The dating of Chinese rock art

Robert G. Bednarik *

Summary

Isolated attempts of 'direct dating' of rock art have occurred in China for the past few decades, but since 2014 this pursuit has found a new impetus. A major expedition in June and July 2014 covering three provinces (Henan, Ningxia and Jiangsu Provinces) succeeded in increasing the country's number of credibly dated rock art motifs several times. China is exceptionally well suited for petroglyph age estimation, possessing hundreds of rock inscriptions whose ages are known exactly to the day, and these have been exploited to provide comprehensive calibration data for petroglyph analysis. The success of this survey has led to the establishment of the first International Centre for Rock Art Dating (ICRAD), now located at Hebei University.

Riassunto

Negli ultimi decenni abbiamo assistito a isolati tentativi "datazione diretta" dell'arte rupestre cinese, solo nel 2014 questa ricerca ha trovato un nuovo slancio. Un'importante spedizione nei mesi di giugno e luglio 2014 ha percorso ben tre provine (Henan, Ningxia e Jiangsu) arrivando ad ottimi risultati. L'arte rupestre cinese è presenta numerose iscrizioni rupestri di cui sono noti il giorno e l'anno esatti di esecuzione, questi sono stati sfruttati per fornire termini di calibrazione completi per l'analisi dei petroglifi. Il successo di questa indagine ha portato alla creazione del primo International Centre for Rock Art Dating (ICRAD), presso l'Università di Hebei.

Introduction

The publication of rock art research commenced in China earlier than anywhere else in the world. The philosopher Han Fei (280–233 BCE) first reported observing rock art, and the geographer Li Daoyuan (386-434 CE) described numerous sites from many parts of China, even mentioning rock art from India and Pakistan (Bednarik 2007, p. 7). In the 8th century CE, Zhang Yue recorded rock paintings at Xianzitan, Fujian Province, together with a legend about them (Bednarik, Li 1991). These earliest records precede those anywhere else by over one millennium, and date from a time when much of the presently dated rock art was still being produced across much of China. Yet until 1984, no scientific report about Chinese rock art had been published in a Western language (Wang 1984), at which time the world map of rock art compiled by the Centro Camuno di Studi Preistorici still showed a complete blank for China (Anati 1984). But in reality, about 10,000 rock art sites were known across that huge country at that time. From the Chinese perspective, Europeans were caught in a colonialist time warp, assuming knowledge only existed when available to European scholars. In reality, European scholars were largely backward: they only discovered in the mid-19th century that humans evolved from other animals, a fact known to indigenous Australians for tens of millennia.

Since the mid-1980s close working relationships have been developed between rock art researchers in Australia and various Asian countries, especially India, Saudi Arabia and China, i.e. the continent's rock art-richest regions. The traditional *indirect* or archaeological methods of rock art age estimation have been gradually replaced by *direct* dating approaches in recent decades (Bednarik, Li 1991; Tang, Gao 2004). 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 sometimes correct, but usually they are not refutable (Tangri 1989) and thus not scientific. Direct dating 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 lichen dissected by petroglyph grooves).

Indirect approaches in estimating the ages of Chinese rock art have included the attempted 'identification' of animal species and genera apparently depicted in the art. Unfortunately the meaning of ancient rock art is inaccessible to science and to testing, therefore 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. These are Pleistocene species thought to have become extinct by the Neolithic peri-

* Convener and Editor, International Federation of Rock Art Organisations (IFRAO), robertbednarik@hotmail.com

od, 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). 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 BCE).

Another indirect method of age estimation traditionally applied in China has been to infer the age of rock art by comparison of motifs with excavated and datable artefacts. Many 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 Jiangjunya, Jiangshu Province. Similar decorative patterns were observed on Neolithic pottery excavated in the region. 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 BCE - 8 CE) (Qin Shengmin *et al*. 1987).

The degree of weathering often allows inferences about the probable age of rock art. 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. The Tibetan characters were created during the Songzhangan Bu era of the seventh century CE (Tang 1989). 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. Another approach used in China was to infer the age of rock art from the apparently depicted theme. For instance, one might assume that, among purported hunting scenes, the earliest would be those depicting hunting on foot, with very large bows. It is also evident that the non-iconic 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), partly because early motifs may be culturally re-cycled later, through a variety of processes, and partly because any technology can be used by any subsequent society (for instance a spear or an axe is not typical of any specific technological tradition).

The introduction of direct dating

The first applications of direct dating in China took place in the mid-1980s, i.e. soon after the method was established in Australia (Bednarik 1980, 1984), and well before it was first used in Europe. In 1986 eight samples were taken from the large rock painting site Huashan in Guangxi Zhuang Autonomous Region (Fig. 1), from reprecipitated calcium carbonate located both below and above pigment (Yuan *et al*. 1987). Using the approach pioneered in Australia, six samples were analysed for radiocarbon below pigment, yielding ages ranging from about 2420 BP to 6810 BP; and two more samples were secured from calcite superimposed on pigment, dating c. 2130 BP and 2410 BP respectively. This places the rock art in the Warring States Period (475-221 BCE) to the early Western Han Dynasty of Chinese history. However, this age estimate has been contradicted by recent re-dating by uranium-thorium analysis.

Similarly, a painting at Cangyuan, Yunnan Province (Wang 1984), was concealed under a series of flowstone laminae which have yielded several radiocarbon dates, ranging from about 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 (Bednarik, Li 1991).

Another direct approach to estimating the ages of Chinese rock art has been via lichenometry. This work has focused on *Xanthoria egans* in Ningxia Region (Xie, Xiao 1989, pp. 328-332) and on petroglyphs at several sites in the Helanshan region: Mailujing, Heimaoshi, Damaidi, Huangyangwan, Helanshankou and Qingtongxia (Li, Zhu 1993). Lichenometric minimum age estimates have been proposed, most of them in the order of 2000-1000 BCE. However, the reliability of these results can be questioned (Tang 2005; cfr. Bednarik 2007, pp. 127-129), for instance by reference to the lichenometric dates reported by Su and Li (2007) from Damaidi, which at up to 15,000 BP are arguably not credible.

In 2008 it was attempted to apply uranium-series and radiocarbon analyses to Baiyunwan, one of many rock painting sites on the Yinsha River in Yunnan Province (Taçon *et al*. 2010). Two samples of carbonate underlying pigment were removed from this large limestone shelter, three more from deposits younger than pigment. The radiocarbon results are inconclusive because the contamination by 'dead' carbon remained unknown. Eight more samples were analysed by uranium-series dating, four from below and four from above paint residues, but the high $^{230}Th/^{234}U$ ratios and low $^{230}Th/^{232}Th$ ratios imply that contamination from detrital matter renders the results unreliable. Similar issues with this method have been encountered in other countries (Bednarik 2012; Clottes 2012). Moreover, the authors' notions of potential Pleistocene age are refuted by the previous findings from very similar rock art in the region, attributed to the late Holocene (Peng Fei 1996).

As in various other countries, the most successfully applied approach of direct rock art dating has been via microerosion analysis of petroglyphs in China. This region is particularly amenable to this method because of the country's outstanding wealth of very precisely dated rock inscriptions and other natural rock surfaces of known ages, such as those of statues or structures. From many of the Chinese rock inscriptions it is clearly evident on which day of which year the dedications were engraved, even for what purpose. Such precisely dated rock features provide valuable calibration references for microerosion analysis, which still benefits greatly from such information even though that need is gradually being replaced by a universal coefficient curve (Bednarik in prep.). In China the method was first introduced in Qinghai Province in 1997, initially using a stone lion from Kexiaotu and Buddhist inscriptions from Shuixia and Lebagou sites for calibration (Tang, Gao 2004). These determinations from granite (Figure 2) enabled the tentative age estimation of petroglyphs at three sites of the same rock type: Lushan (c. 2000 years), Lumanggou (c. 2300 years) and Yeniugou (c. 3200 years BP).

Subsequently Tang also applied microerosion analysis to the famous petroglyph site Jiangjunya at Lianyungang, Jiangsu Province, on the coast of China (Tang, Mei 2008; Tang 2012). At this granite exposure he secured a series of five exploratory age estimates which he based on calibration derived from a Buddhist rock inscription of the nearby site Kongwangshan. The provisional Jiangjunya dates range from about 4000 years to possibly up to 12,000 years BP, implying that the site has been in use for a long period of time.

Microerosion analysis has several advantages over all other of the many methods so far applied to securing age estimates for rock art. For instance, apart from the radiocarbon analysis of beeswax figures, it is the only method providing actual 'target event' dates rather than minimum or maximum ages (Dunnell, Readhead 1988). Even the analysis of charcoal pigment does not refer to the 'target event', which is the execution of the palaeoart. With the exception of colorimetry (Bednarik 2009), microerosion analysis is also the only known technique that involves no intervention in the rock art, and the process it is based on is entirely irreversible. Concerning the latter factor it is noted that in other rock art dating methods applied so far, the possibility of reversibility in the variable being determined cannot be excluded with certainty. With the appropriate recording, microerosion analysis is clearly repeatable, and it is cheap and relatively simple. Having been applied successfully in all continents except Antarctica it was for these reasons used exclusively in the following endeavour.

The expedition of 2014

Taking place in June and July 2014, this project was perhaps the greatest rock art dating venture ever undertaken, involving a large and well-equipped team that worked at dozens of petroglyph sites covering three regions of China: Henan, Ningxia and Jiangsu Provinces (Tang *et al.* 2014; and in press) (Fig. 3). The strategy of the project was to acquire calibration data from these regions, with their different climates; to design a standard protocol for processing the results of this work (Tang *et al.* 2014); and to subject numerous suitable petroglyphs to microerosion analysis. These objectives were met most successfully. Calibration curves were determined for quartz at First Gate Site at Mt Juci, Guanyinshan, Deyunshan and Laomogou in Henan; and at Duijiu Nunnery and Songpan in Jiangsu. A calibration curve for feldspar was obtained at Guanyinshan, but no calibration could be secured for any of the Ningxia sites. All calibrations were derived from precisely dated rock inscriptions (Fig. 4).

Armed with these data, age estimations were attempted at a total of 22 petroglyph sites, and this work succeeded at 11 of these sites. They yielded estimates from a total of 27 petroglyphs: 14 in Henan, 5 in Ningxia (all from one site), and 8 from Jiangsu Province (Table 1). While this represents an impressive data bank about the time depth of Chinese petroglyph corpora, it does not amount to more than a preliminary perspective on the ages of major rock art traditions, dating from Neolithic times to most recent centuries. It also shows the effectiveness of multiple age determinations from single motifs, including the use of different minerals (quartz and feldspar), and of establishing the ages of multiple uses of motifs (i.e. retouch of older motifs). Both these potentials of the microerosion method have already been demonstrated in both Asia other continents. Of particular relevance is the comparison of the new Chinese data with calibration microerosion coefficients in other continents, which has recently shown a strong correlation between them and mean annual rainfall for a range of greatly varying environments (Bednarik in prep.). This suggests for the first time that the great dependency of microerosion analysis on regional calibrations can be progressively phased out (Figg. 5 and 6).

The future of Chinese rock art dating

These developments have considerably improved the position of China as a source of reliable information about rock art ages. They have shown that microerosion analysis has a great future. The country's wealth of very precisely dated natural but anthropogenically modified rock surfaces, such as inscriptions, provides obviously favourable conditions for the application of this method, while at the same time strengthening its applicability elsewhere in the world. There is, however, a second reason suggesting that rock art dating has a secure future in this country.

One of the most positive outcomes of the 2014 rock art dating expedition in China has been the decision by Professor Tang Huisheng to establish the International Centre for Rock Art Dating and Conservation (ICRAD) at Hebei Normal University, Shijiazhuang, Hebei Province. It has just been officially inaugurated and is intended to become a world repository of all direct dating results, in collaboration with the Interna-

Region	Site	Motif	Micro-wane	Age estimate
Henan Province	Mt Juci	Cupule Juci1	China-Juci1-EQ-27/6/2014	E3170 + 620 / - 440
	Xiaomazhuang 1	Cupule Mazhuang1	China-Mazhuang1-EQ-29/6/2014	E1240 + 280 / - 180
	Xiaomazhuang 1	Cupule Mazhuang2	China-Mazhuang2-EF-29/6/2014	E1540 + 70 / - 30
	Xiaomazhuang 1	Cupule Mazhuang3	China-Mazhuang3a-EF-29/6/2014	E1450 + 60 / - 110
	Xiaomazhuang 1	Cupule Mazhuang3	China-Mazhuang3b-EQ-29/6/2014	E1610 + 210 / - 250
	Xiaomazhuang 2	Cupule Mazhuang4	China-Mazhuang4-EQ-29/6/2014	E2840 + 180 / - 240
	Huihuimo	Cupule Huihuimo1	China-Huihuimo1-EQ-30/6/2014	E2260 + 770 / - 440
	Huihuimo	Cupule Huihuimo2	China-Huihuimo2a-EQ-30/6/2014	E2950 + 380 / - 540
	Huihuimo	Cupule Huihuimo2	China-Huihuimo2b-EF-30/6/2014	E3140 + 130 / - 120
	Huihuimo	Cupule Huihuimo3	China-Huihuimo1-EQ-30/6/2014	E2890 + 440 / - 470
	Wufuling	Wufuling1	China-Wufeling1-EQ-1/7/2014	E910 + 300 / - 150
	Zhaodian	Zhaodian1	China-Zhaodian1-EQ-2/7/2014	E4520 + 330 / - 580
	Shipengguo	Shipengguo1	China-Shipengguo1-EQ-2/7/2014	E2650 ± 380
	Xuanluoling	Xuanluoling1	China-Xuanluoling1-EQ-4/7/2014	E1830 + 140 / - 310
Ningxia Province	Helanshan	'Mask'1	China-Helanshan1-EQ-6/7/2014	E2000 + 120 / - 180
	Helanshan	Petroglyph2	China-Helanshan2-EQ-6/7/2014	E1670 ± 150
	Helanshan	Petroglyph3	China-Helanshan3a-EQ-6/7/2014	E2180 + 240 / - 210
	Helanshan	Petroglyph3	China-Helanshan3b-EQ-6/7/2014	E2080 + 340 / - 260
	Helanshan	Petroglyph4	China-Helanshan4-EQ-6/7/2014	E2330 + 90 / - 210
Jiangsu Province	Jiangjunya	Rectangle	China-Jiangjunya1-EQ-13/7/2014	E1630 + 190 / - 110
	Jiangjunya	Cupule in 'sun'	China-Jiangjunya2-EQ-13/7/2014	E3200 + 440 / - 170
	Jiangjunya	Petroglyph1	China-Jiangjunya3a-EQ-13/7/2014	E2210 + 210 / - 90
	Jiangjunya	Petroglyph1	China-Jiangjunya3b-EQ-13/7/2014	E360 + 90 / - 60
	Jiangjunya	'Meridian'	China-Jiangjunya4-EQ-13/7/2014	E920 + 140 / - 160
	Jiangjunya	Diagonal groove	China-Jiangjunya5-EQ-13/7/2014	E2650 + 80 / - 230
	Jiangjunya	Large cupule	China-Jiangjunya6-EQ-13/7/2014	E5380 + 380 / - 530
	Duijiu Nunnery	Large cupule	China-Duijiu1-EQ-14/7/2014	E850 + 210 / - 90

Table 1. The microerosion dating results from China of the survey conducted in June and July 2014.

tional Federation of Rock Art Organisations (IFRAO). This promises not only a surge and consolidation of scientific rock art dating work in the People's Republic of China, but also a significant strengthening of international rock art research.

At the time of writing, the second stage of the Chinese rock art dating project led by Tang Huisheng is imminent. It is to take the project team to the most remote part of China, the far north of the Sinkiang Uighur Autonomous Region, to research several rock painting and petroglyph sites in the area of the Altai Mountains, near the Russian border. The objective is to increase the number of credible rock art datings in the country, and to open up new regions for rock art study, including sites that have been suggested to be of the Pleistocene. Clearly, rock art dating in China has become a well-established endeavour in the Republic, and one that is at least as well supported there as it is in any other country. In short, the future of the discipline seems assured.

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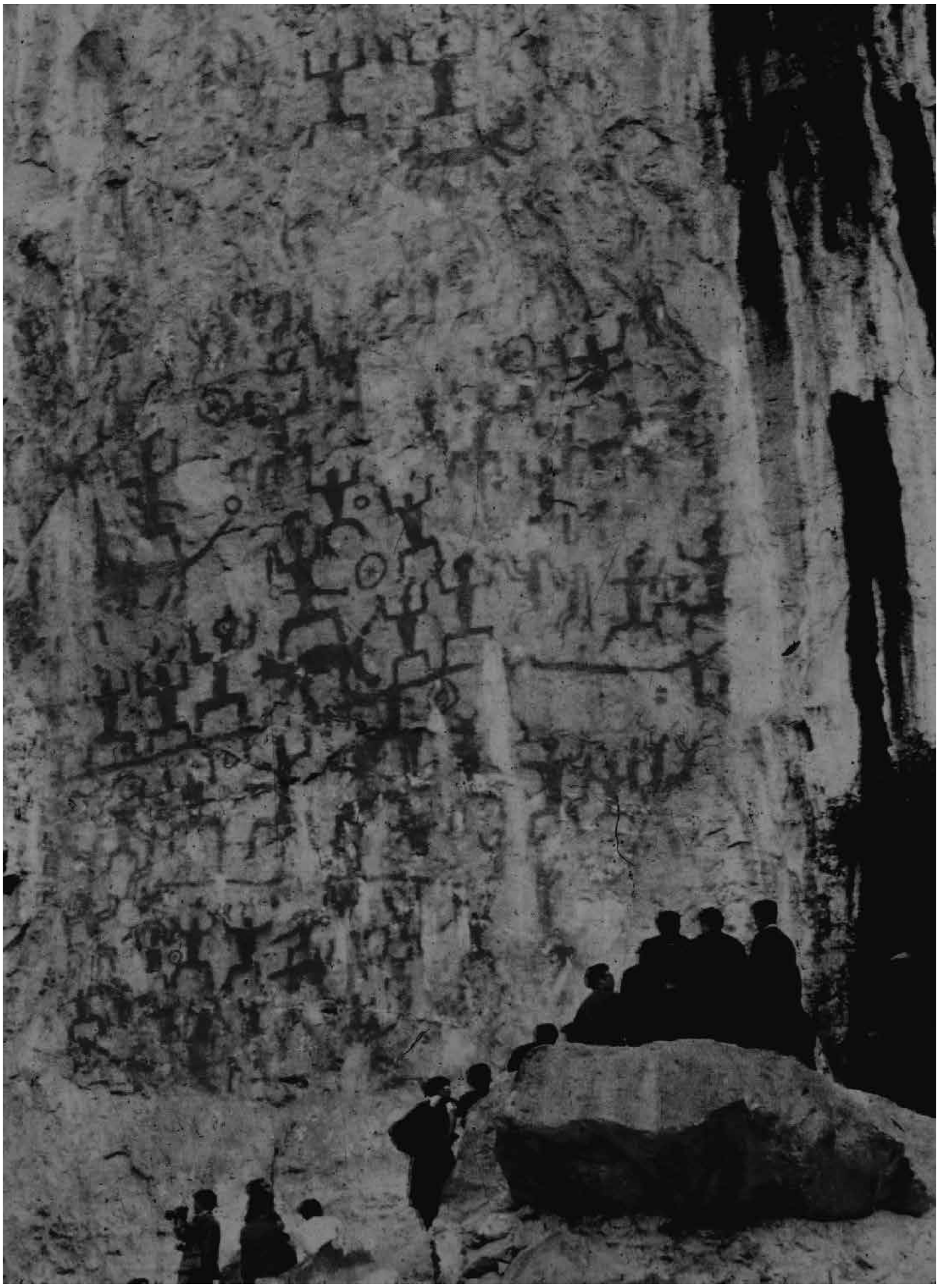

Fig. 1 - Portion of the main cliff of Huashan site, whose several hundred large anthropomorphs extend to 40 m height.

Fig. 2 - Tang Huisheng conducting microerosion analysis at the Lushan site, Qinghai Province, in 1997.

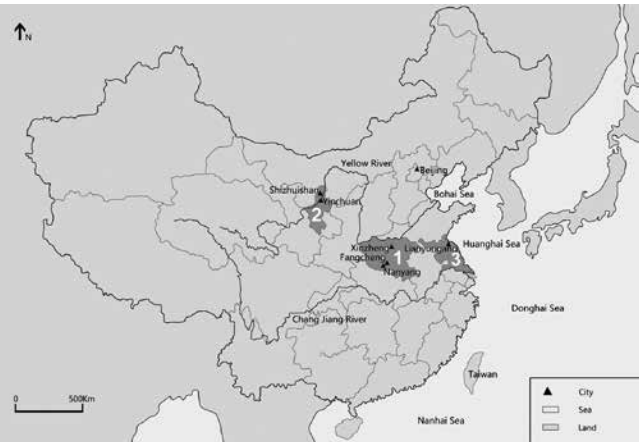

Fig. 3 - Map of China, showing the regions of Henan (1), Ningxia (2) and Jiangsu (3).

Fig. 4 - The Gan Gou inscription of 1548 CE; calibration was obtained from the quartz pebble visible to the right of the IFRAO Scale.

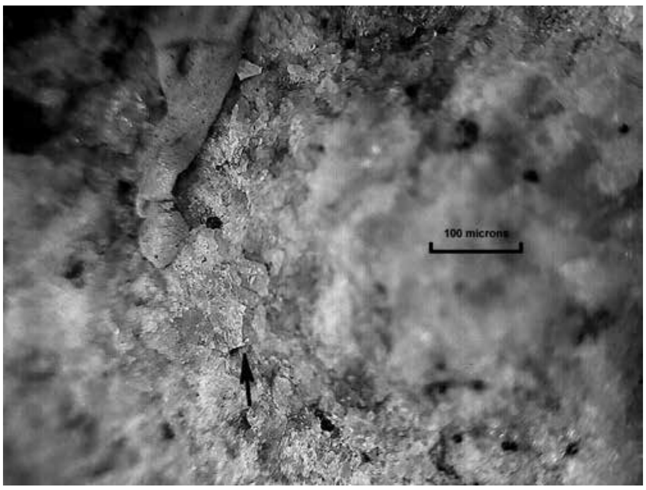

Fig. 5 - Micro-wane measured in the Deyun Shan inscription, Henan Province. The wane is 47 microns long and vertical, on a fracture of just under 90° that was made on 1 April 1001 CE, and it has yielded six wane-width measurements.

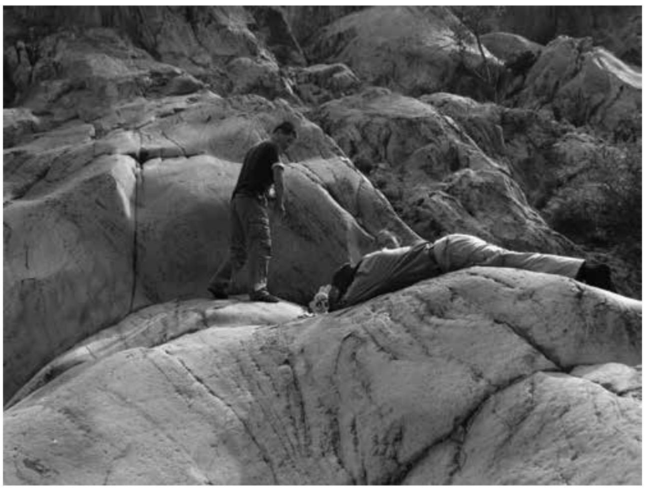

Fig. 6 - Microerosion analysis of petroglyph 2 at Helanshan, Ningxia Province (photo G. Kumar).