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Rock art conservation in the upper Lena basin, Siberia

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ABSTRACT

The measures employed in a current Siberian rock art conservation project are briefly described, and preliminary results are examined. The future development of the project is considered, and specific noninterventionist methods are suggested in an effort to contain contamination of the rock art, and so to avoid the destruction of its remaining research potential. The main site among the series of sites being discussed has suffered extensive damage from rock art recorders, as well as intentional vandalism by residents of the district's villages. In view of the steepness of most of the sites, access modifications are considered to be the most effective measures of alleviating anthropic damage. A number of less serious threats can be mitigated by fairly simple measures of altering the conditions threatening the rock art. Such measures of minimal intervention are listed. Although the paper deals with a particular region, climate, demography and geology, the underlying management philosophy may be much more widely applicable.

In recent years, rock art conservation has significantly gained importance in various parts of the world. Australia, in particular, has had a national rock art protection program since 1987 [1,2] and has made considerable progress in curbing rock art deterioration – especially that which is caused by human visitation. The Australian strategy involves site management techniques, protection and conservation measures, legislative safeguards and public education. The general concepts of rock art conservation have found worldwide acceptance, and programmes are now underway in all continents, and in most regions possessing major corpora of rock art.

One of the first rock art conservation projects of the former Soviet Union is being conducted in the upper Lena basin, in central Siberia. It addresses the significant conservation problems at a series of petroglyph and rock painting sites along the Lena River and some of its tributaries, about 250km north of Irkutsk [3,4], particularly at the main site, Shishkino. Having acted as a consultant for this project, and having examined nearly all the known sites on the upper Lena River, the author presents here a brief report about this initiative; some of the recommended site management strategies may be relevant to many rock art sites in other parts of the world.

THE ROCK ART OF SHISHKINO

By Siberian standards, Shishkino is a major rock art site. It consists of about 2730 recognizable motifs [5], on dozens of discrete art panels, which are found scattered among a series of cliffs extending for almost 1km along the right bank of the Lena near Kacug (Fig. 1). The Lena has formed vertical exposures of horizontally stratified sandstone, with interspersed occasional strata of purplish-coloured, argillaceous and mechanically unstable rock. The lichen and moss flora is well

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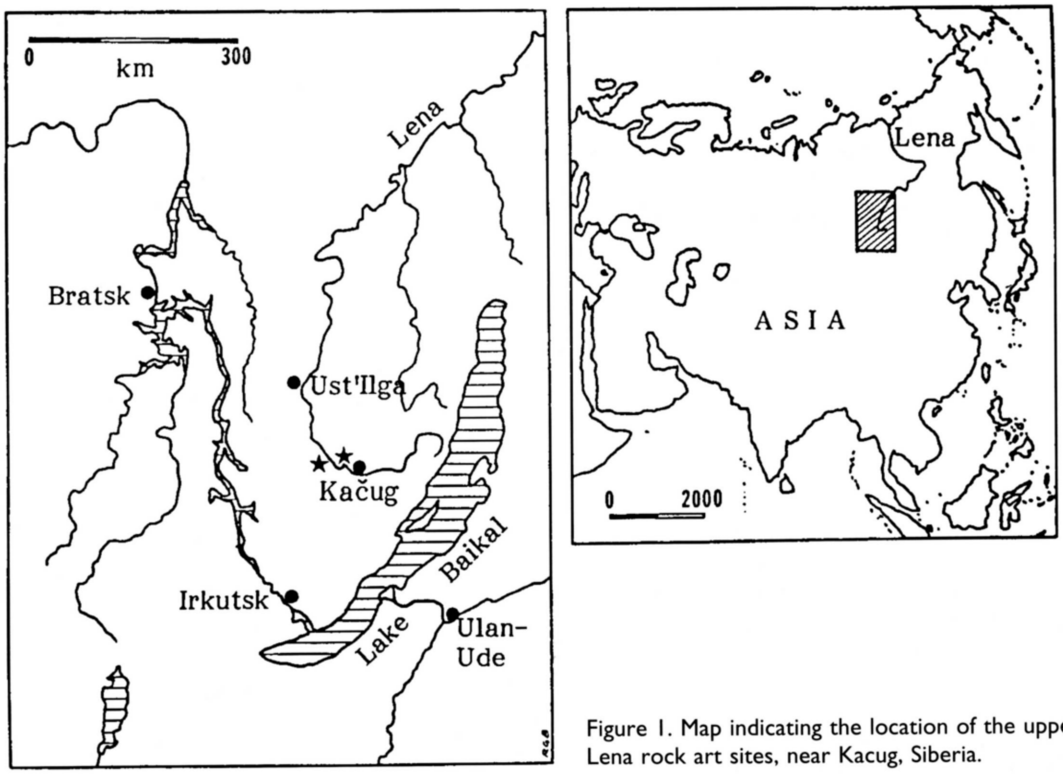

Figure 1. Map indicating the location of the upper Lena rock art sites, near Kacug, Siberia.

developed, but far from luxuriant, providing a mildly acidic chemical environment (pH 5–6). Capillary moisture in the cliffs is not adequate to effect granular mass exfoliation, and rock shelter formation attributable to this factor has not been observed in the region. Stable rock surfaces are case hardened by ferromanganese and silica deposits, but there are considerable variations in surface conditions.

Most rock art motifs at Shishkino consist of very shallow, vaguely defined and faintly abraded forms, and as in a few cases pigment traces appear to be present, it is possible that these abraded forms are the result of applying dry and fairly hard pigment 'crayons' rather than true petroglyphs. The pigments themselves may have been removed by rain or vadose water. 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. The emphasizing of motifs by people trying to interpret or record them was practised for centuries. Judging by the apparent iconographical content of the art, most of it is probably Historic, and such a recent dating is confirmed by all geomorphological indicators. It is at considerable odds with the claims by Okladnikov, frequently cited in the literature on rock art, that a few paintings of the site (and one figure at Tal'ma II, another site in the region) are of the Upper Palaeolithic.

In many of the Shishkino rock paintings, the red paint was apparently applied wet and with fingers, but in rare cases the use of a brushlike 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 synthetic paints and bitumen have by the same token significantly compromised the scientific potential of the site.

THE CONSERVATION PROBLEMS

Making an initial classification, in a systematic fashion, of the deterioration factors active at a site helps in understanding the interplay and relative effects of the processes involved; remedial measures often become self-evident in the process and it is easier to predict their effectiveness. Conservation problems fall into two basic classes, those caused by natural processes, and those attributable to human intervention. Humans are almost universally the main culprits. Proportionally, the human threat to rock art increases with its age [6]. The most persistent rock art vandals are often not careless tourists, but local residents [7] and researchers who hold some belief that they have an inalienable right to interfere with rock art 'in the name of science' [8]. The damage humans inflict exceeds that of natural agencies in most world regions, and it is far more selective than any other: it often compromises the research potential rather than destroys the art itself. Abrasion, chalking, pencilling and similar subjective recording methods impose the recorders' bias and interpretations on the motifs, recording their cognitive responses to alien graphic systems rather than the art itself [9]. Lacking scientific significance (other than the potential to study human responses to alien graphic systems), such activities alter the rock art permanently, as has frequently been the case at several of the upper Lena sites. Yet most research designs in rock art studies, such as those of iconographical or statistical interpretation, relate to epistemologically unsound models which have quite limited scientific relevance. For instance, they are not accessible to falsification [10] or refutation [11], they are generally taphonomically naive [12] and their proponents have thus little cause to cite 'scientific rights'.

Among the upper Lena sites, Shishkino has attracted most professional vandalism, but it is also evident at several other sites. 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. When the author carefully removed samples of the latex residues with tweezers, many sandstone grains adhered to the back of the flakes. Latex moulding not only destroys some of the analytical potential of a petroglyph, but, done repeatedly, may result in the slow destruction of the rock surface [13]. It has been rejected years ago as a routine method of recording [14,15].

The various chemicals applied in the course of recording and conservation work are all likely to limit the analytical options of future generations of rock art researchers (e.g. in rock art dating [16]). Therefore the application of any noninert substances with which rock art does not normally come into contact (i.e. on a petroglyph pavement, anything other than rainwater) is unacceptable [9,17], whether the substance is chalk, paint (casein-based or otherwise), motor oil, crayon, latex, distilled water, plaster, papier-mâché, vulcanized silicone rubber, kerosene, potato flour, whether it is organic or not, whether it washes off or is 'naturally degradable'. Several recent studies have shown what devastating effects physical recording methods can have on analytical studies of rock art. For instance, Chaffee *et al.* [18] have obtained an AMS radiocarbon date from one of the most famous rock art sites of North America, the Great Gallery in Horseshoe Canyon, Utah (the type site of the 'Barrier Canyon style'), of 32,900 ± 900 years BP. After investigating this surprising result, they found that the rock had been contaminated with a hydrocarbon derivative, probably kerosene, which had presumably been applied to enhance photographic contrast. Dorn [19] has conducted experiments to show that many rock art recording methods alter the cation ratios of rock varnish. Even the production of petroglyph rubbings may change the chemistry of accretionary deposits that may otherwise be suitable for minimum dating.

The effects of natural processes, on the other hand, often reflect a compromise between the competing forces of weathering and case hardening. The conservator is firmly on the side of the latter, but by assisting it is likely to accelerate the former. The major natural processes contributing to the deterioration of the Shishkino art are mass exfoliation, congelifraction [20] and solution at surface.

CONSERVATION WORK TO DATE

The systematic conservation programme 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 database for addressing aspects of conservation. This work has been very meticulous in some areas, for instance several excavations were undertaken along the crest of the ridge to study longitudinal faults (arranged parallel to the river) and their possible tectonic and hydrological effects.
2 Removal of graffiti, especially of synthetic paints which were frequently used for very large inscriptions. Most graffiti consist of the names of individuals, and there is at least one religious text. Upon removal with commercial solvents, a blackish 'shadow' appeared where the paint had been, which has resisted attempts to remove it. 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 2m^2 which had been cleared of graffiti in summer 1989 attracted three fresh ones within 12 months (Fig. 2).
3 Experimental stabilization of exfoliated areas had been carried out on two small panels (total area about 2m^2) one year before the author's 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 1mm had appeared, not only between the rock and the cement, but also within the cement itself.

Figure 2. Large painted inscriptions over rock art at Shishkino, with conservator Sergei Frolov at work and Katja Devlet observing.

Three pits of about 40mm 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 1mm, while still adhering to the rock. Significantly, the fracture had not occurred between the grout and the rock, *but 1 or 2mm beneath that interface*, within 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 quite sound). Rather, fracture occurred in the weakened former surface zone of the rock. A greenish deposit had developed in the fracture, avoiding a surface-nearest zone of 3–4mm, and a similar edaphon 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 [14,15]. Nevertheless, these chemolithotropic organisms do not themselves create the fissures they colonize.

The cracks in these experimental repairs are attributable to material fatigue of basically two types. The silane grout is far less pervious to moisture than the leached rock it conceals (for details about the practical problems in the use of silanes, see Spry [21]). Moisture accumulating in the porous weathering zone would repeatedly freeze under severe Siberian winter conditions, with mechanical failure caused by freeze-thaw cycles first affecting that zone. Secondly, the grout would present a barrier to migrating salts, which would precipitate subcutaneously and further weaken the former weathering zone, producing essentially the same effect (actually the processes involved are more complex than implied in this brief comment).

The destruction of the silane grout placed in cracks is the result of processes that seek to establish mechanical equilibrium conditions within the general rock mass concerned. The minute movements the cracks facilitate are essential to the rock's structural survival. Stress fractures are adjustments to differential thermal expansion coefficients (perhaps amplified by anisotropic properties of component minerals), to gravitational force, hydration, *Salzsprengung*, insolation and similarly powerful dynamics. Blocking the cracks that provide the required flexibility with silane grout will either have no effect, or it will actually accelerate the deterioration.

RECOMMENDATIONS

Contemporary rock art conservation prefers to operate through indirect measures: it is mostly concerned with modifying the environmental factors that threaten the survival of rock art, addressing climatological, hydrological, tectonic (structural), biological and, most particularly, anthropic aspects [22]. Direct interference with the art or its support is usually seen as a last resort, and there is a trend towards avoiding it whenever possible.

Two other basic rules need to be observed in rock art conservation planning. Firstly, any measures adopted must be reversible [23]. Secondly, the relative value of preservation work is measured not only in terms of its apparent success, but also in terms of the monitoring taking place after its completion.

The author's recommendations for appropriate conservation measures at the central Siberian sites are based on a strategy combining minimal expenditure, minimal direct interference and maximal reversibility, with a maximal effect on humanly caused deterioration. They are, beginning with the most urgent measures:

Modifications of site access

As far as human damage to rock art is concerned,

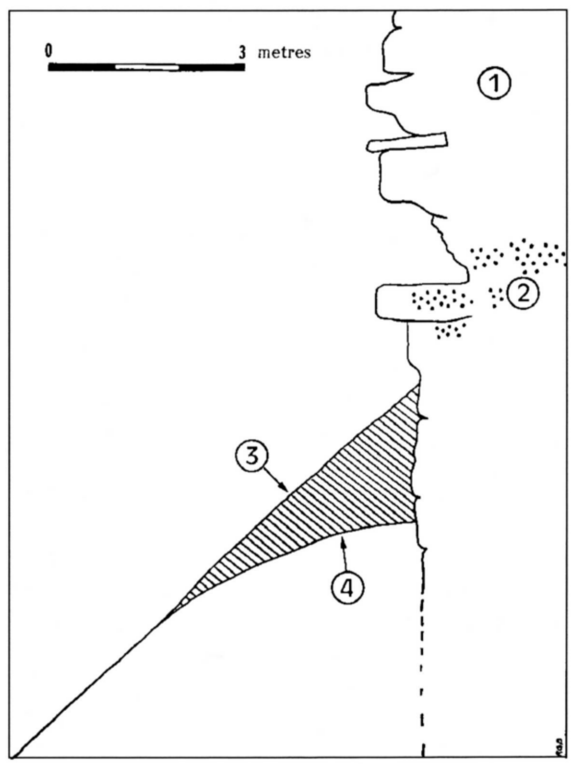

Figure 3. Vorobiovo petroglyph site, upper Lena River. Typical section showing the suggested reshaping of the slope to modify accessibility. 1, vertical cliff; 2, petroglyphs; 3, present slope; 4, proposed slope.

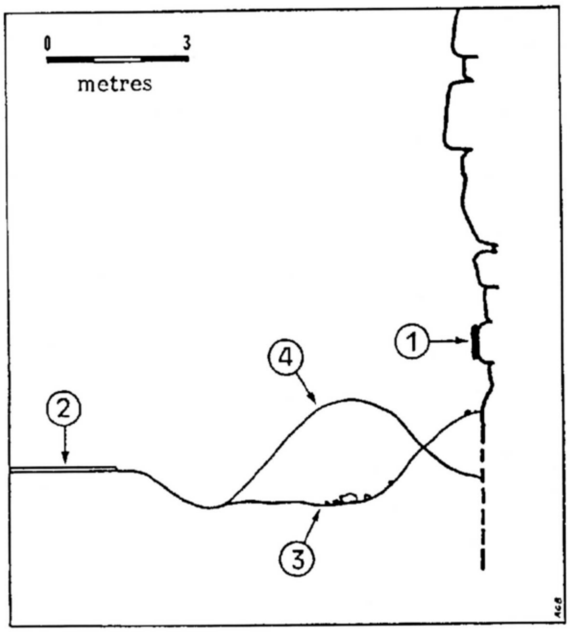

Figure 4. Shishkino, lowest petroglyph panel, adjacent to road. Proposed removal of slope below rock art and construction of mound. 1, petroglyphs; 2, bitumen-covered road; 3, present contour of floor; 4, proposed contour.

be it intentional or unintentional, the greatest problem is that there is a distinct spatial bias in the location of rock art in favour of the 'most convenient' part of a site, which is its most readily accessible aspect. Unfortunately, it is also the most accessible part in terms of damage by site visitors. The obvious solution, then, is to alter the accessibility of the art panels, which can be achieved by many different means. Fortunately, the topography of some of the best-preserved sites in the upper Lena region is ideal for implementing simple access modifications, because of their extreme steepness. The Vorobiovo petroglyphs are at the base of series of cliffs rising from a high, extremely steep slope. If the top 2m of the detrital slope is removed and the resulting shoulder rounded to prevent the use of a ladder (Fig. 3), all petroglyphs will be well out of reach, and the cliff is practically unscalable because it is most unstable. Photography will remain possible, at least with telephoto lenses, and, should detailed research be necessary in the future, it will be feasible with appropriate equipment. Other applications of this principle can be suggested for Kartuchai, and for the lowest panel at Shishkino, which is just a few metres from the road passing under the site's cliffs: if the detrital slope were rebuilt as shown in Fig. 4, visitors would see the art from a short distance without being able to reach it. The construction of elevated viewing platforms and walkways, widely used at Australian rock art sites, would involve much greater expense, but the underlying site management philosophy can be implemented much more easily at such steep sites (as most of the art sites on the Lena are).

Various other forms of access restrictions are possible, some being direct rather than indirect, but nevertheless still unobtrusive. Rock recesses providing footholds can be filled in, small ledges or steps can be removed, slopes reshaped and narrow openings closed, all with minimal effort and structural work. Once these measures are completed, existing paths from the road up to the various cliffs can be filled in and revegetated. A good example of such measures is provided by the site modification work at Torotoro, Bolivia [24].

Protective roofs

These would be very effective in many locations. An excellent example is again the lowest panel at Shishkino, part of which is exfoliating because it is not as well protected from rainwater as the rest of the panel (Fig. 5). A small, quite unobtrusive roof of nonmetallic material, attached and sealed to the rock with silicone, could be easily installed less than 2m above the petroglyphs, and save this panel from further natural destruction. Since nearly all upper Lena rock art occurs on vertical rock surfaces, much of it would gain greatly from strategically placed roofs or gutters of this type. In the few sites where rock art occurs under natural shelters (e.g. at Tal'ma I), the installation of artificial driplines may be considered [25]. Such driplines are of clear silicone, applied with a pressure gun, and they are strategically placed to redirect laminar water flow or to break its inward flow and prompt it to fall to the ground before it approaches the art. The dripline needs to be only

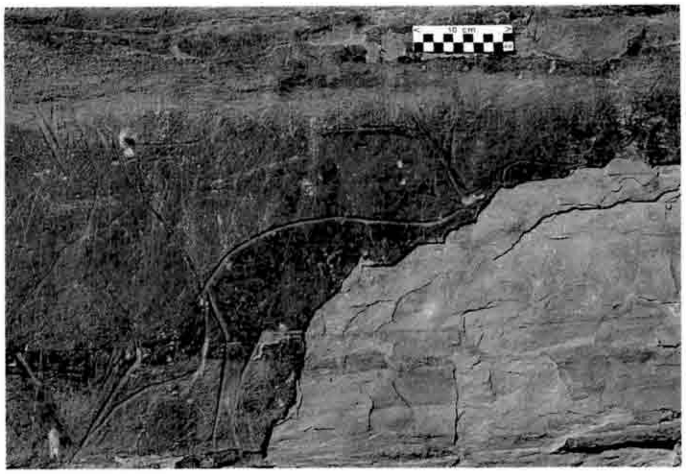

Figure 5. Lowest petroglyph panel at Shishkino, cervid outline figure being truncated by laminar exfoliation caused by rainwater runoff.

a few millimetres high, and it is best positioned along the lowest part of a shelter roof. Naturally it must be located so that water splash cannot reach any rock art.

Graffiti removal

This should be discontinued until such time as access to a panel is restricted, or about to be restricted. Removing the extensive graffiti without implementing the modifications to site access (see above) 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. Introduced chemicals of any type will prejudice present or future analytical methods of study (e.g. dating work) [9,14,18], and if there is any prospect that the graffiti removal (or any other chemical treatment, such as 'surface stabilization' or patina repair, see below) would be ineffective, it should be avoided. Once access modifications are underway, judicious removal of graffiti may be resumed, but detailed records should always be kept of the extent and type of treatment, so that future analysts of the rock art can appreciate what forms of contamination have taken place [26]. Graffiti removers need to be aware that their activities destroy much of the research potential of a site, and that dated graffiti have been used by researchers for dating rock art (e.g. in the calibration of microerosion dating [27]).

Structural repairs

Structural repairs of panels dissected by cracks should be discontinued, as well as the application of silanes, except in specific cases (see under Surface stabilization, below). The failure of experimental repairs described above was fully predictable. Such measures are akin to welding closed the expansion joints in railway rails, or to grouting the expansion joints in a building: they will either fail structurally, or they will result in much greater damage. However, where sound rock art panels are threatened by undercutting due to a receding argillaceous facies, major structural repairs might be justified. The principles are shown in Fig. 6. This would involve a considerable effort and expenditure, and it may necessitate the consultation of a structural engineer with appropriate experience. It is to be emphasized 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 were not included in the design, as shown, to facilitate the release of structural stresses; or if efflorescence were allowed to develop at the interface of the repair work with the rock. However, if properly constructed, such walls would not only prevent further erosion, they would also provide structural support for the sound rock stratum above, and in effect replace the rock lost through mass exfoliation. One of the main panels in the central part of Shishkino could be a candidate for this treatment, involving a wall of 12–15m length and up to 1.2m

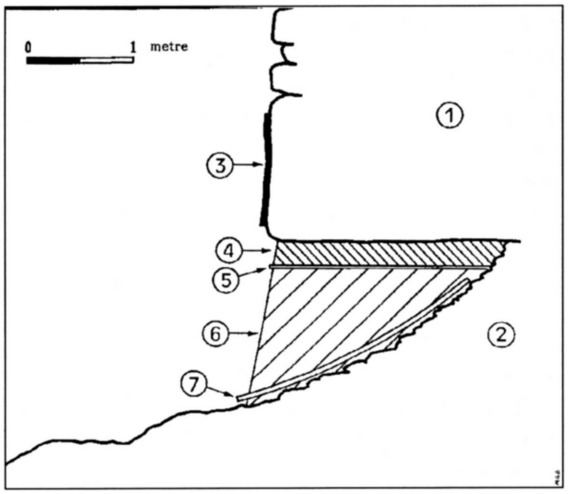

Figure 6. Shishkino, central art panel, which is undercut by mass exfoliation of weaker stratum, with suggested method of repair shown. 1, sound sandstone strata; 2, disintegrating argillaceous stratum; 3, rock art; 4, dry-packed cement grout, rammed into position after a chemically inert film has been applied to the rock above; 5, elastomeric membrane (e.g. Neoprene); 6, reinforced cast concrete; 7, slotted drainage pipes embedded in thin layer of sand.

height. This location is little more than 20m above the road, and would thus be within the operational range of a concrete pump. Other locations in the region where rock art panels are disintegrating due to the exfoliation of the unstable rock facies below their support are at Kozlovo and at Kartuchai, and in both cases the deterioration can only be arrested by underpinning the remaining sound rock by major structural repairs of the type described.

Ford and Watchman [28] have recommended the use of antifreeze and water repelling compounds to reduce spalling by freezing/regelation. Such measures would be quite ineffective at Shishkino, and, it may be suspected, at most rock art sites affected by congelifraction (freeze–thaw cycles).

Surface stabilization

This should be applied only in extreme cases. Most attempts at consolidating fragile and spalling rock surfaces by impregnating them with a variety of substances have led to unsatisfactory, if not disastrous, results, and efforts to stabilize the surfaces of rock art panels with silicones, silicon esters and silanes have been generally unsuccessful. When attempting to arrest laminar exfoliation at Shishkino, the edge of the disintegrating, up-curled skin should not be sealed, but only tacked on with small dots of silane preparation (or, preferably, inorganic grout) spaced along the margin at regular intervals of 8 or 10mm. Free exchange of moisture between the atmosphere and the core of the rock is essential, and no 'traps' must be created for either water or salts under any part of the exfoliating lamina (Fig. 7).

Surfaces lacking a protective skin and suffering from rapid granular exfoliation, as well as minor damage to patina (scratches etc.), can be repaired with artificial rock varnish [29]. A microcrystalline coat of iron and manganese oxides is precipitated on the rock, which should result in the appearance of natural rock varnish. In this essentially cosmetic

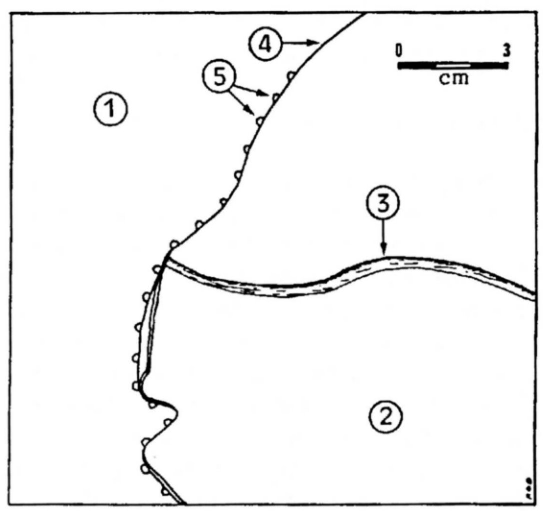

Figure 7. Suggested emergency measure for arresting laminar exfoliation: the skin on the right is curling off, and could be tacked on along the margin with small dots of silane or inorganic grout preparation.
1, freshly exposed rock; 2, exfoliating old surface;
3, groove of petroglyph; 4, margin of exfoliating skin;
5, small dots of grout.

method, two solutions are applied, one of sodium hydroxide, the other of a mixture of ferrous and manganous salts. However, the long-term stability of artificial rock varnish remains unknown; the method must not be seen as providing a panacea for unstable rock surfaces; and it may result in the destruction of a surface's geochemical dating potential. A recent assessment [30] describes the method as quite unsatisfactory, and its application should be avoided except as a very last resort. In such instances, the extent and type of treatment need to be recorded.

Vehicle speed control

Control of the speed of the vehicular traffic below Shishkino could significantly reduce the effects of vibration on the stability of the detrital slope and rock structures. There is no doubt that the site's geophysical stability is significantly affected by the river below, by its influence on the less stable of the rock strata. Although empirical proof is lacking, it is quite possible that the natural process of structural adjustment is being accelerated by heavy vehicular traffic at the foot of the cliffs. Appropriate measures would be to install a series of effective speed traps along the road, and warning signs at either end of the site.

Lichen and algae control

This is not considered to be important at the sites under discussion: microorganisms seem to pose only a minor conservation threat. 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 [31,32]; they are based on a wide variety of chemicals, and the contamination and reduction of research value these would involve must be weighed against their benefits, as in any other application of contaminating substances.

Naming of sites

A factor contributing to uncontrolled visiting 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 renaming of sites, and the introduction of nonspecific names for newly discovered sites, the locations of which should not be provided in published form.

Monitoring

This is an essential, integral part of any rock art conservation project [33]. It should continue for at least 20 years, and consist of annual programmes of analytical work designed to check the effects of all work.

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