THE STATE OF RESEARCH IN ROCK ART

ROCK ART CONSERVATION RESEARCH IN CANADA

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Introduction

The rock art of Canada has been the subject of interest since the nineteenth century. A notable early study, of Agawa Rock in Lake Superior Provincial Park, was published by Henry Schoolcraft in 1851. Dewdney (Dewdney and Kidd, 1967, pp. 80-85) has concluded that certain of the paintings were executed ca. 1800 A.D. (Dewdney, 1970b, p. 28). The Writing-On-Stone petroglyphs were observed in 1855 by James Doty. Later archaeologists and ethnographers like James Teit (1896) in British Columbia and David Boyle (1896) in Ontario described and frequently illustrated pictographs. Geologists, such as William McInnes (Smith, 1923; Dewdney & Kidd, 1967, p. 161), also sketched rock art.

The methodical study of this Amerindian heritage is, however, a more recent development. Most of the sites have had to be rediscovered, often purely by chance. The Peterborough Petroglyphs were not found until 12 May, 1954 when a geological team from Industrial Minerals of Canada stopped to rest on the marble outcrop bearing the glyphs.

Because of the difficulty of dating, in the absence of an established stratigraphic context, archaeologists have been reluctant to include rock art in their studies. As yet no absolute dating techniques have application to Canadian rock art; even superimpositions, which could provide clues to relative chronology, are rare.

In 1957 Selwyn Dewdney began a systematic search for rock art in the Canadian Shield Woodlands. In British Columbia several workers including John Corner, Ed Meade and Beth and Ray Hill searched for and recorded coastal petroglyphs and pictographs in the interior. In 1969 the Canadian Rock Art Research Associates (CRARA) was formed, with the aims of promoting rock art research and conservation, and of informing the Canadian public of its aboriginal art heritage (1).

The involvement of the Canadian Conservation Institute with rock art began in 1972, when Selwyn Dewdney asked us to investigate the causes of deterioration of pictographs of the Canadian Shield. Our research later extended to several sites in British Columbia, principally in the Similkameen Valley. More recently we have been involved in conservation of the Peterborough Petroglyphs and other sites.

This paper reviews some results of current interest, in particular, several of the issues discussed by the author at the International Training Seminar on Rock Art and the Consultation of Specialists on the Study, Documentation and Conservation of Rock Art, held at the Centro Camuno di Studi Preistorici in Capo di Ponte, Italy, 31 August - 13 September 1981. One theme which emerged was the need for better exchange of information between rock art researchers, and the references to this paper have been compiled with this in mind. The list is certainly not complete, but will serve as a guide to rock art conservation research, particularly as it applies to Canada.

An outline, *Rock Art Determination: An Approach to Its Study* (see Appendix), has been developed in collaboration with François Soleilhavoup (1981). It is intended as a summary of current work in rock art conservation and as a basis for future discussion (2).

Pictographs, Petroglyphs and Petroforms

In North America there is widespread, but not entirely unanimous, agreement on the technical use of the words *pictograph* (rock art rendered on the rock surface without disrupting it) and *petroglyph* (rock art executed by disrupting the rock surface by pecking, incising or abrading). These terms, although adopted more through usage than semantic logic, are workable. Dewdney (Dewdney & Kidd, 1967, p. 43) has used the term *lichenoglyph* for rock art scraped in lichen-encrusted rock. The word *petroform* is used to describe boulder effigies, mosaics and alignments.

In describing the distribution and concentration of rock art we have adopted Dewdney's (1970b) definitions of *Site*, *sub-Site*, *Face* and *sub-Face* and use the word *Figure* for a single rock art unit. The use of the term *morph*, a catchall abbrevation for zoomorphic and anthropomorphic pictograph elements, and *glyph*, the comparable term for petroglyphs, has become fashionable. These terms are convenient particularly when a precise interpretation is to be avoided. The description of sites and the figures of which they are comprised is not often straightforward, but varies from one researcher to another. Typically, a figure identification scheme for a given site is revised during subsequent research.

In Canada a comprehensive archaeological site designation scheme, developed by Borden (1952), is used for rock art sites. It is a grid reference system which is compatible with the National Topographic System maps (Surveys and Mapping Branch; Department of Energy, Mines and Resources). The system is based on blocks of 2° Latitude by 2° Longitude, which are divided into units of 0° 10 Latitude and 0° 10 Longitude. Each of these smallest units has a unique alphabetic code; sites within the unit are numbered sequentially as they are reported. For example, a shamanistic figure in the complex of Smith Channnel between Hickson and Maribelli Lakes in Saskatchewan has the Borden designation HbNc-1:Face 14. (H = 56°-58° Lat.; b = 0° 10 -0° 20 Lat.; N = 104°-108° Long.; c = 0°20 -0°30 Long.; the site is actually at 56° 15 Lat. and 104° 28 Long.). Implementation of this system has greatly facilitated the recording and cataloguing of rock art sites (3).

Distribution

The rock art of Canada is widely distributed from the coastal waters of British Columbia to Nova Scotia (Lundy, 1980; Wellmann, 1979). Wellmann places it within four major North American rock art regions: Northwest

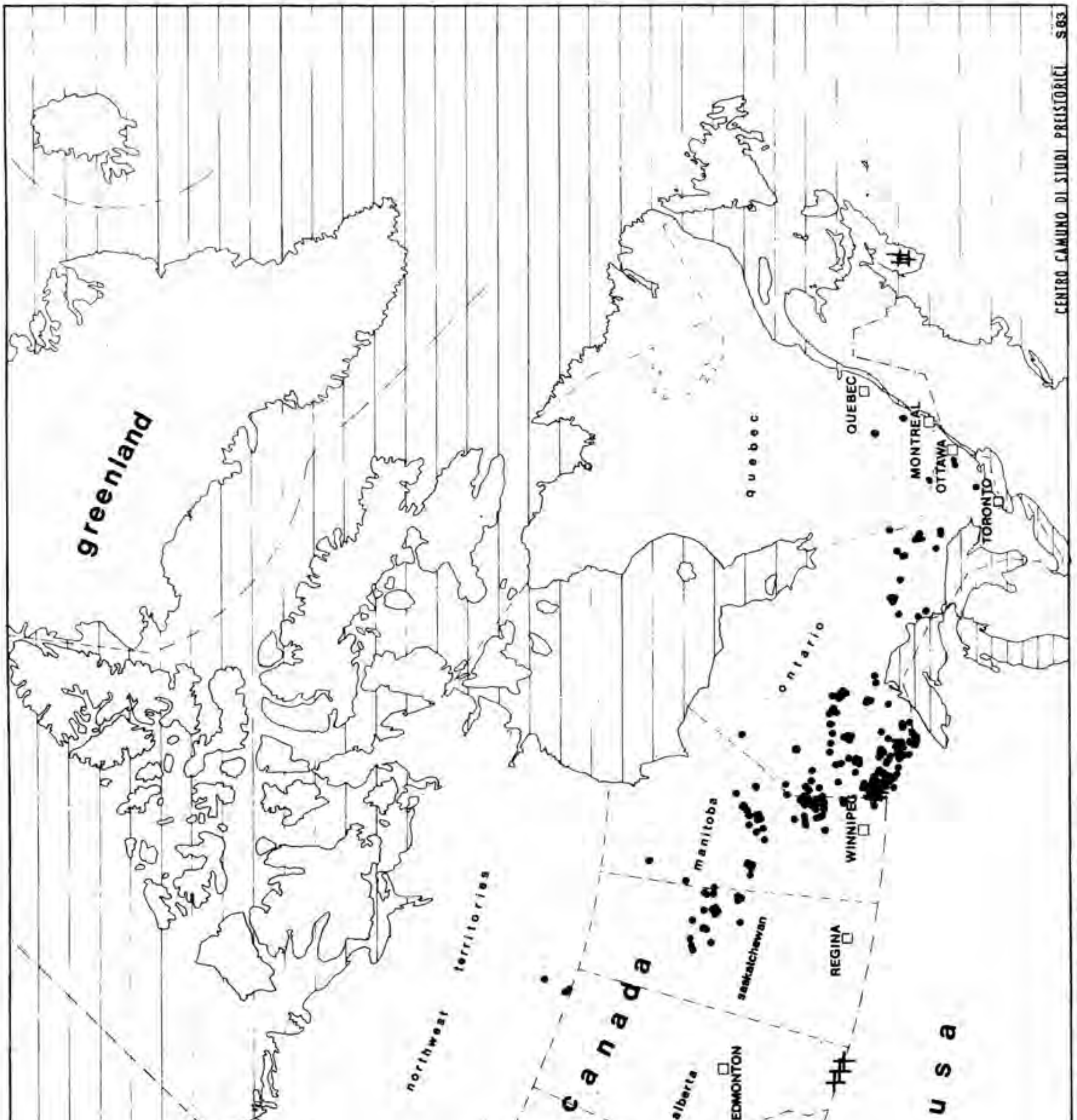

Fig. 9 Distribution of rock paintings and petroglyphs in Canada.

Coast; Columbia-Fraser River Plateau; the northern Great Plains; and Northern Woodland Regions (Wellmann, 1979, maps 1,4,9,11). The petroglyphs of the Pacific Northwest have been reviewed by Meade (1971), Hill & Hill (1974), and Bentley & Bentley (1981). Corner has surveyed 105 pictograph sites in British Columbia's interior, primarily within the boundaries of the Interior Salish, Kootenay and Athapaskan tribes and concentrated mainly in the South Okanagan and Similkameen areas.

One of the few sites in Alberta, the Writing-On-Stone petroglyph complex along the Milk River near the southern provincial boundary, is among the largest rock art areas on the continent (Keyser, 1977, 1979).

Petroglyph sites east of Writing-On-Stone are comparatively rare, except for two major concentrations: the Peterborough Petroglyphs in south central Ontario (Vastokas & Vastokas, 1973) and the petroglyphs within Kejimkujik National Park in southwestern Nova Scotia (Meyers, 1972). These extensive petroglyph sites and those such as Petroglyph Park, near Nanaimo on Vancouver Island, present a great conservation challenge because they are so readily accessible.

The Canadian Shield is that area of essentially exposed Precambrian rock that makes up about half of the Canadian land mass. Towards its southern perimeter and below the tree line, are found the pictographs and, occasionally, petroglyphs, of the Canadian Shield Woodlands. This region, occupied principally by Algonkian peoples in the period before European

Fig. 10
Pictograph face at Site BfGh-5 Mazinaw Lake, Bon Echo Pronvincial Park, Ontario.

contact, extends from northern Saskatchewan to central Ontario and Quebec. The majority of pictographs are found between Lake Winnipeg and Lake Superior in the area corresponding to the known range of wild rice (Dewdney, 1970b, p. 7). The area, under continuing investigation, contains several hundred sites (see Dewdney & Kidd, 1967; Dewdney, 1970a, 1970b; Tassé & Dewdney, 1977).

Structure, Materials and Dating of Pictographs

The cross-sectional structure of a typical pictograph has been established by work in our laboratory from 1972, based on sites in both the Canadian Shield Woodlands and the interior of British Columbia. Samples of pictographs are obtained with tungsten carbide microchisels. The standard petrographic techniques of a mineralogical laboratory have been adapted for the extremely small samples (typically less than 4 sq. mm surface area) which it is felt can be removed without noticeable damage to the pictograph. Whenever possible, chips which are about to be lost are sampled. The end result is a flat, highly polished, *opaque* section. These are first examined by conventional incident light microscopy and fluorescence microscopy and are photomicrographed in colour. The distribution of chemical elements within the section is then determined by electron beam x-ray microanalysis using a scanning electron microscope incorporating an x-ray energy spectrometer. These studies may be supplemented by preparing *thin* sections for examination in a polarizing microscope.

The main findings are as follows. (For detailed discussion the reader is referred to Myers & Taylor, 1974; Taylor *et al.*, 1974, 1975). The sections reveal the development on the rock substrate of a deposit which is formed by groundwater containing sodium, magnesium, aluminium, silicon, potassium, calcium and iron seeping over the rock face. The least soluble of these elements (silicon, calcium, aluminium, iron) which are deposited most readily as the water evaporates, are the ones detected in greatest concentration by x-ray microanalysis. The more soluble elements are largely washed away by rain, or wave splash.

The layer is an amorphous or cryptocrystalline material, often formed in rhythmic bands paralleling irregularities in the rock. Usually it is richest in silica and is called *silcrete*, although calcite has also been found. If calcium predominates, the term *calcrete* is applied. Similar deposits are found at many rock art sites in the world (Butzer *et al.*, 1979, p. 1211, note 6; Denninger, 1971; Willcox, 1971; Walston & Dolanski, 1976; Dolanski, 1978; Weisbrod, 1978, p. 4). In the examples we have studied, this layer is not formed as a result of efflorescence, nor is it a product of chemical weathering of the rock surface.

In most cases a second deposit, essentially identical to the first, has formed over the pictograph. The disegn surface of the pictograph itself was executed on the first deposit; its exact nature is interesting both for the history of materials and for the dating of pictographs. Unfortunately a precise characterization of the original paint has thus far eluded us.

The *pigment* component has been relatively easy to define in the case of the majority of pictographs which are red or orange-red in hue. X-ray diffraction analysis shows it is the mineral haematite, α Fe_2O_3. (It is not merely coincidence that the word haematite derives from the Greek αἷμα for blood). This pigment, used worldwide by prehistoric artists (McKee & Thomas, 1973; Clarke, 1976a, Butzer *et al.*, 1979), derives from deposits of red ochre which, typically, are mixtures of haematite with clay, calcite, quartz and other minerals. The pigment particles of a pictograph may form a discrete layer, readily distinguishable from the enveloping discontinous layer of irregular thickness, which gives the impression of being suspended within the deposit. Gandolfi x-ray diffraction patterns frequently include a contribution due to calcite ($CaCO_3$) or quartz ($\alpha\ SiO_2$), which may stem from the initial ochre used or from the admixture of crystallized deposit with pigment.

Red ochre deposits are often relatively close to the sites and were undoubtedly mined for the pictographs. It is also known (Watson, 1969, p. 3; Dewdney & Kidd, 1967, p. 21) that yellow ochre, primarily goethite, was roasted to produce haematite ($\alpha\ FeO(OH) \xrightarrow{\Delta} \alpha\ Fe_2O_3$). The range of hues observed results from various concentrations of these iron oxides and oxyhydroxides. Other colours, such as black, green and white, are observed infrequently.

The more difficult problem concerns the *vehicle* (4) that may have been used. A wide variety of possible natural materials has been suggested: egg, casein, animal flue or fat, blood and honey (Watson 1969, 1967; Denninger, 1971; Judson, 1959; Leechman, 1932; Corner, 1968); "Gull's eggs would serve admirably and bears' grease would likewise suffice. Beaver tails and fish roe, the hoofs of moose and deer, could all be boiled to make glue, and fish and rabbit skins may have been utilized also" (Dewdney & Kidd, 1967, p. 169). Jones (1981) has recently presented ethnographic evidence for the possible use of isinglass derived from the sturgeon. It is also possible that water alone was used as a *diluent*, without any vehicle *per se*.

Three hypotheses exist: 1) a vehicle was used and is responsible for the preservation of the pictographs; 2) a vehicle was used but has deteriorated to a level where its presence cannot be determined; 3) no vehicle was used. The resolution of these hypotheses has considerable consequences for both conservation and dating.

Is commonly believed that a vehicle, as yet undetermined, is responsible for the remarkable state of preservation of many pictographs (hypothesis 1). Denninger (1971) estimates the vehicle would amount to 5-10 per cent of the paint, in which case it would be readily observed. However, in studying paint by infrared spectrophotometric, gas chromatographic, thermogravimetric and fluorescence microscopic methods we have been able to discern only a trace of organic material, which could also be attributed to contamination. By contrast, analyses of Pacific Northwest masks have readily detected the vehicle and showed it to have been salmon egg date. If a vehicle were present in sufficient quantity, dating by radiocarbon methods or the time dependent deterioration of amino acids might be possible (Butzer *et al.* 1979, p. 1201; Weisbrod, 1978, p. 6; Denninger, 1971; Willcox, 1971). A more sensitive analytical technique may shed light on this problem (hypothesis 2). However it can be concluded that there is insufficient vehicle for dating and that it is not a vehicle that is responsible for preservation.

We currently prefer hypothesis 3, that no vehicle was used, and that the finely ground red ochre was applied either as a dry chalk or as a water paste. Watson (1967, p. 7) and Judson (1959) have discussed this opinion, as has Dewdney (1970b, p. 21), who asks "whether in the long term, given the amount of protection typical of the settings of most Shield paintings, there might not be a bonding action between pigment and substrate that would be inhibited by the microscopic film of a binding agent". The reason modern paints fail on such sites is precisely because the vehicle deteriorates. If the pigment alone were able to cling to the rock surface long enough for mineral deposition to begin it would become, essentially, part of that surface. There is considerable evidence that these deposits protect the rock art, at least up to a point where their increasing thickness can become detrimental (Taylor *et al.*, 1974; Watson & Dolanski, 1976, p. 7; Butzer *et al.*, 1979, p. 1212, note 9).

None of the three recent dating techniques reviewed by Weisbrod (1978) (instrumental neutron activation analysis of desert varnish; amino-acid racemization; radiocarbon-dating with electrostatic accelerators used as mass spectrometers) would appear useful for rock art in Canada.

There cannot be much hope that lichenometry will have broad application in dating pictographs, either (Taylor *et al.*, 1979, pp. 303-305). Lichenometry depends on constructing a curve relating lichen size to age. Given that such a curve could be derived, one could determine a *terminus a quo* for a pictograph by measuring the size of a lichen thallus grawing on it. The technique, developed by Beschel (1961), has been applied primarily to geomorphological problems. Portions of a lichen growth curve have been established by measuring lichens graowing on substrates of historical interest (Benedict, 1967, 1968; Denton & Karlén, 1973), and Follmann (1961) has applied lichenometry to dating Easter Island megaliths.

The very serious drawbacks to the application of lichenometry to rock art may be summarized as follows. 1) A considerable time may have elapsed between the execution of the pictographs and the *terminus a quo*, the time the individual lichen started its growth. 2) Many shoreline pictographs, painted below a high-water line, are submerged during years of high water, thus killing any lichen (Dewdney, 1970b, p. 24). 3) Lichen growth curves are not linear. "There is still a great temptation to extrapolate the age of a thallus from the diameter and an approximation of the rate of growth. This can be a foolhardy operation since rate of growth varies throughout the life history of a thallus and a senescent period with little or no growth can last an indeterminate length of time" (Hale, 1973, p. 489). 4) Direct measurement of thallus size increments, particularly over the considerable time lapse required due to the slow growth rate, is subject to large experimental error; 5) Local microclimatic variables, as enumerated by Benedict (1967), preclude the application of a growth curve determined in one region to a pictograph in another. 6) The wide distribution of pictographs and the infrequency of finding suitable thalli growing directly on them make the compilation of statistically reliable data extremely problematic. 7) During the period required for the study of thallus size increments, the lichen will continue to cause irreparable damage to the pictograph.

The rates of weathering processes may be applicable to the dating of rock art. Bard *et al.* (1978) have met with preliminary success in correlating the trace elemental concentration of desert varnish deposition with the relative age of petroglyphs in Nevada. But most authors are understandably cautious, in view of the multiplicity of variables affecting weathering at the microscopic level (Soleilhavoup, 1980, p. 538) and the cyclic nature of certain weathering processes (Bednarik, 1979, p. 29). In Australia silcrete skins seldom reach a thickness greater than 0.3 mm (Walston & Dolanski, 1972). Nevertheless, silcrete thickness on dated surfaces such as railroad cuttings might have application to chronology (Dolanski, 1978).

There are severe constraints on the size of samples that can be removed from a pictograph. Cross-sections cut from such samples always show great variation in the thickness of the deposit layers; a variation of at least one order of magnitude over a surface distance of 1 mm is not uncommon, due to the random pattern of seepage over the rock and the deposit coagulating as discrete rivulets. Not does the rhythmic banding exhibit a simple (i.e. seasonal) relationship. In a thick deposit layer on a Similkameen Valley pictograph a rhytmic variation in silicon and calcium concentrations was observed across the section, but the number of cycles was not a function of seasonal variation in, for example, rainfall; it indicated instead a complex process of deposit formation. Rhythmic lamination may be accompanied by

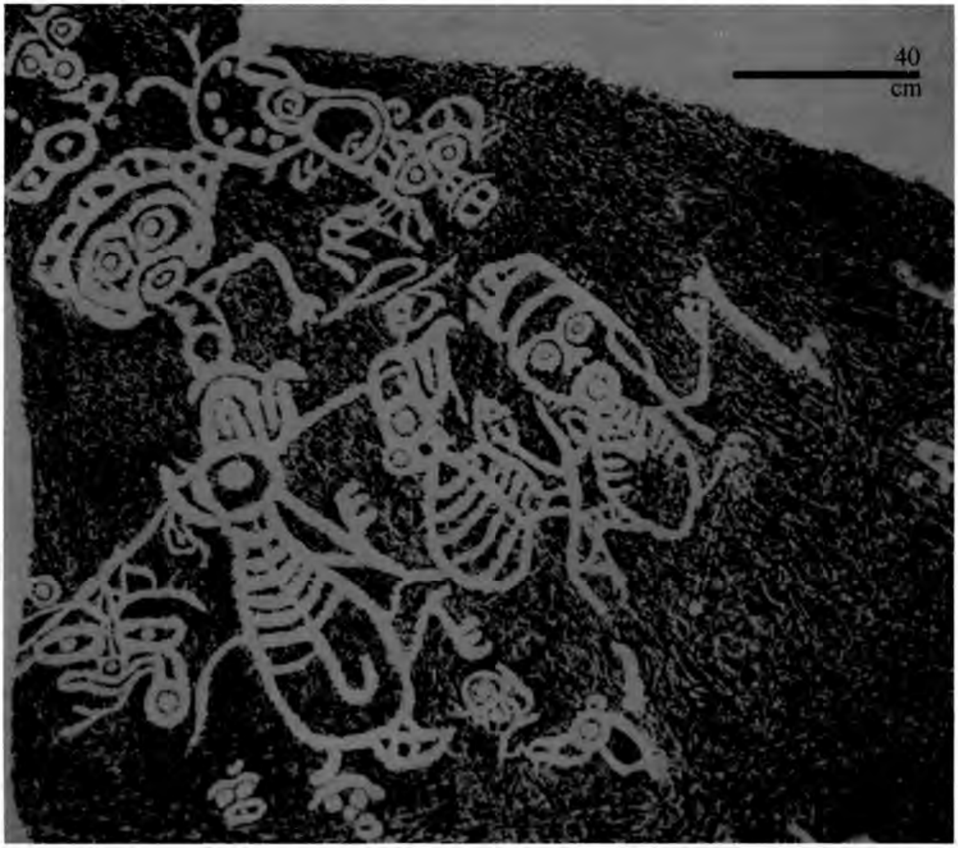

Fig. 11
Rubbing of a petroglyphs panel from Site GdTc-6, Ringbolt Island, Kitselas Canyon, Skeena River, British Columbia (courtesy of Doris Lundy, British Columbia Provincial Museum).

an apparent migration of the pigment layer and its dissociation into two or three layers (Wainwright 1978). The phenomenon, named the *Mazinaw effect* after a pictograph site at which it was observed, may be analogous the the formation of Liesegang rings in colloids (see, e.g., Augustithis & Ottmann, 1966). There are three implications for dating: the evolution and thicknesses of surface deposits are not simple linear functions of age; the wide variation in deposit thickness rules it out as an absolute dating tool; if ion exchange continues between laminae at all depths, radiocarbon dating of calcite deposits (Weisbrod, 1978) may not be possible.

The use of surface deposition, however, is a straightforward technique for establishing sequence in superimposed pictographs. At the Cuttle Lake Large Site (DfKg-2), near Rainy Lake in the Candian Shield, there are two sets of overlapping figures; one set is wine-red, the other orange-red (Rajnovich, 1980). A cross-section from an area of overlapping clearly reveals the sequence: rock substrate, deposit layer, wine-red pigment layer, intervening deposit layer, orange-red pigment layer, subsequent deposit. Preparing the sections is a simple, widely used technique for laboratories accustomed to preparing thin rock sections, requiring additional care only because the samples are small.

The Deterioration and Conservation of Rock Art

Rock art conservation and rock art site management are the subjects of a growing body of literature, including the proceedings of two international symposia held in the 1970s: *Conservation in Archaeology and the Applied Arts*, published by the International Institute for Conservation of Historic and Artistic Works for its Joint International Conference held in Stockholm in June 1975; and *Conservation of Rock Art*, the proceedings of the International Workshop on the Conservation of Rock Art held in Perth and the Pilbarra region of Australia in September 1977, published by the Institute for the Conservation of Cultural Material (Pearson, 1978).

Important work has been done in Australia (Clarke, 1975; Boustead, 1970; Sullivan, 1979), Asia (De Silva, 1975), Africa (Hoffmann, 1971; Avery, 1975; Smits, 1975), Europe (Anati, 1977; Brunet & Vidal, 1980; Lefèvre, 1974) and North America (Ritter, 1978; Pohorecky, 1979; Taylor *et al.*, 1979; Taylor *et al.*, 1975; Taylor, 1978).

A recent *Canadian Rock Art Research Associates Newsletter* discussed rock art site management in the provinces most concerned: British Columbia (Simonsen, 1980), Alberta (Brink, 1980), Saskatchewan (Dyck & Spurling, 1980), Manitoba (Pettipas, 1980), Ontario, Québec and Nova Scotia (Wamboldt, 1980).

Successful rock art conservation programmes have usually been co-operative, involving provincial archaeologists and ministries responsible for cultural resiurce management, Indian Bands and other concerned parties including CRARA associates, universities, museums and private industry. Besides natural weathering the recurring issues are vandalism and its prevention, the need for site inventories particularly as they relate to development, and the need for accurate records.

Fencing has reduced or eliminated vandalism of the Tie Creek petroform site in Whiteshell Provincial Park, Manitoba, and of the Peterborough Petroglyphs (until 1983 surrounded by two chain-link and barbed-wire fence enclosures). Many other sites have been damaged irreparably. Fencing methods and electronic surveillance with seismic sensors to detect vandalism are described by Ritter (1978).

Major concentrations lie within provincial parks (e.g. Sproat Lake, Writing-On-Stone, Whiteshell, quetico, Lake Superior, Petroglyphs, Bon Echo) and Kejimkujik National Park, where restricted access and the presence of guides and otehr park staff reduce vandalism. Educational programmes and interpretive exhibits at some sites increase public awareness and sensitivity to the fragility of rock art. Another stragegy has been to reduce the amount of information available about some sites, while advertising and developing a few main sites whose preservation can be ensured through surveillance, natural protection or enclosures. Legislation protects rock art and other archaeological sites, as well as providing permits for field research.

Accurate and comprehensive site inventories are of fundamental value in the study of rock art *per se*, its stylistic distribution in time and place, and its relationship to waterways, trails and trade routes, and to other archaeological features. They also enable the pinpointing of sites which may be affected by development. For example a new road near the Bloodvein and Rice Rivers, east of Lake Winnipeg, could have harmed pictographs had the planners not been alerted to their existence. Similarly, timber harvesting in Whiteshell Provincial Park is monitored for its impact on the petroforms there (Pettipas, 1980). Sites threatened by hydroelectric development and flooding can be located, and either removed to safety or at least fully recorded. Knowledge of the distribution of petroglyphs in the intertidal zone along British Columbia coast has alerted us to the potential harm of oil tanker spills.

Rock art site inventorying is ideally suited to electronic data processing. In Canada, rock art sites are included in the National Inventory of Prehistoric Sites (NIPS), which is managed by the Canadian Heritage Information Network of the National Museums of Canada. A comprehensive, accurate, computerized inventory of all rock art sites filed by Borden designation is a realistic, but as yet unachieved, goal.

Few methods can prevent the natural weathering of rock art sites. Water is the one agent which, above all others, is responsible for the deterioration of rock art. It is ultimately necessary for almost all forms of weathering to proceed (see for example Carrol, 1970; Ollier, 1969; Winkler, 1973; Hudec, 1978; Keller, 1978); if water could be eliminated from rock art sites their deterioration would be considerably reduced. In general, this is an impossible goal, for the typical Canadian site is entirely exposed to the elements. Sites in the Canadian Shield are usually on rock walls very close to water or indeed rising straight out of the water. Agawa Rock, one of our better-known sites situated on Lake Superior, bears the brunt of violent gales. In winter parts of the site are sheathed in ice. Clearly, there is no viable way of mitigating the influence of water here.

In more moderate climates the action of water may be more subtle. The expansion and contraction of montmorillonite with relative humidity fluctuation has been implicated in the deterioration of rock art at Altamira

(Valle *et al.*, 1979). The complex interrelationship of relative humidity, carbon dioxide and other factors in the growth of microorganisms at Lascaux and other Palaeolithic sites has been well documented (Lefèvre, 1974; Brunet & Vidal, 1980). Lambert (1980) postulates that crystallization and hydration pressure of soluble salts are major factors in the deterioration of petroglyphs in sandstone shelters of New South Wales, Australia.

Our research has been primarily concerned with three broad categories of natural weathering: *superficial accretion, frost weathering* and *biological weathering.* These predominant forms of deterioration reflect on our climate, on the materials and choice of substrate of the prehistoric artist, and on the relative stability of most of these substances. The rock art of Canada is comparatively recent, and large-scale geomorphological processes are less of an issue than elsewhere. Furthermore, art in anything even resembling a shelter or cave is rare.

Increasingly acidic precipitation, caused by emissions of oxides of sulphur and nitrogen, also has its effect. The pH of pre-industrial rain is estimated at 5.6, with natural carbon dioxide the only contributing solute. In some rock art areas much lower pH values are now obtained. The Peterborough Petroglyphs, for example, have experienced rain with a pH as low as 3.8. Despite concern that solution weathering of the marble surface may have been accelerated, atomic absorption spectrophotometric analysis indicates, rather suprisingly, that at present pH levels the dissolution capacity is not significantly increased. The accumulation of pollutants in the snow, which covers the site during the winter months, must also be a source of added acidity. The trend in the pH of precipitation in Canada is downwards, and it may eventually fall below a pH of 3.5, the level from which the dissolution of marble increases exponentially.

The formation of superficial accretions has been discussed. Several authors refer to the dual nature of these deposits. In the initial stages of formation they protect the pigment layer by bonding it to the substrate and forming a natural protective coating against erosion.They may be quite invisible to the unaided eye. The groundwater from which they precipitate may originate from quite high above the rock wall, eventually emerging from cracks, fissures and ledges in a random pattern. As their thickness grows they can obscure the pictograph completely. In this latter stage microscopic cracks in the accretion may cause it gradually to fall away, taking pigment with it.

More serious deterioration, caused by frost weathering, can take the form of exfoliation. The process probably begins with fissures parallel to the rock surface caused by thermal expansion and contraction. Water is then able to penetrate and, with subsequent freezing, exerts great pressure which propagates the cracking. The delamination of the rock must proceed most rapidly during the late fall and early spring when diurnal temperature fluctuations are most extreme. A classic case of destruction by exfoliation, discovered by Tim Jones and Selwyn Dewdney (Dewdney, 1970, p. 45), also illustrates that different substrates, even ones very close together and subject to similar influences, may react quite differently. A control dam built at the outlet of Horwood Lake in northeastern Ontario in the 1930s raises its water level by a maximum 6 m and submerges two rock art sites on Hardiman Bay. The dam is gradually lowered each winter, returning the lake to its original level by early April. A comparison of photographs taken in 1922 and 1974 shows the virtually complete destruction of one of the sites. However, the other site, only 8 m away, was found to be well preserved, apparently unaffected by the yearly cycle of wetting and drying, freezing and thawing.

The important role of biological agents in rock art deterioration is well known in the cases of Lascaux, Altamira and other caves closed to the public after the growth of micro-organisms (Levèvre, 1974; Somavilla *et al.*, 1978; Brunet & Vidal, 1980). After vandalism, biological growths frequently constitute the most obvious forms of disfiguration. Not only do they actively dissolve and penetrate rock and obscure or hide pictographs and petroglyphs, they also act as catalysts for other weathering processes by retaining water and disintegrating the substrate.

Lichens are a particulary tenacious growth at almost every rock art site. Brodo (1973) and Syers & Iskandar (1973) review the mechanisms of rock deterioration by lichens; Jones *et al.* (1981) used scanning elctron microscopy and electron beam x-ray microanalysis to reveal evidence of lichen weathering. We have observed a considerable reduction in pigment intensity and a tendency for a red stain to develop below pictographs in areas affected by lichens. Rock from which lichens have been removed exhibits pitting caused by rhizine penetration. In some instances, attempts at removing lichens from pictographs using rather primitive mechanical means has caused even further damage.

Algae can be equally pernicious in their effect on rock art, as the Peterborough Petroglyphs show. Over half of the site is covered with a black accretion which has grown worse in recent years. More alarming was the presence of living algae at a considerable depth in the marble. We found at least five species of green and blue-green algae to be present (*phormidium* sp., *chroococcus* sp., *chlorococcum* sp., *lyngbya* sp., and *gloeocapsa* sp.). These vary in their ecology, some preferring the rock surface, others the interior. A scanning electron microscopical examination revealed pitting of calcite grains and infiltration along grain boundaries.

The frustrations encountered in dealing with vandalism and the relentlessness of natural weathering cannot but leave one with a feeling of pessimism for the survival of rock art in the very long term. However, there have been a number of areas in which significant progress has been made in site management and in the conservation and restoration of rock art.

Coating rock art with a synthetic high polymer seems to have little chance of success. Actually sealing the surface with a relatively impermeable barrier would accelerate deterioration by prohibiting the exchange of moisture between substrate and atmosphere. Surface consolidation may result in discontinuities in physical and chemical properties between layers in the material; impregnated and unimpregnated layers of rock having different coefficients of thermal expansion could result in damage during temperature fluctuation. The effect of a consolidant on the appearance of the rock art must be considered, as must its photooxidative degradation. These drawbacks have led to a critical reassessment of treatments for building stone in recent years, and it is wise to approach new developments with great caution. All treatments must be carefully studied in the context of the particular rock to be treated, the polymer to be used, and the method of application. One promising method may be the use of perfluoropolyther water-repellants (Frediani *et al.*, 1981), which are reported to be stable, colourless, transparent and permeable to water vapors. Poly(methyl methacrylate) is being considered for use at a pictograph site on sandstone in Arizona which is threatened by inundation (Turner *et al.*, 1979). Artifically promoting the consolidation of sandstone with silica-rich solutions has been suggested (Walston & Dolanski, 1976, p. 16).

The diversion of water away from rock art can often be simply accomplished by gutters, drip flashings and the like (Walston & Dolanski, 1970), but their impact on the general setting and appearance of the sites must be carefully considered. At the Peterborough Petroglyphs we have recommended that a building be constructed over the entire marble outcrop (approximately 22 x 14 m), and this project was completed in August 1984 by the Ontario Ministry of Natural Resources. At this site a building, in spite of its impact on the natural setting, is the only long-term method of arresting frost weathering and algae accretion and of controlling vandalism.

Some conservation procedures can be quite dramatic. The Kitselas Indian Band and citizens of Terrace, British Columbia, were concerned that the Ringbolt Island petroglyphs (GdTc-6) on a rock slab weighing over 4 metric tonnes would slip into Kitselas Canyon of the Skeena River. A Sikorsky 61, owned by Okanagan Helicopters Ltd., was able to lift the rock with

Fig. 12
The Peterborough Petroglyphs, Site BdGm-10, Petroglyphs Provincial Park, near Stony Lake, approximately 56 km northeast of Peterborough, Ontario. Several glyphs have been crayonned for visibility.

slings to a safe position about 90 m away. At another site in British Columbia, the Cranbrook Petroglyphs (DiPw-1), severe exfoliation compounded by vandalism persuaded the provincial Heritage Conservation Branch and the British Columbia Provincial Museum to bury the site under 15 cm of sand and, next, 1 m of earth seeded with grass. Prior to burial the petroglyphs were accurately recorded by contour maps, drawings, photographs and latex moulding. This approach may appear *prima facie* drastic, but it is based on sound principles of conservation (Kennedy & Cassidy, 1981; Cornford & Cassidy, 1980).

Another site, Wesakechak's Footprints in northern Manitoba (GkLr-1), was cut from bedrock to rescue it from flooding. Prior to salvage it was replicated, and the casts were incorporated into a display at the Manitoba Museum of Man and Nature. In general, however, removal of rock art is an extreme measure. Rock art is uniquely linked to its immediate natural surroundings; to separate the two is to lose this relationship.

Reattachment of loose and fragmented rock caused by frost damage has been successful with a filled polyester resin at the Peterborough Petroglyphs. At another site, Deer Corral, (DiRa-7) in the Similkameen Valley (Corner, 1968, p. 59), a large slab of rock on which the pictographs were executed had separated from the rock behind, creating a large gap. Staff of the British Columbia Provincial Museum grouted the fissure with a mixture of mortar and acrylic resin after sealing the interior surfaces with acrylic resin (Kennedy, 1979).

Virtually nothing can be done about the worst form of vandalism, the scraping away of rock, except possibly to remove the affected area with sandblasting. Defaced Arizona petroglyphs in desert varnish have been restored by artificially precipitating oxides and hydroxides of manganese and iron (Elvidge & Moore, 1980). The other common form of vandalism is the use of paint, often from spray cans. Methylene-chloride-based paint-strippers are effective, if applied with a brush and allowed to stand for about 20 minutes before rinsing off with copious amounts of water and further brushing. These strippers will also work on paint recently applied directly on top of pictographs without harming them; since they work by swelling the vehicle of the paint, they have no effect on pictographs which have no residual vehicle. In addition the covering deposit layer protects the pictograph from any damage incurred while brushing. It is nevertheless of the *utmost importance* that the method be tested on a small area of the pictograph to determine its effectiveness and safety. The method, used successfully in the Similkameen Valley (Kennedy, 1970) and at Mazinaw Lake (BfGh-5), will present difficulty with more porous rock. (It is interesting to note that the figure of the great lynx Mishipizhiw at Agawa Rock was overpainted with two initials in 1937 (Dewdney, 1970, p. 71, plate 15). Only those parts not actually on the lynx's body were cleaned off, but with time the vandal's paint on the lynx itself has almost completely disappeared).

Biological encroachment of rock art sites presents a wide range of problems of varying difficulty. Some growths yield to a cleaning with water using wire or bristle brushes, providing the substrate is capable of withstanding abrasion. At the petroglyphs (DhSf-1) in Sproat Lake Provincial Park, moulding with silicone rubber of the glyphs was found to remove dirt, moss and lichen effectively (Kennedy & Lundy, 1972).

Effective biocides for lichens, algae, moss and other microorganism have been extensively investigated in connection with historic buildings and monuments as well as in the case of rock art (e.g. Richardson, 1976; Clarke, 1972b; Dupuy *et al.*, 1976; Lefèvre, 1974; Brunet & Vidal, 1980; Somavilla *et al.*, 1978). A solution of ortho-phenylphenol in dehydrated ethanol is an effective biocide for both crustose and foliose lichens growing on granite/gneiss. We have not tested the solution on rock art, but at an historical engraing within the BfGh-5 pictograph complex on Mazinaw Lake (a memorial to the American poet Walt Whitman) it worked well on the 12 species of lichen encountered. The rock face, area approximately 50 sq. m, was sprayed in mid-June and late July 1980. In late July 1981, when it was scrubbed using stiff bristle brushes, removal of all but a few crustose species was relatively straightforward. Protective clothing, rubber gloves, goggles, and face masks with organic vapour cartridges were used during spraying.

To kill the algae at the Peterborough Petroglyphs and to prevent their recurrence we are testing a number of algicides. In addition, we are seeking to control moisture and humidity and to remove the black algae accretion. Algicides under study include chelates of copper citrate and copper gluconate, quaternary ammonium compounds and combinations of substituted phenyl ureas and triazine derivatives. The building over the petroglyphs will abate algal growth by eliminating rainfall, the primary source of moisture. The enclosure was designed and its environment will be carefully monitored to ensure that temperature, relative humidity and surface moisture are not conducive to algal growth.

The removal of the black accretion is important, not only for the appearance of the petroglyphs, but also to eliminate a nutritive source for further algal growth. Unfortunately, the washing techniques we have tried impart an unsightly brown stain to the white marble. A Neodymium YAG laser using a mixture of near infrared radiation and green light is known to be an extremely effective and safe method of cleaning the marble, but has great practical limitations, notably the small area irradiated. High-intensity flash lamps may offer a more feasible alternative.

Rock Art Recording

Given the fate that can be predicted for much of our rock art, as a result of natural weathering and deterioration caused by man, its recording must be our highest priority. In addition to fulfilling the primary requirements of scholarship and communication, recording produces a durable image for posterity which will in many instances outlast the rock art. Thus, in addition to developing accurate means of recording, we must consider the longevity of the records themselves.

The American Committee to Advance the Study of Petroglyphs and Pictographs has recently published minimum recording standards for pictographs and petroglyphs. We particularly endorse their statement that " ... methods requiring surface pressure, application or insertion ... tracing, rubbing, molding or grid anchoring, cannot be universally condoned and should not be attempted on friable surface markings" (Swartz, 1981, p. 118). The damage that has been caused to rock art through improper recording methods is inexcusable.

For many rock art sites in Canada, methods requiring contact, rubbing of petroglyphs and tracing of pictographs, can be accomplished safely. Dewdney used rice paper applied to pictographs with a wet sponge roller to render it transparent. The tracings, made with Conté chalk, give a durable record and could be done quickly under often adverse field conditions. Rubbings are typically done using unbleached cotton or muslin and cobblers' wax. Other researchers have used felt-tipped pens on synthetic transparent materials such as poly(ethylene) and poly(vinylidene chloride) and phthalate plasticized poly(vinyl chloride). Since some felt-tipped pens are notoriously fugitive and many plastic films may degrade rapidly, these preliminary tracings must be re-traced onto an archival quality transparent paper (as is done at the Centro Camuno di Studi Preistorici, for example; see Anati, 1977). Silicone rubber is a far safer material for moulding than latex rubber because it does not flow as readily into the microscopic pores and fissures of the rock; nor is it as strong as latex, and the risk of damage when the mould is taken up is minimized. In general, however, moulding is *not to be recommended* as a rock art recording technique except for salvage purposes.

Each of the above techniques has drawbacks. None record the subtle nauces of substrate colours, patination and shading which form an integral part of rock art. Tracings and rubbings inevitably introduce an element of subjectivity which is a function as much of the recorder as of the pictograph or petroglyph being recorded. Tracing cannot produce an accurate orthogonal projection onto a plane, especially on undulating or concave surfaces. The three-dimensional aspect of rock art is lost in tracings and rubbings. No single recording methodology can be regarded in isolation; they must be used to complement each other. We have investigated several techniques with particular application in Canada: contrast enhancement of red ochre petroglyphs; conventional colour photography and stereophotography; raking light electronic flash photography of petroglyphs; and stereophotogrammetry (5). Our results will appear in a monograph to be published by the Canadian Conservation Institute (see also Anati, 1977; Clewlow & Wheeling, 1978; Stuart, 1978).

Following previous photographic work using the ultraviolet (Clark, 1954; Holliday, 1961; Webster, 1966) and infrared (Pederson, 1953) portions of the spectrum, these techniques were tested in the Canadian Shield for enhancing the contrast of red ochre pictographs against their substrate. None were successful. Infrared modified colour ("false colour") photography was found to accentuate the mineral accretion on the sites studied. Kodak Technical Pan Film 2415 with a Wratten 47 B Deep Blue Tricolor filter used in colour separation (Eastman Kodak Company, Rochester, NY 14650, U.S.A.) was found to be most effective for image enhancement. Wratten 38 A, which has greater transmittance, may also be used.

For colour photographs it is essential to measure the colour temperature of the ambient illumination and then to employ light-balancing filters to convert the prevailing temperature to the colour temperature rating of the film used. Direct and tangential sunlight on the pictograph must be avoided

Figg. 13-14
Pictograph Face, Irving Island, Lac la Croix, Quetico Provincial Park, Ontario, general view and detail.

in favour of diffuse light. Shade or a slightly overcast sky works best but gives too high a colour temperature; a bluish cast results which must be corrected. We include a scale of appropriate length (10 or 20 cm) incorporating a Kodak Separation Guide and Gray Scale.

We have used 35 mm, 120 mm and 9 x 12 cm cameras. The larger formats are cumbersome and are prone to vibrate in wind. The best stability has been achieved by photography from the ice in winter. Working from the ledge at Agawa Rock, Eberhard Otto (Dewdney, 1970a) obtained superb colour fidelity and saturation using artificial illumination and cross-polarization (polarizing filters on the light sources and in front of the camera lens to eliminate scattered light). Working from a canoe at "wet" sites in the Canadian Shield can make sharp photographs very difficult to obtain.

The more universally applicable instrument is the 35 mm single-lens-reflex (SRL) camera. The simplicity of its use and remoteness of most of our sites make it the obvious choice. With all formats it is a simple matter to obtain stereoscopic pairs, which are invaluable in interpreting the site.

Raking light photography at night has been successfully employed at the Ringbolt Island petroglyphs (Walker *et al.*, 1979), and we have undertaken similar experiments at the Peterborough Petroglyphs using electronic flash. Glyphs which are virtually invisible in daylight become sharply defined in a dramatic fashion at night. A pilot lamp establishes an appropriate angle for revealing the relief. The film, either 35 mm or 9 x 12 cm, is exposed by flash. An extraordinary amount of detail was obtained on the 9 x 12 cm negatives, and stereo pairs provide a threedimensional image in which individual calcite grains in the marble are resolved.

Stereophotogrammetric recording of rock art has been used in several countries (Atkinson, 1968; Clouten, 1976, 1977; Rivett, 1978, 1979; Scogings, 1971, 1978; Turpin *et al.*, 1979; Lahanier, 1981), and experiments are under way in Canada to document petroforms, pictographs and petroglyphs using this method. Photogrammetry has several advantages. The resolution of the glass plates used is high, and dimensional stability is superior. The camera lenses and construction reduce image distortion. The archival quality of correctly processed plates makes them ideal for long-term preservation. Accurate contour drawings showing the interrelationship of glyphs and their accurate distribution even on undulating or concave surfaces can be constructed.

The most severe problems in archival storage of rock art records lie in the long-term preservation of photographs, particularly colour film (Giles & Haslam, 1974; Scott, 1975; Short, 1980). We are currently studying two accepted methods of processing colour materials: low humidity freezing and colour separation. Any rock art recording scheme must seriously take into consideration the longevity of the various colour film available and should include provision for archival quality black and white photographs and tracings.

Conclusion

It is impossible to foresee a very happy future for much of the world's rock art heritage, unless the very serious problems of theft and vandalism can be redressed. Even when no malice is intended, rock art sites are frequently

Fig. 15
Pictograph Face at Site DbKm-3, Picture Rock Island, Face II, Whitefish Bay, Lake of the Woods.

endangered by an increasingly heavy burden of tourism, by development in its many forms and, all too often, by improper methods of recording by the archaeological community itself.

On the other hand, the success of rock art research and conservation has never been a question simply of allocating funds from government revenues. Rather, it has depended on the enthusiasm, the interest, the expertise and the dedication of individuals. Without their contributions the study of rock art would not have advanced as rapidly as it has in recent years. Without their concern, government agencies would not have responded as they have to the pressing need for conservation measures.

NOTES: (1) For information on CRARA and its publications the reader should write to Mr. Tim Jones, Communications Associate, Canadian Rock Art Research Associate, Box 101, Dalmeny, Saskatchewan, SOK 1EO, Canada.

(2) The research outlined in this paper represents the combined work of many individuals. I am particularly indebted to my colleagues in the Analytical Research Services laboratory of the Canadian Conservation Institute for their contribution. The Appendix resulted from a fruitful exchange of ideas with François Soleilhavoup of Epinay-sur-Seine, France. My barely legible handwriting was transformed into a legible manuscript through the patient effort of Lilian Miller.

(3) At the Valcamonica seminar in 1981, Dr. Fidelis Masao reported that the Borden System is also used in Tanzania.

(4) The preferred term for the film-forming and binding material of paint also referred to as medium, binding medium or binder.

(5) Stereophotogrammetry has been undertaken by the Heritage Recording Services Section, Restoration Services Division, Engineering and Architecture Branch, Parks Canada, Environment Canada.

APPENDIX: Rock Art Deterioration: An Approach To Its Study
(after Dewdney, 1980; Ollier, 1969; Soleilhavoup, 1981)

I General regional data (refers to an aggregate of proximate sites, sub-sites, faces, shelters, caves, etc.)
  A Geographical, Climatological and Meteorological Data
    1 site designation, map co-ordinates, toponymy, aerial photographs, etc.
    2 Borden designation, Archaeological Survey of Canada Site Record Form
    3 topography
    4 precipitation, relative humidity, dew point temperature
    5 temperature, frost
    6 duration and intensity of sunshine, insolation, albedo
    7 wind speed and direction frequency
    8 hydrography and hydrology (pattern of surface water, runoff, etc.)
  B Geological Data
    1 structural geology (geotectonics, geodynamics, geomechanics)
    2 geomorphological and physiographical description (structural and climatic geomorphology, folding, faulting, evolution of landforms, soil formation, etc.)
    3 tectonics and seismicity (seismological disturbances, earthquake probability)
  C Ecological, Archaeological and Historical Data
    1 paleoclimatological data (derived from geomorphological and pedological evidence)
    2 paleoecology, paleozoology, paleobotany, palynology (Quaternary evolution)
    3 present natural environment (fauna, flora)
    4 definition of prehistoric and protohistoric occupation zones (proximity to water routes, trade routes, human settlement)
    5 proximity to population, agriculture, industry, development, roads, pipelines, transmission lines, dams etc.
    6 synthesis: establishment of the distribution of prehistoric occupation of the region and the relationship between the rock art and industries or economies

II Specific Site Data
  A Characterization of the Artist's Methods and Materials
    1 petroglyphs: characterization of pecking, incision, etc.
    2 pictographs: characterization of pigments, vehicles, colours, etc.

  - 3 superimpositions: relative chronology of figures
  - 4 present-day occupancy or use
  - 5 analysis of possible chronological relationships between the rock art and other material remains
- B Orientation and Natural Protection
  - 1 strike, dip
  - 2 overhang, depth of shelter, etc.
  - 3 relation to adjacent waters, wave-splash, ice formation
- C Characterization of Rock Substrate
  - 1 facies, petrography, mineralogy, texture, granularity, etc.
  - 2 chemical composition and properties
  - 3 physical properties (porosity, permeability, mechanical strength, coefficient of thermal expansion)
- D Characterization of Rock Surface and Weathered Cortex
  - 1 colour, texture, albedo
  - 2 patina, varnish, desert varnish, mineral accretions, mineralization
  - 3 thickness, hardness, coherence, integrity
- E Hydrology of Rock Substrate
  - 1 circulation of meteoric water, seepage
  - 2 water table, soil moisture, groundwater suction, capillarity

III Agents and Processes of Rock Art Deterioration

- A Large-scale alteration and deformation (geomorphological evolution)
  - 1 internal (tectonic) geodynamic processes (cleavage, open joints, sheeting, unloading, regional seismicity, rock falls, landslides, etc.)
  - 2 external (gradational) geodynamic processes (slope evolution, solifluction, creep, bulging, rock falls, landslides, mechanical collapse as a result of undercutting, change in water level, flooding, etc.)
- B Geophysical and Geochemical Weathering Resulting From Crystal Growth and Accretion
  - 1 frost weathering, cracking, exfoliation
  - 2 salt weathering
  - 3 chemical alteration
  - 4 superficial accretion (mineral deposition, silcrete, calcrete, sinter, etc.)
  - 5 efflorescence and subflorescence
- C Other Geophysical Weathering
  - 1 insolation weathering, heat, fire (differential thermal expansion and contraction, thermoclastic disintegration)
  - 2 moisture swelling, slaking, water layer weathering
  - 3 abrasion, wind erosion
- D Geochemical Weathering
  - 1 solution (acidic groundwater, acidic precipitation)
  - 2 oxidation, reduction, carbonation
  - 3 hydration, hydrolysis
- E Biogeophysical and Biogeochemical Weathering
  - 1 microorganisms, bacteria, humus, chelation
  - 2 algae, lichen, moss
  - 3 higher plants (roots)
  - 4 mammals (cattle, sheep, goats, hyrax, etc.)
  - 5 insects (Hymenoptera, Isoptera, digger wasps, etc.)
  - 6 birds (nesting)
- F Deterioration Caused by Man and Man's Presence
  - 1 vandalism (theft, displacement, spray paint, incisions, etc.)
  - 2 pressure of tourism
  - 3 alteration of micro-climate (caves)
  - 4 occupancy (smoke blackening)
  - 5 development (agricultural and industrial development, roads, pipelines, transmission lines, etc.)
  - 6 improper recording methods
  - 7 deterioration caused by archaeologists (improper excavation, etc.)

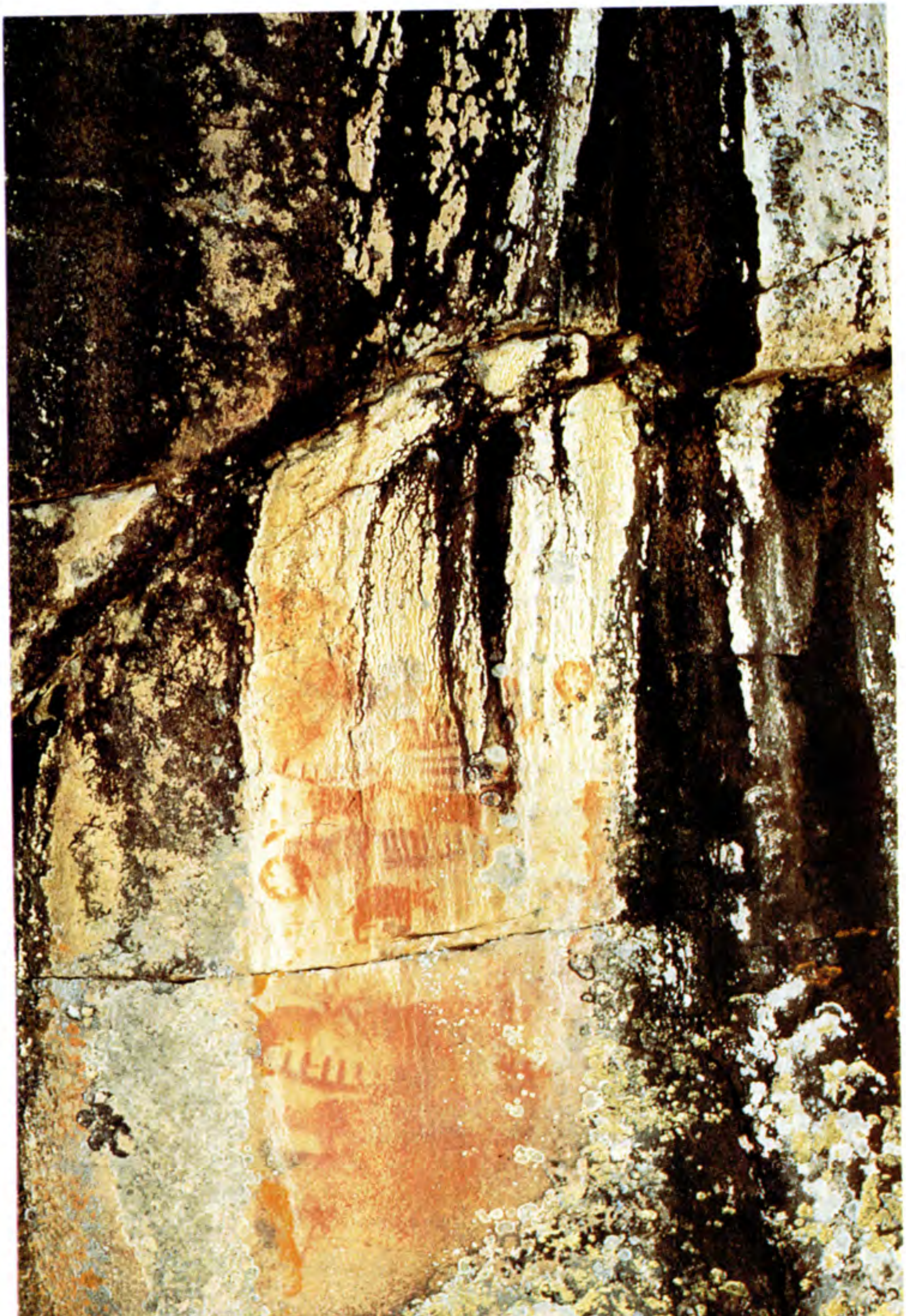

Fig. 16
Middle Panel of the south Face of pictograph Site Dfkg-2 on the west side of channel between Obikoba Lake and Cuttle Lake, near Rainy Lake, Ontario. (See also Rajnovich, 1980).
Fig. 17
Detail of central figures of the same surface showing overlap of orange-red and wine-red morphs.

Résumé: La conservation de l'art rupestre et l'aménagement des sites rupestres préoccupent au plus haut point les spécialistes canadiens. La recherche actuelle en matière de préservation porte sur le effets de l'altération naturelle, qui prend trois formes: concrétions superficielle, altération par le gel et altération biologique. On peut enrayer cette dégradation par diverses procédés en utilisant, par example, des hydrofuges "perfluoropolyth" en détournant l'eau qui menace l'oeuvre d'art rupestre et, dans les cas extrêmes, en enlevant cette oeuvre à son environnement. Le vandalisme, autre sérieux problème poûr les responsable de la protection de l'art rupestre, est en régression au Canada, grâce à la mise en place de clôtures, à la surveillance et à des campagnes de sensibilisation du public. Le relevé de l'art rupestre reçoit une attention prioritaire et s'il y a de nombreuses méthodes de relevé qui conviennent, aucune technique ne devrait être utilisée exclusivement. La photographie et la photogrammétrie ont été utilisées sous plusieurs formes, mais la conservation à long terme de ces relevés pose encore des problèmes.

Resumen: La conservación e administración del arte rupestre es de suma importancia para los especialistas Canadienses. Actualmente, mucha investigación se concentra en la preservación del arte rupestre y los effectos del deterioro natural. La investigación se puede dividir en tres categorías: incrementación superficial, deterioro causado por congelación y el deterioro biológico. Esta clase de deterioro natural puede ser combatido con métodos tales como los repelentes de agua perflouropolyth, la desviación del agua, y en casos extremos, la destitución del arte rupestre de su ambiente. Vandalismo, otro grave problema, se ha reducido en el Canada con nuevos programas de orientación para el público, mas vigilancia y protección. La registración del arte rupestre tiene una alta prioridad y existen varios metodos de relevamiento de los cuales no se debe emplear un número limitado. Fotografías y fotogrammetria se han usado extensamente, pero continuan los problemas de preservación a término largo.

Riassunto: La conservazione dell'arte rupestre e la gestione dei siti rupestri impegnano a fondo gli specialisti canadesi. L'attuale ricerca sulla conservazione, ha sviluppato un particolare interesse per comprendere le conseguenze delle alterazioni naturali che si possono classificare come: formazioni di concrezioni, alterazioni dovute al gelo o a cambiamenti termici e alterazioni dovute a fattori biologici.

Si possono ovviare tali degradazioni usando diversi procedimenti, ad esempio utilizzando degli idrofughi e deviando le fonti di umidità che minacciano le pareti decorate; in casi estremi anche modificando il contesto ambientale immediato nel quale s'inserisce l'opera.

Il vandalismo costituisce un problema molto serio per la protezione dell'arte rupestre ed è in Canada, in netta diminuzione, grazie alla protezione di sorveglianti e della recinzione assicurata ai siti e alle campagne di sensibilizzazione del pubblico.

Il rilevamento e la documentazione dell'arte rupestre ricevono in ogni caso un'attenzione prioritaria e vengono utilizzati diversi metodi che si integrano gli uni con gli altri.

La fotografia e la fotogrammetria vengono usate sistematicamente sotto varie forme, ma la conservazione a lungo termine di tale documentazione suscita a sua volta ulteriori problemi.

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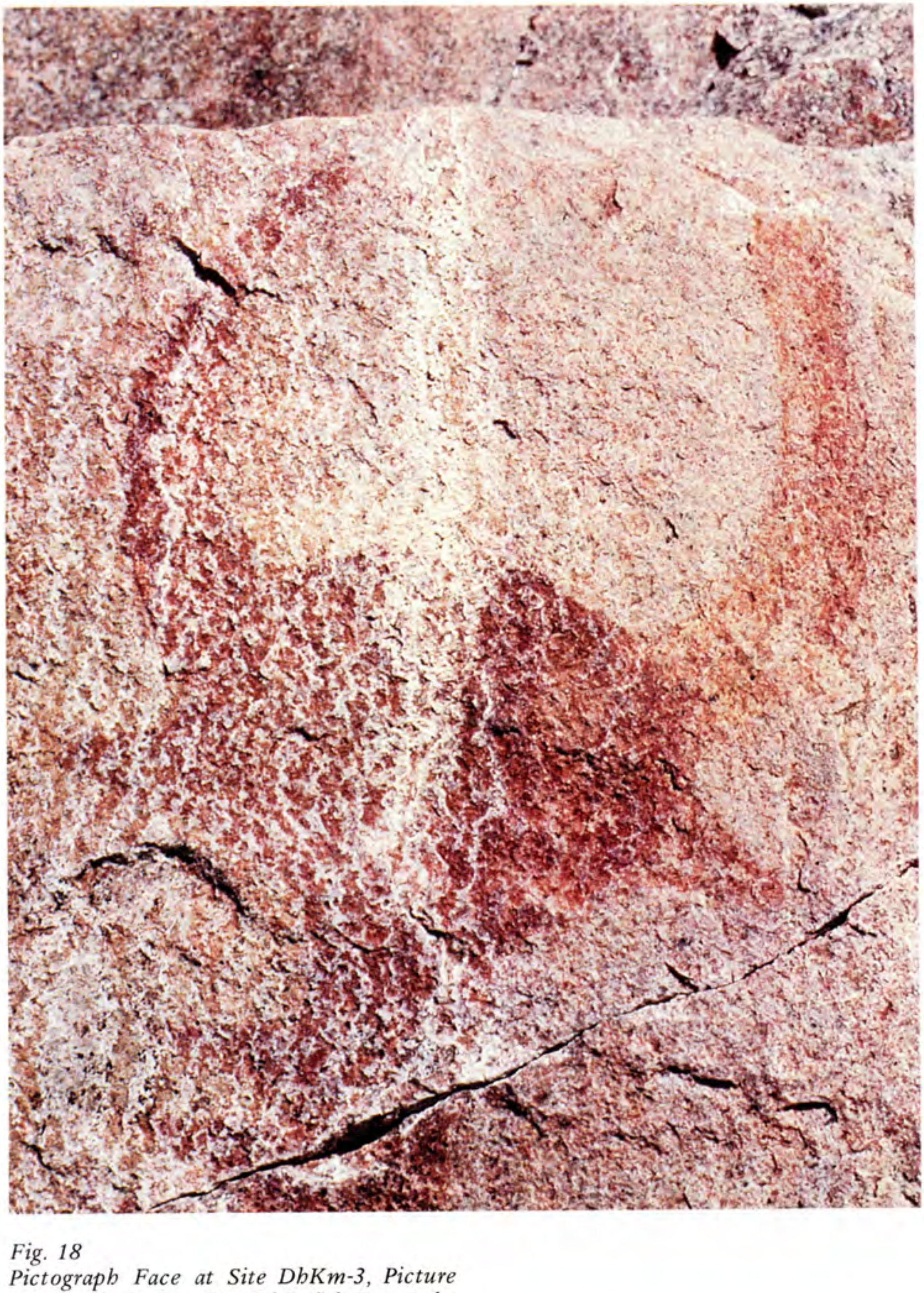

Fig. 18
Pictograph Face at Site DhKm-3, Picture Rock Island, Face III, Whitefish Bay, Lake of the Woods, Ontario.
Fig. 19
120 mm and 9 x 12 cm at pictograph site DfKg-2 (see also Figures 16 and 17). Note the windbreak.
Fig. 20
Detail of Mishipizhiw at Site CiIe-3, Agawa Rock, Lake Superior Provincial Park Ontario.

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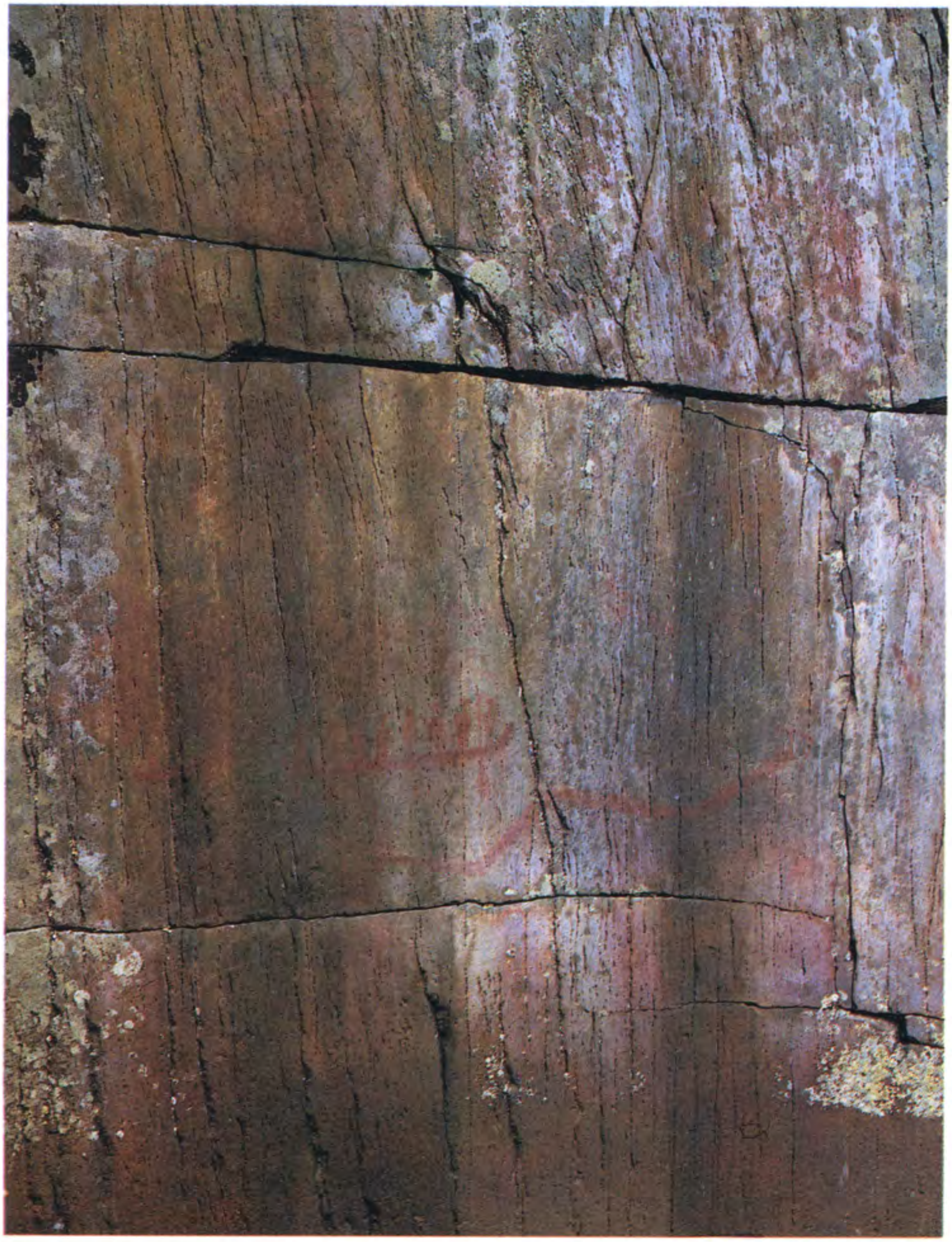

Fig. 21
Pictograph of cow moose with bull calf, Darky Lake, Quetico Provincial Park, Ontario.
Fig. 22
Detail of Pictograph Face at Site DjKl-1, Dryberry Lake, Face I, near Lake of the Woods, Ontario, showing lichen thalli.
Fig. 23
Pictograph Face at Site DbJj-2, Pictured Lake, Ontario.

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