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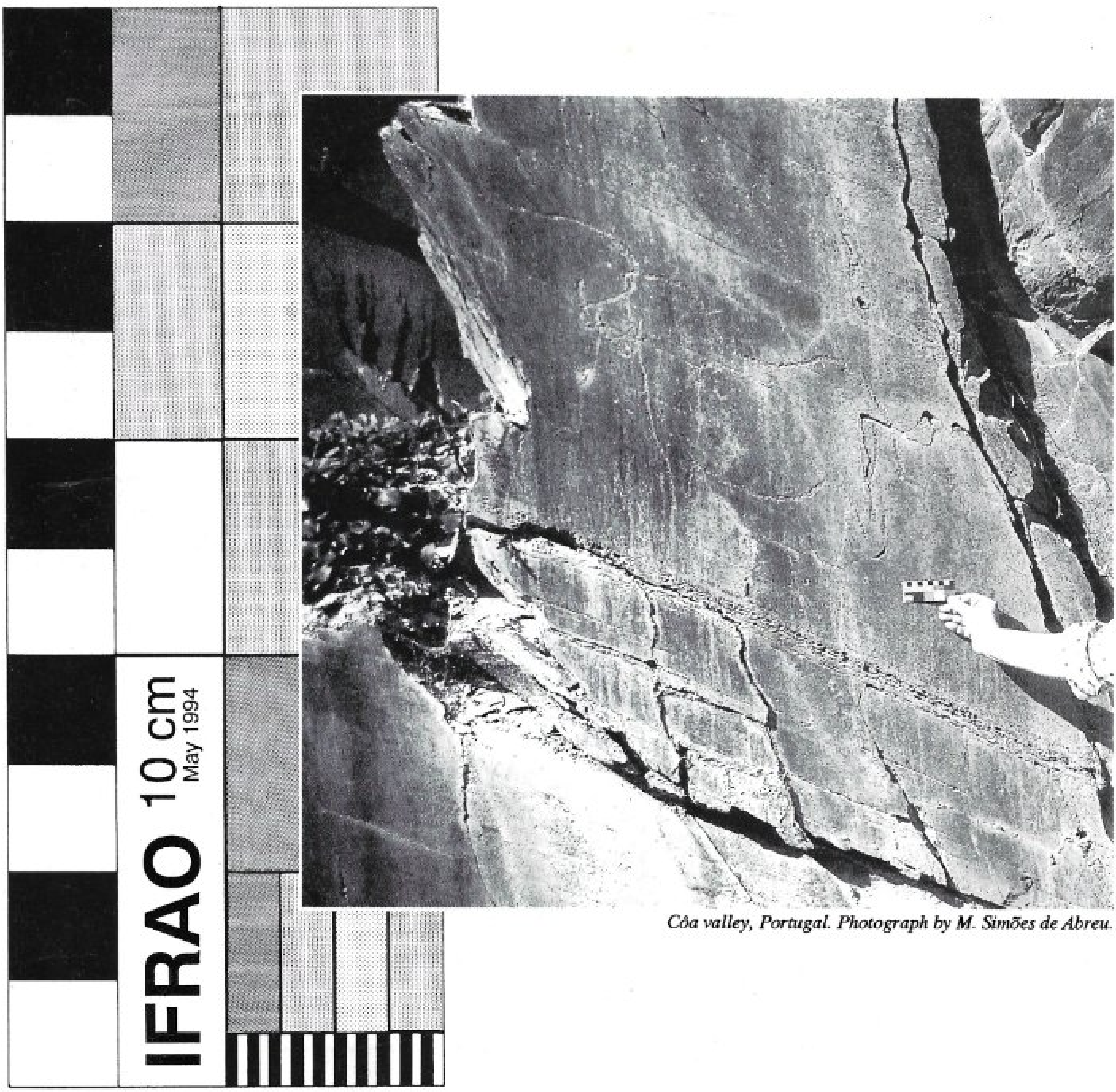

Côa valley, Portugal. Photograph by M. Simões de Abreu.

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The principal objectives of the Australian Rock Art Research Association are to provide a forum for the dissemination of research findings; to promote Aboriginal custodianship of sites externalising traditional Australian culture; to co-ordinate studies concerning the significance, distribution and conservation of rock art, both nationally and with individuals and organisations abroad; and to generally promote awareness and appreciation of Australia's prehistoric cultural heritage.

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The contents of this journal are listed in the *International Current Awareness Services* and in the *International Bibliography of Social Science*. Major papers are abstracted by international abstracting services.

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KEYWORDS: **Perception - Rock art - Psychology - Depiction - Taxonomy**

PERCEPTION - DEPICTION - PERCEPTION, AND COMMUNICATION: A SKELETON KEY TO ROCK ART AND ITS SIGNIFICANCE

J. B. Deręgowski

Abstract. Rock art depictions from a variety of sources are examined and it is argued that the manner of depiction is governed by the manner in which perceptual mechanisms operate. It is further argued that a taxonomy of depictions can be established and that this taxonomy distinguishes quintessentially different kinds of portrayal; eidolic and epitomic, which underlie distinct kinds of symbolic representation.

Introduction

The initial assumption which I shall make is that the eye (and by the eye I mean the human visual system) has remained essentially unchanged since the times before the first known drawings were made. There appears to be no evidence to the contrary. I shall examine the significance of this assumption for the development of the art of picture-making and for cognitive phylogeny.

The eye derives its information about the world by extracting it from the light which objects reflect. Some would indeed argue that this is all that there is to seeing: an object reflects the light, the eye catches it, and the object is therefore seen. An artist who wishes to represent an object has to use his or her skills to create another object, a picture, capable of providing the eye with flux of light resembling as closely as possible that furnished by the model. This description of the artist's task, I shall argue, is only partly true; and the truth is much more interesting than it suggests.

The theory just outlined implies that, given that untransformed and uninterrupted flux reaches the eye from an object, this object, if familiar, will inevitably be recognised, and therefore that no perceptual advantage ensues from the differences in the flux associated with the differences in orientation of the viewed object. The problem can be illustrated by considering the three drawings of a bottle shown in Figure 1. Since each of the drawings represents schematically the flux which would reach the eye placed above, in front of and below a bottle, respectively, the information is, according to the implied postulate, precisely equivalent in all cases. The empirical evidence suggests that it is not. Certain views of a bottle are more bottle-like than others. Indeed, it is possible to construct solids whose different views are so distinct that observers are generally unable to accept perceptually that they are views of the same objects. Thiery's solid is an example of such an object as shown in Figure 2a, as are those solids which are generally unexceptional but which when viewed from certain stances appear to be impossible, such as Reutersvard's triangle, shown in Figure 2b **1**). Thus unimpeded flux emanating from an object is not inevitably unambiguous.

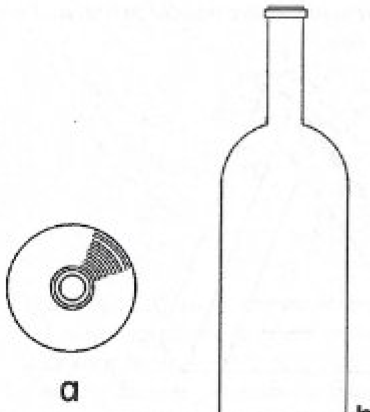


Figure 1. *Three equally legitimate pictures of a bottle as seen from (a) above, (b) the side and (c) below. Of these views only the side view is readily apprehensible.*

1) For discussion of the perceptual concepts used here see any contemporary textbook on perception. Perception of impossible figures is discussed by Gregory (1968, 1970, 1973). For excellent illustrations of a large number of works of art incorporating such figures see Ernst (1986). Some of the issues within the broader spectrum of art are discussed in Deregowski (1984) and Parker and Deregowski (1990). For interesting philosophical and literary interpretations of impossible figures see Cresswell (1983) and Prickett (1972). For a recent and interesting exploration of perceptual aspects of Palaeolithic art see Halverson (1992a, 1992b).

The differential effect resulting from depicting objects from various angles has its parallel in viewing objects from various angles; not all views of an object are equally readily recognisable, just as not all depicted views of an object are. However there is a marked difference, among various angles of view within the same kind of stimuli, in the magnitude of perceptual difficulties. The difficulties of pictorial perception are much greater, as are the differences among pictorial stimuli associated with different angles of view. The reason for this lies in the almost inevitable impoverishment of cues which depiction entails. The concern here is with pictures.

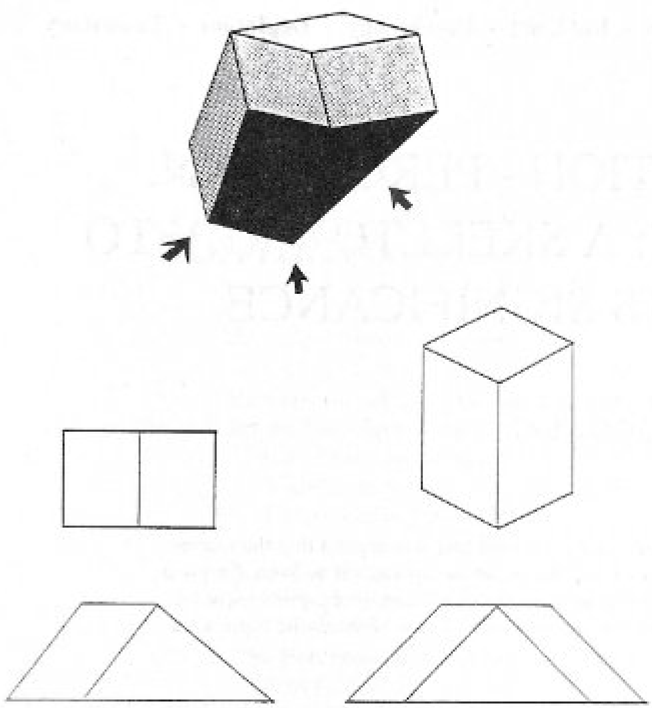


Figure 2a. *A view of Thiery's solid and below, four views from specifically chosen stances. Top row: a view along the left arrow and the view obtained by keeping the eye in the same vertical plane but looking down on the solid. Bottom row: a view along the middle arrow and a view along the right arrow.*

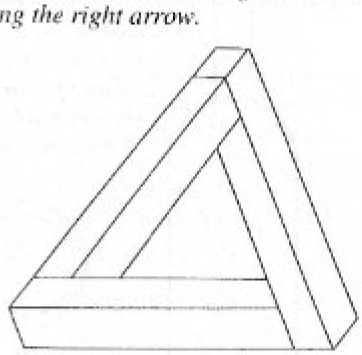


Figure 2b. *Reutersvard's triangle (often erroneously attributed to Penrose). The picture appears to be that of an impossible object, although in fact the depicted object can be built as Gregory (1973) has demonstrated, and the picture shows rather an unusual view of such an object — a view which is about as untypical as the view of a bottle from above shown in Figure 1.*

On the typical views and on the sufferings of the Kakadu crocodile

These considerations call for an elaboration. Clearly, when two or more pictures are seen as presenting different views of the *same* object, two entirely different stimuli are seen as denoting the same object. The process could be described as follows. Each of the pictures is mistaken for the object itself; and since all of them are mistaken for the same object, all of them are seen as depicting the same object. Such a process does not therefore necessarily imply any more complex perceptual skill than that shown by a predator responding to the decoy. But if the skill were of such simple kind then the perceiver would need to have a very large store of 'templates' (one for each distinct view of the object) for each of the objects that he is able to identify in a picture. Such a gargantuan store of 'response triggers' seems unlikely. It is more parsimonious to assume that each of the pictures evokes a percept of the represented object and that this percept is generally sufficiently comprehensive to enable the observer to visualise other views of the depicted object. As shown above, not all views of a solid are either equally mutually compatible or equally meaningful. Some of the views of an object are more typical than others. This observation brings forth the questions: what are the typical views? And, how does the eye arrive at typical views?

Consider two distinct 'schools' of painting, the Palaeolithic and the Bushman. Examination of paintings of both of these 'schools' shows strong preference for lateral views of animals. Other views are used only rarely.

It seems extremely unlikely that the motor skills necessary for drawing a lateral view are easier to acquire than those called for when drawing other views. It is much more probable that the lateral view is favoured for purely perceptual reasons. One is therefore obliged to seek a perceptual explanation for lateral depiction of animals which must have been seen from a variety of angles **2**).

One superficially plausible reason for the dominance of side views is the use of carcasses of animals as models. Indeed, Leason's (1939, 1956) comparative studies of some of the portrayals with which we are concerned cogently demonstrate the likelihood of this **3**). However, the use of carcasses, which presumably lay on their sides, as models does not explain why these are portrayed predominantly in a side view. A carcass, like any other object, projects a multiplicity of views and the models could therefore have been used to create pictures showing animals from the top or from the bottom, from the front or from the back, or from any other position. The approximate side views of Palaeolithic art and of Bushman art must have been chosen for some other reason, such as the readiness of the perceptual system to apprehend such

2) The importance of the perceptual rather than the motor element in drawing is demonstrated by the following simple experiment (Deregowski 1976). When children are given a cube and a drawing of such a cube and asked to draw them they find the task of drawing the former markedly more difficult. As they refer to both stimuli as a 'cube' one is obliged to assume that it is the 3D-2D translation called for by the first task rather than mere motor execution of the picture or failure to realise that a cube can be successfully depicted that is at the root of the difficulties.

3) Ucko and Rosenfeld (1967) disagree with Leason's (1956) suggestions. They do so, in my view, on the rather slippery ground that 'it is foolhardy to accept conclusions derived from a twentieth century visual impression without fully taking into account the technical achievements and stylistic conventions of the artists concerned ...'. We do not know (and presumably will never know) the conventions of the Palaeolithic artists. All we have are the figures they have drawn. It is possible of course to postulate that for some unknown reason it was conventional in those times to draw erect animals as if they were prone, but it is much more parsimonious and therefore definitely more acceptable to assume that the animals were drawn as they were seen. It is noteworthy that the depictions of prone animals made by the Palaeolithic artists do not normally call for abandonment of typical outlines, but rely on subtle use of the cues within the outline. This effect is demonstrated clearly in Figure 16 where a silhouette of a prone elephant (Figure 16a) is made to get up and walk (Figure 16b). The present author is more favourably disposed to Leason's than to Ucko and Rosenfeld's view.

portrayals as showing animals, and the extent to which the features of the animal shown in the picture corresponded to those features which struck an observer viewing the animal.

How are the outlines which define the typical view detected in a model? What defines these crucial features? In attempting to answer these questions we shall turn to Attneave's notion of points of concentration of information **4**). Attneave (1954) maintains that, in line drawings, information is concentrated at the points of rapid change. In a triangle, for example, it is concentrated at the corners where the direction of the perimeter changes, and indeed *perceptually* a triangle is more similar to the three points so placed that they would coincide with its corners than, say, three points so placed that they would coincide with mid-points of its sides (Figure 3), although geometrically the triangle could be reconstructed equally easily given either triad of points.

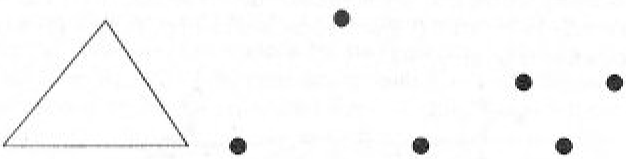


Figure 3. *A triangle and two mathematically equally legitimate ways of representing it by means of three points. Perceptually the two representations are not equivalent, that directly related to the spacing corners being clearly superior.*

Extension of this reasoning to perception of solids implies that the amount of information present at any point of a solid's surface is proportional to the rate of change of curvature of the surface at that point. (Thus, for example, in the case of an egg the largest amount of information is present at its pointed end.)

Any outline of the object can be thought of as a trace made by the object's surface on an imaginary plane passing through the object. For each object there is an infinite number of such planes. The shape of the outlines of these planes will, generally, vary. It is put forward that those ´outlines which pass through the points of concentration of information on the object's surface represent the object better than those passing through other points, and therefore their transfer onto a flat surface (such as a wall or a canvas) makes better pictures.

Accordingly a plane passing transversely through an egg has upon it a circular outline, a trace of a set of points having equal information loads. A plane passing longitudinally through an egg bears an ovoid outline containing the trace of the point at which the greatest amount of information is concentrated; and the latter outline represents the egg better (Figure 4). The same reasoning can be applied to other solids including animals and explains why animals are generally drawn from certain standardised stances, why eland, say, are drawn in a side view but turtles are drawn from above. (The obvious counter-suggestion that turtles are generally seen from above is not, incidentally, convincing because numerous other small animals such as fowl are also generally so seen, yet are not normally so drawn; they are usually drawn in side view.)

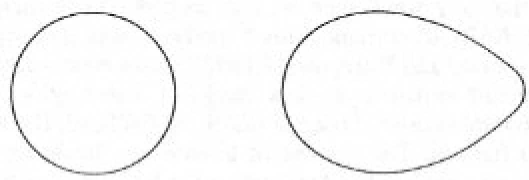


Figure 4. *Two equally legitimate but not equally meaningful representations of an egg.*

It explains, too, the 'distortions' which are sometimes found in depictions, as when, say, a crocodile's head and tail are drawn in a lateral view but its body in a view from above. Such figures are, of course, characteristic of Aboriginal art (see Figure 5). They are simply combinations of the three drawings; each of the elements being drawn in its most 'telling' view, and the three views combined although they are not co-planar **5**).

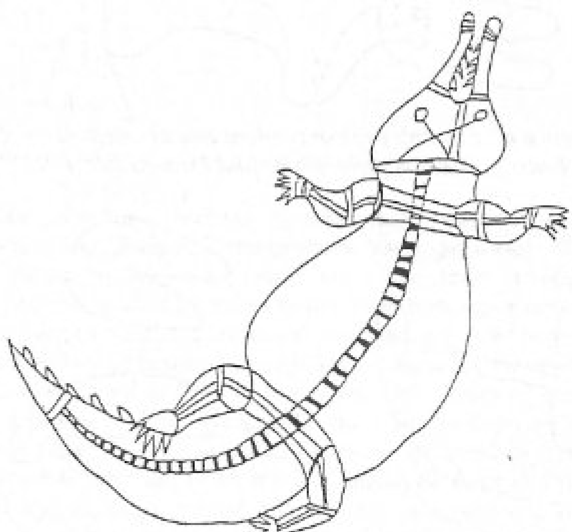


Figure 5. *A Kakadu crocodile, a typical Australian Aboriginal drawing of a crocodile. The snout is drawn as seen from the side and so is the tail. The trunk is drawn as seen from above. This is the arrangement that one would expect from consideration of the typicality of view of these elements considered separately. Note that both eyes are shown. This probably derives from the importance of eyes in representation of mammals, a vector entirely independent of the typicality of views and not examined here.*

These theoretical speculations call for empirical support. Support is fortunately to hand. It was obtained from Scottish children in an experiment inspired by the drawing of a Kakadu crocodile reproduced by Chaloupka (1984). This crocodile (Figure 5) must be most uncomfortable; its head and tail are twisted in relation to its body.

The crocodile's discomfort derives, it is suspected, from

4) See Attneave (1954) for the seminal paper. The extension of Attneave's ideas to define typical outlines as described here is adumbrated by Deregowski (1984). The notion of typical view and its use in art is discussed in Deregowski (1994).

5) Such combinational failures have long been noted in drawings as well as in perception of drawings by certain groups (see Deregowski 1984). For an empirical investigation involving perception of impossible figures (cf. Note 1) see Young and Deregowski (1981).

the fact that the crocodiles as perceived by the artist did not have a single planar typical contour; the typical contours of its three constituent parts (the head, the body, and the tail) were seen as not co-planar and therefore perceptually discordant. This hypothesis was investigated (Dziurawiec and Deregowski 1992), using concordant and discordant tripartite models made of balsa wood. The concordant beastie consisted of, say, a flat head, flat body, and a flat tail. The discordant beastie was made by, say, grafting a slim head and tail onto a flat body (Figure 6).

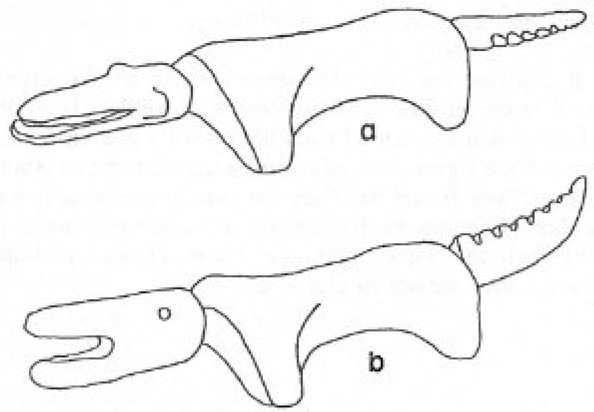


Figure 6. Examples of concordant and discordant beasties used by Dziurawiec and Deregowski 1992.

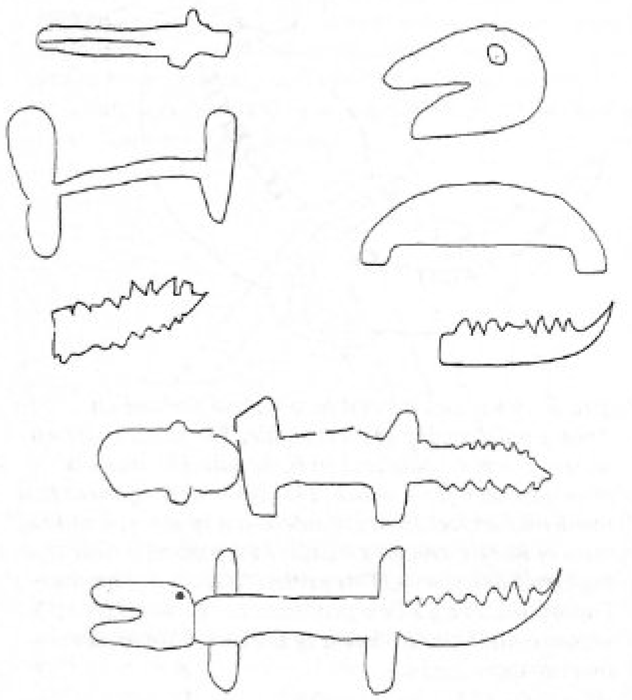


Figure 7. Examples of drawings made by children in response to the models shown in Figure 6. Figures above show drawings of isolated elements, those below of complete beasties.

Children were required to draw concordant and discordant animals as well as their constituent parts presented in isolation. Drawings of individual elements show that typical contours are generally chosen for depiction. Flat head, body and tail were drawn as seen from above; slim head, body and tail as seen from the side. Accordingly one would expect 'twisting' to occur in drawings of discordant but not of concordant beasties, and drawings of complete but discordant animals do clearly show such twisting. Figure 7 shows examples of responses obtained to both kinds of stimuli and to their component parts presented separately.

The tendency to draw typical views seems therefore responsible for the 'distortions' found in pictures such as the Kakadu crocodile, and since the 'distortions' of this kind are also characteristic of drawings made by young Scottish and other Western children, it seems likely that they are due to the inherent characteristics of the visual mechanism rather than to some unspecified cultural effect.

Generally an object has only a limited number of planes containing markedly high concentrations of information. These planes will be referred to as the typical planes, and the outlines of the object which they help to generate will be referred to as typical outlines. Such typical outlines are responsible for the universal tendency to portray wheels by drawing circles, a phenomenon demonstrated by Luka's (1968, 1971) cart (Figure 8) as well as by Tang's (1984) chariots (Figure 9) **6**).

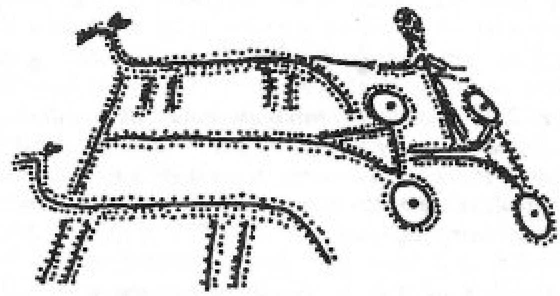


Figure 8. A cart as represented on a Pomeranian urn of the Hallstatt period (after Luka 1968, 1971).

Figure 9. A Chinese petroglyph of a chariot (after Tang 1989).

6) It may well be that so-called 'footprints' are another instance of drawing of typical contours. 'Footprints' are footprint-like designs which artists of several cultures drew immediately underneath and often appended to the feet of animals shown in side-view. Such drawings can be found in several disparate cultures, for example there is a well known rock painting of a lion, in Namibia, showing pad-prints so arranged; and there are numerous rock paintings of horses, in the Cairns region of Australia, showing hoof-prints of police horses. The popular wisdom has it that these pendant footprints are drawn in order to label the animals, but if this were the case then another explanation has to be put forward for depicting more than one footprint appended to an animal. It is of course possible to invoke notions of completeness of aesthetic balance, but this adds to the complexity of the explanation. The alternative explanation based simply on the workings of the perceptual mechanism seems simpler and therefore, to a student of psychology of perception, more acceptable. It is, alas, the less 'romantic' of the two explanations.

Pager's (1972) immensely scholarly *Ndedema* conveniently provides a large body of field data which one can examine in the light of the speculations put forward and of the laboratory investigation reported. The Ndedema gorge contains a number of abandoned, decorated Bushman shelters. Pager surveys various aspects of these decorations. He reports the frequencies in which figures of animals and humans are drawn in lateral and in front views. The relevant data can be summarised thus:

Frequencies of particular views

	Humans (N = 1669)	Animals (N = 1024)
Lateral view	98%	99%
Front or rear view	2%	1%

Prima facie, these figures support strongly the conclusions arrived at above, but it is doubtful whether it is legitimate to treat figures of humans and of other animals as if they were perceptually equivalent because whilst the animal drawings are such that they can be said to show the typical contours, this cannot be so in the case of homunculi. The figures of humans are essentially 'stick figures' composed of linear representations of those parts of the body which are normally seen as sharing movements, such as calves, thighs, trunks or arms. There are admittedly some figures which incorporate typical contours (Figure 10) but there are many in which evidence of such contours is entirely absent (Figure 11). It is therefore prudent to treat all representations of humans as belonging to that sub-category of epitomic figures which is classified as 'stick figures' in Table 1 and to consider only animal figures in the analysis. (It should be parenthetically noted that these data should not be interpreted as showing that animals cannot be represented by stick figures. They clearly can, as the depictions of horses on Luka's urn testify. It is also noteworthy that stick figures do not represent women as efficaciously as they represent men. Admittedly women can be portrayed in this style as if they were incomplete men. Such a portrayal lacks evocative power, since the breasts, objects of considerable interest, are not shown. In order to remedy this defect an artist may resort, as the Tale artists have done [Fortes 1940, 1981; Deregowski 1978], to drawing these organs as floating independently [Figure 12]). In so doing they have unwittingly followed an ancient artistic tradition as clearly demonstrated, for example, by a petroglyph found in Valcamonica (see Anati 1982: Fig. 179).

Figure 10. *A figure of a woman showing typical contours (after Pager 1972).*

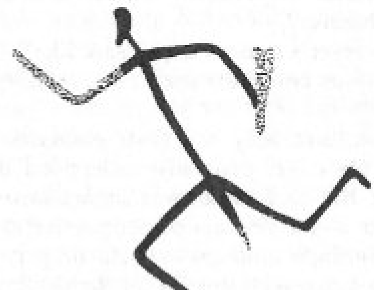


Figure 11. *A stick drawing of a man (after Pager 1972).*

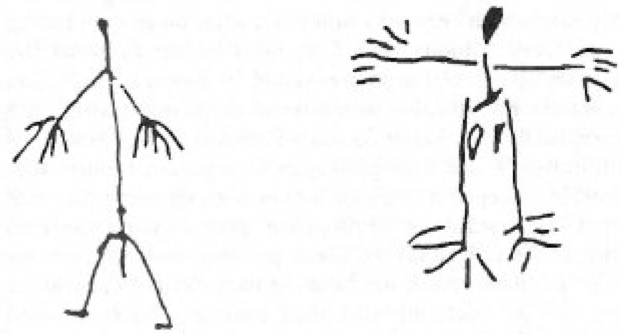


Figure 12. *Tale drawings of a man and a woman.*

The Ndedema animal figures are overwhelmingly drawn in lateral view. Some of them, however (about 9%), are drawn in 'twisted perspective'. The term 'twisted perspective' is used by Pager to describe drawings wherein bodies are twisted into unnatural positions, e.g. a 90 degree turn whereby (i) hooves are depicted in *side* view while the body is depicted in front or rear view, (ii) hooves or head are depicted in *front* view while the body is depicted in lateral view, (iii) the horns and ears are depicted in *front* view while the head is depicted in lateral view, or (iv) the head and neck are turned 180 degrees in relation to the body 'as if it were folded back on a hinge'. It is apparent from these definitions — and examination of the figures confirms this — that the instances of 'twisted perspective' by-and-large fall into the same category as the Kakadu crocodile. They do not therefore contradict the general principle enunciated, but merely show the effect of its application at various levels. An artist working at a global level is not concerned with the shape of an animal's hoof and may well be satisfied by depicting the entire animal by a single line showing a side view of the shape of its spine and its head. In contrast, another artist who wishes to show the shape of the animal's hoof as well as the shape of its back encounters the same problem as that encountered by his or her Kakadu colleagues drawing a crocodile, and arrives at the same solution. Another 'twisted' animal is born.

The Bushmen whose art Pager studied recorded those entities in which they were interested, animals and men, and they did so in the readily apprehensible forms, as typical views or as pin figures. The models were recorded 'as they were', that is they answer the very first of four questions which Chwistek (1924/1960) put forward in his essay on realism in art suggesting that they may be used to classify works of art. The questions were:

Q.1. What are things like?

Q.2. What are the relationships among objects, sources of light and the observer?

Q.3. What is the observer's sensory experience like?

Q.4. Which impressions constitute the basic elements of reality?

The first question, and only the first, elicits, when properly answered, objective, generally understood truth about visual objects. But such an answer cannot incorporate, say, perspective, as the concept of perspective arises out of visual relationships amongst objects or parts of objects. Pager's data agree with this. In all the depictions that he has collected, Pager identifies but five figures in which he thinks perspective might have been used. Four of these, however, he himself deems unconvincing and the only one which seems to him somewhat more convincing is still very dubious indeed. It must be stressed that the relationships in question are visual in essence. Depiction by means of typical contours renders pictures which are perceptually two-dimensional. Perceptual flatness does not, however, preclude portrayals of vigorous scenes. It is possible to depict a chase or a hunt without using pictorial depth by portraying appropriate poses; and Ndedema painters did indeed do so. These painters shunned portrayals of pictorial space, not because they did not experience space — they certainly did, they could not have survived otherwise — but because spatial notions were essentially alien to the purpose of the portrayal: to depict things as they really are, and not to depict visual relationships among things, or observers' sensory experiences. It may be thought that the depictions which Lewis-Williams and Dowson (1988) describe as derivative of entoptic phenomena contradict this. Such contradiction is, however, only apparent, for 'entoptic' pictures (this very concept is, however, questioned by some, notably by Marshack 1989; Bednarik 1990a) portray phenomena which the artist perceives in certain circumstances. They do not evoke the nature of the observer's sensory experiences. These observations can be generalised to a larger body of rock pictures; these should therefore be viewed bearing the following points in mind:

(i) The side views of animals are drawn because the typical outlines which envelop such views are concordant with the typical contours which the artists see more cogently than any others when looking at animals, whatever their orientation. The viewers of pictures recognise these typical outlines as identical with the typical contours and hence readily recognise the pictures. The perceptual loop is thus closed.

(ii) More complex and visually interesting figures can be obtained by folding typical contours. This may also explain figures (such as those of north-western Canadian art [Boas 1927]) wherein the typical contour is repeated so as to form a symmetrical 'unfolded' figure.

(iii) Distorted, twisted pictures such as the Kakadu crocodile result when an artist depicts as co-planar typical contours which are non-coplanar in nature.

(iv) All these 'laws' issue directly from the artist's drive to tell the 'perceptual truth': to portray objects as they really are and appropriately incorporate in pictures those characteristics of objects that are 'naturally' striking, in the 'real world'.

On the cultural implications of epitomic and eidolic pictures

An outline which can either be left empty or filled so as to create a silhouette does not contain any immediate perceptual cues showing that the depicted object is three-dimensional. An observer is able, if he recognises the outline as derived from a three-dimensional object, to name the object but he does not perceive the third dimension in the manner in which he perceives it when looking at density gradients. Thus he is able to recognise Figure 1b as portraying a bottle but he does not see it in the manner in which he sees Figure 13 as extended in space, even though the latter figure does not represent any specific object or group of objects. Such depictions devoid of perceptible depth have been termed *epitomic*, in distinction from those pictures which lead to direct perception of depth, which have been termed *eidolic* 7).

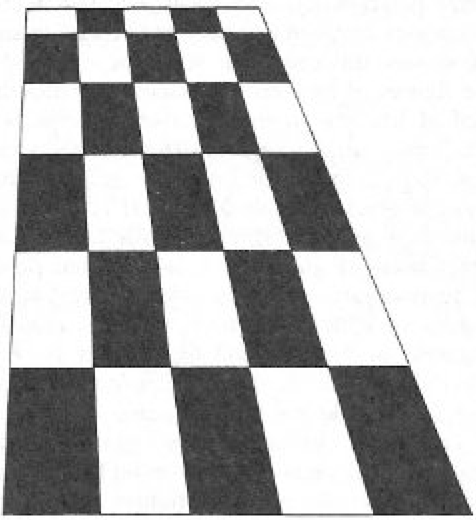


Figure 13. *This pattern of lines is seen by most viewers as showing a receding surface without any implication of an object.*

An outline drawing is not the only kind of epitomic figure. An entirely different kind of figure is created when a draughtsperson depicts, as some Bushmen decorating Ndedema shelters have done, percepts derived from the relative movement of various parts of the depicted object. Since such movement can only be observed in some living creatures, the resulting pictures, which are generally known as stick or pin-figures, can be, and are, used to portray humans and quadrupeds but not fishes or plants. The independently moving elements are in those pictures represented by short lines. Such units can be combined by the artist; s/he can choose to depict legs by, say, rectilinear segments joined at the knee or by a simple segment extending from the hip to the foot (see Figure 14).

The difference between the two kinds of epitomic figures, the outline type and the pin-type is, it will be argued, fundamental, and the two types of figures have entirely different implications for human development. An

7) For extensive examination of the concepts 'eidolic' and 'epitomic' see Deregowski (1984, 1989). In the latter publication the terms '2/3d' and '2/3i' have been substituted for the original terms. Conley (1985) presents a philosopher's examination of these terms.

outline can be used in making an eidolic figure. This is done by incorporation of various surface details and perceptual depth cues (e.g. shading) within the outline. In contrast, a pin figure cannot be easily endowed with eidolic properties. The development of realistic (photograph-like) depictions is therefore related to the former and not to the latter, and involves two conceptually quite distinct perceptual processes; one of these concerns the establishment of the typical outline and the other the furnishing of this outline with eidolic cues to give it bulk. The eidolic information facilitates representation of idiosyncratic characteristics of an object in a picture (such as differently coloured patches of skin of depicted animals or different disposition of facial features in the case of both animals and humans) and therefore opens the route to individual portraits and other pictures conveying fine distinctions among the portrayed objects.

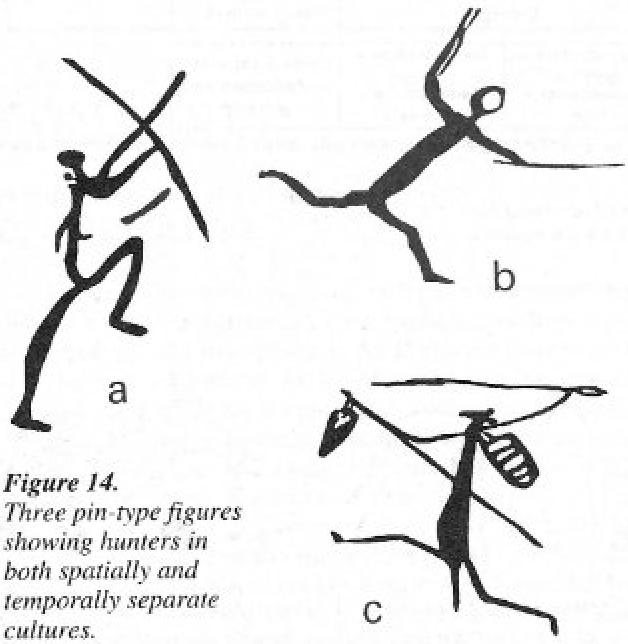


Figure 14.
Three pin-type figures showing hunters in both spatially and temporally separate cultures.

Pin-figures do not offer such possibilities. They are a blind alley, as far as the development of realistic portrayals is concerned. They do, however, have certain other very important characteristics. A pin-figure is necessarily an abstraction, one which is easy to recognise and whose structure is so simple that it can be more easily remembered than an outline figure. It follows that both artists and non-artists can readily *perceive, remember* and *copy* a pin figure [8]), and that such variations as are likely to occur in the course of copying are not likely to affect its meaning. A pin-figure, although copied repeatedly, will on each occasion convey the same general statement; a pin-man will remain a representation of a man throughout the process, it will not become a representation of a specific man. Furthermore, the speed with which the pin-figures can be drawn ensures that several can be used to depict a scene without the artist floundering in the process. A complex, concise and immediately comprehensible statement can thus be made. (In contrast, difficulties presented by outline figures are such that inexpert draughtspersons often get lost in the course of their execution; a child may start to draw a dog and in the course of drawing transmogrify it into a horse.)

Neither epitomic outline nor eidolic figures need be based on the typical outlines, but abandonment of such outlines leads to marked changes in the nature of pictures. Both kinds of pictures become more 'lively' [9]). This makes the figures less perceptually stable and therefore more prone to modifications when copied. Consider the ploughing team from Fontanalba shown in Figure 15a. The ploughmen are shown in typical views and so is the plough. The oxen are, however, shown atypically, as seen from above. The entire figure therefore consists of spatially incompatible elements, an attribute which it shares with the crocodile in Figure 5, but with the important difference that one of the elements, the oxen, is shown in an atypical view. This atypicality of the oxen is, I believe, responsible for figures such as Figure 15b, also found in Fontanalba. This figure could be thought of as a symbolic representation of 'a yoke of oxen and a plough', in which the oxen are represented merely by their heads. Such an interpretation is conceptually appealing but it seems more likely that the 'heads' were depicted, not by drawing from a model, but by inept copying of the bodies of the oxen of such figures as Figure 15a. They are therefore not typical views of heads but typical views of bodies which have lost their rudimentary tails and have been markedly shortened.

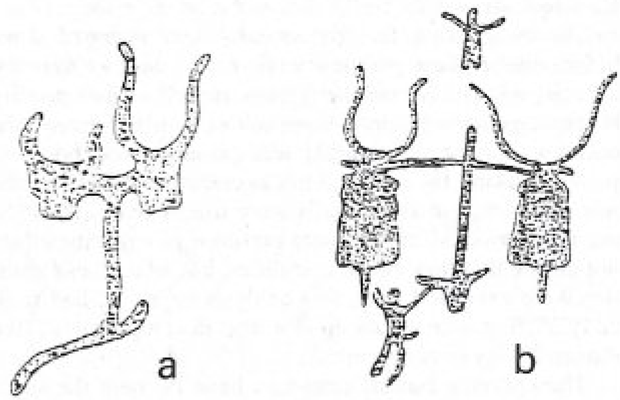


Figure 15. *Ploughing in Fontanalba. The representation of oxen in the left-hand figure is, it is suggested, a result of distortion of oxen originally drawn in untypical views such as that in the figure on the right.*

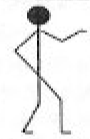
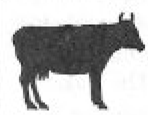
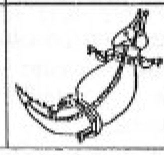
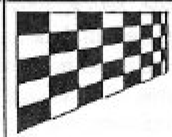
8) For pin-drawings done entirely by unexperienced Bushmen see Reuning and Wortley (1973).

9) Such 'liveliness' is the characteristic of certain schools of Japanese art (see Deregowski 1984), which favoured representation of objects from unusual angles and in unusual poses. The instability also applies to geometric figures. Thus the rhombus on the face of the cube in Figure 17b is more likely to be subject to deformation when copying (see Deregowski 1976, 1980, 1984) than a congruent rhombus presented on its own (Figure 17a).

It would be wrong, however, to think that the outline is the only vector affecting the readiness with which depictions are recognised. There are certain features of living objects which readily convey their essence and which are not related to the outlines. Ethologists (Coss 1968, 1970; Hinton 1973) have, rightly, drawn attention to the importance of the eyes (or eye spots) in depiction of living creatures, and many works of art in which eyes are presented as seen from the front, although the other parts are presented as if seen from a side, confirm this. This arrangement can be found in the crocodile in Figure 5, in the tenth century lion from Faras (Figure 18a), and in Picasso's cat in Figure 18c as well as in many other figures (see Deregowski 1984). For the discussion of such figures in the broader context of perceptual studies see Deregowski (1989).

Table 1. The table shows classes into which figures can be divided. It is argued that use of different types of drawing has different cognitive implications. The unitary typical views and pin figures are the dominant forms of early artistic expression and were at the root of two disparate ways of expressing one's thoughts and therefore of thinking. Note that atypical views, when readily recognisable (as in the sample figure provided but not as in the view of a bottle from above Figure 1a), tend to be eidolic and 'lively'.

Taxonomy of Depiction

	Epitomic figures				Eidolic figures
	Pin figures	Outline figures			
		Typical views		Non-typical views	
		Unitary	Collage		
Examples					
Essential attributes	Not suitable for depicting specific objects	May depict specific objects			Does not depict object but conveys the idea of space
Recognition of the figure	Easy	Very easy	Moderate	Not easy	
Memorability of the figure	High	Moderate		Very low	
Ease of copying of the figure	Great	Difficult		Very difficult	
	Likely to develop into a pictogram	Reproduction - difficult Memorability - high	Reproduction - difficult Memorability - moderate	Correct repeated reproduction very difficult	

N.B. Pictures such as photographs or paintings generally embody both Epitomic & Eidolic cues.

A summary of the perceptual characteristics of the various kinds of figures considered will be found in Table 1.

Conclusions

The assumption that the eye has not changed since before the earliest pictures were made implies that the capacity to perceive eidolic figures as well as the capacity to perceive two distinct types of epitomic figures (the outlines and the pin-figures) was present throughout the picture-making times. It did not necessarily imply that the relevant picture-making skills were used equally throughout this period, since the mere presence of capacities does not ensure that they become abilities; but when these abilities were exercised they, this analysis suggests, had radically different implications for the development of the human ability to communicate.

The epitomic outline drawings have in them the seeds of illusion which in combination with eidolic visual cues provide realistic depictions — objects which have a double existence: as objects per se (as cave walls and pigments, for example) and as representations of other things such as animals.

The epitomic pin-drawings, on the other hand, open the way to symbolic representations and therefore to pictograms and through pictograms to representation — not of objects but thoughts pertaining to relationships among objects. Such externalised, publicly accessible thoughts are exposed to scrutiny and comments of viewers and provide important stimulus for discourse similar to that which is nowadays provided by written statements — descendants of epitomic figures.

Thus different types of depictions based on different visual capacities have made distinct and fundamental contributions to the development of human communication and therefore human cultural development.

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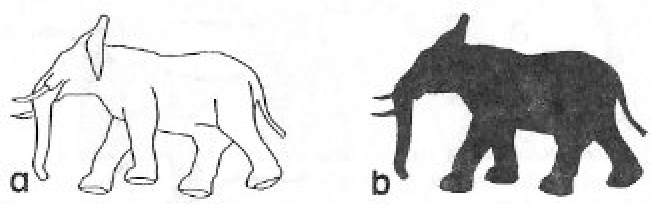


Figure 16 (see Footnote 3). The prone elephant (a) is made to get up and walk, although the outline of the animal remains unchanged (b).

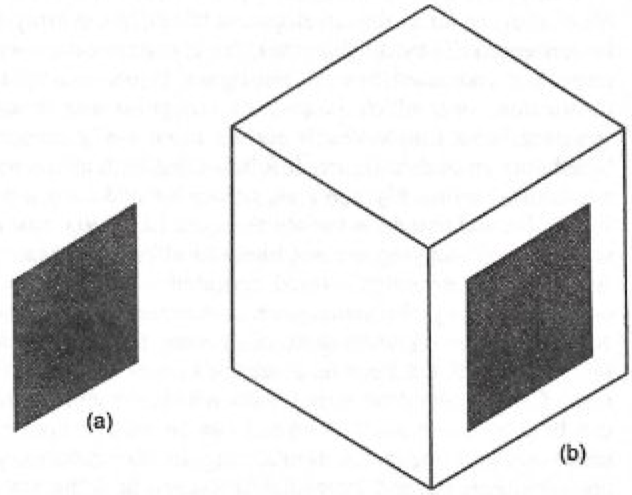


Figure 17 (see Footnote 9). When asked to copy the mottled rhombus, people tend to draw a less squarish figure when copying Figure 17a than when copying Figure 17b.

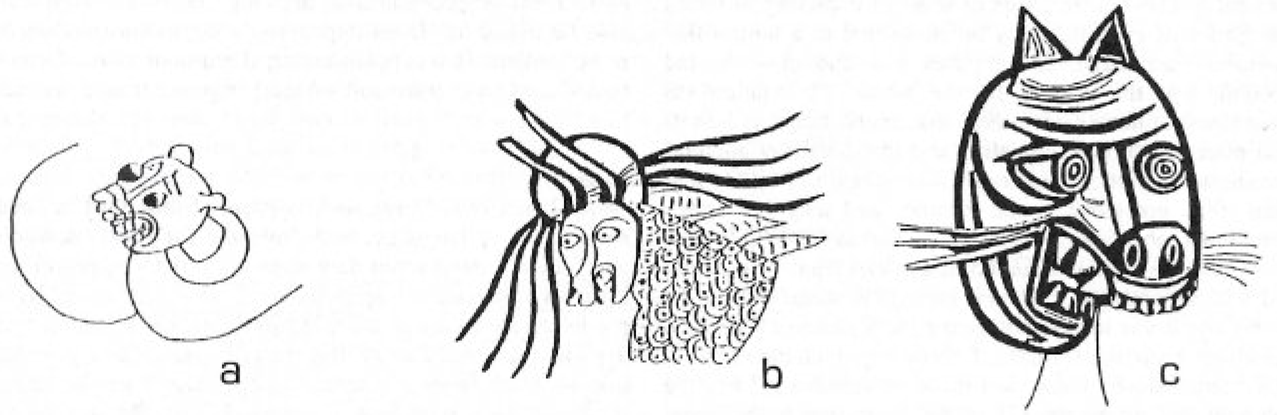


Figure 18 (see Footnote 9). Three illustrations of typical-view collages as used in art. (a) Tenth century head of St. Mark's Lion from Faras. (b) Head of a beast of apocalypse decorating eleventh century Spanish manuscript. (c) Head of Picasso's cat.

COMMENTS

About pictures of echidnas and cats
By JOHN CLEGG

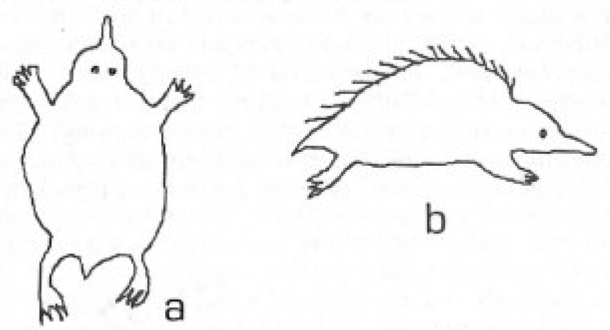
The study of rock art is of interest and importance outside its traditional areas of ethnography, archaeology, anthropology and management. As Professor Deregowski shows, it is of interest to his discipline of perceptual psychology. In turn he demonstrates — to me, at least — that his discipline is directly relevant to the study of rock art, which this journal has done so much to foster. This paper packs a great deal into a very few words. In the process of writing this Comment, I kept writing notes to myself, suggesting that Jan might have already covered the point I was raising. On checking, I invariably found that he had done so, and that I had failed to give it due attention on earlier readings. Many of my points are expansions of his statements.

The paper addresses the nexus between how minds work, what people see when they look at objects, and ways to resolve conflicts between what things look like and how they can be drawn. People of different cultures draw in different ways. The different ways of drawing contribute to 'style', which can also be used as a focus for identity, or symbol of it, or a material clue to the way people structure their identities. So the ways people draw are directly relevant to many studies of rock art. The drawings people make are conditioned by the subjects of the drawing, but also by the concepts, values, and interests of the artists and their societies. This conditioning means that drawings have clues — however unmanageable they may be — to the concepts, values, and interests of the artists.

Rock art makes chronically unfulfillable promises. They are sometimes expressed as a set of muddled motherhood statements, like the common assertion that art is communication. We whose business it is to get archaeological data out of rock art have been through many cycles of despair over the difficulties of extracting anything more than waffly good intentions. Deregowski's paper provides a powerful tool. It is full of focused hypotheses and real experimental observations. Since the observations are experimental, their significance and reliability can be checked. Do, for instance, artists choose how to draw crocodiles entirely from the style of their parents? The concurrence of drawing methods between Scottish school children and Aboriginal elders makes this hypothesis unlikely.

Echidnas

The ways in which echidnas are drawn in Australian rock art provides a frustratingly ambiguous test of Deregowski's thesis. South of Sydney and in Cape York Peninsula, echidnas are drawn in plan, north of Sydney in side elevation, and in all manner of ways (including 'twisted perspective') in the Top End (Figure 1).



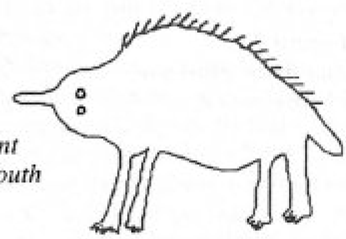


Figure 1. Drawings of echidnas by John Clegg, attempting to illustrate ways of drawing in different regions of Australia: (a) south of Sydney; (b) north of Sydney; (c) Top End (e.g. Arnhem Land).

I am using these drawings as an example for discussion, so I hope it does not matter that the figures are drawn by me from memory, and that I do not present numbers or locations. My drawings doubtless reflect more of my memory than they do of the originals, and they are inferior drawings. Deregowski treats very lightly competing theories about the ways animals are depicted. It is often said that mammals are shown in lateral elevation, and reptiles in plan. People (in the Sydney area) are shown in front elevation. These differences in ways of depicting different categories of creatures may be connected to a notion that mammals are large, and reptiles low and close to the ground. But this cannot be the whole explanation (as Deregowski shows), for small mammals, like bandicoots and mice are shown in profile, and tree-dwelling goannas are shown in plan. Echidnas are well suited to be shown in plan (they are close to the ground, and they lay eggs). Could my observation that the depiction of echidnas is sometimes in plan and sometimes in elevation be connected with an ambiguity in their biological status? Or is the ambiguity in the location of their *typical planes*? Where do echidnas keep their lines of most rapid change? What three-dimensional shape do I think an echidna is? For the moment and simplicity, I limit the discussion to the body. My image is of an egg, the shape you would get by rotating an ellipse about its long axis. But the ellipse is not quite regular: the tail end of an echidna's body is more sloping and pointed than the head end. Applying Deregowski's rules to that mental image, an echidna's body could be drawn from either side or top, just like an egg. So echidnas have two ambiguities, one of biological status, the other of typical planes. They are doubly ambiguous, and provide no test between 'biological' and Deregowskian explanations of the origins of their drawing.

There may be another possibility. Echidnas have spines (more marked in *Tachyglossus* than *Zaglossus*) which are erectile. These have the same structure as mammalian hairs, and their erectility is analogous to our goose pimples (M. L. Augee pers. comm.). So the animal can change its plane of maximum inflection. Putting its spines up makes it more spherical, which would favour a profile depiction. Lowering its spines makes an echidna ventro-dorsally flatter, for which a plan view would be more appropriate. Assuming that defensive echidnas have their spines up, the differences in drawing could be open to the interpretation that people north of Sydney drew frightened echidnas. This idea receives some support from the fact that spines are more often shown in profile than in plan drawings. The 'obvious' explanation, that it is easier to draw spines on profile than plan pictures is simply not true (see Figure 2).

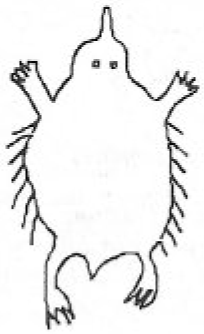


Figure 2. Another perspective of the echidna.

As Deregowski states, a typical outline is chosen to display a plane containing markedly high concentrations of information. But there may be more than one such plane — as echidnas demonstrate. There must be some sort of choice between the many planes which pass through points of maximum inflection. Is it a matter of maximising information, so that a picture is drawn so as to maximise the bits of non-misleading information the drawing shares with the object? Will the addition of more non-misleading information make it easier to recognise the subject of a correct but unrecognisable drawing? This question can also be asked as 'Does improving a depiction (making it more realistic, by supplementing the amount of information shared by picture and subject) improve it as a denotation?'

Cats

As I first read Deregowski's paper, I thought I noticed some slippery language, with 'mistake for', and 'denote', and 'depict', used when they were not strictly appropriate. I suspect that the competence of a *depiction* is at least partly related to the amount of information common to the depiction and the subject. But the competence of a *denotation* is much more determined — perhaps entirely determined — by convention. Deregowski's paper seemed to say that a simple outline picture may be easier to read than a more complex rendition with extra information, perhaps about colour or light. My alternative hypothesis is that recognition is better associated with denotations than with depictions. I started to play with this idea, in a fuzzy and unfocused way. I made a teasing depiction of a cat (the ornately stoppered bottle of Figure 3a). In response to family feedback, which found the bottle too straight sided, I made it a bit more catty (Figure 3b). I used Figure 3b to generate more pictures. First I added shading, to make the picture a grey cat on a grey carpet (Figure 3c).

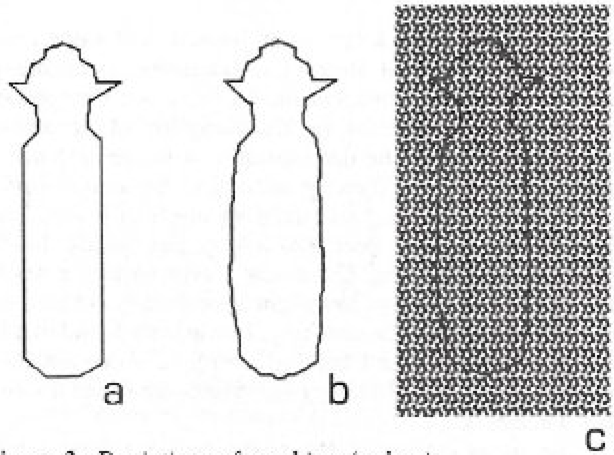


Figure 3. Depictions of an object (a, b, c).

This makes it, as expected, a bit harder to *see* (though my anecdotal observations have not discovered whether it is also harder to *recognise*). I then opened the door and let some sunlight in, adding light, shade and shadow (Figure 4).

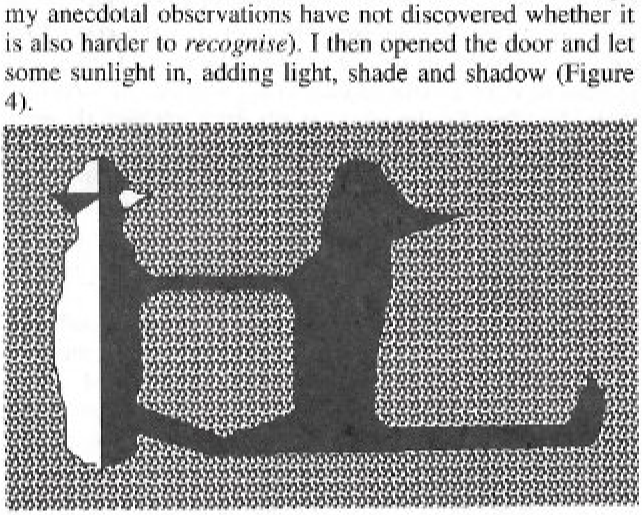


Figure 4. Another depiction of the object.

This at once seems to get rid of the bottle perception, though even with the extra information — which includes in the shadow a lot of information of an outline drawing — it is not at once recognisable to all subjects as a cat. Rather it presents a puzzle, which may be frustrating enough to be annoying. Perhaps the drawing is not good enough, so the animal could be meant as a monkey. Or perhaps adding another dimension of representation may make my depiction more catty?

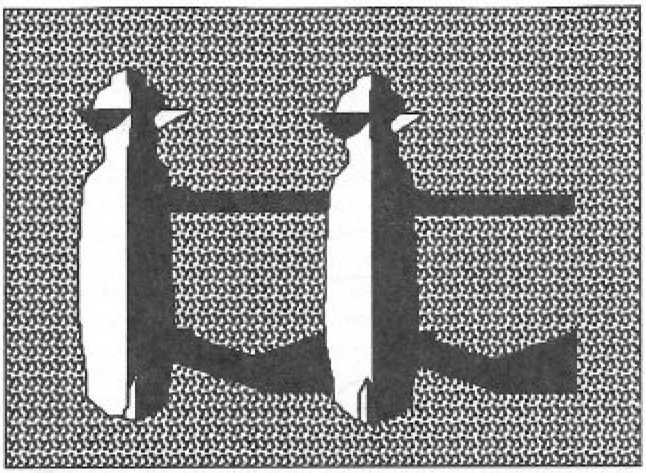


Figure 5. *Stereogram of an object.*

Figure 5 is a stereogram of the cat, in which the tail tip is really close, head and back in the middle distance. Does that help to make it recognisable as a cat?

I cannot tell whether any readers will invest the effort to follow me this far, or whether they find the exercise rewarding. But the chances are that they have done some experiments, by glancing at the pictures (all but the stereogram which takes more effort) before they read the text. Figure 6 was generated in response to my family's request for whiskers. My guess is that the whiskers improve the picture as a denotation, perhaps by decreasing the picture's resemblance to a bottle. I could claim that whiskers would not be visible in a realistic picture using this scale and medium, so their addition improves the picture as a denotation but harms it as a depiction.

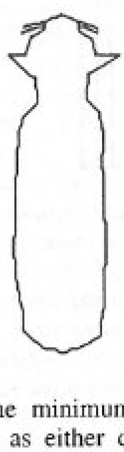


Figure 6.
Object with whiskers.

Pictures need to contain some minimum amount of information if they are to work as either denotation or depiction. This generates further ideas for exploration. Do the ubiquitous engravings that look like animal tracks in Australian rock art denote the tracks or the whole animal? All depiction (until the state of *trompe l'oeil*, for which the phrase *mistake for* is entirely appropriate) involves the taking of a part for the whole. But some parts (for example, heads, footprints, *certain* outlines) are better than others, like torsos or ears. Are torsos and tails non-specific, or is the study of which parts are characteristic another provocative field for perceptual or conceptual investigation? (Rosenfeld 1982: 199.)

Non-depiction in pictures

Is rock art about things other than drawing, which occur in Art, such as some European Art of the last century or so is ABOUT paint, or making eyes fuzzy, or light? Not all 'Western art' is or involves depiction of things. Yet many times we are told that the pictures of other cultures should not be seen by us as we see 'our' art, for there is no word or concept for art in their languages. Yet not all Aboriginal art can be seen as depiction. Whatever a hand stencil is, it is NOT in any sense a depiction of a hand. Taçon (1989a: 246) has pointed out the great significance of a *shimmering* effect produced in the eye of the onlooker by fine cross-hatching in rock art. Close juxtaposition of contrasting bright colours produce a similar effect, which was exploited by Najomolmi (Haskovec and Sullivan 1989) and many other Aboriginal artists. These phenomena and their exploitation clearly have something in common with 'Western' op art.

Pins

I have spent all my energy and far too much space on the first half of the paper. The part about pin-figures is also very productive — or at least stimulating (what Binford would call *provocative*). An enormously important event in the past of much of the world was identified as (the) *Neolithic revolution*. Its importance is often understood in simple economic terms. Deregowski's paper shows that we have clues to insights about what conceptual changes happened during those times. The informative phenomena are changes in ways of picturing — perhaps a change of emphasis from depicting towards denoting. Neolithic pictures seem to have greatly increased predominance of static pin-figures. There are plenty of hunter-gatherer pin-figures which clearly show activity and motion. The effects of static pin-figures in Neolithic pictures could be to generalise depictions by removing individuality or it could be a significant move, through simplification (and 'schematisation'?), away from art and towards the use of signs rather than representations.

All these considerations are stimulated by Deregowski's paper. He has opened doors which makes a whole swag of questions now potentially answerable, and therefore worth asking. What are pictures about? Are they good representations in that they have a lot of information in common with the model? How easy are they to recognise? And in turn there is just a chance that those of us who study rock art from an approach other than perceptual psychology may be able to help their studies or insights. Any such cross-disciplinary work is dangerous, for it may shamefully demonstrate ignorance. Perhaps the fear of demonstrating ignorance explains why there is so little cross-disciplinary work.

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Information and typicality
By JOHN HALVERSON

Attneave (1954) proposed that in the visual perception of an object, relevant information is concentrated first of all in contours (created by abrupt changes of colour, texture, luminance etc.), and second in changes along the contour. The first proposal is generally accepted in perceptual psychology, and accounts for the fact that three-dimensional objects can be effectively represented by line drawings. The second is plausible, but has some problems. For instance, a sphere is best represented by a circle, which has no changes of contour and no points of information concentration. A wheel viewed obliquely is an ellipse with more points of concentration than the full lateral view, yet is not the best representation — the opposite of Deregowski's egg. It is also easy to construct outline figures omitting all contour changes which are nevertheless fairly easily identifiable (Figure 1). It is true that the shape of any outline figure can be described or determined by a topological algorithm — which is evidently the basis of Attneave's theory — but, as shown here, such an algorithm can be constructed using only length and direction of discontinuous straight lines where 'points of concentration' are empty spaces. Strictly speaking, there is no contour here except that supplied by the mind along Gestalt principles.

Figure 1. *Attneave's (1954) sleeping cat with points of contour change omitted.*

Nevertheless, in general, Attneave's proposals seem quite acceptable, especially for real-world perception. We can readily agree that a typical outline, like any other outline, can be generated or described by a topological algorithm — but this leaves entirely open the question of what a typical outline is. Deregowski seems to imply that the more points of concentration a figure has, the more 'typical' it is. However, the top-down view of Figure 2 bristles with points of concentration in comparison to the side view, yet no one would regard it as in any way typical. Similarly, a three-quarters view of most animals supplies more concentration points than a parallel view, as well as more visual information (two more legs, a second eye and ear, for example); it is also a more natural view. Yet strict profile is the norm in palaeoart. Of course the features visible in a three-quarters view are redundant, in the ordinary sense that they add nothing necessary for identification of the animal, so the preferred aspect suggests that economy of representation is a balancing factor. Maximal points of concentration are not necessarily optimal.

The same is true of 'imaginary planes' passing through points of concentration of information. Suppose the object in question is a fluted column (Figure 3). A longitudinal bisection produces fourteen corners (points of contour change), whereas a latitudinal slice produces thirty-two points of concentration (the redundancy rate, in the information-theory sense that one feature reliably predicts others, is nearly identical in both figures), but the lateral cut produces a virtually unidentifiable picture. Imaginary planes do not, in fact, seem really relevant outside of geometry. The plane that permits the representation of the top-down dog in Figure 2 can only be the one on which the dog is standing. The side-view dog could be thought of (rather strangely) as a bisection, but if the other two legs were represented, partially occluded as is very common, the only imaginary plane possible would be the one the dog is standing against.

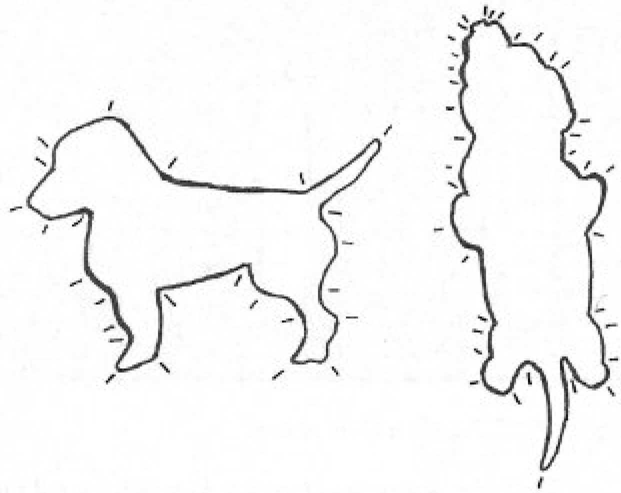

Figure 2. *Side view and top view of a dog with lines indicating points of contour change.*

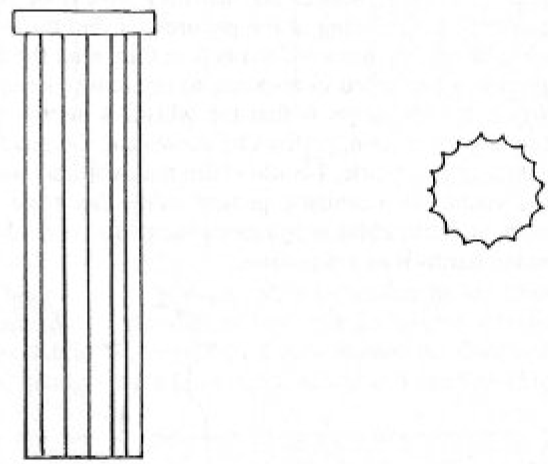

Figure 3. *Fluted column bisected by longitudinal and latitudinal planes.*

In all, the road from Attneave's theory of visual information processing does not seem to lead us very close to typical views and typical outlines. But what do we mean by 'typical' and what kind of information are we talking about? Deregowski says that 'typical outlines' are generated by 'typical planes', which are those 'containing markedly high concentrations of information'. Leaving aside imaginary planes as an unnecessary complication, perhaps we can simply say that typical outlines have high concentrations of information. This seems reasonable, but topological concentrations alone clearly do not produce typicality; some other kind of information is wanted. In the end, Deregowski suggests what it is, namely, distinguishing or salient features. Typical outlines render 'typical contours which the artists see more *cogently* than others when looking at animals' (emphasis added); they 'incorporate those characteristics of objects that are "naturally" striking in the "real world" '. For the most part, side views are optimal for this purpose, but sometimes a response to saliency generates alternative (turtle) or discordant (crocodile) perspectives. This will account, too, for partial or 'abbreviated' animal depictions so common in Palaeolithic art.

What constitutes 'information' in a given situation depends on what we want it for. Floor plan and elevation in an architectural blueprint are equally informative about different aspects of a house, as are a cross-section and frontal view of a column. If the preferred aspect of animal depiction is the lateral view, it is presumably because it provides more information of the kind wanted than an overhead view does. If the former is more 'typical' it is surely because it represents a more typical, i.e. habitual, view of the animal depicted (like frontal views of houses and columns). With the exception of our own toes, there are vanishingly few things in nature that are habitually viewed from a straight-down perspective (which is presumably why objects photographed from that angle are difficult or impossible to interpret). The typical contours of animals are typically (though not exclusively) viewed laterally and typically include distinguishing characteristics.

In some cases of perception, orientation is crucial. An upside-down map of Africa, for example, is notoriously hard to identify, though it contains exactly the same information as a map in its customary position, which is easily recognisable. If an animal depiction is more recognisable upside-down than a map, it is probably because salient features (legs, horns etc.) are still discernible.

It would seem to be the case that epitomic stick-figures of humans are also recognisable largely due to the presence of salient features or, here, body components (head, torso, arms, legs, hands, feet) in natural arrangements. These provide minimal but sufficient information for identification. However, it should be pointed out that genuine stick figures, that is, those in which only single lines are used to represent torsos, limbs etc. are actually rare. In Mesolithic, African and Australian art, human figures usually do have some shape; they are mostly just very skinny — in appropriate contrast, I should think, to the natural bulkiness of so many animals.

Deregowski speculates that stick-figure drawings may have been a precursor of writing, but almost all of the earliest pictograms — Sumerian, Egyptian, Mayan — are clearly outline figures. The earliest extant Chinese writing — on an oracle bone from the Shang dynasty — shows both outline and non-outline forms, suggesting that it was already on its way to a reduction of pictograms to linear signs, as happened in Mesopotamian cuneiform. In short, epitomic stick figures seem never to have had any cultural role at all outside the kindergarten.

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Perceptions of depth in rock art
By CLAIRE SMITH

In this article Deregowski continues his important work into the psychology of perception, in this case with particular reference to rock art. This paper presents a dichotomy between two forms of pictures, based on different visual capacities, which Deregowski labels epitomic and eidolic. The former are devoid of a perception of depth and are of two main types, outline drawings and pin drawings, while the latter contain cues indicating perceptual depth. Deregowski argues that the capacity to perceive both epitomic and eidolic figures has been present throughout the time that people have been making pictures, and that the manner in which they are, or are not, incorporated into an artistic system is a matter of cultural preference.

Deregowski's work is most relevant to the analysis of figurative art which has a demonstrable iconic relationship to the depicted object — that is, the relationship is discernible to people not initiated into the system of signification. He explains a general tendency to depict animals from a lateral rather than a front or rear view in terms of the limited number of planes that exist which contain markedly high concentrations of information. Outlines which pass through the points of concentration of information, generally located at points of rapid change, are more likely to be chosen by artists seeking to produce an iconic representation since they transmit the overall information more efficiently. In representational art this makes 'better' pictures. The combination of perceptual process and cultural intent produces what Deregowski calls a typical view.

Deregowski argues that eidolic information facilitates the conveying of fine distinctions through the depiction of idiosyncratic features of an object and that this allows the possibility of individual portraits. He contrasts this with epitomic stick figures which he argues are more likely to represent a generic rather than a specific person, since this form of depiction is not conducive to the conveyance of the specific distinctions which are features of the individual. This distinction of Deregowski's is an important one for the study of both contemporary and archaeological art and one that clearly holds in most cases. An intriguing extension of this line of argument would be that sculpted figurines, through their three-dimensionality, have a great inherent potential to be used in the depiction of specific individuals. This is particularly interesting in terms of the 'Venus figurines' of the Upper Palaeolithic and raises the question of why the idiosyncratic detailing that might be attributed to a the depiction of a particular individual frequently is absent.

However, there are two points which I would like to raise. The first is that the artist may, indeed, have an individual in mind when drawing a stick figure, but that the identity of the individual may not be the main focus of the picture. I have known this to occur within my own experience of Aboriginal people making rock paintings in southern Arnhem Land. In this case a large picture of a fish was accompanied by a much smaller drawing of a stick figure holding a spear and another small drawing of a stick figure carrying a fish. The stick figure was identified by the artist as Lamjerod, the deceased leader of the clan on whose land the painting was made: his identity was coded into the picture through its placement in the landscape. In cases such as this information on specific identity may become lost or blurred immediately since it is not encoded in the picture in a way that can be decoded securely by people other than the artist (though it may survive through other communicative forms, such as language or systems of land ownership). *Ipso facto*, this was not the crucial information that was being communicated by the picture. This example demonstrates the possibility of specific identity being ascribed to stick figures.

My second point concerns the Wandjina figures of the Kimberley, each of which have individual identities and which in a loose sense might be considered to be portraits, even though they are depicted without cues indicating perceptual depth. In these cases identity cues relate to the placement of the Wandjinas in the overall landscape and the species that are depicted in association with them. This illustrates the possibility of individual portraits being depicted using only epitomic means and for the necessary additional information to be encoded in other ways.

I should like to finish my Comment on a general note. One of Deregowski's enduring research interests has been the establishment of cross-cultural regularities in perception and depiction. This is a difficult and a grand task. A task that is open to criticism by those of a postprocessual turn of mind on the grounds that each culture needs to be assessed in light of its own particular peculiarities and cultural proclivities. However, it seems to me that there is an abiding need for cross-cultural research of the type pursued by Deregowski: there is an inherent and broad value in seeking the actual links that exist between peoples who are disparate in time and space. I expect that cross-cultural studies such as that of Deregowski — enriched by the criticisms of postprocessualism so that they are less naive than earlier studies in a similar vein — will, indeed, turn out to be one enduring facet of post-postprocessual archaeological research.

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Cognising rock art

By PAUL S. C. TAÇON

For many years there has been much debate at AURA Congresses, in this journal and in publications throughout the world about the merits of a multi-disciplined analysis of rock art versus a strictly archaeological or anthropological approach. For instance, Robert Bednarik (1990b, 1994a, 1994b) has frequently publicised what he sees are the shortcomings of some archaeological and other Western scientific approaches to rock art studies, and there has even been an argument advanced that a new discipline with a new name should be founded (Kumar and Odak 1992; Odak 1991, 1992). On the other hand, researchers such as Paul Bahn (1992), Christopher Chippindale (1988), Robert Layton (1993), myself and others have favoured retaining the study of rock art within archaeology, or at least anthropology. However, we also have advocated incorporating perspectives from a wide range of specialists, indigenous peoples and special interest groups if this will assist us in better understanding some of the complexity and multitude of messages, motivations and meanings expressed on or with rock throughout at least 40 000 years of human history (e.g. Bahn 1978; Chippindale 1993; Taçon and Faulstich 1993; Taçon 1987: 42-3, 1994). For some, such as Whitney Davis (1986, 1987), Paul Faulstich (1992) or John Halverson (1987, 1988) this includes cognitive psychology (see also a recent discussion 'What is cognitive archaeology' in *Cambridge Archaeological Journal* 3[2]: 247-70, 1993).

In this regard Deregowski's paper is most welcome as it gives us fresh insight into observed differences or changes in some of the rock arts recorded in many parts of the world. A version of the paper was first presented at the First AURA Congress (Darwin 1988) and after several revisions it is at last published here. However, the paper appears too focused outside, on aspects of the discipline of cognitive psychology, rather than inward on the concerns of rock art research, so that it fails to tell us as much about rock art as I think the author intended. In the end it offers little that is new and instead reinterprets differences in rock art from a more narrow and less informative perspective than some anthropologists, art historians or archaeologists have done previously. But Deregowski does make some good points, so what I will attempt to do in the following paragraphs is to re-evaluate what he has said in light of observations made by others who more directly work with the sorts of images he examined.

To start, what does the title really mean? I do not believe that the paper provides us with 'a skeleton key to rock art and its significance' and I also do not believe that the punctuation in the first part of the title helps inform us about the paper's content. Something along the lines of 'The role of perception in depiction and communication among early humans' or 'The role of perception in understanding changes in rock art depictions' might have been better.

It is not only the title that suffers from lack of clarity. Unfortunately, there are numerous imprecise statements scattered throughout the text. For example, on the second page Deregowski says:

> Clearly, when two or more pictures are seen as presenting different views of the *same* object, two entirely different stimuli are seen as denoting the same object. The process could be described as follows. Each of the pictures is mistaken for the object itself; and since all of them are mistaken for the same object, all of them are seen as depicting the same object.

This is problematic for two main reasons. First of all, this statement is at odds with the rest of the paragraph. Secondly, I do not believe that most humans, past or present, mistake their depictions for the actual objects themselves.

Later we read 'Consider two distinct "schools" of painting, the Palaeolithic and the Bushman'. This is a very imprecise statement as Palaeolithic art is found throughout the world, not just in Europe! Anyone wishing to participate in discussions about world rock art has to abandon Eurocentric language, terms and notions. After all, in recent years we have been trying to do away with stereotypes or inaccurate impressions based on geographically limited research and we have seen how an obsession with a statistically small number of sites from Europe has distorted *our* perceptions of the rock art record. Furthermore, as Bednarik (1994a) notes, what really is Upper Palaeolithic rock art? 'The Upper Palaeolithic is a chronological pigeonhole that is not a real historical period, it does not define a culture, ethnic entity, and probably not a language group, religion or distinctive way of life' (1994a: 118). Certainly, it is not a 'school' as Deregowski contends. We have to be more precise in our statements, comparisons and discussions about different bodies of art and we should strive for accuracy in our research and our reporting of it.

Occasionally Deregowski uses obscure words to fancy up a sentence but ends up confusing us about the meaning of both the sentence and the paintings he refers to. For instance he states:

> ... it is doubtful whether it is legitimate to treat figures of humans and of other animals as if they were perceptually equivalent because whilst the animal drawings are such that they can be said to show the typical contours, this cannot be so in the case of homunculi. The figures of humans are essentially 'stick figures' ...

According to various dictionaries I consulted, it is not good form to use 'homunculi' interchangeably with 'human', as homunculi is often used to refer to 'little beings without a body, sexless and endowed with supernatural power, whom alchemists claimed to create' (*Webster's Encyclopedic Dictionary* 1988). Sometimes the word is used to describe dwarfs, manikins or diminutive men but these definitions are also not equivalent to 'human figures' or 'anthropomorphs' and imply some sort of interpretation. Again, the point is that we must strive for accuracy and preciseness in our descriptions and reporting, wherever and whenever possible.

Elsewhere wording is also loose, for example:

> It is also noteworthy that stick figures do not represent women as efficaciously as they represent men. Admittedly women can be portrayed in this style as if they were incomplete men.

Not only is this an inaccurate statement (I have seen dozens of successfully portrayed 'female stick figures') but also there is the ridiculous implication that women are incomplete men, or at least their portrayals are. In the end I am not sure what Deregowski's point is and I am concerned about the sexist overtones.

On the other hand Deregowski makes some excellent observations about the relationship between perception and depiction. For instance, his generalised list of four observations is very important and for the most part I agree with them. However, the last statement seems incomplete:

> All these 'laws' issue directly from the artist's drive to tell the 'perceptual truth': to portray objects as they really are and appropriately incorporate in pictures those characteristics of objects that are 'naturally' striking, in the 'real world'.

But are artists not driven by more than just 'perceptual truth' and a desire to portray objects as they really are in the 'real world'? Or does the 'real world' include imagined or unreal things? And are there not occasions when artists sometimes do not wish to tell the 'perceptual truth'? Indeed, some things are purposely not portrayed the way they really are by artists, so as to distinguish their renderings from similar objects, creatures or things that have different meanings. Artists the world over are particularly adept at this and many examples spring to mind. For instance, Rainbow Serpents are essentially very large snakes but for Australian Aborigines it has always been important to not confuse them with large pythons or other 'real' serpents. Conventions developed so that Rainbow Serpents are portrayed with essentially a snake-like form that is somehow different from the norm. They also have features from a variety of other creatures, such as macropod or crocodile heads, plant or animal appendages, and so forth (see Lewis 1988 and Taylor 1992 for examples) and there is much consistency across time and space in the use of these conventions (Taçon et al. 1995). What has occurred is that depictions derived from conceptions are made up of perceptions about actual objects or creatures. In other words, the elements of these 'unreal' creatures are derived from actual perceptions but when combined together they define a conception. In this way things not actually seen or experienced can be depicted. There are many other examples of this from other cultures and Tatiana Proskouriakoff (1971) has labelled such figures 'grotesque'. By this she means 'primarily a symbolic stricture which deliberately combines elements incongruous in nature in order to define a supernatural world' (1971: 134). Perhaps this type of portrayal is symptomatic of a subsequent stage of human cultural development. Obviously this is an area that needs further exploration and delineation.

The main point of Deregowski's paper is 'on the cultural implications of epitomic and eidolic pictures'. Depictions devoid of perceptible depth are termed epitomic while those that have a perception of depth are labelled eidolic. Two types of epitomic pictures are distinguished, outline drawings and stick or pin figures, and it is argued they are fundamentally different. Specifically, outline drawings can be made into eidolic figures through the incorporation of various surface details and depth cues but stick/pin figures cannot. Deregowski makes several observations about the uses and implications of use of these figures and most seem valid. However, I disagree with the statement 'a pin-man will remain a representation of a man throughout the process, it will not become a representation of a specific man'. In children's art it often does represent specific people, such as specific fathers, mothers, brothers and so forth. It is quite possible that in the minds of some rock artists, the pin/stick figures they made represented specific individuals (for instance, a repeated stick/pin figure in central Arnhem Land is shown with only one leg. He has a name, *Daddubbe*, and the representations are said to refer to a specific Mimi spirit that someone once encountered). However, without being able to consult the artists or their immediate descendants we will be unable to ascertain which specific personages were portrayed.

Finally, I think Deregowski's discussion of the two types of epitomic figures is important but needs to be grounded in a discussion of how these have been used by artists for two essentially different purposes, narrative versus iconic pictorial expression. Joan Vastokas (1990) has outlined their differences and applications in detail, basing her terms on an analysis of the work of Eliade (1959), Hallowell (1974) and others. She notes that these are the two basic modes of expression in visual art, especially that of indigenous peoples. As Vastokas (1990: 65) has stated:

> Each mode of expression is not mere stylistic difference, but serves instead a different function and communicates a different meaning. There appear to be two fundamentally distinct modes of pictorial representation in Native North America. One I term 'iconic', the second 'narrative'.

Iconic modes of expression that 'manifest the cosmic and timeless conception of an eternal present' (Vastokas 1990: 65) frequently consist of images that Deregowski has termed outline figures, although they usually have some form of infill. Narrative modes of pictorial expression that 'manifest historical and experiential space-time conceptions, grounded in experiential reality' (Vastokas 1990: 65), often are made up of Deregowski's pin/stick figures. Examples of this can be found throughout the world and recently the use of iconic versus narrative rock art imagery in northern Australia was documented. Again it was concluded that pin/stick figures most often related to narrative functions, while outline figures had iconic roles (see Taçon 1989b: 141, 1992: 205).

In conclusion, I think there is some merit to this paper but wish it were more fully integrated with relevant rock art literature. Cognitive psychology can be of value to rock art studies but it needs to be used carefully and in a considered manner. This is true of theoretical approaches from other disciplines as well and the best approach is a truly multidisciplinary one. For if we obtain similar results when testing hypotheses from a number of theoretical perspectives or when examining problems from a variety of viewpoints we must surely be closer to finding satisfactory answers.

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REPLY

By J. B. DERĘGOWSKI

Before addressing the issues which attracted the commentators' attention it is prudent to enlarge upon one of the main concepts used in the papers; the *typical contour*. The typical contour is a visual characteristic of an object which can be translated onto a surface for the purpose of efficacious depiction. The typical contour can be defined in mathematical terms as a globally defined curve connecting points of maximum curvature, whose principal direction corresponds to the minimal curvature. An excellent example of such a curve is the line of a horse's neck. This line is normally contained in a plane and an evocative depiction of a horse's neck and, by implication of a horse, is readily obtained by translating this plane onto a pictorial surface. When the typical contour curve is not planar, as is the case with the Kakadu crocodile (my Figure 5), translation onto the pictorial plane may result in a 'distorted' picture.

This expatiation places two of Halverson's figures (his Figures 2 and 3) in appropriate categories, which are not those of Halverson. His standing dog is a happy exponent of the potency of the typical contour; whilst its immediate neighbour shows what can happen when the typical contour is not used. This, second, figure is essentially an outline of a shadow of a dog cast by a light source high above (or perhaps well below) the animal by the rays which are effectively parallel to the plane containing the typical contour of the animal. It is, therefore, a portrayal far removed from that of the typical contour. It is, one suspects (one cannot be sure without seeing the beast), mischievously deceitful, as it represents as co-planar projections of elements which are not co-planar. (This phenomenon is first encountered in one's youth when one's elders by clasping their hands in curious ways produce on walls shadows of horses, dogs and rabbits. The surprise occasioned in such circumstances is the consequence of a mismatch between the typical contours of the hands and the typical contour shown by the shadow). The argument which Halverson advances about the number of twists and turns in the outlines of the two animals is therefore clearly out of place, but the figures do unambiguously support the relevance and perceptual significance of the typical contours and of the typical planes. A similar argument applies to the juxtaposition of two drawings of a column (one a side view, another a section, Halverson's Figure 3). The definition of the typical contour clearly indicates that in this case the typical contours run along the flutings. There are several such contours, just as there are several such contours in Clegg's echidna; but unlike in the case of echidna, they are perfectly equivalent since the flutings are identical. This, incidentally, would not be so in the case of an elliptical column; such perceptual egalitarianism of typical contours would not prevail. Flutings at the ends of the major axis of the section would be privileged, even though their own shape would not be noticeably affected by the change in the column's shape. The general elliptical shape should augment the significance of these particular flutings, the perceptual apparatus would take account of both the general shape and its local variation. It is an instance of the old principle of big fleas having little fleas, and is the same principle as that which Marr and Nishihara (1978) implicitly consider when postulating that an object such as a quadruped can be represented by means of generalised cones and that the finesse of the representation can be varied by varying the depictive significance of these cones, an issue considered further below. Therefore the column when drawn so as to show its typical contour should be drawn in side view by delineating any pair of typical contours which lie in a plane passing through the axis of the column. Such planes are not an unnecessary complication. On the contrary, they are central to translation from three dimensions into two.

Clegg's cat confirms these observations: it is much easier to recognise it by its shadow than by its plan view. This shadow is cast by the setting sun whose parallel rays have glanced the body of the animal near to the plane containing its typical contour so that the projected shape is very similar to that which the typical contour defines and is therefore readily recognisable.

The notion of the typical contour does not appear in Attneave's (1954) paper, but the closely related notion of redundancy of information does. The former notion subsumes the latter but is not identical with it, a point missed entirely by Halverson.

There are two distinct issues:

(i) How to identify the most telling outline of an object for its depiction?
(ii) Which features of an outline are most informative?

Attneave, pace Halverson, does not examine the first of these; he is concerned with the second. The picture of a sleeping cat, which is very similar to that reproduced by Halverson (Figure 1), is not used by him to show the most clearly recognisable representation of a cat but to demonstrate how a clearly recognisable picture can be made by connecting points which are orthogonal projections of the points of concentration of information on the animal's body, that is projections of points at which contours of the animal's body are subject to rapid change. This problem is central to his thesis. The relative perceptual efficacy of various views of the beast is not discussed by Attneave. It is a logical fallacy to argue that Attneave's answer to the second query answers the first.

The selection of an appropriate outline to depict an object is one of the central issues of the paper discussed. An artist has to decide how to depict an object; the extent to which his decision is influenced by the way his perceptual system works is under discussion. The paper argues for a two-stage process, (i) detection of the typical contours of a model (a process to which Attneave's observations are immediately relevant), and (ii) determination of an imaginary plane which provides a vehicle for translation of the contours from the model to the picture's surface (a process which Attneave does not consider). The perception mechanisms involved in picture making are, however, not uniquely concerned with picture making and pictures (which clearly are adventitious artefacts) but, as empirical data (Deregowski et al. 1995) show, are exercised daily by the need to discriminate amongst objects.

Consider Clegg's echidna (his Figures 1 and 2). These creatures are depicted from various stances: as seen from above, as seen laterally, and also curiously twisted in a manner reminiscent of the Kakadu crocodile (my Figure 5). It seems more plausible that, as in the case of the crocodile, the absence of unique clearly defined typical planes, rather than echidna's metaphysical equivocations, is responsible for such depictions. Some objects, Claire Smith observes, have a number of such planes in perceptual competition. When several such planes are concatenated, as they are in the case of the Kakadu crocodile, twisting may result, but when such planes intersect the draughtsman may feel obliged to choose one of them. Clegg's drawings suggest that the echidna has a pair of such intersecting planes (one approximately vertical and another approximately horizontal) passing through its body and a concatenated pair passing through its head. This scheme offers four distinct combinations, three of which Clegg has drawn. The missing combination is that showing a 'plan view' of the body and a side view of the head. This is shown in Figure 19.

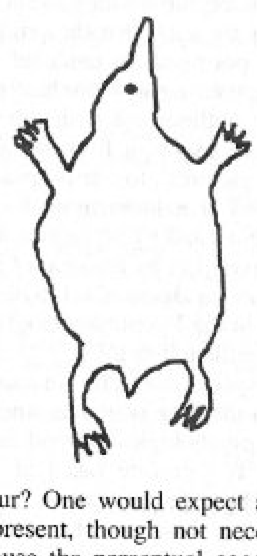
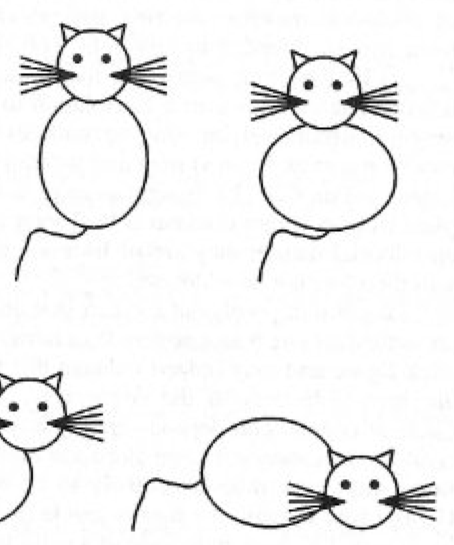


Figure 19. Echidna's 'plan view' of body combined with side view of head.

Do such portrayals occur? One would expect all four types of portrayal to be present, though not necessarily with equal frequency because the perceptual cogency of the two planes relating to each part of the animal need not be equal. One would expect that the depiction combining the more cogent contour of the head with the more cogent contour of the body would be found most frequently, that consisting of the two less cogent contours least frequently, whilst those consisting of one of each kind of contour would occupy intermediate stances. It should be possible to obtain the relevant frequencies and to see how they match the wee beastie. Multiplicity of typical planes which depictions of the echidna may show, as Clegg observes, results from changes of echidna's mood.

Echidnas are not unique in this respect. All animals change their typical contours. The extent to which this is done varies considerably from species to species. The capacities of a tortoise in this sphere are meagre when compared with those of a hare and the hare's are less than those of a cat, say. Cats, pace Clegg's rigid bottle-cat, scarcely have a constant shape. The typical contour of a walking cat is very similar to that of many other quadrupeds walking but the typical contour of a sitting cat or that of a cat curled up are strikingly different. Such variability of the contour makes detection of stable, preferably rectilinear, central axes which are used in construction of stick figures (of which more below) impossible. Hence cats are unlikely to be so drawn and other devices need be employed. One such device is that of adaptation of the manner of depictions of other animals whose shape is at times similar to that of the cat, but is also inherently more constant. Most quadrupeds would provide an appropriate model. Another method is to advance the notion implicit in Clegg's cat's whiskers and create the collage consisting of selected elements, say, (1) whiskers, (2) pointed ears, (3) round head (4) oval body, (5) long sinuous tail, (6) two dots for the eyes (in acknowledgement of their ethological significance). Such collages are often drawn (generally copied, not devised) by children. Four such cats appear in Figure 20.

Figure 20. Four cat collages.



Unfortunately no evidence seems to be readily accessible as to the frequency (predicted to be low) of pin figure depiction of cats, nor of the frequency (predicted to be rather low) of their depiction in any other manner.

Clegg's comment about the whiskers is also of more general interest because it clearly applies to all manner of representation. It applies for example to three-dimensional models. A toy elephant about 8 cm tall and made of grey plastic has its surface roughened in imitation of hair. Considering the size of the toy it is an instance of gross mis-scaling. The elephant's body should be smooth. Yet as in the case of Clegg's cat so here this perceptual incongruity does not offend, it is acceptable, indeed, welcome.

Pure stick figures can be thought of as assemblages of axes of generalised cones describing an object in Marr and Nishihara's (1978) speculations on object recognition. In these terms an upright human being can be described as an assemblage of six cylinders: a short squat cylinder for the head, a longish cylinder for the body, and four intermediate cylinders for the limbs. Such a depiction can be extended by including axes of other cylinders representing other parts of the body. The essential requirement of this manner of portrayal is perceptual derivability of the axes from the outer contours of solids. Such axes are not always apparent. A bag of flour has such an axis but an empty bag has not. Objects which do not have a reasonably permanent axis cannot be effectively drawn as stick figures. Women's breasts fall in this category. Their elusive shape has compelled the Tallensi artist (see Figure 12, which incidentally shows that Halverson's assertion that stick figures have no cultural role, is somewhat overhasty) to abandon the 'stick style' used for the rest of the body and to draw, in mid-air, two objects of nondescript shape. When Taçon maintains that he is familiar with dozens of 'female stick figures' I take him to mean females of the human species, and suspect (since he offers no illustration) that his definition of a stick figure differs from mine. He cannot possibly mean stick figures in their pure form for the simple fact that women lack distinctive morphological characteristics which lend themselves to depiction by means of axes of generalised cones. Men do happen to have such an organ which is unique to their sex and which is frequently depicted (Figures 11, 12, 14). The sexes can therefore be happily differentiated even in the purest form of stick-drawings by omitting the relevant central axes from figures intended to represent women thus depicting women by depicting incomplete men. Alas, this cannot be helped. There is however a consolation to be had. In half-length portraits relying on the outlines (and therefore, clearly not stick figures) men and women can be differentiated, and men can be thought to be represented as incomplete women. Other comments by Taçon are essentially of an editorial nature; they are of little scientific import and will therefore not be addressed.

Claire Smith points out the fact that an artist may have an individual (such as Lamjerod) in mind when drawing a stick figure and may indeed indicate this by means which are accessible only to the cognoscenti. The size of the circle of cognoscenti depends greatly on cultural familiarity. A man wearing a strange attire and doing rather unpleasant things to a dragon is likely to be recognised as St George well outwith the narrow circle of those devoted to hagiology, but the significance of a palm frond in a hand in another portrayal is likely to be less generally known. When learning of the significance of various devices is called for, simple perceptual speculations on their own are simply inadequate; they can only explain certain aspects which are related to the perceptual apparatus common to all human beings. Finer and more specialised apparatus are needed to explain esoteric differences in depictions. The Wandjina figures, Smith observes, convey individual characteristics although they are strictly epitomic. This is done by their juxtaposition to other depicted objects; i.e. the very same manner in principle, as that used to indicate martyrdom by depicting a martyr as holding a palm frond. Such devices are however not always necessary to make epitomic figures represent individuals. Although silhouettes of heads are perfectly epitomic they are, provided that they incorporate the typical contour of the human face, that is, show it in profile, readily recognisable as depictions of individuals. Had Clegg's cat been unfortunate enough to have his tail trodden upon when dozing on the carpet (a likely occurrence because the uniform density gradient extending over both the cat and the carpet renders the former not only perceptually identical in pattern but also perceptually flatter), the resulting kink would indubitably show in his monstrous shadow and would individualise him greatly.

The notion that epitomic figures (not just epitomic stick figures, pace Halverson) contributed to development of writing is questioned. Written statements are referred to in the paper as descendants of *epitomic* figures. The hypothetical development sequence is implied to be thus: epitomic outlines develop into eidolic figures and pin figures. For this very reason it is difficult to see why developments of Sumerian writing, which, as Halverson says, 'contains clearly outline figures', contradicts the postulated development. It may help, perhaps, to re-examine the entire problem briefly.

Two psychological vectors are postulated to be involved in the development of writing, one 'cognitive', another 'perceptuo-motor'. The former is responsible for the detachment of a picture from a particular model. Claire Smith's stick figure cannot be used to represent men in general as long as it is perceived as representing Lamjerod. The stronger the perceptual cues indicating that it is Lamjerod, the greater the resistance to such generalisation. Since outline drawings make it easier to depict idiosyncratic characteristics (it is quite easy, for example, to distinguish between a tall thin man and an equally tall fat man) than pin figures do, the latter are more likely to foster the desired conceptual abstraction. There appears, alas, to be no empirical evidence immediately pertinent to this issue.

The perceptuo-motor issue concerns changes in portrayal which are such that the original meaning is preserved, but the portrayal is rendered easier to reproduce. Pin figures are easier to reproduce than epitomic outlines and epitomic outlines are easier than eidolic pictures. Hence one would expect a form of communication which uses eidolic pictures to drift gradually towards epitomic pictures by abandonment of the inner content of the epitomic outlines and by replacement of these outlines by their central axes, i.e. by creation of stick figures. Such a trend is present in Jewson's (1970: Fig. 53) table showing changes in the Egyptian hieroglyphs between the third and the first millennium B.C.

The speculation put forward rests, however, not so much on the data available, since data are very sparse, but on the psychological hypothesis that such two vectors exist. It is therefore taken at a risk. The issue can be resolved by experimentation.

*

Résumé. *On examine des représentations sur roche d'origines variées et soutient que la façon de représenter est gouvernée par la manière dont les méchanismes perceptuels opèrent. On soutient de plus qu'une taxonomie des représentations peut être établie et que cette taxonomie discerne essentiellement les différents modes de représentations, eidoliques et épitomiques, qui servent de base aux genres distincts de représentations symboliques.*

Zusammenfassung. *Felskunstdarstellungen verschiedener Quellen werden untersucht und es wird erörtert, dass die Darstellung von der Weise bestimmt wird, in der Wahrnehmungsmechanismen wirken. Es wird weiters besprochen, dass eine Taxonomie von Darstellungen festgelegt werden kann, die grundlegend verschiedene Arten von Wiedergaben unterscheidet, eidolisch und epitomisch, die deutlichen Arten symbolischer Wiedergabe als Basis dienen.*

Resumen. *Representaciones en arte rupestre de una variedad de fuentes son examinadas y se argumenta que la manera de representación está regida por la manera en la que operan los mecanismos de percepción. Se argumenta además que una taxonomía de representaciones puede ser establecida y que esta taxonomía distingue de manera muy depurada diferentes clases de representaciones gráficas; de reproducción de imágenes y de resúmen, que señalan distintas clases de representaciones simbólicas.*

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KEYWORDS: ***Beeswax* - *Native bee* - *Rock art* - *Wandjina* - *Ethnography* - *Kimberley***

BEESWAX ROCK ART IN THE KIMBERLEY, WESTERN AUSTRALIA

David Welch

Abstract. Beeswax obtained from the hives of native bees has been pressed onto rockshelter walls in order to make various designs. This paper describes and illustrates this form of rock art in the Kimberley region. General notes on the Aboriginal uses of beeswax and the significance of the native bee to the Kimberley tribes are included.

Introduction.

The first published account of beeswax figures in rock art was by Brandl (1968), who described this art form in the region now known as Kakadu National Park. He used the term 'collage technique' to describe the application of lumps of beeswax in definite shapes to rock surfaces. Beeswax figures from this region have subsequently been illustrated and discussed by Edwards (1979), Welch (1982), Walsh (1988) and Chaloupka (1994). Chaloupka has described the Kakadu region's Aboriginal names for the different native bees, their honey, and the uses for the beeswax obtained from the hives.

In the Kimberley region, only one example of a beeswax figure has been published (Utemara and Vinnicombe 1992), and mention has been made of the existence of anthropomorphous figures and a Wandjina head (Walsh 1991: 132). Crawford (1968) has illustrated paintings of native beehives and given accounts of some of the related mythology. Akerman (1979) has provided a detailed account of the Aboriginal names and significance of the bees and their honey ('sugarbag').

In other areas of Australia, rare examples of beeswax art have been noted in the Victoria River headwaters and the Keep River area. Both these areas are located between the Kimberley region to the west and the Kakadu region to the east. Well over a thousand kilometres to the east, a pressed beeswax pellet has been added to a painted flower-like motif in north Queensland's Princess Charlotte Bay area (Walsh 1988: 240-1).

Comparing my research in both the Kakadu and Kimberley regions, one finds that sites with beeswax figures are relatively common in the Kakadu region where motifs include animals, squatting females, simple human figures with 'spears' and 'spearthrowers', and rows of pellets. Pellets of beeswax have also been placed on painted figures in Kakadu in the position of the eyes, joints and sexual organs.

However, in the Kimberley region, beeswax figures are far less common, and these will be discussed here.

The Australian (stingless) native bees

Australia has more than ten species of stingless native bees which have recently been divided into two genera (Dollin and Dollin 1994). These are the *Trigona*, which are black with thick white hair on the face and sides, and *Austroplebeia*, which are black with tiny yellow markings. Previously, *Plebeia* was a subgenus of *Trigona*, and this has now been reassigned to the separate genus of *Austroplebeia*. Australian native bees are small black insects which look superficially similar to the common fly. They have no sting and make their nests in the hollow trunks and branches of trees, in the ground, or in rock crevices, including sometimes in the back of rockshelters and in building cavities.

The Aborigines of the Ngarinjin, Worora, and Wunambal tribes of northern Kimberley recognise three distinct types of native bee (Akerman 1979). The name of each varies from tribe to tribe. Using the Ngarinjin language, *namiri*, the largest, is the only one that lives in the ground or in rock crevices, but it can also live in trees. Its honey is thick and syrupy. *Narra* is the next down in size, and lives exclusively in hollow trees. Its honey is the most fluid. *Wanangka* is the smallest and also lives exclusively in trees.

These three types are recognised by entomologists as three distinct species, but their scientific names have changed since Akerman's 1979 paper (Graham Brown, pers. comm.). *Namiri*, the largest, is *Trigona hockingsi* (Rayment 1932: 106) which is also found across the Northern Territory and north-east Queensland. The worker bee averages 4.5 mm in length. *Narra* is now known as *Austroplebeia essingtoni* (Cardale 1993: 319), about 4 mm in length, and this bee is also found across the coastal Northern Territory. *Wanangka* is an unnamed *Austroplebeia*, about 3.6 mm in size.

As Aborigines walk through the bush they keep an eye out for any sign of these bees. When seen the bees are followed to their hive whereby the honey can be scooped out and eaten. Sometimes, when a beehive was located high in a tree, notches were cut with a stone axe into the trunk to allow footholds in order to climb the tree. The stone axe was often used to widen the hive entrance and to cut into the tree to obtain the contents of the hive. Trees can be seen today in the Kimberley that have old footholds still visible on them. Akerman notes that the stone axe in the Kimberley was usually owned by the women rather than the men. He also noted that it was the women who did the final work in making a stone axe, grinding the edge and hafting the stone.

In Arnhem Land in the Northern Territory of Australia, sometimes when a stone axe is made it is decorated by painting it with ochre pigments. Often the design painted is simply dots, and I have been told by Aborigines that these dots represent the bees whose wax was used to bind the axe head to the handle. In turn, the design is placed on the stone axe because that implement was so important in obtaining the beehives for honey and wax.

Once the hive is reached, handfuls of the hive contents can easily be scooped out without any danger because the native bee has no sting. The contents of the hive are put into the mouth, and this may include the honey, wax, pollen and some of the bees themselves. The sweet honey is sucked from these clumps, and the remaining material, consisting mainly of wax, then becomes a useful commodity.

Rock paintings of bee hives occur regularly throughout the Kimberley region. They often appear in a segmented or compartmental form, representing the pollen and honey pots (Figure 1).

Beeswax resin in the Kimberley

Of the three types of bee, the *namiri* (Ngarinjin) is the largest, is slow flying, and has thick-walled honey pots which do not have to be handled as delicately as the others. The wax extracted from *namiri* is called *njal*. After the honey was chewed or squeezed from the comb, the remaining wax was then beaten and mixed with powdered charcoal or ochre before being used (Akerman 1979). This beeswax is easily moulded when fresh, but dries out to a hard consistency when exposed to light and air. However, it can be softened and re-used if needed, simply by heating it over a fire.

Beeswax was used in the following ways:

(A) Hafting and binding, along with bush string, such as in:
- (1) Stone axe heads to wooden handles
- (2) Spearpoints made from stone, hardwood, metal or glass to spear shafts
- (3) Stone adzes (chisels) to wooden handles
- (4) Hardwood hooks to spearthrowers
- (5) Feathers to body adornments and ornaments
- (6) Pearlshell and other items to bush string to make pendants, necklaces etc.

(B) Sealing and water-proofing items such as the bark bucket, *garagi*, or the bark coolamon, *anngum*.

(C) Repairing items such as filling in a knot hole in the wood of a spearthrower, or filling a hole in a broken baler-shell water container.

(D) To form the mouthpiece on didgeridoos. (It is thought that didgeridoos may have been introduced to the northern Kimberley in historic times.)

(E) Children played with the wax like a plasticine and used it to make models.

Beeswax resin was similarly used in various ways across the rest of northern and coastal Australia where native bees occurred. Stingless bees are found on other continents, including Africa and tropical America. Irian Jaya and Papua New Guinea to Australia's north also have similar bees, and the indigenous people there use beeswax extensively in making their body decorations and artefacts. However, there are no reports yet of beeswax rock art from these areas. In central Australia, where these bees do not occur, resin for artefacts is obtained primarily from spinifex grass (*triodia* sp.), and it is the honey ant that provides a sweet component to the diet.

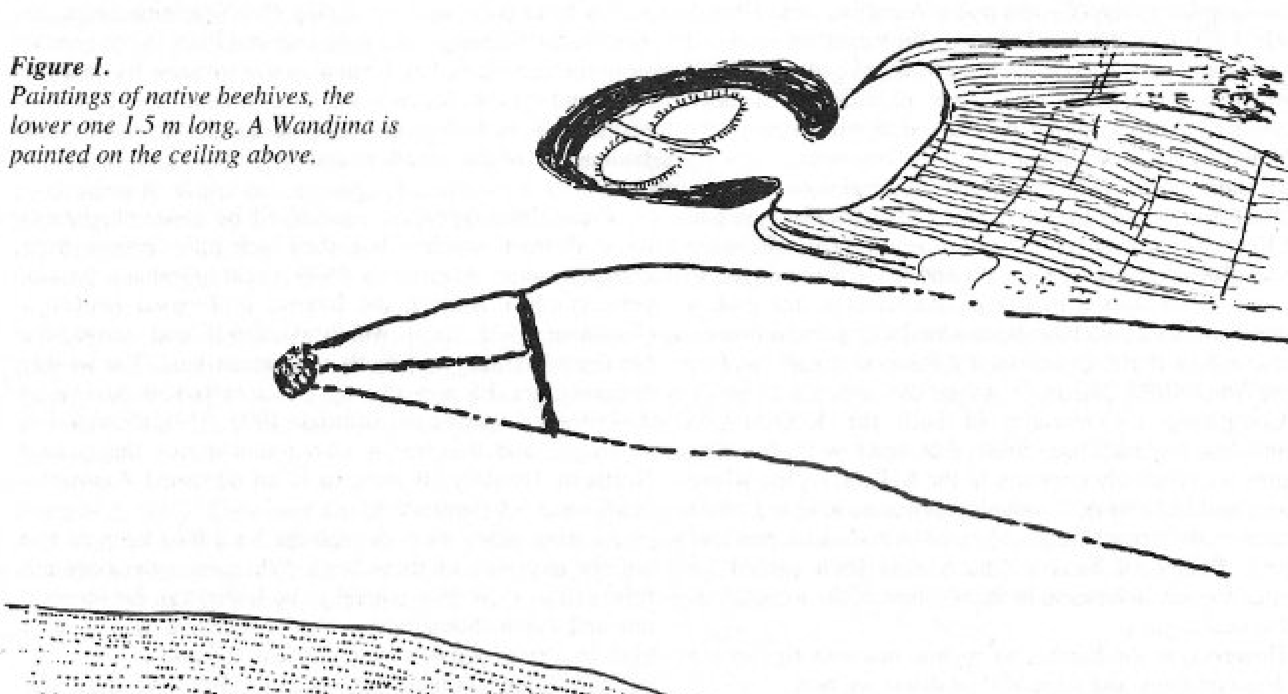

Figure 1.
Paintings of native beehives, the lower one 1.5 m long. A Wandjina is painted on the ceiling above.

Other resins used by Kimberley Aborigines in artefact production were extracted from trees such as the cypress pine and from the root of the ironwood tree. These other resins are harder and more brittle when they set, they set quicker, and they lack the adhesive properties of the beeswax resin. It is for this reason that they are less suited for application to a rock surface as an art form. If used, they were probably more likely to peel from the rock with subsequent weathering. I have not yet recognised any other resins in Kimberley rock art, but in the Kakadu region, Chaloupka (pers. comm.) has seen an ironwood resin figure.

Beeswax rock art in the Kimberley

My research in the Kimberley would suggest that the incidence of sites with beeswax figures is about four or five per thousand art sites, compared with an incidence of about twenty-five to thirty per thousand in the Kakadu region. These sites are widely scattered and no concentration of sites has yet been discovered. All beeswax figures appear in the rockshelters of the quartz-sandstone areas. Some shelters have only single motifs while one shelter has been found containing eight figures.

Other researchers have also found beeswax figures to be rare. Kim Akerman saw one turtle figure at a coastal site (pers. comm.), and Pat Vinnicombe recorded a figure identified as *Djangarr*, a lightning figure, by Aboriginal informants in 1981 (Utemara and Vinnicombe 1992). This figure was identified as a 'painting' by her informants who at first did not recognise that beeswax had been used. After discovering that beeswax had been the art medium, the informants remembered how they had made small models with beeswax when they were children (P. Vinnicombe, pers. comm.). At a nearby site she saw other weathered human-like figures in beeswax.

Beeswax art occurs either as motifs made entirely of this material, or it forms part of otherwise painted motifs. The *Djangarr* figure illustrated by Utemara and Vinnicombe (1992) is an example of this latter form. Its body and penis outline are in beeswax, while the infill on the penis is in red ochre.

The known motifs of Kimberley beeswax figures include the following categories:

(1) Simple human figures
(2) Animals ('dingo', 'turtle')
(3) Wandjina and other spirit figures
(4) Animal tracks (macropod)

The rows of pellet dots seen commonly in the Kakadu region and any evidence of 'contact' beeswax art have not yet been identified in the Kimberley.

It is interesting to note that the Reverend Love (1930: 8) was shown a shelter in the Kimberley where a line of beeswax had been made in order to form a drip line to divert rain water from damaging a painting. This is a remarkable example of early rock art preservation by Aboriginal people.

One large occupation shelter has been found that contains eight beeswax figures in various states of preservation (Figure 2). Towards the back of the sloping roof, the beeswax appears relatively dark, glistening and fresh. It can be indented with the tip of one's fingernail. This is level (A) in Figure 2. However, the beeswax figures on the vertical rock face below, more exposed to the weather and sunlight, appear whiter, hard, brittle, cracked, and parts have dislodged from the rock surface (level B).

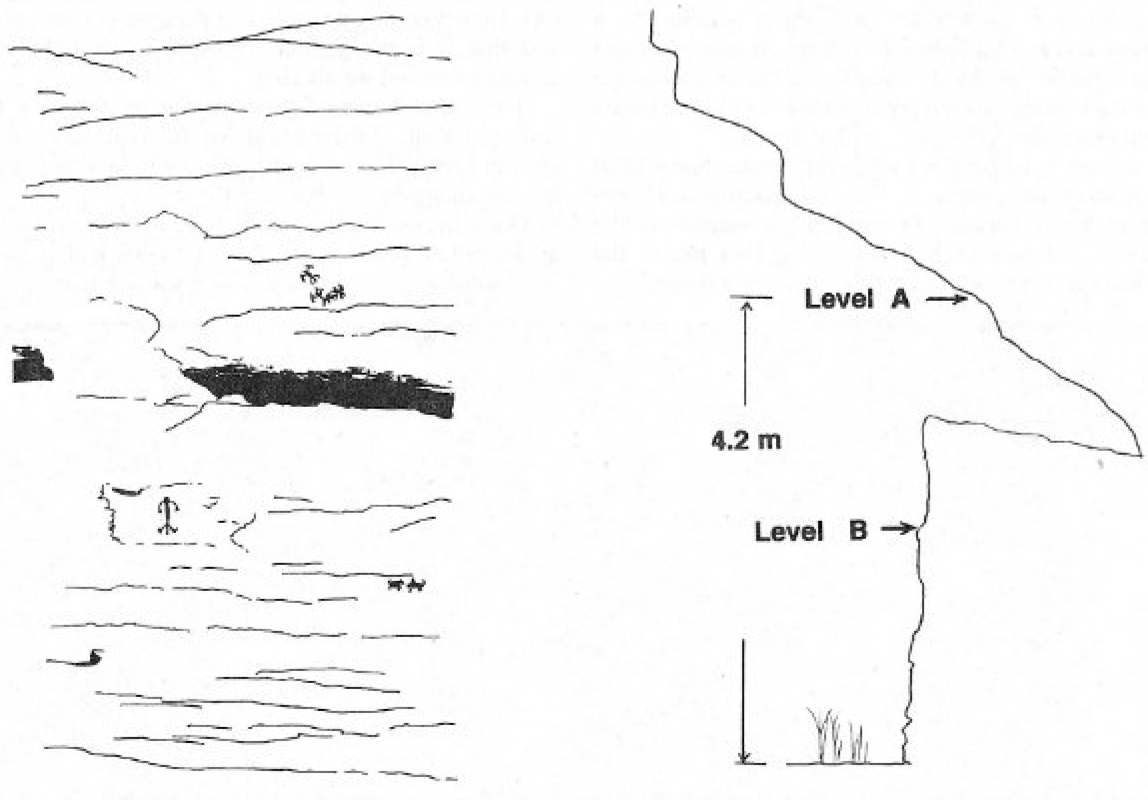

Figure 2. *Plan and profile view of rockshelter with beeswax art.*

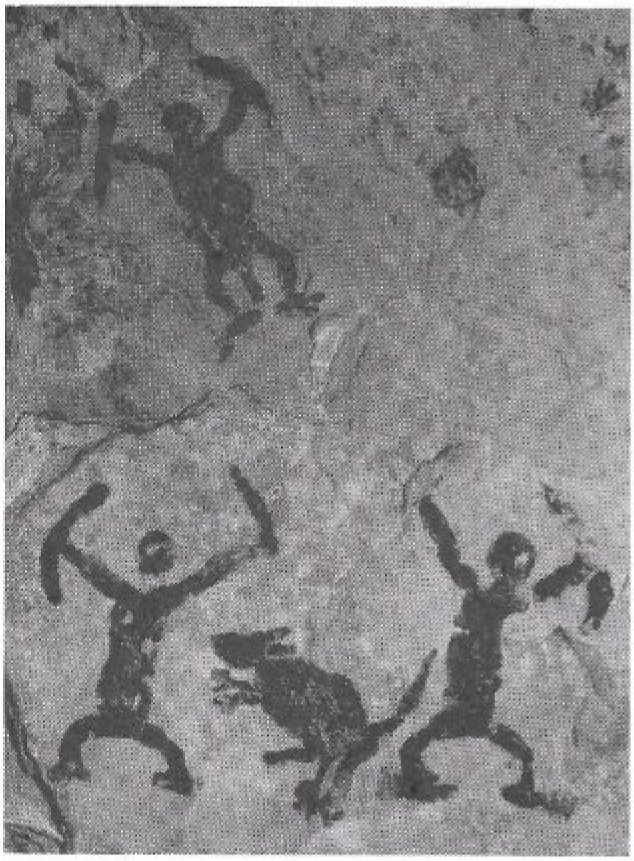

Figure 3. *Beeswax of fresh appearance. Lower human figures 17 cm tall.*

Figure 5. *Weathered beeswax figure, 29 cm tall.*

Figure 3 depicts a composition of three human figures and an animal at level (A). Each human figure holds what may be interpreted as one bent object similar to a boomerang and one straighter object which may represent a club or a throwing stick. The top figure has an appendage between the legs that may represent a waist or pubic tassel, ornament or a penis.

The animal between the two lower figures has a head and body shape suggestive at first of a macropod. However, the high tail, forward facing genitals anterior to the hind limbs, and lack of macropod hind foot makes the correct identification more likely to be that of a dingo.

Figure 4 depicts two more animals of similar form at level (B). The difference in weathering is apparent, making these two figures appear much older than those at level (A). However, it is possible that they are contemporaneous and that it is the greater exposure to daylight that has caused increased weathering.

Two other human figures appear on the rock face at level (B). Both of these are also quite weathered, one being seen in Figure 5. This figure appears to lack any weapons, but has an appendage between the legs.

Other beeswax applications have been seen where only an irregular 'blob' of beeswax remains and it has been impossible to tell whether a design was intended.

Figure 4. *Two beeswax animals of weathered appearance. Complete design 27 cm across.*

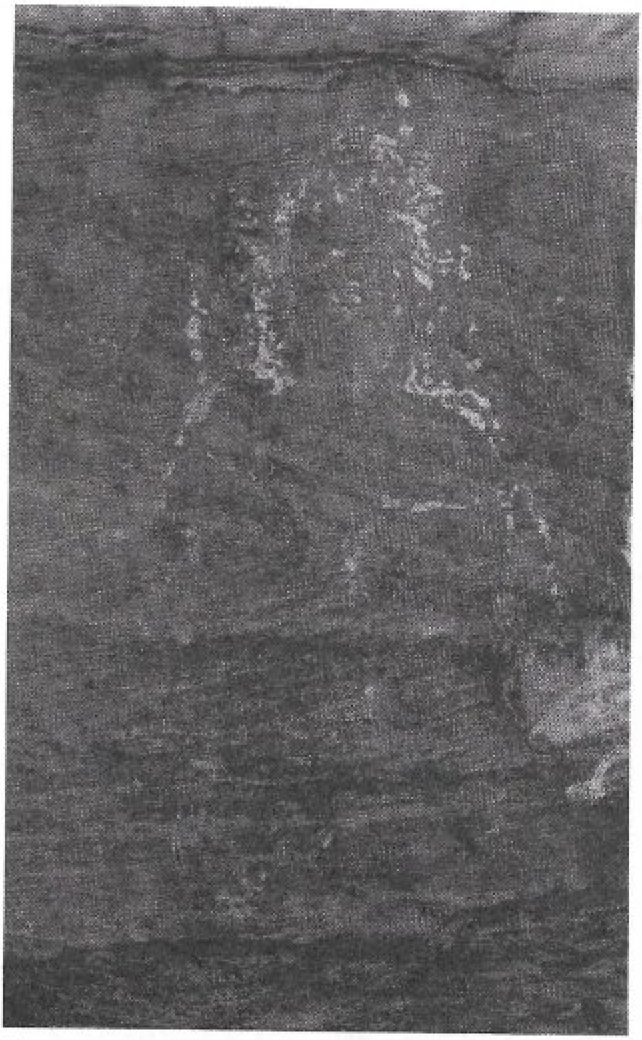

Figure 6. Beeswax Wandjina figure, the feet extending below the rock ledge.

Beeswax Wandjina figures

The Wandjinas are very important ancestral beings who typically have a crescent-shaped headdress and a face without mouth. There are many paintings of Wandjinas across the northern Kimberley (Figure 1).

Figure 6 depicts a beeswax form of a full-length Wandjina figure found in a river gorge. It is located in a small recess, facing slightly downstream, and would be covered by water for at least a few days, if not weeks, each year during the peak of the Wet Season flooding. As well as this, the morning sun shines directly into the small shelter. Most of the figure is on a vertical face and appears very weathered because of its exposed position. However, the feet of the Wandjina continue under the rock ledge and appear darker and fresher. They can just be seen in the photograph, but Figure 7 has been drawn to assist the reader. This excellent example demonstrates how it is the sun or light exposure that mostly determines the rate of beeswax deterioration.

The features that enable one to identify this as a Wandjina are the head/headdress shape and the 'chest' line with the central chest decoration, *rungoo* (Walsh 1988: 186). This chest design variation is found on some Wandjinas. Figure 8 has been drawn as a possible reconstruction of the original figure.

Figure 7. Drawing of beeswax Wandjina in Figure 6, 59 cm tall.

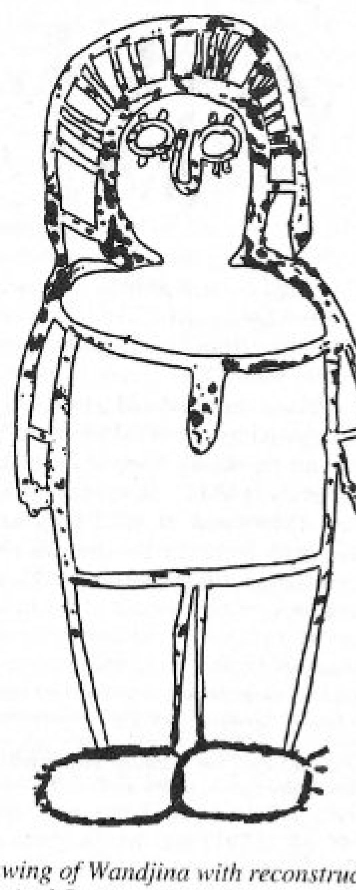

Figure 8. Drawing of Wandjina with reconstruction of possible original figure.

Although this Wandjina was located in a small recess, the flat rocks of the river bed in front of the shelter were covered in well patinated 'grinding hollows'. These grinding hollows are large cupules, about 10 cm in diameter, often found in occupation sites across northern Australia and are of great antiquity (Welch 1982: 82). Their occurrence at this particular location suggests that occupation of the site may predate the Wandjina figure.

Antiquity

The motifs seen in beeswax appear also in the painted art forms of the Kimberley. As for the simple human figures, the painted equivalent is often found in an orange-red pigment, appearing to be amongst the topmost paintings wherever superimposition occurs. Examples from three different sites are illustrated in Figure 9.

Figure 9. Crudely executed paintings at three separate shelters. Upper left figure 37 cm tall, upper right approx. 17 cm, while the lower figures are 14 cm tall.

Recently, Nelson carbon-dated a turtle figure in Kakadu to an age of approximately 4000 years BP (Nelson et al. 1993). New carbon dating techniques using accelerator mass spectrometry (AMS) have now been applied to Kimberley art (Morwood et al. 1994), and samples of beeswax have been included for analysis (Morwood pers. comm.). I look forward to the results of this exciting aspect of rock art research.

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Australia

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Résumé. *De la cire d'abeille provenant de ruches d'abeilles indigènes a été pressée sur les parois d'abris-sous-roche de façon à produire une variété de motifs. Cet article décrit et illustre ce genre d'art rupestre dans la région du Kimberley. Des notes générales sur les usages de la cire d'abeille par les aborigènes sont incluses, ainsi que sur l'importance de l'abeille indigène aux tribus du Kimberley.*

Zusammenfassung. *Bienenwachs von Stöcken der Wildbienen wurde in die Wände von Abris gepresst um verschiedene Felskunst Motive zu schaffen. Dieser Artikel beschreibt und illustriert derartige Formen von Felskunst im Kimberley Gebiet von Australien. Allgemeine Bemerkungen über die Verwendung des Bienenwachses durch Aborigines, sowie die Bedeutung der Wildbienen für die Kimberley Stämme sind eingeschlossen.*

Resumen. *La cera de abejas obtenida de las colmenas de abejas nativas ha sido apretada sobre paredes de abrigos rocosos para hacer varios diseños. Este artículo describe e ilustra esta forma de arte rupestre en la región de Kimberley. Se incluyen notas generales sobre los usos Aborígenes de la cera de abejas y la importancia de la abeja nativa para las tribus de Kimberley.*

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THE PETERBOROUGH PETROGLYPH SITE: REFLECTIONS ON MASSIVE INTERVENTION IN ROCK ART

Paul G. Bahn, Robert G. Bednarik and Jack Steinbring

Abstract. The effects of massive interventions at petroglyph sites are considered by examining the history, procedures and results of such practices at a public site near Peterborough in Canada. It is argued that the impact of projects such as the massive altering of environment needs to be monitored independently, and that such objective information is required in the planning of other projects of this kind. The need for competent scientific assessment of such projects is stressed, and the paper considers the potential disadvantages of massive intervention projects.

Introduction

It is amply clear that policies and practices in rock art preservation and management have been subjected to considerable changes over the past ten or twenty years, and that it would be grossly unfair to criticise any rock art management practice of the past on the basis of today's standards. In reflecting upon the practices of massive intervention in rock art, our aim is primarily to establish the extent to which their effects have been or are being monitored and examined. We consider such reflection necessary for the creation of an empirical base for more developed future strategies in rock art site management.

It will also be clear that we could have singled out for examination any one of the many intervention projects we know of, and that whatever criticisms are implied in the present paper would no doubt in some form apply to many others. The Peterborough petroglyph site is selected here merely because it represents an interesting conjunction of factors, including a fairly long history of intervention and the use of a considerable variety of techniques, representing much of the spectrum of such measures. Also, the project has been hailed as an exemplar of modern site protection measures, which is likely to lead to the emulation of its specific measures in other projects.

Any radical alteration of a site within its natural environment is experimental. It is entirely impossible to perceive, much less calculate, the profound range of variables which come to bear upon the transformed conditions. The degree to which empirically derived predictions can be met becomes the degree to which planned changes will be successful. Only rarely are sufficient data available by which the impact of alteration can be measured. This is because the reasons for intervention on any major scale can themselves be highly complex, and quite often conditioned by factors entirely separate from the simply stated goals of conservation and preservation. To balance perceived physical needs with the art of architectural design, the cross-currents of political interests, the availability of funding adequate to the best plan, personal and group ambition, the interest of the media, and the changes in nature itself is an act not suited to the abilities of mere humans. The structural protection of the Peterborough petroglyph site involves all these things, and more.

The Peterborough project

The Peterborough petroglyph site is located 54 kilometres north-east of the city of Peterborough, Ontario, in the Petroglyphs Provincial Park, Burleigh Township, Peterborough County, Canada. The site occurs at the southernmost edge of the Precambrian Shield, a vast granitic peneplain which covers nearly two-thirds of Canada. A reported concentration of over 900 petroglyphs occurs in an area encompassing less than 80 square metres. The petroglyphs are pounded and ground into a metamorphosed white crystalline limestone, also referred to as 'white marble'. It is a soft, crumbly material extensively invaded by algal colonies.

The modern rediscovery of the site took place as early as 1924, as reported by Charles Kingan (Vastokas and Vastokas 1973: 143). However, no real attention was directed to the site until 12 May 1954, when it was again rediscovered by Ernest Craig, Charles Phipps and Everett Davis of Industrial Minerals of Canada while they were examining some mining claims. The next day Nick Nickels, a reporter for the *Peterborough Examiner*, took the first photographs of the site, initiating an uninterrupted history of media attention to the site. A concern for site protection led very quickly to a formal survey with test excavations by Paul Sweetman of the University of Toronto in July 1954. His report (1955) constitutes the first professional coverage of the site. Sweetman concluded that the petroglyphs may have been executed by local Archaic populations (a nearby site had yielded Archaic materials) or Algonkians of Late Woodland times. He recommended that it be protected, and the Ontario Department of Lands and Forests later erected a chain-link fence around part of it. In the summer of 1967, Joan and Romas Vastokas, art historian and archaeologist respectively, undertook the most extensive study of the site (1973). In 1972, the site became incorporated into Petroglyphs Provincial Park. The tourist activity generated by this development eventually led to more exacting concern for protection and ultimately to massive structural intervention. A building was erected over the site in 1984, at a cost of close to $Can800 000.

With perhaps as much as sixty years (1924-1984) of preconstruction interest in the Peterborough site, it is inevitable that procedures alien to current conservation practices will have been applied. The first publicly documented case of what are now considered to be inappropriate (and often destructive) procedures is noted by the celebrated Canadian rock art authority, the late Selwyn Dewdney (Dewdney and Kidd 1967: 158). Without mentioning the site in his text, he presented an illustration of a small concentration of petroglyphs in which 'the surrounding rock has been chalked for photography'. Since the petroglyphs themselves are very dark, it seems possible that some darkening agent has been added to the engravings as well. If so, such an effort would only anticipate extensive future treatments. For example, Vastokas and Vastokas (1973: 143, note 14) indicate that prior to their 1967 field project 'some of the more pronounced glyphs had been filled in with crayon ... to give visitors a view of the site'. The initial fencing by the Ontario government had failed to incorporate all of the site, so petroglyphs recorded by the Vastokases outside the fence were filled with charcoal for enhancement. This 'was washed away after recording and photography (1973: 143). Since many petroglyphs were discovered outside the fence, they remained unprotected. The 'washaway' charcoal was applied because the otherwise nearly invisible motifs would tend to be protected from vandals who might alter and deface them (1973: 16, Pl. 8).

Inside the fence, the Vastokases continued the practice of using wax crayon to enhance the glyphs (1973: 143, note 14). At the time the Vastokases were writing their privately published book on the site, Selwyn Dewdney and Nathan Stolow of the Canadian Conservation Institute (CCI) were engaged in 'a comprehensive study of Shield rock art preservation'. This initiated a continuous relationship between local and regional interests in the site and the CCI.

Another exceedingly common practice of the time was tracing. The Vastokases feared that 'the process of weathering and patination will obliterate new glyphs in about twenty years, and once it has occurred, makes their tracing and identification extremely difficult' (1973: 14). The 'most satisfactory means adopted in recording the site was that of running the fingers over the entire rock surface in search of glyph forms which were then traced out and filled in with black crayon' (1973: 17) (Figure 1).

The tracing procedures of the day often featured the use of a thin polyfilm (Saran-Wrap, TM) laid over the rock surface, upon which a felt marker (black for petroglyphs, red for rock paintings, and green for lichen) was used to trace the surface features. This system was perfected by Pohorecky and Jones (1967: 305) and widely used in western Shield sites (Jones 1970: 109). Dewdney had found that rice paper, when thoroughly wetted and placed on a decorated face, became invisible and could easily be traced with a felt marker, or at times a crayon (Dewdney and Kidd 1967: 8, 9). A massive collection of these tracings at the Royal Ontario Museum constitutes the core of Dewdney's profound contribution to Shield rock art.

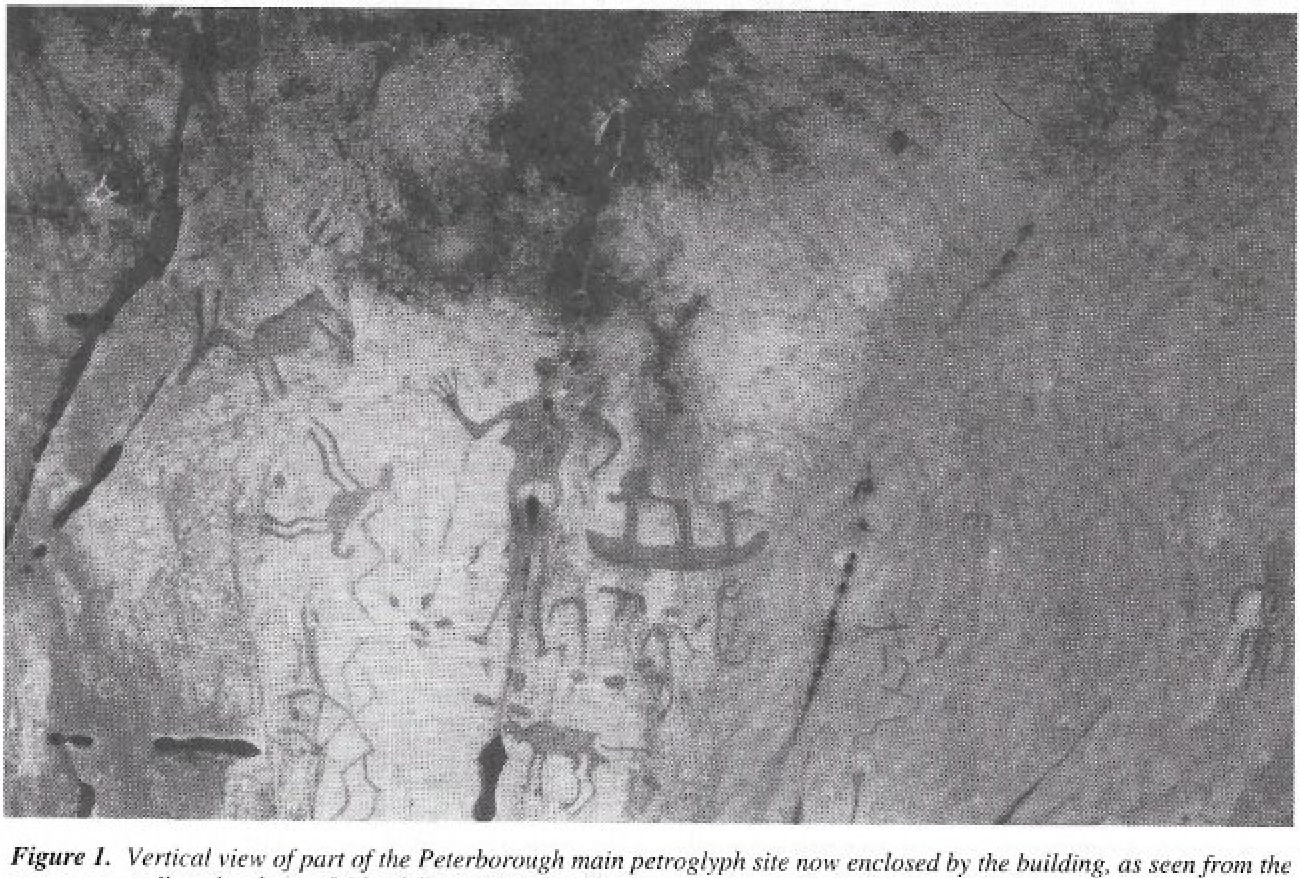

Figure 1. *Vertical view of part of the Peterborough main petroglyph site now enclosed by the building, as seen from the catwalk under the roof. The difference in visibility between crayoned (left) and uncrayoned (right) glyphs is shown (PGB).*

The rapid technological development in rock art research, taking place all around us, has more or less expectedly eliminated all of the early contact recording procedures used at Peterborough. The sum total effect of their use is a permanent denial of almost all presently known scientific dating procedures for the site. The introduction of foreign carbons, by any means and in any amount, renders AMS radiocarbon dating invalid. Contact recording is on the way to being totally eliminated in modern rock art recording, and replaced with a methodology of advanced optical and digitised alternatives (e.g. Rip 1989; Seglie et al. 1991; Henderson 1995; Bednarik and Seshadri 1995).

The investigators at Peterborough, generally speaking, were not schooled in 'hard sciences'. Guided by art-historic and ethnohistoric theory, they regarded it as their mission to record an endangered phenomenon and to exact from it all possible meaning. Future dangers were obviously given little or no attention. Science demands that an awareness of procedural development and the long-range effects of intervention be an integral part of research. A preoccupation with theory and humanistic persuasions led most of the Peterborough investigators on a track which has led to significant problems — both protective and culture-analytic. Perhaps the most critical among these is attitudinal, and it embraces the question of where we draw the line between the immediate and practical (usually political and economic) and the long-term future of a significant heritage resource. The pressures of the former sometimes find practitioners taking an 'optimistic' stance. Thus we must be vigorously circumspect about any form of intervention, and perhaps especially the application of untested foreign substances thought to be 'inert' and harmless. Unless long-term scrutiny is directed to such proposed applications, we may be repeating the problems of Peterborough. The purpose of the present paper is to help avoid this in the future, by critically examining some of the effects of massive intervention in a long-term perspective.

Site interpretation

We distinguish basically two types of recording of petroglyphs by the use of pigment: the filling in of individual motifs with paint of some description, which is a 'subjective enhancement method' (Bednarik 1987), and the painting of entire panels, usually with white and black paints, which is a largely objective method of physical enhancement. Both methods are rejected by the International Federation of Rock Art Organizations (IFRAO) because of their significant impact on the scientific research potential of the rock art, and to a lesser degree because of the conservation hazards they may create in some rock substrates. The first of these methods has been used extensively on the Peterborough site. One of the principal objections to it is that, like the practice of chalking rock art, it 'tends to obliterate the design's purport as it merely superimposes the recorder's interpretation' (Bednarik 1979) over the actual design:

> With the exception of the psychologist who happens to study the cognitive responses to alien graphic systems, absolutely nobody is interested in a record of the recorder's personal interpretation of petroglyphs (Bednarik 1987).

The point is well exemplified at Peterborough. For instance, one of the figures has been identified as depicting a snake with three eggs on its left-hand (western) side. It was filled with wax crayon on that basis and continues to appear in publications in this form (Figure 2a). Moreover, it was interpreted as a reproduction of the topographical landscape of the Adena-Hopewell Indian burial ground at the nearby Serpent Mounds Provincial Park. Such interpretative and imaginative cross-referencing by humanist interpreters of rock art are then used to construct all kinds of chronological and cultural models, and they are cited as 'scientific' evidence in many contexts. In this particular case, the figure in question is in fact an anthropomorph with large, ear-like projections above the head (Figure 2b). This is clearly visible on night photography recordings (Wainwright 1990: 69).

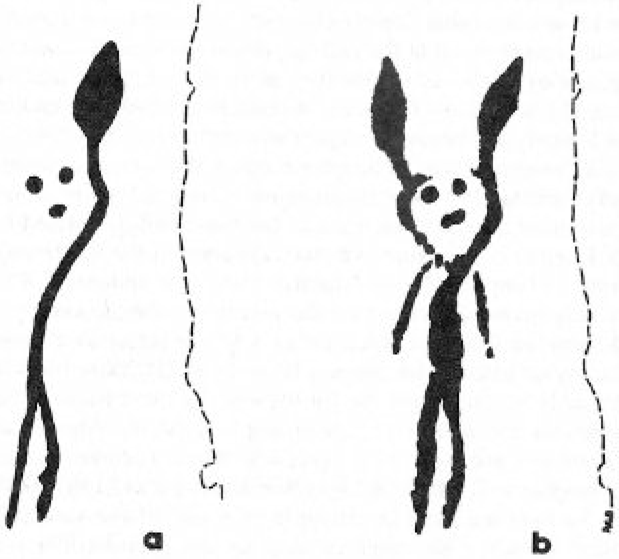

Figure 2. (a) Peterborough petroglyph as recorded and as infilled with wax crayon, identified as a picture of a snake and three snake eggs. (b) The same petroglyph as it appears when examined closely or photographed properly (with oblique lighting).

No doubt other Peterborough motifs have been similarly mis-recorded, and the same applies to the many thousands of petroglyphs still being daubed in this way in Scandinavian countries. The difficulties in eradicating these practices in just a few world regions are attributable to the examples set by authorities of rock art who have not only used such means to misinterpret rock art in the past, but who have proudly photographed the culprits at work and then published such evidence of professional vandalism in action. Projects of this kind continue to be conducted in Sweden and Denmark, where teams of usually young and enthusiastic people are encouraged to 'interpret' petroglyphs in this fashion. It is impossible to estimate the amount of data distortion one would have to allow for in the 'records' resulting from these efforts, and yet scholars sometimes base their hypotheses on this type of iconographically conditioned information.

The second principal objection to the practice of painting petroglyphs is the self-evident fact that the immediate substrate is inevitably contaminated by the application of *any* chemical, and that this, for instance, prejudices practically all currently available methods of direct dating of petroglyphs. Perhaps more importantly, rock art science is only in its early beginnings. Numerous investigative techniques will be developed by future generations of researchers, and it is reasonable to expect that these, too, will be prejudiced by the procedures of professional rock art vandalism, be they recording, enhancement or conservation procedures (Bednarik 1990).

There are still further objections to the physical enhancement of rock art: it is aesthetically controversial, and many practitioners would object to it simply as being intrusive, as compromising a site's integrity. Then there is an ethical objection: does an alien society have the right to exercise such power over an indigenous culture? For instance, it is frequently claimed or suggested that the Peterborough site is sacred, although there is absolutely no ethnographic evidence for this. Nor, conversely, is there evidence for other claims concerning the cultural aspects of this property: that the petroglyphs are evidence of vision quests by adolescents, that they were made by shamans, or that the audible subterranean stream beneath the pavement indicated an access to the spirit world.

Ethnographic evidence concerning the site is completely lacking, and since its art remains undated, no extraneous ethnographic evidence can be convincingly related to it. In view of the extensive contamination of the site it may now be impossible to establish the art's antiquity. The widely-promoted view that the petroglyphs were made by Algonkian Indians (which rather vaguely refers to a large family of historic languages) between A.D. 900 - 1400 is the only 'dating' we have for the site. Its main basis is the apparent absence of European-inspired motifs. Algonkian languages are generally agreed to have become distinguishable well before A.D. 1 (Rhodes and Todd 1981: 60).

So here we have an example of a site whose susceptibility of scientific research was so compromised in the course of pseudo-scientific work that present and future methods, in dating for instance, may be incapable of shedding any new light on the rock art. Instead we have a site interpretation model based on iconographic notions of Europeans and speculative ideas about the meaning, age and ethnic attribution of this intriguing rock art corpus. The site was then subjected to a major conservation project and one of the world's most expensive programs of massive intervention at a rock art site. Here we propose to review some aspects of this work, and our rationale for this critical assessment is explained below.

Assessing strategies of site intervention

A perusal of the various publications dealing with the Peterborough site suggests that one of the problems with the design of the protective building may have been uncertainty about its actual main function. Wainwright (1985: 29) cites the control of algae as the principal purpose: the structure's 'environment will be carefully monitored to ensure that temperature, relative humidity and surface moisture are not conducive to algal growth'. Other stated purposes are to arrest frost weathering, shed direct precipitation and control vandalism. But in the same paper he reports that the earlier provision of a security fence had 'reduced or eliminated vandalism' (which we take to mean that he is not aware of any), and elsewhere he notes that damage caused by 'frost weathering far outweighed that from other sources' (CCI 1988: 6). It remains entirely obscure what this latter finding is based on, and congelifraction is in any event still an inadequately understood process of rock weathering (Bednarik 1979: 16). Moreover, it must be remembered that neither frost action nor algae create new fissures in a rock substrate; both merely occupy existing spaces. We also note in passing that the severity of the effect of algal attack remains as conjectural as that of freezing and may be limited mostly to the effects of prolonged moisture retention and metabolic products (e.g. organic acids).

The maximal loss through chemical solution, in contrast to unsubstantiated speculation about frost action, is calculated in great detail for the Peterborough marble: 0.026 mm per year, or 26 cubic centimetres per square metre of surface area. Since frost action is thought to be 'much more' effective, and since other forms of weathering (thermal expansion and contraction, abrasion wear, algal action, salt wedging etc.) could also contribute to the cumulative surface retreat, we may assume an annual retreat in excess of 0.1 mm. This would amount to at least 75 mm since the proposed time of production, which renders it rather extraordinary that the petroglyphs still survive (unless they are considerably younger than assumed).

CCI's (1988) determination of the amount of chemical solution is based on their own experiments, and it does not agree with similar determinations by others. For instance, Carroll (1970: 103) cites a considerably lower rate in even higher precipitation, of 1 ft in 44 700 years (about one-quarter of the rate calculated by CCI). But most importantly, such theoretical speculations are of very limited value, because the actual quantity of calcite dissolved depends on far too many variables for such simplistic rationalisations. CCI (1988) seems to consider pH to be the crucial factor, when in reality it is principally the partial pressure of CO_2 that determines the effectiveness of precipitation in the solution of calcite (whereas the pH of atmospheric water might be controlled by, say, organic acids). Indeed, there are seven chemical variables involved in an open system of calcite solution at constant temperature (Ollier 1975: 38). Then there are other factors of great influence still to be considered, notably water flow or turbulence, the relative area of the solid-liquid interface, and the presence of certain trace elements (Mg, Sc, Pb, La, Y, Cd, Cu, Au, Zn, Ge and Mn, several of which are common in limestone) that can be very effective inhibitors. CCI's belief in their model of predicted solution rates is no more than an act of faith, and they admit themselves (1988: 18) that the empirical Ca values from surface water from the site are considerably lower than in their own laboratory experiments. Moreover, their own detection of surface accretions of calcite (CCI 1988: 14) renders their quantitative predictions absurd.

All of this adds to the impression that the rationale behind the recommendation to enclose the site in a building was uncertainty about what the *main threat* might actually be: solution, frost damage, algae or vandalism. Relative importance of these factors was not established, only conjectured. But since all of them could be addressed by erecting a protective structure this appears to have been seen as the safest solution.

The ambiguous rationalisations about the relative effects of precipitation and frost certainly failed to clarify whether these are serious threats, and the menace of vandalism does not necessarily call for a building (nor is such a measure necessarily effective, see below), while a threat from algae is not even substantiated by Wainwright.

Rather, it was defined as an aesthetic issue, and it was conceded that the algal presence is largely attributable to prolonged shading of some areas by two red pines. Nevertheless, chemical warfare was unleashed against the algae, involving trials with 'chelates of copper citrate and copper gluconate, quaternary ammonium compounds and combinations of substituted phenyl ureas and triazine derivatives' as well as radiation (Wainwright 1985).

This is not the only form of chemical contamination the site has been burdened with over the years. Moulding has been undertaken since August 1954, initially with plaster, which resulted in distinct bleaching of the rock. The casts themselves have unfortunately been lost. Despite an awareness that these may have caused the removal of rock surface, and that all mouldings taken at hundreds of sites world-wide had caused damage in the past, casts were made with silicone rubber and silastic rubber (Wainwright 1990). The former was found to produce dark discolouration of the rock, and the latter left a 'slight' discolouration (CCI 1988: 27-8; Wainwright 1990: 68-9). The superior method of using thermoplastic mono-matrix, developed by Dario Seglie and others in Italy in the 1970s (Seglie and Ricchiardi 1980; Seglie et al. 1991), was apparently not considered. Infrared spectroscopy of a stain on the Peterborough pavement showed the presence of vulcanised silicone rubber, which is very difficult to remove. This prompted Wainwright to observe that it 'should serve as a warning to anyone attempting to mould petroglyphs. The need for careful testing cannot be stressed enough.' We agree completely — but must point out that this has been known for a long time and did not have to be tested on the Peterborough petroglyphs. Bednarik, for instance, was critical of such methods in 1979, after observing the chemical and physical damage caused by latex application to patinated rock.

One of the objections to intervention by applying chemicals to rock is that such conservators seem oblivious to the concerns of others in the field, and favour blind application of unsophisticated 'technological solutions' to simplistically formulated 'technological' problems. It is not even self-evident to us that the preservation of rock art has precedence over all other considerations in the discipline, especially when it serves no other purpose than naive empiricist interpretations based on subjective notions of humanist researchers, and the curiosity of a misinformed public. We believe that the first priority in rock art studies is to create a scientific data base, and the core element in this is to determine the age of the art. Without some idea of the antiquity of rock art it can only be of limited value to archaeology: it cannot be correlated with archaeological models or data which are organised mainly according to chronology. Hence a central key to using rock art in any archaeologically meaningful manner is its age. From the perspective of the rock art scientist, any treatment that destroys the dating or other research potential of rock art irrevocably is as massive an intervention as its wholesale vandalisation.

We would therefore argue that there is little value in prolonging the life of rock art if in the process its scientific research potential has to be sacrificed. Moreover, it is to be emphasised that there is considerable doubt about the effectiveness of direct intervention methods in rock art conservation. Rock art sites have been destroyed in creating artificial rock varnishes (Bock and Bock 1990) or applying transparent sealants. We know of no sites that can be said to have been undeniably 'saved' by the impregnation of substrates with chemicals. Hence we are most sceptical of the claims that interventionist conservation methods must be tolerated because they save rock art: none can be conclusively shown to have been saved in this fashion. Non-interventionist methods of rock art conservation are of course a very different matter, they are being used widely and have at times been spectacularly successful.

The white elephant of Peterborough

The specially designed building surrounding the petroglyphs at Peterborough has, over the past decade, been generally regarded — and promoted by the Canadian Conservation Institute — as 'one of the most rational, scientific approaches to the preservation and protection of a rock art site in the world' (McLennan 1989: 11). In photographs, and even from outside the building itself, it appears impressive and striking; but when one takes a closer look at the project's development and current state some very disturbing facts emerge. Not only was there an absence of clear objectives in the planning (which would have been immensely useful in design), the building was probably not needed at all. Its construction has done considerable damage to the rock art, and there is continuing deterioration through lack of maintenance. This is despite the Government of Ontario's 'long term commitment to the preservation, protection and interpretation' of a site which 'is protected and managed as Petroglyphs Provincial Park by the Ontario Ministry of Natural Resources' (McLennan 1989: 1).

Staff of that ministry had been monitoring what appeared to be accelerating deterioration of the site from 1974 to the late 1970s. In 1980 the CCI was called in and found that water was the culprit in the deterioration, through severe frost weathering (Wainwright 1987: 8), together with the growth of several species of green and green-blue algae in a dark accretion (Wainwright 1981: 21). It was ascertained that acid rain was not a significant factor. The CCI recommended that the main petroglyph site be enclosed in a protective structure to eliminate rain, snow and surface run-off while permitting a maximum of sunshine on the rock surface to keep it dry (CCI 1988: xvi). It was felt that the building would 'abate algal growth by eliminating rainfall, the primary source of moisture' (Wainwright 1985: 29); it would prevent frost weathering, and 'protect the site from acts of vandalism' (Wainwright 1987: 8); its environment would be carefully monitored to ensure that temperature, relative humidity and surface moisture were not conducive to algal growth (Wainwright 1985: 29). They predicted that 'without such protection, many of the petroglyphs would not survive beyond about ten years' (Wainwright 1987: 9), despite their evident survival through centuries or millennia of weathering.

Bearing in mind that the earlier chain-link fence had largely eliminated the incidence of vandalism, the argument that the building was erected to reduce this danger is particularly specious. There are many examples of massive vandalism at fully enclosed archaeological sites worldwide, including the use of explosives. A building erected over a petroglyph site, considerably more substantial than the Peterborough structure, was broken into by vandals in Russia, who engraved their names in large letters over the petroglyphs (see below). Even the apparently impregnable underwater Grotte Cosquer in France was entered by at least five clandestine visitors in 1994, after they had broken open its gate, 35 metres below the surface, and traversed the long, incredibly dangerous access tunnel (where several divers have lost their lives already). No rock art site is entirely safe from vandalism, so why, at a minimally damaged, remote site, should it have been deemed vital to enclose it for protection?

It is hard to believe that 'the decision to proceed with the construction was only undertaken after all other possibilities had been exhausted' (CCI 1988: 61), since it would seem far simpler and cheaper to remove the trees whose shade was encouraging the algae, tackle the algae (which are presumably very slow-growing in this climate), and cover the rock in some way each winter to prevent snow cover and frost damage. One has the distinct impression that a deliberate decision was taken to adopt a glamorous, high-tech solution, at a great expense which would serve as a clear and impressive signal of Canada's commitment to rock art conservation.

The CCI continued to play an active role while an architectural firm (Klein and Sears Architects, of Toronto) was carrying out a feasibility study, by liaising with the Ministry of Natural Resources and attending many major meetings. The study was completed in September 1983, and the building was erected in 1984 (by Maple Engineering and Construction Canada Limited, of Brampton, Ontario). It is a seven-sided structure of 540 square metres, of steel beam, glass curtain wall construction. It comprises a substantial cantilevered concrete walkway around the petroglyph pavement, and a catwalk system in the ceiling of the building.

The site obviously occurs above cavities in the rock which permit the subterranean flow of water. Incredibly, nothing has been published on the structural study of the site's ability to support such a massive building weight without detrimental effects. There is no information on the load stresses on the decorated pavement and its geophysical context. The CCI's unpublished report merely mentions that 'geological testing [was] undertaken to ensure that the rock could carry the anticipated building loads' and that

> careful consideration was given to the location of all foundations under major bearing points to ensure adequate bearing capacity beneath the rock surface. Individual core drillings were taken at such locations for evaluation. All foundations were secured to the rock with a carefully cut key (CCI 1988: 40).

One wonders, therefore, whether the weight of the structure is a factor in the marked widening and deepening of a crevice at the north-east end of the site, which has become especially noticeable in the past two years.

Similarly, the report states that,

> to provide a good waterproof connection between the building and the marble outcrop, a key was cut into the rock to provide a solid mechanical connection between the rock and the wall. The wall was waterproofed to prevent water penetration (CCI 1988: 40).

Yet no details are given of how the key was cut, or to what depth, how the waterproofing was carried out, or what it consisted of. Instead, the report contains page after page of theoretical geological information extracted from text books on rock weathering. Knowledge about these aspects of construction would be crucial, especially as they appear to have failed, judging by the considerable seepage of water and quantity of ice visible at the north-east end of the rock in March 1995, and which has become a permanent feature of the site. Indeed, jewel-weed began growing in this very humid area last summer, bringing a little life back into this sterile site.

During construction, the site was protected by

> a layer of straw bales covered with plywood sheets which were, in turn, covered with laminated plastic sheeting sealed at the joints ... difficulties were encountered with the straw bales when it was realized they were being ignited by sparks from welding torches and they had to be removed (CCI 1988: 40).

In fact, such a fire led to the production of a large white stain, still visible over eight or nine petroglyphs, from the use of fire extinguishers and heat damage to the marble on the east side of the site. The corner of one of the plywood sheets left a still-clear dark stain on the rock among the figures, presumably due to condensation (Figure 3).

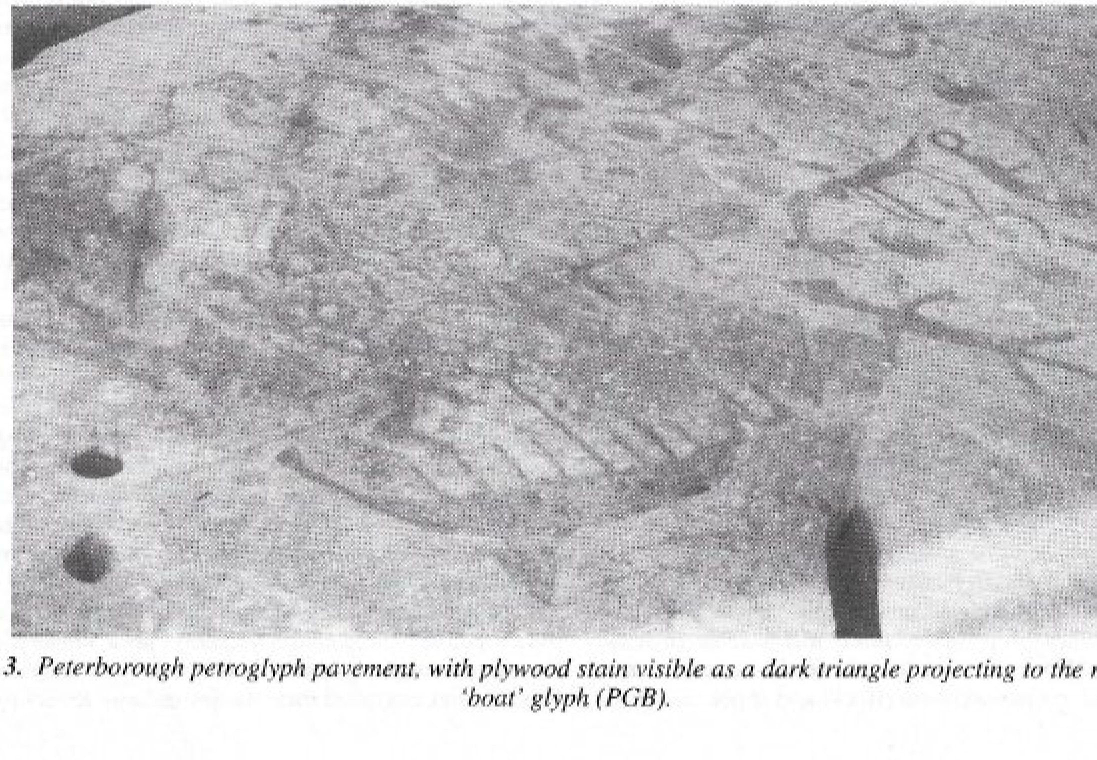

Figure 3. *Peterborough petroglyph pavement, with plywood stain visible as a dark triangle projecting to the right of the 'boat' glyph (PGB).*

Likewise, the unpublished report states that 'No damage to the rock surface in the form of scratches or other marks was observed except in areas near where trees were removed with heavy equipment' (CCI 1988: 40); yet many long prominent scratches made by a backhoe lie over unwaxed petroglyphs at the north-east end of the rock (Figure 4).

It was determined by the CCI that the building should 'detract as little as possible from the appearance of the site, reflect its spiritual ambience, and maintain ... the harmonious relationship between the site and its surroundings' (Wainwright 1987: 9); but of course this is all quite impossible. The best one can say is that the building could have been far uglier, but inevitably it is an intrusion on the site's atmosphere. In cutting the rock off from the outside world it has rendered it quite 'dead' and made it a museum exhibit. It is debatable too whether highly angular modern architecture blends appropriately with the naturalism of an aboriginal world view (Figure 5).

The current state of the art

Conservation of the rock surface within the 12-m-high, column-free building is by passive solar heating and natural air circulation to prevent excessive relative humidity levels (CCI 1988: xvii). Outside air can only be brought in during sunlight hours, and green-tinted glass was used to help reduce temperatures. The building is not, therefore, kept at a constant temperature — indeed it ranges, like the outside, from well below freezing to a maximum of about 100 degrees Fahrenheit (38°C). The mechanical ventilation system is intended to help keep the rock surface warm and dry to prevent frost shattering and the growth of algae, as well as to provide an acceptable level for human comfort. It was designed to maintain an indoor temperature of not more than five to seven degrees higher than outside, to prevent condensation on the inside of the windows, and to ensure that humidity is not greater inside than out. It does this by monitoring outdoor air temperature and relative humidity, and indoor air temperature and humidity both at the rock surface and in the roof.

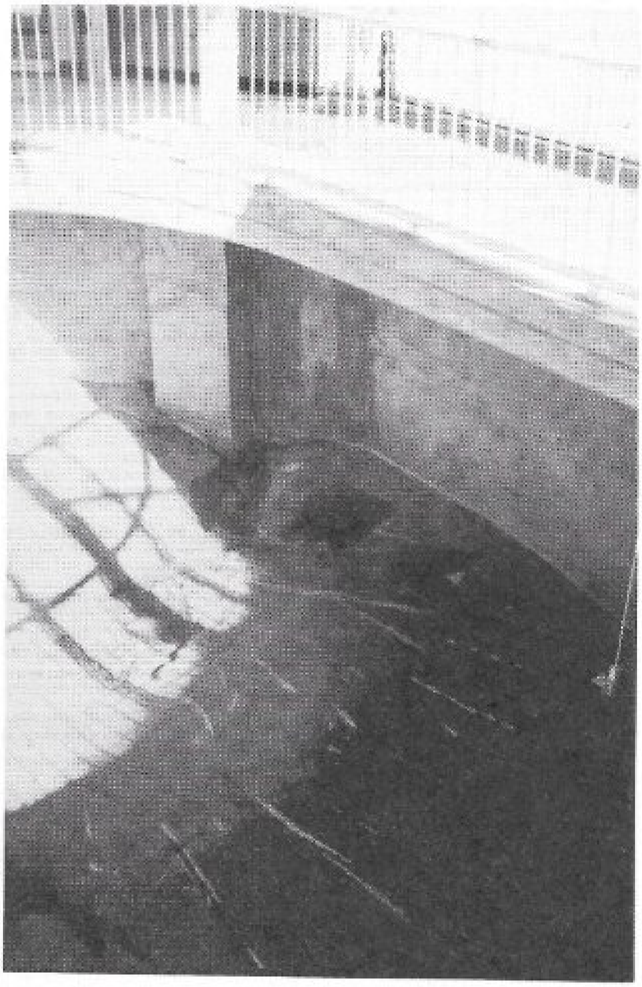

Figure 4. *Peterborough, north-east end of the petroglyph pavement within the building, showing the many large scratch marks made by a backhoe, and the water/ice that has seeped in. The instrument hanging down at right is one of the lights used to bring out the glyphs during evening visits (PGB).*

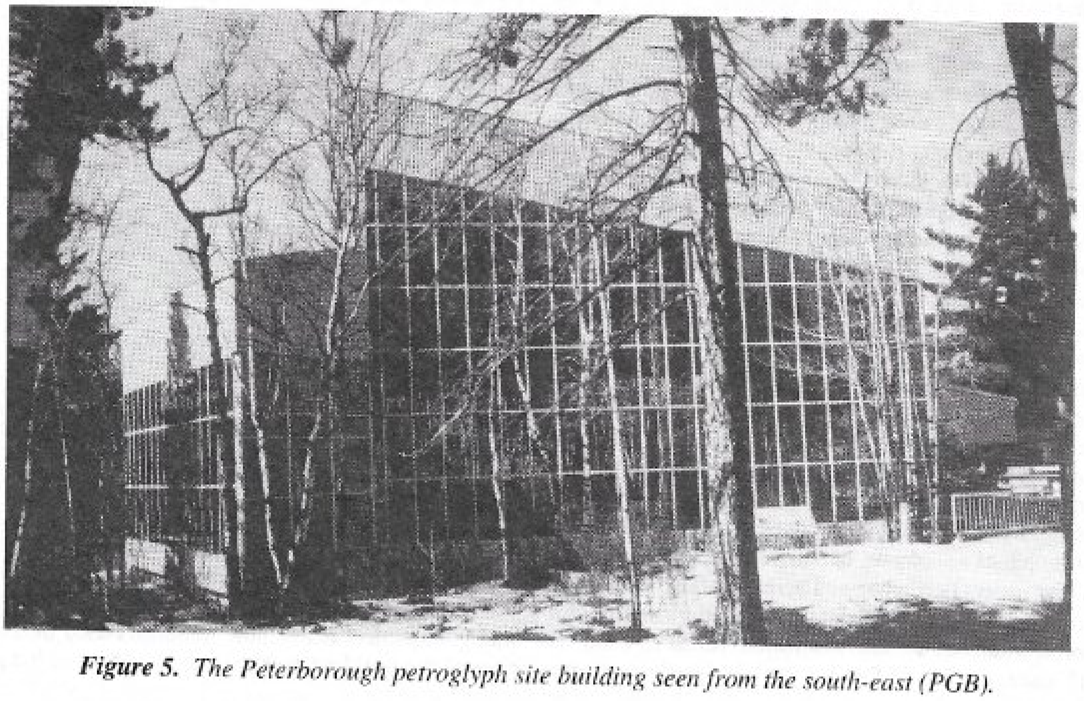

Figure 5. *The Peterborough petroglyph site building seen from the south-east (PGB).*

In the summer, the five propeller or circulating fans in the roof come on automatically when the temperature in the top of the building is more than two degrees Celsius higher than that at the rock surface. As this difference increases, the fans increase in speed from low to medium (3 degrees difference) and fast (over 4 degrees). However, these fans merely circulate the air, they do not extract it; consequently, the staff and many visitors (according to verbal and written comments) find the building unbearably stuffy and lacking in fresh air; feelings of tiredness and lethargy have been reported, which are hardly surprising when one realises that on a summer weekend there may be a total of 200 visitors per day, each spending an average of one hour inside the building. Often the propellers are not on, and even when they are turning they merely move the stale air around. Amazingly, there appears to be no monitoring whatsoever of the CO_2 levels in the building, which would be of importance in conserving the rock surface.

Although the building was equipped with 150 square metres of louvres 'to allow the escape of warm air and assist in providing a more pleasant human comfort level', 40 per cent are blocked off (though could be opened up again); the other 60 per cent can be opened manually, but staff have found that they make no noticeable difference to the stuffiness. The only relief comes at times when the temperature inside is five degrees higher than outside: two large air exhaust fans then come on automatically to take out the warm air and bring in cooler, less humid air. This procedure is intended to prevent condensation on the windows and keep humidity lower inside than out — in fact, even if the temperature inside is more than five degrees higher than outside these supply fans will not come on automatically if exterior humidity exceeds that inside. Yet it has been noted that the rock still 'sweats' on really humid days, and the relative air humidity in summer can reach 90 - 97 per cent. Readings taken by hydrothermographs on the rock and in the roof show that humidity fluctuates far more widely in the building than does temperature, but temperature varies more in the roof than at the rock. However, owing to cutbacks and the lack of full-time staff, monitoring of the hydrothermographs is not as consistent as it might be.

In the winter, the louvres and the supply fans are switched off, but the propellers can still activate if necessary, to force warm air down to the rock surface (whereas in summer they take it off the rock).

Although the CCI believed that the underground stream under the north of the site must be at considerable depth 'since there is now no evidence of water transport on the inner surface of the crevices' (CCI 1988: 14), in March 1995 there was a quantity of 'snow' — presumably ice crystals — visible at the top of the 4.5-m-deep crevice over this stream.

The cement walls of the building are cracking in numerous places, and salts are leaching through and humidity is getting in. Much of the structure consists of large double-glazed glass windows; but not only have they never been cleaned inside or out, at least thirteen of the outer panes have damaged seals, and condensation has penetrated between the panes — some of them have been in this condition for over two years. There are also areas of condensation on the rock in the morning, and clear marks of puddles in hollows of the decorated surface, even in summer (Figure 6). Finally, there are spots where water drips from leaks in the roof, and there is extensive rusting on some catwalks and staircases and around the supply fans in the upper part of the building.

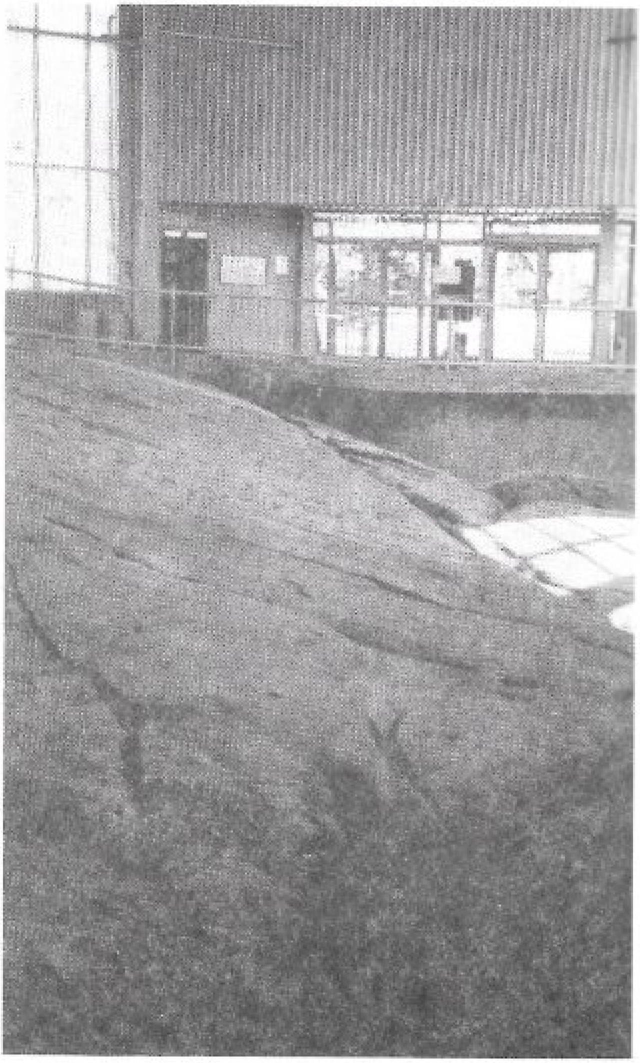

Figure 6. *View of the housed petroglyph rock, looking north-east, showing hollow in foreground that clearly contains a puddle at times (PGB).*

Rust is not the only problem. Paint (a white anti-condensation paint, according to the CCI report; CCI 1988: 41) is also flaking very badly in several areas of the railing around the rock, as well as on the catwalks and staircases in the roof, and flakes of paint are falling onto the engraved pavement. The rock gets very dusty all the time and staff have to clean it with soft brushes and a vacuum cleaner. One edge of a plaque of rock on the decorated outcrop has crumbled, and staff simply do not know if this has come about through humans walking on the surface or some other factor.

In short, whereas the CCI claims that 'the most careful consideration [was] given to the design of the structure' (CCI 1988: 61) and that 'the petroglyph protective structure is particularly special in that the design concept envisaged by the architects is in total accordance with the preservation criteria identified by conservation science' (1988: 32), it is clear that those criteria are inadequate in many ways. Ironically, 'the materials used in the construction of the building were chosen to have as long a maintenance life-cycle as possible' (CCI 1988: 36), yet after only ten years the structure is in poor condition and there is an ever-growing threat to the art.

A fine 2286 square metre visitor centre was built over five years ago, 365 metres from the main petroglyph site, to provide the public with information on the Algonkian culture and on rock art before they reach the site. Meant to house a film-theatre, cafeteria, gift shop and other facilities, it still remains totally empty, so that visitors have to rely entirely on the hard-pressed park staff and on a few leaflets for their information.

Some plans for the future: a whiter shade of pale

Wainwright and Stone (1990) have recommended that 'the site should now be returned to a state more closely resembling its initial appearance, in which the glyphs would have been lighter in colour against a darker, weathered marble background'. They dislike the fact that many of the glyphs have previously been coloured in with black wax crayon. This is indeed regrettable, but something we should now live with. They make the glyphs easy for the public to see (an important consideration at a site that has been turned into a tourist attraction), whereas those without crayon — whether inside or outside the building — are virtually invisible to the untrained eye.

Yet Wainwright and Stone have carried out experiments in cleaning three of the glyphs inside the building, with the aim of achieving a lightening of the figures 'without resulting in any *noticeable* damage to the marble' (Wainwright and Stone 1990: 24, our emphasis). After trying a whole series of techniques unsatisfactorily, they settled on dry air abrasion, using glass beads and crushed glass propelled by nitrogen. They admit that the technique occasionally dislodged grains of rock, but are prepared to tolerate this since the loss was less than that from frost weathering in the past and was not visible to the unaided eye (Wainwright and Stone 1990: 27). Yet there is a difference between natural damage to the site and manmade damage inflicted for no good reason. A J-shaped petroglyph was cleaned of wax, but then became barely visible (as it remains today), since it has less contrast against its background (Figure 7).

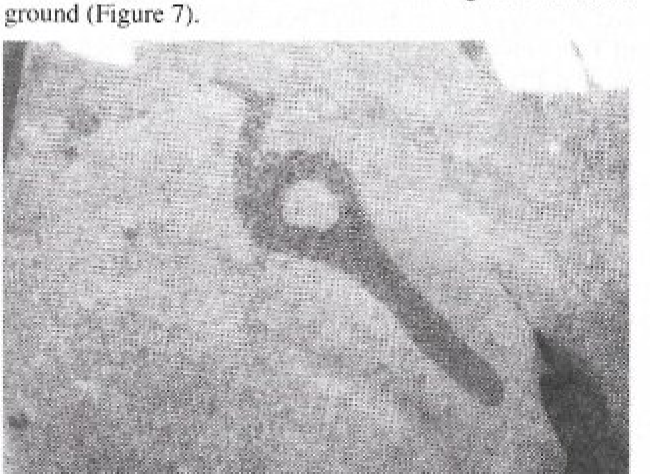

Figure 7. One of the glyphs abraded by the CCI at the Peterborough petroglyph site is the curved line next to the crayoned glyph, showing how it has been made virtually invisible for the public (PGB).

Figure 8. The turtle glyph abraded by the CCI, showing how visible it is, and how radically different from the crayoned motifs (PGB).

A small snake was likewise cleaned of wax, but two rock fragments were dislodged in the process (1990: 30) and the figure's visibility was again greatly reduced. Finally, a small turtle glyph on a dark background was cleaned to such an extent that it stood out — and still stands out — extremely clearly. Wainwright and Stone remark that 'almost no loose rock grains [sic] were removed during the procedure' (1990: 28), and that the figure does not give the impression of having been over-cleaned. On the contrary, it still sticks out at the site like a sore thumb (Figure 8), and the prospect — advocated by Wainwright and Stone but, fortunately, not yet executed — of having all the wax crayon removed at the site seems too ghastly to contemplate. They even (1990: 32) suggest carrying out the cleaning in such a way as to produce differences in contrast between glyphs and background rock according to the entirely speculative age of the glyphs! And they cheerfully admit (1990: 30) that it will require 'keen judgement' to ensure that the areas cleaned actually correspond to the glyphs as originally carved, especially as the crayon has not always been applied accurately (which may actually be fortunate for the rock art scientist). In other words, the abrasive method would almost certainly — and indelibly, unlike the crayon —

create new edges and hence change the shape of some figures. It would superimpose the interpretation of the air tool operator over that of the wax crayon artist and in the process destroy the last vestiges of original petroglyph surfaces. Moreover, it would impose an arbitrary relative age on each glyph, even though there is no credible evidence to attribute such ages to the motifs. This is unequivocally professional vandalism. It would make the figures either far less visible or too visible and would finally ruin any hopes of applying scientific analytical methods. If all the petroglyphs were scoured in this way to some shade of white, it would become far harder to notice any new marks made on the rock, and might indeed encourage other vandals to add marks of their own. Returning petroglyphs to a pristine unpatinated state is simply not a viable option; the CCI should take note of an abortive project of this type with petroglyphs in the Sydney region of Australia, or of what French authorities did recently with the facsimile of Niaux cave, where the paintings have been reproduced as they would have looked originally, before they were covered with calcite or damaged by waterflow (Clottes 1995: 57). French site managers would not dream of removing calcite deposits or patination for the sake of better visibility. If a pristine version is thought necessary for the Peterborough site, it should be a full-size facsimile, not a vandalised original.

Discussion

The purpose of this paper is to initiate debate concerning the most important aspect of massive intervention at rock art sites (sadly neglected at Peterborough and elsewhere): the need for objective performance assessment. Massive intervention, ranging from alterations to the rock art right through to its removal (hundreds of cases around the world are known) or enclosure in a building, has been or will be contemplated in various parts of the world. As in Peterborough, little consideration has been given to previous such experiments, which is at least in part attributable to a consistent paucity of post-event reports, an apparent reluctance to assess the effects of such projects objectively. As in the case of the Peterborough project, there is no shortage of predictive literature, recommendations by professional consultants, and technical details of what ought to be done. But for any such project to be of value beyond its most immediate purpose it is absolutely essential that its performance and results be monitored and independently assessed. How else can other site managers facing similar problems or decisions learn from past experiences and mistakes? For this purpose it is not sufficient to have some self-laudatory or palliative assessments by the managers of a project. Prospective users of such strategies need to know precisely what difficulties were encountered during construction, or what defects in the design were found after construction; coloured reports to the underwriting organisations are unlikely to provide this kind of information. Peterborough is no exception, and it is essential to report the damage to the rock art that occurred during construction and subsequently; the mistakes that were made in recording, conserving and managing this property; and particularly, the ways in which the management design could have been improved with the benefit of hindsight. In part, mistakes made at Peterborough were the result of inadequate information about similar projects in the past, and by not assessing that project's performance we would only perpetuate the same problem. The structure erected at Peterborough is certainly not the only one of its kind in the world. Other types of archaeological sites have been housed in vastly larger buildings, such as Roman sites in Britain or Iron Age sites in China (in comparison to the enormous building housing the Chinese terracotta warriors at Xi'an, which is a major engineering achievement, the Peterborough structure is puny), while shelter buildings for rock art sites occur in various other parts of the world, including North America (e.g. Judaculla Rock, North Carolina), and have been proposed at many others. Their designs differ widely, and for the benefit of future projects of this kind it is much more important that the experiences gained from past projects be assessed, than to consult the opinions of local experts who have not before attempted massive site intervention and may be biased in favour of their own work.

Evidently the Peterborough project did not have the benefit of previous experience, and as a result the problems we have described here are much the same as those experienced by similar past projects. For instance, those observed at the building erected over the petroglyphs of Besovy Sledki in Karelia not only mirror those at Peterborough, there the deterioration has already progressed further due to that structure's greater age. The Besovy Sledki building, about twice the size of the one at Peterborough, is in poor repair (Figure 9). There are severe problems with dampness, deterioration of concrete, rampant rust, broken windows, and there is extensive dust development on the pavement surface. The site comprises some 470 figures on the edge of a dry river bed close to the mouth of the Vyg River, near Belomorsk on the White Sea and just 130 kilometres outside the Arctic Circle. Climatic conditions are even more severe than those at the Canadian site, located on a latitude 20 degrees further south.

The Besovy Sledki 'pavilion' (as it is called in Russian) is structurally considerably more robust than the comparatively flimsy structure at Peterborough, yet it was broken into by rock art vandals. Paint flakes and decayed concrete particles exfoliate from the internal walls and this material and other dust cover the rock because it is not, unlike that of Peterborough, regularly cleaned by staff. Much of the sloping pavement (which is quite similar to the rock at Peterborough, although of granite) is thickly coated by a whitish deposit. The site is strewn with broken glass, the air is stuffy, and the rock varnish the petroglyphs have been hammered into has lost its natural sheen. In short, the state of the site resembles that of Peterborough, except that deterioration is more advanced.

The general observation from this site's condition is that, in enclosing a rock art site in a building one alters its natural environment dramatically. By shielding it from natural processes which are perceived to be harmful one also cuts a site off from natural processes or conditions that would contribute to its preservation or well-being. Worse still, one introduces an artificial environment that may well involve new conservation hazards: high relative humidity and the greenhouse effect may give rise to new microbiota, assisted by organic airborne particles settling as dust; the inability of wind and rain to clean the pavement renders manual cleaning necessary; the carbon dioxide levels buffered by frequent visitation, which would be highest at the rock pavement, not only facilitate a new

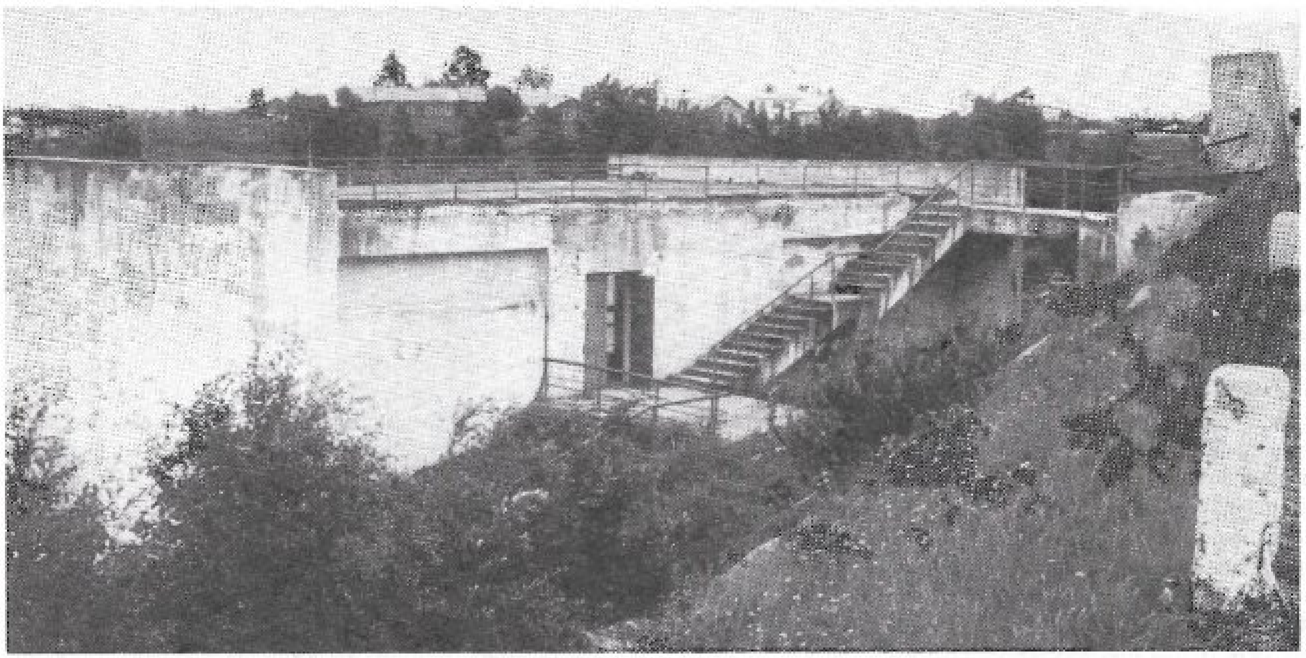

Figure 9. *The building constructed over the Besovy Sledki petroglyph site, near Belomorsk, Karelia, Russia (RGB).*

biological regime, they are likely to attack calcite in the presence of even small amounts of moisture, such as capillary moisture fed from the Peterborough stream, seepage of precipitation, or condensation as observed at the site. The use of anti-condensation paint in the roof structure of the Peterborough building may suppress condensation there, but it does not affect its source, the high relative air humidity.

There can be no doubt that to enclose the site in a building relegates it to the status of a museum object: it isolates it from its natural setting, it alters its cultural meaning indelibly. We do not wish to sound alarmist, but it must be pointed out that we have to contend with a complete lack of empirical knowledge of the long-term effects such massive environmental intervention has on rock art that has survived centuries or millennia of natural deterioration. It must be remembered that the existence of any rock art is attributable to it having survived many deterioration processes, and that especially older rock art exists in a state approaching equilibrium with its natural environment (cf. Bednarik 1989). To ensure that the museums do not become *mausoleums*, it is essential that the effects of such structures be studied at least as thoroughly as the pre-construction feasibility studies were conducted. In other words, no such project should be attempted if the means of maintaining a long-term monitoring program cannot be guaranteed during the planning stage. Neither the short-term funding patterns for capital works typical of democratic systems nor those of socialist countries (as shown by the cited Russian example) can be relied upon for attending to such responsibilities in perpetuity, hence a soundly based institution such as the CCI is ethically obliged to guarantee that a long-term monitoring program is conducted. Some provision for this has been made at Peterborough but the necessary actions are not being taken. To the best of our knowledge, there is no program to monitor the site's geophysical integrity, the effects of microerosion on the rock face, or the introduction of new biota, while the efforts to assess the effects of the intervention are entirely inadequate.

Our first recommendation is therefore that the construction of a building over a rock art site should be undertaken only if the project manager can guarantee an independent, long-term sophisticated monitoring program extending over many decades.

Instead of conducting such a study, which would be of immense help to the field of rock art conservation, the CCI seems preoccupied with more 'glamorous' plans, such as the removal of wax crayon at the Peterborough site. Instead of disclosing the full extent of mishaps during construction so that rock art managers around the world may learn from this experience, further direct intervention is proposed. While we accept that the colouring in of the petroglyphs was misguided, it is to be seen in the historical context in which it occurred: at the time there was no significant opposition to such practices. More importantly, whatever one may say about the aesthetics or accuracy of the crayon marks, they do not pose a significant conservation threat, in fact they very likely inhibit chemical solution quite effectively. The proposed removal of the crayon, on the other hand, clearly would involve damage to the petroglyphs.

One of our objections to chemical intervention of any type is the argument that the effects of specific introduced ions may have on weathering processes is not normally considered in such intervention. Some chemicals may retard deterioration processes quite unintentionally, while others will accelerate them. To illustrate this point: limestone (calcite, marble) is of course the most solution-susceptible of all the rocks commonly used in rock art production. We know that traces of heavy metals can significantly inhibit $CaCO_3$ solution; for instance, scandium in concentrations of only 10^{-5} moles/litre reduces the saturation content of calcium by 56 per cent, while lead is an even more effective retardant. Hence it is simplistic to consider, as the CCI (1988) does, the question of chemical solution at Peterborough as hinging entirely on the predicted lowering of pH in atmospheric precipitation due to modern pollutants (of which heavy metals, particularly lead, are well-known components, and may thus actually assist rock art conservation!). In reality, the processes of rock weathering can only be understood by holistic comprehension of a system so complex that it is several magnitudes removed from that implied by the CCI report (cf. Hendy 1971) — a model which we regard as scientistic rather than scientific.

Which leads us to our second recommendation: that massive intervention in rock art only be undertaken in circumstances guaranteeing scientific support of the highest calibre. It is clear that deterioration processes may be inhibited by various techniques, and the most obvious is not necessarily the best. For instance, chemical solution can be retarded by means other than a building, and if the introduction of a new environment merely replaces one form of deterioration with another, the net gain may be negligible (or may even be negative). It is clear that the site manager needs to appreciate all the options available, and also needs to understand fully the relative contributions and interplay of the various deterioration factors, as well as the various proposed measures. At Peterborough, we believe that this was not established satisfactorily — in fact it was not even established that significant or accelerated deterioration was occurring (other than perhaps humanly caused). In designing a protective building for a rock art site, different conservation threats may demand conflicting measures, so it is essential that the principal threats to the art be identified in order to achieve maximum effect. For instance, neither security nor precipitation demand a sealed building that creates its own atmospheric conditions. If, however, the atmosphere has to be controlled because human visitation tends to alter the atmospheric regime, the design of the structure would be significantly different. Designing and constructing a building without defining the conservation threat precisely seems to be an expensive stab in the dark.

Our third recommendation is to make available all adverse information relating to intervention projects. In the case of Peterborough it seems reasonable to suggest that the degradation the site has experienced through research, recording, construction work, tourism and experimentation by far exceeds that which we would expect to have occurred naturally in the same period, in the absence of human intervention. The damage we would envisage if abrasive cleaning were to proceed as proposed would equal that of a long period of natural deterioration. If this project is to be of any value to rock art research, full details of its past failures need to be independently assessed and made available to the rock art site managers around the world.

In this paper we have obviously not been able to provide such detail; we have merely had the benefit of visual inspection of the site and we have consulted the limited literature available. This has shown, however, the need for far more comprehensive investigation and reporting. We emphasise that this paper is not a witch hunt of any kind. We are in no position to apportion blame and have no right to judge past performances outside their historical context. Since it is always easy to be wise in hindsight we should be outspokenly critical only on subjects on which we had spoken out by the time in question. Nevertheless, we point out that we did speak out against the practice of making casts of the sort made at Peterborough before they were made, and that we and others (e.g. Swartz 1981) have long cautioned against poorly conceived projects of intervention. We point out that rock art preservation and management practices elsewhere have been very successful without intervention. Without going into details we would like to contrast the Peterborough project with the management measures at Kakadu National Park in Australia, where the materials used in catwalks were precisely of the standards specified to be used in the Peterborough project: for instance corrosion-free materials such as stainless steel were used at Kakadu. If such materials as were specified had been used at Peterborough, some of the problems mentioned above would not have developed. As it stands we now have a building there, just over a decade old, that is deteriorating fast and is on the way to resembling the dilapidated state of the structure at Besovy Sledki. McLennan's statement (cited above) that it is one of the best examples of rock art protection in the world is decidedly misleading, and merely exemplifies the self-congratulatory tone of internal reports of this type. Management decisions about intervention elsewhere must not be based on such boastful statements, they require impartial assessments of such massive intervention projects.

Acknowledgments

The authors are deeply grateful to Lisa Roach, Visitor Services Officer at Petroglyphs Provincial Park, for providing access to the site and documentation about its history and current situation. It should be stressed that she is in no way responsible for the opinions expressed above, and certainly not for any of the problems highlighted. The park staff, indeed, are deeply concerned about the preservation of the site, the building's woeful maintenance state, and the lack of facilities for the public; it is hoped that their dedication will eventually be matched by the necessary input of funding and concern from the CCI and the relevant Ontario authorities.

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Résumé. *On considère les effets d'interventions massives sur les gravures rupestres en examinant le passé, les méthodes et les résultats de ces pratiques à un site public près de Peterborough au Canada. On soutient que l'impact de projets tel que la modification massive de l'environnement doit être contrôlé indépendamment, et que cette information objective est nécessaire pour organiser d'autres projets de ce genre. L'article considère les désavantages potentiels des projets massifs d'intervention.*

Zusammenfassung. *Die Effekte von massiven Veränderungen in den Erhaltungsbedingungen von Petroglyphen werden besprochen, indem die Geschichte, Verfahren und Resultate solcher Praktiken auf einer öffentlichen Fundstelle nahe Peterborough in Kanada untersucht werden. Es wird erörtert, dass die Auswirkungen von Projekten, wie die vollkommene Änderung der Umwelt, unabhängig untersucht werden müssen, und dass derartiges objektives Wissen für die Planung anderer Projekte dieser*

Art erforderlich sei. Der Beitrag berücksichtigt die potentiellen Nachteile, die Projekte massiver Eingriffe bewirken.

Resumen. *Los efectos de intervenciones masivas en petroglifos son considerados mediante el examen de la historia, procedimientos y resultados de tales prácticas en un sitio público cerca de Peterborough en el Canadá. Se argumenta que el impacto de proyectos tales como la alteración masiva del medio ambiente necesita ser controlado independientemente, y que tal información objetiva es requerida en la planificación de otros proyectos de esta clase. El artículo considera las desventajas potenciales de proyectos de intervención masiva.*

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ROCK ART BYTES

In establishing this new column in *Rock Art Research*, we acknowledge the growing importance of computers in our discipline. For better or for worse, the study of rock art is becoming increasingly intertwined with the digitisation of rock art, with colour manipulation, interactive systems and computer-supported solutions to research problems. Perhaps most important, however, is the anticipated use of the computer in the ultimate solution to the ever-present menace that overshadows our discipline — the inevitable and irreversible deterioration of our data base before our eyes. One of the conservation miracle cures we had pinned some hopes on a few years ago were silica skins. Silica is no longer seen to be the answer to our prayers — but perhaps silicon is.

Before we accept the silicon chip as our long-term conservation saviour we shall need to learn a lot about the use of computers in our field. They can handle graphic information well, they can process vast amounts of data, and they are particularly adept at playing with colour. Rock art research is a natural application of computer technology, having so much to do with visual imagery. This journal has in the past published pioneering articles about the use of computers in solving rock art problems. Current developments render it essential that practitioners become familiar with the present and future roles of computers in our discipline. This new column is *RAR*'s contribution to that objective.

KEYWORDS: ***Rock art* - *Photography* - *Colour calibration* - *Colour re-constitution* - *Conservation***

DIGITAL COLOUR RE-CONSTITUTION IN ROCK ART PHOTOGRAPHY

Robert G. Bednarik and Kulasekaran Seshadri

Abstract. The main purpose of the recently introduced IFRAO international colour calibration standard was to facilitate the implementation of colour re-constitution. This paper reports the first successful attempt to achieve this. The subjectivity of photographic recording is explained, the transiency of such records is elucidated and the basic principles of colour perception and digitised processing of colour information are considered. The role of image digitising and storage systems in rock art recording is also explained. Finally, the paper provides detailed guidelines for the use of the IFRAO Standard Scale to realise the best possible conditions for future digitised manipulation of photographic rock art records.

Introduction

The IFRAO Standard Scale was first proposed in 1990 (Bednarik 1991), primarily as a measure to facilitate colour re-constitution in rock art photography. The underlying rationale in its introduction was that the true colour of rock art and related features (such as rock patination) should be recoverable with the help of computers, provided that the recorded imagery includes a colour calibration device the computer software can effectively refer to. It was recognised that the many millions of rock art photographs, transparencies, films and videos in the world's archives are all 'doomed to eventual destruction. No known photographic dye is fadeproof, and we still lack any form of permanent photographic or digitised storage of imagery' (Bednarik 1994a). It was pointed out that this massive present archival record of rock art will probably be survived by most of the rock art it is intended to be a record of, in spite of all the preservation hazards the art may have to contend with.

In the absence of any technological means of preserving rock art records (or, for that matter, rock art itself) in perpetuity, the senior author decided that the most sensible course of action to circumvent this severe limitation to our discipline's long-term viability was to render photographic and other records susceptible to colour re-constitution: the method of recreating the true colours of rock art and rock surfaces at the moment of their photographic recording.

The perceived benefits of introducing such a system are very considerable indeed. The facility of recovering true colour information from faded photographs, as well as from badly illuminated, poorly photographed or inadequately developed records provides a means not only of creating reliable records, but also of preserving them permanently: periodic re-calibration would maintain a reasonable level of colour veracity indefinitely. Even if the original photographs were taken several decades (and, eventually, centuries) ago, the computer could re-constitute the true appearance of the subject, irrespective of the distorting influences of the photographic process itself (exposure, film development, printing from negatives — each of which involves colour distortion) and of the subsequent deterioration of photographic dyes. By reference to a known colour standard included on the image, the computer can correct for the combined effects of all these distortions and produce a very close if not perfect likeness of the subject at the moment it was photographed. The same, conversely, applies to emulsion film or video film. By virtue of the permanent retrievability of colour information it can then be preserved in perpetuity.

It is self-evident that this technology offers numerous practical applications; it revolutionises rock art recording, research and publishing. Once such real colour records are translated into digital format, they are susceptible to electronic manipulation, notably colour enhancement (a method of emphasising small colour differences; Rip 1989), the precise monitoring of changes to pigments or patinae over long periods of time, the permanent storage in archival systems, specialised pigment studies of various types, and in rock art publishing. One only needs to consider the last-mentioned application to appreciate the fundamental change such a technology would bring to our work: until now, colour fidelity in the production of rock art books or exhibition materials depended entirely on subjective judgment or on painstaking and intensive review with the help of colour scales. Anyone who has been involved in such a project knows the frustration of trying to compensate for the various sources of colour distortion. The truth is that nearly all published colour reproductions are inaccurate, even those produced with the greatest possible care and dedication. The colour plates in some books on rock art are of truly abject colour fidelity. This could soon be a thing of the past because with standardised colour calibration, the publisher will in future re-constitute true colour information, and then from this corrected image directly produce the colour separations using the same software support. The published image will then resemble true colours as closely as the printing process itself allows: overall colour distortion will be minimal, rather than cumulative due to the various stages, and it should not be detectable by the human eye. The published image may well be superior to the photograph it is derived from.

This example provides an inkling of the potential effects of this new technology, but from our discipline's point of view, scientific applications are the more important. They will include the recovery of very faint or inadequately differentiated images through enhancement techniques, dating work, comparative pigment studies, sourcing studies, integration of records into major computer-based archival or interactive systems, and various applications in conservation (especially monitoring), retouch, as well as graffiti and lacunae repair. With this technology, many research methods we may have envisaged for the future may very soon become standard tools of the discipline.

The subjectivity of photography

Photography, the process of rendering optical images on photosensitive surfaces, is often considered to be an objective means of depicting reality. However, this impression is perhaps so defined because as a process, photography resembles human vision itself, roughly duplicating what occurs in the eye: light which has been selectively (in terms of its wavelengths) reflected by the surfaces of physical objects is collected by a focused lens and projected onto a surface of light-sensitive chemicals. In the case of the human eye, these are the rhodopsin and other pigments on the retina's cone and rod cells; in the case of the camera we have a light-sensitive emulsion of chemicals on cellulose film. The considerably more sophisticated, 'organic' system of our vision converts the continual chemical reactions into neural signals, while the simple system of the camera fixes the result of the photochemical reaction permanently.

In an anthropocentric-technical sense, the photographic result is a faithful conversion of the light image in question into a likeness of the surface aspects human vision records of the same configuration. In a more objective, scientific sense it is preferable to say that the similarity between photographic image and visual perception is merely attributable to the similarity of two means of selectively processing information about physical reality. Human neural reactions perceive the visual information in a colour photograph in rather the same way as they process the corresponding light patterns in the object world. Consequently photography does not record reality objectively, it is merely in tune with human visual perception and could thus be yet another contributor to human delusions of having access to objective reality. It is the role of science to counter these delusions to the best of our abilities.

In the present context, another epistemological aspect of photography is of more relevance. Human vision detects some but certainly not all optically detectable information of objects, and the same is likely to be the case with photographs of these objects. In other words, it is quite possible that a camera records aspects of reality which human vision does not perceive. The similarity of the optical processes involved does not negate this, there is not even any evidence that the human visual system is capable of processing all the optical information visual input consists of. It is much more likely that this system simply deals with visual data 'favoured' by anthropocentric sensory dynamics of reality construction. In this context it is relevant to consider the diversity of the range of visual abilities and competence across the animal kingdom, or in fact the entire spectrum of sensory operational ranges of all species. The operational range of human vision is probably a fairly random entity derived from our phylogenetic history, and to base on it principles of objectivity belongs into the realm of mythology.

Subjectivity exists in photographic imagery at the more mundane technical level also, where it is attributable to the limitations and imperfections of the various processes involved in its creation. To begin with, numerous factors combine to influence the optical input entering the camera lens: type, quality and direction of lighting are foremost. Relative air humidity or air-borne matter such as dust, smoke or fog have an effect. Then there are factors related to equipment, such as lens type, film type (temperature, speed, make etc.), exposure time and aperture used, to name those coming to mind readily. But of particular interest are those variations that are caused after the film has been exposed. They include changes to the film before it is developed (deterioration due to temperature or humidity, for instance) as well as variations attributable to the development of the film or prints. Such variations can be very considerable. In commercial development, the colour properties of a photograph differ significantly according, for instance, to when in the chemical replacement cycle a print was produced. We are all familiar with these variations. In addition, several other variables contribute to the outcome, which is best described as a random result of many distorting factors: if it resembled the original optical input very closely it would be attributable to sheer luck.

All of these distorting factors may be successfully limited by the experienced photographer and the use of an institutional, non-commercial developing laboratory, but they can never be eliminated altogether. The distortion occurring in storage is entirely unavoidable and its effects cannot be compensated for. The storage life of black and white photographs is comparatively good, because here the image is formed by metallic silver, and thorough washing tends to remove most of the thiosulphate, rendering the chemical emulsion fairly stable. Colour films, however, depend upon the stability of chemical dyes, all of which are known to be unstable and experience significant dye loss over a number of decades, even in permanently dark and cool storage. These losses are greatly exacerbated by exposure to light, high relative humidity and high temperature. For instance, dyes fade about twenty times faster at 30°C than at 7°C. At 60 per cent relative air humidity, the yellow dye of Kodak films fades at about twice the rate as at 40 per cent humidity. Other aspects of storage also damage photographic materials. Glass slide mounts can increase the atmospheric humidity and promote fungal growth, paper may affect colour dyes through its pH if it is in contact with them over long periods of time, and polyvinyl chloride storage jackets may cause chemical deterioration if they are in prolonged contact with the emulsion side.

The subjectivity introduced by these many technical factors is of course of a different nature than subjectivity in the above, philosophical sense. Nevertheless, their combined and to some degree inescapable effects show us that it is unrealistic to expect photography to be an objective means of recording optical information. The many distortions that occur during photographic processing, combined with those the image is inevitably subjected to as it deteriorates over subsequent decades, limit the permanency and reliability of photographic archives of rock art severely. This limitation has significant consequences for rock art studies, archival records and rock art preservation. For instance, the rock art archives of the world are made up of many millions of photographs and transparencies which were assembled at huge costs (just the costs involved in the journeys necessary for acquiring this massive record must have been astronomical, not to mention individual sacrifices). Their contents are all subjected to slow and irreversible deterioration and will ultimately become worthless. Other limitations engendered in this subjective, inadequate recording method include our inability to conduct precise long-term studies relating to preservation (monitoring of pigment fading or varnish degradation, for instance), the great difficulties of attaining colour fidelity in publishing, and the lack of precision in colour determination (e.g. with the Munsell Charts).

The various sources of subjectivity in colour recording and photography do not apply to methods involving the translation of such information into digital language, i.e. its computerisation, provided that there is no intermediate error source, or that it can be compensated for by calibration of colour information. Hence we shall next examine the properties of colour, their perception, their digitisation and the principles of colour printing.

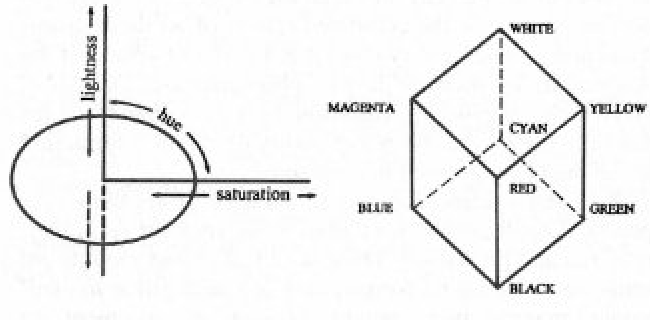

Figure 1. The three co-ordinates of the colour solid (on left), and the Cartesian Colour Cube.

About colour

Colour is described in terms of hue, value (or lightness) and chroma (or saturation), which define the three co-ordinates of the colour solid (Figure 1). Hue is the name of the colour, such as pink, brown or green, and is a function of the dominant wavelength of the radiant energy we call light. Value indicates the rate of energy flow by how close a colour is to black and white. Chroma refers to the vividness or dullness of the hue, being a function of the purity of wavelength distribution. In the colour solid (Figure 2), all colours are arranged in accordance with these three attributes. It is divided into 267 colours, as determined by the Inter-Society Colour Council (ISCC).

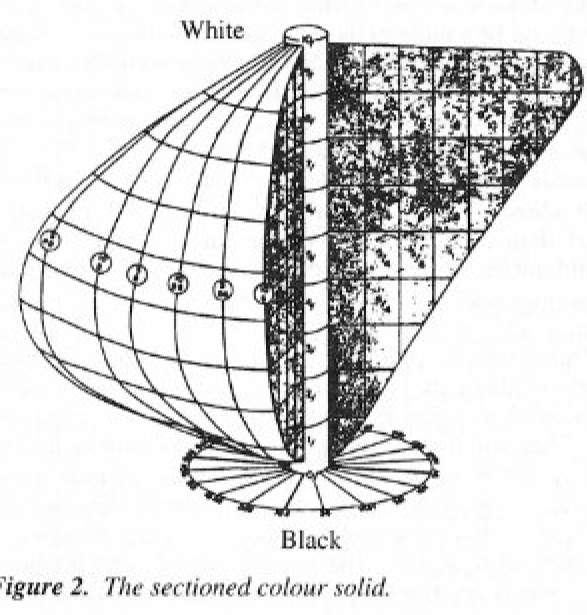

Figure 2. The sectioned colour solid.

Many of the colours the human eye can actually perceive and distinguish (in all, the human eye is capable of differentiating about a million colours; Terstiege 1983: 563) cannot be displayed on a computer monitor, or printed on a commercial printing press, even though a computer may discriminate many millions of colours within the spectrum accessible to it. That spectrum is not identical to that used in standard printing processes, because the colour models used differ significantly.

Isaac Newton was the first scientist to arrange colour in a spectrum. In 1905, the American painter Munsell created a model of 'solid colours', and the Munsell colour charts' many applications include their use in archaeology and rock art research (Munsell Soil Color Charts, Kollmorgen Corporation, Baltimore, U.S.A.). They were also adopted as an industry standard (e.g. JIS Z B721 in Japan). Due to differences in the lightness and saturation found in both yellow and purple, Munsell's chart is neither horizontally nor vertically symmetrical.

Our colour perception is far from perfect and working with colour is not an exact science. Colour determination by human vision is a notoriously subjective process: even in the absence of physiological encumbrances (e.g. colour-blindness, which affects 8% of all males) there is considerable variability in the human ability of colour discrimination. For instance it is believed that female colour perception is generally superior to that of males (Mollon 1982: 187; Terstiege 1983), especially in the region bounded by green, blue and grey (RGB, pers. obs.). Ethnographically defined colour perception differs significantly between different societies (Berlin and Kay 1969; Bulmer 1968; Conklin 1955; Hutchins 1986; Jones and Meehan 1978; Plomley 1976: 164-7, 244, 393, 468; Ray 1952; Turner 1966; Turton 1980). Environmental factors can affect our colour vision profoundly, such as the proximity of colours to each other, and lighting. While colour subjectivity has no great effect on us in daily life, it must be accounted for in such fields as colour printing and scientific work — including in rock art research, recording, digital storage or manipulation.

The display monitor of a computer (or television screen, or scanner) uses the *additive colour model*, in which colour is created by combining varying intensities of three specific wavelengths of light which are combined to simulate the natural colours: red, green and blue (hence RGB). If 100% each of red, green and blue are combined, the colour is perceived as white, and if no primary colour is present, we will perceive black.

In the *subtractive colour model* used in printing processes, the translucent inks cyan, magenta and yellow (CMY) are printed on a page. These are created by subtracting red, green or blue from white light (being a 100% intensity of these three colours). For example we perceive a surface as being of yellow colour if it absorbs 100% blue but reflects green and red. If 100% of cyan, magenta and yellow were mixed, it should create black, but in reality inks are imperfect and such a combination would merely produce a dark-brown colour. Besides, such oversaturation of an area would cause printing defects. Therefore black is added as a fourth colour (K), and we speak of a four-colour printing process (CMYK). This involves four separate plates, one each for cyan, magenta, yellow and black, in which black also normally accounts for any texts, borders etc. However, it is then necessary to compensate for the adding of black ink by reducing the concentrations of the three other inks, by under-colour removal (UCR) and gray-component replacement (GCR). With the appropriate software, both processes are possible on a suitable microcomputer (PC).

The colour separations bear halftone screens of colour dots in the four respective colours, similar to halftone bromides in monochrome printing. To create the colour blue, for instance, cyan dots (which absorb red and reflect blue and green) and magenta dots (which absorb green and reflect blue and red) are combined, which our vision merges and perceives as the colour blue. From these four film separations, the printer prepares four plates for each print page.

Because the CMYK system does not consist of solid colours it is difficult to relate it to the co-ordinates of the colour solid, hue, lightness and saturation. The limited compatibility, in terms of colour perception, of the human visual system (which itself differs from that of most other animals) with the additive RGB model (which has a smaller range than human vision) and the subtractive CMYK model (which differs somewhat from the RGB spectrum, extending less into the three primary colours but more into the intermediate areas) has to be considered in the digital treatment of colours, be it for calibration or for printing purposes. As colours move from the computer monitor to the printing press, they are converted from the RGB model to the CMYK model. Hence it is essential to consider the differences and compensate for them to obtain best results.

Rock art and computers

The use of image digitising and storage systems in rock art studies and archiving has been investigated for many years, but until now it was severely restricted by the lack of uniformity in colour calibration. Also, the requirements of rock art recording are of no commercial interest to the computer industry, which means that we have had to wait until vastly more influential marketing demands and technology would match our specific requirements (Bednarik 1984: 34). This did not, however, prevent the development of image enhancement in rock art (Rip 1983, 1989). Dickman (1984) noted over a decade ago that the system he used was based on technology that had then been available for fifteen years. Since the time when he described a rudimentary system of image processing for rock art, revolutionary changes have taken place in the development of PCs for the mass market, as well as in the development of the supporting software. The work Rip performed in the early 1980s on the computer of a satellite remote sensing centre can now be handled with ease by a PC with commercially available software.

In 1984, Dickman recommended the use of optical discs for the storage of rock art images. Each side of the disc has the capacity of storing 54 000 black and white images, which a decade ago seemed most impressive. The digital video disc (DVD) proposed by a conglomerate of eight world leaders in consumer electronics software in January 1995 will store up to five gigabytes (five billion characters of data) on each side, or a 135-minute colour video movie. This is approximately fifteen times the storage capacity of a standard compact disc, or 6900 high-density 3.5-inch floppy discs (or the amount of information printed on a stack of office paper twice as tall as the Empire State Building). The DVD, expected to be released in 1996, will be of 12 centimetres diameter. It will be read by red lasers, not the longer wavelength, infra-red lasers employed in CD systems. The production mastering equipment will need to be able to cut masters with a track pitch of 0.725 microns, i.e. 1379 tracks per millimetre. The number of colour stills one can store on such equipment should be similar to that of an optical disc, if each concentric ring were used to store one image.

It is obvious, then, that a small number of such discs should be capable of storing images of all the rock art that has ever been photographed. The entire surviving rock art of the world (most of which remains un-photographed) might fit on a hundred or two hundred such discs. It is not yet known how perdurable the DVDs will be, but optical discs have a limited life span. Therefore even here, the facility of ongoing colour calibration remains essential, because without it, deteriorating records cannot be 'rejuvenated' when this becomes necessary.

The principles of manipulating colour electronically are obviously central to the subject of using computers in rock art work. The recent trend towards sending colour data from CRTs (cathode-ray tubes) directly to high-end systems for outputting has created additional problems. One such problem is the difference between colours displayed on PC screens and colours printed on paper by traditional methods. We have noted that on CRT screens, colours are composed of the three primary colours (RGB), whereas in printing, the subtractive model is used. The digital colour chart now in use can deal with these problems, and it can handle some 16.77 million displayable colours on the monitor screen. This is made possible by dividing analog colour into digital values representing the relative position of the colour within the colour solid. These positions are expressed in equations and numerical values. The RGB and CMY tables are treated as colour solids with similar structures (Table 1), black is handled separately.

Additive colours	Subtractive colours	Complementary colours
R + G = Y	Y + M = R	R : C
R + B = M	Y + C = G	G : M
G + B = C	C + M = B	B : Y

Table 1. *Model of mixing colours digitally.*

The generic term for a system for controlling a colour reproduction process to ensure a certain level of predictability and quality is 'colour management system' (CMS). At the core of the CMS is the *device profile*: the means of calibrating input and output devices. Calibration in this sense is a combination of visual and numerical evaluations against established standards. A profile is a description of the way a device handles the reproduction of colour. A device profile is a means of adjusting devices to produce predictable colour results, to achieve matching values on monitor, printer and separations. Calibrating a device ensures a certain level of predictability about its future performance. It can be as simple as visually comparing output to a standard or as complex as measuring dot percentages at key points on a test image. When a production environment is calibrated properly, an image should look very similar, but not necessarily exactly identical, at each stage of the production process (scanner, monitor and the various output devices).

Colour reproduction today tends to allow generic software to perform much of the device calibration required. CMS solutions rely on a concept called 'device-independent colour'. Most systems use the CIE L*a*b* (Commission International d'Éclairage) colour space to move colour data from one system to another. Using device profiles, the CMS is responsible for organising and translating the colour values to ensure accurate colour reproduction. The majority of image manipulations are by adjusting colour and tone controls. Colour correction is usually the first and often the only image processing performed on an image. Corrections in most image-retouching programs are usually done via curves and tables. Tables indicate specific numerical changes in colour and are useful in communicating these, whereas curves are graphic representations of colour change (Miller and Zaucha 1994a: 91-3). In our project, the numeric tables colour correction method was preferred.

The most familiar colour space used in digital colour manipulation is RGB. For designers, the HSL colour space offers a friendly interface for easily adjusting colour psychologically. In addition, there are three major CIE models: xyz, Luv and Lab. The CIExyz was developed in 1931. In 1978, the CIE established two approximately uniform colour spaces to serve as new standards, called CIE L*a*b* and CIE L*u*v*. The latter is used primarily for monitors, while the CIE L*a*b* is most popular with colour print reproduction, encompassing as it does both the RGB and CMYK colour spaces. Most attempts of developing device-independent colour management solutions centre around the CIE system and most often the CIE L*a*b* colour space. It is currently the most popular vehicle to communicate from one colour system to another. Adobe uses CIE L*a*b* as a recommended colour mode when moving images between systems and for printing to PostScript Level 2 printers. The YCC colour used by Kodak's PhotoCD system is based primarily on the CIE L*a*b* colour space. The YCC space is also device independent as well as supported by PostScript Level 2. EFI, Kodak KEPS and Agfa ColourMatch all use CIE L*a*b* to translate from one colour space to another. Light Source, Inc. of Larkspur, California, is developing a colour management system incorporating these ideas, called AeQ Meta RGB. The emergence of ATD colour space should herald the coming of appearance-based, device-independent colour systems (Miller and Zaucha 1994b: 100-2).

Colour calibration of rock art with the IFRAO Scale

Computer technology is now developing faster than almost any technological endeavour in the history of humanity, and it is obvious that it will deliver even more sophisticated possibilities of data manipulation and storage in the future than those currently envisaged. It is equally obvious that, despite all good intentions and encouraging successes in the field of rock art conservation, our discipline needs a reliable 'back-up system' to preserve rock art by means other than its physical survival. Photography does not provide such a back-up system. Digital storage does, provided that imagery is colour calibrated. 'Digital conservation' of rock art is not suggested to provide an alternative to physical conservation, rather it should be seen as a 'last resort strategy', but one which needs to be developed alongside physical conservation. The latter can prolong the life of rock art; it cannot promise perpetual preservation of the imagery — which digital conservation can.

We have above identified two principal distortions in rock art photography: that which occurs in the production of a photographic record, and that which occurs subsequently, during the archival storage of the record. Most of the many processes involved would affect each colour or dye uniformly, including that in the image of a colour scale on the photograph. The principle of colour calibration and re-constitution involves the following basic steps:

a. Translate the photographic record (print, negative, slide, film, video) into digital information. This record must include an image of the calibration reference device (i.e. the colour scale) which has been photographed together with the rock art subject.
b. Instruct the computer to recall the true digital colour information contained in the reference device and compare it with that found on the photographed colour chips as they appear now. The computer determines overall distortion irrespective of source.
c. The computer then compensates for the distortion measured in each primary colour, re-constituting colours as required to re-create the known true colours in the photographed colour scale.
d. By extending the same corrections to the rest of the image and assuming that distortion was uniform over the entire image surface, the original subject colours are re-constituted by the same process.
e. The corrected image is then out-put to the required format (separations, colour printer, electronic storage).

At the time of writing we have conducted twelve case studies of colour re-constitution of rock art imagery, and we emphasise that this project is far from complete. The main purpose of this paper, apart from explaining the rationale of the work and presenting preliminary results, is to ensure the earliest possible dissemination of detailed recording recommendations guaranteeing the best-possible conditions for future colour re-constitution. Many thousands of IFRAO Standard Scales have now been distributed world-wide, one year after the first edition of the Scale was printed, and have hopefully been received by up to 6000 rock art researchers. However, in order to use the Scale most effectively it was necessary and urgent to conduct a pilot program that could determine optimum conditions of the Scale's use in the field. We have succeeded in digital colour re-constitution since December 1994, and we are working on perfecting the procedures with the intention of creating customised software. At the present time, all calibration is still done manually, but a considerable simplification of the process is possible through programming its repetitive aspects so that the operator merely has to supervise the procedure after downloading the raw data. Once the appropriate software has been written, the calibration process itself can largely be computer generated, with the operator only having to select sites for reference device spot checks for white, black, red, green and yellow. After calibration, the photographic image of the blue chip is checked to confirm accuracy, and if there is a minor discrepancy, it can be compensated for manually or automatically. This envisaged procedure is simple and efficient, which will be necessary in future calibration of large numbers of images held in archives. To render the proposed technology fully effective, massive numbers of images will need to be processed, and it would not be realistic to expect operators to spend a great deal of time manipulating imagery by review and manual adjustment — nor would such a manual process be remotely as precise as the purely digital (mathematical) manipulation of the colour properties (because it would rely on various subjective factors). Hence it is the ultimate aim of this project to create software that takes care of the repetitive calibration. But at the same time it should also be compatible to other programs the rock art specialist of future decades is likely to use. For instance, the calibrated and digitised image would be ideally suited for colour enhancement treatment (Rip 1989), which would assist research enormously in securing information about rock art that cannot be obtained by other means. This type of procedural extension is a quite modest development in terms of software requirements and should be envisaged to become available comparatively soon. Other possibilities of further applications exist also, and it is obviously important that future developments in the area of rock art imagery manipulation take into account all possibilities of this kind. For instance, integrated programs about rock art could include a comprehensive bibliography organised as per the keyword system being introduced by the Centro Studi e Museo d'Arte Preistorica in Pinerolo, Italy (Seglie 1991).

We emphasise that there is no a priori reason why the IFRAO Standard Scale should have to be used as the preferred device profile in a rock art colour management system. Any agreed colour standard could be used, provided it includes suitably sized and spaced (i.e. spaced within the colour solid) spot colour chips. Some popular colour charts, however, are not well suited. For example the Munsell Soil Color Charts bear only a small range of colours on each page, representing only one hue designation, so to use it effectively one would have to include two or three charts on the photograph. Also, there are numerous colour chips per page, so they are individually small relative to page size. As we will see below, the area of the calibration chips available on the photograph is an important consideration in colour accuracy. Finally, the Munsell charts are very expensive, and the prospect of supplying many thousands of them to researchers in developing countries would be financially daunting. Other expensive colour standards have also been used by rock art students, notably the Kodak Color Separation Guide and the Letraset Pantone colour charts.

Universal availability was one of the many motivating considerations in producing the IFRAO Standard Scale, which is being supplied free to all specialists of the world. Another is that the digitised systems being produced now and in the future should not be expected to have to convert calibration values for any number of standards, simply because we have not been able to agree on a uniform standard. The digital calibration procedure is entirely based on the colour values of the IFRAO Standard Scale. These are given in Table 2. The monochrome scale chips are of the following reflection densities: 0.0 (white), 0.70, 1.60 and 2.0 (black). Their values were chosen to comply with the Kodak Three-Aim Point Control methods for reproducing colour reflection copy with traditional masking and colour separation procedures. The first three represent average highlight, middle tone and shadow values in colour or black-and-white reflection copy.

Colour	YCC (CMY)	RGB	CMYK	HSB	L*a*b*
Red	0, 10, 10	214, 0, 39	0, 100, 100, 0	349°, 100, 84	47, 75, 49
Yellow	0, 0, 10	255, 215, 0	0, 0, 100, 0	51°, 100, 100	94, -14, 100
Green	10, 0, 10	0, 134, 73	100, 0, 100, 0	153°, 100, 53	55, -79, 36
Blue	8.8, 10, 0.2	50, 0, 90	89, 100, 2, 0	274°, 100, 35	22, 49, -45

Table 2. *The digital colour values of the IFRAO Standard Scale in YCC colour space, and for RGB, CMYK, HSB and CIE L*a*b* spaces.*

Colour re-constitution of rock art imagery was first attempted in December 1994, in the well-equipped computer centre of the Indira Gandhi National Museum of Man in Bhopal, India. In the first trials, four photographs of cupules and rock paintings of the Bhimbetka rock art complex were used (Figure 3). These attempts succeeded at once and we conducted numerous experiments subsequently (Bednarik 1994b) in an effort to determine optimum conditions for the field use of the Scale. During these trials we considered also the question of calibrating photographs taken before the introduction of the Scale and we found that limited re-constitution is possible if there is only a black-and-white scale present. In good-quality slides in which no direct light from a flash or strobe is reflected by such a scale, colour calibration of 70 - 80 per cent may be possible. This is because pure white areas, which should be of 0.0 - 0.05 reflection density, may bear discolouration. Similarly, the black chips are usually not quite black in the image, and we know that their reflection density should be 1.95 - 2.0. By compensating for both these known distortions the image can be considerably improved. Naturally this applies only to scales with pure white and black markings, not to wooden rulers and other assorted devices, the true colour of which is not readily available.

We have found that, in some circumstances, even photographs lacking any scale may be improved by our procedures. They may bear natural white, black or coloured patches of known values, especially areas of shadows in the case of pictures taken with artificial lighting. Deep shadows provide an excellent reference point for black. Alternatively, common objects of known colours may appear on a photograph, and may assist the operator in securing limited calibration. Such reference points may include white accretionary deposits, charcoal, chalk marks, site management signs, freshly damaged or broken rock, one's own hand, a note book or some other object fortuitously appearing in the picture. They may even be provided by field recordings of Munsell colour designations of pigment or of rock varnish or other patination where these are available and can be relocated on a photograph. The result of such limited calibration would be of debatable absolute colour fidelity, but it is certainly a considerable relative improvement.

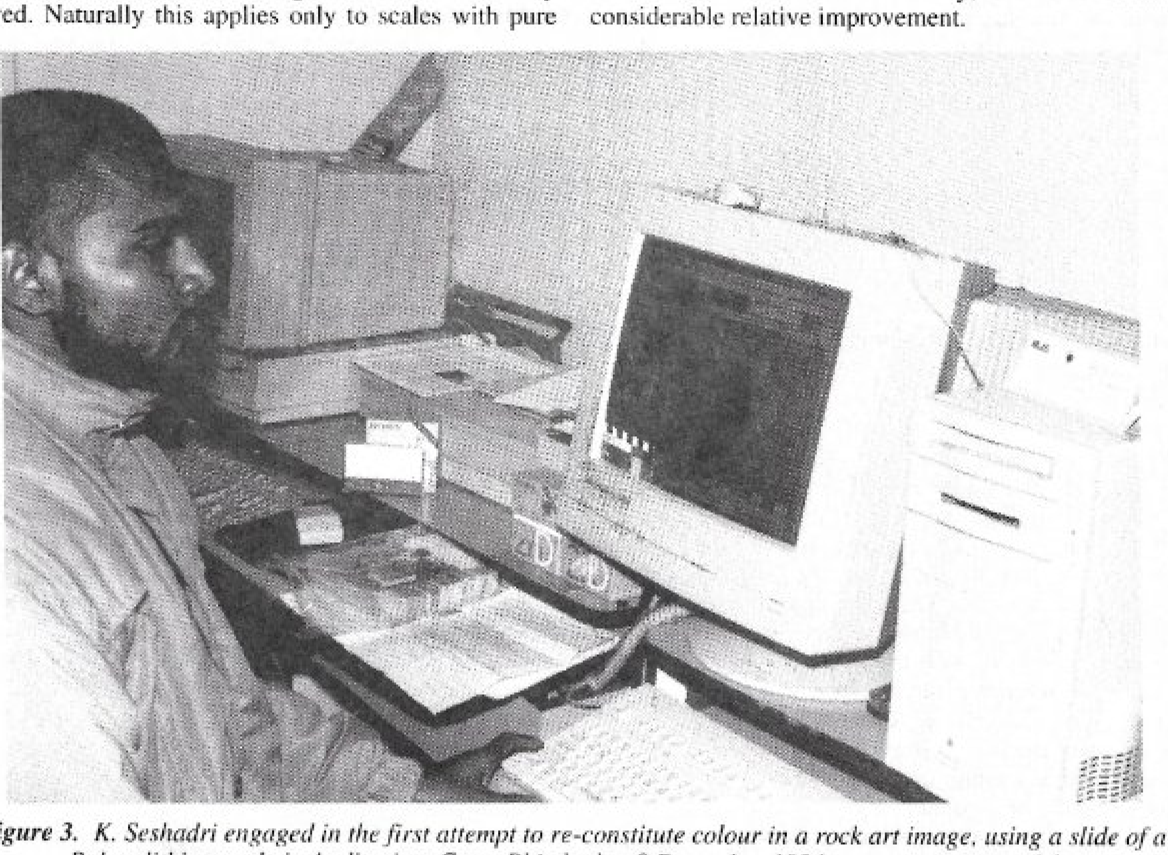

Figure 3. *K. Seshadri engaged in the first attempt to re-constitute colour in a rock art image, using a slide of a Palaeolithic cupule in Auditorium Cave, Bhimbetka; 8 December 1994, computer centre of the National Museum of Man in India.*

Nevertheless, such alternative applications of this methodology are of only limited value, and they involve an inordinate amount of operator effort. They can justifiably be used for photographic recordings of rock art that has since vanished, but it would not be reasonable to apply them to post-1994 photographs in which the inclusion of scales was neglected. In effect one may say that, in rock art colour re-constitution and in the establishment of permanent archives, 1994 was the year zero. As from now it is inappropriate to create archival rock art records without using a colour calibration device profile that is backed by proven computer applications. In fact it is now imprudent, and inconsiderate to future researchers, to take any photographs of rock art without a colour scale, irrespective of the purpose of the photograph as perceived at the time it is taken.

Optimum recording conditions

The principal objective of the present paper is to provide clear recommendations for the use of the IFRAO Standard Scale. The guidelines initially issued with the Scale were limited to aspects of rock art conservation and to prolonging the life span of the Scale itself: to avoid placing the Scale near the rock art, and to store it in a dark, dry and cool place (Bednarik 1994a). However, it was also recommended that the Scale be so positioned that it would appear near a margin of the photograph, and that *it must receive the same photographic exposure as the rock art motif.* It would have been premature to provide further guidelines for field use at the time, but it was clear that they should be made available before extensive use of the Scale began. The optimum conditions for the use of this new research tool of colour re-constitution have now been determined and they are summarised below.

1. *Recording medium:* The colour calibration input should preferably be as **slides** (transparencies) or colour **negatives**. This is because the scanning process presently required for paper prints is inferior to the digitisation directly from film, and colour transmission from photographs to CRT does not produce precise results.
2. *Lighting:* **Natural lighting** is clearly superior to artificial light, which means that increased exposure times are preferable to the use of flash or other artificial lighting. Where necessary and possible, use a sunlight reflector. Avoid direct lighting in dark locations, and when using artificial lighting, use white light, not yellow halogen light.
3. *Direction:* Where artificial light is necessary, and especially for three-dimensional subjects (petroglyphs, cupules), the light source should be from the **upper left**, and the Scale should also be on the left upper corner of the frame.
4. *Area:* Full 100 per cent calibration, which would result in a colour re-constitution adequate for rigorous technical and scientific purposes, requires that at least **5-10 per cent** of the photograph's area should be occupied by the Scale. With standard lenses this might correspond to a distance of about 0.5 to 0.8 metre. There is a gradual but initially negligible loss in reliability as the image area occupied by the Scale decreases with distance.
5. *Distance:* One Scale suffices for distances of up to 1.5 metres. If uneven lighting is unavoidable, place the Scale in the better lit section. For distances between 1.5 and 4.5 metres, two scales must be used for optimal results: place one of them anywhere suitable, but the second one always vertically and in the upper left corner of the frame. Beyond a distance of 4.5 metres, the Scale is too small to permit a calibration level approaching 100 per cent, because at that distance the colour chips become too small to obtain precise digital readings from (i.e. using lenses of standard focal length).
6. *Alignment:* Care must be taken to position the Scale so that it is **parallel** to the predominant plane of the rock art motif, and about the same distance from the camera lens. Misalignment will reduce the reliability of colour calibration.
7. *Reflection:* The Scale has been printed on matt stock, but this does not eliminate reflection entirely. If a camera-mounted flash is used, the scale must not be at right angle to the camera's focal axis, and if the subject is side-lit, the Scale should be perpendicular to the focal axis (Figure 4).

Special attention should be given to the last two points which refer to the factors most likely to result in unsuitable photographs. It will be obvious from them that the use of camera-mounted flash or floodlight is not to be recommended, because to comply with recommendations 6 and 7, the rock panel would have to be photographed at an angle (Figure 4b). This is not desirable for several reasons (uneven lighting and focusing, foreshortening), hence it is to be preferred that the lighting device be positioned independent of the camera location.

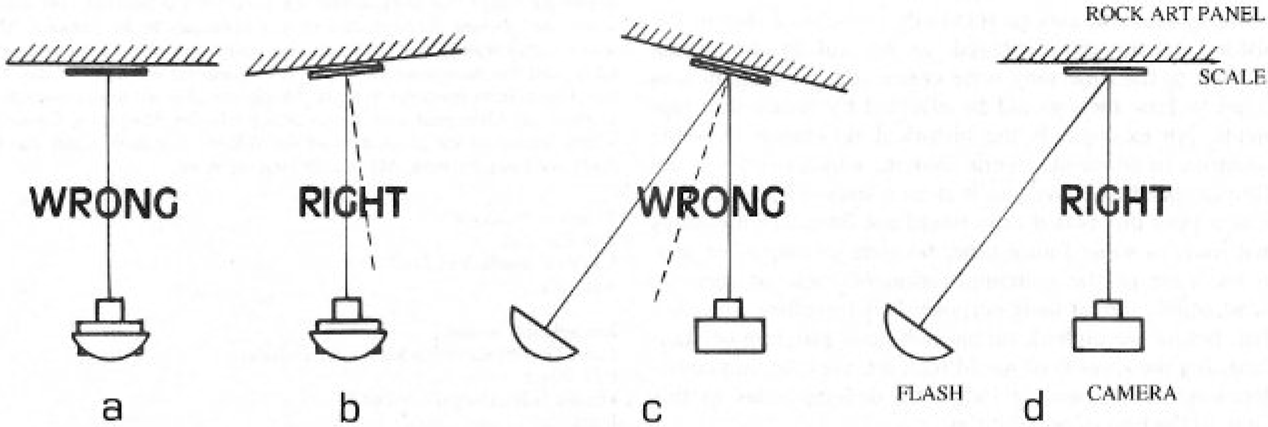

Figure 4. The relative positioning of camera, flash/strobe, scale and rock art: light and camera in the same position (a and b), and in two different positions (c and d).

This is the preferred procedure in any case because camera-mounted lighting always results in poor image depth. In placing the lighting separately it must be made certain that the Scale is not angled mid-way between camera focal axis and lighting axis (Figure 4c). Ideally, both the art panel and the Scale should be perpendicular to the focal axis, and the lighting should be from the left (Figure 4d), at an angle of reflection suitable for the relief of the rock panel: a low angle (20 - 50° to the focal axis) for an uneven panel, a higher angle (50 - 80°) for a very flat panel.

Conclusion

The present paper does not satisfactorily deal with colour printing, being concerned primarily with scientific and archival applications of the method described. This is in part also because current technology in the area of transposing digital colour information to the printing press remains inadequate. Printing presses can reliably reproduce only a fraction of the more than 16 million colours of a 24-bit colour monitor.

It is obvious that most rock art imagery is of a very restricted colour spectrum, roughly between yellow, red and black, with many shades of brown and ochre. One of the most promising ways of developing specialised rock art colour programs for scientific applications would therefore be to create a customised colour library for our discipline which printers would use for achieving best results. Such a standardised library could then be attached to the software programs that specialists in our field will inevitably use world-wide. As we have noted above, there are possibilities of connecting the program being developed with various other digital functions, thus creating a major support structure for the discipline.

On the basis of existing technology, the discipline really does not have a choice in how to render our photographic records permanent. Perhaps an alternative technology of electronic (or other) storage will become available in some future century, but in the meanwhile rock art is being lost at an ever-accelerating rate, and it would be irresponsible of us to hesitate any longer in striving for a universal recording system. We have been considering the use of computers now for some time in this field, and we have procrastinated because of a lack of direction and disciplinary standards. Standards are at last becoming available, and the direction to be taken is fairly self-evident. The system we have described here promises to deal satisfactorily with the demands of future technologies.

Many technologies or standards introduced during the history of humanity proved to be cul-de-sacs, often because at the time they were conceived, no thought was given to how they would be affected by future developments. An example is the historical reluctance of some countries to adopt the metric system, which results in the ultimate need to convert to it at an astronomical cost. The lesson from this is that one should not introduce measures that may, at some future time, become incompatible and, in the case of the computerisation of rock art records, substantially defeat their purpose. It is therefore advisable that, before we embark on an ambitious program of standardising the records of world rock art, we take into consideration the foreseeable long-term developments in this field, to the best of our abilities.

If rock art research is to be a viable discipline it cannot rely on the long-term survival of rock art, it has to create an archival data bank on a global scale. Colour standardisation and calibration are absolutely essential for this to be meaningful. While this is obvious, it is much harder to predict the shape technological innovations will take in future centuries. We may begin by extrapolating from our present position: to 'save' rock art for posterity, we shall have to create massive permanent records of it. Anati's (1984) early quantitative estimate of global rock art resources was probably quite conservative. We know that it excluded several large concentrations (e.g. in China, with upwards of 10 000 sites) and underestimated others. With an expected true number well in excess of 100 million motifs it is obvious that, at the present rate of progress, it may take centuries to record this global corpus *satisfactorily*. By that time, a good portion would have fallen victim to relentless deterioration, so we need to find less time-consuming ways, not only more effective ways of recording. For instance, the use of a video camera has the benefit of preparing the data in a format facilitating subsequent digital colour re-constitution. Digital cameras are already in use for recording rock art. It does not seem unrealistic to predict that, sometime in the next century, rock art recorders would take a computer-supported video (or similar) system or digital camera into the field that would calibrate colour at the site, while the actual art can be viewed to check the recording for veracity. Upon return to the base institution, the fully corrected, permanent digital records would simply be downloaded onto the archive memory. Vast numbers of art panels could be recorded for all future in this fashion as the questions of digital storage capacity are solved, and they need to be recorded only once. But irrespective of the technology's sophistication, a calibration standard would still have to be used, therefore we suggest that the future of the IFRAO Standard Scale seems assured.

With the present developments, rock art photography has become a method of temporarily storing optical information about rock art until a permanent form of storage becomes available. It is no longer a means to its own end, but a *provisional* form of recording rock art. To unlock coded optical information from photographic records it is not sufficient to produce good photographic imagery: it must be colour calibrated also.

Acknowledgments

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Résumé. *Le but principal de la récente introduction de l'échelle internationale IFRAO pour le calibrage des couleurs était de faciliter l'instrumentation de la reconstitution chromatique. Cet article rapporte le premier essai positif à réaliser ce but. On explique la subjectivité de l'enregistrement photographique; on élucide le caractère éphémère de tel enregistrement et on considère les principes fondamentaux de perception chromatique et du traitement digitalisé de l'information chromatique. On explique aussi le rôle de la digitalisation de l'image et des systèmes de la mise en réserve des données d'art rupestre. Finalement, l'article donne des lignes détaillées pour utiliser l'Échelle Standard IFRAO et réaliser les meilleurs conditions possibles pour la manipulation digitalisée des données photographiques d'art rupestre.*

Zusammenfassung. *Der Hauptzweck des kürzlich vorgelegten IFRAO internationalen Farbkalibrierungs-Standards war es, die Einführung von Farb-Rekonstitution zu ermöglichen. Dieser Artikel berichtet die erste erfolgreiche Verwirklichung des Systems. Die Subjektivität photographischer Unterlagen wird erklärt, die Kurzlebigkeit solcher Unterlagen besprochen, und die Grundlagen von Farbwahrnehmung und der elektronischen Verarbeitung von Farbdaten werden erörtert. Die Rolle von elektronischen Bildumwandlungs- und Aufbewahrungs-Systemen in Felskunst wird ebenso erklärt. Abschliessend enthält der Artikel auch detaillierte Anweisungen für die Verwendung der IFRAO Standard Skala um die bestmöglichen Bedingungen für zukünftige elektronische Manipulation photographischer Felskunstinventare zu bewirken.*

Resumen. *El principal propósito del recientemente presentado modelo internacional de graduación de colores de IFRAO fue de facilitar la implementación de la re-constitución de colores. Este artículo informa acerca del primer intento exitoso para lograrlo. Se explica acerca de la subjetividad de la documentación fotográfica, lo pasajero de tales documentos es elucidado y los principios básicos de la percepción de colores y el procesamiento digitalizado de la información de los colores es considerado. El rol de la digitalización de imágenes y sistemas de almacenamiento en la documentación del arte rupestre es también explicado. Finalmente, el artículo provee pautas detalladas para el uso de la Escala Standard de IFRAO a fin de obtener las mejores condiciones posibles para el futuro manejo de codificación de la documentación fotográfica del arte rupestre.*

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RAR 12-341

REVIEWS & ABSTRACTS

Rock art studies: the post-stylistic era, or, Where do we go from here?, edited by MICHEL LORBLANCHET and PAUL G. BAHN. 1993. Oxbow Monograph 35, Oxford. viii + 215 pages, line drawings and monochrome photographs, bibliographies. Paperback, £30.00, ISBN 0-946897-63-8.

Rock art studies: the post-stylistic era, or, Where do we go from here? is a collection of papers presented in Symposium A of the Second AURA Congress in Cairns, 1992. The symposium, of the same name as the book, was organised by Paul Bahn and Michel Lorblanchet to address an apparent increasing rigour in the use of the concept of 'style' in rock art analysis. The employment of the term 'post-stylistic era' by Bahn and Lorblanchet did not mean to suggest the death of style but, rather, was purposefully used to be provocative, to challenge participants to demonstrate its changing role in rock art studies in the face of new and improved methods of analysis (including direct dating methods). To these ends, the symposium was, as this book is, very successful. All contributors directly addressed the usefulness and/or limitations of stylistic analyses to their own research.

Interestingly, and as Bahn and Lorblanchet point out in the Introduction to the book, there have been major differences in the way that stylistic analyses have been used in different parts of the world. In particular, until recently European researchers used stylistic analyses predominantly in a unilineal, evolutionary way. Entire rock art panels would be allocated a specific 'style', and each style was allocated a temporal niche. There was little acknowledgement that different styles could coexist in time. Furthermore, there was little investigation of the integrity of a given style, that is, its internal variations and how this contrasted to broader styles (the 'robustness' of a style). In retrospect, this created problems, for pictures of very different characteristics were often included in a single 'style' by virtue of the fact that they occurred together on a single panel. These 'styles' were then attributed specific chronological frameworks, even though the art itself was never directly dated. It was usually assumed that *all* of the pictures dated to this allocated time frame, even though the internal (temporal) relationship of the various pictures on a panel (all attributed to a particular 'style') was never investigated. Therefore, the 'stylistic era' was often based on methodological shortcomings and potentially faulty assumptions that were rarely, if ever, investigated. It is these shortcomings and assumptions of stylistic chronology, and 'where do we go from here', that Bahn and Lorblanchet wished to address in this book.

Rock art studies: the post-stylistic era, or, Where do we go from here? contains nineteen chapters. As Bahn and Lorblanchet note in their Introduction, the book 'starts with some general papers [by Franklin and Mathpal], moves into Palaeolithic art [Clottes, Sieveking, González García, Bahn and Lorblanchet and others], then regional studies [Chaloupka, Welch, Clegg, Smits, Johnston, Taçon, Tratebas, Dronfield and Haskovec], and closes with papers which explore new avenues of rock art research [Bouissac and Bednarik]'. Most of the chapters directly address a methodological issue in the context of their chosen regional study. There is a regional emphasis on European Palaeolithic and Australian rock art, although other areas also receive some attention (India, Africa, Ireland, Canada, North America).

The book is very well presented and, generally speaking, has been well edited. Of very minor concern is some lack of consistency in presentation: some papers have abstracts, others do not; there are different bibliographic 'styles' between some papers; a few times Figures would be called Tables; and there are the usual spelling mistakes (but not many — I picked up five). But overall these editorial mistakes are neither here nor there. Of far greater importance is the excellent job done by the publishers, editors and authors in presenting this well produced volume so promptly after the AURA conference in Cairns.

I will not discuss each paper in detail in this review. Rather, I wish to identify what were, to me, the most interesting papers — by Bahn ('The "dead wood" stage of prehistoric art studies: style is not enough'), Lorblanchet ('From styles to dates' with Appendices by Labeau, Valladas, Cachier and Arnold), Chaloupka ('You gotta have style') and Clegg ('Style at Sturts Meadows and Gap Hills') — and to make some observations about the concept of 'style' itself.

An interesting thing about this book on 'style' is that nowhere is the concept of 'style' itself discussed in any detail. I am not sure if this is good or bad, for one of the strengths of the concept is its plasticity — style can relate to a number of things (e.g. individual conventions or sets of conventions), and people can therefore chose their own variables and definitions for themselves when doing 'stylistic analysis'. However, the book could have benefited from detailed discussions of seminal ideas such as those of Wobst, Conkey, Sackett, S. Binford and others. None of these authors received anything more than a passing reference (at the best of times), a surprising thing given their great influence on stylistic analyses in rock art studies all over the world. It is these authors in particular who have explicitly stressed that if ways of doing things vary through space and time, they become amenable to 'stylistic' analysis. But there are many ways of doing this — that is, there are different styles of stylistic analysis. It is not stylistic analysis as such that is at stake, but the manner in which we do stylistic research.

'Style' and context in social systems

As Smith (1992: 29) notes, 'in theory, artists can depict anything they wish, but they don't'. This is an important assumption that is constantly implied but never discussed in Lorblanchet and Bahn's book. Following Sackett (1977: 370), we usually assume that 'form is an index to history', in that behaviour is encoded by socio-cultural convention. The range of possible ways people can behave with respect to any aspect of life is inconceivably large, restricted only by immediate historical choices. Hence Sackett writes that

> the material culture of any given society exploits only a few narrowly selected ranges of the enormously broad spectrum of formal possibilities that are potentially open to it. In short, there are invariably alternate means of achieving the same end and a society tends to 'choose' but one of them; and since the potential range of equally valid and feasible options is so great, chance alone dictates that the precise choice made in one society is extremely unlikely to be made in another, unrelated society (1977: 370).

Rock art is influenced by socio-cultural convention, which means that by analysing the distribution of rock art conventions through time and space, we are investigating continuities and discontinuities in material behaviour. Where conventions are relatively homogeneously patterned across space, it is assumed that a continuity exists in social practice; the presence of contiguous traits implies some form of interaction between individuals or groups across space. In contrast, dissimilar traits are treated as signifying some form of discontinuity in material behaviour. The latter specifically indicates that people behaved differently with respect to that particular material item, but not necessarily with respect to other things. This implies a discontinuity in a specified field, or context, of action. For example, differences in the way people dress means that there is a discontinuity in contexts of dress, but not necessarily of any other factor, such as language, eating habits, hair-styles and so forth (or even in other contexts of dress). I am not talking here about 'peoples' in a culture-historical sense, but about specific practices. Documented cases of continuity and discontinuity in the distribution of rock art conventions have implications for the spread of conventions across space and through time. The distributions of these conventions are directly related to contexts of information exchange and inter-regional behaviour.

The conventions used in creating and using material items are often referred to in terms of 'style' (e.g. S. Binford 1968; Conkey 1978, 1989, 1990; Davis 1990; Sackett 1977, 1982; Wiessner 1983; Wobst 1977). However, style is a broad term which refers to combinations of particular conventions (e.g. patterns of line, colour, design elements and so forth), such as in McCarthy's (1968: 125) definition of style as 'the total design or pattern of a figure'. Such concepts are analytically cumbersome, and do not encourage investigations of definable spatial/temporal continuities and change. It is this problem that seems to be largely acknowledged to be the greatest limitation of 'stylistic' analysis in this book. Instead of traditional stylistic analysis, a number of authors have therefore argued that researchers would be better served by focusing on *specific* conventions, rather than on broad 'styles'.

There have been many definitions of 'style' offered in the literature, during the past thirty years especially, and I will not attempt to review these here as they are, in the main, of little relevance to this review. Furthermore, the various definitions are not conflicting, for they largely address different aspects of the concept, such as those that concentrate on the role of 'style' in effecting communication and interaction in harsh environments (e.g. Gamble 1982), its active participation in creating and reproducing social formats of behaviour (e.g. Hodder 1981, 1986) and its role in information exchange, social communication and negotiation (e.g. Wobst 1977). An important set of assumptions (generally common to the above definitions of 'style') can nevertheless be made here. These assumptions include:

1. Social interaction is patterned, in the sense that human behaviour involves social sets and cultural frameworks. Such sets can take a very large number of potential formats, such as age sets, friendships, clans, sports clubs and so forth.
2. Following (1), behaviour becomes contextualised.
3. Social interaction, and human actions in general, involve material properties. Because of the patterned nature of behaviour, matter also becomes patterned.
4. Any given social practice involves an interaction of a very large number of contexts. Partly because of this, the social correlates of material patterns are usually ambiguous.

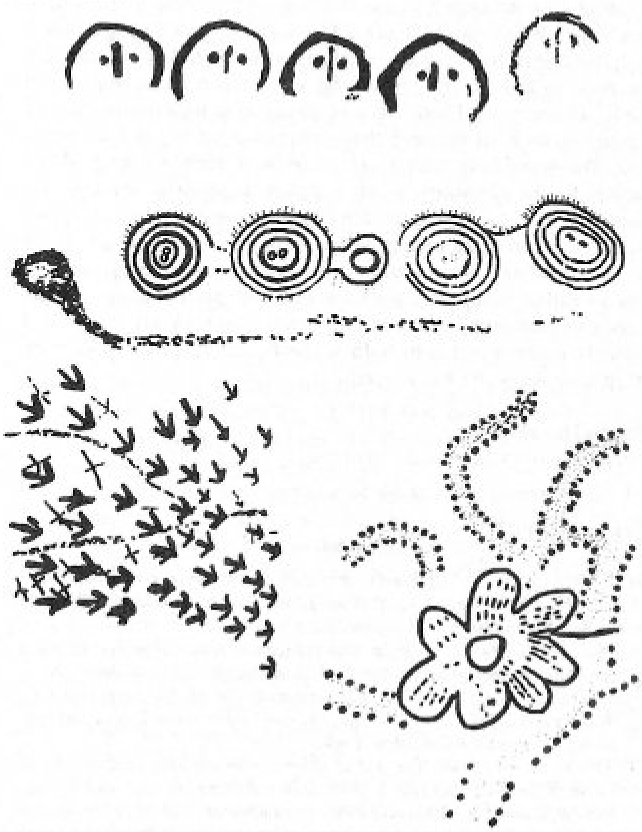
Because of the above issues, Conkey (1990: 15) has argued that the distributions of 'styles' should not be treated as representing the distributions of social groups or 'cultures', but implies 'that what style can "tell" us about is *not* culture or groups per se, but the contexts in which group or other social/cultural phenomena are mobilized as process' (see also Conkey 1989: 119; Hodder 1981, 1987). Such contexts are archaeologically ambiguous. They can, for example, relate to clan affiliation, language groups or tribal membership, all of which consist of formal and exclusive sets of social actors. An example of such contexts occurs amongst the Dhuwa and Yirritja moieties of eastern Arnhem Land (Morphy 1977). Here, individuals of a given moiety share common rights in various social practices, such as ritual roles, dances and painting designs. As Smith, quoting Morphy (1977: 182) notes,

> clans belonging to the Yirritja moiety all own variants of a basic diamond pattern [in bark paintings], while those of the Dhuwa moiety own various design combinations of a square and a set of opposed curved lines ... these designs simultaneously serve to differentiate groups in terms of their rights to particular tracts of country (Smith 1992: 33).

Such formal, structural contexts of social interaction, however, do not constitute the full array of patterned social behaviours. The ultimate concerns of many researchers employing the concept of 'style' does not appear to be with formal structures per se, but with the way in which praxis has been structured in the process of social interaction. These issues cross-cut formal structural concerns, while at the same time including them. By this I mean that while formal social structures are involved in the creation of patterned social behaviour, other factors also come into play. An example of this issue is presented by Thomson, who notes that among Australian Aboriginal groups in Cape York Peninsula,

> where the territory occupied by a tribe was extensive, the clans at one side of the tribal territory frequently had more in common with the clans of neighbouring tribes than with those of their own tribe situated on the other side of the territory (Thomson 1972: 1).

This point is extremely important, as it highlights the fact that patterned behaviour cannot be treated solely in terms of formal groups (e.g. clans, tribes, languages). One also needs to consider less formal relationships. Styles, therefore, need not relate simply to formal groups. Proximity of individuals and groups may relate to spatial dimensions or to a potentially infinite number of social or cultural relations. For instance, it may involve friendships, which may be more appropriately treated in terms of inter-personal interaction than in terms of formal social sets such as age-mates or clans. The significance of this is that such interactions can cross-cut formal social boundaries, and therefore need not reflect them.



Kimberley rock paintings, Western Australia. Recording by D. Welch

I have purposefully addressed Lorblanchet and Bahn's new book with the above discussion in order to demonstrate one simple point: the key issue about 'style' is not whether it is useful or not, but about *how* should stylistic analysis proceed when addressing temporal and spatial issues in social systems. In a way, there is no such thing as a 'stylistic era', and therefore there can be no such thing as a 'post-stylistic era'. Rather, researchers have used the concept of 'style' so as to order the archaeological record. There have been many ways in which this was done in the past. Sometimes each picture is treated as a whole and attributed to a particular style. At other times, specific conventions are treated separately — e.g. thickness of lines, colours used etc. — and it is these that are analysed separately. In the latter case, it is each of these conventions that is attributed a 'style' (e.g. styles of line-work, or of infilling or colour use).

The concept of style is a heuristic device to order an otherwise chaotic material record. Style is itself devoid of time and space, while at the same time it insinuates some spatial and temporal order (the exact nature of which remains to be determined). But we should not treat style as inherently being able to tell us how old something is, without first establishing the temporal and spatial integrity of a 'style'. Once defined on morphological grounds, a given style could have been used for a year or for a hundred thousand years. It could be used near one water-hole or across the whole world. A style is something that is morphological (material), and therefore needs to be defined according to morphological (material) criteria. Its temporal and spatial specificity needs to be established independently, using special methods such as AMS carbon dating and spatial analysis. Strict criteria need to be established to determine where a style starts and where it ends — that is, the integrity of a style needs to be established in its definition. This is important as stylistic analysis is about pattern recognition. Failure to strictly define a 'style' could lead to circularity of argument.

This, I think, are the major messages of this book. Its success in presenting its message(s) was foreshadowed by the large number of participants in Symposium A of the Cairns conference. It can also be measured by the diversity of responses presented in this book. While most, if not all, authors appear to argue for a continued need for 'stylistic' analysis, most would also argue that we need to tighten-up our act, be more rigorous in our use of 'style' in analysis. There are now many new techniques that we can use in rock art research that were not available just ten years ago. We should therefore use these new methods (e.g. AMS dating) to our advantage when undertaking stylistic analysis. As Bahn and Lorblanchet state, however, 'our entry into this "post-stylistic era" must be undertaken with the utmost prudence' if we are to learn from our mistakes. This book is an excellent start to this so-called new 'era', pointing out both strengths and weaknesses of traditional and new approaches to rock art research. I strongly recommend it to both students and researchers of rock art in both Australia and abroad.

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RAR 12-342

In plain sight: Old World records in ancient America, by GLORIA FARLEY. 1994. ISAC Press, Columbus, GA, U.S.A. 481 pages, drawings, photographs, references by chapter, index. Hardbound, US$37.00. ISBN 1-880820-08-0.

In plain sight is a big book: 458 pages of text and illustrations, an appendix showing ancient scripts, and a postscript with bibliographical sketches of fifteen epigraphic investigators with whom Gloria Farley has been associated during the past twenty-five years. The more than 450 numbered illustrations are intriguing, although fewer than a tenth are actual photographs of the petroglyphs on which Farley bases her assertions of Old World presence in ancient America. Her thesis is that hundreds of glyphs in Oklahoma and adjoining states are the work of pre-Columbian visitors and settlers who were not Amerindians, and that this should be obvious to anyone who is not blinded by conventional biases. The book is divided into eighteen chapters on such specialised topics as signatures, horses, ships, sex and astronomy, imposing a degree of order on an eclectic collection. Where pertinent, Farley shows what she believes to be Old World counterparts to support her claims, although the supposed connections are often nebulous.

We have seen most of these petroglyphs and would agree, on the basis of our own studies, that a handful of engravings in the central United States seem best explained as examples of Old World writing or iconography made more than 500 years ago. Our findings to date are detailed in *Ancient American inscriptions: plow marks or history?* (1993). Farley deserves credit for recognising and publicising certain enigmatic glyphs, but her proclivity for seeing things in Old World terms forces us to describe her book in largely unfavourable terms. Most of Farley's 'Old World records' were made in Historic times, as can be seen from their style, context and lack of patination. For example, more than twenty horses she claims to be ancient are in the abraded-outline style of the Plains Indians and are too recent for repatination to have begun. Farley simply cannot seem to tell old marks from the modern graffiti and Indian carvings that make up 95% of her examples, and this will be apparent to rock art specialists who see her book.

In plain sight is an autobiographical account of more than four decades of exploration and is a good adventure story, but the bulk of the interpretation is fantasy of the familiar kind that has turned linguists and rock art scholars away from examination of American petroglyphs as potential indicators of early contact. The absurdities on nearly every page are masked by an entertaining anecdotal style, and will hardly be noticed by readers who already believe in a massive Old World presence in pre-Columbian America.

It is amazing how many people accept books like this without knowing the details of the research on which they are based. In fact, the heated controversy over possible Old World influence on American petroglyphs has taken place almost entirely among partisans who have never seen the subject matter. Most arguments have been based on ideology, not on careful examination of the rocks. During our efforts to enlist professional scholars for rigorous research on the epigraphic potential of American glyphs, we were astonished by the way belief systems dominate thinking, and we discovered that the actual evidence is insufficient to support either the strongly held convictions of typical epigraphic advocates or those of their debunkers.

The perception of 'epigraphy' by conventional scholars is that its loose methodology has created an illusion with no substance. This is only partially true, but the perception is periodically reinforced by fanciful books like this. Our criticism of Farley's methodology in *Ancient American inscriptions* was considered harsh by some of her associates, but *In plain sight* provides further examples of the same problems. We commented specifically on Farley's failure to take the age of petroglyph grooves into account, and on her tendency to see too many sets of parallel lines as Ogam inscriptions. We found it essential in our own work to pay careful attention to the degree of repatination of grooves, and in some cases we have used the cation-ratio method to determine the age of patina. It is almost always possible to distinguish suspected alphabetic carvings that are 1000 to 2500 years old from petroglyphs such as those of Plains Indians that are less than 300 years old, and we believe it is irresponsible to present recent carvings as the work of pre-Columbian Old World visitors.

A major reason conventional scholars look askance at 'epigraphy' is the slipshod but once popular work of Barry Fell, with whom the field is identified. For nearly twenty years, American epigraphy has meant primarily the claims of Fell, who died in April of 1994. Fell created the Epigraphic Society and its annual publication, *ESOP*, as a vehicle for his reconstructions of Polynesian prehistory, but he soon focused on American 'inscriptions'. After publication in 1976 of his popular *America B.C.*, Fell was deluged with photographs and drawings to be 'translated', and he seldom failed to come up with a decipherment for awestruck patrons who usually accepted them at face value. Although Fell almost never saw the actual engravings, his corpus of imaginative decipherments grew to astounding proportions without peer review or informed debate.

In plain sight documents how this game was played. There are seventy references to personal correspondence from Fell about material he never published. For example, Fell published only one horse image, but he advised Farley privately that he could see readable script in the manes, tails, brands or other features of twelve. Fell's ingratiating letters have left more than a few of his correspondents with the impression that they have made important epigraphic discoveries. In Farley's case, the sheer volume of her contributions moved Fell to list her on the mast-head of *ESOP* as 'Director of Field Explorations'. Unfortunately for the credibility of *In plain sight*, the more than 250 items claimed to indicate Old World contact include only nine bedrock engravings that we think are potentially valid evidence, and only two of these appear to be epigraphic.

This is a shame because for decades Gloria Farley devoted every spare moment to tracking down reports of promising petroglyphs, and she was an integral part of the network of like-minded people determined to find evidence of pre-Columbian contact. She was more determined than most, and it is unfortunate that the few potentially significant petroglyphs she recorded are obscured by the mass of recent material for which she made the same claims of antiquity and Old World content. The fact that Fell claimed to extract alphabetic meaning from many of these will seem laughable, not impressive, to seasoned students of petroglyphs. But for anyone interested in the Barry Fell phenomenon, *In plain sight* is a clear exposition of Fell's ability to 'read' a wide variety of marks, and the ability of his adherents to accept even the most absurd interpretation without question.

But the book is not all fantasy. Some of the petroglyphs presented not only appear to be old, but differ significantly from those made by indigenes or by later settlers. These few deserve further study by specialists, but they must be evaluated first by checking them in the field. They cannot be assessed from Farley's drawings, which are not always accurate and which do not show age.

Foremost among the important carvings are those of the 'Anubis Caves'. Few would disagree that Farley's most valuable contribution was to notice and publicise the apparent Old World affinities of these glyphs. They have been known for generations to local people, but Gloria Farley was the first to note the canine, portrayed in Egyptian style with crown and flail in the role of Anubis. This led to later identification by others of related elements on the main panel as well as the 'six months Ogam' inscription and two solar alignments at the same site. Taken together, these are strong evidence for a pre-Columbian Mediterranean contact. Our interpretation of the caves as a possible Mithraeum is detailed in *Ancient American inscriptions*.

Also to be taken seriously, in our opinion, is the apparent Libyan 'Battle of Yatrafa' inscription in Oklahoma (pp. 429-31). Somewhat similar script-like glyphs are known from Arkansas and from Nebraska, so that a more secure interpretation might be developed by further investigation of the whole group. In the same promising category are some of the pecked pictorial glyphs found in Arkansas and the apparent depiction (pp. 408-13) of a planetary conjunction in Arkansas. The well-known Oklahoma runestones also deserve objective study, although runes were known to settlers in some parts of America during the 18th and 19th centuries.

Readers not familiar with the territory are likely to get the impression that Farley's subject matter is widely scattered, but most of it is clustered at a few sites in Colorado and the Oklahoma panhandle. It is annoying to find her posturing throughout the book as the premier explorer of that country, referring to others as 'assistants' or 'helpers'. Of the several hundred promising sites under investigation in the core area, she has seen only a handful, and all but two or three of these were shown to her by local ranchers. One of these men has counted thirty of her 'finds' that are improperly credited in the book.

Even more objectionable is her advocacy of latex casts as a desirable method of recording petroglyphs. Dozens of glyphs bear the scars of her activity because she applied latex without using a release agent. When such molds are stripped off they remove protective patina as well as rock fragments, accelerating erosion and preventing reliable dating of the grooves. Not only does Farley show no remorse over this practice, she gives instructions on page 17 for its continuance.

Friends and associates of Gloria Farley will rejoice that she has been able to finish a work that has been in progress for so many years. But informed readers will view *In plain sight* primarily as a peculiar exposition of the way 'epigraphy' has been conducted in the United States. It is certain to have a negative impact on any attempt to bring respectability to the study of American petroglyphs as possible evidence of early Old World contact.

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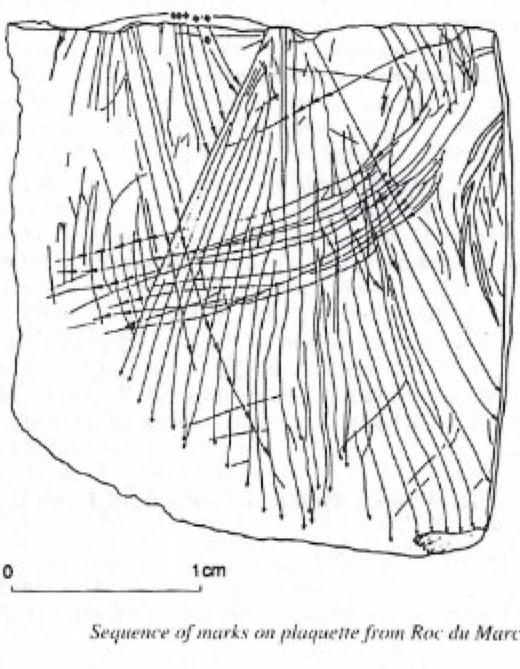
RAR 12-343

L'art gravé azilien. De la technique à la signification, by FRANCESCO D'ERRICO. 1994. 31st Supplement of *Gallia Préhistoire*, CNRS Éditions, Paris. 329 pages, 331 figures, plates and maps, 19 tables, bibliography, abstracts in French, English, Italian and Spanish. Paperback, ISBN 2-271-05247-5.

Over the past decade the author of this academically most substantial book has become a household name in the field of scientific palaeoart studies, primarily through his massive contribution to the microscopic studies of portable engravings. In that field he has become the undisputed world authority, turning Marshack's 'internal analysis' into what must be described as a fine art. Some samples of the best of his work have appeared on the pages of past issues of this journal, adding one of the most important chapters to modern scientific work in the study of prehistoric art.

This volume is an updated version of d'Errico's doctoral thesis of 1989, with comprehensive bibliographical coverage of recent work in the field. It presents the detailed results of a very major analytical study of portable engraved finds from the Azilian. Some 160 specimens bearing a total of 190 engraved surfaces are included in the study, representing well over half the known 246 Azilian finds of this type known from France. Each engraved surface has been carefully studied and recorded with the microscope, and where possible, the order in which the lines of a set or sequence were engraved was determined by means of the specialised techniques d'Errico has developed. These include, besides visual examination of minute details, systematic replication attempts, which have become a hallmark of the author's work. To examine striations and other details, he uses not only the reflected-light optical microscope, he also creates transparent cast replicas to study with a transmitted-light microscope, and resin casts to examine under a scanning electron microscope. By examining the ancient engraved patterns as well as modern replicas of them, d'Errico is frequently able to determine the direction in which a prehistoric burin was moved, or whether the same tool was applied repeatedly at the same time, and other technological details relating to the manufacture of Azilian portable art. For instance, incidental striations can occur where tool aspects other then the point touched the surface, or where changes in the pattern of contact may be found within a single line (e.g. in response to changed curvature of surface) when the contact relationship of the tool point relative to the engraving surface changed or when the point splintered while engraving a line.



Sequence of marks on plaquette from Roc du Marcamps.

One of the most important findings from d'Errico's painstaking studies is that the patterns resulting from slight changes in the way the burin is applied to the engraving surface can produce significant changes in the morphology of the engraving groove. If a tool is put down briefly between engravings, or if the grip or direction of application is slightly changed, it may be impossible to recognise the repeated application of the same tool. The implication of this is that while one can definitely recognise the repeated application of a tool in certain cases, one can never with certainty say that two different marks were not made by the same tool. This, I contend, is a fundamental problem with the identification of notational markings.

The Azilian is an Epipalaeolithic/Mesolithic tool tradition of the final Pleistocene and early Holocene (c. 11 000 to 8000 BP). The engravings occur mostly on flat pebbles or cobbles, less frequently on plaques of bone, schist or cortex. They consist of often large sets of sub-parallel, usually long lines, sometimes supplemented by sets of very short lines. The marks seem to have been produced rapidly, and there is in most cases no impression that a notational intent may have been involved. Nevertheless, the known examples include many of considerable structural complexity, and there are two specimens with drilled perforations, probably used as pendants.

D'Errico tackles this huge corpus systematically, beginning by explaining the basis of his study techniques in admirable detail, particularly the experimental methods — the replicative work he has conducted in order to understand the microscopic traces he found on the pre-Historic specimens. He explains, using his always excellent illustrations, the effects of plaque surface curvature on striation patterning, the interpretation of 'tear marks' (*déplacement du support*) and superimposition sequence, identification of groove profiles and striation signatures, and then develops from these empirical means his method of reconstructing 'engraving gestures' on ancient surfaces. Next, he discusses the Azilian: the problems of the Epipalaeolithic/Mesolithic transition, the spread of the available radiocarbon dates and the ecology and economy of the Azilian tradition. This leads to the *surviving* Azilian art forms (rather than the Azilian art forms, as the author implies), the two most common forms of which are the well-known Azilian painted cobbles, which are only very briefly considered in this volume, and the portable engravings. The latter are then tabulated and described preliminarily, after which the book's main part begins, the analytical description of the engraved specimens, accounting for 144 pages of the volume. It is followed by a thorough discussion of these data, which includes a detailed review of Alexander Marshack's approach. In some ways, the author's work is a continuation of Marshack's pioneering work, and while d'Errico could not find adequate evidence for notation among the Azilian plaques, he has since accepted notational evidence in a final Palaeolithic/Epipalaeolithic context (on a bone fragment from Tossal de la Roca, Spain).

The perhaps most interesting part of the book is the following chapter, dealing with the 'engraving gestures' and the meaning of the art. D'Errico's identification of the pattern sequences found on the Rochedane pebbles, the largest single assemblage of Azilian engravings, is particularly intriguing. It is soon clear to the reader that this kind of analysis has enormous potential in creating scientific knowledge about art production sequences in rock art, replacing the traditional speculations about significance with solid empirical evidence. D'Errico has in recent years successfully applied his techniques to Upper Palaeolithic portable engravings, but there is no doubt that they are perfectly suited for other applications. Among them would be systematic studies of the elaborate and almost certainly meaningful patterns found on many Russian portable objects (particularly from Eliseevichi and Mezhirich); similar analyses of the engravings often found on the mysterious cylcons of Australia (which can be of very great antiquity as the specimen from Cuddie Springs shows). Similar techniques have long been used in some of the Australian cave sites of non-iconic rock engravings and finger flutings, and these studies have also shown the utility of such work in eliciting sound information about how these markings were made.

D'Errico rounds off his book by describing and illustrating the art forms of various roughly contemporaneous art traditions in Europe, including the sometimes iconic engravings of the Magdaleno-Azilian and several other Epipalaeolithic to Mesoli-thic contexts (e.g. Ahrensburgian, Epigravettian). The purpose is to test the idea that the non-iconic Azilian engravings represent an advanced level of schematisation of iconic art. In observing the apparent trend towards increasing 'abstraction' or schematisation at the Pleistocene - Holocene transition, d'Errico speculates that this might be reflected in the Azilian plaques and pebbles. Perhaps so, but there are alternative explanations possible and it might be judicious to reserve our judgment on that score.

The conclusion one has to draw from this book, concerning the possibility of Azilian notation systems, are not encouraging. D'Errico shows that the series of markings were usually produced by the consistent application of the same tool, marking the entire surface in a definite sequence, turning it as necessary. Little control was exercised in the execution of individual marks, which often cross each other randomly, as if their number or precise arrangement did not matter to the artist. Patterning in the arrangement of the lines does follow certain general conventions, but it is not sufficiently distinctive to permit the deduction that there is some meaning to be derived from specific syntaxes or configurations. In other words, this tradition is not some form of writing. However, there are alternatives d'Errico does not consider, particularly the possibility that such objects served as mnemonic devices, in some sort of memory-prompting capacity. This is not notation in the strict sense of the word, and does not require well-differentiated markings. Mnemonic devices were used by many non-literate peoples, including the Australian Aborigines, and it would be surprising if such conventions did not extend well into the distant past.

His analyses of the Azilian engraving patterns enables d'Errico also to conjecture about the handedness of the makers, by comparing the results to those of modern engravers. He concludes that the proportion of left- and right-handed artists in the Azilian was very similar to that observed in modern populations, which also agrees with pre-Historic Australian data suggesting a clear predominance of right-handedness.

In short, this book provides a wealth of solid information of a calibre that remains sadly lacking for most other topics of palaeoart. D'Errico shows us that, with the appropriate determination, a great deal more reliable information can be squeezed from ancient arts than the sometimes interesting but ultimately worthless speculations that have so often been favoured in our discipline. In this sense, his book should be an inspiration to all students of palaeoart: it shows us that there *are* ways to escape the treadmill of speculative hypothesis construction that has been the dominant force in this field over the past century — that there *are* sound and rigorous ways of constructing models about palaeoart. What d'Errico has been able to do with the portable engravings of just one short art tradition of south-western Europe can, in principle, be applied to many rock art traditions the world over. The actual techniques will differ according to varying conditions, but the underlying principles of 'internal analysis', first expounded by Marshack and developed to such extraordinary sophistication by d'Errico, apply universally. They show us that there is a great deal more to scientific palaeoart studies than the subjective recording and statistical interpretation of vast numbers of rock art motifs. The methodology d'Errico has developed is an integral part of the scientific palaeoart studies of the future; it is one of the most promising tools the discipline has developed so far.

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RECENT ROCK ART JOURNALS

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CERVICEK, P.: Chorology and chronology of Upper Egyptian and Nubian rock art up to 1400 B.C.
SOLEILHAVOUP, F.: Art rupestre du Tassili de Ti-n-Reroh (sud-ouest de l'Ahaggar). Premières données paléoculturelles.
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WARMIND, M.: Keltiske billeder og helleristningerne.
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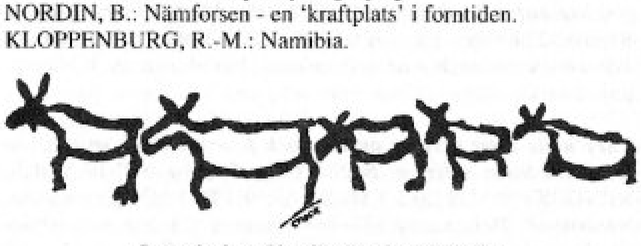

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Enquiries to AURA Editor, or to AASV, P.O. Box 328C, Melbourne, Vic. 3001, Australia.

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Volume 7 (1995), Number 2:
PRINS, F. and H. LEWIS: Some expressions of San derived concepts on the beliefs of Nguni traditionalists.
LEE, G.: The petroglyphs of Kalaoa O'oma, Hawai'i Island.
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BEDNARIK, R. G.: The empiricist impasse revisited.
Enquiries to SARARA, P.O. Box 81292, Parkhurst 2120, South Africa.

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Enquiries to ARARA, P.O. Box 65, San Miguel, CA 93451, U.S.A.

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HOLMLUND, J. and H. WALLACE: Palaeoseismicity and rock art in southern Arizona.
HEDGES, K. and D. HAMANN: The Palo Verde petroglyphs: a preliminary report.
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MOORE, E.: 'The Cochimí ritual landscape' in the great murals of the Sierras of San Francisco, Baja California: is Ron Smith's system valid?
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They write their dreams on the rock forever. Rock writings in the Stein River valley of British Columbia, by ANNIE YORK, RICHARD DALY and CHRIS ARNETT. 1993. Talonbooks, Vancouver. 299 pages, 172 monochrome illustrations, bibliography, index, cloth bound. ISBN 0-88922-331-9.

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Some new developments in Ice Age art, by PAUL G. BAHN. *Complutum*, 1994, Volume 5, pp. 197-202.

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Fires depicted in the rock paintings of southern Africa, by H. C. WOODHOUSE. *South African Journal of Ethnology*, 1994, Volume 17, Number 3, pp. 98-102.

Art origins, by ROBERT G. BEDNARIK. *Anthropos*, 1994, Volume 89, pp. 169-180.

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ORIENTATION

Forthcoming events

NEWS 95: International Rock Art Congress. 30 August - 8 September 1995, Pinerolo and Turin, Italy. Venue: the Royal Castle of Valentino, which is part of the Faculty of Architecture of Turin University. Ten days of academic proceedings comprise 16 symposia and the 1995 IFRAO Meeting. There is an extensive program of field trips and cultural tours, and the congress will include an opening plenary session, cocktail party, farewell dinner, films, displays and exhibitions. For full particulars please consult the enclosed brochure. The **Annual AURA Meeting** will be held during the Congress, on 2 September.

European Association of Archaeologists, First Meeting. 20-24 September 1995, Santiago, Spain. Themes covered will be the interpretation of the archaeological record, management of the archaeological heritage, and politics of archaeological practice. The official language will be English. Write to First Meeting EAA, Apdo. de Correos 994, 15700 Santiago de Compostela, Spain.

Preservation and Restoration of Cultural Heritage. 25-29 September 1995, Montreaux, Switzerland. Organised by the Laboratoire de Conservation de la Pierre, Département des Matériaux, Lausanne. The 1995 LCP Congress will address stone materials, air pollution, murals, and scientific research work and case studies. Registration is about $A800.00. Write to EPFL-DMX-LCP, Congrès LCP 95, Renato Pancella et Michèle Citti, MX-G Ecublens, CH-1015 Lausanne, Switzerland.

Myths, signs and memories is the title of the 1995 Valcamonica Symposium, to be held 5-10 October 1995 in Italy. For details, write to Centro Camuno di Studi Preistorici, 25044 Capo di Ponte (Bs), Italy.

Australian Archaeological Association Conference 1995. 6-9 December 1995, Gatton College, University of Queensland, Brisbane. Write to Anne Ross, Department of Anthropology and Sociology, The University of Queensland, Qld 4072, Australia.

Oxalate films in the conservation of art. 25-27 March 1996, Milan, Italy. This symposium will address issues related to the presence of oxalate films on the surfaces of works of art and in natural environments, particularly in conservation. Write to Congress Studio International srl, P.za dei Volontari, 4, 20145 Milano, Italy.

SARARA Conference 1996. 11-18 August 1996, Swakopmund, Namibia. This major international rock art event will be held by the Southern African Rock Art Research Association with the participation of the East African Rock Art Research Association. Session topics include the use of computers to aid research, technological advancements in photography and copying, dating, preservation, conservation and tourism. The event has been nominated as official IFRAO Meeting for 1996; AURA will not stage a competing congress as a mark of support. Enquiries and proposals to: Shirley-Ann Pager, P.O. Box 81292, Parkhurst 2120, South Africa.

Annual AURA Meeting 1996. Mid-1996, dates and place to be nominated (Alice Springs is being considered).

XIII U.I.S.P.P. Congress. To be held in Forlì, Italy, in 1996, dates to be announced. This congress by the International Union of Prehistoric and Protohistoric Sciences will comprise 37 colloquia. Section 8 will address art in the Palaeolithic and Mesolithic.

SIARB Congress 1997. Sucre, Bolivia, dates to be announced. This international congress by the Sociedad de Investigación del Arte Rupestre de Bolivia has been chosen by the IFRAO as its official conference venue for 1997. It will comprise the following symposia: 1. Rock art dating (A. Watchman and A. Prous); 2. The earliest rock art in the Americas (J. Steinbring and J. Schobinger); The earliest rock art - a world perspective (R. G. Bednarik); New approaches to rock art studies (P. G. Bahn); New studies of Bolivian rock art (F. Taboada); New studies of rock art in Argentina (M. M. Podestà); New Studies of rock art in other countries of South America and the Caribbean (L. Briones and C. N. Dubelaar).

AURA 2000. The Third AURA Congress: Rock art in the new millennium.

Notices

Does your institutional library subscribe to *RAR*? If not, we would be profoundly grateful if you would persuade your library to place *RAR* on its subscription list. We thank you for considering this, and for your help in keeping our production costs low by expanding circulation in this way.

Back issues of *RAR* are available, beginning with 1988. All earlier issues have been out of print for several years.

In the previous issue of *RAR* we noted (on the top of p. 140) that it was reported by the media that the WAC3 declared the World Heritage nomination of the Bhimbetka site complex near Bhopal effective. These reports in the printed and electronic media were, we understand, restricted to the Bhopal region.

The approved Constitution of AURA is reproduced on the following three pages.

Constitution of AURA

Article 1

The name of the Association is Australian Rock Art Research Association, and it is also known by the acronym AURA, as it is called hereinafter.

Article 2

Objectives

The objects and purposes of AURA are:

2.1. To provide a forum for the dissemination of research findings in the field of rock art studies.
2.2. To promote Aboriginal custodianship of sites externalising traditional Australian culture.
2.3. To promote the study, preservation and appreciation of rock art.
2.4. To facilitate communication and contact with overseas organisations and individuals possessing similar interests.
2.5. To facilitate communication and contact with agencies and individuals in related fields.

Article 3

Membership of AURA

The conditions applicable to membership of AURA are:

3.1. The members of AURA shall consist of Full Members (including Life Members and Institutional Members), Subscribing Members and Subsidised Members.
3.2. Only Full Members are eligible to quote membership as a professional qualification, by the placement of the initials 'MARA' following their academic qualifications (if any).
3.3. Individual membership of AURA is open to all who profess an active interest in rock art research.
3.4. Institutional Members of AURA are entitled to appoint an officer to act as their nominee.
3.5. An application for membership of AURA shall be made in writing to the Editor, on the prescribed form.
3.6. Membership of AURA shall be contingent upon payment of an annual membership fee, or, in the case of Subscribing Members, of an annual subscription fee.
3.7. Applications for subsidised membership shall be received and considered by the Editor.
3.8. A member of AURA may at any time resign from the association by way of a written notice of resignation.
3.9. A right, privilege or obligation of a person by virtue of membership cannot be transferred to another person and terminates upon the cessation of membership.
3.10. Members of AURA are not liable to contribute towards payment of liabilities of the association.
3.11. The Executive Committee may expel a member of AURA if, in the opinion of the Committee, the member has been guilty of conduct detrimental to the interests of AURA.
3.12. Expulsion of a member does not take effect until the expiration of 14 days after notice has been served, unless the member exercises the right to appeal in which case the expulsion shall be decided upon by the first general meeting thereafter.
3.13. Expulsion for non-payment of fees is not subject to approval by the Executive Committee or appeal.

Article 4

Officers of AURA

The officers of AURA shall be subject to these rules:

4.1. Elected officers shall be the President, the Vice-President(s), the Secretary, and the Treasurer.
4.2. Appointed officers shall be the Editor, the Archivist, and any consultants or members of committees appointed from time to time.
4.3. Elected officers shall hold office until the general meeting of AURA next after the date of their election, but are eligible for re-election.
4.4. The Editor and Archivist shall hold office until they resign in writing, cease to be members of AURA, or decease.
4.5. Consultants or members of committees shall hold office for the term nominated, or until the Executive Committee terminates their commission.
4.6. The Executive Committee shall consist of the elected officers of AURA, the Editor, the Archivist, the chairpersons of any standing or special committees, members of the Editorial Committee specifically nominated by the Editor, and the chairperson of each chapter (refer Article 11).
4.7. In the event of a casual vacancy occurring in the Executive Committee, the same may appoint a member of AURA to fill the vacancy until the following general meeting.
4.8. Only financial Full Members may be elected or appointed officers. This rule is not applicable to consultants.
4.9. Officers of AURA may not receive payment for their service.
4.10. The President shall represent AURA to the public, other organisations and individuals. He or she shall preside at meetings, decide on matters of procedure, and co-ordinate the activities of the Executive Committee.
4.11. The Vice-President(s) shall assist the President in his or her duties and powers, which he or she shall assume in the event of the President's absence or incapacity.
4.12. The Secretary shall assume the duties and powers of the President in the event that both the President and Vice-President(s) are absent; keep a detailed record of minutes of meetings; prepare press releases;

conduct the correspondence of AURA, prepare annual reports; and perform other duties as determined.

4.13. The Treasurer shall keep true and faithful records of AURA's financial transactions; present a financial statement listing assets and liabilities to the membership at each general meeting; and maintain a register of Full Members.

4.14. The Editor shall be responsible for the timely publication of *Rock Art Research* and *AURA Newsletter*, and for other published material; he or she shall be responsible for maintaining a high scholarly standard and shall appoint members of the Editorial Committee as he or she deems necessary.

4.15. The Archivist shall maintain and catalogue the library of AURA, including published and unpublished materials, Photographic and other visual material, film, video and digitised material; and act as an information resource on behalf of AURA.

4.16. The members of any committee shall be appointed, after consultation, by the President or Editor of AURA, and its size and terms of reference shall be decided in consultation with the Executive Committee.

4.17. Consultants may be appointed by the Executive Committee as deemed necessary. Their responsibilities, tenure and activities shall be specified at the time of their appointment.

4.18. It shall be acceptable for one officer to hold more than one office at a time, having been duly elected and/or appointed.

Article 5

Income and Property

The following shall apply to the income and property of AURA:

5.1. Income, however derived, shall be applied solely towards the promotion of the objects and purposes of AURA, and no portion thereof shall be paid or transferred, directly or indirectly, by dividend, bonus or otherwise, to any member of AURA.

5.2. AURA shall not appoint a person to any office to the holder of which there is payable any remuneration by way of salary, fees or allowances (other than the repayment of out-of-pocket expenses).

5.3. The Treasurer of AURA shall, on behalf of the association, receive all monies paid to it, and deposit them in a bank account.

5.4. Except with the authority of the Executive Committee, no payment shall be made from the funds of AURA otherwise than by cheque drawn on the association's bank account.

5.5. Once in each financial year the accounts of AURA shall be available for examination to all Full Members.

5.6. If upon dissolution of AURA there remains any property whatsoever, the same shall be transferred to some other institution or institutions having objects similar to AURA.

5.7. The financial year of AURA is the one-year period beginning with the first day of January in each year.

Article 6

General Meetings

The following shall apply to the general meetings of AURA:

6.1. General meetings shall be held at intervals of at least four years, at such date and venue as determined by the Executive Committee.

6.2. The date and venue of any general meeting shall be announced at least twelve months before the occurrence of such event.

6.3. The ordinary business of a general meeting shall be:
(a) to confirm the minutes of the last preceding general meeting;
(b) to receive the reports of Executive Committee members;
(c) to elect the officers of AURA for the subsequent term;
(d) to receive the reports of any committees or consultants.

6.4. In addition to the general meeting, special general meetings shall be convened, on the request in writing of not less than 100 Full Members of AURA.

6.5. All business that is transacted at ordinary general meetings of AURA and all business that is transacted at the quadrennial general meeting, with the exception of that specially referred to in these rules as being the ordinary business of the quadrennial general meeting, shall be deemed to be special business.

6.6. No item of business shall be transacted at a general meeting of AURA unless a quorum of members is present at the time.

6.7. The quorum for a general meeting of AURA shall be 100 Full Members.

6.8. The quorum for meetings of the Executive Committee or other committees shall be four provided that all members of the said committees have been notified of the meeting.

Article 7

Elections and Votes

Elections shall be conducted in accordance with these rules:

7.1. A question arising at a meeting of AURA shall be determined on a show of hands and unless before or on the declaration of the results of the show of hands a poll is demanded, a declaration by the chairperson that a resolution has been carried or lost, and an entry to that effect in the minute book of AURA shall be evidence of the fact.

7.2. Each Full Member or committee member has only one vote and all votes shall be given personally (except as allowed in Clause 8.9.).

7.3. In the case of an equality of voting on a question the chairperson of the meeting is entitled to exercise a second or casting vote.

7.4. A motion put to a vote shall be carried if it has the support of more than half of the voting body.

7.5. Nominations of candidates for election as officers of AURA shall be made in writing, and indicate that the candidate's consent has been obtained, and nominations shall be delivered to the Editor.

7.6. If insufficient nominations are received to fill all vacancies, the candidates nominated shall be deemed to be elected, and further nominations requested at the general meeting.

7.7. If the number of nominations equals the number of vacancies the candidates nominated shall be deemed to be elected.

7.8. If the number of nominations exceeds the number of vacancies a ballot shall be held in such usual and proper manner as the Executive Committee may direct.

Article 8

Committees of AURA

Committees of AURA shall be subject to these rules:

8.1. Meetings of the Executive Committee or any standing or special committee may be convened by any four of its members, after notice of at least two months has been given to all members of the committee concerned.

8.2. No business shall be transacted unless a quorum of four is present at a meeting of a committee.

8.3. Meetings of the Executive Committee shall be chaired by the President, or in his or her absence the Vice-President or Secretary, or in the absence of all three, one of the members shall be elected as chair.

8.4. Questions arising at meetings of the Executive Committee or of any standing or special committee shall be determined on a show of hands, but consultants who are not members of AURA shall not be entitled to vote.

8.5. Each member present at a meeting of any committee, being a Full Member of AURA, is entitled to one vote, and in the event of an equality of votes the person chairing may exercise a second or casting vote.

8.6. Meetings of committees other than the Executive Committee shall be chaired by a member appointed chair by the President or Editor.

8.7. Committees for specific purposes shall be standing or special. Standing Committees shall include the Education Committee and Conservation Committee. Special committees may be established to organise symposia and publications, for instance.

8.8. Committees for specific purposes may be appointed by the President or Editor, with appropriate consultation.

8.9. Where specific questions being addressed at a meeting of any committee have been precirculated among committee members, voting by proxy is permissible where a member being present tables written instructions from the absent member. The absent member's instructions for proxy voting shall stipulate whether the proxy authorisation covers all questions raised at the meeting, or is restricted to specific questions. In the latter case the specific questions covered shall be clearly defined.

Article 9

Members of AURA shall observe a professional code of ethics.

Article 10

Publications

Publications of AURA shall be subject to these rules:

10.1. AURA shall publish the bi-annual journal *Rock Art Research* under the supervision of the Editor, which shall be received by all Full Members, Institutional Members, Subscribing Members and Subsidised Members, as well as organisations with whom AURA maintains reciprocal information exchange arrangements.

10.2. AURA shall publish the occasional *AURA Newsletter* under the supervision of the Editor, which shall be received by all Full Members.

10.3. From time to time, AURA shall publish volumes of the *AURA Occasional Papers*, or any other special publications, under the supervision of the Editor.

10.4. When required, the Editor, in consultation with the Executive Committee, shall appoint special committees to address specific publication projects, or appoint editors for specific volumes to be published.

10.5. The Editor shall appoint members of the Editorial Committee, which is a standing committee.

Article 11

Chapters

Any chapters or sub-chapters of AURA shall be subject to these rules:

11.1. Where at least ten Full Members of AURA desire to form a local, regional, state or overseas chapter of AURA, they shall make written application to the Executive Committee.

11.2. Chapters of AURA are subject to the rules of this Constitution, as are their individual members.

11.3. Each chapter of AURA shall elect or appoint a chairperson who shall represent the chapter at the Executive Committee.

11.4. Provided that there is no discrepancy with the rules of this Constitution, chapters of AURA may adopt any further rules or by-laws desired by their members.

11.5. Chapters of AURA may conduct independent meetings and produce publications.

Article 12

Amendments

Proposals to amend any rules of this Constitution shall be submitted in writing to the Editor. They shall be gazetted in *Rock Art Research* at least six months before a quadrennial general meeting where they are to be decided. An amendment must be supported by three-quarters of the voters present at the meeting to be passed, and it cannot be presented for voting if one half of those Full Members who are not present have objected to the amendment in writing.

IFRAO Report No. 14

MEMBER'S PROGRESS REPORT

RASI
(Rock Art Society of India)

The Rock Art Society of India (RASI) was established in Agra on 24 February 1990. Since then it has played an important role in the promotion of scientific study, conservation, management and popularisation of Indian rock art, and in supporting similar endeavours of the other IFRAO member organisations. One can feel a considerable change in the attitude of Indian and overseas scholars to the rock art heritage of India. The Code of Ethics developed by RASI for dealing with rock art is gradually becoming popular among scholars. Slowly rock art is becoming a major concern to be taken care of by Indian scholars, national laboratories and government organisations. International rock art conferences, such as by the Indira Gandhi National Centre for the Arts in New Delhi (1993) and the symposium 'Rock art of Asia and the Pacific' in the World Archaeological Congress 3 (New Delhi 1994), along with the exhibition 'Rock art of India and the world' by the Indira Gandhi National Museum of Man and IFRAO may be seen in this perspective.

The decision taken by the Archaeological Survey of India (ASI) to propose the Bhimbetka complex of rock-shelters for World Heritage listing to UNESCO through the government of India was a major development in 1994. Dr R. C. Agrawal and his colleagues of ASI Bhopal Circle are preparing the proposal. RASI and IFRAO are playing crucial roles in this regard and are seeking help and support from all possible parties. Thanks are due to the generous co-operation and support from all Indian scholars and ASI authorities, especially Prof. B. B. Lal, Dr M. N. Deshpande, Dr K. V. Soundara Rajan, Prof. V. N. Misra, Dr D. P. Agrawal, Dr K. K. Chakravarty and others. R. G. Bednarik, Convener of IFRAO and a close friend of mine, has been an inspiring source throughout, having helped RASI in many ways besides providing guidance from time to time.

This change in attitude to the Indian rock art heritage has been achieved by RASI over the past five years. The publication of *Purakala*, the biannual journal of RASI, is its foremost achievement. It was begun in July 1990, and volume 5(2) is to appear shortly. Volumes 3(1-2), 4(1-2) and 5(1-2) are special issues on the rock art of Chambal valley, rock art and education (the proceedings of the Cairns 1992 symposium), and the conservation and management of Bhimbetka respectively. *Purakala*, a member of the family of IFRAO journals, is of the international standards of that family. It is distributed to scholars in India and is exchanged with other IFRAO members in academic exchange programs. *Purakala* is now well established, and is the only journal of its kind in Asia. It plays an important role in making Indian and other scholars aware of the rock art heritage of India, and of the efforts in its scientific study, conservation, management and popularisation. It also reflects the gradual clarification of regional characteristics of Indian rock art. Among the specific activities of RASI during the past five years, the following may be mentioned:

1. Purakala Samaroh, Agra 1992.
2. Workshop on a system for orientation and training in rock art for the young, Narsinghgarh 1992.
3. First RASI Congress, Agra 1993.
4. Awareness promotion of rock art among the people and students of the Bhanpura rock art region, 1992.
5. Dr V. S. Wakankar memorial rock art exhibitions at Laduna (Madhya Pradesh) 1991, Agra 1992 and 1993, Srisailam 1992.
6. Lectures on rock art delivered at DEI, Agra, Wakankar Shodh Sansthan Ujjain and Govt. P. G. College, Kotputali.
7. Six-week lecture and study tour of R. G. Bednarik to most major rock art sites and archaeological institutions in India in 1990; and Dr M. J. Morwood's tour to rock art sites of Fatehpur Sikari region, and DEI Agra in 1993.
8. RASI project 'Early art and archaeology of Fatehpur Sikari - Agra region', and exhibition of 57 exhibits and original antiquities on the same theme sponsored by Agra University. This was prepared by Dr Ashvini Kumar Sharma and Satya Narayan Maurya under the direction of the author.
9. RASI education-cum-excursion tour of 62 trainee teachers of the Faculty of Education, DEI Agra, to rock art sites at Madanpura and Rasulpur in the Sikari region, in 1995.

In 1995, a RASI team will conduct analytical studies of rock art of Chaturbhujnath nala. The Second RASI Congress will be held in Orissa in November 1995.

Giriraj Kumar
Secretary and Editor, RASI

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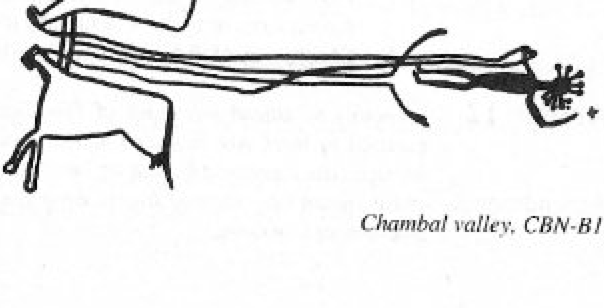


Chambal valley, CBN-B17

All eyes on Italy in 1995

Rock Art Congress NEWS 95

30 August to 8 September 1995
Pinerolo and Turin, Italy

A final announcement with Registration Form and Hotel Reservation Form is enclosed in this issue of *RAR*. Your registration for what promises to be a very major academic event in international rock art studies is cordially invited.

The Congress is organised by the Centro Studi e Museo d'Arte Preistorica (CeSMAP), Pinerolo, a founding member of IFRAO. The venue will be the Royal Castle of Valentino (Faculty of Architecture), Turin. The congress is supported by the Italian Central Office, by regional government agencies, by the EEC, the European Authority, and the International Federation of Rock Art Organizations (IFRAO).

Program: the Congress consists of sixteen academic symposia, as well as debates, films and displays, field trips to rock art sites, exhibitions (e.g. 'Rock art in the Alps', 'Rock art in Europe', 'Rock art in the Sahara', etc.), and several special events, including the 1995 IFRAO Meeting, opening plenary session, cocktail party and concert, farewell dinner etc.

Contributions: prospective participants are encouraged to submit abstracts (in English) for any of the following symposia.

Thematic areas and symposia

Thematic area A: *Rock art studies*
1A - New approaches
2A - Semiotics, signs and symbols
3A - Rock art and music-archaeology

Thematic area B: *Rock art and presentation*
4B - Mass media
5B - Museology and museography
6B - Management

Thematic area C: *Rock art and conservation*
7C - Ethics
8C - Preservation and restoration
9C - Rock art and archaeological excavation
10C - Dating, recording and computer science

Thematic area D: *Rock art in the world*
11D - Rock art of the circum-polar countries
12D - Rock art and Mediterranean Sea
13D - Rock art of the Sahara
14D - News of the world
15D - Christian manifestations in rock art
16D - Rock art and ethnography

Field trips: numerous field trips will be conducted, both during and after the academic program: to post-Palaeolithic rock art sites in the Alps, Mount Bego, the Rock Cavour Park, western Alps, Savoy, Val d'Aosta stelae, Val Camonica, Carchenna etc. Tours will be conducted on the subjects of prehistory, ethnography and history in Italy, to Turin, Milan, Venice, Florence, Naples, Rome.

Pre-registrations and enquiries to: CeSMAP, Viale Giolitti 1, 10064 Pinerolo (TO), Italy
Telephone 121-794382, Fax 121-76550

Professor Dario Seglie (Director, CeSMAP)
Dr Piero Ricchiardi (President, CeSMAP)

Call for papers

Abstracts of papers for the following symposia should be submitted to the chairpersons listed below:

1A - ***Rock art studies: new approaches***. Abstracts of 100-150 words from Africa, the Americas, Asia and Australia to Robert G. Bednarik, AURA, P.O. Box 216, Caulfield South, Vic. 3162, Australia: from Europe, including Russia, to Francesco d'Errico, Department of Archaeology, Downing Street, CB2 3DZ Cambridge, United Kingdom.

7C - ***Rock art and conservation: ethics***. Abstracts to François X. Soleilhavoup, Groupe d'Etude et de Recherche sur les Milieux Extrêmes (GERME), B.P. 132, F-93805 Epinay-sur-Seine-Cedex, France

10C - ***Dating, recording and computer science***. Abstracts can be sent to either B. K. Swartz, Jr, Department of Anthropology, Ball State University, Muncie, IN 47306-0435, U.S.A. — Tel. (317) 285-1577, Fax (317) 285-2163, E-Mail 01BKSWARTZ@LEO. BSUVC.BSU.EDU.; or to Mila Simoes de Abreu, Av. D. José I, n. 53, 2780 Oeiras, Portugal — Tel and Fax 351-(0)1-4421374 or 4101359.

14C - ***Rock art: news of the world 1995***. Papers and abstracts can be submitted to either Paul G. Bahn, 428 Anlaby Road, Hull HU3 6QP, England — Tel./Fax 44-482-52172; or Angelo Fossati, Cooperativa Archeologica 'Le Orme dell'Uomo', Piazzale Donatori di Sangue 1, 25040 Cerveno (Bs), Italy — Tel. 39-364-433983, Fax 39-364-434351.

16D - ***Rock art and ethnography***. Papers from Africa, the Americas, Asia and Australia can be submitted to Alicia A. Fernández Distel, Centro Argentino de Etnología Americana, Av. de Mayo 1437 1° "A", 1085 Buenos Aires, Argentina. Papers from Europe, including Russia, can be submitted to Alberto Guaraldo, Instituto di Antropologia Culturale, Dipartimento Scienze Antropologiche, Archeologiche e Storica Territoriali dell'Università, Via Giolitti 21/E, 10123 Torino, Italy.

For full details concerning the above symposia, please consult *AURA Newsletter* 11/2 (September 1994).

8C - ***Preservation and restoration***. Papers to Alan Watchman, Data-Roche Watchman, Inc., 1631 rue Eden, Ancienne-Lorette, Québec, Canada G2E 2N2.

13D - ***Rock art of the Sahara***. Abstracts to A. Muzzolini, 7 rue J. de Rességuier, 31000 Toulouse, France; or J. L. Le Quellec, Brenessard, 85540 St-Benoist-sur-Mer, France.

15D - ***Christian manifestations in rock art***. Abstracts to Roy Querejazu Lewis, Casilla 4243, Cochabamba, Bolivia

Rock Art Research — Moving into the Twenty-first Century

International conference by SARARA, with the participation of EARARA, in 1996

This international conference will be held by the Southern African Rock Art Research Association (SARARA) in Swakopmund, Namibia, from 11 to 18 August 1996, with the participation of the Eastern African Rock Art Research Association (EARARA). The member organisations of IFRAO have voted in favour of adopting this conference as the official IFRAO Meeting for 1996.

The objectives of the southern African rock art conference will be to focus on new and innovative approaches to rock art studies and to assess the latest technologies that will carry our discipline decisively into the twenty-first century. The preliminary program is as follows:

1. *Recording methods:* new and safer copying methods, advances in photographic techniques, digital recording.
2. *Dating:* latest methods, accuracy.
3. *Meaning and motivation.*
4. *Environmental issues and site management:* conservation and preservation, protection of rock art, visitor control, the role of government in protection programs.
5. *Education.*
6. *Aesthetic considerations.*

Papers are now invited, maximum presentation time 20 minutes, to be followed by 10 minutes of question and discussion time. SARARA will have first publication rights on papers unless special arrangements are made.

The conference will feature displays of posters, photographs, rock art recordings, plans and models of conservation programs, and publications. A number of pre- and post-conference tours lasting from five to ten days will be available, to major rock painting and petroglyph areas in Namibia and South Africa. EARARA plans to organise a tour to rock art sites in Tanzania.

For details and registration forms, please contact SARARA, P.O. Box 81292, Parkhurst 2120, South Africa.

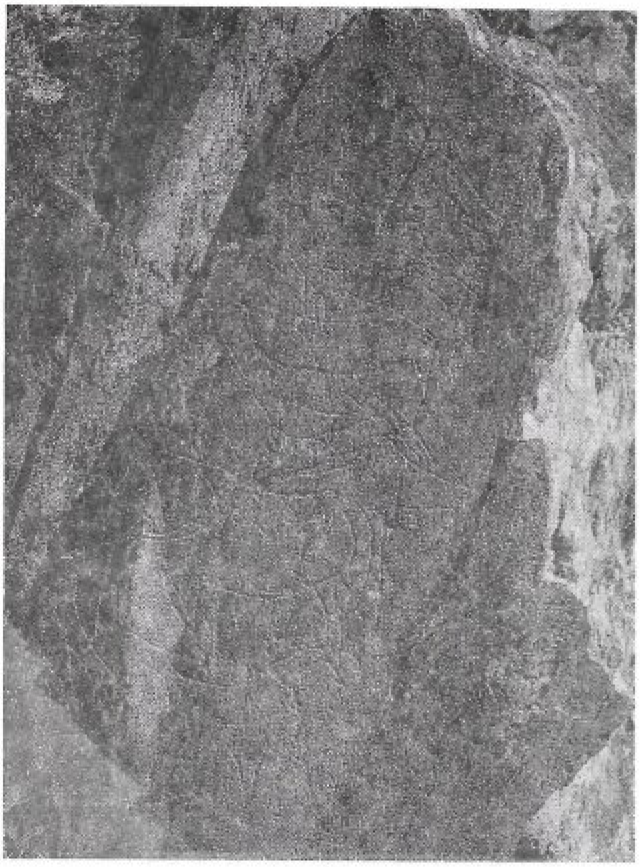
The Hell's Canyon saga continues

ROBERT G. BEDNARIK

The archaeological controversy concerning the petroglyphs at Canada do Inferno (Hell's Canyon) in the Côa valley of northern Portugal (Bahn 1995; Bednarik 1994, 1995a; Clottes 1995; Simoes de Abreu 1995) continues to widen. It has become a major political, economic, cultural and scientific issue.

Our call for official expressions of condemnation from IFRAO member organisations has resulted in swift responses from most member associations, among them letters of censure from Professor Dario Seglie (Chairman, IFRAO), Dr Paul G. Bahn (Vice-President, Australian Rock Art Research Association), Angelo Fossati (President, Società Cooperativa Archeologica 'Le Orme dell'Uomo'), Dr Michel Lorblanchet (Chair, Groupe de reflexion sur le méthodes d'étude de l'art parietal paléolithique), Professor Ben Swartz (President, American Committee to Advance the Study of Petroglyphs and Pictographs), William Hyder (President, American Rock Art Research Association), Dr Giriraj Kumar (Secretary, Rock Art Society of India), Roy Querejazu Lewis (President, Sociedad de Investigación del Arte Rupestre de Bolivia), Dr Fidelis Masao (Chairman, Eastern African Rock Art Research Association), Shirley-Ann Pager (President, Southern African Rock Art Research Association), Professor Lawrence Loendorf (Chairperson, ARARA Conservation Committee), Professor Jack Steinbring (Chairman, Rock Art Association of Manitoba), Alfred Muzzolini (President, Association des amis l'art rupestre saharien) and Robert G. Bednarik (Convener, IFRAO). In addition to these official reactions, many protest letters from individual members of IFRAO organisations have been received in Portugal. There have also been admirable individual actions of international support, such as Angelo Fossati's collection in Italy of tens of thousands of signatures for a petition. The affair has been reported in many of the world's leading newspapers and mass-circulation magazines (e.g. *Time, New Scientist*), in some cases in a commendably sustained fashion. *The Times*, in particular, has been foremost in its critique of the Portuguese government. Its editorial of 11 March 1995, entitled 'Dam folly: the Portuguese Government must end its cultural vandalism', elicited an angry response from that government. *The Sunday Times* has featured at least three articles on the issue, and the *New York Times* had a major story on it. Across Europe, numerous papers reported the Portuguese vandalism in Côa valley, among them *Le Monde, El País, Dal Giornale, de Volkskrant* and many others.

The Portuguese government is under still considerably greater pressure at home, all of which is in some way attributable to IFRAO Representatives Dr Mila Simoes de Abreu and Ludwig Jaffe. What may have been the world's first public demonstration in support of rock art conservation was held in Vila Nova de Foz Côa, the town nearest to the site (P. G. Bahn, pers. comm.), with the slogan 'The engravings don't know how to swim'. Students at the local high school of that town have collected almost a million signatures for a petition to save the rock art. A civic action group, the Movimento para a salvaguarda de Arte Rupestre do Vale do Côa, has been established in Portugal to prevent the construction of the dam. Recently, Simoes de Abreu and Jaffe, as general co-ordinators of the campaign to save the rock art, led a protest fast outside a historical building in Lisbon, and police trying to break it up by force faced massive public opposition. While the rock art remains the main issue, other environmental and economic concerns have been voiced, including the destruction of the valley's natural ecosystem and substantial archaeological heritage, the diversion of water resources, the damage to the region's important port wine industry (the dam will flood up to 1600 hectares of first-class vine-growing land), as well as the loss of habitat of an endangered species of eagle. The former Secretary of State for Energy, Nuno Ribeiro da Silva, who rejected the project repeatedly while he was in office, argues that the dam is not needed for projected electricity requirements. Now a report by Unesco has recommended to the Portuguese government that construction of the dam be deferred, and there is great domestic as well as international political pressure on the government to comply.



The issue has become an important test case in more than one sense. For instance, it concerns the question of the independence of technical consultants and government agencies that ostensibly represent scholarly interests. It also concerns scientific aspects themselves: if the Côa petroglyphs were not Palaeolithic (Bednarik 1994), how would this affect other undated rock arts claimed to be Palaeolithic? (This could render it doubly important to preserve the rock art for future study.) Then there is the issue of who should exercise administrative control over archaeological properties of global significance in countries whose state-run archaeological agencies are antiquated, incompetent or academically corrupt? The credibility of archaeology as a discipline is at stake in this very public controversy, and scholars of integrity have no choice but to demand the most rigorous remedial action.

Portugal's eighteen university professors of prehistory have petitioned the Attorney General to deploy legal means of stopping the dam. The intensive media attention has had some welcome if unexpected effects. For instance, the Portuguese may be said to have become the most rock-art conscious nation on earth during the past few months. In this sense alone, the campaign has been an outstanding success. The Portuguese Archaeological Association, which had been practically dormant over recent years, has acquired a new lease of life through this issue, strongly supporting IFRAO in the confrontation, as do other organisations. To save the reputation of the discipline it is essential that scholarly societies campaign against an inept technocratic administration. Since the scandal was first announced in November 1994, there has been no bloodletting in the culprit organisation, the Instituto Portugûes do Património Arquitectónico e Arqueológico (IPPAR), which seems more concerned about closing ranks than with its public credibility.

Meanwhile, construction of the dam is continuing. IPPAR, an organisation that lacks any understanding or knowledge of rock art and the modern methods of its study, is recording the rock art in Hell's Canyon, still excluding outside researchers from this work in the same clandestine fashion that has characterised its work for years. There are unconfirmed reports of latex moulds being taken by a French firm, there has been talk of using physical enhancement (organic white paint and soot!), and a Swedish firm has undertaken trials of sawing the petroglyph-bearing rock type. An inspection by Alan Watchman to check the prospects of finding datable material in accretionary deposits has not resulted in the detection of any such residues, nor would the results derived from them be particularly helpful in direct dating (Bednarik 1995b). No other measures have been taken to attempt dating of the Côa rock art, or of any other of the open air sites attributed to the Upper Palaeolithic.

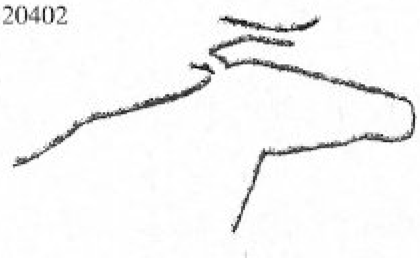
I have examined samples of the rock in question, and it is obvious that its structure renders the plan of sawing off panels of petroglyphs technically impracticable. The freshly broken schist is of a dark-grey colour (Munsell 7.5R 5/0 to 7.5R 6/0). Its distinctive lamination is locally characterised by a variety of crystalline minerals including quartz and staurolite, which should render microerosion dating possible. The rock's pronounced cleavage tendency has resulted in the development of innumerable parallel weathering fissures which are perpendicular to the rock faces and contain alteration products, notably iron salts. If a petroglyph on a Côa schist panel were sawn off it would inevitably disintegrate into a large number of lamellar fragments of roughly the thickness of a finger. To prevent this, the rock structure would first have to be stabilised, presumably by vacuum-assisted injection of synthetic material. Not only is this unlikely to be successful in such a dense, metamorphosed rock, some of the great variety of minerals present in the fissures are likely to reject the consolidation agent, at least in the long term. The logistics of conducting the envisaged salvage operation in this inaccessible site seem incredibly difficult. Before attempting such an operation, its feasibility must be satisfactorily demonstrated to independent specialist observers. On the basis of the limited information available it would seem that the two options currently entertained by IPPAR, sawing off or inundation, seem about equally certain to result in the total loss of the rock art. While sawing off would bring about fairly instant destruction, inundation involves the prospects of water damage, chemical and kinetic erosion, followed by the ultimate burial under many tens of metres of river sediment.

The cynicism of 'the authorities' in all of this is breathtaking. One version circulated to the media is that the petroglyphs will be better off under water, at least there would be no vandalism possible then, and there is always a chance that they might survive prolonged inundation reasonably well. Even if they would, who is going to pay for excavating them late next century? The sedimentation rate of the Côa is estimated to be 1.5 metres per year, which means that the dam will be abandoned in seventy years or so, having become silted up by then. The cost of excavating the rock art would be much greater than the cost of the dam itself (US$300 million), it would involve the excavation of thirteen kilometres of valley to a depth of 100 metres or so (a task I estimate would involve the removal of over 300 million tons of silt and gravel). Is the construction authority suggesting that it undertakes to meet the eventual cost of reclaiming the site? If not, then the argument of the art being 'recoverable' is an exercise in blatant cynicism, and based on the belief that archaeologists and the public are too ignorant to think that far. We should regard it as a foregone conclusion that nobody will ever see the petroglyphs again if they are allowed to be submerged, because their recovery, even if they did survive inundation and sedimentation, is simply not a realistic option.

The Hell's Canyon scandal can be resolved satisfactorily by adequate international pressure. This discipline owes its Portuguese representatives, Simoes de Abreu and Jaffe, its unqualified support in their selfless, utterly dedicated struggle to save this site. The issue of the Côa petroglyphs has already galvanised the discipline into taking decisive action. There are precedents for this kind of confrontation between powerful electricity utilities and conservationists in various other countries, and we know that even the most powerful vested interests can be defeated in a democracy. In 1983, a federal government of Australia lost office over a similar issue, the Franklin dam in Tasmania, when that three-billion dollar project (which also threatened archaeological sites) was soundly rejected by the public of Australia. The Côa valley issue is similarly winnable: it involves an indecisive government, a conspiracy of power-hungry technocrats, a mostly supportive public, and a highly motivated and dedicated campaign leadership. What is required from the international discipline, represented by the twenty-four members of IFRAO, is systematic lobbying: protest letters need to be received by the Portuguese government, and perhaps we should petition the Portuguese embassies in our various countries where such embassies exist. It seems also advisable to write to Swedish embassies, protesting about the proposed involvement of a Swedish company in cultural vandalism in Portugal, pointing out perhaps the less than encouraging examples of other sites where the sawing-off of rock art was attempted in the past. In Portugal, letters can be addressed to The President of the Republic of Portugal, Dr Mário Soares, or alternatively The Prime Minister of the Republic of Portugal, Mr Anibal Cavaco Silva, and should be sent via:

The IFRAO Representative of Portugal
Dr Mila Simoes de Abreu
Av. D. José 1, n. 53
2780 Oeiras
Portugal

FAX 351-1-4120402



IFRAO members will be aware that this issue does not concern only the rock art in one remote valley in Portugal: it affects all rock art in the world. A defeat of the Portuguese rock art vandals will have profound effects elsewhere, and governments and technocrats in the democratic countries of the world would take note of such an outcome. Hence we will all benefit from a favourable outcome in Portugal, and we have a moral obligation to stand up and be counted.

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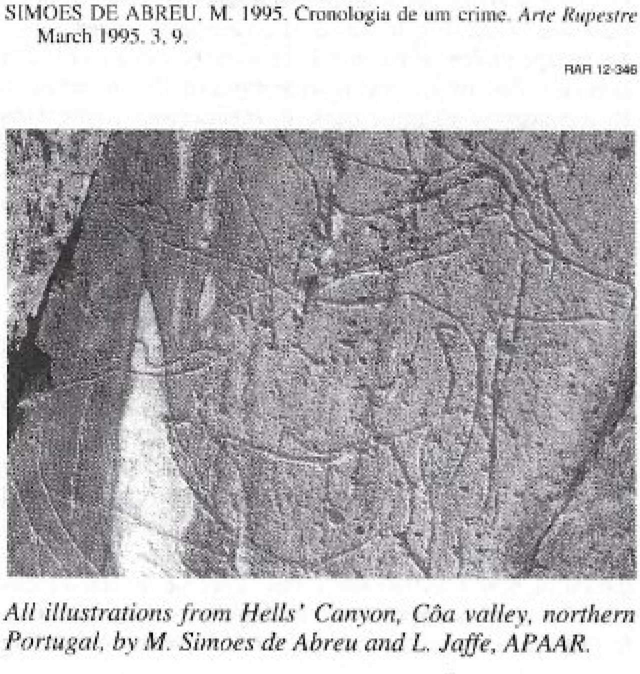

All illustrations from Hells' Canyon, Côa valley, northern Portugal, by M. Simoes de Abreu and L. Jaffe, APAAR.

NOTES FOR CONTRIBUTORS

Manuscripts of major research papers should preferably be from 4000 to 8000 words. Longer articles will be considered on the basis of merit. Submissions should comprise the original together with one copy, typed in double-space, with a wide margin on one side of each page. Underline words to be italicised and identify each page by number and author's surname. The preferred method of submission is on a 5.25 inch double-sided, double density (DS-DD) diskette written in *MS Word*, together with a hard copy. The content of the paper should be outlined by three to five keywords (e.g. 'Petroglyphs - patination - ethnography - Pilbara') placed above the title. The manuscript must include an abstract of 50 to 100 words, summarising the article.

Spelling and punctuation in this journal follow the *Style manual for authors, editors and printers of Australian government publications* and the *Macquarie dictionary*; where the two disagree the former has precedence. Footnotes should not be used. The bibliography and references in the text should follow the style indicated in this issue.

If line drawings are included they must be larger than the intended published size (preferably by a factor of 1.5 to 2) and line thicknesses, stippling, lettering sizes etc. must be selected accordingly. Photographs should be black and white gloss prints of high contrast. Photographs of rock art which were obtained by physical enhancement or other interference will be categorically rejected. In regions where traditional indigenous rock art custodians exist, their approval must be obtained before submission of any illustrations of rock art, and where copyright applies the author must obtain the appropriate consent. Captions (on a separate sheet) are required for all illustrative material, together with an indication in the text as to where they, and any tables and schedules, are to be placed.

Announcements intended for a specific issue of this journal ought to be available at least two months before the month of intended publication. Galley proofs are issued of all articles and must be returned promptly after correction by the author(s). Each author or group of authors receive thirty free copies of their article, additional reprints are available at cost.

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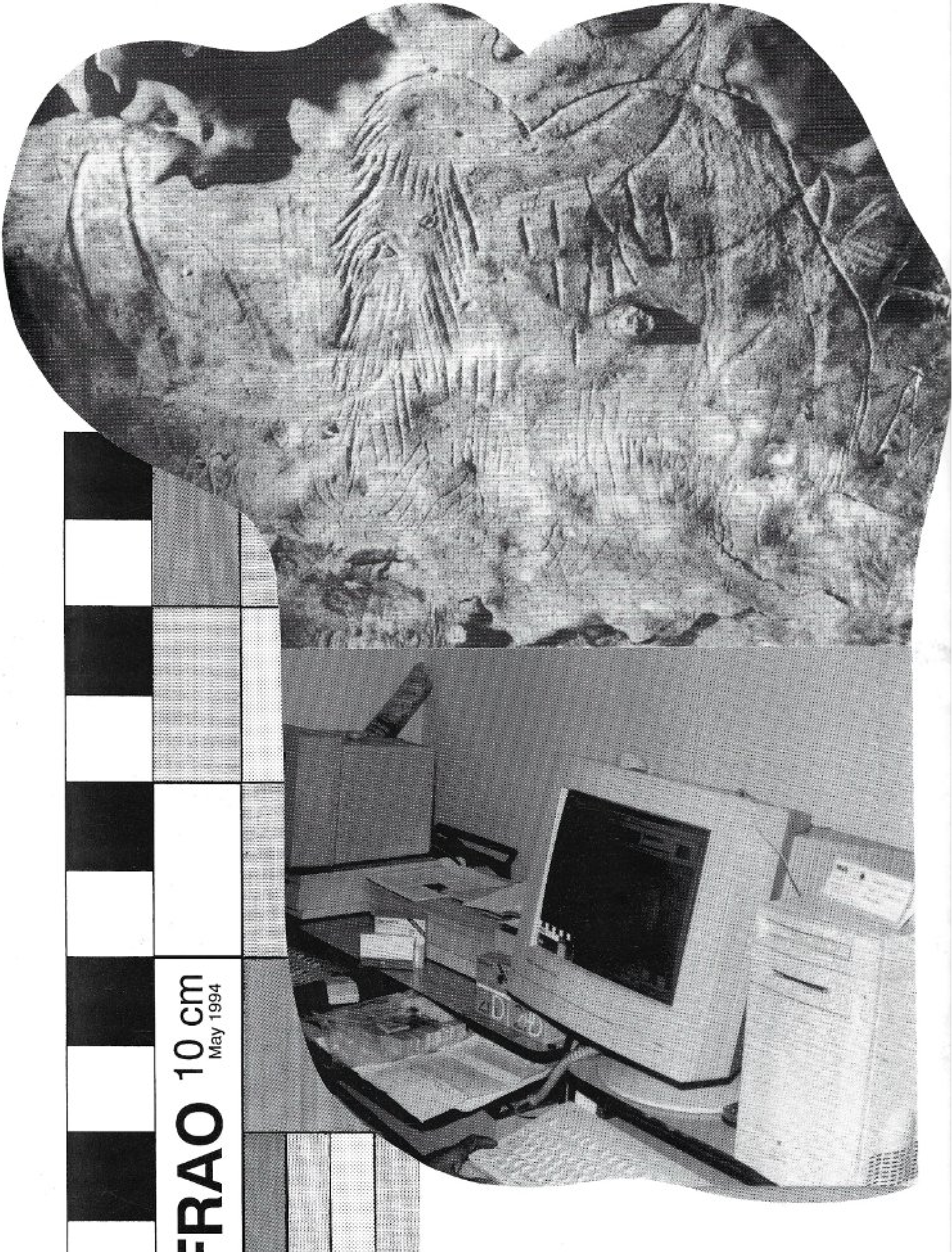

Colour re–constitution of rock art