KEYWORDS: ***Petroglyph – Cupule – India – Lower Palaeolithic – Chronology – EIP Project***

PRELIMINARY RESULTS OF THE EIP PROJECT

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Abstract. The primary rationale of the Early Indian Petroglyphs Project is to investigate claims of the occurrence of Lower Palaeolithic petroglyphs in central regions of India. Other purposes of this multifacetted research project are to provide new data for the chronology of the Middle and Late Pleistocene hominin history of India; to introduce scientific methods of rock art dating in this country; and to investigate its Lower Palaeolithic stone tool industries. This project, a collaboration of Indian and Australian researchers, was commenced in 2001. It involves archaeological excavations, a range of analytical studies and intensive field surveys, and it will continue for several more years. Since its findings are of considerable significance it would not be appropriate to defer the publication of all details until after its completion. The present paper is a detailed progress report of this work, offering an overview of its theoretical base and presenting its first tangible results. They indicate that Lower Palaeolithic petroglyphs have been located at two sites, and may exist at a few others not yet adequately investigated. These initial results also provide the first datings of Indian rock art, secured from many sites of petroglyphs and pictograms in various parts of central India.

Introduction

Disciplines such as palaeoanthropology and Pleistocene archaeology are often susceptible to fads induced by spectacular finds, which is probably due to the inherent uncertainties governing these disciplines. There is a pattern of over-reaction when new discoveries are accepted, sometimes not warranted, and sometimes leading to neglect of alternative possibilities. An example is the preference of Africa as the sole arena of human evolution that developed since the important east African finds, initially by the Leakeys and others working with them. Prior to the 1950s, Asia shared with Africa the status of likely locus of initial human evolution. Since then the case for an Asian contribution to human evolution seemed to correspondingly diminish with every new find made in the Rift Valley and elsewhere in Africa.

It may well by correct that hominoids originally arose in Africa — though not necessarily in east Africa — but neglecting alternative possibilities is not a scientific procedure to test this proposition. The geographical distribution of found and reported hominin remains is not a reflection of actual populations, it merely reflects taphonomic factors, such as the presence of suitable preservation conditions (alkaline and volcanic sediments), serendipitous erosion of fossil strata and the relative intensity of relevant research activities. It is obvious that hominin remains have been recovered only where particularly suitable sedimentary conditions apply, such as rapidly laid down ash layers, loess terraces or limestone cave deposits. They have not been recovered in other geological environments. Unless one made the absurd assumption that hominins avoided regions where their remains would have no chances of preservation, we have to accept that distribution maps of hominin finds are of suitable regional geologies, and not of hominin distribution.

Similarly, it has not been demonstrated satisfactorily that all of human evolution occurred in Africa, from where successive waves of hominins are said to have colonised the world. This is biologically unlikely and the evidence from eastern Asia contradicts it consistently. Hominins existed at least in China and Georgia by the end of the Pliocene (Huang and Fang 1991; Huang et al. 1995; Ciochon 1995), but we do not know how much earlier they arrived or where else they occurred. As creatures of tropical latitudes, hominins were in no position to adapt to cool climates such as that in China or, in the Middle Pleistocene, northern central Europe, unless they had cultural means of coping with such environments. These could have included clothing, fire use, shelter construction and social structures.

Unless we assumed that *Homo habilis* or *ergaster* hominins reached eastern Asia via Siberia we have no choice but to accept that they colonised southern Asia, and most specifically, the Indian subcontinent, before they could have reached China, Java or Flores. On the basis of the fossil record as it stands, essentially erectoid hominins seem to appear in Africa as well as eastern Asia at the very same time, during the Plio-Pleistocene (Swisher et al. 1994). In whichever direction these presumed migrations took place, we should assume that India was greatly involved, and that India has been occupied by humans at least since the first appearance of *Homo erectus*, if not earlier. Yet the Indian subcontinent has been much neglected in palaeoanthropological research, despite the much earlier presence there (and at several other sites in Eurasia) of *Ramapithecus*.

Even more disturbing should be the way in which we have come to be accustomed to think of hominin evolution as a process that concerns largely or only the species' physical changes through time. The study of physical evolution of hominins is concerned mainly with the development of cranial architecture, and to a lesser extent with issues of body posture and other post-cranial evidence. The non-physical evolution of humans, i.e. the cognitive, intellectual and cultural changes they experienced, is completely ignored in this practice. We are not speaking in favour of a humanistic viewpoint here, or suggesting that humans need to be studied by different standards than other animals. Rather, we point out that such factors as technology or symbolling became major evolutionary selection criteria, hence to ignore them seems to defeat the purpose of the investigation. There can be little doubt that, at some stage in hominin evolution, such factors as the ability to create models of reality or 'consciously' selecting breeding partners must have appeared, because they existed in historical times but are not thought to have been present in the Pliocene ancestors. In no other genus do such factors as technological or cognitive competence play any significant selective role, if indeed any at all. Yet in the human, they far outweigh traditional selection criteria (e.g. camouflage, tolerance to toxins, body weaponry, plumage) in determining evolutionary success. The processes of humanisation were in all probability much more determined by the complex ethology of hominins and by powerful factors largely unrelated to physical development. The defining characteristics of humans and their evolution have largely been disregarded in pursuing the two main preoccupations of palaeoanthropology, hominin origins and the emergence of modern humans. There is, contrary to much writing on this subject, not one iota of evidence that the appearance of what is often described as 'modern human behaviour' appeared together with physical 'modern' traits. On the contrary, these two features are almost certainly unconnected and appeared separately. Yet throughout recent work in human evolution, there is a usually unstated expectation that the origins of modern humans will also provide us with a master key for opening all secrets of the non-physical evolution of hominins. This is clearly a fallacy, as much so as a similar belief of previous centuries that cultural superiority was racially determined. The people who promoted these views yesteryear were equally wrong, and it is hard to believe that these notions remain still ingrained in mainstream archaeology.

Moreover, it is becoming increasingly apparent that much of non-physical human evolution may have occurred outside of Africa, and in particular southern Asia is a region in need of special attention in that context. For instance, it was apparently here that *H. erectus* took to the sea around a million years ago, perhaps first in what today is Indonesia (Bednarik 1995a, 1997a, 1999a). The almost complete absence, east of Wallace's Line, of land-bound eutherians larger than small rodents indicates, as Wallace (1890) correctly deduced, that there was never a land-bridge to the geologically very young islands of Nusa Tenggara (Lesser Sunda Islands). Proboscideans and hominins are the notable exceptions, and in the case of the former we know that they can swim more than twice the distance any other land mammal can (Bednarik and Kuckenburg 1999). But humans lacked their trunks and buoyancy, and the fact that no other species made it across on vegetation matter suggests that *H. erectus* used something that was not available to other animals: a propelled watercraft. Without propelling power, nobody can cross sea straits, because of their strong transverse currents. Any archaeologist disputing this is obliged to disprove the proposition by demonstration (cf. Morwood and Davidson 2005).

Early seafaring, however, is far from being the only evidence suggesting that southern Asia could have been a hub of cognitive development in hominins. For instance, some of the earliest recorded use of pigment and presumed collection of crystal prisms comes from India. Among the numerous haematite pebbles from the Lower Acheulian of Hunsgi, Karnataka (Paddayya 1976, 1979, 1991; Paddayya and Petraglia 1996/97), one was found to bear an abrasion facet that indicated that it had been rubbed against a hard rock surface, apparently in the fashion of a crayon (Bednarik 1990a). Another Indian find of relevance are six tiny but complete quartz crystals from the Lower Acheulian of Singi Talav, Rajasthan (Gaillard et al. 1990), which are much too small to have served as stone tool material (d'Errico et al. 1989). They are assumed to have been collected from different localities, purely for their visual properties, and not for utilitarian reasons. This implies a rudimentary appreciation of 'special qualities', or discrimination of ordinary from exotic objects, and the use of haematite and ochre pigments implies symbol use (Bednarik 1990b). Another factor of relevance is that the stone tool assemblages of Indonesian seafaring hominins of the end of the Early Pleistocene, and those found from the same time in north-western Africa (the Strait of Gibraltar may have also been crossed then; Bednarik 1999b) are among the technologically most developed of the period. These and other aspects suggest southern Asia, a geographically central region, was where much of cognitive human evolution occurred (Bednarik 1995b: 628). Southern Asia may have given rise to very early human achievement of such magnitude that many archaeologists are still unprepared to accept it today.

The discovery of the oldest known rock art in the world in India, the subject of this paper, adds yet another intriguing dimension. But it also highlights the neglect of Palaeolithic studies in the subcontinent, and the need for a greatly improved effort in exploring the Pleistocene history of that region. It is possible that the technological, cognitive and cultural development of hominins occurred primarily in the major centres of human occupation, such as southern Asia, the Middle East and parts of Africa. It is less likely to have occurred in peripheral regions, such as the geographical cul-de-sac of south-western Europe, as the orthodox and neo-colonialist model would prefer. The evidence currently available projects southern Asia as a prime candidate for such developments, as a hub of non-physical evolution. However, the Lower Palaeolithic of India lacks even a rudimentary chronology, and its early phases, especially the cobble tool industries, have been neglected severely. Palaeolithic research in the subcontinent needs a new impetus, a new dynamism. Hominin research has been focused on Africa long enough, and has been very productive. It is now time to shift the centre of attention to southern Asia — if only to prevent our geographical bias from formulating and preferring a distorted paradigm.

Reviewing the Lower Palaeolithic of India
R. G. Bednarik

When we consider the Lower Palaeolithic period globally, we find ourselves referring to some quite specific constructs as they have been promoted in world archaeology. For instance, we might think of an immensely long period of time during which there was supposedly very little cultural or technological development. This tends to prompt us to see this as evidence indicating that there was also very little cognitive and intellectual evolution during this lengthy period. In this sophism we ignore that in the ethnography of recent populations, such as Australids, such technological conservatism usually has other reasons, and is no indication at all of non-technological status. Another dominant concept is that the Lower Palaeolithic begins in Africa, especially eastern Africa, and expands first to Asia, then to Europe. Africa remains the focus of hominin evolution, and it remains the source of all important developments in this process up to the appearance of essentially modern humans, still in that continent.

In broadest terms, this is the kind of initial mindscape characterising how we tend to perceive the Lower Palaeolithic. When we look at it more closely, we make out some of the details that have contributed to formulating this dominant construct: the few specific stone tool traditions that are being identified, especially the Acheulian. Other perceived traditions, such as the Oldowan, Clactonian, Soanian, Abbevillian and Tayacian, are even less definitive and sometimes quite nebulous formulations. We also relate specific human fossil remains to this coarse framework. But when we consult our models for greater detail, about how the people of the Lower Palaeolithic really lived or what their various abilities were, we find that there is extensive disagreement.

Indeed, the spectrum of views is so great here that it includes literally all possible options. At one extreme end we have models such as that of Davidson and Noble (1990), who ‘propose that all human ancestors [prior to moderns] should be considered as apes, closer to chimpanzees than to humans’. At the other extreme we have views that grant these hominins largely modern human capacities. In other words, their cognitive status is to be found somewhere between that of apes and that of *Homo sapiens sapiens*. It is immediately obvious that we could have arrived at this finding without the help of archaeologists, and if this is all they have come up with, after a couple of centuries of investigation, then there seem to be some serious deficiencies in the way archaeology operates. This kind of interpretational latitude would not be acceptable in disciplines less than half the age of archaeology, for instance, in ethology or plate tectonics.

Before tackling this ambitious task of bringing into focus the relevance of India to world palaeoanthropology it is most appropriate to review the basic knowledge we currently have about the Middle Pleistocene (and earlier) hominin occupation of this country. Although the Lower and Middle Palaeolithic stone tool traditions are widespread (Petraglia 1998), represented in massive quantities and typologically well explored in India (Korisettar 2002), their absolute chronology has remained largely unresolved so far. This is due both to a paucity of excavated sites (most known sites are surface scatters) and a pronounced lack of well-dated sites. Prior to the excavation of three Bhimbetka sites in the 1970s, only one primary Acheulian site had been excavated in India (Bose 1940; Bose and Sen 1948). There are some preliminary indications that the Middle Palaeolithic commenced prior to 160 ka (160 000 years) ago. At Didwana (V. N. Misra et al. 1982; V. N. Misra et al. 1988; Gaillard et al. 1986; Gaillard et al. 1990), thorium-uranium dates for calcrete associated with Middle Palaeolithic industries (V. N. Misra 1989) range from 144 000 years upwards. Their validity is reinforced by a thermoluminescence date of 163 000 ± 21 000 years BP from just below the level dated by ^{230}Th/^{234}U to 144 000 ± 12 000 years BP. A single thermoluminescence date for a Middle Palaeolithic deposit in a sand dune in Rajasthan has been reported to be >100 000 years BP (Korisettar 2002).

Another indicator of age comes from the Jhalon and Baghor formations in the central Narmada and Son valleys, rich in mammalian faunal remains and stone tools. They contain a layer of Youngest Toba Ash, up to 3 m thick (Acharyya and Basu 1993), which has been dated at 74 000 ± 2000 years BP in Indonesia, based on argon and potassium-argon determinations (Chesner et al. 1991). At the upper end of the time scale, carbon isotope dates as young as 31 980 + 5715/ - 3340 (Mula Dam, Maharashtra) and 33 700 + 1820/ - 1625 years BP (Ratikarar, Madhya Pradesh) have been reported for Middle Palaeolithic horizons (V. D. Misra 1977: 62).

Prospects for a comprehensive temporal framework are at least as bleak for the Lower Palaeolithic period, which is represented primarily by Acheulian industries. However, this dominance of Acheulian forms may well be an artefact of collecting activities that may have favoured the easily recognisable Acheulian types, notably well-made handaxes. Several attempts to use the thorium-uranium method, at Didwana, Yedurwadi and Nevasa (Raghvan et al. 1989; Mishra 1992), placed the Acheulian beyond the method’s practical range (which ends at about 350 ka BP). But one of the molars from Teggihalli did yield such a date (of *Bos*, 287 731 + 27 169/ - 18 180 ^{230}Th/^{234}U years BP), as did a molar from Sadab (of *Elaphus*, 290 405 + 20 999/ - 18 186 years BP) (Szabo et al. 1990). However, an *Elaphus* molar from the Acheulian of Tegihalli is over 350 ka old. An attempt to estimate the age of a presumed Acheulian cupule in Auditorium Cave, Bhimbetka, by microerosion analysis remained inconclusive because the age was also beyond that method's limit, which is thought to be in the order of 100 ka in this particular context (Bednarik 1996).

While the Lower Acheulian remains essentially undated, preliminary indications suggest a late Middle Pleistocene antiquity for the Final Acheulian. Thorium-uranium dates from three calcareous conglomerates containing Acheulian artefacts suggest ages in the order of 200 ka (Korisettar 2002). These results are from the sites Nevasa (Pravara Basin), Yedurwadi (Krishna Basin), and Bori (Bhima Basin). The most recent date so far for an Indian Acheulian deposit is perhaps the uranium-series result from a conglomerate travertine in the Hunsgi valley (Karnataka), which seems to overlie a Late Acheulian deposit (Paddayya 1991). The travertine's age of about 150 ka at Kaldevanahalli appears to confirm that the change from the Lower to the Middle Palaeolithic occurred between 200 and 150 ka ago.

In addition to these very sparse dates from the earliest periods of Indian history, there are several presumed 'relative datings', but these were always subject to a variety of qualifications. Early research emphasised the relation of artefacts to lateritic horizons (but cf. Guzder 1980) and biostratigraphic evidence (de Terra and Paterson 1939; Zeuner 1950; Badam 1973, 1979; Sankalia 1974), which often resulted in doubtful attributions. Sahasrabudhe and Rajaguru (1990), for instance, showed that there were at least two episodes of laterisation evident in Maharashtra and that extensive fluvial reworking occurred. Attempts to overcome these limitations included the use of fluorine/phosphate ratios (Kshirsagar 1993; Kshirsagar and Paddayya 1988–89; Kshirsagar and Gogte 1990), the utility of which was affected by issues of re-deposition of osteal materials (cf. Kshirsagar and Badam 1990; Badam 1995). Similarly, attempts to use weathering states of stone tools as a measure of the antiquity of lithics (e.g. Rajaguru 1985; Mishra 1982, 1994) are plagued by the significant taphonomic variables involved in weathering processes (cf. Bednarik 1979). The emergence of anomalous results and inconsistencies established in recent years illustrates a distinct need for a chronological framework based on a series of reliable numerical age estimations, especially from undisturbed Lower and Middle Palaeolithic occupation deposits.

There remains wide disagreement about the antiquity of the Early Acheulian. Based on the potassium-argon dating of volcanic ash in the Kukdi valley near Pune to 1.4 million years ago, some favour that magnitude of age for the earliest phase of that 'tradition' (S. Misra and Rajaguru 1994; Badam and Rajaguru 1994). An age of well over 400 ka seems also assured by thorium-uranium dating (S. Misra 1992; S. Misra and Rajaguru 1994). Others, especially Acharyya and Basu (1993), reject such a great antiquity for the Early Acheulian in the subcontinent.

By the time we arrive at the earliest phase of human presence in India, the available record fades into non-existence. It consists of a few tantalising mentions of archaic cobble tools, similar to those of the Oldowan, well below Acheulian evidence and separated from it by sterile sediments at the first site it was described stratigraphically (Wakankar 1975). These quartzite tools from Auditorium Cave at Bhimbetka are partially decomposed and have not yet been studied in any systematic way. Since it is logical to expect human occupation evidence in India for at least 1.8 million years, it is to be expected that cobble tools should precede the bifaces of the Acheulian, and one would have assumed that these have attracted some attention. In reality, they have remained practically ignored. While it may be justified to argue that much of India presents sedimentary facies that are less than perfect for the preservation of osteal remains, which may explain the dearth of skeletal remains, this should not prevent the preservation of stone tools. Yet undeniably the first phase of human presence, perhaps the entire first half of human occupation of India, remains in effect archaeologically unexplored.

The need for a secure chronological reference frame for the earliest Indian history is not merely a local, south Asian issue, it is an issue of global relevance. As noted above, the presence of early hominins in eastern Asia renders it almost inevitable that they also occupied India before they could have colonised the eastern regions (i.e. if we make the reasonable assumption that hominoids initially evolved in Africa). Their development of maritime navigation about a million years ago in Indonesia as well as the relative sophistication of stone tool traditions in Flores and Timor (Bednarik 1995a, 1997a, 1999a, 2000; Bednarik and Kuckenburg 1999; Morwood et al. 1999) are of importance to questions of the cognitive and technological development of hominins. The proposition that very early palaeoart traditions developed in southern Asia adds further impetus to the idea that while Africa may have been the engine house of physical human evolution, at least initially, southern Asia was a hub of cognitive and technological evolution. But in comparison to the archaeological attention lavished on eastern Africa, the Levant and southwestern Europe, the Pleistocene human history of India has been significantly neglected. Yet its potential in illuminating key issues of hominin development may well be unequalled anywhere in the world. Our project intends to improve our understanding of the chronology of these early developments.

The only two hominin fossil specimens of Asia found between the Levant and Java, the Narmada calvaria (Fig. 1) and clavicle (Fig. 2), were both recovered at Hathnora (H. de Lumley and Sonakia 1985; Sankhyan 1999), about forty kilometres south of Bhimbetka, where Acheulian petroglyphs were first identified (see below). The partially preserved cranium was initially described as *H. erectus narmadensis* (Sonakia 1984, 1997; M.-A. de Lumley and Sonakia 1985), but is now considered to be of an archaic *Homo sapiens* with pronounced erectoid features (Kennedy et al. 1991; Bednarik 1997a). Its cranial capacity of 1200 to 1400 cubic centimetres is conspicuously high, especially considering that this is thought to be a female specimen. The clavicle, however, is clearly from a 'pygmy' individual, being under two thirds of the size of most modern human groups. It is of an individual of a body size similar to *Homo floresiensis*. Both specimens are among the most challenging hominin finds ever made, yet both remain widely ig-

Figure 1. *The Middle Pleistocene Narmada cranial fragment, Hathnora, south of Bhopal, central India.*

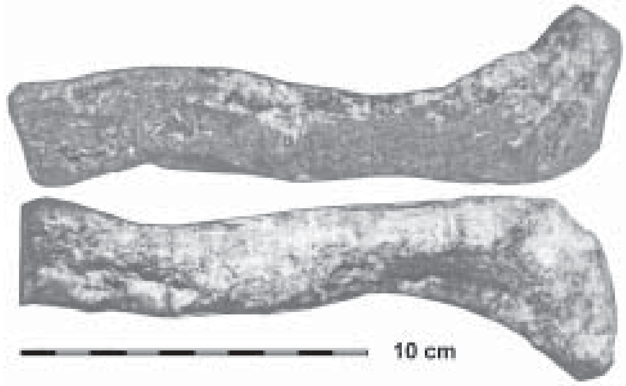

Figure 2. *The Middle Pleistocene Narmada clavicle from Hathnora.*

nored. There is, however, no evidence to show that the two finds are of the same individual, or even of the same subspecies. They simply co-occurred in the Unit I Boulder Conglomerate of the Hathnora site (H. de Lumley and Sonakia 1985). The rich accompanying fauna implies a middle or late Middle Pleistocene age for the hominin finds. It comprises three Elephantidae, five Bovidae, a hippopotamus, a horse, a pig and a cervid. The equally rich stone tool assemblage from the same unit consists of Late Acheulian to Middle Palaeolithic tools. The stratum extends elsewhere along the central Narmada valley and is generally rich in Middle and Late Acheulian industries, featuring a large number of handaxes, cleavers and discoids.

The hominin-bearing sediment at Hathnora has been suggested, without much tangible evidence, to be in the order of 200 000 years old. The only secure age information comes from a series of palaeomagnetic determinations, according to which the entire relevant sediment sequence at Hathnora is of the Brunhes Normal Chron, hence the human remains must be younger than 730 ka (Agrawal et al. 1988, 1989). On the other hand it is unlikely that they are under 150 ka old. Within this rather long interval, both tool typology and fauna point to the uppermost time zone. Having examined the Narmada calvaria I consider that its most likely age is in the order of 200 ka, because its essentially modern cranial volume renders a greater age highly unlikely. I am amazed that in the recent claims concerning another Pleistocene pygmy, *Homo floresiensis*, the existence of these Indian specimens was entirely ignored (Morwood et al. 2004). The tenor of the description of this Indonesian species on the tenuousness of current palaeoanthropological models of hominin evolution in Asia would have gained much support from the Narmada 'dwarf' species. But the authors were apparently unaware of this find's relevance, and in accepting the spin doctors' hobbit spin ignored the real heuristic potential of the issue. After all, *H. floresiensis* is merely an endemic island species, easily explained as such, and of no major consequence to pan-Asian evolutionary history. Narmada's hominins, on the other hand, pose significant interpretational challenges: how can we account for the fact that the only hominin fossil from such a huge land area combines the cranial architecture of *H. erectus* (massive supraorbital torus, slight occipital bunning and post-orbital constriction; Bednarik 1995b, 1997a) with a cranial capacity exceeding that of modern humans? That palaeoanthropology has not addressed this phenomenon in any sustained fashion provides much stronger evidence for its inability to formulate a plausible model than a possibly endemic, marginal population on a small island. The obvious answer is that we have, realistically, not the faintest idea of the course of Asian hominin evolution, because major chapters have yet to be written about it. In these circumstances the African emphasis in palaeoanthropology is inopportune and counterproductive.

The coincidence of the geographically very isolated Narmada hominins, distinguished respectively by exceptional brain size and pygmy size, with the earliest known petroglyphs, spatially and quite possibly chronologically, is a tantalising aspect of the evidence as it currently stands. Could there be merit in speculating why the earliest rock art known in the world happens to occur in the same area as these important and yet almost completely neglected human specimens?

The early rock art of India

R. G. Bednarik

Whenever we read of the early rock art of the world, the first region and often the only region finding mention is the Franco-Cantabrian cave art province of northern Spain and southern France, with its famous corpus of Upper Palaeolithic cave art. Few publications even mention that Pleistocene rock art may exist elsewhere, and almost always the details remain elusive. This already illustrates a significant Eurocentric bias, because the largest body of surviving Ice Age rock art is almost certainly that of Australia. In that continent alone, many thousands of sites include what is thought to be a component of Pleistocene petroglyphs, numbering perhaps in the hundreds of thousands of motifs. Not only is this body very much greater than that of the European cave art, it is of cultures belonging to a Middle Palaeolithic rather than an Upper Palaeolithic technological mode (cf. Foley and Lahr 1997). Even in Europe itself, we have at least one instance of

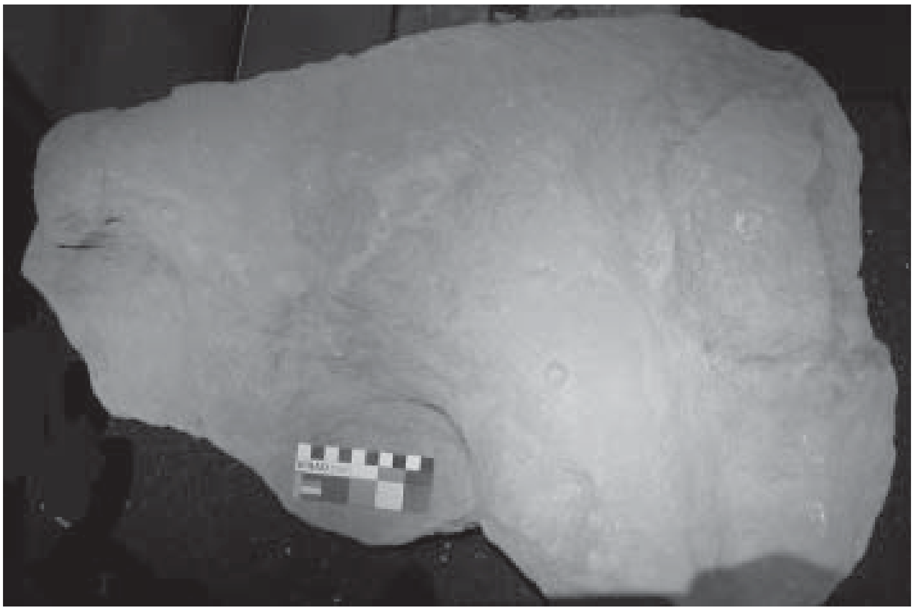

***Figure 3.** Limestone slab with cupules and other work traces, placed with the cupules on the underside over Neanderthal burial 6, of an infant, La Ferrassie cave, France.*

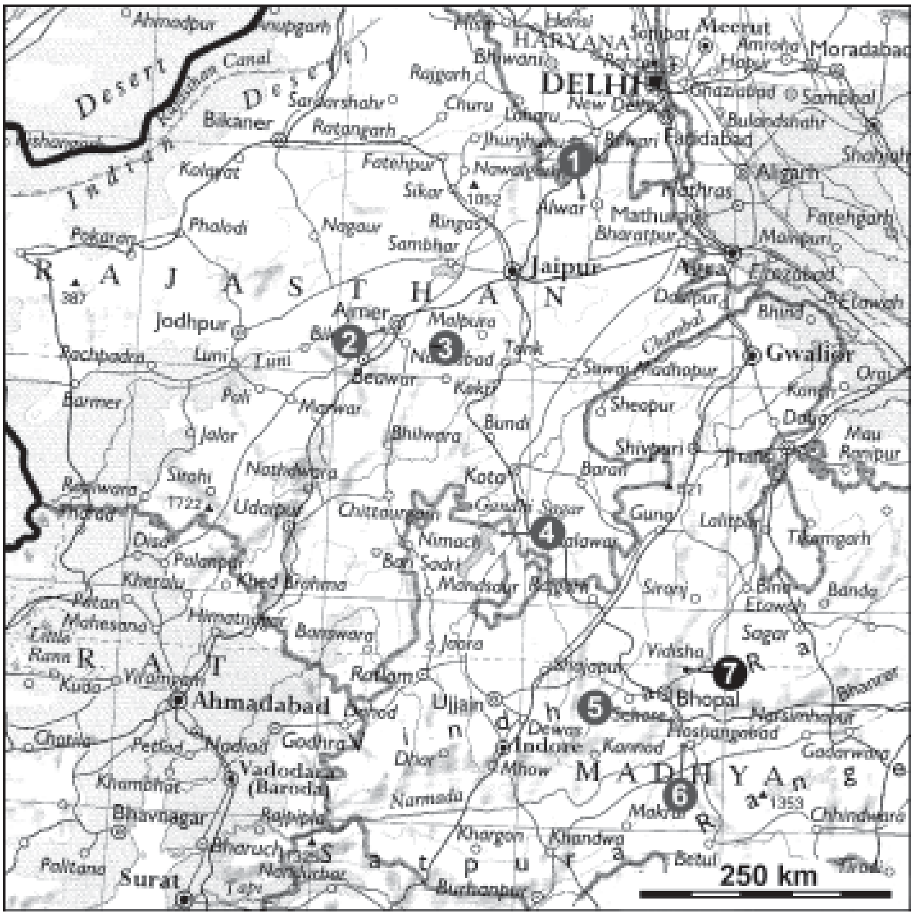

***Figure 4.** Map of central India, with principal sites mentioned in this paper: 1 - Bajanibhat, 2 - Moda Bhata, 3 - Morajhari, 4 - Daraki-Chattan, 5 - Bhimbetka, 6 - Hathnora, 7 - Raisen.*

Middle Palaeolithic rock art, the eighteen cupules that covered the underside of a large limestone slab (Fig. 3) placed on top of La Ferrassie burial No. 6, the grave of a Neanderthal infant (Peyrony 1934). This, however, is an isolated case, whereas in other continents, pre-Upper Palaeolithic rock art and portable palaeoart is much more common (Bednarik 1992a, 1993a, 1994a, 2001a, 2002a, 2003).

While we have huge numbers of Middle Palaeolithic rock art motifs, mostly from Australia, the incidence of Lower Palaeolithic cases remains, admittedly, very rare, and confirmed cases of it remain limited to India. Nevertheless, the very first Middle Palaeolithic seafarers that reached Australia, perhaps in the order of 60 000 years ago, may have brought with them a tradition of rock art production (Bednarik 1993b). These mariners are thought to have ultimately originated in southern Asia, hence it is relevant that the earliest rock art we have in Australia is precisely of the same type as the earliest rock art we know of in India. It consists exclusively of simple petroglyphs, among which cupules (cup marks) predominate to the point of excluding almost all other types. Moreover, the oldest rock art of Africa, at present presumed to be in the southernmost part of that continent, also consists mostly of cupules (Bednarik 2002a, 2003). So does the earliest rock art of North America, of South America, and as we have seen above, of Europe. Yet if we examine the world literature on art origins, this kind of distinctive pattern is not conveyed in it, which illustrates that this literature is fundamentally flawed.

In central India (Fig. 4), no petroglyphs were reported until quite recently, and it appears that there had been no previous attempt to locate any (Bednarik et al. 1991). In 1990 eleven petroglyphs were observed in Auditorium Cave, the natural focus of the large rock art complex of Bhimbetka, which otherwise consists entirely of rock paintings. Two of the petroglyphs, a cupule and a meandering line (Fig. 5), had been excavated by V. S. Wakankar in an Acheulian occupation deposit directly covering them (Bednarik

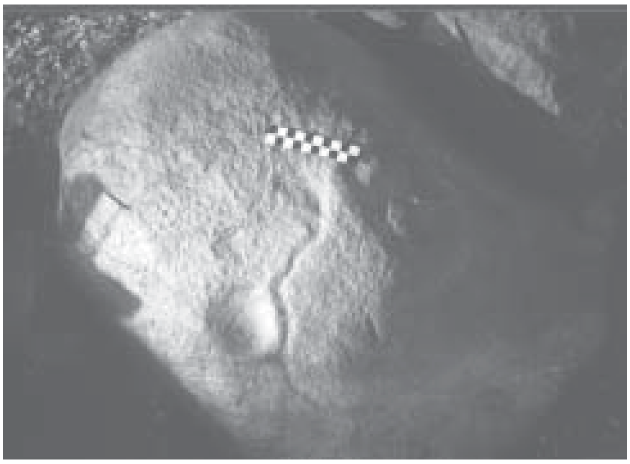

Figure 5. *Two percussion petroglyphs on boulder in Acheulian layer, Auditorium Cave, Bhimbetka.*

1993a, 1994a, 2001a, 2003; Chakravarty and Bednarik 1997: 58–9). The overlying Middle Palaeolithic stratum is so solidly cemented by calcite deposition that the possibility of post-depositional disturbance can be ignored. However, it has been proposed that the remaining nine motifs (all cupules), although found above ground, are almost certainly of similar age (Bednarik 1996). They are located on the vertical panel of a huge boulder on the floor of the cave, called Chief's Rock (Fig. 6). The Auditorium Cave petroglyphs occur on heavily metamorphosed, extremely hard quartzite, which was extensively quarried for stone tool material in the Lower Palaeolithic. The Acheulian handaxes and cleavers at the site, and elsewhere in the Bhimbetka site complex, were made from it. The petroglyphs occur in the central part of the cave, well protected from weather, yet they are extremely corroded due to their extraordinary antiquity. An antiquity well in excess of 100 000 years is confirmed by an attempt to analyse the microerosion of one of the Auditorium Cave cupules (Bednarik 1996).

The two Auditorium Cave petroglyphs below ground were noticed before 1990 by Erwin Neumayer (1995), an Austrian specialist of Indian rock paintings, who was uncertain as to their anthropic origin. Michel Lorblanchet, a French specialist of limestone cave art, examined them in the 1990s and judged them to be natural rock markings rather than petroglyphs. In my examination I was certain that they are anthropic, but initially I remained hesitant to pronounce them so because of their obvious Acheulian age, which at the time seemed impossible to reconcile with rock art production. Only after examining the nine cupules above ground microscopically and thus realising their extreme antiquity did I gather the courage to propose the Lower Palaeolithic age of those below Acheulian sediments (Bednarik 1993a, 1994a).

Kumar (1996) has since reported a second cupule site in central India that appears to be of extremely great age. Daraki-Chattan is a small and narrow quartzite cave at the foot of a prominent escarpment. Apparent Acheulian and Middle Palaeolithic tools occur on the surface of its floor deposit. The two walls of the cave bear more than 500 cupules, and Kumar recognised that there was a realistic possibility that their age might match, or at least approach, that of the Auditorium Cave petroglyphs.

Since then, several more Indian cupule sites have been proposed to be of Palaeolithic age. They include one site

Figure 6. *East face of Chief's Rock, Auditorium Cave, Bhimbetka, with some of its nine cupules visible near the scale.*

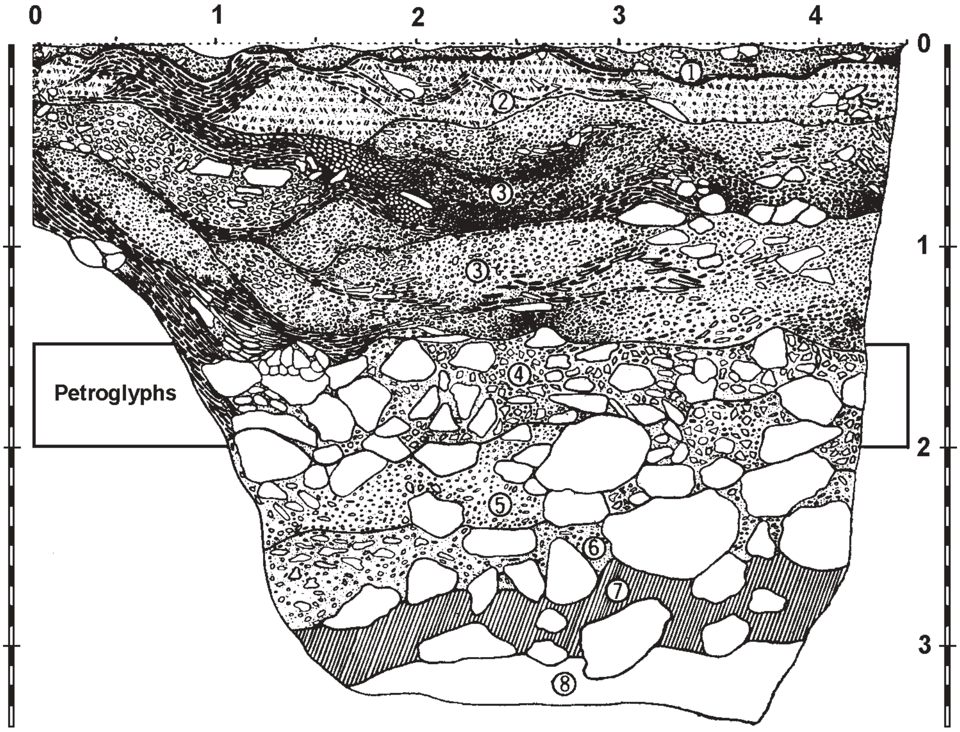

Figure 7. Stratigraphy of trench II in Auditorium Cave, Bhimbetka, according to V. S. Wakankar, with the position of the two petroglyphs shown. The sediment layers are:
1 - Loose blackish ashy earth with Historic finds,
2 - Blackish-greyish soil with Chalcolithic,
3 - Greyish-reddish soil with Mesolithic microliths,
4 - reddish soil with Middle Palaeolithic tools,
5 - reddish soil with Acheulian II,
6 - reddish soil with Acheulian I,
7 - reddish soil, archaeologically sterile,
8 - reddish soil and laterite with cobble tools.

near Kotputli, Rajasthan (Kumar and Sharma 1995), three sites near Ajmer (Kumar 1998; Bednarik and Kumar 2002), some further sites near Daraki-Chattan, and two more sites near Gandhi Sagar. These developments rendered it necessary to examine all these claims on a common basis, and to subject them to rigorous review.

The EIP Project

R. G. Bednarik

These data reported from India contradict a great deal of the current model of Pleistocene archaeology. If they were being interpreted correctly, they would re-write the history of cognitive and cultural evolution of hominins, just as the Pleistocene evidence of seafaring has recently revised the technological paradigm. It has become apparent that language should be at least a million years old, and that a largely modern form of human cognition might have developed during the reign of *Homo erectus*. Most of the evidence these new claims are based on comes from the general area of southern Asia. In view of their extraordinary importance to world archaeology it is essential that the claims concerning India's extremely early petroglyphs be examined thoroughly and critically. Mindful of this need, the establishment of a major research project focusing on the examination of these Indian data, and of an international scientific commission to compile a comprehensive dossier on these extraordinary claims, were initiated by the two principal authors of this report. We called this the Early Indian Petroglyphs (EIP) Project and in 1999 Dr Giriraj Kumar, the President of the Rock Art Society of India and I established it as joint Project Directors.

In 2000 we met in Alice Springs to assemble the EIP Commission under the aegis of the International Federation of Rock Art Organisations (IFRAO) and various other scholarly bodies, formulating a rationale for its work (Bednarik 2001b). The Commission is to investigate all matters concerning the very early rock art of India thoroughly, using methods such as carbon isotope analysis, optically stimulated luminescence dating, microerosion analysis, uranium-thorium analysis and archaeological excavation. The Commission consists of geologists, archaeologists, rock art scientists and archaeometrists from India and Australia. In the course of its work so far, members of this Commission have already conducted research at almost twenty cupule sites in Madhya Pradesh and Rajasthan, as well as at numerous other, more recent rock art sites. The fieldwork of the EIP Project was commenced mid-2001 by G. Kumar and several colleagues, and has peaked in late 2002 with an intensive campaign involving several specialists (Kumar et al. 2002). A project web-page was established at *http://mc2.vicnet.net.au/home/eip1/web/index.html*. The first tangible findings were presented at the RASI-IFRAO congress in Agra at the end of November 2004, but fieldwork has continued, and will take several more years to complete.

However, the EIP Project is not limited to the investigation of the very early petroglyphs themselves, it includes also various objectives that are of considerable importance to Lower and Middle Palaeolithic studies of India generally. Notably, it includes a concerted endeavour to provide some solid key reference dates for these periods. One of its aims is to provide optically stimulated luminescence dates for the two Bhimbetka main sites, Auditorium Cave and the adjacent Misra's Shelter (V. N. Misra 1978). These should supply reliable chronological anchor points for the late Acheulian and the Middle Palaeolithic. At Daraki-Chattan, numerous exfoliated cupule-bearing rock fragments were excavated between 2002 and 2005, together with a stone tool industry reflecting Lower Palaeolithic features (see below). As in Auditorium Cave, linear petroglyphs were also excavated on a boulder, and one in-situ cupule on the edge of a large boulder was excavated under Acheulian debris. The immense age of the extensive rock art in this quartzite cave was thus demonstrated beyond any reasonable doubt, and this confirms that the previous claims for Auditorium Cave were not precipitate. They are entirely consistent with the new evidence from Daraki-Chattan, in every possible respect.

Yet another objective of the EIP Project, and one that has already been achieved substantially, is the introduction of scientific dating of rock art generally in India. This is being achieved through the transference of rock art dating technology from Australia, including that of 'direct dating' of pictograms (paintings and drawings). In addition to attempting an improvement in the chronological framework of the Indian Palaeolithic, the project team also intends tackling further neglected key issues, such as the question of the Indian 'pebble' (more correctly 'cobble') tool occurrences. If India has been occupied by hominins longer than China, then we must assume that the occurrence of an Oldowan-type industry preceding the Acheulian is a reasonable expectation. Bearing in mind that Wakankar (1975) has reported such an industry in Auditorium Cave and that similar finds have been made elsewhere (e.g. Ansari 1970; Armand 1980), and now also in Daraki-Chattan (see below), this issue, too, requires clarification. Where cobble tools occur together with an Acheulian, they clearly predate the latter industry, sometimes being separated from it by sterile layers (in Auditorium Cave). It is therefore a further priority of the EIP Project to examine the status of the early cobble tool industries of India. This is just one further reason why Auditorium Cave has been made a principal focus of attention, because its sediments have been reported to contain a complete sequence of the main phases of hominin presence in the subcontinent, beginning with cobble tools (Fig. 7). Finally, the EIP Project is also intended to consider the issues of site preservation, protection and management.

Whatever the eventual outcome of the EIP Project will be, it is set to affect not only our concepts of Pleistocene hominin development in southern Asia, but it will influence the way we view cognitive evolution generally.

The Bhimbetka petroglyphs

R. G. Bednarik

Located in the northern fringes of the Vindhyan mountains, some forty kilometres south of Bhopal and the same distance north of the Narmada hominin site, the quartzite formations of Bhimbetka comprise 754 numbered shelters. Over 500 of these shelters contain rock paintings that have previously been attributed to various Holocene cultures, starting with the Mesolithic tradition (V. N. Misra 1978). Archaeological investigation began in December 1971, and within three years eleven shelters had been partly excavated. It was shown that some of these sites contained well-stratified sequences beginning with Lower Palaeolithic cobble tool industries, and ending with Historical deposits.

The focal geological formation of the site complex are the quartzitic sandstone towers of Bhimbetka, dominated

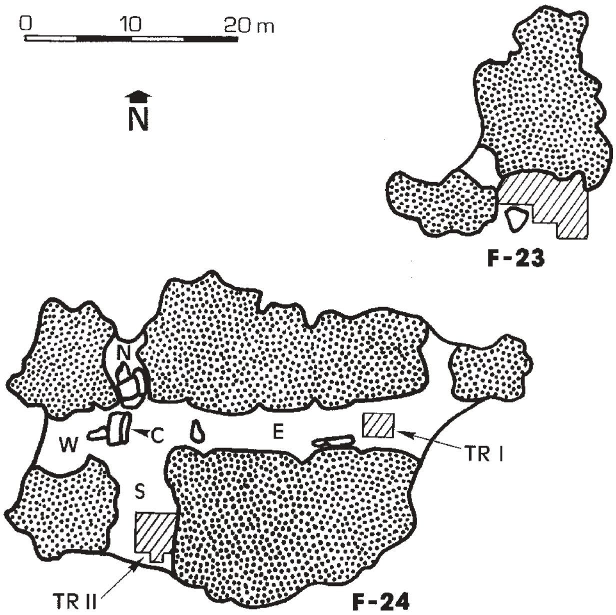

Figure 8. Plan of Auditorium Cave (III F-24) and Misra's Shelter (III F-23). C - Cupule panel on east side of Chief's Rock; N, E, S, W - the four passages of Auditorium Cave; TR I and TR II - excavations by V. S. Wakankar.

by a spectacular rock under which site III F-24 is located. Auditorium Cave consists of a spacious horizontal tunnel of about 25 m length, ending in a cathedral-like hall that has three other openings, so that the plan view of the cave resembles a cross (Fig. 8). The four entrances face the four cardinal directions. In its very centre, clearly visible from outside the longest passage, from the eastern entrance, lies a large, altar- or pulpit-like rock, called Chief's Rock by local archaeologists. Its prominent flat and vertical wall faces the eastern passage squarely. On this panel is a group of nine extremely ancient cupules, which Wakankar had thought were markings resulting from the use of the rock as a lithophone. They precede all surface deterioration that is evident on the rock face, including the gradual exfoliation of a 14 to 20-mm-thick cutaneous layer. Once fully detached it will obliterate all cupules. It is impossible that the cupules could have been made once the exfoliation process (probably caused by subcutaneous salt deposition from capillary moisture) had commenced. Moreover, microscopic examination failed to locate any crushed or impact-fractured grains in the cupules, while recent impact damage is clearly recognisable.

Chief's Rock is over 2.5 metres high and 3.4 metres wide. The actual eastern panel of it, the face we are concerned with here, measures 2.2 metres in height (Fig. 9). The massive boulder, weighing perhaps thirty to forty tonnes (an estimate based on its approximate volume), originates from the high roof of the large cave. It rests on other boulders, the remains of earlier rock falls still largely concealed by sediment. Long after it had fallen to the cave floor it split longitudinally into two portions. The surfaces of the rocks' upper portions are generally well preserved. On their top are clear traces of kinetic weathering (impact

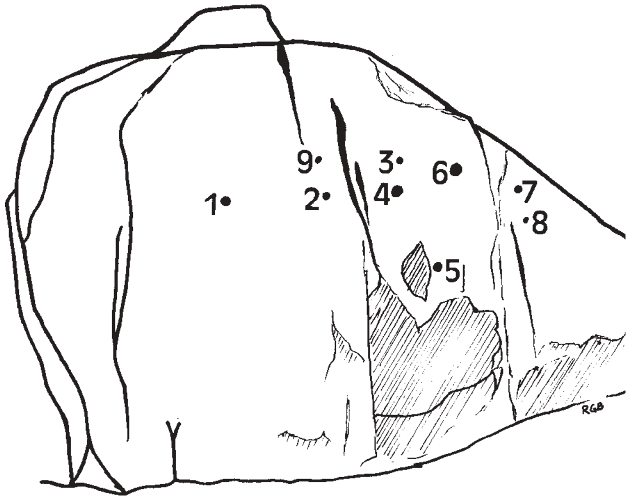

Figure 9. *Elevation of the eastern face of Chief's Rock, Auditorium Cave, Bhimbetka, showing the distribution and relative sizes of cupules 1 to 9.*

by rocks falling from the cave's roof). On the lower section of the eastern panel, several scales have exfoliated. Chief's Rock is in one of the driest locations in the cave, but during the monsoons rain may be driven in from the high north entrance.

The vertical panel on the east side of Chief's Rock bears two types of rock art. Firstly, there are several barely perceptible marks of red pigment, presumably of an iron mineral such as haematite, evidently remnants of rock paintings. Significantly better-preserved pictograms occur elsewhere in the cave, especially high up on a wall a few metres south-east of Chief's Rock. None of the paint traces on the Chief's Rock art panel are superimposed over the petroglyphs. The nine petroglyphs on this panel are cupules, of greatly varying depths (ranging from 1.1 mm to 13.4 mm). They were presumably produced by percussion with hand-held stone tools. Cupules Nos 3, 4, 5 and 6 (Fig. 10) bear minor recent impact damage, and faint traces of it are also discernible in cupule No. 2.

Microscopic examination of the cupules also reveals the presence of various types of small-growth lichens. The rock surfaces in and around the cupules are equally weathered, and there is no appreciable difference in surface structure evident at magnifications of 60× to 80×. The only weathering clearly visible on the upper part of the panel, next to most cupules, is microerosion (Bednarik 1992b). Cupules No. 9 and especially No. 2 are largely covered by tiny gnarled ridges of a precipitate forming 'terraced' arrangements visible only under magnification. These formations are darkly coloured and extensively corroded. It is possible that they are not related to meteoric water, but to the urine of monkeys who still occupy the hill and may have entered the cave. Speleothems, mostly of reprecipitated carbonate, occur in the middle part of the cave's eastern passage, about twelve metres from Chief's Rock, where there is considerable seepage from the top of the rock tower.

There is no archaeological evidence available that would indicate the age of the petroglyphs on Chief's Rock. The presence of two Acheulian petroglyphs just six metres away, found below undisturbed archaeological layers, may be suggestive, particularly as one of them is also a cupule (Bednarik 1993a). However, mere co-occurrence at the same site does not provide conclusive evidence that the cupules on Chief's Rock itself also have to be of Acheulian antiquity. More detailed information is available from cupule No. 5, which is located lower than the main group (Fig. 11). It occurs on a surface that is much more recent than the cupule, because it was formed by cutaneous exfoliation around it. In other words, only the deeper part of the original cupule is preserved. This exfoliation surface has itself since been subjected to a second cycle of the exfoliation process. Immediately to the left of the cupule begins a large exfoliation scar where the 10 to 20-mm-thick lamina has become dislodged already long ago.

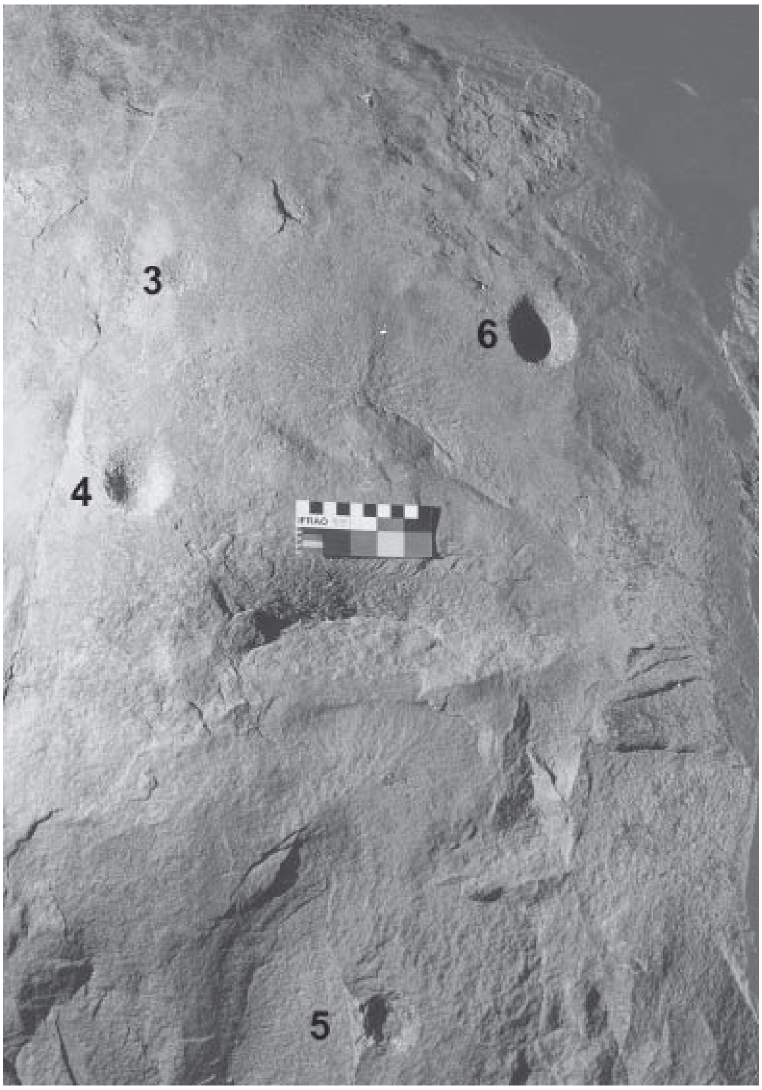

Figure 10. *Chief's Rock, Bhimbetka, cupules 3 to 6. Note exfoliation scar to the left of cupule 5.*

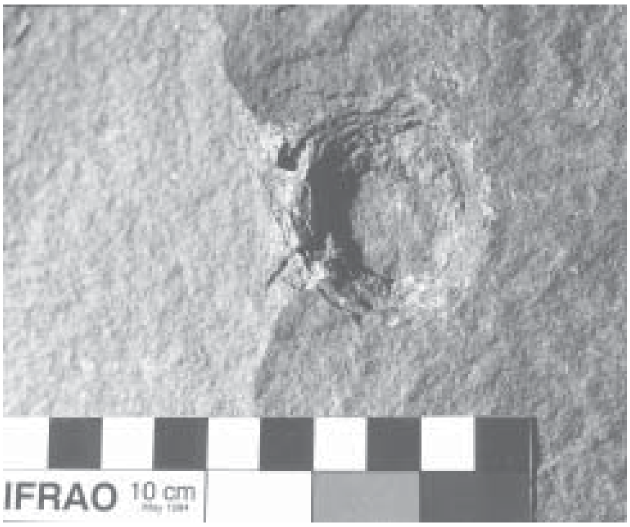

Figure 11. *Cupule 5 on Chief's Rock. The area to the left is the scar of the second exfoliation event since the cupule was made (2 in Fig. 12). The wafer-like structure of the lamina in which the cupule survives partially (3 in Fig. 12) is visible. The deteriorating material to the left of the cupule was subjected to microerosion analysis.*

The rock around the cupule is loose and 'drummy', and once it in turn also becomes dislodged, only the very base of the cupule, under one millimetre deep, will remain behind (see Fig. 12).

The thin bridge between cupule 5 and the scar to its left, just 15 mm wide, is thus of considerable significance in the relative dating of the cupule. As depicted in Figure 12, the currently exfoliating rock lamina has a wafered appearance in section, and while one might argue that this weathering process could have commenced before lamina 1 became detached, it is obvious that the edge of lamina 2 along the exfoliation scar must postdate the detachment of lamina 2 in that area. Hence the wafering along this margin must also postdate that event. Fortunately I detected several thin slivers of stone among these wafer-like laminae that protruded far enough to examine them under the microscope. The edges of truncated quartz grains in them were well-rounded and there can be no doubt that this would have required at least some tens of millennia to develop to the stage observed, in this kind of environment. The degree of rounding is quite uniform on fractured grains in these quartz slivers and I have detected micro-wane radii of between 200 and 300 microns.

We can be certain that the cupule was originally made on perfectly sound rock, because if the rock had already begun to deteriorate, it would have fractured and shattered by the numerous percussion blows necessary to produce the cupule. Therefore the minimum relative age for cupule No. 5 consists of necessarily *successive* periods or processes, none of which could have overlapped with the previous or subsequent. These were:

1. The time span between the commencement and the completion of the cupule.
2. The time span between its completion and the commencement of the exfoliation of the first lamina. Its duration cannot be estimated.
3. The duration of the laminar exfoliation processes that led to the detachment of the first lamina. Depending on moisture availability, this may be from a few millennia to several tens of millennia in this type of location, considering lithology (heavily metamorphosed quartzite) and limited intermittent moisture availability.
4. The time span between the first exfoliation event and the commencement of the second exfoliation process. Its duration remains unknown but can be assumed to be substantial.
5. The duration of the processes leading to the subsequent detachment of lamina 2 to the left of the cupule. A similar order of time as in item 3 is probably involved.
6. The time span required to cause the wafering along the margin of the remaining lamina 2, e.g. just left of cupule 5. This would seem to require at least several millennia to develop.
7. The time span required for eroding edges on individual wafer laminae to attain the degree of rounding now evident on truncated quartz grains, 200–300 microns, which would involve several tens of millennia at least.

It follows from this that the age of cupule No. 5 would have to be at least in the order of many tens of millennia, and that it is likely in excess of 100 000 years. It is thus very unlikely to be from the latest part of the Pleistocene, i.e. the Upper Palaeolithic period. Moreover, Wakankar (1975) has observed a complete absence of Upper Palaeolithic occupation deposit in Auditorium Cave, finding the

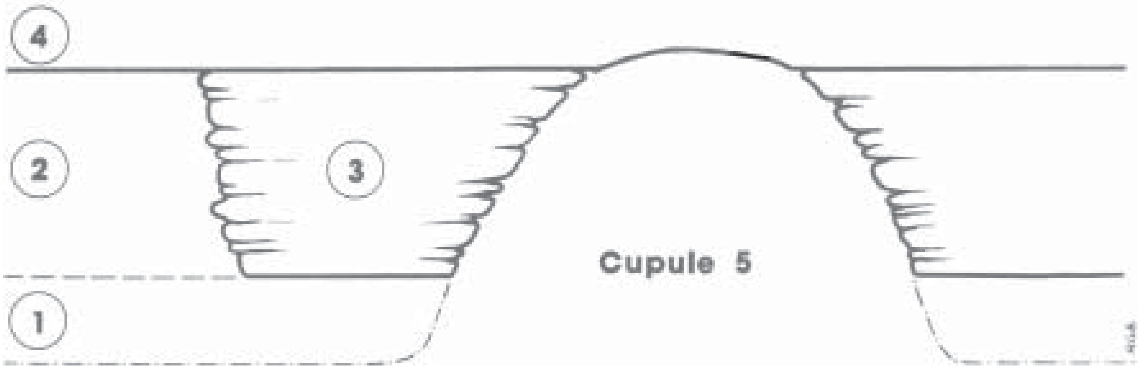

Figure 12. *Section through cupule 5 on Chief's Rock, viewed from above, showing the development of a wafered layer and the sequence of the exfoliation of laminae: 1 - exfoliated lamina 1; 2 - exfoliated portion of lamina 2; 3 - remaining portion of lamina 2; 4 - sound rock core.*

Middle Palaeolithic deposit immediately under the Mesolithic (Fig. 7). The absence of an Upper Palaeolithic occupation deposit does not prove that the cupules could not be of that period (Upper Palaeolithic evidence has been found elsewhere at the Bhimbetka site complex, e.g. at site III A-28), but it does coincide with the apparently greater age of the cupules on geomorphological grounds.

On the basis of this geomorphological analysis and reasoning, the nine cupules on Chief's Rock are most probably of either Middle Palaeolithic or Lower Palaeolithic age. Microerosion study of the cupules has been useful in investigating the possible durations of specific phases of their geomorphological history. However, this method cannot provide a reliable estimate of age, because the actual surface of the cupules is too much eroded to permit the identification of fracture edges or their micro-wanes. Moreover, the panel is only exposed to minimal weathering by rainwater. These factors render an age of over 100 000 years highly likely.

The only other useful strand of evidence is the presence of one nearby cupule found covered by Acheulian deposits (Fig. 5). It cannot have been visible to the Middle Palaeolithic occupants, so it cannot have inspired them to copy it. It would then be a complete coincidence if Middle Palaeolithic residents had used the same method of creating rock marks. This is of course possible, and we know that people of 'Middle Palaeolithic' mode of technology (Foley and Lahr 1997) in Europe and Australia certainly created cupules (Bednarik 1993b). However, it would seem to be an odd coincidence if two peoples, one of the Middle and one of the Lower Palaeolithic, had created similar rock art at precisely the same location, independent of each other, but no similar markings within 20 km of this place. Logic therefore suggests that it is much more likely that the cupules on Chief's Rock were made when the Acheulian specimen was still visible, and it is suggested here that they should tentatively be considered to be Acheulian — a proposition to be subjected to refutation attempts. Excavations in future years or centuries are expected to further clarify the issue, because it seems likely that more petroglyphs will be uncovered in the vicinity of Chief's Rock once a greater part of Auditorium Cave is excavated.

So far the most important excavations at the Bhimbetka complex are trench II in site III F-24 (Auditorium Cave) by Wakankar, and trench I in III F-23 (the immediately adjacent rockshelter) by V. N. Misra. Both sites yielded fairly similar archaeological and sedimentary sequences, consisting of a thin Holocene overburden covering substantial series of Pleistocene facies. The dominating components are in both cases the Acheulian strata, accounting for 2.4 metres of sediment in F-23, but only for about one metre in F-24. Hence our more complete information about the Acheulian of Bhimbetka comes not from Auditorium Cave itself, but from Misra's Shelter, from which also the most comprehensive reports are available (V. N. Misra 1978).

Misra's painstaking work represents the first major attempt of analysis through time of early material in India. His findings suggest a gradual development from the Acheulian to the Middle Palaeolithic, with a few handaxes and cleavers still occurring in the lowest 10–15 centimetres of the latter deposit in Misra's Shelter (Misra 1978: 71). Wakankar (1975: 15) notes that an evolution from the earlier cobble tool tradition he perceives in Auditorium Cave (and also at III A-30; unpubl. field notes by Wakankar; and at III A-29) to the overlying Acheulian is not evident at Bhimbetka. Indeed, the two are separated by a substantial occupation hiatus in his Auditorium Cave trench II, of 50–60 cm.

A few metres from the Chief's Rock, at the base of Wakankar's trench II, lies a boulder bearing a single large cupule with an adjacent meandering groove line (Fig. 5). The cup mark is well-shaped and circular, over 1.5 m below the sediment surface, on the sloping surface of the excavated boulder facing east. The line approaches the large cupule from above, then follows part of its circumference, running parallel to it but maintaining some millimetres distance from its periphery, and veers off to the right. It is not a natural marking of the rock, nor is the cupule. The surface of the quartzite is quite weathered, including in the petroglyphs, as is the nearby bedrock.

In view of the excellent recorded stratigraphies at the Bhimbetka sites it is possible to consider the cultural provenience of these petroglyphs. An important stratigraphic marker of the Pleistocene at the Bhimbetka site complex is a pisolitic layer, 60 cm thick at site III A-29 (Wakankar 1975). At that site, its upper part is looser and finer than the more compact, coarser lower part, and while the upper half contains an Acheulian, the lower half provides a heavily weathered cobble tool industry of choppers and scrapers. The pisolitic stratum occurs also at III A-30 and III F-24, and in trenches 1–7, Choti Jamun Jhiri Nala. Misra's excavation in III F-23 did not reach beyond the Acheulian, so here it was not encountered. The facies can be found widely throughout the Vindhyan Hills, it is often exposed at lower elevations where it contains early Acheulian tools and Levallois cores.

In Bhimbetka III F-24, the Auditorium Cave, a red clay comprising lower Acheulian tools (bifaces dominant, with scrapers and cleavers) overlies the pisolitic layer, which here represents an occupational hiatus, but is underlain by a horizon with cobble tools (Fig. 7). The upper Acheulian layer (cleavers dominant, with bifaces and scrapers) is found at depths ranging from about 1.4 m to 1.9 m. It, in turn, is overlain by a Middle Palaeolithic deposit, a calcite-encrusted breccia averaging about 60 cm thickness, comprising quartzite tools of an industry Wakankar calls Bhimbetkian. He believes that this deposit is marked by wetter conditions. Its consolidated nature certainly precludes the possibility of postdepositional changes in the stratigraphy. This Middle Palaeolithic deposit contained an artificial stone wall. Wakankar (unpubl. field notes) has reported a similar feature, a set of aligned boulders, at another Bhimbetka site, shelter III A-30, where it occurred in the Acheulian deposit. There is no Upper Palaeolithic in Auditorium Cave, although occupation evidence of that period (including a human burial with ostrich eggshell beads) has been recovered from other shelters at Bhimbetka, including III F-23, which has an otherwise very similar stratigraphic sequence to that of III F-24 (V. D. Misra 1977). The uppermost 80–90 cm of the Auditorium Cave stratigraphy comprises a series of Mesolithic, Chalcolithic and Historic layers.

It follows from this that the large cupule and meandering line are located slightly below the interface of the Acheulian with the Middle Palaeolithic levels. They were thus covered by the uppermost Acheulian sediments. It therefore seems more likely that they were made during the Acheulian than during the following Middle Palaeolithic period.

Excavations at Daraki-Chattan, 2002 to 2005

G. Kumar

Excavation of early Indian petroglyph sites is one of the major aspects of the EIP Project. In 2001/2002, I secured permission from the Archaeological Survey of India to excavate the initially nominated EIP sites, Daraki-Chattan in Rewa-Chambal valley, Auditorium Cave at Bhimbetka in Madhya Pradesh, Bajanibhat in the Alwar district and two more sites in Ajmer district of Rajasthan. The excavation of Daraki-Chattan commenced in 2002 and will be continued to 2006. That of other sites had to be deferred as this project expanded in its complexity since 2002.

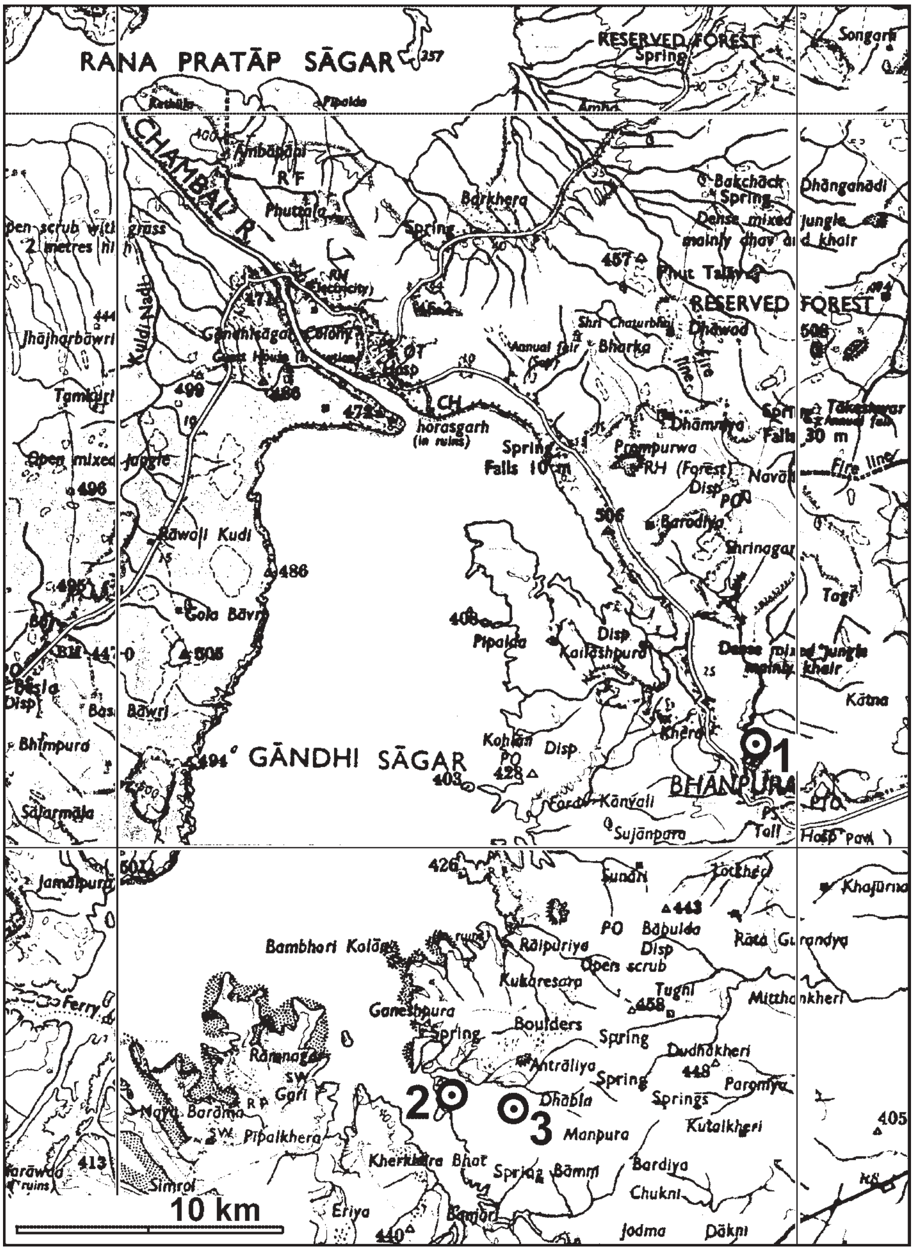

Figure 13. Map of the area surrounding Gandhi Sagar reservoir, Chambal valley, Madhya Pradesh, with approximate site locations indicated: 1 - Daraki-Chattan, 2 - Pola Bata, 3 - Arnyabhan.

The Daraki-Chattan cupules were discovered by Ramesh Kumar Pancholi in 1993 (Pancholi 1994) and the site was studied by me since 1995 (Kumar 1996, 2000–01, 2002). Daraki-Chattan is a small, narrow and deep cave in the Indragarh Hill in Tehsil Bhanpura, district Mandsaur, Madhya Pradesh (Figs 4 and 13). The exact location is not provided here but the precise GPS co-ordinates have been recorded. The site, located at an elevation of 420 m a.m.s.l., is among a complex of painted rockshelters in Indragarh Hill which on its top bears a fort of the Rashtrakuta period (seventh century A.D.), and near its base has yielded remains of an early Historic period habitation. This Historic site was excavated by H. V. Trivedi and V. S. Wakankar in 1959–60 (1958–59: 27–8; 1959–60: 22–4). Indragarh Hill is part of the Pariyatra Hill valley system, which comprises further rock art and Stone Age sites.

The entrance of Daraki-Chattan is located in the upper strata of quartzite buttresses broken into big blocks with vertical fracturing (Fig. 14). It faces almost due west (orientation 10º NE and 190º SE) and overlooks a nearly 1.5-km-wide fertile valley bounded on both sides by the Vindhya Hills. The valley opens into the plains of fertile agricultural fields and *panvaris* (betel farms). Deccan trap escarpments with laterite capping in places join the hill on the north-western side of the valley. Through the valley flows a small perennial river, the Rewa (Ganjoo and Ota 2002). The cave passage is of tapered shape, both in its depth and height (Kumar 1996: Figs 3a and 4). It is slightly more than 4.0 m wide at the dripline and 1.4 m wide at its mouth. From here it continuously narrows down in width, to 34 cm at 7.4 m depth. It than becomes slightly wider, up to 40 cm, and finally closes at a depth of 8.4 m from its

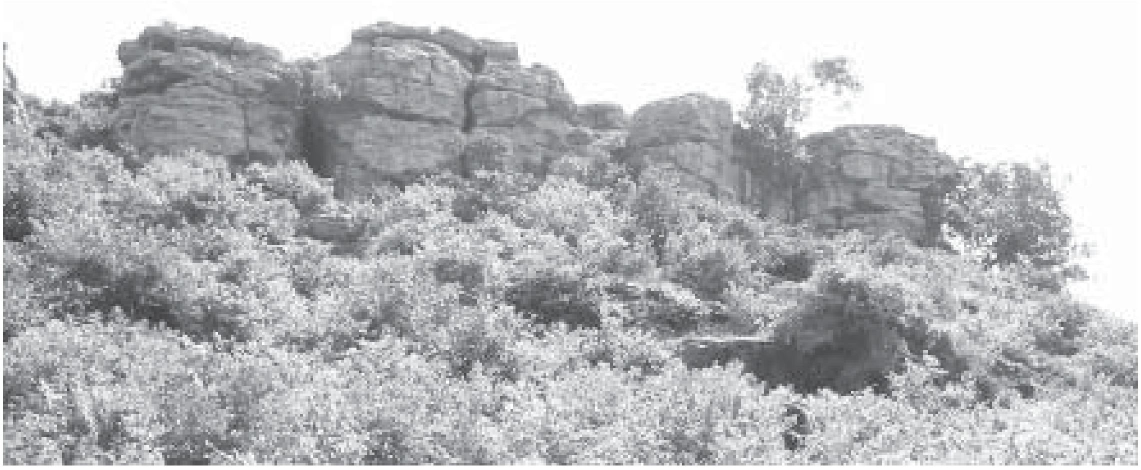

Figure 14. *Part of Indragarh Hill, with the entrance of Daraki-Chattan Cave on upper left.*

mouth. The passage is maximal 7.75 m in height. In its upper half, its walls are tilting towards the northern side and converge at the top. The small gap between them has been sealed by boulders and cobbles. The rock mass of both walls of the cave is divided into three strata of unequal thickness. The lowermost stratum of both walls bears cupule groups on its upper two thirds. They occur mainly in four groups on the northern wall and in six groups on its southern one (Kumar 1996: Figs 5 and 6).

The cave walls bear over 500 cupules. I initially documented 498 cupules on its vertical walls in 1995, out of which five were doubtful (Kumar 1996, 2002). Afterwards I discovered four more cupules on the southern wall in 2002, out of these two were on the upper stratum. Two more cupules were discovered on the bedrock inside the main body of the cave in 2004. Besides, 28 cupules were discovered on slabs exfoliated from the walls of the cave in the excavation during 2002 to 2005. The cobbles and rubble scattered on the cave floor yielded Middle Palaeolithic-Lower Palaeolithic artefacts when I studied the cave in 1995. I also observed that in front of the cave is a deposit of sediments of up to more than 6 m length. Beyond that the hill slopes steeply. This sediment in front of the cave and in the associated rockshelter in the north forms the potential area for excavation.

The initial objectives of the excavation and exploration at and around Daraki-Chattan were as follows:

1. To establish the stratigraphy of the sediments and palaeoclimatic and cultural history of Daraki-Chattan.
2. To find evidence related to the production of cupules in the cave, and other art objects and artefacts, if any, from the sediments.
3. To obtain scientific dates for different levels of sediments exposed in the excavation and bearing artefacts and other antiquities related with human creation, including cupule production, by using the OSL dating method. AMS ^{14}C method will be employed for obtaining dates from the accretions and patination on the cupules. If possible, microerosion analysis will also be employed for dating of the cupules.
4. To establish the cultural sequence and Pleistocene history of the region.

Excavation progress

The total area excavated in the Daraki-Chattan excavation during the four seasons from 2002 to 2005 was 25 square metres, in the entrance part or vestibule of the cave, in the associated rockshelter to the cave's immediate north, with only minimal work within the actual cave passage (Fig. 15). Measurements of depth are of two types: (1) from the surface, and (2) from the datum A1. Mostly both are stated simultaneously here. Besides advancing in the excavation slowly but steadily in every season, we also explored the surrounding region in order to better understand the problems posed by the project. Our gradual progress and overall observations in coming to understand the site are given in the following pages.

In 2002, in squares XB1(2,3), XA1, A1(1,4), XB2(2,3), XA2, A2(1,4), XA3, the excavation reached a depth of -65 cm from A1. In A2(1) and in part of XA2(3), it reached -85 cm from A1. In squares ZA1(1,4), ZA4(1,4), bedrock appeared at a depth of only -20 to -35 cm.

The closing depth in 2003 in XE4, XD4, XE5 and XD5 was -166 cm from A1 datum. In XE5, XD5 we conducted limited excavation to examine the already exposed Acheulian floor of flat slabs. To see its continuity we opened new squares XC4 and XC5. In this process some excavation was also done in XE4 and XE5. In 2004, the closing depths in these squares were XD4, XD5 -64 cm (-173 cm from A1 datum), XC4 -34 cm from XC4 (-140 cm from A1), XC5 -29 cm from XB5 (-151 cm from A1). We also extended the main trench towards west in XB4(2), XA4(1,2), A4(1,2) and also in XB5(2,3), XA5. Excavation was closed in XA4 at depth -240 cm from A1 datum at bedrock. In XB5(2,3), XA5 excavation was stopped at floor level at depth -93 cm from XA5 (-204 cm from A1 datum). In B3 and C3 it was closed at depth -99 cm from B3 (-147 cm from A1 datum) and -82 cm from C4 (-140 cm from A1 datum) respectively.

The main objective of the 2005 excavation was to understand the nature of the Acheulian floors exposed in the main trench, and to obtain evidence of petroglyph production from the lowermost sediments if available. Hence it was necessary to reach bedrock, and to understand the exact nature of the sediment and cultural stratigraphy of the site. Excavation was conducted in squares XA2, XA3,

XB2(2&3), XB3(2&3), XB4(2&3), XB5, XB6(1&4), XC4(2,3&4), XC5, XC6(1&2), XD4, XE4(3&4), XE5, XF5(2&3). The shape of the trench became a reversed L shape in 2005, with a total length of 560 cm, total width of 650 cm, while the total width of the main trench became 260 cm, and the total width of the rockshelter trench 210 cm (200 cm in XE5, XE6, XF5 and XF6). The total area of excavation in 2005 was therefore 11 square metres.

Observations in 2002

1. Rubble forms the major constituent of the sediment with a small amount of brown soil. The excavated sediment does not show any stratigraphy. After removing the surface material, the soil remains almost unchanged in the excavated sediments.
2. The frequency of artefacts in the sediment is low. Most of them are of quartzitic sandstone. Finished microliths and chips of chert and chalcedony also appear occasionally, which seem to be intrusions by natural agencies from the top of the cave which is open at its mouth.
3. Most of the artefacts are flakes, both man-made and naturally available, almost in equal numbers. Most of the artefacts are scrapers, some of them of extremely fine workmanship and micro-retouch, e.g. a beak-shaped hollow scraper found from A1(4) at locus A1 -60 × A2 -42 × 22 cm, with dimensions of 53 × 71 × 22 mm. Most of the artefacts are fresh in appearance, only a few weathered and rolled, which might have been introduced by natural agencies.
4. To establish the sedimentological and cultural history inside the cave, a trench was also laid in ZA4(1), ZA(4) and YA4(2) (Fig. 15). It yielded a small cleaver, artefacts of flakes, flakes with sharp edges, rolled flakes etc. At a depth of -35 cm the bedrock appeared in the northern half of the excavated area inside the cave. The observations made inside the cave are similar to those made in its front.

Considering the size and typology of the lithics obtained from the excavation from the upper layers (layers 1, 2 and 3), Kumar considered them to belong to the terminal phase of the Lower Palaeolithic. V. N. Misra, R. G. Bednarik and G. Kumar, after thorough discussion, agreed that the artefacts seem to represent a transitional phase from the Lower Palaeolithic to the Middle Palaeolithic. But to reach a conclusion it is essential to consider the results of the excavation in the following years. Three soil samples were collected from the excavated trench for OSL dating and sediment analyses in September 2002.

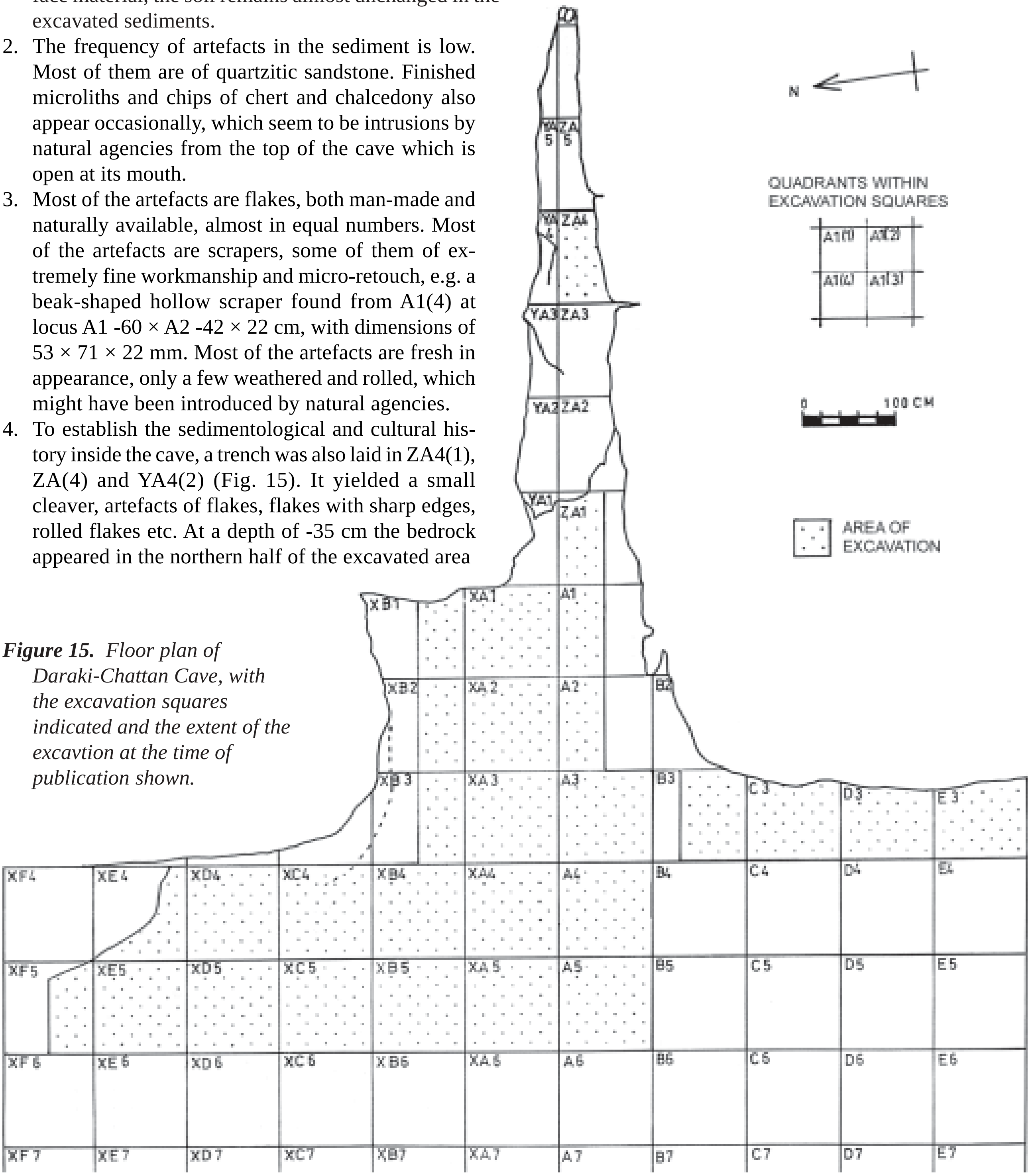

Figure 15. *Floor plan of Daraki-Chattan Cave, with the excavation squares indicated and the extent of the excavtion at the time of publication shown.*

Observations in 2003

1. The site appears to present a very good example of the transition of Lower Palaeolithic artefacts to Middle Palaeolithic ones in layers 1, 2 and the upper part of layer 3.
2. In squares A1 and XA1, the concentration of artefacts increased sharply at depth -65 cm from A1. An artefact floor was obtained at depth -70 to -75 cm from A1. Numerous artefacts were also found below this level. From a depth -90 cm onwards, the concentration of artefacts decreased. It was very low from depths of -98 cm to -110 cm. The sediment changed from loose light-brown to comparatively compact dark-brown at depth -112 cm to -115 cm from A1. With this change in the stratigraphy, the concentration of the artefacts increased. A second artefact-rich horizon occurred just above bedrock, at a depth of -122 to -125 cm from A1. It consists mostly of cobble tools and choppers.
3. In XB3, XA3 and A3, the intensity of the artefacts decreased considerably at depth -120 to -130 cm from A1 (i.e. -70 cm to -80 cm from surface). Two choppers were found at depth -135 cm from A1 (-85 cm from surface).
4. Artefacts of quartzite were made both of local quartzite and of river cobbles or flakes. Laterite pieces and chunks were found in XA3(1) at depth -80 to -90 cm from A1 (-30 to -40 cm from surface), and in XA1(3) at depth -112 cm from A1. They were brought in intentionally by man, perhaps because of a fascination with the rock's peculiar structure and form. Laterite caps have been formed on the Deccan Trap hills across the valley about 3.5 to 4 km in the west of the cave.
5. Boulders and blocks exfoliated and fallen from the cave walls were found throughout the vertical depth of the excavated sediments. Heavy exfoliation residue was observed at a general level -60 to -65 cm from A1 and fallen boulders up to the end of the excavation (in 2003) at depth -177 cm from A1 in XA3. It indicates intensely hot climate with great temperature fluctuations. Steep changes in humidity might have helped to increase the rate of exfoliation, and the impact of earthquakes or tectonic movement may not be ruled out.
6. During the excavation period in May and June 2003, we recorded the temperature and relative air humidity at the cave daily, in the morning, at noon in the shade, and in the afternoon when the cave entrance is exposed to direct sunshine from the west. This gives an idea of the temperature and humidity fluctuation in the summer at present. Before noon the temperature fluctuated from 4°C to 7°C only (recorded temperature in the general range from 29°C to 36°C), while the difference between morning and afternoon temperatures ranged from 19°C to 27°C. From this we may speculate about the fluctuation of temperature and humidity during the Stone Age. This great differential in before-noon and afternoon temperatures might have been responsible for the exfoliation of wall panels at the entrance of the cave, hence the absence of cupule on these surfaces. The time of this exfoliation period has to be established.

S. B. Ota, R. K. Ganjoo and G. Kumar along with D. Dayalan, SA, and Arakhita Pradhan, Asstt. Archaeologist, ASI Agra Circle, studied the excavated material from Daraki-Chattan at Agra and Fatehpur Sikari in the last week of December 2003. The team reached the conclusion that the artefacts revealed in the excavation of Daraki-Chattan during the 2003 season presents a Lower Palaeolithic assemblage. It is almost in mint condition, hence the artefacts were either manufactured on the spot or might have been brought to the site by human agency. The occurrence of the 'art' objects from the lower strata is important. In order to have a clear picture of the cultural history at Daraki-Chattan it is necessary to reach the bedrock and conduct further scientific investigations in the coming season, in 2004.

Observations in 2004

In the process of scraping the section and excavating deep up to the bedrock in XA4 (1,2) and A4(1,2), up to a depth of -240 cm to -245 cm from A1 datum, an almost complete sequence of stratigraphy appears to have been exposed. Hammerstones and stone floors exposed in layer (4) and (5) are being described in the following pages. Excavated material and observations made in the excavation at Daraki-Chattan, and exploration carried out in other sites from 2002 to 2004, were presented in the RASI-2004 International Rock Art Congress in Agra as keynote lectures on 29 November 2004. The artefacts, hammerstones and slabs bearing cupules obtained from the Daraki-Chattan excavation were examined by rock art researchers and prehistoric archaeologists from all over the globe, including Jean Clottes, Ben Swartz Jr, James Harrod, John Clegg, among many others.

Observations in 2005

After the 2005 field season, the following depths were reached:

XA2(1) at -275 cm from A1 datum (-252 cm from surface)
XB5(3) at -290 cm from A1 datum (-153 cm from surface)
XB5(4) at -292 cm from A1 datum (-155 cm from surface)
XC5(3) at -282 cm from A1 datum (-145 cm from surface)
XF5(2&3), XE5(1,2,3&4) in rockshelter -87 cm from rock surface, and -55 cm from surface (XB6) and -192 cm from A1 datum.

It is expected to reach bedrock in all of the main trench in 2006. Scientific analyses and dating of the samples to establish the antiquity of the sediments are in progress.

In the excavation a large rock occurred in the middle of the trench (Fig. 16). Its top portion began appearing in the very first year of excavation, in 2002. It became almost fully exposed in 2004. It prevented further excavation, hence we had to remove it. But before that we studied it carefully. It was occupying a portion of XA1(3&4), A1(4) in full, XB2(2&4), XA2(1&2) in full and XA2(3&4) partly, A2(1&4) partly, and a small portion of XA3(1&2). The boulder (see feature 1 in Fig. 16) was 140 cm × 119 cm × 64 cm in size. Its maximum thickness was 50 cm at its upper part at its breakage from the parent rock, 43 cm at its lower southern portion and 64 cm at the lower northern

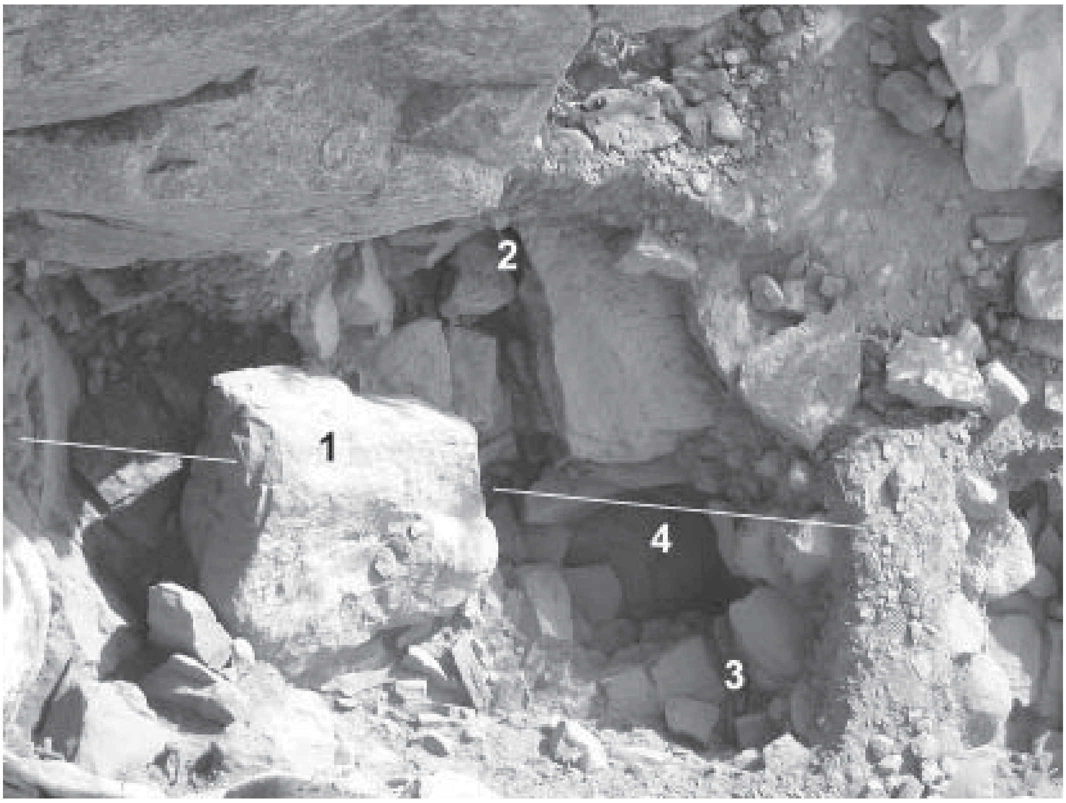

Figure 16. *Plan view of the Daraki-Chattan main trench, viewed from about 8 m height, the cave's interior being to the left (east). The line indicates the position of the generalised sediment section shown in Figure 26, and the following features are indicated: 1 - the collapse boulder, which has broken off from the left; 2 - position of the only excavated in-situ cupule on the edge of large boulder (cf. Fig. 31); 3 - some of the slab fragments forming the main 'slab floor'; 4 - deepest part of the trench in 2004.*

portion. It was a part of the bedrock of the cave before it broke from it and later on slipped towards west from the surface of bedrock at a depth of -120 to -125 cm from A1. It slipped to 64 cm at its southern corner, 66 cm at its middle portion and 35 cm at its northern corner.

The gap was filled in with sediment bearing Lower Palaeolithic artefacts (choppers and cobble tools close to the bedrock), slab pieces bearing cupules, hammerstones etc. The rock was packed with vertically and almost vertically lying stone slabs on its northern side. The sediment on its southern side contained blocks resting on slightly northerly tilted flat slabs/blocks, Lower Palaeolithic artefacts, slab pieces bearing cupules etc. The lowermost head of the tilted rock rested on south-easterly orientated slabs. The upper northern corner of the rock was also concealed by south-easterly tilted slabs and a few cobbles. The upper, lifted (eastern) portion of the rock was lying on flat slab pieces aligned with the lower surface of the rock, which may have been the exfoliated lower portion of the rock.

In order to clarify the stratigraphical issues surrounding this boulder we decided to remove it. We considered all possible means of removing it intact, but we could not do so. There was almost no space to fix a pulley or any mechanical device, and we had to extract it without damaging the excavation sections. Therefore we decided ultimately to remove it by breaking it into pieces.

We consider that this large rock was formerly attached to the bedrock, forming a little overhang, and sediments bearing stone artefacts were lying below it. The bedrock under it has still not been reached at a depth of -290 cm from A1. This interpretation also explains the tilting of slabs and rocks in the trench towards north and north-west, which could be possible only when either there is a hollow space or loose sediment. It also explains the eastwardly tilting of the lower sediments in the section facing south in the main trench. This rock therefore divides the sediments in the excavation in two parts, those deposited before and after its breakage and sliding away to the west. The latter sediments contain Lower Palaeolithic artefacts, cupules and hammerstones. A number of chopping tools were obtained close to bedrock, to the south of the collapsed boulder. Deposits excavated after its removal include Lower Palaeolithic artefacts, but comprise more chopper/ chopping tools, spheroids and discoids.

The stratigraphy

In the excavation at Daraki-Chattan during four season's work (2002 to 2005), we have exposed sediments up to a depth of -292 cm from A1 in the main trench and still we have to ascertain the bedrock. The sediments slope towards west by 150 cm over a distance of 5 m, i.e. up to XB6(2). The nature of the sediment so far exposed in the excavation is fairly uniform with gradations of colour, size of the exfoliated flakes, stones, blocks and slabs. However, for convenience of study the sediments have been divided broadly in two parts, a lower deposit with sub-layers 6, 5

No.	Thickness	Nature of sediment	Associated cultural material
1	Only a few cm to 10 cm	Loose rubble with little humus	Artefacts representing transitional phase from Lower Palaeolithic to Middle Palaeolithic, mostly of purple red quartzite, a few of patinated chert. Because of the gradient, rainwater sweeps away the soil leaving behind the heavy material, hence difficult to separate constituents of layers 1 and 2.
2	15 to 24 cm, including layer 1	Loose greyish-brown sediment with rubble	
3	37 to 110 cm	Loose brown soil with exfoliated flakes and stones	Lower Palaeolithic flake artefacts, some of cobbles, mostly of purple-red quartzite, a few of patinated chert. Hammerstones, exfoliated slabs bearing cupules, no handaxe, no cleaver.
4	26 to 50 cm	Compact calcareous yellowish-brown soil	Lower Palaeolithic flake tools along with cobble tools. Cupules, petroglyphs and stone structures, mostly of purple-red quartzite, a few of patinated chert. Hammerstones, exfoliated slabs bearing cupules, no handaxes, no cleavers.
5	25 to 28 cm	Compact brownish-red soil	Lower Palaeolithic flake tools along with cobble tools. Cupules, petroglyphs and stone structures, mostly on purple-red quartzite, a few tools of patinated chert, rare occurrence of handaxes, only one cleaver, some hammerstones and slabs bearing cupules.
6	25 cm (?) (still to reach bedrock)	Red lateritic soil, comparatively loose because of rain water	Lower Palaeolithic. More artefacts of quartzite cobbles and thick nodules (cobble tools, discoids and spheroids (bolas?), some also of natural flakes, split cobbles and man-made flakes of quartzite, a few of patinated chert also. Hammerstone found at the beginning of the red laterite soil.

Table 1. *Stratigraphy and tool typology, section facing south, main trench. Layers 1 and 2 are visible only in the area of XB3 and XB4 and are almost indistinguishable.*

and 4; and an upper deposit with sub-layers 3, 2 and 1 (Table 1).

1. *Lower deposit*: the lowermost sediment is laterite red soil that became slightly loose because of rainwater. It grades into the following compact brownish red soil and again into compact calcareous yellowish-brown soil (sub-layers 6, 5 and 4).These sediments comprise also fallen large slabs and stone blocks. Most of these slabs have been weathered deeply and became highly patinated with dark-brown mineral accretion. Such weathered rocks are locally known as *barbarya bhata*. These sediments bear Lower Palaeolithic artefacts. Their stratigraphic typological variation has been given in Table 1.
2. *Upper deposit*: composed of loose brown sediment with exfoliated flakes and stones, generally of comparatively small size and progressively of lower number. It consists of the upper three sub-layers (3, 2 and 1). The top 20 to 24 cm sediment grades into greyish-brown pseudo layer (2) and thin humus layer (1). At places sub-layers 1 and 2 have been washed away by rainwater.

Observations on the stratigraphy

1. From the very beginning of the excavation in 2002, the artefact assemblage represents a late phase of Lower Palaeolithic or transitional phase from the Lower Palaeolithic to the Middle Palaeolithic. However the proportion of Lower Palaeolithic typology increases with depth.
2. Tortoise and discoid cores of quartzite are found from the lower level of layer 3. Cobble artefacts, like spheroids, were also found from the lower part of layers 3 and 4. Layers 6 and 5 revealed artefacts mostly of quartzite cobbles and thick nodules (cobble tools, discoids and spheroids). Patinated chert flakes and artefacts of chert nodules are found even up to the last level of the excavated sediment but their number decreases with increasing depth. Microliths of chalcedony and chert are rarely found in the loose sediments of the upper layers.
3. Tiny granules of haematite were found throughout the depth of the sediments.
4. The thin humus layer 1 contains some pottery shards, brick fragments, microliths and chert and chalcedony flakes.
5. In layer 3, the size and number of the stone blocks increase with the depth of the sediment. Huge blocks were found lying at a depth of -135 cm from A1 (-85 cm from surface) and continuing up to the depth of -177 cm from A1 (-127 cm from surface). Besides the huge collapse boulder in the centre of the trench, a big block measuring 104 × 46 × 21 cm was lying at a depth of -135 cm from A1 in A3 and XA3. Lower Palaeolithic artefacts of quartzite are numerous, mostly in mint condition, only a few bearing abrasion marks. Patinated chert flakes and nodules are also found. The concentration of Lower Palaeolithic artefact assemblage is greatest in its lower half. Highly patinated utilised chert flakes and nodules occur there.

Figure 17. *Exfoliated slab, assembled from seven fragments excavated in Daraki-Chattan in 2002.*

6. In layer 4, a 20-cm-thick floor made of well arranged, flat and thick rock slabs has been exposed in the main trench in XB4, XA4, XB5, XA5. It is preceded by three layers of arranged slabs, which are highly weathered and extend deep down to bedrock at the bottom of layer 6. Similarly, three layers of arranged flat slabs have also been exposed in the adjacent rockshelter in XC4, XC5, XD4, XD5, XE4(2), XE5(2).

Section facing south in the southern side of the rockshelter

Layer 1. Loose brown soil (humus)	5 to 8 cm
Layer 2. Blackish soil, compact	25 to 28 cm
Layer 3. Dark brown soil, compact	15 to 17 cm
Layer 4. Red soil	14 to 15 cm

The disturbed upper layers (1 and 2) yielded Lower Palaeolithic artefacts with microliths, pottery pieces and brick fragments. They also contained a few pieces of animal bones, kaoline pigment and small fragments of charcoal. The cultural constituents of layers 3 and 4 are similar to those of layers 5 and 6 in the main trench (Table 1).

Cupules from the 2002 excavation

Many slab pieces were recovered from squares A2, XA2, XA1 and A1, distributed mostly around point A2 at depth -26 cm to -43 cm from A2 (-38 cm to -55 cm from A1). Out of these, seven fragments joined perfectly to form a slab measuring 95 × 50 × 5–10 cm (Fig. 17). Its three big

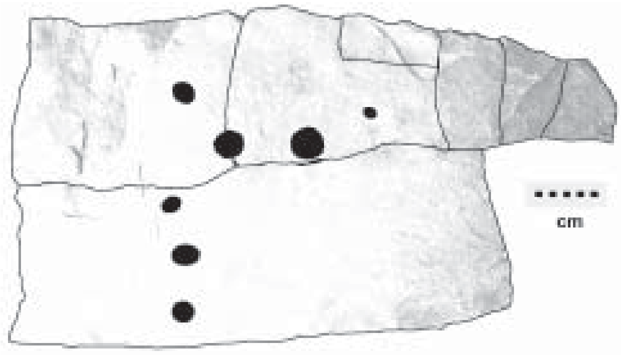

Figure 18. *Recording of the exfoliated slab in Figure 17, showing sizes and locations of the seven cupules found on it.*

pieces bore seven cupules. One of its large pieces was covering a portion of another one in the excavation. These were found with a southward orientation at an inclination of nearly 25º. The inclination might indicate a former hollow space below. After removing them, one more piece was discovered 10 cm below them. Besides, four more slab pieces (including the vertical slab in the southeast corner of the trench) were found bearing one cupule each. The dimensions of the cupules range from 26.1 × 29.0 × 1.85 mm to 50.5 × 51.9 × 7.4 mm (Fig. 18). Stone artefacts representing the transitional phase from the Lower Palaeolithic to the Middle Palaeolithic were discovered both above and below these slabs.

Another slab piece bearing three cupules was discovered from A2(2) at the time of collecting soil sample No. DC-1 on 27 September 2002. The soil sample was collected at a depth of -50 cm from the surface. The cupule slab fragment came out while digging horizontally into the section facing north. This fragment is roughly rectangular in shape, with one corner curved and another side obliquely cut towards the end. The maximum dimensions are 22.0 × 13.5 × 5.5/2.6 cm. The upper surface of the slab is sloping, while its lower surface is almost plain with a shallow depression in the centre. The slab piece bears three cupules:

1. At the ‘left’ side, 45.8 × 37.7 (broken) × 6.7 mm.
2. In the ‘right’ half of the slab, 41.0 × 35.0 (broken) × 8.8 mm.
3. At the extreme end of the ‘upper right’ corner, and broken; only one-quarter of the cupule remains, 16.0 mm deep.

Excavated cupules, 2003

1. A piece of cupule-bearing slab was found in XB(3) at depth –63 cm to -70 cm from A1. It is 18 × 16 cm in size and was inclined towards north. It bears two deep cupules and two shallow ones. It comes from slightly below the level from which cupule slabs were obtained from the Daraki-Chattan excavation last year. Stone artefacts obtained from around it were of quartzite. In the month of December 2003 a team of Stone Age archaeologists, consisting of S. B. Ota, R. K. Ganjoo, D. Dayalan, G. Kumar and A. Pradhan, studied the material. The team came to the conclusion that the assem-

blage represents a late Acheulian tradition. Two fine chalcedony blades were also obtained close to this slab, one from towards its east and another from towards its south.
2. A small piece of cupule slab was found lying upside down in XB2(2) at a depth of -72 cm from A1. Two stone artefacts of quartzite were obtained close to it.
3. Another small slab piece with two broken cupules was obtained from XA2(1) at a locus 55 cm from XA2, 81 cm from XA3, at a depth of -85 cm from A1 (-55 cm from surface).

Excavated cupules, 2004

1. A slab piece of quartzite bearing two cupules was found upside down in XC5(1) in the adjacent rockshelter at a locus 36 cm from XC5 and 74 cm from XB5, at a depth of -17 cm from the surface (-127 cm from A1 datum), in a Lower Palaeolithic context. The cupule surface is weathered, the cupules' dimensions are as follows: cupule 1, diameter 31.0 × 25.0 mm (broken), depth 4.7 mm; cupule 2, diameter 40.6 × 36.8 mm (broken), depth 5.0 mm.
2. A small cupule slab piece of quartzite was found in XC4(1) at a locus 59 cm from XB5, 59 cm from XC5, at a depth of -36 cm from XC4 (-142 cm from A1 datum). The cupule surface is smooth and patinated. It was found in the Lower Palaeolithic level. The dimensions of the cupule slab piece are 70 × 69.4 × 20.7 mm, and those of the cupule are diameter 30.7 × 19.2 mm (broken), depth 6.4 mm.
3. An irregularly broken thick slab was found lying along the slabs of the of floor along the section facing south in XA3(1)/XB3(2) on 28 May 2004. The locus of the slab is 79 cm from XB4(2), 110 cm from XA4, depth -93 cm from surface and -164 cm from A1 datum. The sediment covering it yielded four Lower Palaeolithic artefacts, out of these three were of quartzite and one of highly patinated chert. When we removed this slab we observed two broken cupules on its patinated and slightly weathered surface. The cupules are smooth and appear to be equally patinated with a little light-brown encrustation on them. The dimensions of the slab are: upper surface 13 × 13 cm, lower surface 26 × 17 cm. It bears two cupules: cupule 1, 42.5 mm × 42.7 mm (broken) × 7.8 mm, ovoid in shape; cupule 2, 41.7 mm × 30.7 mm (broken) × 7.0 mm.

Cup marks on slabs still lying in the main trench

On 19 June 2005 we observed a cupule on a quartzite slab projecting from the section facing south in XB3(2). The locus of the cupule is 39 cm from XA3, 70 cm from XA4, 119 cm from A3, depth -129 cm from XB4 and -184 cm from A1 datum. The dimensions of the cupule are: 32 mm (broken) × 29 mm × 6 mm. The thickness of the cupule-bearing slab is 20 cm and its visible size is 49 × 45 cm. It is resting on another slab at a height of 32 cm above bedrock in layer 5, early phase. So far it represents the earliest cupule from the Daraki-Chattan excavation. Soil sample No. DC-5 for OSL dating was collected just above this slab on 9 and 10 December 2004.

Another cupule was observed on a very big fallen slab slanting NW in 2004, still lying in A2, A3 and A4 in layer 4. The cupule is slightly diagonal, with dimensions 32 (broken) × 34 × 16 mm. It is located just close to the section facing north, at locus A3=83 cm × A4=124 cm, depth -58 cm from surface of section facing north and -240 cm from A1 datum. The visible slab size is 118 × 93 × 34 cm.

Other petroglyphs

Two engraved lines were observed on a boulder lying obliquely in XB4(2), XA4 (1&2), XB3(3), XA3(3&4). The rock was removed to enable further excavation. Nearly twenty Lower Palaeolithic artefacts were found from above and alongside of this slab. About 15 cm below its tilted lower end were the arranged slabs of the floor (see below). It was fully exposed on 3 June 2004 and was removed on 4 June 2004.

The boulder forms a rough rectangle when seen from above. One side of its lower surface is very thick compared with the other. Its upper surface measures 64.5 × 50.0 cm, the lower surface 60.0 × 44.0 cm, the thickness on its thick side is 35.0 cm and on its thin side 18.0 cm. The upper surface of the rock bears thick brown patina, in places it appears glossy. A similar patina also runs through the engraved lines, indicating their great antiquity. The engraved two lines are smooth and run obliquely at two corners of the slab. The 'left' one (southern) groove is big and the 'right' one (northern) is small. They show fractured crystals of the rock under the magnifying glass. Their detailed measurements are as follows:

Engraved long line on the 'left' southern corner of the slab: length 295 mm, running obliquely on southern upper corner of the slab with dark-brown patination. Widths at different points: 14.2 mm, 20.3 mm, 19.0 mm, 14.0 mm, 19.0 mm, 18.4 mm, 18.2 mm, 14 mm. Depths at different points: 5.0 mm, 4.7 mm, 4.8 mm, 5.3 mm and 5.1 mm.

Engraved short line on the 'right' (northern) corner of the slab: widths at different points are 8.4 mm, 10.0 mm, 11.3 mm, 8.0 mm. Depths at different points: 2.0 mm, 3.0 mm, 2.0 mm.

A small piece of slab with a broad groove was found in A3(1) at a locus 5 cm from A3, 97 cm from B3, at a depth of -187 cm from A1 datum, on 9 June 2004. It is also of the Lower Palaeolithic. The slab measures 110 × 117 × 42 mm, the groove varies from 15.5 to 18.0 mm in width and 2.8 to 3.3 mm in depth.

Hammerstones

Hammerstones used for the production of cupules were obtained from the excavation at Daraki-Chattan. A hammerstone fragment of a quartzite river cobble in XA2 (2) is from a locus 53 cm from XA2(3), 28 cm from XA2(2), at depth -37 cm from A1. It has a broad striking surface, which has been worn smooth by impact, obtained just 5 cm below the two major Acheulian artefacts in the same quadrant. It was found on 8 June 2002. The same sort of smooth crushed surface on hammerstones has been produced in the replication of cupule production.

A big sturdy hammerstone of quartzite from XA1(2) at a locus 50 cm from XA1, 50 cm from XA2, at depth -63 cm from the surface and A1 datum was discovered on 28 May 2003. In the same year, a second hammerstone of quartzite used for cupule production was found. It had been split after use to produce a secondary artefact, and occurred in XA1(2), 70 cm from XA1, 85 cm from XA2, at depth -127 cm from A1. It was lying just on the bedrock, hence it represents one of the earliest evidence of cupule production in the cave. It was discovered on 16 June 2003. This level yielded a rich concentration of Lower Palaeolithic artefacts, one of them is a 30-cm-long flake of quartzite.

Five more hammerstones were recovered in 2004. In XA3(1), a pointed hammerstone of quartzite from the Lower Palaeolithic floor level was left in situ for inspection by members of the EIP Commission, and removed in their presence. It was found 5 cm from XA3, 96 cm from XA4, at depth -111 cm from surface (-164 cm from A1 datum). In XA3(4)/XA4(1), a quartzite hammerstone was obtained from the extended trench at 30 cm in line from XA4 towards A4, at depth -107 cm from A1 datum. Another specimen was found in association with large Lower Palaeolithic artefacts of quartzite in XA4(1), at a locus 86 cm from A4, 65 cm from XB4(2), at depth -42 cm from the surface in XB4(2). A long quartzite hammerstone was excavated in XA3(2), in association with Lower Palaeolithic quartzite artefacts at 51 cm from XA3, 51 cm from A3, at depth -145 cm from surface (-190 cm from A1 datum). The fifth specimen found in 2004 came from XA5(1). It was a long hammerstone of quartzite, Lower Palaeolithic, also left in situ for reference. It was found 60 cm from XA5, 85 cm from XA6, at depth -67 cm from XA5.

Finally, three further hammerstones were discovered in the lower strata in 2005. The first was an example with a good battering facet obtained from XA4(3) at a depth of -10 cm to -20 cm from surface, found in loose sediment on 30 May 2005. This was followed by a hammerstone of a quartzite cobble from XC4(2) at a locus XB4 -42 cm, XC4 -80 cm depth, -40 cm from surface, found 14 cm towards south of the fallen big rock in the rockshelter and 8 cm below it (obtained on 3 June). The most recently secured hammerstone, also a quartzite cobble, was found in XB4(4) at locus XB4 -80 cm, XA5 -80 cm, on 18 June. It occurred at a depth of -140 cm from XB4, where the sediment changes from laterite red to brownish red soil. Its dimensions are 97 × 81 × 64 mm. It was found along with a Lower Palaeolithic artefact made from a quartzite cobble, a hematite pigment nodule and another cobble tool. All of these four objects come from an area measuring 17 × 16 cm in XB4(4), at -132 to -140 cm depth from XB4. One more artefact of a quartzite flake, Lower Palaeolithic, comes from nearly 20 cm away from the hammerstone. All these artefacts were found surrounded by decomposed quartzite stone blocks (*barbarya bhatas*).

Other finds

A small hollow stone piece, with its inner surface cylindrically round and smooth, found in 2002, is a unique object of such a great antiquity.

In 2003, a portion of a stone floor appeared in XD4, XC5, XD5, XE4(2), XE5(2), at the depth of -160 cm to -170 cm from A1 (50–60 cm from surface). These squares are in the rockshelter immediately to the north of the cave entrance. Stone artefacts obtained from the excavation represent the late Acheulian phase, but the sediment above the floor is mixed with a few pieces of historical pottery and other material.

To observe the extension of this floor pavement, we also excavated in XC4 and XC5 in 2004 and cleared the surface already exposed in XD4, XD5, XE4 and XE5. Stone floors were found also in layer 4. We observed that there are actually three layers of floors made of flat stone slabs. Lower Palaeolithic artefacts were obtained from above the upper floor. From layer 3 we also found some re-utilised Acheulian artefacts. The sediment close to the surface is mixed with a few pieces of pottery and obvious Historic material. Loose sediment of layer 3 close to the surface in XC5 also yielded many microliths. It indicates that the rockshelter was used even in later periods, when Acheulian artefacts were still lying exposed on the surface.

Another floor, made of generally 20-cm-thick, flat large slabs, was also exposed in the main trench at the depth of -96 cm from XB4 (-168 cm from A1 datum). It was observed that the floor extended up to 3.5 m width in the exposed trench. A portion of it was also exposed in the extended trench in XB4(3), XB5(2,3), XA4 and XA5. It appears to extend also in the west and is slightly tilted in that direction, as is the natural slope. It was exposed at a depth of -82 cm from the surface (-170 cm from A1 datum) in XB4(2) and at a depth of -78 cm from surface XB5(2) (-192 cm from A1 datum) in XB5(2). This floor has been made on three more preceding layers of flatly arranged slabs, which are weathered. The lowermost (fourth) floor layer is in sandy laterite red soil and is resting on the bedrock at a depth of -240 cm from A1 datum. The four floor layers together are 69 cm in thickness.

Stone structure

A series of large stone blocks and slab pieces in the main trench and also in the rockshelter trench, from Lower Palaeolithic strata, appear to be intentionally arranged by humans. This matter is expected to become clearer in the next season's excavation, in 2006. The apparent stone structure rests in layer 4, and numerous Lower Palaeolithic artefacts have been found above, among and below it. The main body comprises six blocks and occurs in XB4 -21 cm to XA4 -95 cm NS × A4 -9 cm, to A5 -52 cm EW, i.e. 175 cm NS × 143 cm ES. The depth is -58 cm to -85 cm from surface XB4, the two big easternmost blocks are tilted towards west. The general body of the presumed stone arrangement consists of seventeen blocks (including those of the main body, and a large slab lying in A3 and A4 appears to have been included as part of the structure. It extends over XB4 -21 cm to A4 -80 cm NS × A4 -9 cm to A6 -58 cm EW, i.e. 260 cm NS × 251 cm EW.

Figure 19. *Cupules on northern wall of Daraki-Chattan, near entrance of passage.*

Replication of cupule creation

In order to understand the nature and fracturing of hammerstones we conducted experiments to replicate cupules in 2002 and 2003. Three cupules were produced at a site 7 m to the south of the cave entrance, under a small overhang, located at a convenient height (about chest high). Hammerstones used and cupules made were examined at intervals of 15 minutes. It was observed that most of the hammering surface flakes off if striking is forceful. This is the reason why we find small hammering surfaces on the hammerstones obtained from the excavation. The time of making one cupule, spread over two days, was six hours, but only one person worked on it. Its diameters in any direction are from 56 to 57 mm; it is nearly perfectly circular. Also, the cupule is nearly symmetrical, i.e. its deepest point is equidistant, both vertically and horizontally. The maximum depth ranges from 7.9 mm to 9.7 mm, depending on which opposing rim locations are used as reference. This provides a fair indication of the great labour effort in making well over 500 cupules, most of which are deeper than 10 mm, and many of which are smaller than 56 mm. Most modern humans would not be able to match the required skill in precise percussion, and considerable physical strength and determination are indicated.

Some hammerstones from Lower Palaeolithic levels are specially prepared from stout, pointed stone pieces. Comparatively deep cupules with good circular shape may be assigned to such hammerstones of Lower Palaeolithic/ Acheulian age.

General observations

In order to consider the cultural material in its total perspective and to understand problems posed by the excavation we (G. Kumar and P. K. Bhatt) thoroughly explored the region and discovered many cupule sites on the Indragarh-Chanchalamata hills, at Kanwala, Arnyabhau and Polabhata, in the exploration of the region in 2004. Lower Palaeolithic implements and cobbles occur in profusion around rock buttresses, and especially at Kanwala a lot of choppers and cobble tools were found along with Acheulian artefacts.

We also observed that fresh Acheulian artefacts occur in the exposed layer of lateritic soil at Barodia Fanta crossing on Gandhi Sagar Road, nearly 18 km from Bhanpura. Artefacts made from cobbles, like spheroids (bolas?), choppers, pointed choppers etc, were also found in the surrounding region. We are trying to understand the correlation between the evidence obtained in the excavation and that observed in the nearby region.

Daraki-Chattan is a Lower Palaeolithic site, yielding Lower Palaeolithic artefacts right from the surface and from all layers below it. From the top humus and to some extent from the following brown soil layers we also found some pottery and brick pieces, and microliths, which indicates that the site was occupied by man in these late period also.

In the early phase of the Lower Palaeolithic, the cave

Figure 20. *Cupules on northern wall, Daraki-Chattan.*

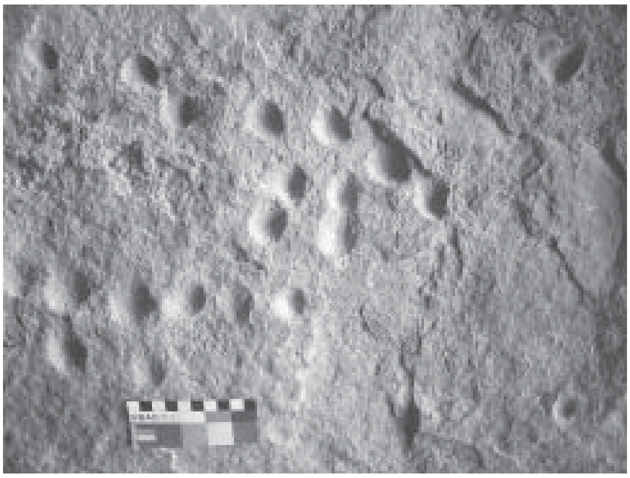

Figure 21. *Cupules on southern wall, Daraki-Chattan.*

was a tool-manufacturing site. It yielded cobbles used as cores, flakes, unfinished tools (from XB5(4) at depth -161 cm from XB4, red laterite soil), reused artefacts etc. A few were also re-utilised from layer 3 upwards, particularly from the rockshelter trench and from the western part of the main trench. In the upper part of the stratigraphy, XA4(4&3) and XA4(1) yielded a good number of fine Lower Palaeolithic artefacts at depths of -20 to -40 cm from surface. Lower Palaeolithic patinated chert flakes and chert artefacts also occur right from the base of the excavation to its uppermost horizon. They include a patinated chert artefact from XA3(2), 64 cm from XA3, 45 cm from A3, at -127 cm depth from surface (-180 cm from A1); and a utilised and retouched knife-like artefact of a patinated Acheulian chert flake from XA5(3), 44 cm from A6, 75 cm from A5, at -10 cm from surface (-166 cm from A1).

The excavation at DRK has yielded definite evidence of human visual creation from the Lower Palaeolithic in the form of petroglyphs, both cupules and engraved lines, and also as hammerstones used for producing cupules. This is evident from the discovery of slabs bearing cupules and engraved lines, and of hammerstones right from the lowest layer 6 onwards. Although many hammerstones used for the production of the cupules were found, they are not in proportion to the very numerous cupules present in the cave. Acheulian floors or stone structures are rare features in the Lower Palaeolithic. We have to continue excavation and exploration work to understand the exact nature and extension of these features.

In most of the trench it appears that we have now reached the bedrock or a bedrock-like slab. However, the area of excavation is limited and in XB5(3) we are still encountering red laterite soil even at the depth of -295 cm from A1 datum, and in XA2(1) at a depth of -275 cm from A1 datum. Hence we have to check and confirm the bedrock in the 2006 season.

The rock art and archaeology of Daraki-Chattan

G. Kumar and R. G. Bednarik

The site

The cupules in Daraki-Chattan were first noticed by local rock art scholar Ramesh Kumar Pancholi on 2 October 1993 (Figs 19 to 22; see also front cover and two images on back cover). One of us (GK) examined the site in June 1995 and, upon finding stone tools of Middle and Lower Palaeolithic types on the floor of the cave, in its vestibule and near its entrance, undertook a detailed study of the site (Kumar 1996). The site was surveyed and the distribution of the cupules was mapped on both walls. In the subsequent months, 244 cupules were recorded and numbered on the cave's north wall, 254 on its south wall (including six doubtful specimens). In subsequent years, several more cupules were found on these walls, their total number now being about 510.

The passage of Daraki-Chattan is quite narrow. At the point where the cupules begin, just after a prominent step in the rock floor, it is 1.1–1.2 m wide and then narrows progressively. The cupules located furthest from the entrance have only 40–41 cm clear working space. It would have been correspondingly difficult to make these, and they are relatively small, but still made by remarkably well-directed blows. They are on the southern wall, and from their positioning some must have been made by left-handed people. In some cases on the northern wall, cupules are incredibly small and yet still deep. In the most extreme case observed, the diameter is 25.5 mm, depth is 9.2 mm, with a quite pointed cross-section. There are several other specimens approaching this extreme diameter : depth ratio. In general there is a tendency in the vertical cupules to have the deepest point of the cupule floor below the cupule's geometric centre point. This aspect is more pronounced in those cases where the ratio of diameter-to-depth is lowest. Similarly, the 'tail effect' (larger diameter curvature of cupule floor) nearest the upper rim is most distinct in the smallest and deepest cupules. These morphological aspects suggest that blows were preferentially applied from slightly above rather than perfectly horizontally. The same characteristics have been observed on other vertical cupule panels, specifically on Chief's Rock in Auditorium Cave, Bhimbetka (Bednarik 1996).

Most of the wall cupules relate in their height to the present floor level, much of which is bare rock. There is very little likelihood that the floor was higher in the past, it slopes markedly (about 7º) upwards and heavy rains result

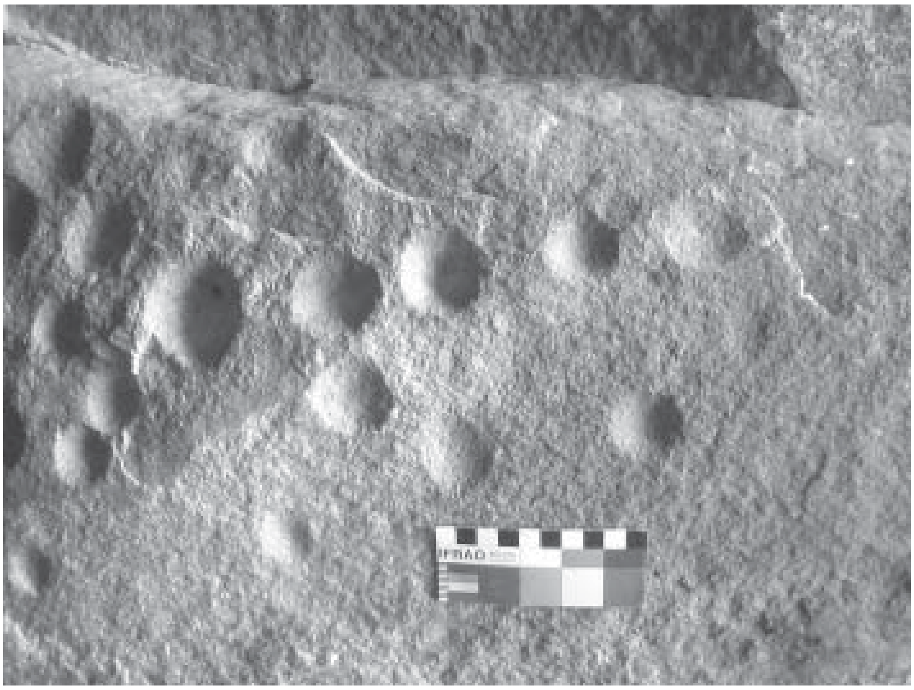

Figure 22. Close-up of cupules on sothern wall, Daraki-Chattan, c. 2.5 m above the floor.

half of the passage, located between 3.60 m and 4.02 m above the rock floor. A few more, up to 3.34 m above the present thin clastic deposit, are in the rear part of the cave. One of them has only 40 cm clear space in front and was certainly made with a left hand. Some of these uppermost cupules are rather shallow and hard to identify, no doubt due to the precarious working positions they relate to (Figs 23 and 24).

Many of the cupules appear to be grouped in some form (Kumar 1996: Figs 5 and 6), but the degree of intentionality involved in their patterned placing needs to be questioned. In several cases sets of aligned cupules are close to rock edges or distinct ledges that would have prompted or governed the grouping of sets that appear linearly arranged. In a few cases, however, the alignments seem to be independent of any pre-existing feature, the most outstanding example being a group of six cupules forming an arc. Five of them are in contact, i.e. overlapping others. Most other groupings, however, are perhaps a result of convenience, of subconscious reactions, or of conscious choices not corresponding to modern constructs of spatiality. The overwhelming majority of cupules appear to be randomly placed. A few occur on a rock ledge forming the southern margin of the cave floor, and two more were placed on the actual rock floor of the passage. One solitary cupule occurs on the southern wall of the entrance area, just above the collapsed rock (see below), where it managed to survive the extensive exfoliation that occurred in that area. Another was found nearly 170 cm above the floor where the southern wall turns south. Apart from these two exceptions, there are no surviving cupules outside the distinct floor step at the cave entrance, which separates the entrance area or vestibule from the interior of the cave. Finally, there is a boulder measuring about one metre, some eight metres from the cave on the slope below the entrance, which bears several apparent cupules that are so weathered that they are almost beyond visual detection.

The quartzite facies of Indragarh Hill is very similar to that forming the Bhimbetka complex: heavily metamorphosed, with

in laminar flow discouraging the establishment of fine sediment. The spatial distribution of the cupules densely covering much of both walls of the passage suggests that their makers averaged a body height in the order of 1.7 m to m 1.8 m, in terms of the maximum reach in positions from which it is possible to work. However, there are also a few isolated cupules at great heights. All of these occur in locations where it is convenient to work by standing on ledges found on both walls by straddling the cavity, which narrows progressively towards the top. All cases of high cupules seem to be limited to the southern wall, although the northern wall would have been just as accessible for making cupules. Four high cupules occur in the outer or first

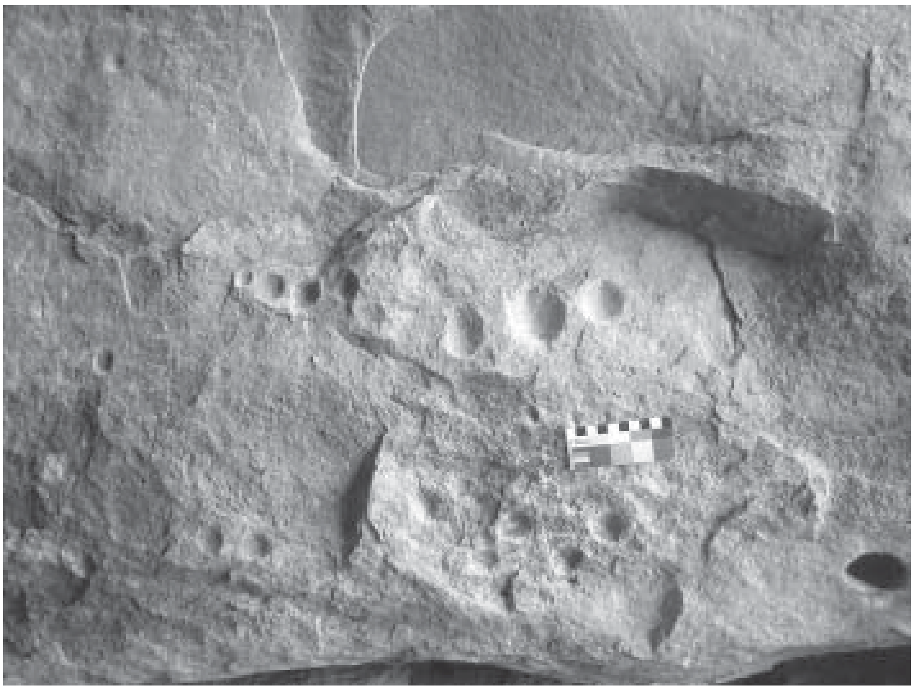

Figure 23. Cupules on southern wall, Daraki-Chattan, 3 to 4 m above the floor.

crystallised silica cement, of such quality that most of the local lithic industries are made from this stone. Noteworthy geological features in Daraki-Chattan are three veins of fully silicified silcrete breccia in the rock floor of the cave, ranging in width from a few centimetres to 20 cm. These are of ancient sediment filling, containing large angular clasts. The breccia later eroded back to the floor level in most places, but about 3 m from the floor step this facies rises above the floor. The breccia fill is much older than the human use of the cave and may chronologically relate to the similarly silicified coarse conglomerate on the plateau above the cave, which postdates an ancient river course found there. The first 2 m of the northern wall within the cave is exposed to run-off from the dripline c. 8 m above. Beyond a distinctly demarcated vertical line, there is no evidence of current run-off on the wall, and water ingress from the back of the cave appears to be only slight. Nevertheless, this may have been more active in the past, leading to the fluvial removal of the finer floor sediment fractions at times, perhaps with alternating phases of fine sedimentation. Apparent calcium carbonate precipitates are common on the undersides of rock ledges in the cave, and apparent silica lacing is extensive on numerous rock surfaces in the cave and nearby.

Figure 24. *Cupules high on southern wall, Daraki-Chattan.*

The exfoliated cupules

Our examination of the site initially focused on the almost complete absence of cupules on the walls of the entrance part of the cave. In the vicinity of the floor step, much of the lower part of both the northern (Fig. 25, see far left) and southern walls (Fig. 26, upper left) has been subjected to natural exfoliation. Since the wall areas affected by this process coincide roughly with those experiencing occasional direct solar radiation in the late afternoon, we made two reasonable assumptions: that exfoliation had been caused by insolation, and that this had occurred since the cupules were produced. This would explain the absence of cupules on all exfoliation scars, and the occurrence of one single cupule on a remnant of the earlier surface below the main exfoliation area on the southern wall. However, the possibility that the exfoliation scar on the north wall (Fig. 25) was caused by fire rather than insolation cannot be excluded. It has a roughly conchoidal fracture surface and stress marks; impact from falling rocks is impossible because it is shel-

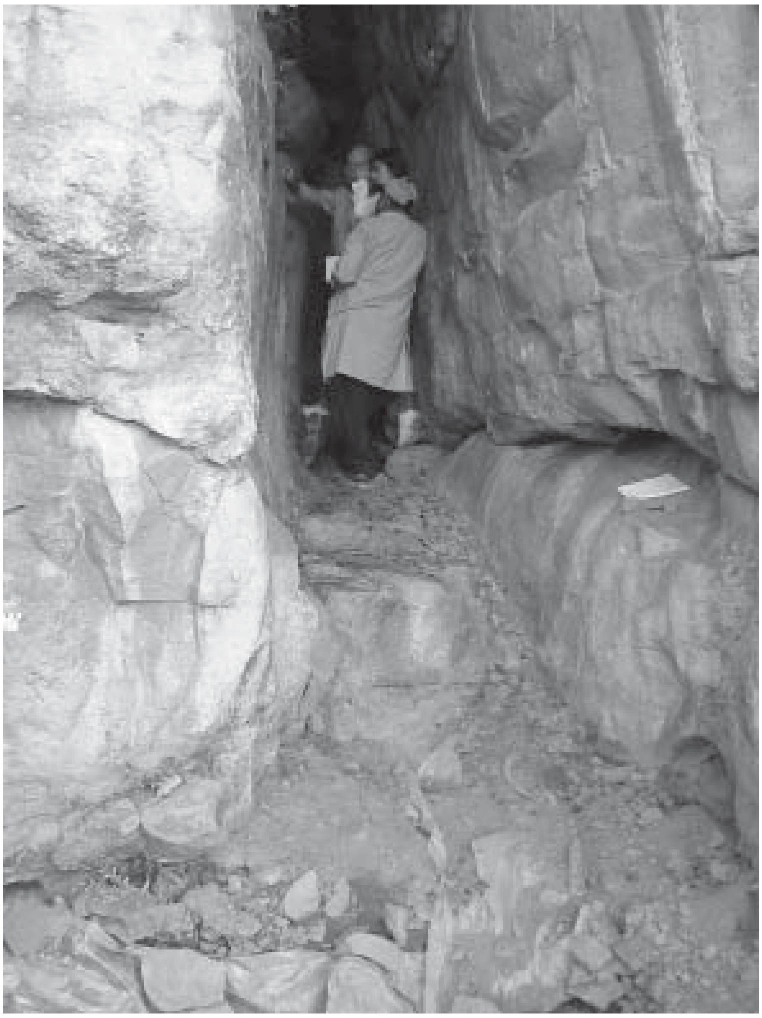

Figure 25*. Daraki-Chattan, passage entrance. Note floor step and exfoliation scar on left wall.*

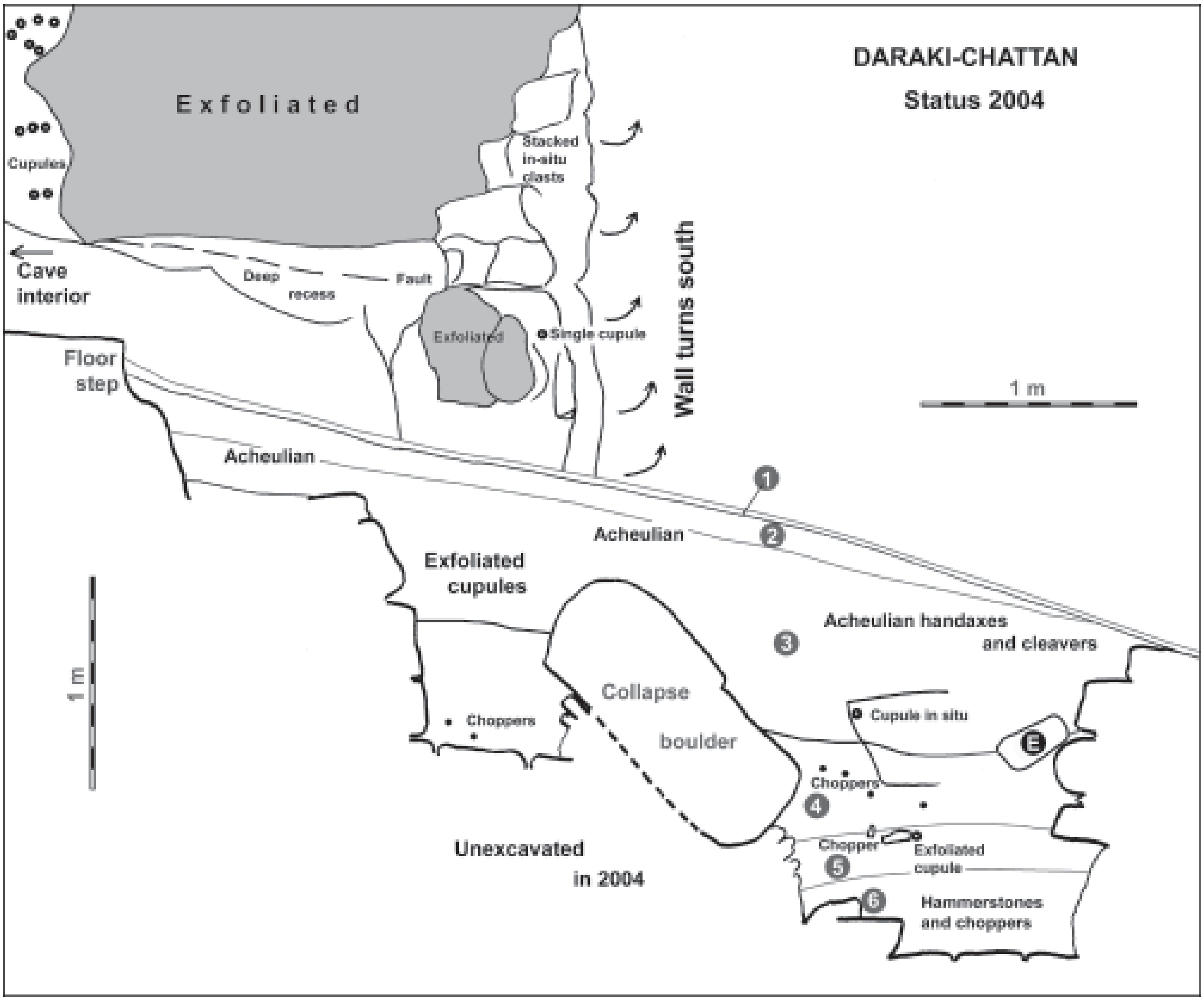

Figure 26. *Generalised section view of the entrance of Daraki-Chattan, looking south, showing the spatial relationships of the exfoliated areas on the southern wall, the outermost wall cupules, the six sediment layers, and the principal features contained in them, such as exfoliated slabs bearing cupules. The engraved boulder (E) and the excavated in-situ cupule are also shown. Status November 2004.*

tered in a shallow alcove.

It followed from this deduction that there would be a fair probability that at least some of the exfoliated wall panels should occur in the substantial floor deposit outside the floor step (Fig. 26). If so, their time of deposition must necessarily postdate the exfoliation event, and if any of the fragments should bear cupules, these must necessarily have been made significantly earlier than the time of deposition. If such fragments were found in datable sediment layers, this would provide a conservative minimum age for the rock art. This reasoning was the principal rationale for the excavation at Daraki-Chattan (see previous Chapter). Other motivations were to establish the vertical extent of hominin occupation evidence, the typology of the lithics, the acquisition of dating evidence, and most especially the vertical distribution of hammerstones used for the production of the more than 500 cupules, of which at least some were expected to be present.

In view of the relatively low sediment pH of the site, the excavation of a large part of the cave's entrance area was not expected to produce any osteal remains, and in view of the suspected water seepage there was limited hope of finding charcoal. The excavation yielded not only hundreds of stone artefact, but also a large number of exfoliated slab fragments, many of which still bore cupules on their outer surfaces. These cupule-bearing slab fragments were vertically distributed through most of the sediment, almost down to bedrock, which indicates that the exfoliation process was very slow and gradual, rather than occurring over just a limited time period. During the 2002 excavation campaign it was noticed that two sections of a cupule on exfoliated slab fragments fitted together, which prompted a search for more connecting pieces. Seven such excavated slab fragments bearing a total of seven cupules were thus assembled successfully (Fig. 17). This reassembled slab is 95 cm long, 49.5 cm wide at right angle to the longest side, roughly rectangular but with one section of about 20 × 24 cm missing from one corner. Its thickness varies, being up to about 10 cm on the thicker end (the left end in Fig. 18).

The surface condition of this assembled slab suggests excellent preservation, but close examination of the cupules indicates that the surface surrounding some of them may be more recent than the cupules themselves. This impression is created by the very reflective crystal facets on the surrounding surface, compared to the dull and weathered surface in the cupules, and also by the perimeter of the cupules. It appears that the surface of the cupules has withstood whatever process caused the surrounding surface. This seems to have been heat, because there are several scalloped scars on the surrounding surface, only 1 or 2 mm deep, tapering down to thin slivers in the opposite direction, mimicking the pattern of heat spalls on granite. Since the slab was found in the deposit with the decorated face up, it is possible that it was part of a living floor, which would readily explain the effects of fire damage and also account for some wear through foot traffic. It is also evident that this surface exfoliation is localised. For instance, close to its most obvious extent, near the wide end of the slab, is an area morphologically dominated by several stress marks resulting from the detachment event. These are worn and weathered, but there has certainly not been any major exfoliation in this area.

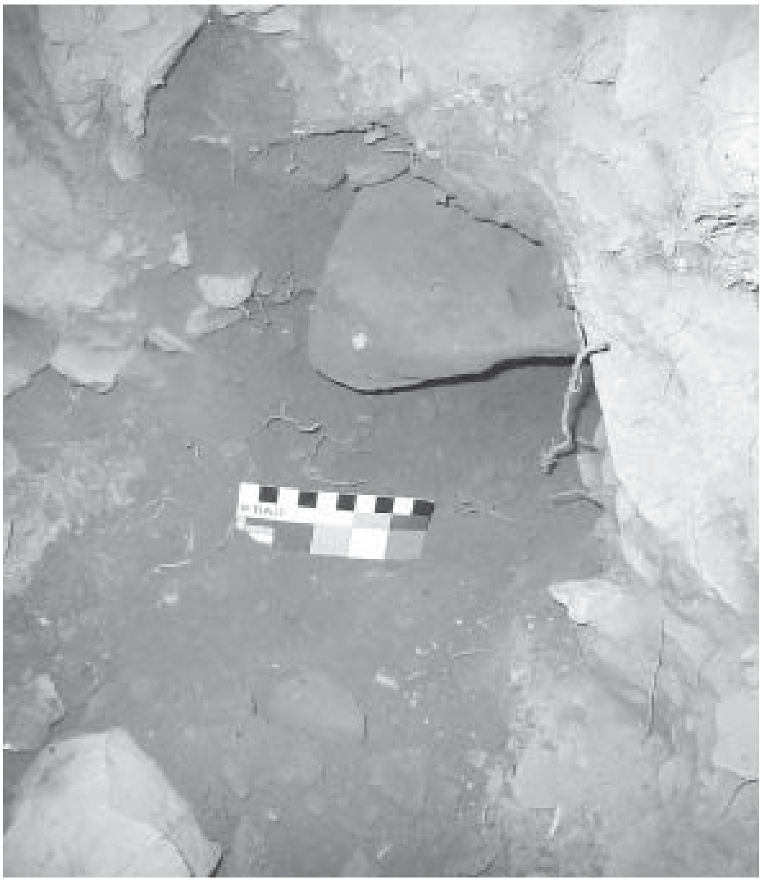

Figure 27. Slab fragment with cupules at the moment of its discovery in the sediment and OSL sampling hole DC-1. The first cupule has just become visible, the slab is still in situ.

Besides the slab fragments incorporated in this panel, the 2002 excavation of the uppermost 80 cm of the deposit also recovered four more cupule-bearing slab fragments, but they could not be connected to any other finds so far. A relevant factor to be considered is the lack of rounding along the various fractures of the slab fragments. The rounding is very significantly greater on the four unconnected fragments than on the assembled slab, by a factor in the order of ten. It would be hard to account for such a great difference except by a significant time interval between fracture events. While it is possible that several fragments became dislodged in a single event, it is perhaps more likely that the seven reassembled fragments remained in one piece until very much later. It could have been broken by later rock-fall or by human activity. The three other pieces excavated in 2002 are more weathered and bear more surface accretion.

During the sampling for one of the first three OSL (optically stimulated luminescence) determinations (DC-1) on 28 September 2002, a rock slab prevented the insertion of the caesium probe to measure the sampling site's gamma radiation. This occurred in the presence of numerous witnesses (all samples were removed under the strictest supervision of appointed officers of the Archaeological Survey of India), and a cupule was found on it before its removal (Fig. 27). After it had been extracted with some difficulty, it was found to bear a second cupule and an apparent part of a third on its other end (Fig. 28). Nearby, in the south-east corner of the excavation, a long, vertically deposited slab fragment of 5 cm thickness protruded 12 cm above the excavation floor at the time. It was found to bear a further cupule, truncated by its end fracture (Fig. 29). Five further slab fragments bearing cupules were also excavated in 2003, at greater depth and west of the collapse boulder. In all, a total of twenty-eight cupules and one doubtful specimen have now been found in the excavation, at varying depths throughout much of the Lower Palaeolithic deposit (Fig. 26). All of the cupules on the walls appear to derive from a single period of cupule production. There are no obvious indications of greatly varying ages or differences in weathering (cf. microscopy, below). If this is the case, then the cupule production phase must correspond to the lowest sediment deposit, and exfoliation has occurred at various times over the duration of much of the site's sedimentary history. In the event that

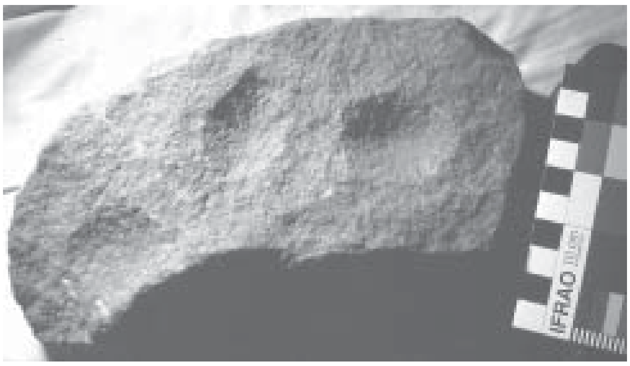

Figure 28. The slab fragment in Figure 27 after removal.

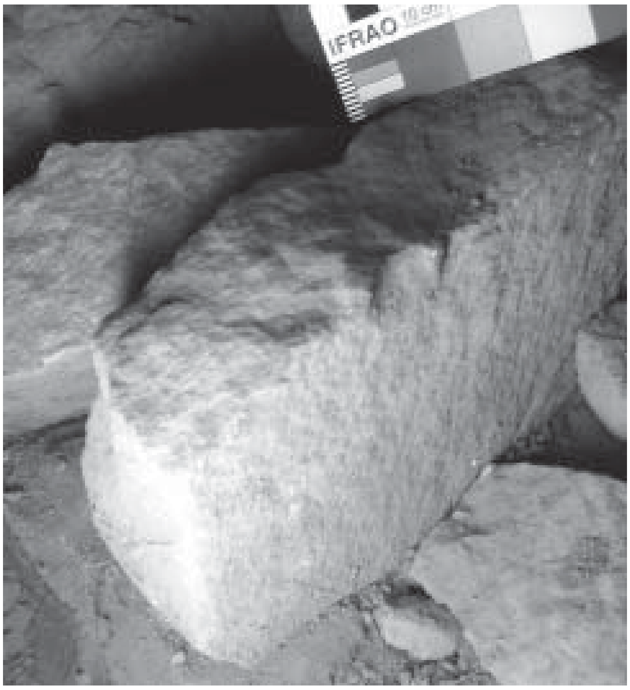

Figure 29. *Upper end of a long, vertically deposited slab bearing a partial cupule, found under Acheulian tools.*

cupules were made over a much greater time span, the first to exfoliate and become buried must still be of an antiquity corresponding to the lowest sediment deposit, but others could have been made much later. However, the concentration of hammerstones of the type used to make petroglyphs (Bednarik 1998) just above and below the 'pavement floor' (see below) renders the first possibility more likely. In either case, the lowest occurrence of exfoliated slab fragments with cupules coincides with the earliest evidence of human occupation at Daraki-Chattan.

Stratigraphy and stone implements

Bearing in mind that this is only a preliminary report and that no sedimentological and little other detailed analytical work has been conducted at this early stage, only the broadest detail is provided here. After establishing in 2004 that the large boulder in the central part of the cave's entrance deposit broke from the bedrock face to its east (the two fracture surfaces match, both in shape and petrographical strata), we divided the sediment stratigraphy into 'pre-collapse' and 'post-collapse' phases. As is evident from Figure 26, upon becoming detached from the rock face to the left, this boulder slid down and came to rest in its present position. We estimate the boulder's weight to be close to two tonnes — a formidable barrier to further excavation — but it was removed in 2005 (see above) and the sediments sealed by it were excavated almost down to bedrock. The stratigraphical distribution of the lowest stone tools indicates that the collapse occurred after the time of the site's initial use by humans. The few chopping tools found to the east of the boulder seem to postdate its collapse, but several other anthropic features on its west side appear to be on the floor on which the boulder came to rest, and continue below it. The latter include stone implements, hammerstones, an apparently artificial floor of several slabs, and one small slab with two cupules.

The large collapse boulder is maximal 1.4 m long, 1.2 m wide and 64 cm thick, of distinct horizontal stratification, now separated from its parent surface by 50 to 60 cm, having broken from it vertically. The quartzite stratum forming the bedrock face it broke from is inclined about 9º, dipping west as does the general facies. The collapse boulder was inclined 54º. Most of the vertical fracture face is flat, 90 cm wide, except the northernmost part, which is 50 cm wide and angled at 30º outward, i.e. west. The outermost part of the collapse boulder probably fell only in the order of 40 cm before it came to rest in its present position, while its inner, i.e. eastern part became raised relative to its previous level.

Prior to the availability of the results of sediment analyses little should be said about the deposit. It is high in regolithic clasts, clearly derived from local breakdown, and low in clay fractions. Saprolithisation increases markedly as a function of increasing depth. The upper strata have experienced water sorting, probably up to the sand fractions, which renders any age estimates derived from them, including OSL analyses, questionable. We thus assume that wetter conditions caused limited sediment transport of the finer fractions in the upper strata, in the direction of the slope (west). Most notable is the difference between the preservation of clasts in the upper and lower halves of the column. Whereas the upper coarse detritus is relatively well preserved, that of the saprolithic lower half is deeply weathered and often coated by ferromanganous accretions. It has clearly experienced conditions of waterlogging, and this is also reflected in the redder colour of these lower sediments.

So far, six sediment samples have been secured for OSL analysis from Daraki-Chattan, and the relevant gamma radiation levels for them have been determined in accordance with standard procedures. The surplus material from these and the two back-up samples from each sampling site will be the initial source of material for sedimentary analysis. During the 2002 field season, three samples were collected from the uppermost levels just inside the dripline. Sampling commenced on 27 September and continued for three days and two nights (OSL samples must be collected in complete darkness). To gain a better understanding of the site's radiation regime, we also took three readings on nearby bedrock surfaces. As already mentioned, during the collection of sample DC-1 we had to extract a rock fragment from the cylindrical sampling hole, on which we found cupules (Fig. 27). The remaining three sediment samples were secured on 8 December 2004. DC-4 is from below the apparent slab pavement, at 142 cm depth, where stone tools occur in abundance. DC-5, 127 cm below floor, was taken from immediately below a large chopping tool and above a slab fragment with two cupules. DC-6 is from under the shelter roof to the north of the main excavation. In each of these three sampling holes, stone tools were recovered, including small flakes and, within DC-6, a hammerstone. All sediment samples and related measurements were taken under the strict supervision of appointed officers of the Indian Archaeological Survey.

A notable feature in the stratigraphy is what appears to be an intentional arrangement of stone slabs to form level floors or 'pavements' (Fig. 30). While it is possible that these features are merely the result of trampling, causing the horizontal orientation and alignment, we regard it as too striking to be entirely fortuitous. This impression is strengthened by the concentration of stone tools, including several hammerstones, immediately above this horizontal feature.

As mentioned above, one solitary cupule was excavated in situ, located on the edge of a very large angular boulder. This boulder, just outside the cave's dripline, was only partly exposed by the excavation, over 120 cm by 90 cm, but it appears to be significantly larger and may rest on bedrock. It is only 44 cm from the nearest point of the collapse boulder and well below it. Its flattish upper surface slopes down towards north. There is an extensive area of use wear, perhaps from foot traffic as well as human activities, measuring 56 cm by 28 cm, showing heavy subsequent weathering. The cupule occurs on the boulder's upper eastern edge, just a few centimetres from the southern face of the excavated trench (Fig. 31). It is about 50 cm above the apparent slab floor, on which we found several hammerstones, as mentioned. This cupule has a maximum diameter of 44 mm, minimum diameter 34 mm, is 16.2 mm deep and well shaped. It occurs c. 60 cm below the present floor level and is overlain by numerous Acheulian tools, and stratigraphically by exfoliated slabs bearing wall cupules.

An exfoliated slab bearing two cupules was excavated lying flat directly on the slab floor, with the cupules on its underside (Fig. 30). About 60 cm east of it occurred a typical hammerstone (marked in Fig. 30), which was at the same level as a second hammerstone further east-southeast (Fig. 32). This fragment, the lowest recovered among the many cupule-bearing fragments excavated by late 2004, suggests that some of the original wall cupules pre-date this floor and the collapse event. It is unlikely that slabs with cupules would have exfoliated shortly after the cupules were made. These circumstances, together with the occurrence of hammerstones below the apparent pavement suggests that at least some of the wall cupules may have been made during the early phase featuring the chopping tools.

The preliminary examination of the substantial stone artefact assemblage recovered from the excavation suggests three broadly definable traditions. The upper sediment units

Figure 30. *Remains of 'slab floor' in sediment layer 5 (on left), fragment with cupules (under left scale) and hammerstone in situ (next to right scale).*

Figure 31. *Cupule excavated in situ, made on the edge of a very large, only partially excavated angular boulder. The south face of the main trench is visible, the sediments contained Acheulian artefacts.*

Figure 32. *Hammerstone in situ (behind scale), sediment layer 5.*

too corroded to be amenable to microwear analysis.

A particularly important component of the archaeological sequence of Daraki-Chattan is the assemblage of the lower deposit, from the sediment that has experienced considerable postdepositional modification, especially through waterlogging. The implements are reminiscent of chopping-tool industries with cobble tools. This industry appears to be related to the lowest assemblages Wakankar has reported from three sites at Bhimbetka (III F-24, III A-29 and III A-30), and which have also been reported elsewhere in India (Ansari 1970; Armand 1980). This possibility is reinforced by the presence at Daraki-Chattan of laterite, occurring also at Bhimbetka, perhaps referring to distinctive environmental conditions. Moreover, like the chopping-tools at Bhimbetka, those at Daraki-Chattan are also deeply corroded or saprolithic. The most distinctive typological elements in the chopper industry at Daraki-Chattan are a few very thick bifacial chopping tools. They have a flat base opposite a distinctive, zigzagging convex working edge that was created by the removal of deeply conchoidal flakes, alternatively from each side. The geometrical regularity of this coarse retouch and consistent morphology suggest that this is not a by-product, a core, but that the removed flakes were the by-product. Another feature of this industry is the occasional occurrence of polyhedrons. It is obvious that this assemblage needs to be closely compared with similar stratified finds elsewhere in India, and that the chronology of the Middle Pleistocene laterisation events in central India needs to be resolved. For the moment it will suffice to make one categorical observation: the period of cupule manufacture at Daraki-Chattan, or at least its earliest phase (if it should have continued later on, for which we lack evidence), coincides with this chopping tool industry with occasional handaxes. The archaeology has shown this unambiguously.

exhibit neither clear Acheulian nor typical Middle Palaeolithic features, being a rather indistinctive ‘intermediate’ industry. The absence of points and the presence of at least two Micoquian-type bifaces are perhaps diagnostic features (Fig. 33a). Overall there are few handaxes present but there are one or perhaps two rough awls or borers. Acheulian handaxes (Fig. 34) and cleavers occur with few large Levallois flakes featuring broad striking platforms and typical tortoise-pattern flaking indicative of core preparation. A specific type of flake tool is a very broad, Clactonian-type flake. It is comparatively thin (at least in terms of the quite coarse raw material), has a distinctive striking platform, usually flat, and a striking angle of c. 110º. These flakes are almost 20 cm wide, 12 or 15 cm long from the platform, and have therefore long and broadly curves edges. These bear little retouch, if any (Fig. 33b). Other utilised flakes are mostly smaller and relatively thick and chunky, bearing several dorsal flake scars. These are often under 10 cm in maximum size. On the whole, the industry is clearly intended for woodworking, although far

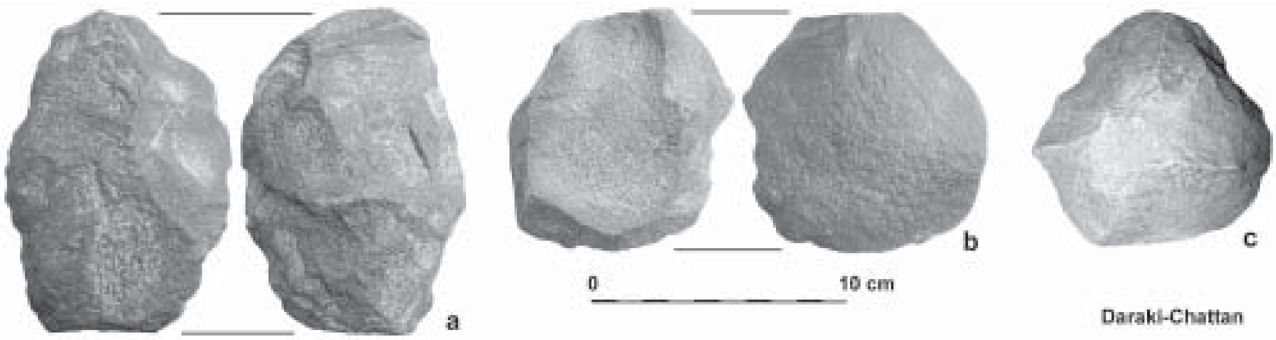

Figure 33. *Some of the Lower Palaeolithic stone tools excavated from well above cupule-bearing slabs: a - asymmetric biface, b and c - flake tools with Levallois-type preparation.*

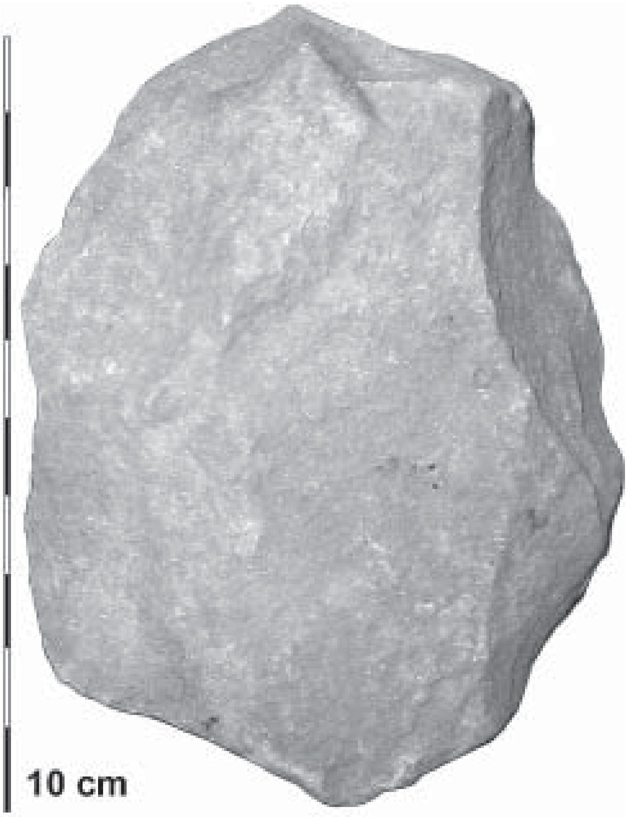

Figure 34. *Acheulian handaxe excavated from sediment layer 3 in Daraki-Chattan.*

Figure 35*. Hammerstone with multiple wear facets, one of which is visible above the millimetre scale. From sediment layer 5 in Daraki-Chattan.*

For the present purpose, the occurrence of definite petroglyph-making tools (mur-e; cf. Bednarik 1998) is of even greater significance. Such tools, called *hammerstones* here, have been shown to be of a specific weight range and morphology elsewhere, they possess typical wear facets, and they have previously been studied ethnographically, archaeologically and in several replication experiments (Bednarik 1998). As a rule they are 160 g to 200 g in weight, and those from Daraki-Chattan have sharply demarcated wear facets of 20 to 30 mm length, i.e. they are heavily worn. The wear facets always occur on the most protruding aspect of the tool, and these implements always fit well into the human hand (Fig. 35). There are rare specimens with two or more (up to four or five) impact facets. However, the hammerstones range from those with very distinctive wear facets to those that require detailed microscopic examination before they can be accepted or rejected as authentic. This is because they are sometimes severely corroded. In all cases examined, the impact zones coincide precisely with the areas that would show damage had the stone been held in the position in which it is most comfortable in the hand. However, in at least one case, that position seems to indicate that the hand was slightly larger than an average modern hand. Also, the hammerstones are slightly larger on average than those known elsewhere (e.g. in Europe and Australia), therefore it is likely that pygmies can be excluded from the making of the cupules. This is of relevance because of the tiny post-cranial find from the Narmada site (see above). Our impression is that the makers of the Daraki-Chattan cupules had comparatively large hands, and this seems to be confirmed by their massive chopping tools. However, they were also incredibly skilled in making very precise cupules, a most demanding skill on this extremely hard rock.

Engraved grooves on boulder

The large corpus of cupules in Daraki-Chattan is not, however, the only evidence of Pleistocene rock art at this site. The 2004 excavation campaign yielded a further example from the Acheulian deposit (Fig. 36). When a boulder was removed from the excavation it was found to bear two distinctive grooves thought to be artificial. Our microscopic examination of the grooves has confirmed this.

The block is fairly rectangular in shape and measures 66 cm × 51 cm × 35 cm. Its former upper surface is a flattish but undulating panel with several natural depressions, bearing extensive dark accretionary deposits, almost certainly ferromanganous. The same accretion, up to several mm thick, occurs on all other blocks at the level where it was found and below it, and to the west of the collapse boulder, including on that boulder. It is absent inside the dripline, which suggests that the accretion derives from run-off from the plateau above. The origin of the iron deposits in the sediments of Daraki-Chattan is probably from either red soil or a laterite facies on the plateau above that is now fully eroded.

Other material from the lower strata is similarly weathered, with the subsurface below the accretion being quite crumbly. Much of the metamorphosed colloid silica has been removed in this zone, and there is a distinct presence of iron oxides indicated by red colour. On the block bearing the grooves, the accretion is exfoliating, especially on its ‘right’ (seen with the grooves on the panel’s lower part).

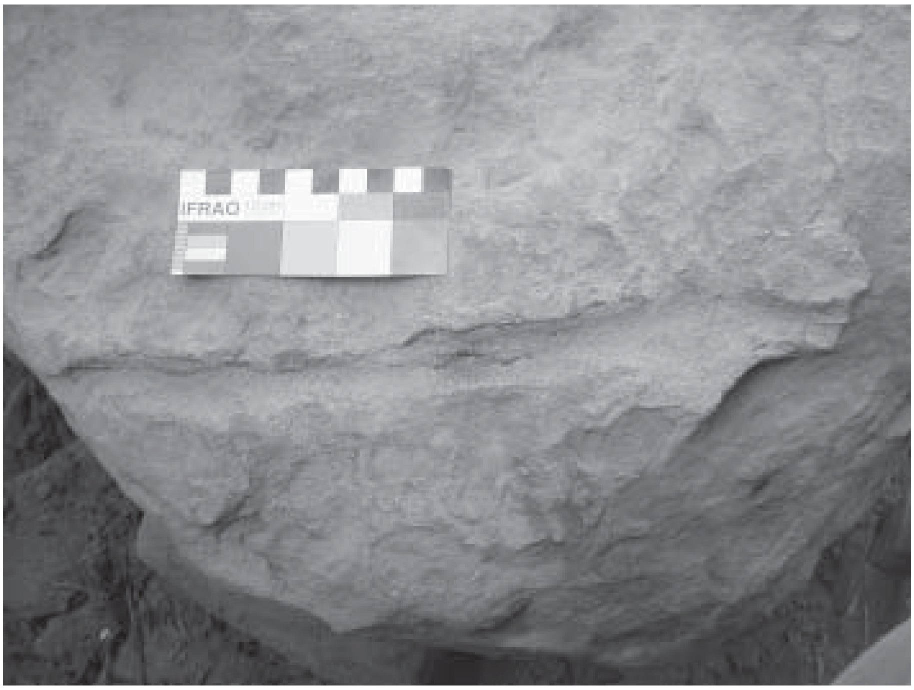

Figure 36. The longer of two engraved grooves on boulder from upper part of sediment layer 4 (see colour version on back cover).

The longer of the two grooves runs diagonally across the 'lower right' corner of the block (Fig. 36, see also colour image on back cover). Its 'upper' end is truncated by exfoliation scars, where the accretion is several mm thick. The groove's other end is truncated by the most recent of the main fractures of the block. The groove has a maximal length of 29.3 mm, its width ranges from 14 mm to 21 mm, but in general it is very consistent at an average of about 19 mm. The groove section is distinctly U-shaped, and its manufacture by an abrasive process is emphasised by the tendency of a slight increase in depth and width across the two surface rises along the groove's course (Figs 37 and 38). The maximum difference between the two rises and the intervening depression along its course is 7.4 mm. The actual depth of the groove ranges from 2.0 mm to 6.9 mm, but as there is extensive accretion along the margins of the groove where preferential deposition occurred, these measurements are deceptive. Without removing the accretion, the true depth of the groove can only be estimated, but it seems to range up to about 4.5 mm at the rises, and was close to 2.0 mm in the depressions. The relative consistence in groove width, despite these distinct variations in depth, underlines the 'flow' and

The block originates from roughly above OSL sample DC-4, its lower surface 68 cm below the present floor, or c. 15 cm above the horizontal slab floor that underlies a significant concentration of implements, while its uppermost point was 35 cm below the present floor (see Fig. 26). Above it, and in close vicinity, eighteen Lower Palaeolithic tools were recovered. The condition of its subsurface indicates its stratigraphic integrity: it is not as deeply weathered as the lowermost clasts, where the accretion is lacking, and it is not from the upper sediment unit with its low weathering and lack of accretion.

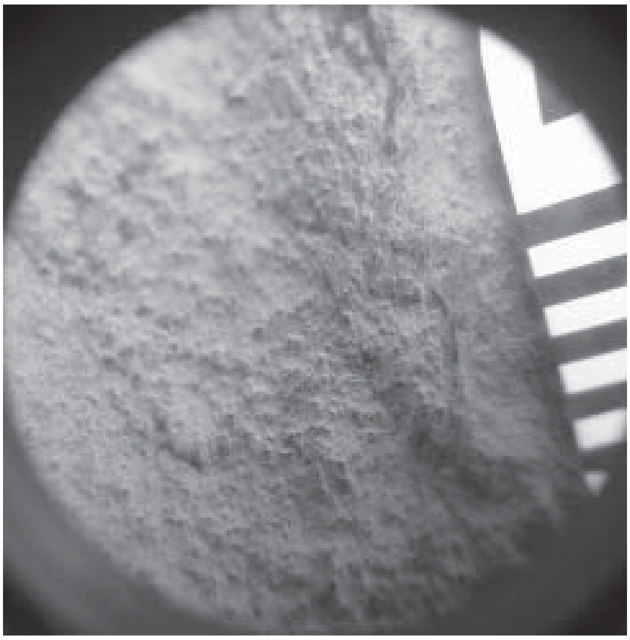

Figure 37. Microphotograph of the floor of the long engraved groove, showing the 'flow' of the line.

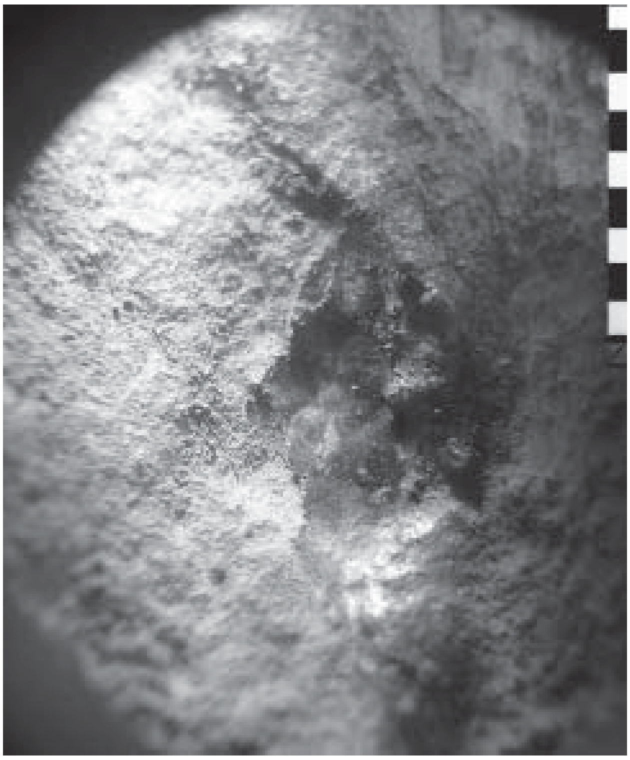

Figure 38. Microphotograph of the long engraved groove, showing exfoliating ferromanganous accretion. Scale in millimetres.

abrasive nature of the marking, which would have been made gradually and with considerable and prolonged effort. This is best observed by touch, as the finger tip detects this consistency in the 'flow', except for two places where the accretionary deposits extend into the groove, being in the order of 1.5 mm to 2.0 mm thick in places. The groove deviates very little from a straight line, only about 5 or 6 mm. There is not the slightest indication that it may have been begun by first making a line using percussion, the method applied in the Bhimbetka linear petroglyph, also of the Acheulian. It is assumed that traces of such preparation work would be detectable along the margins of the groove, but these are lacking entirely. It is therefore suggested that the marking was made by abrasion alone.

Further to the 'left' of this groove is a shorter groove, occurring at a low angle to the 'lower' edge of the panel. It is truncated by exfoliation scars at both ends. This second groove has a maximum length of 8.3 cm, its near end being about 18 cm from the nearest end of the long groove. This line is also straight, forming an angle of 107° with the average direction of the long groove. The short groove appears to be narrower, but this is clearly caused by the accretionary deposit, which emphasises the margins by preferential deposition. The present width of the short groove is around 14 mm, and the original width appears to have been 17 mm or 18 mm. The depth ranges from 2 to 3 mm.

It is possible, if not likely, that the two grooves once formed parts of a single marking, that they were connected, because they are both truncated by the same, most recent of the margin fractures of the panel. The clast bearing the continuation of this marking has not been found yet, it may well be in the immediately adjacent, unexcavated deposit to the west (see location in Fig. 26). At the very least it is highly likely that the two grooves were made at about the same time. The possibility that the two grooves once formed parts of a larger design is also implied by the 'upper' end of the long groove, which shows the start of a curvature. This could have been a groove meandering over a flattish slab panel. There is, however, no evidence of cupules on the remaining portion of this panel.

It is certainly remarkable that at both sites now shown to contain Lower Palaeolithic petroglyphs, Daraki-Chattan and Auditorium Cave at Bhimbetka, a number of cupules co-occur with linear markings. However, before much significance is read into this, several points need to be considered. In the Bhimbetka composition, the large cupule and the meandering line are directly related, as part of the line 'wraps' around the circumference of the cupule. This line was clearly produced by percussion, as were all cupules.

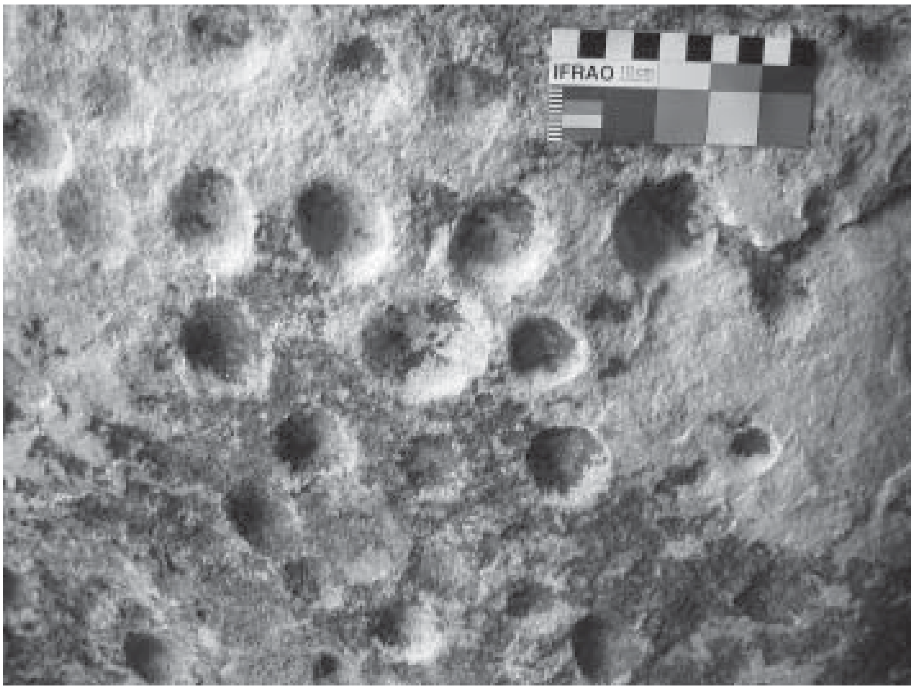

Figure 39. *Close-up of wall cupules on northern wall, Daraki-Chattan, showing their deep weathering.*

The Daraki-Chattan grooves, on the other hand, are regarded by us as the result of abrasive action, and they are quite possibly younger than the (early) cupules at that site, but they are still of the Lower Palaeolithic. This engraved block was found too much above the lower occupation floor to be regarded as related to it, although it would of course be possible that it was located somewhere higher up and merely slid into its present position at some later time. As this is impossible to know it is best to leave this issue open.

Microscopy of cupules

One of us (RGB) has examined several of the in-situ cupules of Daraki-Chattan microscopically. This shows that the surface of the northern wall, at a point where run-off water can occasionally just reach the panel (about 4 m into the cave) has experienced significant retreat (Fig. 39). Some large (>500 microns) grains within the cupules protrude prominently, but are clearly undamaged (i.e. free of impact traces). Therefore the present surface of these cupules is the result of considerable retreat. Just a metre further into the cave, the picture changes dramatically: entire cupules are covered by accretionary deposits. However, on some of the exposed cupule surfaces damaged large grains occur, over 1 mm in size, but if they do have wanes, then these are not readily recognisable because they are too large. This indicates a great antiquity of the cupules.

There are substantial accretionary deposits on many parts of the decorated walls. Particularly noteworthy are the terraced or gnarled, laced silica-dominated deposits of several mm thickness. Under small roofs these are exfoliating due to a white powdery substance, perhaps gypsum. Another mineral deposit resembles aragonite formations and appears to have been formed within cracks of exfoliating clasts. It is therefore likely that exfoliation of slab fragments was accelerated by the deposition of such mineral formations.

Microscopic examination of the stone fragment bearing two (or three) cupules (24 cm max. length, 30 to 55 mm thick) found with the OSL sediment sample DC-1 (Fig. 28) shows that the doubtful ovoid depression in the middle has a pronounced rim and shows linear marks that resemble stress lines. It is certainly not a cupule, despite its appearance and location between two cupules. It lacks grains with evidence of impact, whereas the two other marks present many large crystalline quartz grains with conchoidal facets and various other morphological features indicative of percussion damage. However, it is important that all of these larger grains, up to 1 mm and even greater, now protrude distinctly above the general surface level. The relief of these features is generally between 500 and 600 microns in both cupules, after the loss of impact-damaged grains and colloid silica. While this implies a great age for the specimen, the preservation of the fracture surfaces on individual grains is excellent. In one case at least, linear stress markings remain clearly discernible, and generally the amount of solution evident on the quartz facets is minor. There appears to have occurred very limited chemical degradation of crystalline quartz below ground level, while the degradation of the colloidal component did proceed. This issue needs further investigation.

Other early cupule sites in central India

R. G. Bednarik and G. Kumar

New archaeological work at Bhimbetka

One of the principal aims of the EIP Project is to improve the chronological resolution of the Lower and Middle Palaeolithic periods in India. With this in mind, and also as an effort to refine the very coarse cultural attribution of the Bhimbetka petroglyphs (Bednarik 1993a, 1994a, 2001a), we are continuing our investigations at Bhimbetka, where one of us (GK) excavated with Wakankar already in the 1970s. The large site complex of Bhimbetka has recently been added to Unesco's World Heritage list (Ray and Ramanathan 2002a, 2002b), following our request to pursue listing (Bednarik 1994b). So far we have focused our attention at Bhimbetka on two sites, Auditorium Cave (III F-24) and, immediately next to it, Misra's Shelter (III F-23) (Fig. 8). At the first site, Wakankar (1975) excavated two trenches. His small trench I was located in the eastern passage and has since been filled in. Trench II, much larger (Fig. 7), is in the southern passage and had begun to collapse by 1990, when the two petroglyphs in it were identified (Fig. 5) by one of us (RGB). In the early 1990s, in preparation for the visit of the site by a dignitary, the Archaeological Survey of India decided to open and extend the trench for exhibition and built solid masonry retaining walls with steel railing on three sides of it, the fourth being formed by the east wall of the passage. Substantial railing had earlier been installed to protect the excavation trench in Misra's Shelter, which had therefore not suffered damage from visitation.

After the identification of the two Acheulian petroglyphs in Auditorium Cave the question of the reliability of Wakankar's stratigraphy arose. The masonry wall prevented the inspection of the strata since 1993 and it became apparent that, during its construction, sediments had been randomly mixed. This disturbance of the remaining sediments in the vicinity of Wakankar's trench II posed a significant research difficulty. The issue was simply that the only evidence we had for the upper limit of the Acheulian was Wakankar's section drawing (Fig. 7). However, in 1994 we managed to secure reliable evidence that his stratigraphy was correct, when we found that monsoonal rainwater had exposed an Acheulian handaxe that was so tightly wedged into a bedrock crevice that we found it impossible to remove it. Next to it, a small residue of freshly exposed primary sediments contained three more implements, including a quartzite cleaver (Bednarik 1996: 64 and Fig. 2). This was found well above the level of the nearby petroglyphs, confirming that they had been covered by Acheulian strata.

On 4 October 2002, after the Archaeological Survey of India under the instruction of Dr S. B. Ota had at our request dismantled some of the northern masonry retaining wall, we made an attempt to secure an OSL and soil sample from 40 to 50 cm below the level of the two petroglyphs, which are now covered by backfill for their protection. Despite great efforts to find undisturbed sediments, we remained sceptical that we succeeded in this quest, and although we did secure sample BH-4 and experimentally processed it, we are doubtful that it was uncontaminated prior to collection. The disturbance of the sediments up until 1994, first by unsupervised visitation and then by the uncontrolled work of the early 1990s, is too great.

The collection of three samples from nearby Misra's Shelter yielded three impeccable samples. Their primary purpose was to establish the supposed change from the Lower to the Middle Palaeolithic industries at the site. The excavated sediment column at the sampling site is 3.55 m high. Three samples were secured from it: one from near the base of the excavation (BH-1, Late Acheulian according to Misra 1978), one from the level at which the change to the Middle Palaeolithic is thought to have occurred (BH-2), and one from the middle to upper portion of the Middle Palaeolithic horizon (BH-3) (Fig. 7). Their preliminary results (see below) pose some obvious problems. If we use as a discussion basis the CAM values, they suggest an unexplained inversion between the first and the second samples. 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 this result. However, the result of 94 ± 11 ka for the lowest sample, collected 2.3 m immediately below the other, is a conundrum. The intervening sediments are undisturbed and heavily consolidated, partially cemented with increasing depth. Only the result of the uppermost sample, of about 45 ka, meets expectations. We are at a loss to explain these contradictions and will endeavour to look further into these issues.

The Hathikheda sites

Hathikheda is an outer suburb of greater Ajmer, one of the major population centres of Rajasthan (Fig. 4). This village or suburb is located about four kilometres to the west of inner Ajmer, occupying an expanse of flat fluvial deposits with dry river courses, hemmed in by barren desert mountains that are a few kilometres away.

The name Hathikheda means 'Elephant Village'. A series of rock outcrops, spaced about one kilometre apart, extends to the west of the built-up area, forming a roughly discernible alignment along an east-west line. They rise between 8 m and 20 m above the alluvium and consist essentially of white quartz monoliths. They appear to mark the remains of an unusually broad quartz dyke that extends over a number of kilometres, the western extent of which we did not explore. The dyke must be at least 20 m wide. The first outcrop occurs within the village's housing area and it bears a small temple. It was not examined because any remaining evidence was likely to be obstructed by this building and associated structures. The second outcrop is called Moda Bhata ('Big Rock') and is located immediately north of a usually dry watercourse, on the present periphery of Hathikheda. Moda Bhata is about 8 m high on its northern approach, and 15 m on its much steeper south side, which has given rise to a shallow rockshelter. Its flat and horizontal upper plateau measures 24 m east-west, and 11 m north-south.

About one kilometre to the south-south-west lies a very similar formation, called Mahadev Bhata, which is named after a deity. Its dimensions and morphology are much like those of Moda Bhata, with steep sides and a horizontal platform. We counted a total of twenty cupules on its plateau. Further west along the presumed submerged dyke we could see one more outcrop, but lack of time prevented our examination of it at the time. We also cannot comment on whether the series extends further west, but this should certainly be investigated. One of us (GK) explored the hill southwards of the temple hill and a low-lying escarpment north of it. He discovered many more cupules on them. There is a big rockshelter in the hill, also bearing cupules, some of which are as large as the ones in the rockshelter at Moda Bhata.

Of these sites, only Moda Bhata was examined in any detail so far. The cupules at Mahadev Bhata are very similar, as are the geological circumstances, and the Hathikheda sites appear to be the first known case of cupules — or indeed any form of petroglyphs — having been executed on white crystalline quartz exposures. Pure quartz does not occur frequently in massive form, and when it does it is usually found as eroding dyke formations. These features result from cracks in a plate through which liquid rock has been forced, forming a vertical sheet of intrusive igneous rock. Being frequently more erosion-resistant than the surrounding rock, they project typically above the weathering zone of a landscape. Such phenomena are restricted to very ancient geomorphic exposures, such as those found in Rajasthan. The assumed solution rate of crystalline quartz, as determined in the laboratory, has been reported at only 1 mm per 34 million years (Rimstidt and Barnes 1980). Although the practical retreat rate in the field, which is determined not only by solution, but also by several other factors, is considerably higher (though still much less than 0.1 mm per millennium; Bednarik 2001c: 61), massive quartz deposits will outlast practically all other common rock types. Therefore such formations disintegrate almost entirely by physical processes.

We conducted a surface survey of the surrounding pediment, including the naturally sectioned bank of the adjacent dry streambed. Not a single readily recognisable stone tool was located, but our search was cursory and a more thorough examination is essential.

The rock of Moda Bhata consists of more than 95 per cent pure white crystalline quartz, the remainder being made up by minor components such as mica. The steep south side has given rise to a substantial shelter of un-fractured rock, one or two metres deep and about eight metres long. The floor contains no sediment cover and no tools were observed. On the vertical back wall occurs a series of five relatively large cupules.

Since the hardest rock available to petroglyph makers to use as tool material is also quartz, it is self-evident that the task of creating any rock markings on massive crystalline quartz is highly labour intensive. No replicative experiments of petroglyph production have so far been conducted on quartz (Bednarik 1998; see also above), but one is justified in assuming that this would call for more persistence than the making of similar marks on softer rock, such as granite or even quartzite, not to mention gabbro, diorite and so forth. The discovery of these cupule sites on massive white quartz outcrops reported here is therefore of considerable interest to the various issues.

The cupules of Moda Bhata

A thorough examination of the upper platform, which is quite flat and affords an excellent view of the surrounding alluvial plain, located twenty distinct cupules as well as several faint cupules or worked surfaces bearing traces of impact, plus one very large cupule (resembling the features P. Beaumont in South Africa calls 'mega-cupules'). Most cupules occur in small groups and there is a preference in their positioning on slight rises of the rock platform. This gives them a somewhat 'cup-like' appearance, but any interpretation related to this orientation would need to take into account the presence, on the same rock, of the five vertical cupules in the rockshelter.

In addition to the cupules there are many further signs of human activity evident, notably of impact, abrasion and, in locations suitable for the removal of rock mass, quarrying traces. A productive line of investigation would therefore be to establish to what extent the distinctive white quartz occurs in the lithic industries of the region, and how far afield it can be found as a stone tool material.

One of the first innovations of the EIP Project was to commence a program of applying microerosion analysis to selected petroglyph sites in India. Here we report the first results of this program. The largest cupule measures between 35 cm and 28 cm across its rim and it is 10 cm deep. It is so large that it might have been begun in a natu-

Figure 40. *Three cupules on white crystalline quartz, on the horizontal plateau of Moda Bhata, Ajmer, Rajasthan.*

ral depression, and a utilitarian purpose cannot be excluded. Adjacent to it is a series of three standard-sized cupules (Fig. 40). We selected one of these for detailed analysis. It has a rim diameter of about 60 mm and a depth of 9.4 mm, which is typical for the site's plateau cupules. Its well-textured floor provides ample opportunities for microero-sion analysis, because there are numerous microscopic fractures present that display angles of about 90º between cleavage surfaces. We conducted a preliminary microerosion analysis of this cupule on 7 October 2002, measuring several such micro-wanes and securing twenty-eight measurements from them (Fig. 41). The purpose was not to determine the cupule's antiquity, it was merely to gain some tentative idea of whether it might be of the Middle Pleistocene. No microerosion calibration curve is currently available from India. We have attempted to secure calibrating data by examining a number of sculptures and inscriptions of historically known ages in Ajmer, but failed completely to find specimens of suitable lithology or surface condition. Therefore the geographically nearest calibration curves at this stage are those from Qinghai Province in China (Tang and Gao 2004) and to Um Sanaman, northern Saudi Arabia (Bednarik and Khan 2002), both of which have only limited relevance to the present location.

Figure 41 depicts the histogram of the micro-wane widths measured in the Moda Bhata cupule. It also features the Spear Hill calibration curve for quartz that has been determined for a reasonably similar environment (eastern Pilbara, in a semi-desert monsoonal region; Bednarik 2002b). We emphasise that while this provides a very reliable rough estimate of antiquity, it is only an experimental result. In considering it we need to appreciate that it was derived from only one mineral, whereas in secure microerosion determinations it is preferred to include results from two minerals (Bednarik 1992b). This is obviously not possible at Moda Bhata, a single-mineral environment. Moreover, the Spear Hill calibration curve, although one of the most reliable we have, is also the 'shortest' so far determined, which means that the values it is based on cover only a short time span. This is assumed to affect precision significantly.

Irrespective of these major qualifications, the Moda Bhata values display a very pronounced clustering into two groups. One group corresponds to an antiquity of about E2000 years BP, the other to roughly E9000 years BP. This clear separation cannot reasonably be accounted for by sampling inadequacies or imprecision, it is far too pronounced and we interpret it as unambiguous evidence that the older cupule surface was reworked at a much more recent time. In other words, these data demonstrate the minor reuse of an older cupule, dating from the early Holocene.

However, as with all age estimates derived by microerosion analysis, it needs to be taken into account that the method can only consider surfaces of which remnants remain available. Therefore the possibility cannot be excluded that this is an originally Pleistocene cupule that was significantly deepened or enlarged in the early Holocene, and then slightly hammered in the late Holocene. This issue could only be clarified by conducting similar analyses of several other cu-

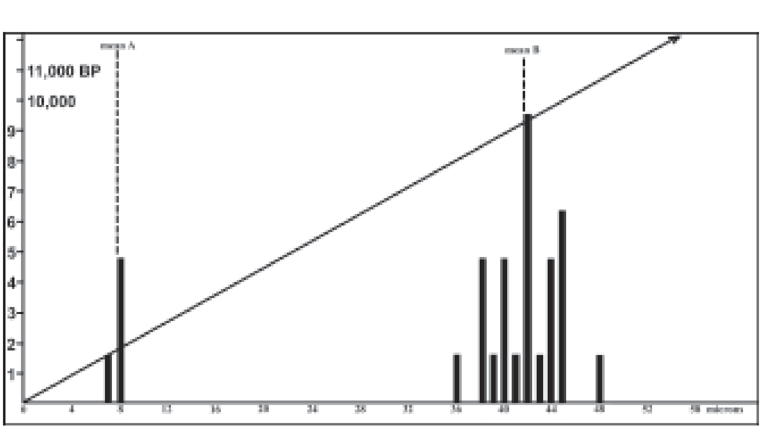

Figure 41. *Microerosion data from Moda Bhata cupule, experimentally placed in the Spear Hill calibration curve.*

pules at this site. Most certainly our work has shown that cupule sites have been reused during more recent periods, so to determine the beginning of the practice at a site such as Moda Bhata it is essential to establish ages of the oldest cupule surfaces present at the location. Although this would involve a considerable amount of work it is certainly recommended, because it would probably also tell us a great deal about the duration of site use, and about the pattern of accumulation of the cupules and apparent cupule arrangements through time. Bearing in mind that currently we know almost nothing about the traditions that created these features, it is obvious that such a strategy promises a great deal of improvement in our understanding of how these mysterious petroglyphs were made.

Figure 42. *Rock 1, Morajhari site, Rajasthan (see also colour image on back cover).*

The cupules of Morajhari

This large cupule site is located about 20 km east of Nasaribad, near Ajmer, Rajasthan (Fig. 4), extending over almost 200 m near a shallow *nala* (Kumar 1998). There are several hundred boulders strewn over the flat alluvial plain, many of which bear cupules. The site is about 500 m from a very small fort on a tiny hill, the only rise visible in this region of extensive alluvial flats of fine sediment, and it consists of an area of very rounded, dark rocks. These are gneissic, of about 40% quartz, 25% black mica, 20% feldspar and 15% minor components. The focal point of the site is a lithophonic rock that rests on top of another boulder, immediately next to a much larger boulder that forms one of the highest of the site (Fig. 42, see also image on back cover). It, too, bears cupules, including one on its very top. The lithophonic Rock No. 1 is of roughly discoid shape and bears numerous cupules on both sides. This means that only those on its upper surface can now be effectively worked, because those on the lower surface, although mostly visible, are too close to the support boulder to be struck effectively. Therefore the rock, which might weigh around 400 kg, must have been turned at some time. This event effectively provides a terminus ante quem for the cupules on the underside, which also cannot bear any recent reworking. The turning of this boulder would have been quite difficult and it probably preceded the manufacture of the cupules on what is now the boulder's upper side.

Within 20 m to the north occur about ten more boulders with cupules, and on a south-sloping, very large boulder are two polished stripes indicating that people used this as a slide for a long time (a practice one of us has observed widely in different continents). The northernmost concentration of cupules is about 150 m from Rock No. 1, immediately next to a road (see colour image on back cover). We have surveyed the site for surface stone tools without any success, even in the small *nala* passing on its west side, where lower strata have been exposed. There are, however, numerous hammerstones of chert and granitic rocks that were presumably used in the production of the cupules.

On 7 October 2002 we attempted microerosion analysis of three cupules at Morajhari ('Feathers of the Peacock'): two on Rock No. 1, and the third about 20 m north of Rock No. 1. The results are summarised in Figures 43 to 45. We are uncertain how to interpret the data secured from the cupule on the upper side of Rock No. 1, but suggest that the groupings of the wane widths, which correspond to individual wanes, indicates re-working of this feature, at about E2600 years BP, E1750 years BP and E800 years BP. Therefore the overall mean value of a little under 1800 BP might be meaniningless (Fig. 43).

The result from one cupule on the underside of Rock No. 1 substantiates the above proposition that the petroglyphs on the rock's underside are significantly older. Al-

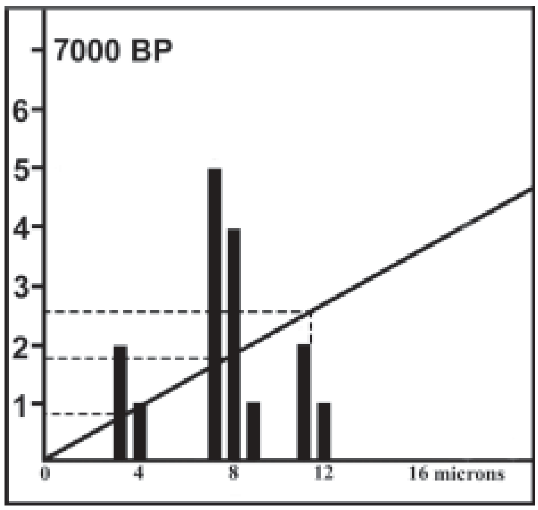

Figure 43. *Histogram of microerosion data from cupule on upper side of Rock 1, Morajhari, experimentally placed in Spear Hill calibration curve. See text for interpretation.*

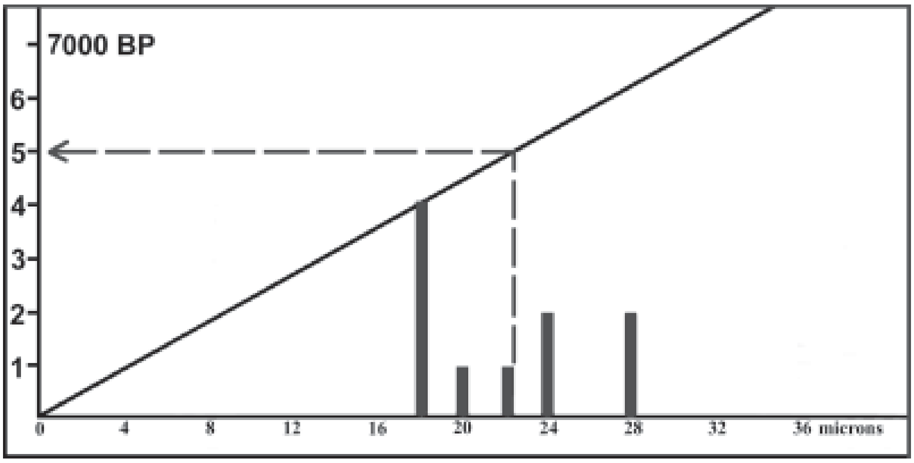

Figure 44. Microerosion data from cupule on underside of Rock 1, Morajhari, with Spear Hill calibration curve.

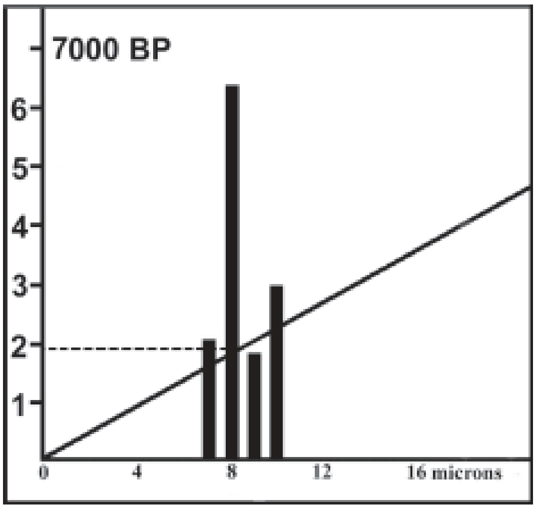

Figure 45. Microerosion data from analysed cupule about 20 m north of Rock 1, Morajhari, with Spear Hill calibration curve.

though the data is widely spread, its mean age estimate of about E5000 seems realistic (Fig. 44). The data derived from the third cupule is very compact, by contrast, clearly favouring an age of about E1900 years, i.e. falling within the range of the events expressed in the results from the first cupule (Fig. 45). We defer any further discussion of these results until much more data, including a geographically relevant calibration, become available, therefore proposed tolerances are not cited here. The results do, however, clearly eliminate any possibility that the Morajhari cupules might be of the Pleistocene. Despite the preliminary nature of the results we present here, a Palaeolithic age of these very ancient features can be categorically excluded.

The Bajanibhat cupule site

Another candidate for Palaeolithic-age cupules is Bajanibhat ('Rock that gives sound'; i.e. lithophone). The link between cupule sites and lithophones is very real in India, and while lithophone cupules and others are easily distinguishable, this is a subject too specialised to be included here (to be discussed separately). Bajanibhat (Fig. 4) is located about 24 km east of the town Kotputli, at the foot of a rocky mountain range named Kalaphad, rising from extensive fertile alluvial plains (Sharma et al. 1992; Kumar and Sharma 1995). Near the foot of the mountain is a prominent shallow shelter, 8 m wide and 5.5 m high (606 m a.m.s.l.). It features a corpus of sixty-seven cupules on its vertical wall (Fig. 46), which vary greatly in both their sizes and ages. The smallest measures 29 mm across (No. 5), the shallowest is 0.9 mm deep (No. 55), the largest are 120 mm (Nos 62 and 65), and the deepest is 50 mm deep (No. 38). The oldest cupule appears to be No. 12, which is in the process of slow exfoliation. After this process has taken its course, only the floor of the former cupule will remain on the surviving bedrock, rather similar to cupule No. 5 on Chief's Rock in Auditorium Cave (see above). The extreme degree of weathering within the joint, which certainly must postdate the cupule, suggests an extremely great age (Fig. 47). Some other very weathered specimens may be of a similar order of antiquity but they are now of difficult access, preventing ready microscopic examination. However, all other cupules are considerably younger, by a factor of dozens of times. We consider that there were initially a few cupules, some of which have now doubt been lost since. This prompted similar behaviour at much later times, and the practice was continued in many of the cupules until historical times. The latter bear still relatively fresh bruising evidence. The heavily metamorphosed rock consists of quartz crystals with veins of undetermined dark minerals, resembling a gneissic quartzite.

A microscopic examination of the apparently oldest cupule present, No. 12, yields no useful information. The feature is so weathered that the surface can be assumed to have retreated at least 5 mm and quite probably 10 mm. A second cupule similarly yields no information. A third cupule, No. 3 in Figure 46, is considerably younger and largely unweathered, although much more patinated than the most recent ones. It yields some fracture edges amenable to microerosion analysis. Eleven wane widths are determined, suggesting an age of approximately 6000 years, but we provide no further detail here as this rather complex site deserves considerably more in-depth research then we have been able to afford it so far.

It is clear that the site has been used as a quarry for the production of Lower Palaeolithic stone tools. There are numerous impact scars where thick flakes of 10 cm to 30 cm length were removed. Lower Palaeolithic tool types occur in profusion at the site, and in its vicinity for hundreds of metres. These include very finely worked, typical ovoid Acheulian handaxes in considerable quantity (Fig.

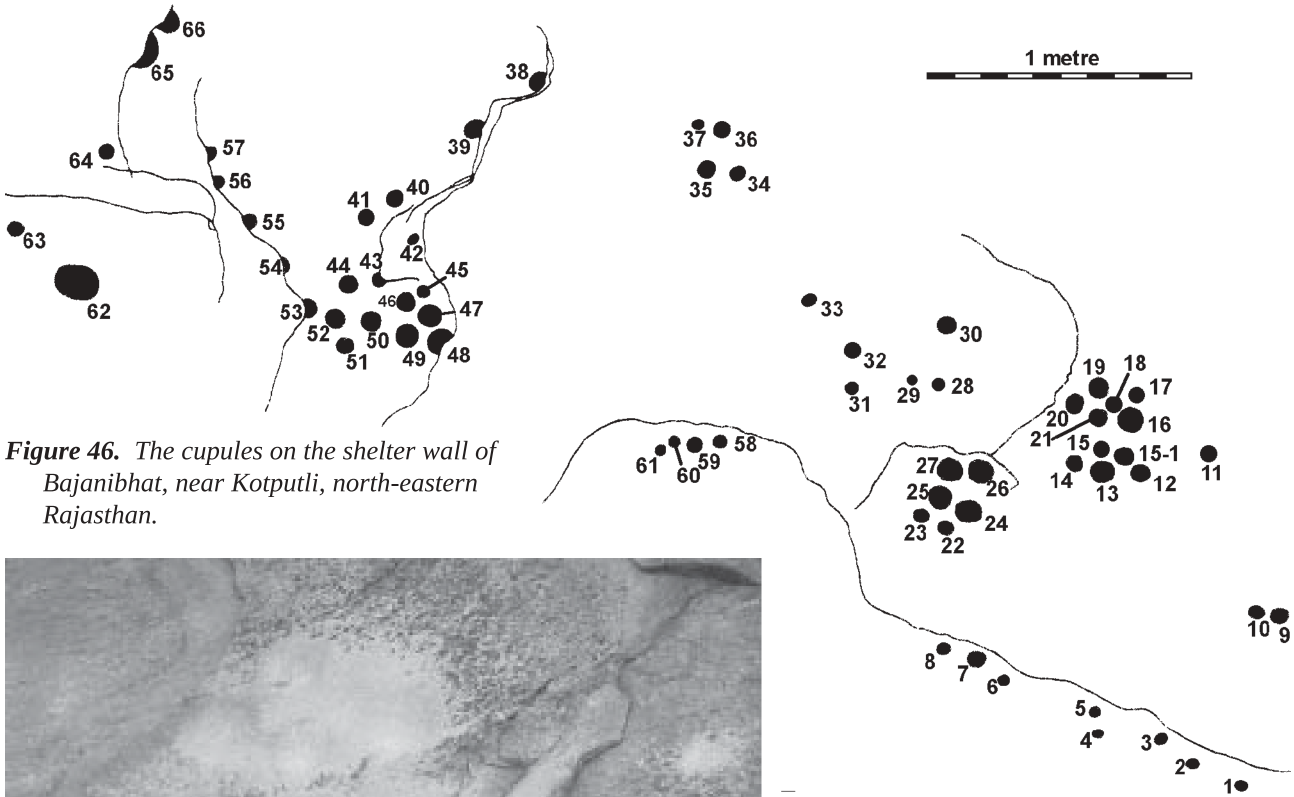

Figure 46. *The cupules on the shelter wall of Bajanibhat, near Kotputli, north-eastern Rajasthan.*

Figure 47. *The apparently earliest, exfoliating cupule at Bajanibhat, and several very recently worked nearby cupules.*

Figure 48. *Acheulian handaxes from Bajanibhat.*

48), rougher bifaces, cleavers, hammerstones and thick Levallois flake tools. Many dozens have already been collected from the surface of this productive site. More recent stone tools occur occasionally, and also some pottery shards, which might be recent. The sediments in front of the shelter are heavily eroded, with lower strata visible in various places. Evidence of fireplaces is visible in these eroding strata, apparent as distinct reddening (due to reduction of iron salts) of the brown rock extending about 80 cm horizontally, and a thermal spall of 25 cm length. The frequent occurrence of eroded Acheulian tools suggests that massive deposits of this tradition might be present in the substantial sediment deposits. The area's loess-like deposit is underlain by compacted, very coarse sediments dominated by gravel and cobbles.

Near the site runs a prominent *nala* (a normally dry creek bed in alluvium), which originates 400 m north from Bajanibhat shelter, at the base of a steep ravine leading up the mountain. This is called Jhiri Nala ('Stream Gully'), formed of house-sized boulders, and about 100 m above the plain reveals a very complex red painting motif under one of the huge granite boulders. A few metres from it, near the edge of a large spall that has split from a boulder, are two large cupules, which are certainly of the lithophone type.

Further cupule sites near Daraki-Chattan

In addition to the sites listed above, we have also examined some cupule sites on the plateau of Indragarh Hill, i.e. above the Daraki-Chattan Cave, and some more in the wider vicinity of that key site. A few hundred metres north of Daraki-Chattan are the ruins of a 7th century fortress constructed of dry-laid local stone. It overlooks an elevated pre-Tertiary river course to its immediate north-east, with finely polished quartzite boulders and substantial deposits of river cobbles and conglomerate

Figure 49. *Part of a geometric arrangement of cupules on the plateau above Daraki-Chattan Cave, fully exposed to weather and assumed to be of relatively recent antiquity.*

exposures. The latter seems to resemble the breccia in the Daraki-Chattan Cave, except that the latter is of angular clasts derived from local breakdown. There are several cupule rocks at scattered locations on this plateau. At one of the cupule panels we have examined a light-coloured crust-like feature, about one millimetre thick, now exfoliating, which comprises the same grain sizes as the rock but presents the visual appearance of an accretionary deposit (Fig. 49). We could not determine its nature, but, having observed a similar phenomenon on some of the ancient river polish just mentioned, consider the possibility that the energy applied in the making of the cupule created a cutaneous zone that was more resistant to the weathering processes. There is no indication that these cupules are of an antiquity comparable to that of the cupules in Daraki-Chattan as they are fully exposed to weathering processes and are relatively well preserved.

Almost 20 km south-west of Bhanpura, close to the shore of the Gandhi Sagar reservoir lake and near the village Hanumankheda is a prominent remnant of a quartzite formation (Fig. 13). Its huge, up to about 12-m-high weathered boulders form cavities that have for hundreds of millennia provided shelter to humans. This site, called Pola Bata, is still in use today. There are several concentrations of cupules among the rocks, especially on the wall of the main tunnel. Numerous largely faded red pictograms occur also in this cave-like space. The cupules are often unusually deep and large, and although there are many deeply weathered examples, others bear distinctively recent damage (Fig. 50). Indeed, some of the site's several dozen cupules are still being used, including at least three lithophones or 'rock gongs'. The cupules of Pola Bata occur on horizontal, sloping and vertical surfaces. On the floor of the main shelter and on the surface surrounding the site occur numerous Palaeolithic and Mesolithic stone implement types. They include handaxes, cleavers, and more recent chalcedony tools and débitage.

About 3 km west of Pola Bata lies the small hamlet Amyabhau. Nearby is another of the quartzite stacks commonly observed in this otherwise fairly flat terrain, called Teej-ka-Pana. These remnant outcrops are typically surrounded by iron-rich sediments, probably the residue of lateritic deposits that have eroded. Since there is little or no iron in the quartzite, we assume this to be a deflated landscape that once featured iron-rich sediments or a lateritic facies, as has also been observed on the plateaus at Daraki-Chattan. The site, elevated about 15 m, consists of the flat top of the steep-sided outcrop. It features several groupings of cupules and abraded grooves. Some of these petroglyphs form an extensive geometric arrangement, now partly exfoliated, and most cupules are arranged in rows. All of the markings occur on a heavily weathered ancient subsurface that is strongly coloured by iron salts, and this layer has exfoliated in various places, so there were probably more markings in the past. Some of the abraded grooves resemble axe grinding grooves, and it is possible

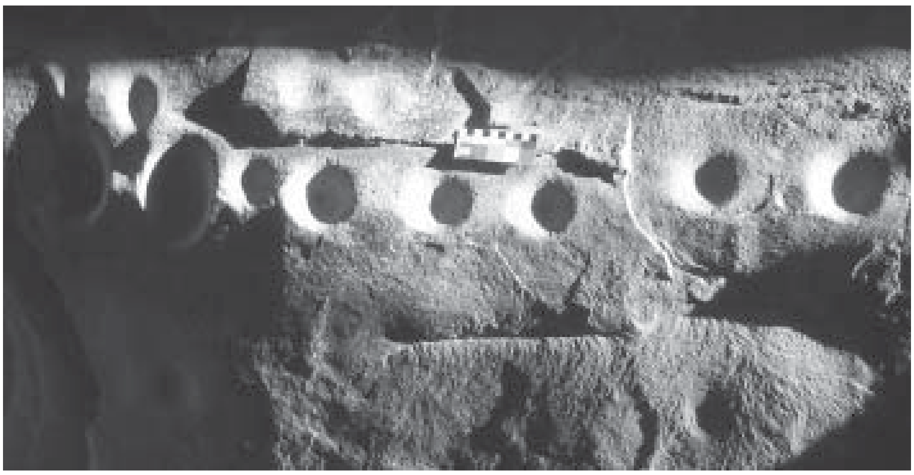

Figure 50. *Large and deep cupules on the vertical wall of the Pola Bata shelter, near Gandhi Sagar reservoir, Madhya Pradesh.*

that these are Neolithic. The rock markings are certainly of relatively recent age, most probably of the mid to late Holocene.

The collection of samples for the EIP Project, 2002–2004

G. Kumar

The Indo-Australian team of scientists collected numerous samples for scientific analysis and dating in 2002 and 2004, all under the supervision of delegated officers of the Archaeological Survey of India (ASI). For this purpose I secured the necessary permits from the Director General of the ASI. The details of sample collections are briefly presented.

The first three sediment samples, intended for both OSL analysis and for sedimentary analyses, were collected from the excavated trench from 27 to 29 September 2002. Each sample consists of three parts, collected at night with a very dim infrared light. Sample A was the primary source for OSL analysis, while B and C are intended for subsidiary radiation measurement and a series of pedological analyses. Standard background radiation was measured in each sampling hole by gamma spectrometer. Details of the samples are shown in Table 2.

From inside Daraki-Chattan Cave Alan Watchman and Carol Patterson collected three tiny samples of mineral accretion from the surface of the northern wall, represent-

Soil Sample No.	Trench	Depth from surface	Comments
DC-1A	A2(2)	-30 to -50 cm	Collected by making a hole into the section facing south. Sediment is loose brown soil with exfoliated flakes, stones and Lower Palaeolithic artefacts, at the level of the lower end of the big cupule slab bearing nine cupules discovered in the excavation in May-June 2002. One more slab with two complete and one broken cupules was discovered while removing the soil sample.
DC-1B	A2(2)	-30 to -50 cm	From the associated area of Sample 1A.
DC-1C	A2(2)	-30 to -50 cm	From the associated area of Sample 1B.
DC-2A	A1(4)	-40 to -62 cm	Collected by making an oblique channel NE-SW after removing a stone from the sediment. Sediment is loose brown soil with exfoliated flakes, stones. Stratigraphically it is contemporary with or slightly earlier than Sample DC-1.
DC-2B	A1(4)	-40 to -62 cm	From the associated area of Sample 2A.
DC-2C	A1(4)	-40 to -62 cm	From the associated area of Sample 2B.
DC-3A	A2(4) and A3(1)	-64 to -84 cm	Collected from A2(4). The hole leads diagonally into A3(1). The sediment is loose brown soil with fewer flakes and less rubble. E. Lawson was doubtful about its potential for OSL dating.
DC-3B	A2(4)	-64 to -84 cm	From the associated area of Sample 3A.
DC-3C	A2(4)	-64 to -84 cm	From the associated area of Sample 3B.

Table 2. *Soil samples collected for OSL dating at Daraki-Chattan in 2002.*

Soil Sample No.	Trench	Depth from surface	Comments
BHIM-3A, B, C	III F-23, V. N. Misra's trench	-65 to -75 cm	Middle to late phase of Middle Palaeolithic.
BHIM-2A, B, C	III F-23, V. N. Misra's trench	-110 to -120 cm	Terminal phase of Late Acheulian to beginning of Middle Palaeolithic.
BHIM-1A, B, C	III F-23, V. N. Misra's trench	-340 to -350 cm	Lowermost Late Acheulian, near bedrock.
BHIM-4A, B, C	III F-24, Auditorium Cave, V. S. Wakankar's trench	-250 to -260 cm	Acheulian, laterite red sediment, appears to be contaminated by recent works.

Table 3. *Soil samples collected for OSL dating from Bhimbetka in 2002.*

ing layers of silica from a surface near cupules (but not concealing any rock art). Watchman also collected five samples from Chaturbhujnath Nala, located north-west of Daraki-Chattan. These were intended to assess mineralogy, chemistry and microstratigraphy, looking for datable material. The samples are as follows:

1. Rockshelter CBN F4, brown seepage crust.
2. Rockshelter CBN B4, red pigment from 'bear-paw'.
3. Rockshelter CBN B4, black paint residue.
4. Rockshelter CBN B4, off-art silica coating.
5. Rockshelter CBN B4, brown floor coating.

Sample collection from Bhimbetka and Raisen

Four soil samples, three from Misra's trench and one from Wakankar's trench, were collected for OSL dating at two Bhimbetka sites, Misra's Shelter and Auditorium Cave (Table 3). Another 21 samples from rock painting sites were collected for processing by AMS ^{14}C analysis from 1 to 5 October 2002. Their details are provided in Tables 4 and 5.

Rockshelter No.	Nature of sample
Hathitol A	Red pigment 1
Hathitol B	White pigment, possibly for dating
Hathitol C	Red pigment 2

Table 5. *Pigment samples from Raisen.*

All the pigment and encrustation samples were collected by Alan Watchman for their analytical study and AMS ^{14}C dating in Australia. All the seven soil samples of 2002, three from Daraki-Chattan and four from Bhimbetka were sent to Australia. They are being analysed for OSL dating by Richard G. Roberts, University of Wollongong, N.S.W. Three more soil samples from Daraki-Chattan were collected from the lower sediments exposed in the excavation of Daraki-Chattan Palaeolithic cupule site in 2004 (Figs 51 and 52). This was done from 8 to 11 December 2004. The details of the samples collected are shown in Table 6.

Table 6 (below). *Soil samples collected for OSL dating from Daraki-Chattan in 2004.*

Table 4 (above). *Samples of pigment and salt encrustations from Bhimbetka region.*

Figure 51. OSL sampling in Daraki-Chattan main trench, measuring background gamma radiation for sample DC- 4, 10 December 2004.

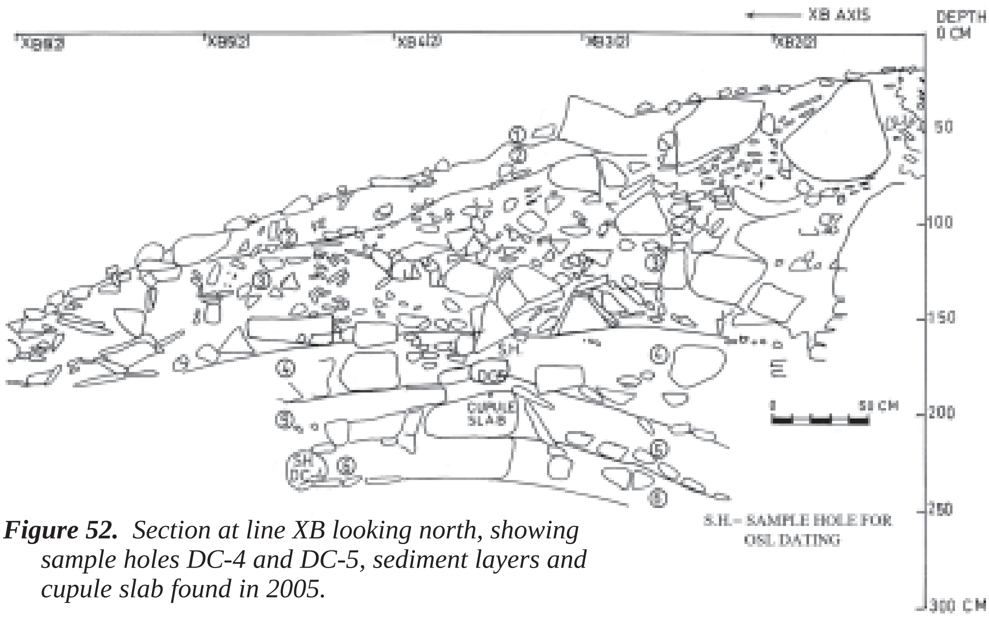

Figure 52. Section at line XB looking north, showing sample holes DC-4 and DC-5, sediment layers and cupule slab found in 2005.

First OSL results of the EIP Project

R. G. Roberts

Optical dating methods

Quartz grains of 90–125 µm in diameter were extracted from the samples under dim red illumination using standard purification procedures, followed by a final etch in hydrofluoric acid to remove the alpha-irradiated rinds (Aitken 1998). Grains were then mounted on stainless-steel discs using silicone oil spray as adhesive, with each aliquot being composed of ~80 grains. The absorbed radiation dose (the 'palaeodose') was estimated for each aliquot from the optically stimulated luminescence (OSL) signals emitted under intense blue (470 nm) illumination. The ultraviolet OSL emissions were detected by an Electron Tubes Ltd 9235QA photomultiplier tube fitted with 7.5 mm of Hoya U-340 filter, and laboratory irradiations were performed using a calibrated $^{90}Sr/^{90}Y$ beta source.

A single-aliquot regenerative-dose (SAR) protocol was used for palaeodose determination, whereby the 'natural' OSL signal of an aliquot is interpolated on to the dose-response curve for the same aliquot, the latter being constructed from a series of regenerative doses that includes, as internal checks of protocol performance, a duplicate dose point and a zero-dose point (Bøtter-Jensen et al. 2003). Each aliquot was held at 200ºC for 10 s before measuring the natural and regenerated OSL signals. Any changes in luminescence sensitivity during this measurement procedure were monitored, and corrected for, using a series of test doses, which were heated to 160ºC before optical stimulation. Each of the natural, regenerative and test doses were optically stimulated for 100 s at 125ºC, and the resulting OSL signals were integrated over the first 3 s of illumination, using the count rate over the final 30 s as background. The SAR protocol has been shown to work well in a variety of depositional environments where independent age control is available (e.g. Turney et al. 2001; Murray and Olley 2002; Olley et al. 2004a, 2004b; Duller 2004; Anderson et al. in press). In addition, we performed 'dose recovery' tests, whereby fresh aliquots of sample are bleached at room temperature in the laboratory to erase their natural OSL signals, and are then given a known dose. Ratios of the measured dose to the given dose of 1.04 ± 0.03 and 1.00 ± 0.02 were obtained for the Auditorium Cave (n = 12) and Daraki-Chattan (n = 9) samples, respectively, indicating that the correct (known) dose can be recovered for these samples using the SAR protocol.

A potential problem in optical dating of multi-grain aliquots is the presence of grains that have not been exposed to sufficient sunlight ('bleached') prior to burial, and/or the inclusion of grains that have been incorporated into the sample from older or younger strata by means of post-depositional mixing. Olley et al. (1999) have shown that incomplete bleaching cannot be readily detected if aliquots are composed of more than ~80 luminescent grains, which dictated the choice of maximum aliquot size in this study. The identification of partial bleaching/sediment mixing is best achieved by single-grain analyses (e.g. Roberts et al. 1998a, 1998b, 1999; Olley et al. 1999, 2004a, 2004b; Jacobs et al. 2003a), which we intend to conduct on these samples in the next phase of investigation.

From the single-aliquot palaeodose estimates, the sample burial doses were determined using two statistical models — the 'common age model' and the 'minimum age model' — which are described in detail elsewhere, together with examples of their application (e.g. Roberts et al. 1998a, 1999; Galbraith et al. 1999; Jacobs et al. 2003b; Olley et al. 2004a, 2004b; Anderson et al. in press). The central age model calculates the weighted-mean burial dose for a set of single-aliquot estimates, taking into account the extra spread ('overdispersion') above and beyond that associated with the measurement uncertainties. Even samples that were well-bleached at deposition can have palaeodose distributions that are overdispersed by up to 20% (e.g. Roberts et al. 1998b, 2000; Jacobs et al. 2003a, 2003b; Olley et al. 2004a, 2004b; Galbraith et al. 2005; Anderson et al. in press), although the exact causes of this overdispersion are not fully understood. The minimum age model provides an estimate of the sample burial dose for the lowest-dose population of single aliquots. This model has been thoroughly tested in simulations and yields correct burial dose estimates for partially bleached samples of known age (e.g. Olley et al. 2004a). Statistical models should, of course, be applied in tandem with stratigraphic considerations and other lines of evidence about the bleaching and burial history of the deposit.

The sample dose rates were determined from high-resolution gamma spectrometry measurements of lithogenic radioactive elements ^{238}U, ^{235}U, ^{232}Th (and their decay products) and ^{40}K in dried and powdered samples of sediment, using the same equipment as Olley et al. (1997). Such analyses provide information on the particular forms of past and present disequilibria in ^{238}U and ^{232}Th decay series that exert most influence on the dose rate. Time-averaged water contents of 6 ± 2 and 7 ± 2% were used for the Auditorium Cave and Daraki-Chattan samples, respectively, to accommodate the present-day field water contents (see Table 7) and any likely long-term fluctuations in these rockshelter deposits. A minor dose rate contribution of 0.02 Gy ka^{-1} from internal alpha and beta emitters was included in the total dose rate for each sample, and the cosmic-ray contributions were estimated from the data of Prescott and Hutton (1994), making allowance for site altitude and geomagnetic latitude, the thickness of bedrock shielding, and the time-averaged depth of sediment overburden.

Optical dating results

Measurements of various radionuclides in the ^{238}U and ^{232}Th decay chains revealed that disequilibrium is restricted, at the present day, to the escape of radon (^{222}Rn) gas from both the Auditorium Cave and Daraki-Chattan deposits (Table 7). Radon is a short-lived (half-life ~4 days) decay product between ^{226}Ra and ^{210}Pb in the ^{238}U decay series, and is commonly lost from unconsolidated sediments (Aitken 1998). The ^{210}Pb/^{226}Ra ratios range from 0.46 ± 0.17 to 0.93 ± 0.06, with an average of ~0.76 (i.e. ~24% loss to atmosphere), which is similar to the values reported for other archaeological deposits (e.g. Olley et al. 1997; Turney et al., 2001; Anderson et al. in press). We have assumed that the measured ratios have prevailed throughout the period of sample burial.

For all of the samples examined, the palaeodose distributions were significantly overdispersed, ranging from 48 ± 8 to 69 ± 15% (Table 7). These values are substantially higher than is typical of samples that have been well-bleached before burial. However, it is premature to attribute the overdispersion to incomplete bleaching before deposition, because the possibility remains that quartz grains deposited at different times may have been mixed together *after* burial. Single-grain analyses are required to distinguish between sediment mixing and partial bleaching, with the dual-signal linear modulation OSL technique being especially useful in this regard (Yoshida et al. 2003; Olley et al. 2004b, Olley et al. in press). Such measurements will form part of our next set of investigations.

As the major cause of the overdispersion is not known at this stage, we have taken a conservative approach to the determination of the optical ages. Following Roberts et al. (1998a, 1999), we have calculated the age of each sample using both the central and minimum age models (Table 7). If the overdispersion is due mainly to insufficient bleaching before deposition, then the minimum age model estimate will correspond most closely to the burial age of the most fully bleached grains, provided the sample has not been disturbed subsequently. However, for a mixed sample — that is, one composed of well-bleached (or poorly bleached) grains that have been turbated after burial, thereby mixing together grains from strata of different ages — the minimum age model will yield the age of the most recently and fully bleached, intrusive grains. The age of the 'host' deposit will be greater, but by an unknown amount.

The central age model will not necessarily yield the correct age for the host grains in a sediment mixture, but it might provide some age constraints. For example, if some of the grains in the sample had been insufficiently bleached at the time of burial, and the OSL signal from these grains overwhelms the OSL emissions from any younger, intrusive grains, then the central age model will yield an age estimate that is too old. On the other hand, if all the grains in the sample had been well-bleached at burial, and older and younger grains have since been mixed together, then the age calculated by the central age model could be too young (if the mixture is dominated by grains derived from younger strata), too old (if the mixture is dominated by

Sample code	Water content [a] (%)	Radionuclide activities [b] (Bq kg^{-1}) ^{238}U	^{226}Ra	^{210}Pb	^{228}Ra	^{228}Th	^{40}K	Cosmic-ray dose rate [c] (Gy ka^{-1})	Total dose rate [d] (Gy ka^{-1})	Number of aliquots / σ [e] (%)		Palaeodose [d, f] (Gy)	Optical age [d] (ka)
Auditorium Cave													
BH-1	5.4	27.6 ± 1.0	24.6 ± 0.3	20.4 ± 1.3	27.2 ± 0.6	27.4 ± 0.4	58 ± 3	0.03	1.07 ± 0.04	23 / 48 ± 8	C	101 ± 11	94 ± 11
											M	50 ± 4	47 ± 4
BH-2	3.5	16.7 ± 2.0	13.0 ± 0.4	6.0 ± 2.2	22.4 ± 0.8	22.0 ± 0.6	60 ± 5	0.04	0.75 ± 0.05	12 / 58 ± 13	C	79 ± 14	106 ± 20
											M	31 ± 9	41 ± 12
BH-3	6.0	18.5 ± 1.0	18.9 ± 0.3	15.3 ± 0.9	30.0 ± 0.6	29.0 ± 0.4	142 ± 4	0.04	1.25 ± 0.05	12 / 62 ± 13	C	56 ± 10	45 ± 8
											M	22.3 ± 1.6	17.9 ± 1.5
BH-4	5.7	31.2 ± 1.1	40.3 ± 0.4	29.2 ± 1.3	37.1 ± 0.6	36.4 ± 0.5	98 ± 3	0.09	1.54 ± 0.05	12 / 69 ± 15	C	93 ± 19	61 ± 13
											M	31.7 ± 2.0	20.6 ± 1.5
Daraki-Chattan													
DC-1	8.2	25.9 ± 3.2	22.9 ± 0.5	16.5 ± 2.6	38.2 ± 1.0	36.5 ± 0.7	165 ± 6	0.12	1.55 ± 0.07	11 / 65 ± 14	C	14.5 ± 2.9	9.4 ± 1.9
											M	4.70 ± 0.63	3.04 ± 0.43
DC-2	6.8	20.3 ± 1.0	17.8 ± 0.3	16.6 ± 1.0	30.5 ± 0.7	30.0 ± 0.4	126 ± 4	0.12	1.30 ± 0.05	11 / 67 ± 15	C	10.9 ± 2.2	8.4 ± 1.8
											M	4.67 ± 0.55	3.59 ± 0.45
DC-3	6.9	21.4 ± 0.9	19.4 ± 0.3	15.9 ± 0.9	31.1 ± 0.6	30.4 ± 0.4	137 ± 4	0.11	1.33 ± 0.05	12 / 66 ± 14	C	15.7 ± 3.2	11.8 ± 2.4
											M	6.87 ± 0.68	5.16 ± 0.54

[a] Measured (field) water content expressed as % of dry mass of sample.
[b] Measurements made on dried and powdered samples by high-resolution gamma spectrometry.
[c] Time-averaged estimates for dry samples, each assigned an uncertainty of ± 10%.
[d] Mean ± total uncertainty (68% confidence interval). Palaeodose uncertainty includes a systematic component of ± 2% associated with laboratory beta-source calibration.
[e] Number of aliquots used for palaeodose determination, together with central age model estimate of dose overdispersion (σ).
[f] Central (C) and minimum (M) age model estimates.

Table 7. *Dose rate data, palaeodoses and optical ages for sediment samples from Auditorium Cave (Bhimbetka) and Daraki-Chattan.*

grains from older strata) or about right (if the flux of grains were equal in both directions). There are situations where a 'maximum age model' may be appropriate (e.g. Olley et al. in press), but it first has to be demonstrated (e.g. by means of the dual-signal linear modulation OSL technique) that the high palaeodose values are not the result of partial bleaching.

At this stage, therefore, we can say that the burial ages of the Auditorium Cave and Daraki-Chattan samples are older than the minimum age model estimates in Table 7, but we cannot discount the possibility that they are also older than central age model estimates. Accordingly, we caution readers that the optical ages in Table 7 should be regarded as preliminary estimates only, pending the outcome of further analyses. Bearing in mind these caveats, we can conclude that the artefacts at the level of the buried petroglyphs in Auditorium Cave are older than ~50 ka, and possibly younger than ~100 ka. We note that the minimum age model estimates are in correct stratigraphic order, whereas the central age model estimates are not. Such an outcome is consistent with the greater complexity inherent in interpreting the central age model values, as discussed above. The palaeodose distributions at Daraki-Chattan are, in general, more overdispersed than is the case at Auditorium Cave (Table 7). The minimum age model estimates for the Daraki-Chattan samples are in correct stratigraphic order, whereas the central age model estimates are equivocal in this regard. Both sets of age determinations, however, indicate that the dated portion of this deposit is probably early to mid Holocene in age. We note that the minimum age model estimates for Daraki-Chattan increase almost linearly with depth, and extrapolate to nearly zero years at zero depth. If this relationship is valid for greater depths, then minimum burial ages could be inferred for the deeper deposits and the cupules buried therein.

The first age determinations from mineralised coatings and organic binders associated with Indian rock art

A. Watchman

Cupules are found on the walls of a narrow vertical opening in a quartzite cliff of the Upper Vindhyan Formation. At Daraki-Chattan (M.P.) thin brown amorphous silica accretions have developed across parts of the surface associated with cupules. A sequence of age determinations was obtained from three micro-excavated levels within a rock surface coating measuring less than 1 mm thick. The sampling location was adjacent to a cupule that also contained the accretion. The purpose of sampling the off-art location was to determine the feasibility of dating the coating by determining how much carbon is present and whether a radiocarbon age could be measured from the small samples. Progressive removal of layers was done using a battery-powered engraving tool fitted with a dental burr, and collecting the powders on aluminium foil.

The amorphous silica coatings are deposited from silicic acid in seepage water that intermittently flows across the surface. The silicic acid comes from the chemical weathering of quartzite and other silicate minerals in the thin soils that are developed at the top of the cliff. Bacteria, algae and fungi live on the periodically damp surfaces because they have a stable rock substrate, warmth, light and a supply of nutrients in the water. Precipitation of amorphous silica from the seepage water occurs when the silicic acid becomes insoluble and the thin mineral film kills the living micro-organisms and encapsulates the carbon within the coating (Fig. 53).

Figure 53. *Close-up of Alan Watchman sampling the coating near a cupule at Daraki-Chattan using the engraving tool and dental burr, and collecting the resulting powder on aluminium foil.*

Systematic sampling of layers from a coating provides a mixture of amorphous silica and the dead micro-organisms. In the laboratory an acid pre-treatment is used to remove any potential carbonate contamination. Combustion of the residue in an atmosphere of pure oxygen oxidises the organic fraction and produces carbon dioxide gas. This gas is then converted into graphite, which becomes the ion source in the accelerator mass spectrometer. The radiocarbon age, which is measured, is actually the age of death of the micro-organisms, and this provides an estimate for when the amorphous silica was deposited.

At the Australia Nuclear Science and Technology Organisation three accelerator mass spectrometry radiocarbon age determinations were obtained from the basal parts of the coating. The layer that had been first deposited onto the rock face gave an age of 1920 ± 60 radiocarbon years BP (OZH031). Above this layer the carbon-bearing amorphous silica gave an age of 1590 ± 80 years BP (OZH030). The third age determination, near the present surface, and above the previous samples gave 250 ± 50 radiocarbon years BP.

Stable carbon isotopic values for the carbon in the amorphous silica coating range from -16.6 to -19.1‰. These values are consistent with carbon derived either from C4 plants that grow in this hot arid region or from a biological origin. They do not indicate that the encapsulated carbon came from the weathering of ancient carbonate rocks or soils.

These age determinations are in chronological sequence and indicate consistency in deposition and dating of the encapsulated carbon. If the coating had started to form soon

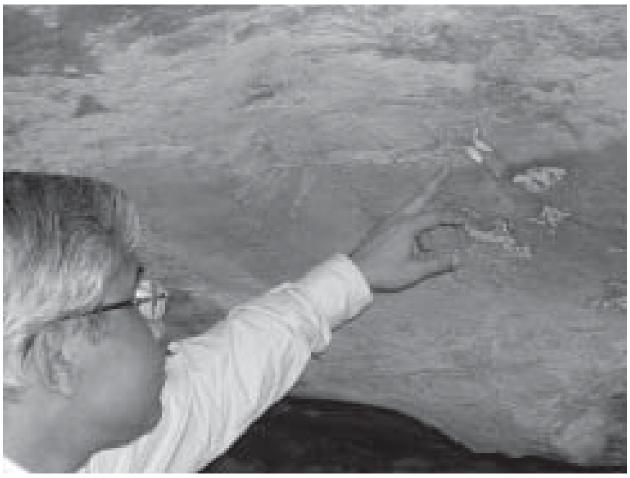

Figure 54. *R. K. Choudhury at site AS-144, Bhimbetka.*

after the cupules were made then the age determinations indicate that the cupules may not be as old as previously thought. The relatively young age for the accretion contradicts the expected ancient age for the oldest cupules at this site. Such contradiction can be argued against on the grounds that cupule production was ongoing for many years and that the accretionary deposits only started to form on the vertical rock faces approximately 2000 years ago.

In Madhya Pradesh several rock paintings were also dated. Sites at Bhimbetka, Jamjori and Hathitol (Raisen) were visited and mostly white paint was collected for analysis. While the bulk of the paintings are in red haematite it is only the white gypsum-bassanite paintings that contain datable carbon. Further research is necessary to establish the source of the organic components in the paints, but at first inspection the compound is consistent with an oxalate salt (whewellite). The preliminary estimates of age range from 1100 to 5200 years ago.

Location AS-144 at Bhimbetka is a shallow rockshelter with the remains of a white quadruped painted on the sloping back wall (Fig. 54). A sample of the hard white paint from the front leg provided an age estimate of 1100 ± 60 years BP (OZG 814). The oldest paint so far dated comes from an adjacent site (AS-122) at Bhimbetka. Another white quadruped with cross-hatching in the abdomen (Fig. 55) gave an age of 5190 ± 310 years BP (OZG 369).

Figure 55. *Sampling at Bhimbetka site AS-122.*

At Jamjori (site J-52), the white paint from one of three interior rectangular lines gave an age of 1720 ± 310 years BP (OZG 368) (Fig. 56). The ceiling at Hathitol contains a panel of red and white quadrupeds with interior cross-hatchings. The back wall contains a series of paintings of animals apparently walking in rows from left to right. These red outline and white infilled animals give the impression of a hump-backed herd migrating across the landscape. White paint from the chest area of one of these animals (Fig. 57) gave an age estimate of 4810 ± 370 years BP (OZG 370). Red paint from the hind leg of the same animal produced an age of 2780 ± 40 years BP (ä^{13}C = -15.3 per mil). These two results indicate that the first painting was white and a later addition of red was used to outline and decorate the body.

White paint at the various locations contains carbon in the form of whewellite, an oxalate salt, but the source of that mineral has not yet been investigated. The carbon in the white paint is easily dated, but only one of the red paints sampled so far contains dateable material. The ages ob-

Figure 56. *Sampling at Jamjori site J-52.*

Figure 57. *Sampling at Hathitol shelter B.*

tained so far for the paintings appear young and it would be appropriate to measure the ages of some figures where the antiquity is known. Some excavated sites where painted sections of the rockshelter walls have fallen off should provide some stratigraphic control over the age determinations. Based on these preliminary analyses potential exists for much more systematic work on the compositions and ages of rock paintings in India.

Interpretation and summary

Robert G. Bednarik

Cupules (or cup marks) are a universal feature in the rock art of the world, and are presumed to be the most numerous of all petroglyph motifs. They occur in all continents except Antarctica, and they seem to have been made in most periods of history, beginning with the Lower Palaeolithic and ending in the Middle Ages in Europe — and in even more recent times in such regions as Australia where their manufacture only ceased in the 20th century. They are very common in Bronze Age and Iron Age rock art, but the most mysterious tradition of them is the earliest. It concerns the Middle Palaeolithic cupule tradition that seems represented in Europe, Asia, Australia and possibly Africa, which in some cases even extends to the Lower Palaeolithic. The great uniformity and enormous geographical extent of these extremely early cupule traditions raise fundamental questions in Pleistocene archaeology. To what degree are they culturally related, or refer to similar cultural practices?

There are specific common characteristics emerging, but because this subject has been so severely neglected until very recently it might be premature to elaborate on possible universal variables within these very early traditions, or the significance they might seem to have shared over immense spatial and temporal distances. The EIP Project (Bednarik 2001b; Kumar 2000/01; Kumar et al. 2002) is endeavouring to secure the first data of Lower and Middle Palaeolithic petroglyphs. The present preliminary report provides unambiguous evidence of such rock art from archaeological occupation strata at two sites, Auditorium Cave and Daraki-Chattan. It consists of a total of thirty cupules, in situ or exfoliated from the cave wall, and four linear grooves. At Daraki-Chattan, the lack of cupules on exfoliation scars on the cave walls implies that the remaining wall cupules are of ages similar to those in the excavation. The same relationship has been suggested for the cupules above ground in Auditorium Cave.

The taphonomic dimensions of the subject of extremely early rock art have also been considered (Bednarik 1997b). It is highly relevant that the very earliest examples we have of this oldest known rock art tradition in the world occur inevitably on the most weathering-resistant rock types available, specifically on well-metamorphosed quartzite. Moreover, they are found only in sheltered locations where they are either protected from precipitation, or experience only very limited run-off. It seems justified to assume that these two factors are directly related to the survival of these examples, i.e. that they are so old that they would have survived neither out of caves nor on less resistant rock. Based on this reasoning, taphonomic logic (Bednarik 1994c) can be brought into play, which would select in favour of a high probability that this kind of hominin behaviour was also practised in less protected locations and on less resistant materials. The mode of occurrence of the surviving sample is probably a function of taphonomy (Bednarik 2000/01: 42–6).

This conclusion seems reasonable, but good science still demands that ways be found to test it. One way to test the proposition would be to establish the ages of similar phenomena in various other circumstances, and to plot these against the predictable resistance of the respective supporting lithologies to weathering. If correct, the model would predict that the maximum age of the cupules on all used rock types increases roughly corresponding to their resistance to weathering. To attempt such testing one would need considerably more data, and more systematically collected data than what are available to us presently.

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