficient resources to inspect and maintain the locality so that it can be kept presentable after a presentation?
- *Possibilities to provide information*. Are there good possibilities to capture the attention of the visitors with the aid of signage at the parking lot and at the actual locality?
- *Immaterial aspects.* Is the locality still the bearer of traditions and representations that are alive among segments of the present-day population? Will a presentation come into conflict with their interests?
- *Other possibilities*. Is there other painted rock art found in the area that has a greater appeal, more generous tolerance limits, better natural conditions for presentation and a location that makes them more appropriate for presentation to a broad public?

See the Directorate for Cultural Heritage's *Informasjon om kulturminner* (Information on Cultural Resources), Chapter 7.3.6 *Formidling og tilrettelegging* (Communication and Presentation);
http://www.riksantikvaren.no/Norsk/Publikasjoner/Informasjonsark_og_brosjyrer/?module=Articles;action=Article.publicShow;ID=2308 (site visited 26.01.05).

When there is a great danger that the rock face with paintings can be touched by the visitors, it must be considered if it is correct to set up a form of barrier that can contribute to preventing damage. Although the silica skin will give most of the figures a certain degree of protection against light contact, there is always a danger for vandalism, and particularly tagging. It can be sufficient that the barrier functions psychologically and only consists of a low fence. It this solution is chosen, the sign text must emphasize how vulnerable the paintings are, and that this vulnerability is the reason for the barrier. Only at this point can the fence be perceived as something positive. However, we cannot avoid the fact that an enclosure represents a foreign element at the locality.

A barrier can potentially be combined with a platform if it is difficult to move about in the terrain in front of the panel or if there is a danger that archaeological material can be destroyed by foot traffic. Such a platform can include a railing, at least in front of the paintings. It is important that the railing does not hinder photography. In other countries, it is common for signs that interpret the paintings to be placed on a railing directly in front of the figures. The platform must be made of materials that give the least possible amount of pollutive stress for the environment. It should not be bolted in place, but rest on solid points in the terrain.

A platform with railing represents a very extensive presentation. At nearly all localities with painted rock art here in Norway, such a solution would be experienced as far too dominating. It destroys the experience of the undisturbed cultural resource that the majority of visitors actually come to experience.

In reality, we have little experience with presentation of painted rock art in Norway. Therefore it is relevant to investigate how this is done at localities with similar rock art in other countries. Here we can observe everything from minimalist to very comprehensive solutions. In some instances, management has been done in a manner that seems importunate and lacking in creativity. "Caging in" of rock paintings with bars is a common protective measure that robs the locality of all experiential value. On the other hand, much has been destroyed by vandalism that is largely due to culture heritage management's lack of judgment or its total absence.

In many instances, guiding is much more desirable than a pervasive, physical presentation. A guided tour will most likely make much of the presentation superfluous and therefore save the locality from the negative impact of many installations, at the same time that a skilful guide can provide the public with far more information than any visual presentation can manage. In addition, a guide will have a preventative effect in relation to undesirable behaviour at the locality.

In sum, the solutions must be chosen individually and adapted to each individual situation. It is not a matter of right or wrong, but more of a trade-off based on sensitivity and common sense.

4.2.8 Guiding

In a few instances, visitors have not been given access to cave paintings without the presence of a guide. A good guide can provide so much information that this can contribute to limiting signage.

All panels in a cave do not necessarily need to be accessible / adapted for the average visitor. Paintings in the innermost parts and in the narrow sections can originally have been associated with isolated rituals, and can still be closed for public access. In narrow sections it can often be impossible to install shielding that can hinder touching.

A successful example of presentation has been achieved at Kollhellaren (Refsvikhula) in Moskenes municipality, Lofoten. This has been done through close cooperation between the county, regional museum, municipality and travel industry in the area. The cave has been officially closed by the county, but permission is given for access to groups accompanied by a guide. The groups are transported by a small boat around Lofotodden to a suitable landing location, and the guide provides an orientation about the cave, the context and the paintings in front of the cave entrance. After this, the visitors are led in to the easily accessible panel with 18 relatively clear human figures. They are also permitted to see in to a narrow side corridor where the paintings can be observed from the opening. The third panel, the innermost, is not shown.

5. CONSERVATION

A fundamental ethical obligation within conservation is to insure responsible care and preservation of cultural resources. It should show understanding and respect for the cultural and physical integrity of cultural resources and their fundamental source value.

Conservation of cultural resources should safeguard important cultural values for the future. The goal is to carry forward cultural resources to future generations in as satisfactory a condition as possible relative to the expertise and available resources at the point conservation is carried out.

Conservation of cultural resources is defined in the following manner by *The International Institute for Conservation of Historic and Artistic Works – IIC:* ”All actions aimed at the safeguarding of cultural property for the future. Its purpose is to study, record, retain and restore the culturally significant qualities of the sites with the least possible intervention.”

Conservation should emphasize the demand for minimal intervention that does not diminish the value of the material and historical integrity. All conservation actions must be documented and, as much as possible, be reversible. All added materials and physical changes must be able to be clearly separated from the original. Documentation must include a thorough description of the intervention, a condition report and a description of possible weathering damage. All added materials must have a known chemical content that is documented, so that one in the future will be able to know what has been used.

Before possible conservation actions are initiated, the Directorate for Cultural Heritage’s Documentation Standard for Rock Art *must* be completed and the actions recorded in a management plan (see Chapter 4.1). Actions to hinder, stop or delay possible weathering damage should be discussed with archaeologists, geologists and botanists before they are carried out. As with management, monitoring is important to control possible side effects of the actions (see Chapter 6).

Conservation can be divided into two main groups, *preventive* conservation (Chapter 5.1) and *direct* conservation (Chapter 5.2). It is important to remember that all actions undertaken should build on the documentation that is recorded in the management plan for the appropriate panel/locality.

5.1 Preventive conservation

Preventive conservation of rock art is all actions the are done outside of the actual image surface. The intention of preventive conservation is also to remove factors that lead to increased weathering of the cultural resource. This can, for example, be diversion of water that runs over the rock surfaces, removal of nearby sources of pollution, cleaning leaves and pine needles from the rock surface, and care of vegetation around and on the actual rock surface. Through preventive conservation one comes closer to the carvings than with management, but not as close as with direct conservation.

Preventive conservation has many elements that are included in management and common care of rock art panels, and the transition between these will often be fluid. It is important to be clear that by focusing on preventive conservation and conducting relatively simple interventions and maintenance, one can hinder the development and enlargement of damages that require direct intervention.

Before possible preventive conservation is carried out, it is extremely important that one confers with an archaeologist. When actions are completed, it is also important that they are followed up with regular care based on a prepared and quality-controlled management plan (See Chapter 4.1).

5.1.1 Vegetation control

Grazing

Many rock carving localities lie in open cultural landscape areas that are in the process of regrowth. Heather and/or deciduous forest is on the advance due to reduced grazing pressure. Accumulation of organic material, vegetation changes in the direction of increased heather, overgrowing of ditches and waterlogging due to reduced grazing pressure leads to increased soil acidity. At localities where this is a problem one can, in collaboration with knowledgeable experts, consider the following actions:

1. One possible action would be to carry out controlled liming on the surface of the vegetation. This leads to an increase in pH and degree of basal saturation and can reduce the chemical weathering.
2. Good grazing will control the development of shrub and forest vegetation that can lead to re-growth of the area and increase decomposition of the rock surfaces due to root action and root abrasion.
3. It is important to insure good drainage of the cultural landscape. Poor drainage halts important biological processes in the soil. This can lead to a shift from plant communities that are typical for the cultural landscape to plant communities more adapted to moist soil. This leads in turn to waterlogging and swamp formation. Sheep and goats do not do well in moist vegetation. Maintenance of old brook channels and drainage ditches should therefore be a yearly routine and incorporated into the management plan in such an area.

The following requirements must be met if grazing is initiated in a rock art area:

1. Management must be viewed in a *long-term perspective*. All-out efforts without a serious follow up will only make things worse and the monetary investment will be futile.
2. One must take into account that hired help will have to overtake management in the future. This requires that the management actions are *cost-effective* in order to be realized.

3. One must take be aware of common *animal protection considerations*. The animals need to have adequate acreage for feed and movement. They need access to fresh water, also during dry periods.

4. Management needs to insure the maintenance of an *open, traditional cultural landscape* on the level area surrounding the rock art panels, and management should not damage the cultural resources.

If one is to achieve this, management actions must be done in advance to make the grazing land attractive for domestic animals:

- Potential coarse heather and trees must be removed.
- The vegetation composition must be changed so that it becomes richer in grass and herbs.
- The area must be regularly grazed so that new growth of bushes and trees is hindered and a grass dominated plant stock is maintained.

General vegetation control

Dense vegetation can indirectly result in physical damage to the rock surfaces by preventing sun penetration. With that, the natural drying of the rock surfaces is delayed. We cannot change air temperature, but if we can reduce some of the rock's surface water, this will reduce some of the danger of frost action. Frequent freeze and thaw periods occur in October/November and March/April, when the rock is free of snow. It is important that the rock surface is as dry as possible. This can be achieved by letting in the low fall and spring sun over the rock by removing dense vegetation and draining away water (see Chapter 5.2.2).

- Obtain an overview of the vegetation around the rock carvings in collaboration with a biologist. Set up a plan over which trees and bushes should be removed to create a more favourable climate on/around the rock surface.
- Draft a plan with the landowner for the relevant panel. Listen to the advice and experience of those that live at the location can contribute. Clearing should be done by professionals to avoid damage to the cultural resource.
- Prevent roots from growing in the rock. This can lead to root action damage. One should be especially aware of juniper and pine trees because these have long roots.
- Remove dense vegetation up to the rock with carvings. This is because the vegetation will lead to a moist climate. At some localities, an alternative can be to remove the lowest branches on trees that surround the panel. By cutting back or removing trees, the rock will get better ventilation, the average temperature of the rock surface will generally rise, the surface will be drier and one prevent an increasing growth of micro-vegetation such as algae. At the same time, the conditions will be more favourable for certain lichen species and the likelihood for a lichen-covered surface will increase.

5.1.2 Water seepage – Drainage of water

Water seepage can lead to rock art damage. A small water seep will freeze and thaw relatively quickly during periods with rapid temperature changes around the freezing point. There are often observed significant damages in the form of peeling along the outer margins of the water seep, but also within the seep itself. The reason that damages are often greatest along the margins of the water seep, is probably because the water freezes and thaws most easily in this area. Frost action is therefore most frequent here.

1. Let an informed geologist determine if weathering damages are so significant that the rock art will be lost if the water seep is not removed.
2. Also consult with an archaeologist before any action is initiated. The water can have importance for the archaeological interpretation of the cultural resource (Figure 49). If drainage or another form of digging is necessary, an application for dispensation from the Cultural Heritage Act must be sent to the Directorate for Cultural Heritage.
3. Diversion of water is done surrounding the rock, never on the actual image surface.
4. By testing carefully in the turf around the rock, one can get information about the rock's extent, depressions in the rock, etc., and on this basis find channels that naturally lead the water away from the rock with carvings. It will often be necessary to remove turf from some of the rock in connection with drainage. In many instances, it is difficult to determine where the boundary is between old and new growth. It can be useful to study old photographs to clarify this.

Painted rock art

Where a water seep occurs underneath an overhang that continues downward to the paintings, the best action can be to mount an artificial drip point or "drip line" under the edge of the overhang. This solution has been used to save paintings on rocks and caves in a number of countries for more than 40 years. It has generally functioned as intended. Materials chosen have varied from rust-free steel bands set into the rock to "sausages" of silicon. Some choices of material have caused problems. It is a good principle that any "drip line" must be able to be removed and be replaced with something new and better at a later stage. This should take place without leaving a trace. When silicon is involved, it is important to choose a type that does not leave remains of material that is difficult to remove. Another situation is that the "drip line" can cause water to splash onto the paintings below. Actions can also contribute to altering the conditions in the cultural layer immediately in front of the panel. Thus there are a number of different considerations to take into account before a "drip line" is mounted. It is also important that the effect is monitored and evaluated. Another solution in caves has been to mount artificial, angled "stalactites" that can trap and divert damaging water drips away from crack formations in the vault.

Figure 49. Here it has been chosen to retain a water seep flowing over the carvings. Begby near Fredrikstad, Østfold. Photo: T. Norsted.

Before a decision is made to mount a "drip line", the possibility of diverting surface water in the terrain immediately in front of the overhang/cave should be investigated. Trees that grow here absorb much of this water.

Local diversion of water seeps can be done by mounting narrow drainage gutters of silicon. The disadvantage is that such a solution represents a highly visible disturbance factor. This must be assessed in relation to the results obtained.

In general, water spreads over a larger area on rocks than on bare rock faces with carvings. This is a contributing cause for the expansion of crack formations in rocks until complete splitting off occurs along cleavage fractures. This applies particularly to schistose rock types. Damages can be dramatic and result in rock slides. Sometimes it is possible to divert a sufficient amount of water that such occurrences can at least be delayed. It is impossible to totally avoid the effect of water in the fissures.

5.1.3 Mechanical wear

Heavily weathered rock with carvings must be secured against mechanical wear because it is very vulnerable to additional destruction. This also applies to rock that is consolidated. This means that demands must be made regarding the environment around the carvings. It must be secured against the public walking on the rock. This can be done in the following way:

1. Set up a physical barrier. Consider if plants can function as a natural barrier around the rock carving surfaces. Make walkways that lead the visitors outside of the rock with carvings.
2. When there is a great danger that the rock wall with paintings can be touched and damaged by visitors, it must be considered if it is correct to set up a barrier.
3. Remember to set up information boards.

5.2 Direct conservation

Direct conservation involves intervention in the actual cultural resource. Conservation of rock art is defined as all intervention done to the image surface and the rock surrounding it. The purpose of direct intervention is to prevent or delay weathering processes that lead to deterioration or complete disappearance of the rock art. In some instances, this involves repairing damages that have already occurred.

To what extent one should carry out intervention in a cultural resource is a constantly recurring discussion. In theory all actions should be reversible, but in practice this will be impossible in the majority of instances if it involves intervention in the original material. Therefore the demand for reversibility has increasingly been replaced by the demand that the intervention should not impede a new and better intervention at a later time (i.e., “retreatability”).

One cannot rule out the potential occurrence of unintended problems down the line as a consequence of the intervention. An overarching goal must be to make the fewest possible interventions and reduce their scope to a minimum, and instead emphasize preventive actions.

5.2.1 Covering

Covering rock art with insolating and sun proof material will both limit physical (freeze/thaw cycles) and biological (micro- and macro-vegetation) weathering processes. The choice of covering material and physical shape is specific to each panel and requires planning and presentation (Figure 50). The covering process generally consists of three layers: (I) The *bottom layer* that will form a drainage layer that removes condensation from the rock surface as much as possible and insures that the covering is held in place, (II) the *insolating layer* that evens out the freeze/thaw cycles and (III) the *top layer* that will protect and hold the insolating and bottom layers in place. The bottom layer can potentially be eliminated for temporary covering. It is important that all three layers cover the rock surface some distance beyond the actual figures (at least 1 m).

Turf (peat) is a natural covering material, but must not be used for this purpose as it contributes to increased chemical weathering of the rock surfaces. Peat surrounding rock art localities should not be removed or disturbed to any significant extent since the layer underneath can contain archaeological material. If there is a need to remove a cultural layer in connection with covering, one must apply for dispensation from the Cultural Heritage Act. Methods for permanent long-term covering with appropriate natural materials (such as clay or ground-up minerals) has not been tested by the Rock

Art Project, and therefore we do not have enough knowledge to make recommendations relating to this type of material at present.

Due to topographic and/or climatic conditions, it can be practically impossible to accomplish a satisfactory covering of some rock carving panels.

1. The rock surface that is to be covered, must be fully documented before covering. The documentation should be carried out in accordance with the Directorate for Cultural Heritage's Documentation Standard for Rock Art.
2. Clean the rock surface with a soft brush. Potential cleaning of cracks and depressions is done in consultation with an archaeologist.
3. Consider the need for diversion of water (see Chapter 5.1.2).
4. Cover the surface with a bottom layer (I) of:
   a. ”Breathable” textile membrane (Sympatex) or
   b. fibre cloth/geo-textile combined with an overlying mesh that creates an airspace against the isolation layer (II).
5. Next cover with an insolating material (II)
   a. Specially designed material with glass wool insulation that is welded into a film (UV-resistant, armoured PVC-film that is fireproof or polyethylene with the same qualities).
   b. Polyethylene mats (Plastazote) (minimum 4 cm thickness). These are welded together with the aid of a hot air gun.
6. Cover with a specially designed tarpaulin (III) (Film of PVC or polyethylene of appropriate strength and durability and with the same qualities as under 5a).
7. Fastening arrangements:
   a. Specially ordered sandbags made of solid tarpaulin (UV-resistant, PVC or polyethylene film) is an alternative. They should weigh c. 5-10 kg and be sausage shaped to best accommodate the rock surface. It is important to insure that the material used for the sandbags lasts throughout the duration of the covering period. Sandbags are not appropriate for covering that lasts more than one to two years if the material is not durable enough. One must also insure that there are no holes in the sandbags that allow sand to run out over the rock surfaces.
   b. In some locations it may be necessary to stretch a rustproof wire over larger tarpaulins to hold them in place. These can be fastened by boring rustproof hooks into loose rocks that are laid over the ends of the tarpaulin. NB! The rocks must not be placed in a way that they can fall over the rock surface and damage the carvings.
   c. Where there are cracks in the rock surface, appropriate wires or a solid rope can be fastened with rustproof carabineers (the same type used for rock climbing).

   NB! Do not combine the use of aluminium and steel.
8. If the terrain is sloping, a net of nylon placed over the tarpaulin (III) to hold the covering material in place should be considered. This is done to prevent backsliding. The net should be fastened at points along the edge.
9. Where the terrain is relatively flat, turf (peat) / natural grass mats can be rolled out over the tarpaulin to conceal the covering.

10. Information / signage. Signs should contain information about what is occurring, why it is being done and how long it will be this way. Photographs of the rock carvings can also be included in the information. Signage must be approved by the cultural resource management authorities.
11. Possible decoration in the form of photographic prints on the tarpaulin can be added along the marked tourist paths.
12. Monitoring of the locality must be done to insure the quality of the covering materials and so that undesirable vegetation does not establish itself around/on the panel.
13. A guide is produced on how the work can/should be done and how it will be followed up.

Figure 50. Covered rock carving panel at Vingeneset, Bremanger, Sogn og Fjordane. A) On this steep rock surface, specially designed covering materials are held in place by a combination of rustproof wire and sandbags.

Figure 50. B) Rustproof wires are drawn between fastening points fastened outside of the actual rock with carvings. Photo: K. Gran.

5.2.2 Removal of vegetation

- When the objective is to secure, preserve and maintain the rock art in accordance with the Cultural Heritage Act's § 10.1a, the actions must be reported to the Directorate of Cultural Heritage, in accordance with the cooperation requirement mentioned in regulation § 3 of the Cultural Heritage Act.
- Before vegetation is removed, one must first allow a competent biologist to determine if there are Norwegian Red List (endangered) species (especially rare and threatened mosses and lichens, but also other plants). Contact the county administrator's Environmental Protection Department (*Fylkesmannens miljøvernavdeling*) and/or The Norwegian Biodiversity Information Centre (*Artsdatabanken*) (see Chapter 9) for more information.
- If there has previously been undertaken direct conservation (gluing) of the rock surface, it must *not* be treated with ethanol because this can make certain glue types swell and lose their consolidation properties. The rock surface should instead be covered to remove micro-vegetation.
- Trees and bushes with solid root systems are first cut down. The roots are then removed with the help of poison plugs (such as Ecoplugg from Felleskjøpet). After a while the roots will rot away so they do not need to be pulled up.
- Herbs and grasses are carefully removed without also removing part of the rock (Figure 51).
- Remains of vegetation on the rock with carvings (leaves, pine needles, etc.) are carefully brushed away. The decomposition of leaves and needles that remain on the rock carvings creates an environment that accelerates chemical weathering.
- Remember information/signage. Signs should include information about what is happening, why it is happening and how long it will appear this way.

Figure 51. A) Before cleaning.

Figure 51. B) After cleaning of vegetation in cracks at Husabø, Egersund, Rogaland. Photo: AmS.

Biofilm

Exposed surfaces that are not covered with lichens are often covered by various microorganisms. This is especially clear in water seeps, where the rock surfaces are often strongly discoloured of a reddish brown to brownish black coating or biofilm of algae and cyanobacteria. On other surfaces without appreciable lichen growth, it is common to find a green algae layer and some fungal hyphae in the uppermost millimetres of the weathering zone.

1. Spray the surface with ethanol (70-90%) or denaturated ethanol. This can be repeated a number of times during a single day.
2. Cover the surface with black sun proof plastic (minimum 0.15 mm thick) (Figure 52). Wait for one year.
3. Brush carefully off all loose organic material (NB! Not a wire brush – always use a soft brush).
4. Spray with ethanol or denaturated ethanol.
5. Cover the surface with black sun proof plastic (minimum 0.15 mm thick). Wait one more year.
6. Brush carefully off all loose organic material.
7. Spray the surface with ethanol or denaturated ethanol.
8. Continue to spray the surface with ethanol or denaturated ethanol once a year to hinder reestablishment of vegetation on the surface and within rock pores.

Figure 52. Short-term covering of a rock art locality (Amtmannsnes, Alta, Finnmark) for removal of micro-vegetation / lichen growth on the rock surface. A) Covering consists of black plastic held in place by sandbags.

Figure 52. B) Covering with a laminated information sign that tells what is happening, why it is happening and how long it will look this way. Photo: L. Sæbø

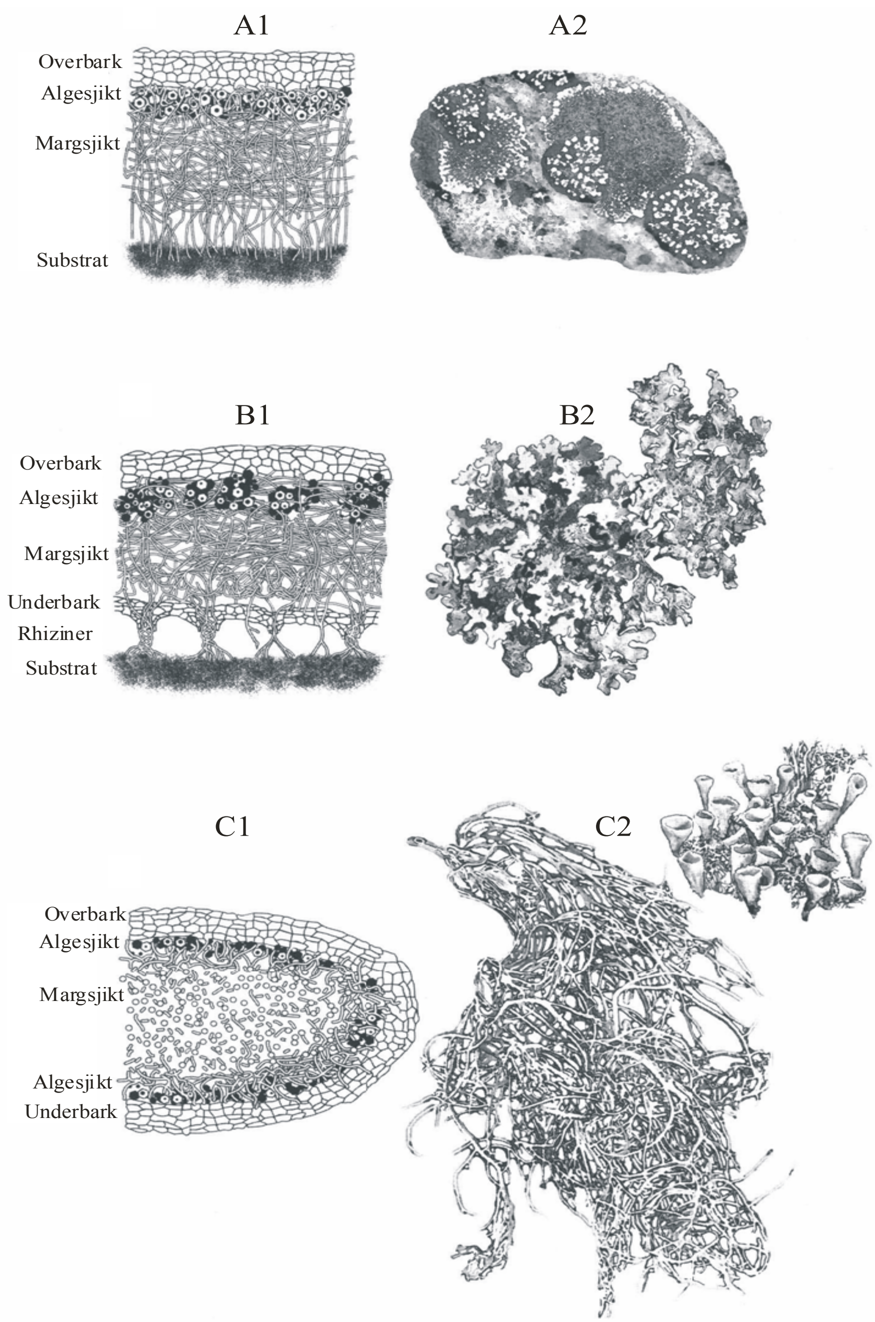
Lichens

Lichen is a stable self-sustaining association that consists of a fungus and an algae, or a cyanobacteria. The lichens can be divided according to their growth forms into crustose, foliose and fruticose lichens (Figure 53). Crustose lichen has a crust-like appearance and is so securely attached to the substrate that it is difficult to remove without taking some of the substrate. Foliose lichen has a flattened appearance, with clear differences between the upper and lower surfaces. The majority of foliose lichens are loosely fastened to the substrate and easy to remove. Fruticose lichen can be flattened or cylindrical in appearance and sits loosely attached to the substrate.

Fungal hyphae can penetrate into rock pores and cavities to a depth of up to 1-2 cm. There are generally more fungal hyphae in the weathering zone under crustose lichen, and fungal hyphae penetrate deeper into the rock under foliose- and fruticose lichen. It will therefore take more time to remove a crustose lichen from the rock surface and the weathering zone than either foliose or fruticose lichens.

1. Allow a competent biologist to determine if there are Norwegian Red List (rare and endangered) lichen species on the rock art surfaces. Contact the county administrator's Environmental Protection Department (*Fylkesmannens miljøvernavdeling*) and/or The Norwegian Biodiversity Information Centre (*Artsdatabanken*) (see Chapter 9) for more information.
2. Carefully brush the rock surface clean (NB! Not a wire brush – always use a soft brush).
3. Spray the surface with water so that the lichen is moist (necessary to activate the lichen). Wait at least one hour.
4. Spray the surface with ethanol (70-90%) or denaturated ethanol. It is important that the surface is well moistened by the alcohol. Spraying can be repeated a number of times during a single day.

5. Cover the surface with black sun proof plastic (0.15 mm thick) (Figure 52). Wait for one year.
6. Brush carefully off all loose organic material.
7. Spray the surface with water (if the lichen is dry). Wait at least one hour.
8. Spray with ethanol or denaurated ethanol.
9. Cover the surface with black sun proof plastic (0.15 mm thick). Wait one more year.
10. Brush carefully off all loose organic material.
11. Spray the surface with ethanol or denaturated ethanol. This can be repeated a number of times during the season until all of the lichen on the rock surface is removed (Figure 54 and 55).
12. Continue spraying the surface with ethanol or denaturated ethanol at least two times a year to hinder the reestablishment of vegetation on the surface and within rock pores.



NB: må tilføye engelsk tekst på illustrasjonen – bruk Figure 3 fra Bjelland, T. 2002 – (Bjelland, T., 2002. Weathering in saxicolous lichen communities: A geobiological research project. PhD-thesis, Department of Botany, University of Bergen.)

Figure 53. Lichen growth forms: (A1) Cross-section through a crustose lichen, (A2) crustose lichen, (B1) cross-section through a foliose lichen, B2) foliose lichen, C1) cross-section through a fruticose lichen and C2) fruticose lichen. Adapted from Brodo et al. 2001.

Figure 54. A) Test section for the removal of lichens before treatment with ethanol in 1997 at Vingen, Bremanger, Sogn og Fjordane. Photo: T. Bjelland.

Figure 54. B) The same test section in 2001. The treatment has led to the death of the lichens and their removal from the rock surface. Photo: T. Bjelland.

Mosses
Before removing mosses, it is important that a competent biologist determines if there are Norwegian Red List (rare and endangered) lichen species on the rock art surfaces. Contact the county administrator's Environmental Protection Department (*Fylkesmannens miljøvernavdeling*) and/or The Norwegian Biodiversity Information Centre (see Chapter 9) for more information.

The majority of mosses are loosely attached to the substrate and can be removed with a soft brush or with fingers. To remove species that are more securely attached to the substrate, it can be an advantage to kill the moss first. This is done by spraying with ethanol (70-96%) or technical ethanol and possibly covering with black plastic (Figure 55).

A

B

Figure 55. The photos illustrate a rock surface A) before and B) after treatment with ethanol and covering with black plastic in connection with removal of micro-vegetation. Bukkhammeren at

Tennes in Balsfjord, Troms.
Photo: B. H. Helberg.

5.2.3 Strengthening / consolidation of the weathering surface

Consolidation (strengthening) of the rock carving surface can be necessary in some instances on rock surfaces with extensive weathering damage and on surfaces exposed to significant granular weathering (Figure 56). This work can *only* be done by a conservator specializing in rock art. The work demands good planning, and is both time consuming and weather dependent.

Consolidation materials that have been used by the current research community include Mowilith DM 123 S. This material provided the best results after exhaustive tests on phyllite and sandstone at the University of Bergen during the 1980/1990s. It is important to be aware that Mowilith swells if ethanol is added, and this leads to a conflict with the removal of lichens. Other consolidation materials are therefore being tested, and we cannot presently recommend any specific materials above others.

1. One requirement for carrying out consolidation, is that the rock and pores in the weathering surface must be free of organic material and micro-vegetation. This is done with the help of a combination of covering and treatment with ethanol. If the weathering surface is thick, it can take several years before all the pores are clean (cf. removal of micro-vegetation).
2. To insure that the consolidation material does not harden too quickly or is diluted, it is most favourable to consolidate in partly overcast conditions rather than direct sunlight or rain.
3. Small surfaces are treated individually.
4. Consolidation material is applied with a brush, syringe or packing (depending on the rock type) until air no longer comes out of the pores in the weathering surface (there are no more air bubbles in the consolidation liquid).
5. Finally, the surface is wiped with a wet cloth to avoid a shiny surface. After hardening, the treatment will not be visible.

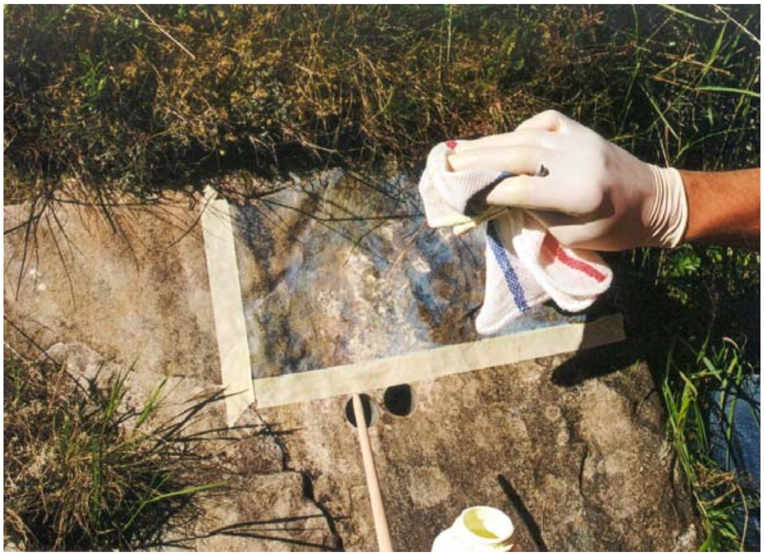


Figure 56. Test of different consolidation material on sandstone at Vingen, Bremanger, Sogn og Fjordane. Photo: L. Sæbø.

Painted rock art

Even if the paint from rocks and caves is sensitive and an easy target for destructive forces in the environment, it is not possible to undertake consolidation of pigment. It is doubtful that this would give a lasting result in the long run. In addition, such an intervention would alter the paint in a way such that it could no longer be seen as an original material. In other words, the scientific value would be significantly reduced. At localities with rock paintings, its use would be limited to refastening rock fragments that are loose or have fallen off.

5.2.4 Conservation of cracks and weathering edges

For crack formation and flaking along crack boundaries, the cracks must be sealed / insulated in order to prevent the rock carving figures from being damaged (Figure 57 and 58). Mowilith DM 123 S has also been used for this type of conservation, but a number of other materials are currently under testing. It is sufficient to seal/insulate along the crack boundaries (do not fill the entire crack!) to prevent the cracks from expanding. This work can *only* be done by a conservator specializing in rock art.

1. When cleaning cracks, an archaeologist must be present if it is being done for the first time as there can be archaeological material here.
2. Large cracks are thoroughly cleaned of all vegetation and soil with a digging trowel, brushes and controlled compressed air (using a nozzle for controlling the stream of air – to be used with caution) so that the caulking material adheres well to the rock and to prevent growth of seed plants and root action.
3. Vegetation and soil is removed from small cracks with the help of dental tools, thin brushes and blowing with compressed air.
4. Finally, the area is rinsed with water.
5. Consolidation material is spread along the sides and fracture surfaces in the cracks.
6. Caulking material is filled / spackled in the cracks or fracture surfaces.

7. Treated cracks and fracture surfaces that are visually disturbing, are retouched.
8. Cracks that are small, must be injected with consolidation material.
9. Regular maintenance is required with regard to cleaning to prevent seed plants from re-establishing themselves as is the control of crack insulation to confirm that it is still effective.

Figure 57. Damage edges with active weathering that have been sealed with cement mortar. Åmøy, Rogaland. Photo: AmS.

Figure 58. To insulate damage edges and prevent further cracking and flaking, it is common to caulk crack edges with cement. Photo: L. Sæbø.

5.2.5 Gluing of loose flakes

In the instances where the surface of the rock with carvings is completely loose and in danger of being lost, it can be necessary to use glue to fasten the loose pieces. This work can *only* be done by a conservator specializing in rock art.

1. The rock surface and loose pieces must be cleaned and dried before gluing.
2. If there are a number of pieces that will be put together, it is practical to lift the pieces off on a broad tape to insure that the pieces remain in the proper order.
3. The underside of the pieces and rock surface is treated with appropriate glue and the loose pieces set in place.
4. It can be necessary to use appropriate caulking material or filling material in the glue to build up and fill out where the original materials are missing.

Painted rock art

It can be necessary to glue loose fragments of the rock that forms a base under the figures or parts of the figures. Many loose fragments have been recorded that actualize such an intervention. But experience with this type of direct intervention in caves is limited. Adhesive material must in the long run be able to tolerate an extreme environment, where frost, water seepage and relative humidity up to 100% make strict demands on durability. In addition, the consolidation material must not prevent later use of new and improved materials. The possibilities for success must be considered carefully in each case. Above all, it is important to consider if the actions can have side effects that lead to a more dramatic damage development than previously.

Some form of reinforcement can be considered when the danger for a large rock fall is present, but it is often difficult to calculate the effects of such an action.

Cracking and flaking of the outer rock layer parallel with the rock/cave surface is another damage development that is difficult to prevent. In addition to structural weaknesses in the rock, this exfoliation can be caused by a combination of freeze-thaw processes and salt precipitates under the surface as well as micro-vegetation in the cracks.

5.2.6 Increasing the visibility of rock carvings

In Scandinavia, it has been common to paint in rock carvings in order to give the public the possibility of seeing the figures independent of light conditions. This practice is criticized internationally in part because it involves a direct intervention in the cultural resource.

It is important to allow for new ways of thinking when rock carvings are presented for the public. We must work to create a change in attitude among both professionals and the public such that one is taught that carvings are not always equally visible. Information must be provided on what time of the day and in what light the figures are most visible. The experience one has when the figures suddenly "rise up from the rock" in the right lighting, should be emphasized (Figure 46). This can be done both in the daytime with proper light and in the evening with artificial lighting, and can be done by pursuing to a greater extent presentation through the offer of guided tours to individual localities. It is important that the local environment is brought into the organization of guided tours.

Rock carvings that have not been previously painted, should not be painted! Carvings that have been painted, can be repainted if this is considered to be absolutely necessary.

Maintenance of painted rock carvings

1. Wash dirty paintings with a toothbrush and water, possibly mixed with ethanol.
2. The painting is maintained primarily by retouching[14], and thereupon by complete painting.
3. The painting disintegrates in a natural way until there is little or nothing left of it. To make this process more aesthetically acceptable, the peeling surface can be retouched with new paint that ages at the same tempo as the older painting.

Painting type

- The painting should be open to diffusion as much as possible, that is it allows good penetration of water vapour.
- The painting should age evenly with erosion of the surface and peel as little as possible.
- The painting should not generate tension that can damage the rock carving weathering surface.
- The painting should promote micro-biological growth as little as possible.
- The colour should be based on red pigmented iron oxide.
- The painting should be adapted to the rock type.
- The painting must be easy to apply precisely and not be drawn out into cracks.
- Spilled paint must be able to be removed immediately and without leaving any noticeable trace.
- The painting must be able to tolerate rain without run-off, also during the drying/hardening period.

[14] Retouching involves infilling of new paint only in the areas where the older paint is gone because of wear or peeling. The objective is to reestablish a visual total effect.

Figure 59. Painting in a critical phase: the painting layer is peeling off, but pigment residue remains and colours in the figure. A locality in Bohuslän, Sweden. Photo: T. Norsted.

Figure 60. The carvings are finely marked with pigment remains after the painted layer has peeled off. Vinnes, Hordaland. Photo: T. Norsted.

Painting types with various characteristics have been tested on different rock types and different climates (Figure 61). Drygolin (60-30% thinning with white spirit, Jotun), Trebitt (110-80% thinning, Jotun) and Vari Tradisjon (60-30% thinning, Jotun) give the best results as far as durability and adhesion to the rock surface independent of rock type and climate. Pigment thinned with water, Max for mur (Jotun) and Flurød fasad (Rødmotaverket), have been shown to be unsuitable. Painting should be done by, or in consultation with, a technical conservator and the painting type should be approved by the Directorate for Cultural Heritage.

Painting process

1. The rock surface must be clean. This means that the rock surface has been treated with technical medical spirit (ethanol or isopropanol) and sufficient long-term covering, so that there is no visible vegetation of any type in the panel.
2. Before painting, the rock surface must be completely dry. The work should preferably be done in the summer. It is best to paint in cloudy weather. In direct sunlight there is a high degree of evaporation from the rock, at least in the morning.

3. The paint should preferably be applied by *stippling*. This means that the paint is "pushed" on by holding the brush vertically. With common brush strokes, the pecking /carving tool marks will be more easily erased since the paint will be thicker in the depressions. Stippling is done with a bristle brush with an appropriate width (no. 4-8). It can be an advantage to reduce the bristle length by cutting off a little with scissors. The brushes come in different bristle lengths, so it is important to make tests in advance to see what works best.
4. The paint is applied thinly. Do not have too much paint on the brush when painting. Pecking marks must be visible after painting.
5. The professionals that carry out the actual painting must be skilled with this type of work. Both conservator and archaeologist **must** have gone through the panels before the painting occurs to consider, among other things, how the different figures should be interpreted before they are painted. It is probably best that a skilled archaeologist does the painting, but the prerequisite for a good result is that those doing the work have painting experience and show an understanding of what the painting means in relation to interpretation, communication and conservation.

Figure 61. Photograph of trial panel for testing of different paint samples at Hjemmeluft/Jiebmaluokta, Alta, Finnmark. Photo: L. Sæbø.

Figure 62. Test surface for testing different paint samples on granitoid gneiss at Leirvåg, Askvoll, Sogn og Fjordane. A) one year after initialization (2003);

B) three years after initialization (2005). Photo: L. Sæbø.

5.2.7 Cleaning

Removal of over painting (tagging)
It is not advisable to unreservedly undertake the removal of over painting unless it can be established that this will not lead to loss of the original material (Figure 63). The provisional method for removing paint is described below. The work is carried out by specialists within rock art conservation.

- Cleaning is undertaken in a way that insures that the solvent penetrates the weathering surface as little as possible – either a compressor or solvent in gel form must be used.
- The solvent used is dependent on which type of paint is to be removed. In each individual situation, one must carefully proceed in order to find the right solvent. NB! One must not use solvent that increases decomposition or leads to discolouring of the rock surface.
- Solvent remains are removed with water as a rule.
- Removal of graffiti and tagging on rock and cave paintings must be carefully evaluated. If the cleaning is done on the paintings, there is always a risk that these will be damaged. Since silica skin is weakly soluble in water and in solvent that is mixable with water, it can be effected by hard-handed cleaning with such material. The consequences are easy to observe: The rock surface that is cleaned becomes duller and lighter than its surroundings. Therefore it is advisable to use other types of solvent for removal of tagging or graffiti that is done with paint or wax crayon. There are several possibilities. Such intervention requires considerable attention and manual dexterity, and must only be done by a conservator with professional insight into the technique and the hazards involved.

Figure 63. A) Example of vandalism before removal of paint. Fluberget, Stavanger, Rogaland. Photo: AmS.

Figure 63. (B) Example of vandalism after removal of paint. Fluberget, Stavanger, Rogaland. Photo: AmS.

Casting remains

- Silicon from casting is difficult to remove with solvents. The remains that sit in the pores must be removed mechanically with scalpel, tweezers and "dental" equipment.
- There is a significant danger of removing mineral grains when the silicon is picked out.

Soot

- Soot on rock and cave paintings should not be removed. Firstly, this can be difficult to carry out with a satisfactory result. Secondly, individual soot spots can actually be remains of prehistoric activity in the cave. Such spots can in this case provide opportunities for direct dating of these activities.
- Soot on rock carving figures and panels can be removed with dry cleaning using a Wishab sponge (synthetic sponge) or soot sponge (natural sponge). These are used like an eraser.
- Gomma pane (chemical dough with c. pH 6) is also used as a dry cleaning agent. This has the consistence of modelling clay and can be shaped. It is used as an eraser or pressed onto the rock so that the soot sticks to the dough.
- If wet cleaning must be done, one can attempt this with Synperonic N (soap) in water and use of a sponge.

Coloured pencils

- Marks from coloured pencils or similar objects are removed carefully with a common eraser.

- If the tagging has been encapsulated in the silica skin on the rock paintings, it should not be removed!

Wax crayon

- Fresh wax crayon can be removed using solvent in gel form.
- If the tagging has been encapsulated in the silica skin on the rock paintings, it should not be removed!

Scratches and incising

- In the case of incised marks in the rock, the loose mineral powder on the surface will contribute to making the incising very clear. In must be considered in each case if removal of this powder gives a desirable effect.
- The loose powder is carefully removed with a moistened soft brush.
- Do *not* use soil to hide the incised lines, as this can lead to the addition of bacteria on the surface. Bacteria increase the dissolution of minerals and the rock.
- Incising on rocks and cave paintings must be treated specially. The powder of loose mineral grains should be removed with a thin brush, moistened with water. If the incising still appears lighter against the remainder of the rock surface, it can possibly be retouched. This must be done by a conservator with experience with experience from this type of work.

Stearine

- Remove mechanically in the most gentle manner possible.

Chalk

- Chalk should be removed as quickly as possible after application.
- Remove with water on a sponge or water and a soft brush.
- Remains of yellow oil crayon is removed in the same way as wax crayon.
- When old chalking is covered by silicon skin, it cannot be removed (see also Chapter 2.3.2).

6. MONITORING

Monitoring forms a central element in all management and conservation and is an important aid in the protection of rock art. In general, we can divide this activity into two categories: a) periodic inspection and b) methods with a technical and long-term character.

A routine recording of changes is a common characteristic for all types of monitoring. This occurs by comparing the present condition with that from the past, and assumes the most concise knowledge possible about the earlier condition. In a professional monitoring, recording does not involve personal memory but a prescribed method that provides a high degree of objectivity. However, the fixed routines must allow for flexibility in order to accommodate a new development.

Monitoring helps us to study the relationship between action and effect. In accordance with other condition recording of rock art, monitoring is necessary to insure that conservation is sensitive towards the locality's form, materials and historic/cultural values. It should contribute to showing that the preservation strategy is well chosen or if there is a need to change course. Monitoring must, at an early stage, be able to reveal if the locality is damaged or in danger of being damaged, so that preventive actions can be initiated in time. Monitoring should, in other words, help us to *point out problems before they become serious.*

The Directorate of Cultural Heritage's Documentation Standard for Rock Art can be used as an aid and starting point for monitoring. Possible changes in condition can be checked later in relation to initial completion of the standard.

Monitoring should have a clear goal. The following should be given special attention:

- The actual purpose of monitoring is to control that the source value of the locality is secured.
- Monitoring should reflect priorities that are based on the physical, cultural and social context of the locality.
- The frequency of inspection should be determined by the locality's importance as culture historical source material, but also by the condition and vulnerability in relation to the natural and anthropogenic pressures.
- Monitoring should include an element of risk preparedness.
- Indicators used during monitoring should be evaluated underway; there must be openness for the possibility of changing the choice of indicators.
- The data and indications from monitoring should be archived.

Regardless of what the ideal is, the scope of monitoring must of necessity be limited by available resources.

The simplest form of monitoring is inspection. This should be undertaken regularly. How often inspection is carried out is determined by the scale of presentation, visitor frequency and the assumed scope of decomposition. It is completely essential for the validity of an inspection that previous documentation material is brought along in order to compare past and present condition. A printout of relevant information in the National Cultural Heritage Database (Askeladden) as well as the management plan and good photographic material provides a suitable base. Professional reports on earlier condition are of special importance, if these have been produced. If direct conservation has been undertaken, documentation material regarding this intervention must be consulted. In addition, it is always an advantage to have a checklist present when the locality is to be inspected. Such a list should preferably be divided up so that it addresses weathering factors, management actions and human-made damages. The list can, for example, include the following:

Weathering factors

- Check the micro-climate (temperature on the rock surfaces, air temperature, relative air humidity).
- Evaluate the local effects of surface and infiltration water.
- Measure pH in the environment (soil, surface water).
- Evaluate the development of mineral precipitates.
- Control the development of crack formation, air pockets, exfoliation and other types of outcomes.

- Evaluate the growth and spread of macro-vegetation on and around the panel (root systems, loose leaves, etc.).
- Evaluate the spread and consequences of micro-vegetation.

Management actions

- Inspect signs, walkways, platforms, barriers and other presentation installations (evaluate the impact of the presentation and need for changes).
- Consider the impact of possible painting as well as the condition of the paint.
- Consider the impact of changes in vegetation.
- Consider the impact of leaf removal.
- Evaluate the impact of direct conservation (cleaning, consolidation/caulking, etc.).
- Consider the effect of covering.

Human-made damages

- Map wear from humans and domesticated animals (on the terrain, rock and vegetation).
- Map new anthropogenic additions/damages on the panel (especially tagging and graffiti).

In practice, it can often be necessary to expand this list. It can also be made more specific as necessary. The checklist contents must in all instances be based on the distinctiveness of the locality, the previous condition documentation and available resources. Inspection should be undertaken by the one or ones that documented the condition, or possibly by persons with equivalent competence.

6.1 Methods for monitoring of rock art

There is a range of methods that are suitable for monitoring rock art localities and their closest surroundings. The most important are use of photography, climatic measurement, systematic visual observations, GIS and the Directorate of Cultural Heritage's Documentation Standard for Rock Art.

6.1.1 Use of photography

When we use photography to record condition and as an aid in monitoring, it is appropriate that the photographs used for monitoring build upon a previously established standard. This makes it easier to use them in the analysis of changes. It is advantageous to support the following principles:

- The basic photographic documentation must show all aspects that give a clear impression of the condition, including potential damage factors. This applies both to the panel and its closest surroundings.
- All information about film type and other relevant data should be placed in a logbook.

- The camera locations must be identical each time[15].
- Copies of photographic material from the basic documentation is taken along during later inspection/documentation to insure that the proper areas are photographed in the same way.
- Light conditions should be uniform as much as possible (artificial lighting, reflector).
- Record the time and weather conditions.

6.1.2 Climate measurement

It can seem unnecessary to monitor natural decomposition factors that we can do little or nothing with. But the more we know about natural forces that contribute to weathering, the more we understand the causes for the current condition and subsequent development. The applies especially to climate.

The starting point is obviously widely different between localities that lie exposed and those consisting of deep caves with large or small openings. But even open rock art panels in the same area can exhibit marked climatic variations. These can be conditioned by orientation, landscape form, wind conditions, shade and solar heat effects, proximity to the ocean, lakes or rivers, the height and density of vegetation, etc. In addition, we must include decomposition factors conditioned by proximity to agriculture, roads, industry and population centres can have an increased importance if strengthened by the climate.

Mapping of the climate can be extremely important for evaluating actions. One example is monitoring of the effectiveness of a covering. In cases where the major objective of a covering is to hinder frost action, measurement of the micro-climate during covering will give an indication of whether the choice of materials and methods are successful.

In certain cases, it can be possible to record the climate with the aid of advanced meteorological measuring stations (Figure 64). For simpler measurement, we can use battery driven loggers that measure air temperature and relative humidity. There are also types that combine this with other functions, such as reading of the temperature on the rock surface. Since climate loggers do not tolerate long periods with high humidity (over c. 92% relative humidity), the sensors must be protected against direct contact with water. This can be a problem with condensation.

[15] One must insure that the same camera position can be relocated at the next documentation. This can be done by marking the positions on a ground plan of the locality, or that the points are marked directly on the locality where this is possible and justifiable.

Figure 64. An automatic climate station can measure air temperature, air humidity, wind and the amount of precipitation. Photo from Vingen, Bremanger, Sogn og Fjordane. Photo: I. H. Thorseth.

6.1.3 Erosion measurement
Earlier methods for erosion measurement were difficult and imprecise. Through the use of digital 3D scanning, we can now document surface textures on the rock surfaces with a precision of 0.2 mm. The method is under constant development. This data collection will come to be extremely valuable in future analyses of speed of decomposition, as long as fixed reference points are placed on the rock surfaces during initial documentation. One can then repeat the measurements at a set interval (10 years, for example) and see if there has been any changes. 3D documentation is more thoroughly presented in Chapter 3.6.

6.1.4 Visual observation
Despite its subjectivity, a systematic visual inspection is of great value. If we use experience and systematics in a sensible way, we will probably discover and understand many unanticipated traits that can be of importance.

One important category for monitoring based in large part on visual inspection, is observation of the locality during each of the seasons and every type of weather. This means, for example, that we can record how the quantity of surface water varies, and how the water drips and seeps over a panel during and after rainy weather. Inspection can also reveal if the water seep above the panel is sporadic, long-lasting or permanent, and where it originates. This and similar observations provide the basis for an evaluation of preventive actions.

6.1.5 GIS
GIS (Geographic Information Systems) is probably the most important monitoring tool both today and in the near future. The system uses “raw data” such as photography, climate measurements and erosion measurements to process, analyze and generate new information with reference to interpretation and presentation. GIS is more versatile than the other monitoring methods.

GIS is a database tool than initially builds on geo-referenced information. The technology integrates a system of database operations and statistics with a spatial analysis (relative position) and visualization that builds on digital maps and images. GIS can collect, store, manipulate and present detailed information that is oriented in both time and space. This combination distinguishes GIS from other information systems and makes it possible to explain processes, predict results and develop strategies.

The information in GIS is stored as thematic layers. These can present different types of information that can be tied together in relation to spatial orientation and placed upon one another[16]. Topographic data can comprise one layer, vegetation types another layer, roads and paths a third, and so on. Detailed information concerning the rock art localities and their surroundings can be input in this manner.

In principle, GIS is applicable to all types of surfaces, regardless of scale. Each type of image, including photographs of small details with high resolution, can be used for a GIS-based analysis. We can choose to investigate what is occurring in larger areas, or analyze details in order to record small changes. Through adjustments, older, digitalized images can be manipulated so that they, point by point, can be compared with new input. Today, and in the future, it will be important to standardize image documentation, so that it can be used more easily by GIS. In the future, we must expect that it will be appropriate to use a digital camera that provides high definition images for this purpose.

The use of GIS technology not only requires that we have the correct software and all relevant raw data, but also that we have the competence that is required. It is not necessary to go further into the different types of possibilities and operations here. We simply wish to maintain that GIS can make use of spatially oriented information in order to illuminate characteristics and processes, and that this is the leading technology for analyzing data in order to confirm tendencies and generate scenarios.

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8. GLOSSARY OF TERMS

acid pH pH < 7

adhesive a fluid component that makes paint manageable; it has the ability to bind together **pigment** particles and fasten them to a foundation; the ability of the adhesive agent to dry and convert the paint to a solid material is usually important; it can be based on protein-rich

	materials from the animal kingdom (such as fat, oil and egg) and plant kingdom as well as minerals (lime), in modern times made of artificial **polymer** substances
aerosols	airborne particles
air pocket	shell of rock that has separated itself parallel with the surface; the shell is loose, but is held in place and produces a deep "booming" sound when one taps lightly on it with a metal object
amphibole	an important rock generating silicate mineral group. Example: hornblende
amorphous	mineral material without a set crystalline structure due to an irregular arrangement of atoms
AMS	"Accelerator Mass Spectrometry"; dating technique based on the separation of ^{14}C atoms in a sample through the aid of a mass spectrometer to calculate their quantity; this advanced method of radiocarbon dating can date extremely small samples
anthropogenic	originating in the activities of humans
anthropomorphic	having or representing a human form
artefact	anything made by human art and workmanship; such as a knife, vase, pottery shard, etc.
asthenosphere	the earth is divided into zones from the surface to the central core. The outermost zone is called the lithosphere and comprises the earth's crust. The asthenosphere is the zone liquid material within the lithosphere from 70 to 200 km beneath the surface of the earth
basic	pH > 7
biocide	a chemical or biological pesticide that is produced to prevent or counteract damages by animals, plants or microorganisms; causes damages or discomfort to human health or damage to property
biofilm	a mixture of microorganisms (bacteria, cyanobacteria, algae and fungus) that form a "slimy" surface on rock surfaces
calcite	(calcareous spar), the most common mineral of calcium carbonate
carbonate	a mineral formed by the connection of carbonate ionite (CO_3^{2-}) and a positively charged ion. Example: Calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$
casting	a cast is a negative mould, while the casting is positive
caulking	sealing/infilling of cracks (direct intervention)
chronology	presentation of the correct sequence of events
chronometric dating	dating that determines placement within a specific temporal sequence
cleaning	removal of foreign substances that completely or partially cover the original materials and influence them in different ways; cleaning exposes the current condition of the original material and involves the use of chemicals, mechanical methods or compressed air
condensation	the transition of air humidity from a steam/vapour form to liquid form through contact between the air and cold surfaces; when warm air flows into a moist cave in the early summer and cools

down without additional moisture, it can become saturated (when the dew point = 110% relative humidity); additional cooling from contact with cold rock surfaces produces condensation

conservation all activity that involves protection of the **source value** of a cultural resource; this includes the development and spread of relevant knowledge (including documentation) as well as different actions aimed at preserving the cultural resource for the future; practical actions can be divided in **preventive** and **direct** (physical) **conservation**

consolidation material structural strengthening undertaken to delay decomposition fluid agent used for structural strengthening of a decomposed material; also used to bind loose particles together and fasten them to a surface, for example in the form of **fixative**

copy positive cast made in a negative mould of silicon

corrosion the reaction of a metal to air, water and different forms of pollution; iron will corrode (rust) at contact with moisture and carbon dioxide

crustose lichen crust-like lichen thalli (see Figure 53A)

crystallization formation of crystals that constitute the regular building stones in a **mineral**; with **precipitation** of a mineral that has been dissolved in a liquid, crystallization also occurs

cyanobacteria a group of microorganisms (lacking a true cell nucleus, photosynthetic, previously called blue green algae)

damage edges the margins along an exfoliation in a surface; the edges are vulnerable to additional peeling

daubing paint applied to a surface with the aid of a rag, sponge, cotton or something similar

decomposition a general designation for a material's loss of previous strength; this leads to increased porosity and reduced cohesion (connective strength) and can be revealed on the surface as **weathering** in the form of peeling, cracking and **granular weathering**; weathered areas disappear over time through **erosion**

decomposition factors various factors, both natural and humanly created, that cause decomposition; can also include qualities of the material itself that induce decomposition

diffusion when a substance spreads itself into another substance; for example, gas molecules can spread themselves in both a fluid and solid substance; the latter is a necessity for water vapour to pass through (diffuse) a painting from the underlying surface, so that the moisture does not remain too long in the base material.

direct conservation direct intervention in an original material to delay decomposition; must be done by persons with special competence (conservator) and is considered a component of management; see also **preventive conservation**

direct dating	dating of material that makes up the rock art itself, such as a pigment with carbon content in a rock painting; the most common method is ^{14}C and ^{14}C (AMS) dating
dissociate	detach(ing), split(ting)
drip line	part of the cave opening where water drips from the terrain above the opening; the drops often fall at set locations that are easily located
drip point	natural or artificial formation where the water stops seeping and starts to drip
electron microscope	see **SEM**
emulsion	mixture of two materials that are not mixable without the assistance of a third material, an emulsifier
encrustation	film or crust of transparent or opaque mineral precipitate that can have variable composition, origin and appearance; carbonates, silicates and iron connections are common; **silica skin** is a form of encrustation
erosion	physical decomposition of the earth's surface caused by running water, wave action, ice and wind; when **weathering** is sufficient, erosion removes the decomposed material from the rock surfaces
ethyl acetate	a solvent
exfoliation	a weathering process where concentric shells/layers of variable thickness split successively off of a rock surface
fixative	**consolidation material** that is injected thinly over a rock surface to bind together loose particles
flaking	flake weathering: removal of flakes of schistose rock types; easily confused with exfoliation
foliose lichen	leaf-like lichen thalli with an upper and lower cortex (see Figure 53B)
fruticose lichen	shrub-, beard- or worm-like, of lichen thalli ± radially symmetrical in cross-section (see Figure 53C)
gas chromatography	analysis method that requires that a material sample can partially exist as a gas where the components are separated and identified; used to identify organic materials; referred to as "GC"
GC-MS	gas chromatography/mass spectrometry; advanced **gas chromatography** that involves the identification of components in the gas phase at the molecular level
GIS	Geographic Information Systems; computer-based monitoring tool based on geo-referenced information
green algae	an algae group with size varying from single cell to multiple cells
greenstone	massive (non-schistose) rock type with a green colour due to the presence of chlorite and/or actinolite and epidote
groundwater	water that saturates the terrain below the earth's surface including the rock's interior; groundwater can form bogs and tarns in depressions in the landscape
habitat	is the spatial area where a particular species lives, such as for a plant

hematite	from the Greek words for "blood" and "stein". A mineral with the chemical composition Fe_2O_3 . Black or dark brown with dark red banding. Varieties include micaceous iron oxide, red hematite, bloodstone and "red ochre" (red iron oxide)
hydrosphere	the water covered portion of the earth, also including water vapour in the atmosphere and bound free water in the earth's solid mass
hyphae	the filamentous elements of a fungus, often modified and resembling round or angular cells
indirect dating	(see relative dating) dating that is not based on the absolute age of rock art itself; examples: overlapping or **patina** relationships can provide information on what is earlier and later in the panel, while dating of organic substances in the **silica skin** can provide a minimum age for the underlying figure
infiltration water	groundwater that moves through pores and crack systems in the substrate towards zones where the water can collect or evaporate; also called "pore water"
ions	two groups of electrical charged atoms, one with a positive and one with a negative charge; a **salt** that dissolves in water will divide itself (dissociate) into positive and negative ions
karst cave	part of a karst landscape, that is, a landscape where the rock base mainly consists of limestone; karst caves are formed by water consuming this rock base and creating underground cavities; dripstone formations are typical of karst caves
lacuna	void; part of a whole that is lacking as a result of decomposition or other causes
lichen	a stabile self-supporting association that consists of a fungus and an algae or a cyanobacteria
limestone	rock type that mainly consists of calcium carbonate, most often in the form of calcareous spar (**calcite**)
lithosphere	the outermost part of the earth that consists of the continental crust, oceanic crust and the part of the mantle that lies above the asthenosphere
macroclimate	the atmospheric climatic relationship with a region, a country or a continent
macro-vegetation	vegetation that includes trees, bushes, herbs, grass and/or ferns
magnetite	mineral of the spinel group with the composition $Fe_2^{+}Fe_3^{++}O_4$, locally with some magnesium, titanium, etc. Black with a metallic lustre, occurring as a granular mass or octahedral crystals. Can be magnetic or strongly influence compass orientation
mica	minerals that cleave very easily into partially transparent sheets, have low hardness and a pronounced lustre on the sheet surfaces. Based on chemical composition, there are three types of mica. The most important are biotite (black mica) and muscovite (light mica), which are both common rock forming minerals for rock types such as mica schist, gneiss and granite

mica schist rock type with schistose structure and composed primarily of clear grains of schist (muscovite and/or biotite) and quartz. Plagioclase, garnet, amphibole, calcite, cyanite, staurolite, etc. can appear and characterize the schist more closely, such as “granite-mica schist”. Distinguished from phyllite by course, easily visible sheets of mica.

microclimate climatic relationships within a limited area or space, in contrast to **macroclimate** that has to do with larger units

micro-vegetation vegetation that includes microorganisms, fungus, lichens and/or moss

mineral a naturally occurring solid substance with a definite inner structure and chemical composition

mineral precipitation precipitation of a water soluble mineral (**salt**) that is transported in **ion**ized form out towards the rock surface where the water is vaporized; this usually occurs on the surface (“blooming”), but can also occur just below; precipitation can include a number of mineral types, where **calcite** is the most common; calcite can form dripstone formations in lime-rich cave environments

organic material material from the plant or animal kingdom; contains carbon atoms

oxalic salt derived from oxalic acid (organic acid); occurs often in nature and can also be present in **lichen**, bacteria, **fungus** and **encrustations** on rock surfaces

oxidation the process which occurs when a substance releases electrons

panel see **rock art panel**

parameters factors that experimentally can be held constant or varied independent of one another; also used for factors in the natural environment

patina a surface layer with physical and chemical characteristics that separate it from the rock that it covers; the layer is most often darker and more porous due to **oxidation**, **mineral precipitation**, **microbiological processes**, etc.

pigment a powder of fine, coloured particles that gives a painting its colour; the pigment is generally a mineral, whether it has a natural origin or has been artificially applied, and is then insoluble in the painting’s **adhesive** and in water

polar measurements all measurements are taken from a telescopic instrument position

polyethylene a **polymer** with high mechanical strength; the most commonly used plastic for the presentation of objects

polymer organic material composed of larger molecules that can be formed by the construction of simpler structural units (monomers); the plastics are synthetic (artificially constructed) polymers

polyvinyl acetate “PVAC”, often mistakenly called “PVA”, a **polymer** based on vinyl acetate, frequently used as a paste/binding agent in water or organic **solvents**; PVAC is too soft to be used for plastic objects

poly(vinyl chloride) “PVC”, a **polymer** often used for plastic objects

precipitation see **mineral precipitation**

preventive conservation preventive actions that are intended to adapt both function and surroundings so that there are optimal conditions for preservation; does not involve direct intervention in the original material (see **direct conservation**)

primary mineral a mineral formed at the same time as the actual rock in which it is found; the mineral maintains its original chemical composition and form in contrast to **secondary minerals**

protection a general term for adopting measures to guarantee protection

RA Directorate for Cultural Heritage (*Riksantikvaren*)

Raman spectroscopy a type of vibration spectroscopy that is used to identify inorganic and organic material without destroying the material being analyzed

Red List species species that are extremely rare in Norway and are in danger of extinction

relative dating see **indirect dating**

relative humidity the amount of water vapour that air contains in relation to what it *can* contain at the same temperature; the amount is given as a percentage; when the air is saturated with water vapour, the relative humidity is 100%, the dew point is reached at saturation

restoring re-establishing a relationship that is assumed to be more like the original one than the existing condition

retouch, retouching in conservation: filling in missing parts (**lacuna**) to re-establish a general effect; this is done such that a new addition accommodates the appearance of the older material; retouching should not be done on top of the older material

rhizine a root-like hair or thread of hyphae acting as an attachment organ

rock art locality spatial designation for a bounded area with one or more discrete entities (panels) with rock art

rock art panel a collection of figures and motifs that appear to form a discrete entity by being separated from other panels through physical distance or the rock formation itself

bedrock a collection of minerals that comprises a considerable portion of the lithosphere

rock veneer a transparent film of variable thickness that can form on rock surfaces; in Norway this film contains, for the most part, silicates; rock veneer can be described as part of the rock surface patina

salts products of a neutralization between an acid and a base; the reaction produces water and a new connection that is called salt, when the water vaporizes from a salt solution, a **precipitation** of the salt is produced, that usually consists of metal and an acid residue; sulphuric acid produces sulphates, carbonic acid carbonates, and so forth; in water the salt exists dissociated in **ions**

scanning method within electronics that is based on the transmission of a fine beam of electrons against an object and a selective recording of the reflections from the object; can be used for detailed recording of three dimensional surfaces and for colour separation

secondary mineral a mineral formed later than the actual rock in which it is found; secondary minerals are usually formed of **primary minerals** as a result of **weathering** and transformation

SEM ”Scanning Electron Microscope”; an instrument that produces three dimensional reproductions at 15-100 000 times magnification by scanning the surfaces with a fine beam of electrons; the object is reproduced in black and white

SEM-EDS ”Scanning Electron Microscope equipped with Energy Disperse X-Ray Spectrometry”; an additional function of SEM that separates elements into individual particles and thereby reveals the chemical composition

silica skin rock “**veneer**” where the main component is **silicates**

silicates a group of minerals that make up most of the earth’s crust; the most common forms are silica, e.g. quartz; feldspar and schist are also among the silicates

siliciferous containing silicon, a common element in a large number of **rock types**

solubility the ability of a substance to combine with another and create a new, homogenous substance; often used in relation to the ability of a solid substance to dissolve in a liquid

solution a uniform mixture of one or more substances; can be in gas, liquid or solid form; often used to refer to a mixture of a solid substance and liquid, such as a **salt** solution

solvent a liquid that can dissolve a solid substance; commonly water or an organic evaporating liquid

source value the value of a cultural resource as a “scientific source material” and as an “enduring basis for contemporary and future generations experience, self understanding, well-being and activity” (Cultural Heritage Act §1)

spray fixative see **fixative**

stalactite dripstone the hangs down from the roof in a limestone cave

stalagmite upright formation of dripstone on the floor in a limestone cave

wave-erosion cave rock caves along the coast formed by wave erosion in weak zones due to faults, infiltration water, frost and seismic activity that has contributed to the expansion and accumulation of rock fall material on the floor

surface water water on the surface of the terrain originating from precipitation

synergy effect the effect obtained when two or more components acting jointly appear stronger than the sum of each of them individually

tagging visual, ego-based message; often name, date, comments, slogans and occasionally a response to rock art motifs in the vicinity; use of many techniques, but not characterized by artistic expression in relation to **graffiti**; a common, more recent addition to rock art that is generally perceived as “visual noise”

thallus a vegetative plant body that in lichens consists of a green algae or a cyanobacteria and a fungus component

traverse measurements that are taken from multiple telescopic instrument points and connected together; the instrument points must be measured in reciprocally in relation to one another

veneer a film forming, transparent material that can be applied to a painting to protect it and make the colours more brilliant; after drying, the veneer can vary in brightness/faintness depending on composition; "veneer" is also used here to describe a transparent thin layer or "skin" of precipitated minerals on a rock surface, see **silica skin**

weathering the process where rocks and minerals are chemically altered or physical broken down to fragments as a result of exposure to atmospheric forces. Weathering often leads to changes in colour, texture, composition, form and shape

weathering zone the outermost zone just below the surface of a rock surface that is weathered

X-ray diffraction "XRD", a method that is built around the fact that an X-ray beam will be diffused by each atom in a **crystal**; the diffusion forms a pattern that reveals the crystal composition and therefore which **minerals** that appear to be present in the sample; XRD can be combined with **SEM-EDS** to obtain a high degree of precision for identification of a material

XRD see **X-ray diffraction**

9. STANDARD FOR PHOTO DOCUMENTATION

STANDARD FOR PHOTO DOCUMENTATION
Updated 02.01.2002

Image documentation

Image documentation is an important link in work with the protection of rock art. In addition to verbal documentation, the Rock Art Database also includes images in the form of photographs, tracings and sketches.

Photographic documentation should be done in a medium or larger format. It should make use of colour negatives or positive material. Documentation should not be done using a digital camera.

Up to eight photographs from each survey (rock art panel) can be placed in the database. This means that *examples* from photographic documentation are placed in the database. Original material is stored in a separate photo archive, and is recorded in Chapter 4 in the database. This standard is intended as a guide in connection with photographic documentation of rock art. The standard includes a minimum standard for photographic documentation. If a museum or county wishes to expand beyond this point, it is obviously possible for this to be done.

Structure

The photo standard is based on the principle that one can, through seeing the images, obtain an understanding that one is moving from the general to the specific. From the overview photograph that shows the locality in the terrain, overview images of the different panels and down to close-up images of individual figures and excerpts of these.

The photographs should show the position of the locality in the terrain, also including the view from the locality. In addition, one moves closer by photographing the locality, the panel, different motif groups/scenes, the individual figures as well as excerpts of individual figures if desirable. It is recommended to take photographs/macro-photographs of damages and other special conditions.

There are many opinions about which light conditions, etc. one should have when rock art is photographed. In this photo standard, we have taken into account that conditions are not always optimal when photographing, and it is seldom possible to wait for optimal conditions. In our example, photographs are taken in daylight with strong sun. The IFRAO scale[17] or something analogous should be used on selected individual images.

Night photography, photographing of wet rock carvings, chalking of the figures (applies to carvings) before photographing, tracing, etc. are assumed to be documentation methods of individual figures at a more detailed level. We wish to reiterate that this suggested photo standard represents a minimum standard and that each institution is free to choose motifs/methods in addition to this minimum standard.

Examples

All of the photographs are from the locality Begby in Fredrikstad municipality, Østfold. The examples illustrate how one approaches the locality first from the general area (overview), then to the level of panel and group and finally down to individual figures.

1. The locality: Overview of the area with the locality

[17] Can be requested from the Directorate for Cultural Heritage.

2. Panel I
3. Panel I
4. Panel I, scene/motif group 1
5. Panel I, scene/motif group 1, individual figure
6. Panel I, scene/motif group 1, individual figure with scale
7. Panel I, scene/motif group 1, individual figure (combination figure)
8. Panel I, scene/motif group 1, excerpt of individual figures (combination figure)
9. Panel I, example of run-off
10. Panel I, example of weathering

In addition, one can take additional photos as needed, for example:

11. Illustration photo: Surroundings of the locality
12. Illustration photo: Technique for overview photo
13. Illustration photo: Don't step on the rock!

Format, resolution and size, digital images

When one scans, it is important to understand that images can be used for different purposes. Images that will be published/printed out have totally different specifications than those that will be placed in the Rock Art Database only for screen viewing. When scanning, many choose to accommodate different types of use for the same image. In this case, one must scan the image in high resolution and then make a copy using the correct screen resolution based on this image. One can always scale DOWN a scanned image, both in terms of resolution and physical (centimetre) size, but cannot scale UP to any extent. If one wishes to scan the image in high resolution for future re-use, such as for publication, it is important to remember that the image files take much more storage space (see below). It is up to the individual institution to decide how this should be done, and it is an advantage to check which routines and formats are used within the institution.

Colour photographs are both scanned and stored in RGB mode. RGB represents colours for screen presentation. If the image will later be published, it must be converted to CMYK, which is colours for publication.

If one has scanned high resolution versions, these can be stored as .TIF and .JPG files. TIF takes the most space, but preserves the image best. JPG is a compressed format that removes some information in the image. An image file that takes up 4 MB in .TIF format will take up ca. 1.7 MB stored in .JPG format. If one uses .JPG format, it is important to use the highest quality, that is with the least compression. Each time the images are stored again, additional information is lost.

The Rock Art Database only accepts image files that stored in .BMP format. In addition, the file name before the file extension is restricted to eight characters, and excludes the Norwegian letters æ,ø and å. All other letters, all numbers and _ (underline) can be used, for example **begby_01.bmp**.

Resolution has an effect on the degree of detail and grain density of an image.

Screen resolution is generally 72 dpi (or pixels per inch). It is therefore not necessary for an image shown on screen has a higher resolution than this. If the image will be printed or published, the resolution should generally be as follows:
Colour images: 300 dpi
Grey tone images (black and white photographs): 450 dpi
Line drawings (only pure black and pure white): 800 dpi

There is a very close agreement between an image's centimetre size, resolution and file size. A 5 x 5 cm image will take up 1 MB at 300 dpi (dots per inch), while a 10 x 10 cm image will usually "take up" 4 MB. The same 10 x 10 cm image will only take up 235 KB if it is stored at 72 dpi. A 20 x 20 cm image will take up 16f MB at 300 dpi. At 72 dpi, it will be 942 KB, that is less than a megabyte.

Here are the same image sizes in pixel-size:

5 x 5 cm at 300 dpi: 591 x 591 pixels

10 x 10 cm at 300 dpi: 1181 x 1181 pixels

10 x 10 cm at 72 dpi: 283 x 283 pixels

20 x 20 cm at 300 dpi: 2362 x 2362 pixels

20 x 20 cm at 72 dpi: 567 x 567 pixels

For the Rock Art Database, the images should not be wider than the screen, which is most often 800 pixels, the equivalent of ca 28 cm at 72 dpi.

10. CONTACT NETWORK

Theme	Institution	Tel. no.
Casts of rock carvings	Museum of Archaeology, Stavanger *Arkeologisk museum i Stavanger* (AmS)	+47 51 84 60 80
Radiocarbon dating	The Norwegian University of Science and Technology *Norges teknisk-naturvitenskapelige universitet* (NTNU) Radiocarbon Dating Laboratory Attn: Dr. Alan Hogg University of Waikato Private Bag 3105 Hamilton New Zealand	+47 73 59 33 09 + 64 78 38 47 07 + 64 78 38 41 92 (fax) Email: Alan.hogg@waikato.ac.nz Web: www.radiocarbondating.com
Reduction of tracings	The Norwegian Museum of Science and Technology *Norsk Teknisk Museum* (NTM)	+47 22 79 60 00
Scanning electron microscopy (SEM)	University of Bergen *Universitetet i Bergen* (UiB) Museum of Cultural	+47 55 58 25 63

	History, University of Oslo *Universitetets kulturhistoriske museer* (UKM) NTNU	+47 22 85 99 24 +47 73 59 41 97
Scanning of rock surfaces	Metimur AB (Göteborg)	+ 46 31 750 63 00
X-ray fluorescence spectroscopy *(XRF, X-ray diffraction)*	UiB University of Oslo *Universitetet i Oslo* (UiO) NTNU	+ 47 55 58 33 87 + 47 22 85 66 56 + 47 73 59 41 97
Gas chromatography	Danish National Museum, Copenhagen *Nationalmuseet i København*	+ 45 33 47 39 01
Cultural heritage management	Directorate for Cultural Heritage *Riksantikvaren*	+ 47 22 94 04 00
Conservation rock carvings, casting, removal of graffiti rock paintings rock carvings, consolidation	 Bitten Bakke, AmS Terje Norsted, NIKU Kirsti Hauge Riisøen,UiB Bitten Bakke, AmS Kjartan Gran, Tromsø	 + 47 51 84 60 80 + 47 23 35 50 20 + 47 55 58 61 72 + 47 51 84 60 80 + 47 90 69 19 62

rock carvings	Roar Sæterhaug, NTNU	+ 47 73 59 21 78
Archaeology documentation, management, presentation	Bjørn Hebba Helberg, TMU/UiTø	+ 47 77 64 50 88 + 47 77 64 50 00
Botany biological weathering, lichens, microorganisms, macro-vegetation Norwegian Red List mosses and lichens	Torbjørg Bjelland, UiB The Norwegian Biodiversity Information Centre *Artsdatabanken*	+ 47 55 58 35 73 + 47 73 59 22 16
Geology weathering, scanning, SEM, XRF, XRD, ICP	Wenche Odden, UiB	+ 47 55 58 36 04
Photography	Arve Kjersheim, ArK-Foto, Oslo	+ 47 22 52 39 47 + 47 91 66 12 01 Email: arve-kje@online.no
Painting	Kjartan Gran, Tromsø Bitten Bakke, AmS	+ 47 90 69 19 62 + 47 51 84 60 80
Management adviser for management, Directorate for Cultural Heritage (RA)	Directorat for Cultural Heritage (RA)	+ 47 22 94 04 00
Covering	Kjartan Gran, Tromsø Bjørn Hebba Helberg, TMU/UiTØ	+ 47 90 69 19 62 + 47 77 64 50 88

Presentation	Counties and regional museums	