KEYWORDS: *Rock art conservation - Exfoliation - Graffiti - Management plan - Central Siberia*

# 3

# ROCK ART PRESERVATION IN SIBERIA

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**Abstract.** The first major rock art preservation project in Russia is being conducted in central Siberia. It addresses the considerable conservation problems at a series of petroglyph and rock painting sites along the Lena River and some of its tributaries, in a sparsely populated region north of Irkutsk. Having acted as a voluntary consultant for the project, the author presents a brief outline of site conditions and description of the art. He then defines the conservation hazards of the region and those of specific sites. The interventionist practices applied to the largest site are described and their results discussed. A set of non-interventionist recommendations is developed from the problems as perceived. They and the experiences from restoration work are likely to be of interest in developing site management strategies in other parts of the world.

It is a tribute to the scientific centre of Irkutsk that the region where Russian Palaeolithic research was pioneered over a century ago, in 1871, has once again emerged as a pioneering region. This time it is in the field of rock art conservation. In 1987, one of the first projects of rock art conservation in the Soviet Union was commenced by the Irkutsk Centre for the Preservation of the Historical-Cultural Heritage. It addresses the serious conservation problems at a series of petroglyph and rock painting sites in the upper Lena basin, north of Irkutsk (Okladnikov 1959, 1977), particularly at the area's major site, Shishkino. The project is a remarkable initiative and achievement, being of a breadth of vision that would do much credit to many a project based on greater experience, access to know-how and institutional support, in countries with well-established conservation programs.

The purpose of this paper is not only to describe the project or to present recommendations for the future direction it might take, but also to examine the underlying strategy, explaining with the help of this case study some of the theoretical universals I believe should guide rock art conservators in their decisions. Thus the specific recommendations I arrive at may not be appropriate for most other sites or regions, but in showing how and why certain measures are selected I hope to illustrate how appropriate strategies may be developed. No two rock art sites are identical because a multitude of factors contribute to the environment of rock art: climatic, geochemical, geomorphological, hydrological, micro- and macro-biospheric, topographic, demographic, cultural and research-related factors may all influence the survival of the art. I therefore begin by briefly describing the site, then examine the various conservation problems, and from this develop my suggestions.

## The rock art of the upper Lena

By Siberian standards, Shishkino is a very major rock art site. It consists of about 2730 recognisable motifs (Okladnikov and Saporoshskaja 1959: 5), on dozens of discrete art panels which are found scattered among a series of rugged cliffs extending for almost 1 km along the right bank of the Lena near Kačug (Figure 1). The Lena, 50 or 60 m wide so close to its source, has formed vertical exposures of horizontally stratified, carbonate-cemented sandstones, with interspersed occasional strata of purplish-coloured, argillaceous and mechanically unstable rock.

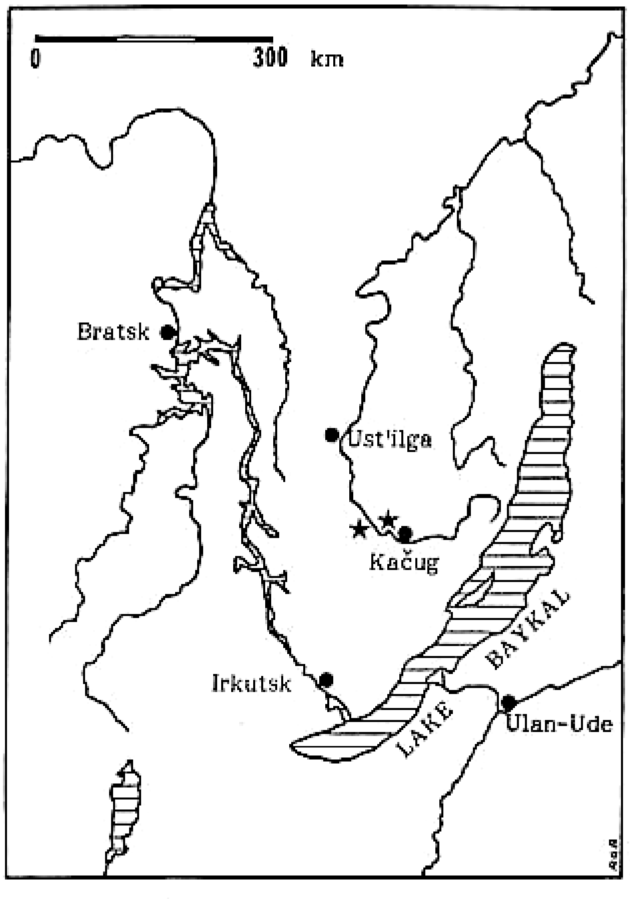


*Figure 1. Upper Lena valley, central Siberia.*

Vertical stress fractures parallel to the river have formed sheer faces and occasional detached buttresses, and can even be discerned along the crest of the 60 or 70 m high ridge, through the sediment capping. These would obviously attract precipitation run-off, which would percolate through the fill of these up to 60 cm wide crevices until forced to the cliff face by an impervious stratum.

Topographically, this part of Siberia is undulating hill country where rock is generally only exposed along the major drainage valleys. The winter climate is severely cold, with the ambient temperature falling below -40°C, while in summer radiant rock temperatures can be as high as +50°C. Winter precipitation is quite low, with the annual pattern distinctly peaking in July/August.

On rock surfaces, the lichen and moss flora is well-developed, but far from luxuriant. The chemical environment is thus mildly acidic, being between pH 5-6. Capillary moisture in the cliffs is not adequate to effect any granular mass exfoliation, and rock shelter formation attributable to this factor has not been observed. Stable rock surfaces are case hardened, by ferro-manganese and silica deposits, but there are considerable variations in surface conditions.

Most rock art motifs at Shishkino appear to be petroglyphs, but this is far from established. Often they consist of very shallow, vaguely defined and faintly abraded areas, and as in a few cases pigment traces appear to be present it seems possible that these abraded forms are the result of applying dry and fairly hard pigment 'crayons'. These pigments may have been removed by rain or vadose water (underground water occurring above water-table and re-emerging). A small proportion of the shallow abrasions is partly or fully outlined with an abraded groove, which was not necessarily part of the original composition. Emphasising of motifs by people trying to interpret or record them was practised for centuries. Judging by the apparent iconographic content of the art, most of it is probably Historic (i.e. it postdates the introduction of writing), and such a recent dating is confirmed by all geomorphological indicators. The possibly oldest art consists of deeply (up to 7 mm) abraded outline figures that were cut with stone implements (according to my microscopic analyses of striations) and filled in with deep surface abrasion. The main scientific significance of the Lena rock art is that two sites have been claimed to include Palaeolithic rock art (Abramova 1962; Kšica 1973; Okladnikov 1977; Bednarik 1994).

Rock paintings also occur at Shishkino, but in smaller numbers. In many, the red paint was apparently applied wet and with fingers, but in rare cases the use of a brush-like instrument is clearly evident. However, it is frequently impossible to determine the original form of individual motifs. Figures have been interpreted subjectively for centuries, and the scientifically most interesting aspect of the site is the potential to analyse the traces of successive responses to earlier art. However, the silhouetting by abrasion, the additions, modifications, chalking, accentuation by pencil, synthetic paints, dye, ink etc., the traces of recording practices such as those left by black, pressure-sensitive film, and the superimposition of large inscriptions in oil-based paints and bitumen have significantly compromised the potential of the site for iconographic analysis.

**The conservation problems**

In assessing the conservation problems of a rock art site and in designing an appropriate management program it is always helpful to initially classify the deterioration factors in a systematic fashion. This not only helps to understand the interplay and relative effects of the processes involved, remedial measures often become self-evident in the process and it becomes easier to predict their effectiveness. Initially one divides all conservation problems into two basic classes, those caused by natural processes, and those attributable to human intervention. Upon close examination humans are almost universally the main culprits. Proportionally, the human threat to the art increases with its age (Bednarik 1989). The most persistent rock art vandals are often not uninformed tourists, but local residents (Gale and Jacobs 1986) and so-called researchers who hold some absurd belief that 'researchers' have an inalienable right to interfere with rock art 'in the name of science' (Bednarik 1990a). The damage humans inflict exceeds that of natural agencies in most world regions, and it is far more selective than any other: it compromises the research potential rather than destroying the art itself. Abrasion, chalking (Bednarik 1990b), penciling and similar subjective recording methods impose the recorder's bias and interpretation on the motif, and record his or her cognitive response to an alien graphic system, not the art (Bednarik 1987a). Lacking any scientific significance, such activities alter the rock art permanently, as has frequently been the case at the upper Lena sites.

Among the upper Lena sites, Shishkino has attracted most professional vandalism, but other sites have also been affected. For instance, latex moulds have been taken at Vorobiovo in 1983, by unknown recorders. This changed the reflective properties (i.e. the colour) of the patination from the 2.5-5YR hue range to the 10-5R hue range (Munsell chart), indicating significant alterations in the state of the iron components of the rock varnish. Much of the latex has remained on the rock due to inept application, adhering to recesses and around the periphery of the affected areas (cf. Bednarik 1979, 1990c; Wainwright 1985).

In assessing the deterioration occasioned by humans at Shishkino I identify the following classes:

(1) *Degradation and destabilisation of rock and slope*

1a. Many of the cliff formations are tectonically unstable and visitor traffic can only accelerate degradation.

1b. The detrital slopes below the cliffs often rely on vegetation and large clasts for stability.

1c. The Kačug-Ust'Ilga road is immediately along the base of the entire series of cliffs, carrying heavy traffic at high speed. Vibration from road traffic is likely to accelerate tectonic destabilisation of the escarpment.

(2) *Tourist or professional vandalism*

2a. Scratched inscriptions and those in modern paints not only disfigure the art, paint solvents seem to react with patina minerals, producing a black coating.

2b. The scientifically most harmful processes are the physical enhancement of rock art and the application of chemicals, because they severely limit sophisticated analytical work for all time.

2c. At some sites latex casts have been taken of petroglyphs, which has resulted in chemical alteration of the patina and in disfigurement.

The major natural processes contributing to the deterioration of the Shishkino art are:

(3) *Mass exfoliation and congelifraction (structural failure due to crystallisation of water).*

3a. Cutaneous or laminar exfoliation is the result of an interplay of complex processes beginning with the mobilisation of water-soluble salts (many of which are common in sandstones) by interstitial moisture, and their deposition just beneath a skin of case hardening which is often less permeable than the porous rock. Other factors are differences of pressure between the closed system of the rock and the zone of atmospheric influence (the amount of solute a solution can hold in suspension is, among other things, a function of pressure; Bednarik 1980), and differences of temperature between rock and surface (a fall in temperature will have the same effect as a lowering in pressure, i.e. precipitation of surplus solute; Lewin 1982; Winkler 1973). The subcutaneous crystallisation of salts (in the case of Shishkino, calcium carbonate, gypsum and probably anhydrite occur locally, but the diversity of geological facies present in the exposure suggests that quite a variety of salts may be involved locally) and the consequent expansion in bulk lead to breakdown in the bond between rock and protective skin, and to the exfoliation of the latter. Laminae of only a few millimetres thickness may curl up from the margins, thicker ones become detached in sheets of up to 10 mm thickness.

3b. Granular mass exfoliation occurs where the surface protection of patination or some other form of case hardening is lost (through cutaneous exfoliation, acidity of surface water, human interference). The carbonate cement binding the sand grains of the rock then deteriorates comparatively rapidly. The loss of individual grains may be accelerated, for example, by aeolian erosion.

3c. Mass exfoliation through mechanical degradation is especially caused by macrogelifraction (frost action) of the argillaceous but poorly cemented strata. Vadose moisture is directed to the surface through their imperviousness, occupying fine cracks and freezing in the severe Siberian winter. However, the principal factor in frost shattering may not be the crystallisation of water to ice, but either regelation (Schmid 1958), or rock fatigue resulting from the compression of air-filled voids (Tricart 1969). Fracture patterns may differ in a single homogeneous stratum at Shishkino, they may be distinctly angular in one part, but subspherical nearby. As the less resistant strata retreat much faster than the better cemented rock, undercutting of the rock mass above them occurs at several sites (e.g. Shishkino, Kartuchai, Kozlovo), which then falls victim to gravity.

(4) *Solution at surface.*

4a. Degradation of patinae occurs through environmental changes, especially the lowering of pH (e.g. pH of precipitation, or by biospheric changes, such as an increase in the thallophyte flora), or through the scavenging of cations (mainly iron and manganese) by microorganisms such as cyanophycae. The loss of such protective layers then exposes the less resistant sandstone to granular exfoliation. No specific cause of patina degradation has been identified at the sites in question, and there are no major industrial installations in the region that might account for a marked lowering in rainwater pH.

4b. Pigment loss is suggested to be of minor significance at Shishkino. All iron oxide pigments ('ochres') are essentially metastable, they can be chemically altered by several reversible processes (Bednarik 1979, 1987b), and they are of course mobile when exposed to moisture. However, sandstone is capable of retaining minute pigment traces interstitially, particularly iron oxides, by bonding to silica (Clarke 1978; Hughes and Watchman 1983). The paintings I have examined on the upper Lena may have reached such a state of relative equilibrium, and would be endangered only by significant changes to the chemical environment.

**Conservation work to date**

The systematic conservation program begun in 1987 at Shishkino has been essentially three-pronged:

(1) Detailed study of specific aspects of the site's geology, tectonics, geomorphology, hydrology and climate, establishing a data base for addressing aspects of conservation. This work has been very detailed in some areas, for instance several excavations were undertaken along the crest of the ridge to study longitudinal faults and their possible tectonic and hydrological effects.

(2) Removal of graffiti, especially of synthetic paints which were frequently used for large inscriptions. Most consist of the names of individuals, and there is at least one religious text. Bitumen and other materials were also used. Conservator Sergei Frolov found that upon removal with commercial solvents, a blackish 'shadow' appeared where the paint had been, which has resisted removal attempts. It is perhaps the result of a chemical reaction between patina minerals and a component of the paint, such as the diluent. An area of about 2 m$^2$ which had been cleared of graffiti in the summer of 1989 attracted three fresh ones within 12 months.

(3) Experimental stabilisation of exfoliated areas had been carried out on two small panels (total area about 2 m$^2$) one year before my study. A panel dissected by stress-induced fractures had been treated with a preparation of tetraethoxysilane ($C_8H_{20}O_4Si$) mixed with the eroded sand (to match rock texture and colour). This silane grout had been carefully pressed into the cracks, and also applied to areas of structural instability and around the edges of eroding cutaneous laminae. The grout in the cracks had failed structurally within a year, some had become dislodged and numerous fractures of up to 1 mm had appeared, not only between the rock and the cement but also within the cement itself.

Three pits of about 40 mm diameter had also been filled with grout, and all three repairs had failed: two of the fillings had fallen off, the third had become dislodged and protruded about 1 mm, while still adhering to the rock. Significantly, the fracture had not occurred between the grout and the rock, but 1 or 2 mm beneath that interface, in the weathering zone of the rock. It is therefore not attributable to chemical incompatibility, inadequate adhesion or lack of internal stability of the repair cement, which was in fact found to be very stable. A greenish deposit had developed in the fracture, avoiding the surface-nearest zone (3-4 mm), and a similar community of algae had formed beneath a sheet of the cement which had also become detached. Algae are found in fine cracks that retain moisture for long periods, deriving their nutrients directly from the rock and atmosphere (whereas lichens depend on the symbiotic support of fungi). They are believed to require at least some light (for photosynthesis) but some species are known to exist in entirely lightless environments (Bednarik 1979: 25; Wainwright 1985: 26). Nevertheless, these chemolithotropic organisms do not create the fissures they colonise.

The cracks in these experimental repairs are attributable to material fatigue of basically two types. The silane grout is less pervious to moisture than the leached rock it conceals (for details about the practical problems in the use of silanes, see Spry 1981). Moisture accumulating in the porous weathering zone would repeatedly freeze under severe winter conditions. Similarly, the grout could present a barrier to migrating salts, which would precipitate subcutaneously and further weaken the former weathering zone. While the repairs of exfoliating surface laminae have apparently not failed in the first year, I predict that swelling due to salt deposition will effect their detachment within a few years.

The second type of material fatigue refers to the destruction of the silane grout placed in cracks. It is the result of processes that seek to establish mechanical equilibrium conditions in the rock mass. The minute structural movements they facilitate may be as essential to the rock's structural survival as, for example, the expansion joints are to a railway track. Stress fractures are adjustments to differential thermal expansion coefficients (perhaps amplified by anisotropic properties of component minerals), to gravitational pressure, hydration, *Salzsprengung*, insolation and similarly powerful forces. Blocking the cracks that provide the required flexibility will have either no effect, or it will accelerate the deterioration. It could be likened to welding the expansion joints of a railway track: if the welds are weak enough, they will break at the first change in temperature, but if they are very strong they will rip the tracks from the sleepers.

**Recommendations**

This comparison illustrates the underlying philosophy in modern rock art conservation, which operates largely through indirect measures: it is mostly concerned with modifying the environmental factors which threaten the survival of rock art, addressing climatological, hydrological, tectonic, biological and anthropic aspects. Direct interference with the art or its support is seen as a last resort.

Two other basic rules are to be observed in rock art conservation planning. Firstly, any measures adopted must be reversible (Bednarik 1988). Among other things, this means that fixing holes for attaching protective devices or permanent structural modifications of a site should be avoided, and 'transparent miracle coatings' are not acceptable.

Secondly, the relative value of preservation work is not only measured in terms of its apparent success, but also in terms of the monitoring taking place after its completion. The long-term effects of a project need to be observed: to modify conservation measures, should the need arise, and to avoid making similar mistakes elsewhere, or prevent others from duplicating them (Bednarik 1988).

Following on from these theoretical guide-lines, my recommendations are based on a strategy combining minimal expenditure, minimal direct interference and maximal reversibility, with a maximal effect on humanly caused deterioration. I list them in the order of priority as I perceive it, beginning with the most urgent measures.

A. *Indirect modifications of site access.* Human visitation is the most immediate threat, but it is felt that blatant access restrictions such as grids or fences will be considered as offensive by some visitors. Fortunately, the topography of some of the best sites on the upper Lena is ideal for implementing simple access modifications, because of their extreme steepness:

The Vorobiovo petroglyphs are at the base of series of cliffs rising above an extremely steep slope. If the top 2 m of the detrital slope is removed and the resulting shoulder rounded to prevent the use of a ladder (Figure 2), all petroglyphs will be well out of reach, and the cliff is practically unscalable because it is so unstable. Photography will still be possible, at least with telephoto lenses, and should detailed research be necessary at some point in the future, it will be possible with appropriate equipment. The remaining latex should be removed from the rock. Any figures not properly recorded should be surveyed.

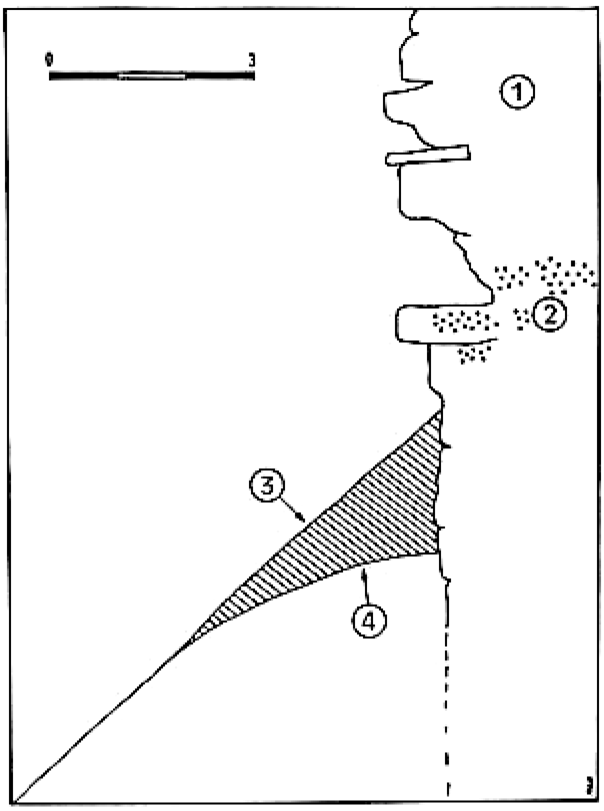


*Figure 2. Vorobiovo site, section of suggested reshaping to modify accessibility. 1 - vertical cliff, 2 - petroglyphs, 3 - present slope, 4 - proposed slope.*

At Kartuchai, the effect such access restriction measures would have is well illustrated: some of the art is over

4 m above the floor, and well preserved, while the easily accessible art is severely vandalised. At the eastern-most site, the steep slope can again be lowered by about 2 m.

Similar measures are possible at several locations at Shishkino. Especially the lowest panel, one of the few to survive in reasonable good condition, is most vulnerable, being just a few metres from the road. However, if the detrital slope were rebuilt as shown in Figure 3, visitors will see the art from a short distance without being able to reach it. The reshaped area could be planted with vegetation in such a manner as to appear natural. Depending on the lower, now concealed part of the cliff it may be necessary to modify the same slightly to prevent access by climbing up. An archaeologist should be present during this work even though the recovery of any archaeological material seems extremely unlikely.

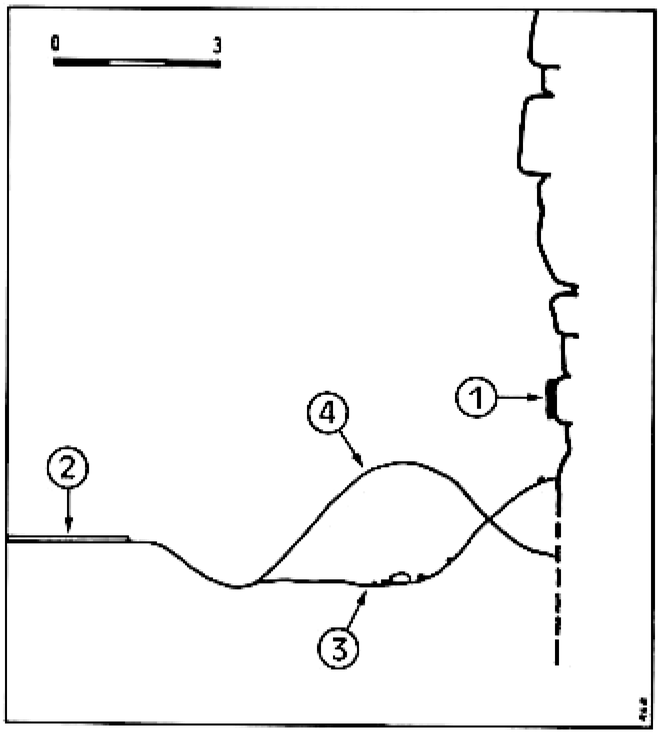


***Figure 3.*** *Section of lowest art panel of Shishkino site, with proposed changes: 1 - petroglyphs, 2 - road, 3 - present topography, 4 - proposed topography.*

B. *Direct modifications of site access.* In several parts of the Shishkino site complex more direct but still unobtrusive site access restrictions could be easily effected: rock recesses providing foot holds can be filled with rocks and non-reactive cement, small ledges or steps can be removed, slopes reshaped and narrow openings closed, all with very minimal effort. In several cases, access to specific panels can be rendered so difficult that it will deter visitors effectively. Once all this work is complete, the existing paths from the road up to the various cliffs should be filled in or levelled, and revegetated. Future access for researchers should be from above the cliffs rather than from the road. The underlying philosophy should be that only a few panels should be sacrificed to the public by remaining readily accessible. An excellent example of a project of this type has been conducted in Bolivia (Huaranca 1995).

C. *Protective roofs* would be very effective in various locations. An excellent example is the above-mentioned lowest panel at Shishkino, part of which is exfoliating because it is not as well protected from rain water as the rest of the panel. A small, quite unobtrusive roof of non-metallic material, attached and sealed to the rock with silicone, could be easily installed less than 2 m above the petroglyphs, and save this panel from further natural destruction. Since nearly all upper Lena rock art occurs on vertical rock surfaces it is obvious that much of it would gain greatly from strategically placed roofs or gutters of this type. Artificial silicone drip lines are one of the main conservation measures in Australia, where many thousands have been installed (Gillespie 1983).

D. *Graffiti removal.* I recommend that this be discontinued until such time as access to a panel is restricted, or about to be restricted. Removing the extensive graffiti without implementing steps A and B is not only ineffective, it introduces chemical agents to the rock surface unnecessarily and unproductively, because new graffiti will appear as soon as the old ones have been removed, and the procedure only has to be repeated at a later time.

E. *Structural repairs* of panels dissected by cracks should be discontinued, as well as the application of silanes, except in specific cases (see F). However, where sound rock art panels are threatened by undercutting due to a receding argillaceous stratum, structural repairs might be considered. This would involve a considerable effort and expenditure, and may necessitate the consultation of a structural engineer with appropriate experience. However, the principles are shown in Figure 4. It is to be emphasised that the repair will be doomed to failure if moisture cannot effectively drain from the rock strata the retaining wall would conceal, or if an elastomeric membrane as shown would not be included in the design.

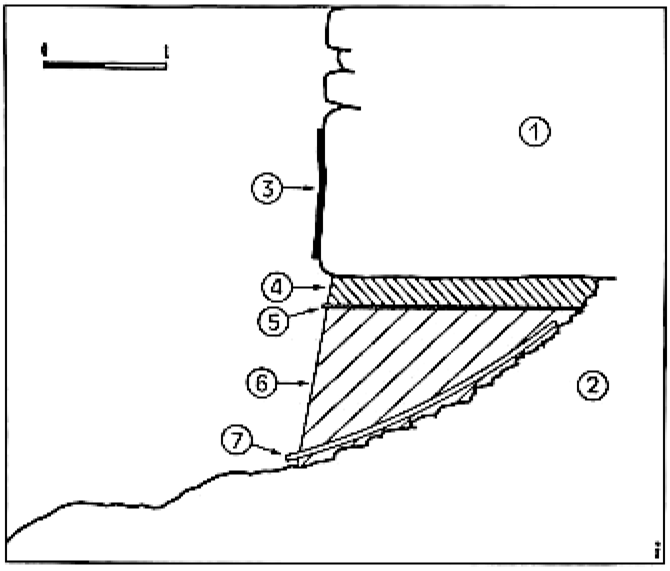


***Figure 4.*** *Section of central rock art panel of Shishkino site, with suggested method of alleviating severe undercutting: 1 - sound overlying rock, 2 - eroding facies, 3 - rock art, 4 - dry-packed cement grout, 5 - elastomeric membrane, 6 - cast concrete, 7 - slotted drainage pipes in thin sand layer.*

If properly constructed, such walls would not only prevent further erosion, they would also provide support for the sound rock above, and in effect replace the rock lost through mass exfoliation. One of the main panels in the central part of Shishkino is the most promising candidate for this treatment, involving a wall of 12-15 m length and up to 1.2 m height. This location, 20-25 m above the road, would be within the operational range of a concrete pump.

A small panel at Kozlovo and the eastern-most panel at Kartuchai, where disintegration of the otherwise sound, art-bearing rock has commenced, would benefit greatly from smaller applications of this measure.

F. *Surface stabilisation* should only be applied in extreme cases. When attempting to arrest laminar exfoliation, the edge of the disintegrating skin should not be sealed, but only tacked on with small dots of silane preparation spaced along the margin at regular intervals of 8 or 10 mm (Figure 5). Free exchange of moisture between the atmosphere and the core of the rock is essential, and no 'traps' must be created for water or salts under any part of the exfoliating lamina.

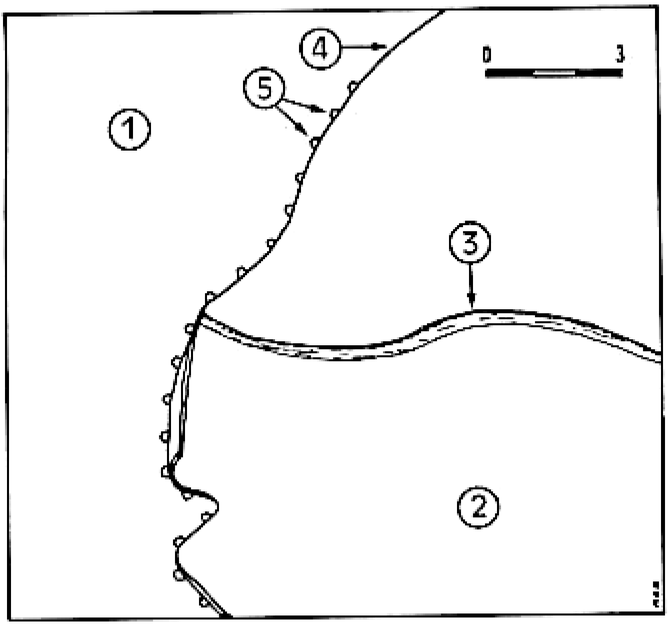


***Figure 5.*** *Shishkino rock art site, suggested temporary measure to arrest thin laminar exfoliation on sandstone. The skin (on right) is peeling off; 1 - freshly exposed rock, 2 - exfoliating skin, 3 - engraved groove, 4 - margin of exfoliating skin, curling up locally, 5 - small dots of silane to fasten skin to rock.*

Surfaces lacking a protective skin and suffering from rapid granular exfoliation, as well as small damages to patina (scratches etc.) can be repaired with artificial rock varnish (Elvidge and Moore 1980). A microcrystalline coat of iron and manganese oxides is precipitated on the rock which has the appearance of natural rock varnish. In this method, two solutions are applied, one of sodium hydroxide, the other of a mixture of ferrous and manganous salts. The latter's composition, the concentrations and the sequence of application are all determined by the desired colour and the type of rock being treated. Natural patina colours may be matched reasonably well after experimentation. Elvidge and Moore (1980) provide a descriptive table of solution compositions and colours. It should be cautioned, however, that the long-term stability of artificial rock varnish remains unknown; that the method should not be seen as providing a panacea for unstable rock surfaces; and that it may result in the destruction of a surface's geochemical dating potential (Bednarik 1992a, 1992b, 1992c). Moreover, a recent assessment of the method (Bock and Bock 1990) describes it as quite unsatisfactory, and its application should be avoided except as a very last resort.

G. *Traffic control* of the vehicular traffic below Shishkino could significantly reduce the effects of vibration. It would consist of speed limiting signs and warning signs at each end of the complex, and a series of speed traps installed across the road at regular intervals to ensure that the speed limit is observed. Ideally, the road should be relocated, as this would also solve much of the problem with human visitation, but it may be unrealistic to expect this to occur in the near future.

H. *Lichen and algae control* is not considered to be important, micro-organisms pose only a minor conservation threat at these sites. Their detrimental effects are the direct (scavenging of cations) or indirect (lowering of pH) degradation of patina. Ammonium hydroxide is effective in their destruction, but it also alters iron oxides. Careful use of commercial fungicides or biocides may be considered (Clarke 1978; Brunet and Vidal 1980); they are based on a wide variety of chemicals (see Wainwright 1985 for list), and the contamination and reduction of research value these would involve must be weighted against their benefits.

I. *Naming of sites.* A factor contributing to uncontrolled visitation is the simple fact that upper Lena rock art sites are usually named after the nearest village, which means that they can be readily located with minimal information. One protective measure involving no expenditure is the re-naming of sites, and the introduction of non-specific names for newly discovered sites (preferably words in an indigenous language, a practice established in Australia; Bednarik 1990d). Most certainly, site locations of new sites are not to be provided in any published form, they should only be available at one central office, and a system of maintaining confidentiality should be introduced.

J. *Monitoring* is an essential, integral part of any rock art conservation project. It should continue for at least 20 years, consisting of annual programs of analytical work designed to check the effects of all work.

It is clear from the magnitude of these works, from the monitoring requirement, and from the need to maintain relevant records, archives and specialist literature libraries, that there should be a central agency which not only takes charge of these matters, but which also maintains a register of sites (to be of restricted access for the protection specifically of the more remote sites), and liaises with a national agency, and any relevant international bodies.

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