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# The difficulties of determining the approximate antiquity of Lower Palaeolithic petroglyphs in India

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## Abstract

*The EIP Project has produced unambiguous evidence of Lower Palaeolithic petroglyphs in the excavations at Bhimbetka and Daraki-Chattan in central India. In order to obtain absolute dates, efforts have been made, through IFRAO and involving Indian and Australian scientists, to meet the challenge since 2001. We have tried OSL dating of the sediments from the excavated sections at both sites, AMS $^{14}C$ dating of amorphous silica, U-Th series dating of ferromanganeous accretions deposited on petroglyphs and stratified boulders and microerosion dating of cupules. We encountered a variety of problems while employing these methods and could not obtain satisfactory results. We are also exploring the potential of using the $^{26}Al$-$^{10}Be$ cosmogenic radiation method to date sediments obtained from the excavations of Lower Palaeolithic strata yielding exfoliated petroglyphs at Daraki-Chattan. The paper deals with the problems faced and the taphonomic issues encountered in this project.*

The excavations in the Auditorium cave at Bhimbetka in the Vindhyas and Daraki-Chattan (DC) in Chambal basin, both in central India, have produced unambiguous evidence of Lower Palaeolithic petroglyphs (Bednarik 1993, 1996; Bednarik *et al.* 2005: 147-197; Kumar *et al.* 2005: 13-68). In Auditorium Cave a large cupule and adjoining meandering line were observed by R.G.B. on a boulder coming from the well-stratified sediments yielding Lower Palaeolithic artefacts (Fig. 1-2). In 1994 we found an Acheulian handaxe on quartzite exposed by rainwater. It was so tightly wedged into a bedrock crevice that it was impossible to remove it. Next to it, a small residue of freshly exposed primary sediments contained three more Acheulian implements including a quartzite cleaver. These were found well above the level of the nearby petroglyphs, confirming that they had been covered by Acheulian strata. The latter were sealed by overlying sediments yielding Middle Palaeolithic artefacts (Bednarik 1996). The trench was excavated by the late V.S. Wakankar in the 1970s (Wakankar 1975).

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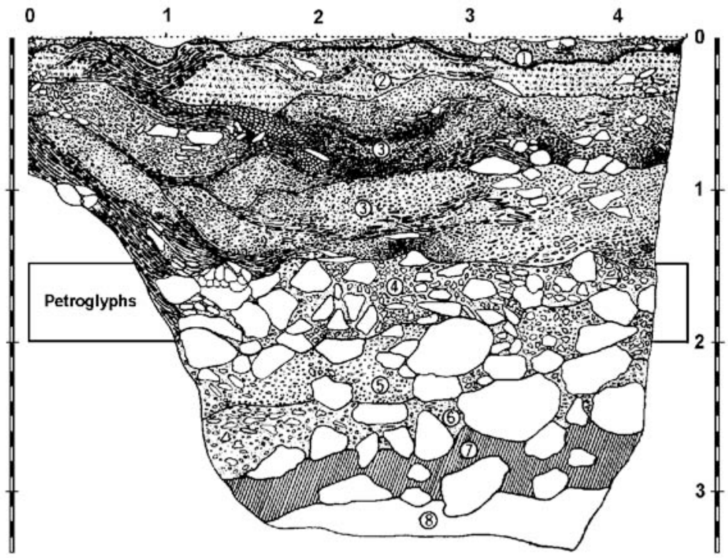


**Fig. 1.** Section map showing the location of petroglyphs-bearing boulder in the Acheulian strata in the trench in Auditorium Cave, Bhimbetka.

**Fig. 2.** Boulder bearing a deep cupule and a meandering line obtained from Acheulian strata in the excavation in the Auditorium Cave.

Daraki-Chattan is a small and narrow cave in the quartzite buttresses of Indragarh Hill near Bhanpura in Mandsaur District, Madhya Pradesh. It bears more than 500 cupules of varying shape and size on both its vertical walls (Kumar 1996). The cave faces west and receives bright sun in the afternoons. The solar temperature fluctuations caused heavy exfoliation in the front part of the cave, leaving the surface there almost devoid of cupules, particularly on the southern vertical cave wall. Therefore exfoliated cupule-bearing slabs were expected in the excavations and were indeed found in almost all layers of the sediments, almost down to bedrock (Fig. 3-6). The cave and its cupules were studied initially by Kumar (1996) and afterwards by a team of Indo-Australian scientists through the EIP project since 2001 (Kumar *et al.* 2005: 13-68; Bednarik *et al.* 2005: 147-197). The excavations and lithic industry so obtained at Daraki-Chattan indicate that the cave was initially used by Lower Palaeolithic hominins, who were producing and using Oldowan-type artefacts on quartzite cores (Fig. 7). The use of the cave continued to the terminal phase of the Acheulian, giving way to the following transitional phase to Middle Palaeolithic tool types.

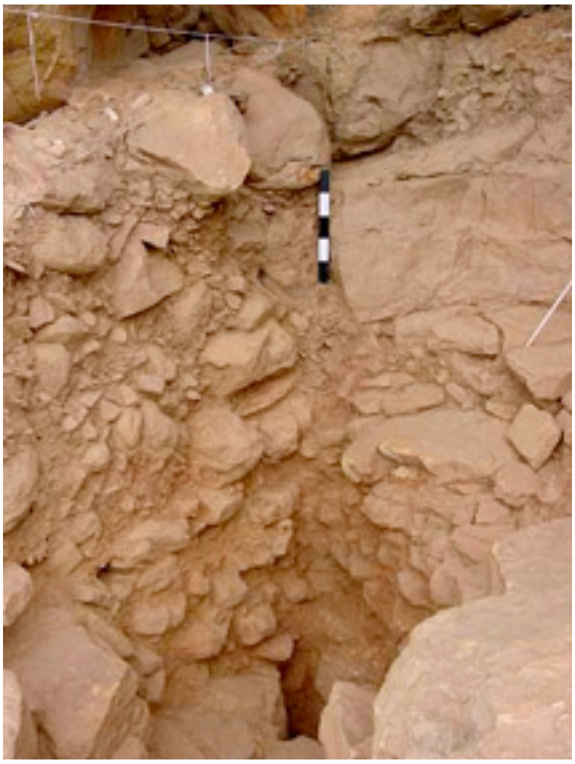

**Fig. 3.** Section facing south showing compositional structure of the deposits in six Lower Palaeolithic pseudo-layers in the trench at Daraki-Chattan.

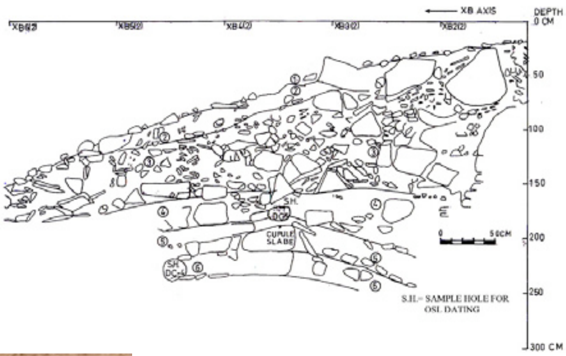


**Fig. 4.** Schematic section of Figure 3 in 2005, showing six pseudo-layers and OSL dating sample holes DC-4 and DC-5 (not yet processed).

**Fig. 5.** Cupule bearing slab lying close to bedrock in the excavation at DC.


**Fig. 6.** Cupule-bearing slab pieces found from pseudo-layer 3, Acheulian, in the excavation at DC, joined together.

**Fig. 7.** Oldowan-type artefact on quartzite core found close to bedrock in the excavation at DC.

The EIP project is a joint venture of the Rock Art Society of India and the Australian Rock Art Research Association, under the aegis of IFRAO. The authors are the Indian and Australian directors respectively of the project. The excavations at Daraki-Chattan were carried out by the Rock Art Society of India in collaboration with the Archaeological Survey of India under the EIP project from 2002 to 2006, under the direction of G.K. Narayan Vyas was the co-director and official representative of ASI in the excavations.

## Efforts made to obtain absolute dates for Lower Palaeolithic art

The team of Indo-Australian scientists under the EIP project has applied different methods to obtain absolute dates for Lower Palaeolithic petroglyphs since 2001. We have tried OSL dating of the sediments from the excavated sections at Auditorium cave and Daraki-Chattan, AMS $^{14}C$ dating of silica accretions, U-Th series dating of ferromanganeous accretions deposited on petroglyphs and stratified boulders, and microerosion dating of cupules. We encountered a variety of problems while employing these methods and could not obtain satisfactory results. These are briefly presented below.

## Microeosion dating

This method has been developed specifically for dating of petroglyphs (Bednarik 1992). It involves measuring the micro-wanes that developed on edges of crystals that were fractured by percussion at the time the petroglyph was made. In order to secure dates the data so obtained are compared against a calibration curve obtained from micro-wanes of known antiquity (Bednarik 2002). R.G.B. applied this method to the cupules on Chief's Rock, standing in the centre of Auditorium Cave, Bhimbetka. He observed that one of nine cupules on the rock had weathered well beyond the limits of the method, which is thought to be in the order of 50,000 ka (Fig. 8). In view of the large cupule in the stratified Acheulian deposit in Wakankar's trench, close to Chiefs Rock (Fig. 1-2), the cupules on the rock are assumed to be of the same age (Bednarik 1996; Bednarik *et al.* 2005).

**Fig. 8.** Cupules on the Chief's Rock standing in the centre of Auditorium Cave. The lowermost cupule is so extensively weathered it is beyond the limit of the microerosion dating method, which is estimated to be 50,000 ka.

Microerosion analysis was also applied to petroglyphs at Morajhari and Moda Bhata in Ajmer District, Rajasthan (Bednarik & Kumar 2002: 45-50), where ages of the very early and the late Holocene were secured from cupules. It is the only method that involves the dating of the petroglyph itself, rather than some other physically related feature. Although very reliable in terms of order of magnitude, it is relatively imprecise, and it can only provide an age estimate of when the cupule or other form of petroglyph was struck last. If all earlier surface is reworked subsequently, the date of the original execution is not obtainable. Many petroglyphs, and cupules especially, have often been reworked at later times.

## OSL dating of soil samples

The EIP project team of Indo-Australian scientists collected seven soil samples in 2002, three from V.N. Misra's trench in III F-23, one from V.S. Wakankar's trench in the adjoining Auditorium Cave, III F-24, and three from Daraki-Chattan for OSL (optically stimulated luminescence) dating in Australia. These were processed and analysed by Richard G. Roberts in the Department of Earth Sciences in Wollongong University, Australia. Three more soil samples were collected from lower layers of DC in 2004. These are still awaiting analysis by Ashok Sahni in the Physical Research Laboratory, Ahmedabad, in India.

The obtained OSL estimates are as follows (C = central age, M = minimum age):

| | | |
|---|---|---|
| BH-1 | Lower layer, Late Acheulian | (C) 94 ± 11 ka |
| | | (M) 47 ± 4 ka |
| BH-2 | Change Acheulian to Middle Palaeolithic | (C) 106 ± 20 ka |
| | | (M) 41 ± 12 ka |
| BH-3 | Change Middle Pal. to Upper Pal. | (C) 45 ± 8 ka |
| | | (M) 17.9 ± 1.5 ka |
| BH-4 | Acheulian, contaminated, Wakankar's trench | (C) 61 ± 13 ka |
| | | (M) 20.6 ± 1.5 ka |
| DC-1 | (C) 9.4 ± 1.9 ka | (M) 3.04 ± 0.43 ka |
| DC-2 | (C) 8.4 ± 1.9 ka | (M) 3.59 ± 0.45 ka |
| DC-3 | (C) 11.8 ± 2.4 ka | (M) 5.16 ± 0.54 ka |

All the three samples from Daraki-Chattan (DC) are from pseudo-layer 3.

Roberts states that the OSL dating method is a complex process. A lot of factors have to be taken into consideration. At this stage we can say that the burial age of the samples from Bhimbetka and Daraki-Chattan are older than the minimum age model estimates, but we cannot discount the possibility that they are also older than central age model estimates (Roberts in Kumar *et al.* 2005: 61-63).

The collection of three soil samples for OSL dating from Misra's trench in III F-23, adjacent to Auditorium Cave, yielded three impeccable samples (Fig. 9). Their primary purpose was to establish the supposed change from the Lower to Middle Palaeolithic industries at the site. The excavated sediment column at the site is 3.55m high. Sample BH-1 (Late Acheulian) was secured from near the base of the excavation. Sample BH-2 was collected from the level at which the change to Middle Palaeolithic is thought to have occurred, and BH-3 comes from the middle to upper portion of the Middle Palaeolithic horizon. Their preliminary results as given above pose some obvious problems. If we use as a discussion basis the central and minimum values, they suggest an unexplained inversion between the first and the second sample. While the suggested transition to the Middle Palaeolithic at 106±20 ka is certainly much later than expected (a more realistic figure would be 160 ka), a variety of scenarios could be invoked to explain the result. However, the result of 94±11 ka for the lowest sample, collected 2.3m immediately below the other (BH-2), is a conundrum. The intervening sediments are undisturbed and heavily consolidated, partially cemented with increasing depth. Only the result of the uppermost sample (BH-3) of about 45 ka, meets reasonable expectations. We are at a loss to explain these contradictions and will endeavour to look further into these issues.


**Fig. 9.** Showing the location of three holes in Misra's trench at Bhimbetka from where soil samples BH-1, BH-2 and BH-3 were taken for OSL dating in 2002. Note the long distance between sample holes BH-1 and BH-2.

The situation at Daraki-Chattan is much as expected. Here the excavations have been conducted in front of the cave entrance, which is subjected to rainwater flow from inside the cave and runoff from the cliff, as well as direct precipitation. The excavations revealed that percolating rainwater drains towards the northwest. In doing so it tends to mobilise the finest sediment fractions, while the coarser material remains in situ. The fine fractions are replaced with more recent material migrating through the sediment. Hence, the relatively young OSL dates for the DC samples from the upper layer refer to recycled recent soil rather than the original deposit. We have not yet secured any OSL results from the lower strata at DC.

## AMS $^{14}$C dating of silica accretions

Alan Watchman of the EIP project team collected silica accretion samples from the rock surface on and off cupules on the northern wall of Daraki-Chattan. The samples, which were a mixture of amorphous silica and dead micro-organisms, were analysed to determine their carbon isotope ratios by AMS dating. The dates obtained for lower, middle and upper layers are 1920±60 (OZH031), 1590±80 (OZH031) and 250±50 (OZH030) radiocarbon years BP respectively (Watchman in Kumar *et al.* 2005: 63-65).

In order to establish why such comparatively young dates were secured from the silica accretions, G.K. examined the minute details of the cave walls from 12 to 14 June 2006, and observed that the surface surrounding the cupule has been continuously exfoliating in very thin layers. As the older accretionary deposit exfoliates, a new process of encrustation follows (Fig. 10). Hence the deposit that had been sampled was the most recent in a sequence of cycles in which the exfoliation of mature deposits is followed by the establishment of fresh deposits (Kumar 2006: 55).

An additional problem with the $^{14}C$ dating method applied to rock substrates is that their carbon system tends to be open, rendering them susceptible to contamination by younger carbon from a variety of sources (Bednarik 1979).

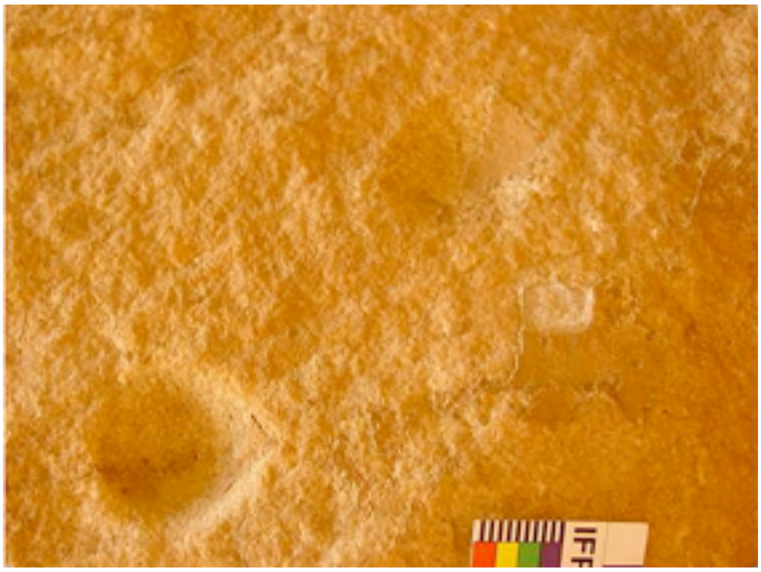

**Fig. 10.** Showing the exfoliated surface near the cupule and amorphous silica accretion with dead micro-organisms deposited on it, from where Alan Watchman took sample for AMS $^{14}C$ dating.

## U-Th dating

With this experience we decided to opt for a more promising method of direct dating of petroglyphs that would cover their predicted age range. We observed ferromanganeous accretions deposited on stratified boulders of the lower sediments in the excavation of Daraki-Chattan, as well as concealing excavated petroglyphs. There is a good probability that the deposit on the petroglyphs contains uranium, which might render it susceptible to U-Th dating. Because it estimates an average of the time of duration required by the process of deposition of the accretion (which covers the petroglyphs), it can only provide approximate ages for the deposit, and not estimates of the petroglyph ages. Having this fact clear in mind we invited Sunil Singh, the Head of the Chemistry Laboratory of the Physical Research Laboratory, Ahmedabad, to sample these deposits at DC. Singh visited the site along with his assistant, W. Rahaman, on 23 and 24 February 2009. G.K. opened the trench for him and brought out the boulder bearing ferromanganeous accretions deposited over two linear petroglyphs. Singh collected eight samples, six from the deposit on petroglyphs (Fig. 11-12) and two from a boulder lying in pseudo-layer 5 in the trench. The results are expected shortly.

**Fig. 11.** Prof Sunil Singh, Physical Research Laboratory, Ahmedabad, taking ferromanganeous accretion samples for U-Th dating. The samples were taken from a linear petroglyph obtained in layer 3 in the excavation in DC.

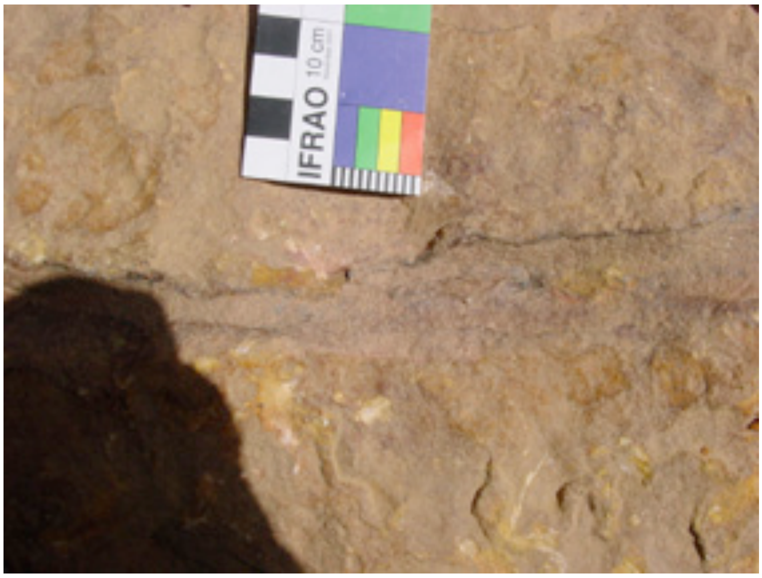


**Fig. 12.** The locations from where ferromanganeous accretions samples were taken from a linear petroglyph from DC.

## Comments

Establishing the antiquity of Lower Palaeolithic petroglyphs in terms of absolute dates is a difficult task. We have experimented with the OSL, AMS $^{14}$C and microerosion methods. We are also trying the U-Th method. So far we have only secured minimum ages, some of which are extremely conservative. We have not determined the actual time of the execution of the petroglyphs, which according to the distribution of exfoliated rock slabs with detached cupules and the presence of the cupule-making hammerstones in the Oldowan-like industry must be of Lower Palaeolithic provenience. So the obtained minimum dates are irrelevant, particularly in the case of Daraki-Chattan. The only satisfactory result is a conservative indication that the Lower Palaeolithic petroglyphs at Bhimbetka are much older than 100 ka.

Secondly, the laboratories analysing materials such as accretions can give estimations of the ages of such features directly related to the rock art, but not the actual date of the artefact in question. Hence, scientists working on obtaining dates for Lower Palaeolithic petroglyphs have to consider many complicating factors. With increasing antiquity of the art object or artefact, taphonomic issues become more crucial and must be clarified properly. The possibility of survival and finding evidence of palaeoart activity of such great antiquity becomes incredibly remote with increasing age. Further, we have to make sure that we are studying the original ancient surface of a petroglyph, which is almost impossible in the present case, or in the case of an exfoliating surface. In Daraki-Chattan the surface has experienced a regular series of deposition and micro-exfoliation as well as large-scale exfoliating through insolation. These processes are continuing today. Finally, all radiometric dating methods are subject to specific sets of qualifications and limitations; they provide scientific propositions, not factual information, and always need to be tested.

## CONCLUSION

From the above discussion it becomes very clear that the EIP project has produced unambiguous evidence of Lower Palaeolithic petroglyphs at two sites in India. This is evident from the archaeological excavations at Bhimbetka and Daraki-Chattan. Our efforts to use various dating methods in this regard have failed so far, particularly at Daraki-Chattan. As rock art scientists we have to continue our efforts of exploring and try other methods in future. We are awaiting the results of the U-Th method and we are exploring the possibility of using the $^{26}Al$-$^{10}Be$ cosmogenic method. Until satisfactory results can be secured we can only rely on the traditional archaeological evidence we have obtained.

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