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Rock art dating in China: past and future

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Abstract. The various methods that have so far been applied to the dating of rock art in China are considered and their effectiveness is examined. The approaches are compared and contrasted with those employed in various other parts of the world, particularly in the light of the new methodology of direct dating. The utility of new techniques is considered for future dating work on Chinese rock art, by discussing their potential applicability, the tendency towards over-sophisticated methods, their reliability and their relevance for Chinese researchers. Guidelines are presented for future strategies in this field.

Introduction

The Artefact specialises in the archaeology of the Pacific hemisphere, particularly the peopling of what has come to be known as the Pacific rim. While it is generally agreed that the regions relating geographically to the Pacific rim were initially peopled from somewhere in eastern Asia during the Pleistocene, this is not reflected in a level of archaeological co-operation commensurate with this relevance, for instance between Australia and south-east Asian countries. Much the same can be said about the interest of American archaeologists in both east Asian and South American Pleistocene settlement evidence (Bednarik 1989: 104): it is not unfair to observe that most American commentators on this subject have never seen any of the relevant evidence (cf. Jelinek 1992). It is hoped that *The Artefact* can fill this hiatus by addressing archaeological questions of specifically circum-Pacific relevance.

The situation is somewhat different in rock art studies, despite the fact that no scientific report about Chinese rock art, for instance, had been published in a Western language until 1984. Indeed, no rock art was known abroad to exist in China (Anati 1984), although rock art research is at least 1500 years old there. The first English report appeared in Australia (Wang Ningsheng 1984), and since then, great strides have been made in Australia in establishing a close liaison not only with Chinese, but also with other Asian rock art specialists (Bednarik 1990a).

While the dating of 'prehistoric' rock art remains one of the most intractable problems in archaeology and palaeoart studies, significant progress has been made during the 1980s, especially in the last few years. Absolute dating of *rock paintings* has been secured in several countries since 1987, and similarly reliable methods are just being introduced for *petroglyphs* (carvings, peckings or engravings). It is therefore most timely and appropriate to discuss the various approaches and methods, to compare them and to summarise the major developments in this area. Some of the latter have taken place in China and Australia, and this has become a focus of bilateral research co-operation.

The scientific study of rock art is crucially dependent upon some form of reliable dating of the art. Without it, different art bodies cannot be convincingly related to one another, nor can the rock art be correlated with any archaeological evidence, and reliable chronological models will remain elusive.

In this paper we will first review the methodology that has so far been applied to rock art dating in China. We will then discuss and compare the various approaches and methods currently in use elsewhere, and finally attempt to provide an appropriate strategy for future endeavours of determining the age of Chinese rock art.

Survey of rock art dating methods in China

The methods of rock art dating used in China so far, like those in other countries, can be conveniently divided into 'indirect' and 'direct' methods (Bednarik 1992a).

Indirect or archaeological dating is through induction of one form or another: presumed association with a dated sediment deposit, perceived stylistic connection, spatial association and similar. The deductions arrived at are no doubt often correct, but usually they are not refutable (Tangri 1989). For instance, the correlative relationships between rock art and archaeological finds or deposits, while often valid, provide no scientific basis for dating. In these relationships the art was either covered by datable strata (claimed to be more recent, which it not necessarily is), or art-bearing clasts were found in the strata, or stratigraphically datable mobiliary art is seen as being stylistically similar to rock art. Most of these claimed relationships can only produce inferred minimum dates, at the very best.

Direct dating (Bednarik 1981a) utilises a feature whose physical relationship with the art is direct and indisputable. This can be a phenomenon which is of the same age as the art (e.g. a binder, pigment, brush fibres, diluent, or incidental organic particles such as pollen contained in the paint), younger (such as cracks dissecting a motif and the surfaces they form, or precipitates deposited over the art) or older (such as the support rock, or the medium of the art) (Bednarik 1981a, 1981b).

Indirect rock art dating in China

The following are the main methods adopted in attempts to determine the approximate age of Chinese rock art:

1. Dating through the *identification of animal species* and genera apparently depicted in the art. This is fraught with considerable uncertainties. For instance, animal figures in the Yinshan, Inner Mongolia, have been identified as those of a large-antlered deer (megaloceros?) and ostrich (Figure 1). These are Pleistocene species thought to have

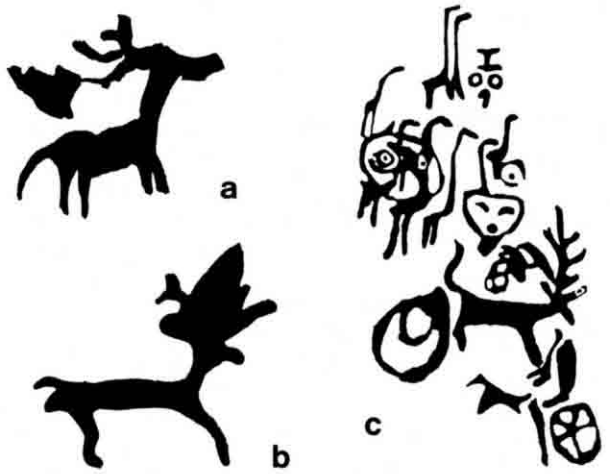

Figure 1. *Apparent depictions of large-antlered deer and ostrich, at Geeraobaogou, Wulatezhong Banner, Inner Mongolia. (After Gai Shanlin 1986.)*

become extinct by the Neolithic period, which raises the possibility that they could be over 10 000 years old. However, literal iconographic interpretation of early rock art is an unscientific procedure, because it involves the implicit but unsubstantiated assumption that a contemporary observer can correctly identify the iconographically diagnostic characteristics in the productions of an alien graphic system. This has been shown to be incorrect (e.g. Macintosh 1977), and such identifications must always remain working hypotheses, as do the deductions derived from them.

2. Correlation of rock art with *ancient documents* is sometimes possible in China, notably with the *jia gu wen* (writing characters found on tortoise shells and animal bones, particularly bovid scapulae, in Henan Province, Shang Dynasty, about 1600-1100 B.C.). Petroglyphs at Yinshan, Inner Mongolia, and Helanshan, Ningxia, were recorded in *Shui Jing Zhu* by Li Daoyuan, a geographer of Northern Wei about 1500 years ago. This shows that rock art must have existed in these regions for more than 1500 years. The rock paintings at Xianzitan, Huaan, Fujian Province, and a legend about the rock art were recorded in *Xuan Shi Zhi* by Zhang Yue of the Tang Dynasty more than 1200 years ago (Li Fushun 1991) (Figure 2).

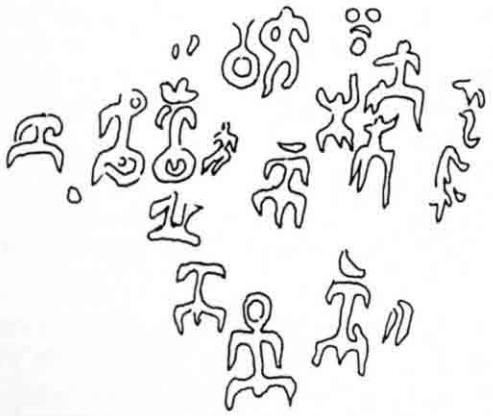

Figure 2. *Anthropomorphous rock paintings at Xianzitan, Jian'an Fujian. (After Qin Shengmin et al. 1987.)*

3. Inferring the age of rock art by comparison of motifs with *excavated and datable artefacts* provides another possibility. Most excavated artefacts can be dated reasonably well, and if they bear decorative motifs that are also found in rock art, the two may well pertain to the same cultural tradition. For instance, there is a set of stylised faces in the petroglyphs at Jiangjunai (General's Cliff), Lianyungang, Jiangshu Province. The lower end of the faces connects with a plant-like motif. Similar decorative patterns were observed on early pottery excavated in the region. The rhomboid lattices on the faces are also repeated on the pottery (Figure 3). In view of the geographical restriction of this stylistic convention and the age of the artefacts of Lianyungang it is reasonable to infer that the rock art is of Neolithic age, around 6000 years old. Another example is provided by the goat horn-shaped bells depicted in the Huashan paintings. All of the goat horn-shaped bells unearthed in the nearby archaeological excavations date from the Warring States to the middle of Western Han, and they are never found in remains postdating the Eastern Han (475 B.C. - A.D. 8) (Qin Shengmin et al. 1987).

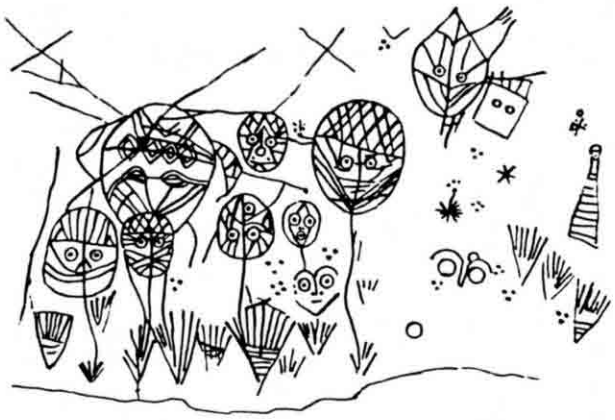

Figure 3. *Stylised faces at Jiangjunai, Lianyungang, Jiangshu Province. (Recorded by Li Fushun.)*

4. The *degree of weathering* often allows inferences about the probable age of rock art: older art is invariably more weathered. For example, among the petroglyphs at Gangchashebuqugou, Qinghai Province, four periods of rock art may be distinguished by their relative weathering. In chronological order, they begin with pictures defined as those of wolves, followed by 'hunting with bow and arrow on foot', then 'hunting with bow and arrow on horseback', then Tibetan letters (Figure 4). The Tibetan characters (cf. Tang Hui-sheng 1989) were created during the Songzhangan Bu era of the seventh century A.D. One might assume, on the basis of proportionally greater weathering in the older phases, that the earliest might be in the order of 3000 years old, and while this would be most tenuous without very detailed microscopic study, it does provide a general impression of the time depth represented in the art. Similar chronological sequences based on superimposition, relative weathering and patination can be obtained at numerous petroglyph sites throughout China.

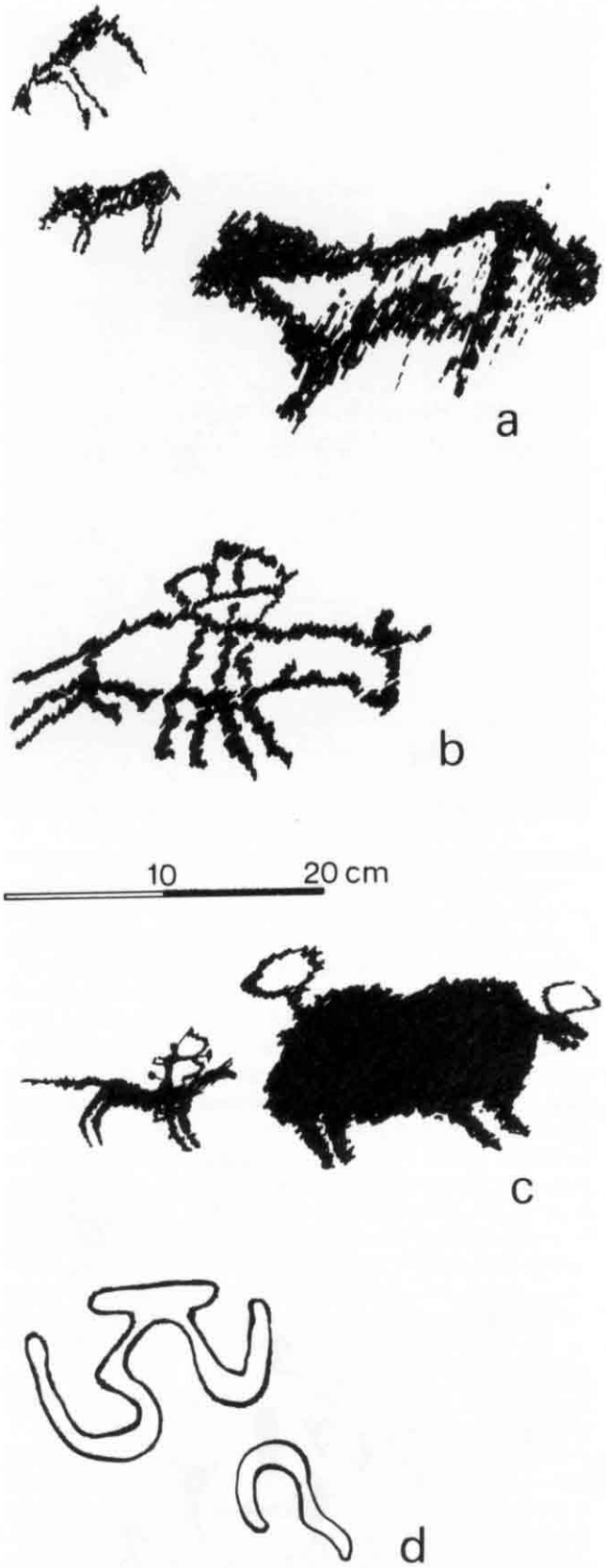

Figure 4. *Chronological petroglyph sequence as perceived from varying degrees of weathering. Gangchashebuqugou, Qinghai Province. Depictions of wolves (a) are followed by hunting with bow and arrow on foot (b), then hunting with bow and arrow on horseback (c), and finally, Tibetan letters. (Recorded by Li Fushun.)*

5. The age of rock art may be inferred from the *apparently depicted theme*. For instance, one might assume that, among hunting scenes, the earliest would be those depicting hunting on foot, with very large bows. It is also clear that the non-iconic ('abstract') traditions are earlier than those of iconic motifs and written characters. However, these criteria by themselves are not adequate evidence, partly for the reasons given above (concerning iconographic identification of motifs), and partly because early motifs may be culturally re-cycled later, through a variety of processes. This is often the case in world rock art (Bednarik 1991).

6. The *style of rock art* may also provide some indication of its antiquity. Most obviously, in iconic or figurative art, there appears to be a general trend from 'naturalistic' images towards increasing stylisation with time (Li Fushun 1991).

7. Finally, rock art can be examined by analysing it in terms of the development of Chinese *writing characters*, which is itself a chronological indicator.

Archaeological dating through sediment stratigraphy, as it is available from Russia, France, Libya, South Africa, India, Australia, Canada and Brazil has not been reported from China. The limited utility of the various methods of indirect dating listed here will be apparent. There is a tendency to resort to such desperate methods as seeking to identify exotic animal species in the art, as illustrated by a recent attempt to identify some petroglyphs of long-necked quadrupeds as giraffes (Liu Yiqing 1991; also pers. comm. to RGB). Since the giraffe is a Tertiary species in China, the author proposed that the petroglyphs must date from the Tertiary period.

Another certainly novel but nevertheless unsuccessful attempt comes from Tang Wei-zhong (1991). He determined that there are essentially two spatial zones of petroglyphs at a site in the Zhuozishan of Inner Mongolia: one between the present valley floor and 6 m above it, the other between 6 m and 30 m above the present floor. He argued that the mountain must be slowly rising, at the rate of 2 cm per year. Although there is a minor problem with the arithmetic (Tang calculated that the oldest pictures are 18 000 years old), the author deserves full marks for originality.

These clearly desperate endeavours to obtain some idea of the rough age of the art illustrate more than anything else the need for a readily available method of providing reliable order-of-magnitude ages for petroglyphs.

Direct rock art dating in China

So far, two methods have been utilised in attempts at dating Chinese rock art, and the potential applicability of a third has also been investigated:

A. A rock painting at Huashan, Guangxi Zhuang Autonomous Region, has been dated via a stalactitic deposit physically related to the art (Qin Shengmin et al. 1987; Li Fushun 1991). According to the radiocarbon content of the *reprecipitated calcium carbonate*, the art appears to date from between 2370 and 2115 BP. Stalactitic limestone, flowstone or travertine are datable by virtue of the fact that about one half of their carbon content is atmospheric, and essentially of organic origin.

It thus contained a known proportion of the ^{14}C isotope at the time of precipitation (Figures 5 and 6). The method was first developed in Australia (see below).

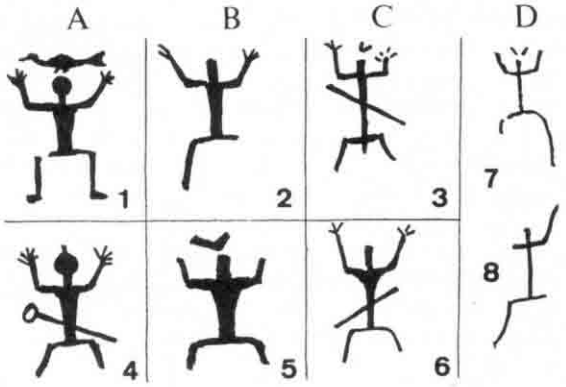

Figure 5. *Chronological development in the frontal depiction of painted anthropomorphs in the rock art of Huashan, Zuojing River valley, Guangxi Zhuang Autonomous Region. (After Qin Shengmin et al. 1987.)*

B. Similarly, a painting at Cangyuan, Yunnan Province (Wang Ningsheng 1984), was concealed under a series of flowstone laminae which have yielded several radiocarbon dates, ranging from 3100 to 2960 BP. Numerous pollen grains were recovered from the paint, providing a *pollen spectrum* of some forty species that is typical of the region about 3500 to 2500 years ago. This suggests that the painting was executed shortly before the carbonate was precipitated over it. Corroborative evidence has also come from an excavation at the site, which produced charcoal ranging in radiocarbon age from 2895 to 2735 BP. It follows that the most likely age of the painting is about 3000 years, or marginally more (Woo Sheh Ming 1991; also pers. comm. to RGB) (Figure 7).

Figure 6. *Section of the decorated cliff of Huashan, on the Ming River, Ningming County, Guangxi Zhuang Autonomous Region. The painted panel is 221 m long and up to 40 m high, and there are 1819 figures, many of which measure 2-3 m.*

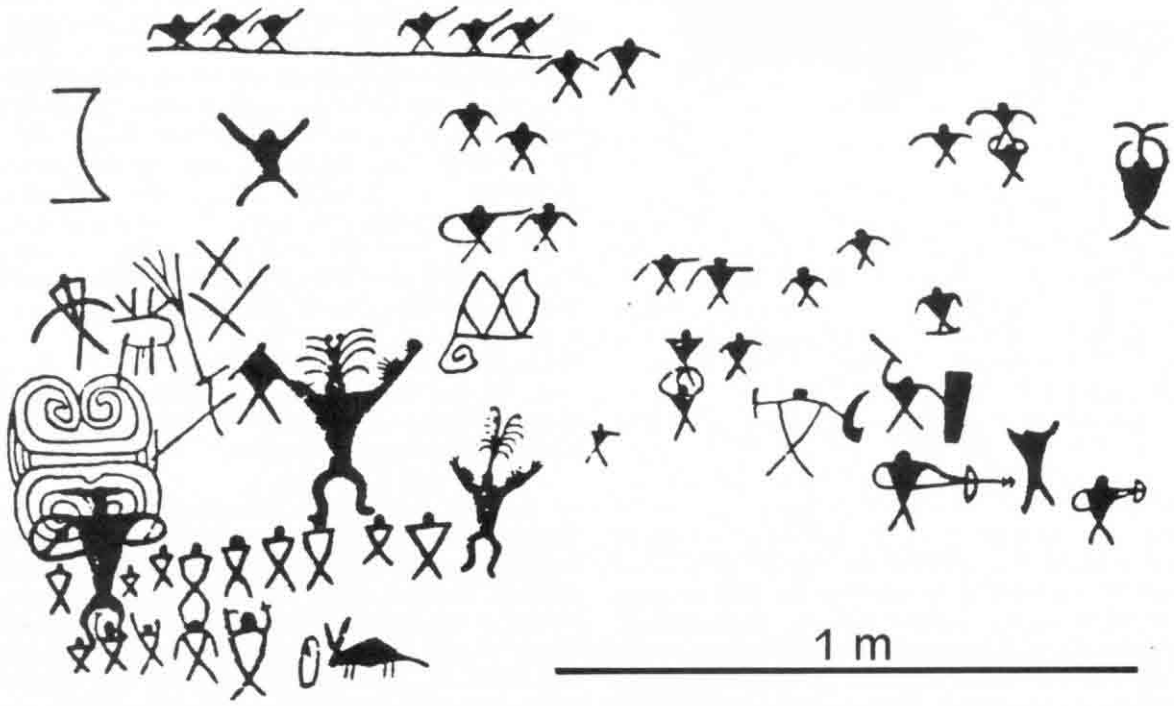

Figure 7. *Human figures that appear to wear head-dresses, and a variety of other anthropomorphous figures. Red ochre paintings, Cangyuan, Yunnan Province. (After Wang Ningsheng 1984.)*

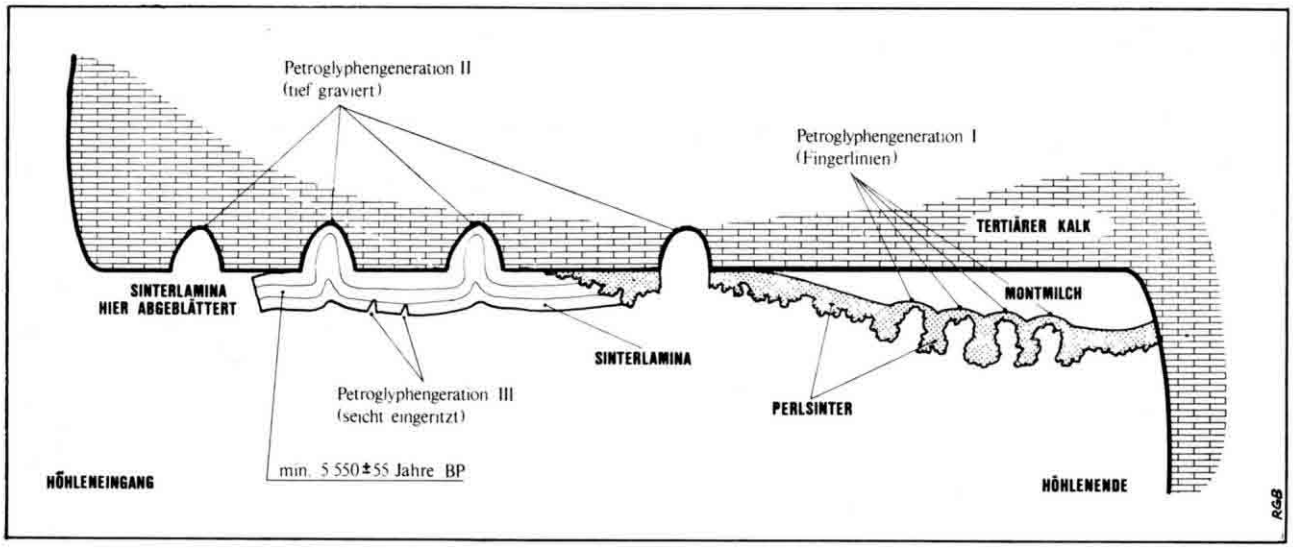

Figure 8. *Schematic depiction of the relationship between three carbonate speleothem formations and three petroglyph 'generations' on the ceiling of Malangine Cave, South Australia. The* montmilch *deposit was first marked with fingers (digital flutings), then covered by a pearly precipitate (*Perlsinter*) in the deep part of the cave. The laminated speleothem (*Sinterlamina*) near the entrance separates the two more recent petroglyph phases and has provided a 'very conservative' minimum age. Based on this and other evidence it was argued that the shallow incisions (petroglyph generation III) are probably of the middle Holocene, the deep carvings possibly of the early Holocene. The age of the oldest petroglyphs, the finger marks, remains unknown, but they must be substantially older than petroglyph generation II. (After Bednarik 1984.) Once published abroad, this method was successfully applied in the dating of Chinese rock art.*

C. A preliminary examination of the potential utility of *microerosion dating* of petroglyphs has provided encouraging results, even though no attempt at actual dating was made. At the Helankou-Suyukou site complex in Ningxia Province, significant differences in microerosional indices indicate that the petroglyphs represent a wide chronological range, and that their chronological order is easily determined with this method. At the very least, relative antiquity can be ascertained with considerably greater reliability than through assessment of patination, for instance. Indeed, microscopic examination of the rock varnish deposits at the site complex has resulted in the refutation of one of the key postulates in the dating of rock surfaces via the cation-ratio method: the postulate that rock varnish formation commences soon after a fresh surface is exposed, usually within a century (Nobbs and Dorn 1988). In the older petroglyphs of Helankou it was noted that the commencement of varnish formation was preceded by a very lengthy period of microerosion.

Modern rock art dating outside of China

Practically no pre-Historic rock art in the world had been firmly dated by about 1980. The numerous earlier attempts (Bednarik 1992a) relate mostly to unfalsifiable claims of archaeological dating, and include circular confirmationist arguments, non sequiturs and stylistic claims of correspondence (the validity of which is no longer accepted without question; cf. Lorblanchet and Bahn 1991). Wherever regional chronological sequences had been created they were not entirely free of speculation, tautological argument, wishful thinking and the idiosyncrasies of specific research traditions or individual scholars. As in China, they were also often based on such subjective notions as the identification of objects apparently depicted in the art, or the belief that a researcher can reliably perceive the iconic intent of an artist from looking at a graphic production. Archaeological dating was available from several world regions, but it referred in nearly all cases to minimum ages, and it was generally contingent upon inferred relationships of different classes of data, which were inaccessible to refutation or independent testing.

The first successful method of direct dating was attempted barely more than ten years ago, when laminar layers of reprecipitated calcite containing cave petroglyphs at a site in South Australia were minimum-dated via their content of biological carbon (Bednarik 1981a, 1981b, 1984, 1985, 1990b, 1992a) (Figure 8). The method's limitations due to the possibility of rejuvenation of the deposit by subsequent deposition (unless it is densely crystallised) had been acknowledged since the method was first devised (Bednarik 1981a), and it is currently being refined and cross-checked as part of a project by R. G. Bednarik and A. Rosenfeld. Since first applied in Australia, this same method has been used in the direct dating of rock paintings in southern China, as noted above.

Also during the early 1980s, Dorn and colleagues developed the cation-ratio dating method in south-western U.S.A. (Dorn 1983, 1986; Dorn and Whitley 1984). It utilises the selective leaching of cations from a ferromanganese accretionary deposit of supposedly biological origin (Scheffer et al. 1963), rock varnish. Previously called 'desert varnish', this is a very distinctive phenomenon (Engel and Sharp 1958) which is found at many petroglyph sites in northern and western China. In response to the criticism the cation-ratio method has been subjected to, direct radiocarbon AMS (accelerator mass spectrometry) dates from organic remains contained in

rock varnish are now preferred, and these have produced far more reliable minimum dates. The oldest currently available minimum date for a petroglyph, derived from organic inclusions in varnish, is 36 400 ± 1700 years BP; it comes from a deeply varnished oval motif at Wharton Hill, South Australia (Dorn et al. 1992).

Watchman (1987) identified oxalate deposits at a series of Australian rock art sites in Kakadu National Park, and recognised their potential to provide minimum or maximum dating where they are in physical contact with rock art. The oxalates whewellite and weddellite are salts of oxalic acid, contain organic carbon, and are susceptible to the radiocarbon dating method (Watchman 1990).

Several other 'direct' methods have been tried or suggested. Besides true rock varnish, various other ferruginous accretionary deposits are found on rock surfaces (Bednarik 1979). Their dating potential remains largely unexplored, perhaps their polymorphous origins and development are a deterrent for researchers. Lichenometry is among the earliest methods explored (Beschel 1961; Joubert et al. 1983). Based on the presumed stable growth patterns of lichen thalli, it has been found to be of only limited utility. Watchman identified organic matter enclosed in silica skins (precipitates of colloid silica commonly found at Australian rock art sites), from which it might be possible to extract AMS dates (Watchman 1985). Bednarik (1979) has described a process in which potash reacts with silica to produce glass during brush fires, which would almost certainly be datable by various methods, but so far such a deposit has not been found on rock art. American researchers have experimented with cosmogenic radiation dating, in which isotopes resulting from cosmic radiation are detected. Its applicability in rock art dating, however, seems remote, particularly as it involves the removal of large areas of rock surface at this stage. Thermoluminescence dating is another possibility, for instance where ochreous pigments have been fire treated, but it has not been applied to rock art so far. Amino acid analysis, on the other hand, has been tried (Denninger 1971), but without providing convincing results.

The first radiocarbon date obtained directly from a rock painting was presented in South Africa by Van der Merwe et al. (1987), on comparatively recent charcoal pigment. Actually, the first *attempt* to date a rock painting via radiocarbon content of the paint was by Grant (1965), with only five per cent of the sample quantity then required. During 1990, several multidisciplinary research teams in Australia and France succeeded in obtaining absolute dating of painting pigments, publishing their results within a few months of each other. In Australia, Pleistocene rock paintings were for the first time dated by Loy et al. (1990), who obtained three AMS radiocarbon dates from human blood protein identified in paint samples. Palaeolithic rock art was for the first time dated by absolute and 'direct' means when Lorblanchet et al. (1990) subjected charcoal-based paint from the cave of Cougnac, France, to AMS dating, obtaining an age of about 14 300 years. McDonald and Officer applied AMS dating to charcoal drawings in the Sydney region, obtaining surprising results at the site Gnatalia Creek (McDonald et al. 1990). All rock art of the Sydney region had so far been assumed to be less than 2000-3000 years old, and the two dates of about 6000 and 30 000 BP have prompted further analyses at the site. More recently, the AMS method produced a date of about 3800 BP from a naturally exfoliated painting fragment collected in a limestone shelter in Seminole Canyon, Texas (Russ et al. 1990).

While certainly not all rock paints contain charcoal or organic binders, methods to date non-organic components of rock paints will no doubt appear. Moreover, the use of organic pigments or binders was perhaps more widespread than has been reported, despite Rosenfeld's (1987) pessimism. For instance, animal proteins have been recently observed in red rock paint from southern China (Li Fushun 1991). Bednarik (1992a) has reported organic paint components from India, South America, North America, Europe, and Australia, and notes the reports of several other authors on the same subject. For example, the use of human blood (Loy et al. 1990) and orchid juices (Mountford 1956: 11) has been demonstrated in Australian rock art, and numerous other organic substances have been observed ethnographically in use as binders or additives in the decoration of portable Australian artefacts. Moreover, microscopic remains of various plant fibres have recently been found and identified in Australian rock paint samples (Cole and Watchman 1992).

The fundamental difference between rock paintings and petroglyphs, in terms of their dating potential, is that the former are the result of an additive process, which is likely to have taken place shortly after the paint was prepared, whereas the latter, being the result of a reductive process (abrasion, percussion, drilling or etching), cannot be readily related to a specific substance. Admittedly, the age of a component of a paint is not necessarily the same as the paint's own age; for instance, one must expect that occasionally the charcoal selected to provide black pigment was not fresh, but was already thousands of years old when it was added to a paint. Nevertheless, this is an inherent risk and one would hope to obtain valid dates in the great majority of cases.

The most recent additions to the range of direct dating techniques for rock art are Bednarik's microerosion dating method (Bednarik 1992b, 1992c) and the FLECS-AMS method by Watchman and Lessard (1992). In the first method, the differential wear of mineral components (e.g. quartz and feldspar) is quantitatively recorded, using primarily the micro-wanes on individual crystal cleavage faces that had been exposed when the petroglyphs were fashioned. A dual calibration curve (in the case of granite starting with feldspar erosion, and continuing with quartz erosion where the former becomes too excessive to estimate; see Figure 9) is established from several surfaces of known, or approximately known, ages (e.g. glacial striae, inscriptions, structural surfaces, monuments, grave stones, lava flows etc.). The petroglyphs of unknown age are then placed in the calibration curves on the basis of their microerosion. The first result of this method was obtained at Lake Onega, Russia, placing an anthropomorphous petroglyph at E4000 BP (the 'E' indicates that this is an erosion-derived age estimate), i.e. in the final Neolithic of Karelia (Bednarik 1992c). This is the only non-destructive method of rock art dating currently known, and it is also the cheapest and one of the simplest.

In the FLECS (Focused Laser Extraction of Carbonaceous Substances) AMS method, localised combustion of in-situ organic matter is caused by a focused laser of about 0.01 mm diameter. The carbon dioxide which forms

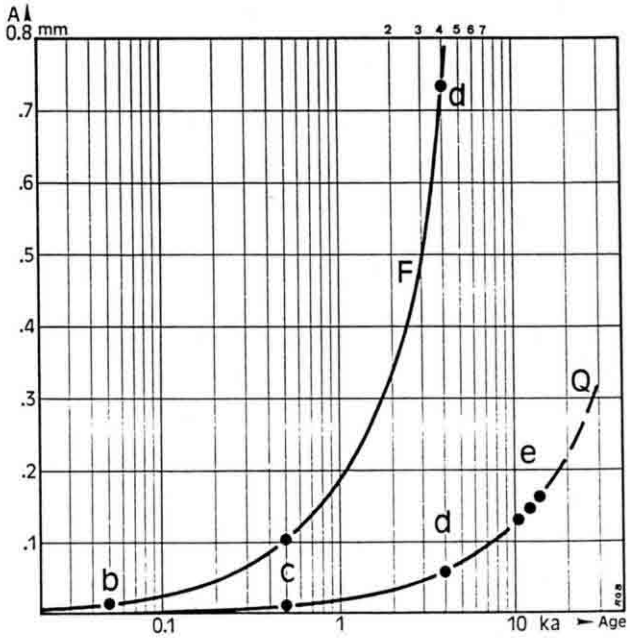

Figure 9. *Microerosion calibration curves for the site Besov Nos, Lake Onega, Russia. The surface ages* **b**, **c** *and* **e** *are known, or approximately known. The age of* **d** *is that of the petroglyph surface, and is to be determined from its position in the curves. Curve* **F** *represents the feldspar component, curve* **Q** *the quartz component. A is the micro-wane width at* $\alpha \approx 90°$*, the age of the samples is shown in ka (thousand years). It is to be noted that the curve shape is entirely a function of the logarithmic depiction, in reality microerosion proceeds in a linear fashion. (After Bednarik 1992c.)*

is collected and converted into a graphite target for accelerator mass spectrometry radiocarbon dating. It is envisaged that this method can be used for direct dating of paints containing organic matter, and for minimum dating of petroglyphs through the organic matter contained in rock varnishes. However, it still involves significant damage to the art, as more than a square centimetre of rock surface needs to be removed.

The future of rock art dating in China

Carbonate, cation-ratio, silica and oxalate dating all belong to the same class of dating techniques, and the preoccupation with them illustrates one difficulty in rock art dating: a preference for techniques that can be developed or neatly packaged into standard procedures, or that in some form lend themselves to standardisation. Such procedures are seen as maintaining a semblance of the replicability science demands, whereas exploratory or tentative methods are more likely to be frowned upon by conservative researchers. While the dating of rock paintings will soon be a routine technique, petroglyph dating, one of the most intractable problems in this discipline, remains a largely opportunistic pursuit demanding considerable methodological creativity.

It has become clear from recent petroglyph dating work that the approaches utilising mineral deposits, irrespective of the accuracy of their results, can only produce associative data. A number of rather basic geomorphological approaches are worth considering in their place, notably in China, if only because they involve procedures that are readily available to all researchers. For instance, the chronological relationship between rock art and the cracks dissecting it can often be determined. Such a crack results in the formation of two edges separating the art from two new surfaces, and these four features are all of the same age. Edges become progressively blunt and rounded with time, surfaces become patinated or they are subjected to granular or laminar exfoliation, to the deposition of accretions, scratching by animals (in caves) and other processes. Many phenomena could be utilised in dating, depending on local circumstances: the wanes on rock edges; multifacetted boulders that are the result of progressive insolation or brush fire spalling, and bear a patination of different age on every facet (Bednarik 1979); differential patination, fracture sequences, and their relation to the different art phases present at a site; carved dates, inscriptions and historically datable symbols, as are often found in China; the spatial relationship of the art to specific topographic aspects of the site, such as subsided floors, roof falls (in caves and shelters), prehistoric quarrying traces, changes in sediment levels or in accessibility may all be datable in some way.

While it is true that such processes are often susceptible to intractable variables (for instance, climatic factors and environmental pH can accelerate, delay or completely inhibit the formation of patinae), it is also true that most petroglyph panels present a complex record of many time-related processes and events, and the relative position of the art within these chronological sequences is often readily apparent. Archaeologists have traditionally ignored these clear sequences of geomorphological events and processes as a source of information, trying instead to correlate the art with *archaeological data*. Very few petroglyph sites offer scientific means of relating archaeological 'data' to the art, yet at each and every site the art can be related to at least some of a multitude of geological, geochemical and geomorphological phenomena, all of which refer to specific events or periods, and many of which may be datable in some way.

It follows that a basic priority in rock art research generally should be a fundamental concern for the geological and geomorphological environment of the art, and a good understanding of the processes that have been active on the rock surface over time. Of the many techniques that have been applied to the task of dating petroglyphs, only one is a truly direct method that seeks to determine the age of the art rather than the age of some associated feature, such as a later mineral accretion. Microerosion dating is also the only such method that involves no laboratory support, no complex technology or special training, and no sample removal or interference with the art. It is an optical technique, provides results in the field, produces statistically comprehensive data, requires no equipment other than an optical microscope, and it is a geological method. Its viability in China has been examined already. It is probably suitable for many Chinese petroglyph sites, partly because they are often on eligible rock types (especially igneous rocks, including rhyolites and granites), and partly because in China there are more opportunities for obtaining precise calibration data than in most other countries. Preliminary examination has also shown that some Chinese rock art may well be considerably older than had been assumed. The pilot study for microerosion dating in the Helanshan indicates that the early petroglyphs are at least several times as old

Figure 10. Deeply carved, eroding petroglyph on steeply sloping panel, Helankou, Ningxia Province.

as those figures which are attributed to the Bronze Age (Shong and Xi Zhou States) (Bednarik and You Yuzhu 1991). The possibility that the early petroglyphs, which resemble the archaic linear tradition of Australia (Bednarik 1988), are of Pleistocene age (which they certainly are in Australia) has to be seriously considered, particularly in the light of the recent discovery of the first Palaeolithic art in China (Bednarik 1992d) (Figures 10 and 11).

Where organic constituents are detected in Chinese rock paintings, they are directly datable with current AMS technology. At the present time this offers the most reliable means of dating rock paintings, but it is possible that more accessible methods will be developed in the near future. Both for the application of AMS dating and the microerosion dating method, it is suggested that co-operative projects with researchers of other countries might be most beneficial - notably with specialists of Australia where most of the pioneering studies in this general field have been conducted.

Of particular benefit to rock art dating in China is the wealth of historical information, reaching back several thousand years. Perhaps there are further opportunities of correlating such information with rock art. It would seem that it is here that the attention of Chinese specialists might be most profitably focused. This approach, combined with greater emphasis on geological aspects and with some well-targetted applications of microerosion and direct paint dating methods might be the most productive overall strategy in the dating of Chinese rock art.

Figure 11. Elaborate animal motif, described as tiger, on boulder, Suyukou site, Helanshan, Ningxia.

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Résumé. *On considère les méthodes diverses employées jusqu'à présent pour la datation d'art rupestre en Chine et on examine leur efficacité. Les approches sont comparées et contrastées avec celles employées dans d'autres parties du monde, particulièrement en vue de la nouvelle méthodologie de datation directe. On considère l'utilité de nouvelles techniques pour le travail de la datation future de l'art rupestre chinois, en discutant leur applicabilité potentielle, la tendance envers des méthodes trop sophistiquées, leur fiabilité et accessibilité aux chercheurs chinois. On présente des recommandations pour les futures stratégies dans ce domaine de recherches.*

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