Palaeoart and Materiality

The Scientific Study of Rock Art

edited by

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Cover image: Part of the Huashan site in Guangxi Province, southern China, the largest rock painting site in the world. Photograph by R. G. Bednarik.

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Scientists collect and analyse data for scientific study, but the relevance of data for scientific study of rock art depends upon proper understanding of the impact of various taphonomic factors working at the site and on the rock art. This became clear during the Early Indian Petroglyphs Project. The impact of temperature fluctuation and climatic change over a long time span has resulted in exfoliation of the cave surface. The impact is very severe in the front portion of the cave. This led to two observations: (1) that the exfoliated slab pieces must be lying buried in the sediments, some hopefully bearing cupules; and (2) the in-situ cupules have been deformed by micro-exfoliation of the cave surface. The first observation prompted the excavation of the site, which archaeologically established the Lower Palaeolithic antiquity of the cupules in Daraki-Chattan. The second reflection led to better understanding of the forms of the cupules in the cave in the perspective of their weathering. It also shows that any metrical analysis of the cupules will not be relevant unless the impact of taphonomic factors is taken into account.

La comprensión del impacto de los factores tafonómicos sobre los primeros petroglifos en Daraki-Chattan, India

Los científicos recogen y analizan datos para el estudio científico, pero la relevancia de los datos para el estudio científico del arte rupestre depende de la adecuada comprensión de los efectos de diversos factores tafonómicos que actúan en el lugar y sobre el arte rupestre. Esto quedó claro durante el proyecto Early Indian Petroglyphs. El impacto de las fluctuaciones de temperatura y el cambio climático durante un largo periodo de tiempo ha dado lugar a la exfoliación de la superficie de la cueva. El impacto es muy severo en la parte frontal de la cueva. Esto llevó a dos observaciones: 1º) que las piezas de losa exfoliadas deben yacer enterradas en los sedimentos, con la esperanza de que algunas de ellas muestren cazoletas; y 2º) las cazoletas in situ han sido deformadas por la micro-exfoliación de la superficie de la cueva. La primera observación condujo a la excavación del yacimiento, que estableció arqueológicamente una antigüedad de Paleolítico Inferior para las cazoletas de Daraki-Chattan. La segunda reflexión condujo a una mejor comprensión de las formas de las cazoletasde la cueva desde la perspectiva de su meteorización. También muestra que cualquier análisis métrico de las cúpulas no sería relevante si no se tuviera en cuenta el impacto de los factores tafonómicos.

Introduction

Daraki-Chattan is a Palaeolithic cupule site in Chambal basin, located in the Bhanpura-Gandhisagar region in district Mandsaur, Madhya Pradesh in India (Pancholi 1994). It is a small narrow cave in the quartzite buttresses of Indragarh Hill with an entrance facing almost due west (Fig. 1). The cave walls bear over 500 cupules (Kumar 1996; Kumar et al. 2002, Bednarik et al. 2005; Kumar et al. 2005). The majority of the cupules are distributed in the first half of the cave, after which they become sparse. Near the entrance the surface on both walls of the cave has become largely exfoliated at a thickness of 6 to 10 cm, and this is most prominent on the southern face where exfoliation scars can be seen quite deep into the cave, rendering the wall devoid of cupules (Fig. 2).

Thin or granular exfoliation of the rock surface has resulted in the reduction of cupule dimensions and ultimately of the cupules. The loss of cupules is clearly evident on both walls of the cave. Generally the smaller diameter and shallowness of the round cupules is because of gradual exfoliation of the surrounding surface (Figs 3 and 4). Hence, any metrical analysis based on the present cupule dimensions will not provide information on original sizes (Bednarik et al. 2005; Kumar et al 2012; Kumar and Krishna 2014). A similar process has been observed on some of the Lower Palaeolithic cupules of the Auditorium Cave at Bhimbetka, reducing their sizes due to laminar exfoliation of the adjacent surfaces (Bednarik 1996). The interior of these cupules is likely to be more erosion resistant due to partial kinetic energy metamorphism (see Bednarik 2016, this volume).

Our examination of the site initially focused on the almost complete absence of cupules on the walls of the entrance part of the cave (Fig. 2). In the vicinity of the opening floor step, much of the lower part of both

Figure 1. Daraki-Chattan Cave (DC), front view, in the quartzitic buttresses of Indragarh Hill.

Figure 2. DC southern wall showing exfoliation scars and is devoid of cupules in its front portion.

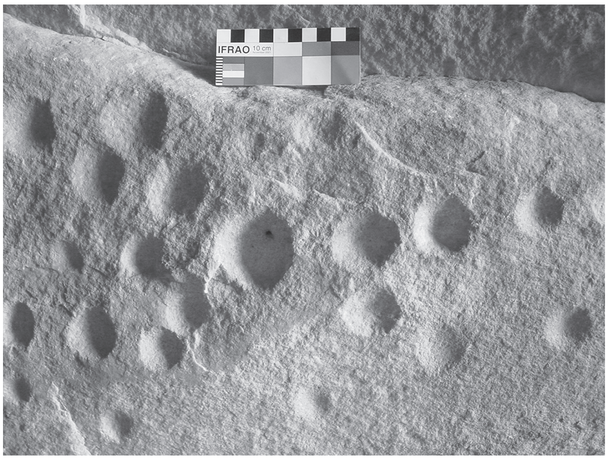

Figure 3. Weathered cupules on southern wall of DC with damage of their shape ,size and depth due to weathering.

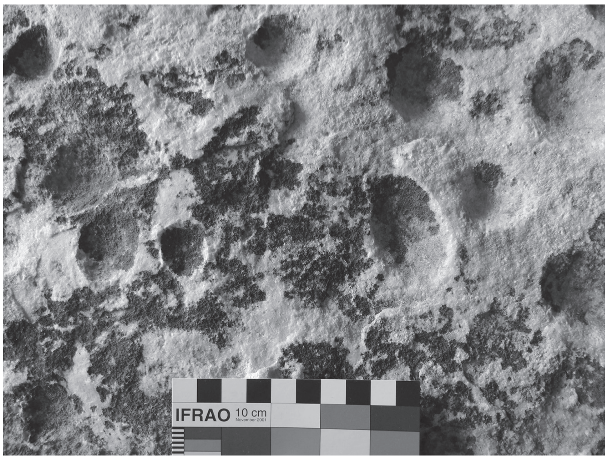

Figure 4. Weathered cupules on northern wall of DC with damage of their shape ,size and depth due to weathering.

the northern and southern walls has been subjected to natural exfoliation. Since the wall areas affected by this process coincide roughly with those experiencing direct solar radiation in the 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 (Fig. 5). However, the possibility that the exfoliation scar on the north wall was caused by fire rather than insolation cannot be excluded conclusively. It features a roughly conchoidal fracture surface and stress marks, and impact from falling rocks is impossible because the wall is sheltered 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. 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. Other motivations were to establish the vertical extent of hominin occupation evidence, the typology of the stratified lithics, the acquisition of dating evidence, and most especially the vertical distribution of hammerstones used for the production of the more than 500 cupules, at

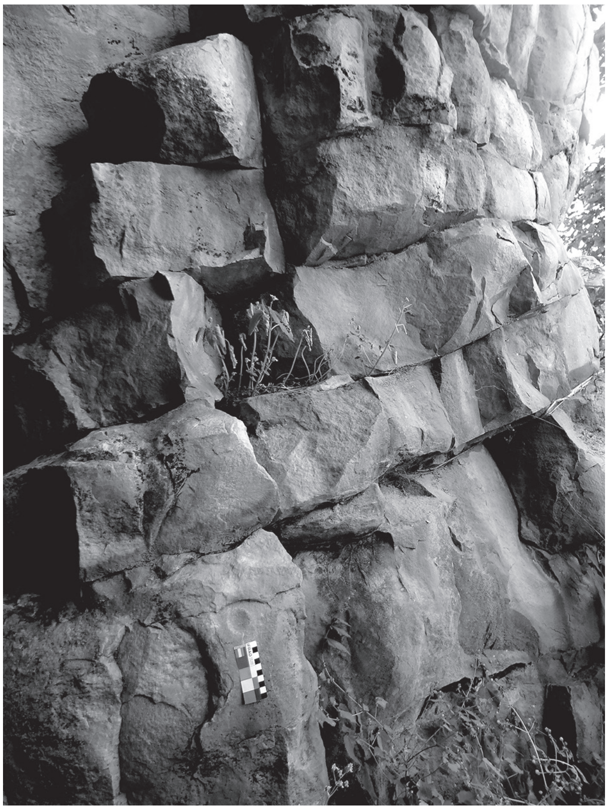

Figure 5. DC solitary cupule on the southern wall near the entrance of the Cave.

least some of which were expected to be present in the sediment (Bednarik et al. 2005; Kumar et al 2005).

Summary of the excavations at Daraki-Chattan 2002–2006

Excavations at Daraki-Chattan (henceforth DC), carried out for five seasons, from 2002 to 2006, formed a major aspect of the EIP Project (Kumar 2006; Kumar et al. 2005). Sediments up to 325 cm thickness forming six arbitrary layers were excavated (Fig. 6). The preliminary results of the EIP Project have been published in India, Australia and other countries from time to time (Kumar et al. 2002a, 2002b, 2005, 2012; Kumar 2008, 2010a, 2010b, 2010c, 2012; Bednarik et al. 2005; Bednarik 2009, 2012a, 2012b; Bednarik and Kumar 2012; Krishna and Kumar 2012a, 2012b; Kumar and Krishna 2012). However, a summary of the excavations is being given for understanding the typological-cultural development of lithics and correlation of the exfoliated cupules and hammerstones found in different layers with them.

The Lower Palaeolithic (LP) stone tool sequence in the DC sediments commences from the uppermost level of the floor deposit, which comprises only a very thin layer of more recent strata. In places an industry intermediate to Lower and Middle Palaeolithic (MP) typology was visible at the surface before excavation commenced. These intermediate tool types are underlain by a substantial deposit defined as Acheulian, but poor in typical hand-axes and cleavers. Six vague and fairly

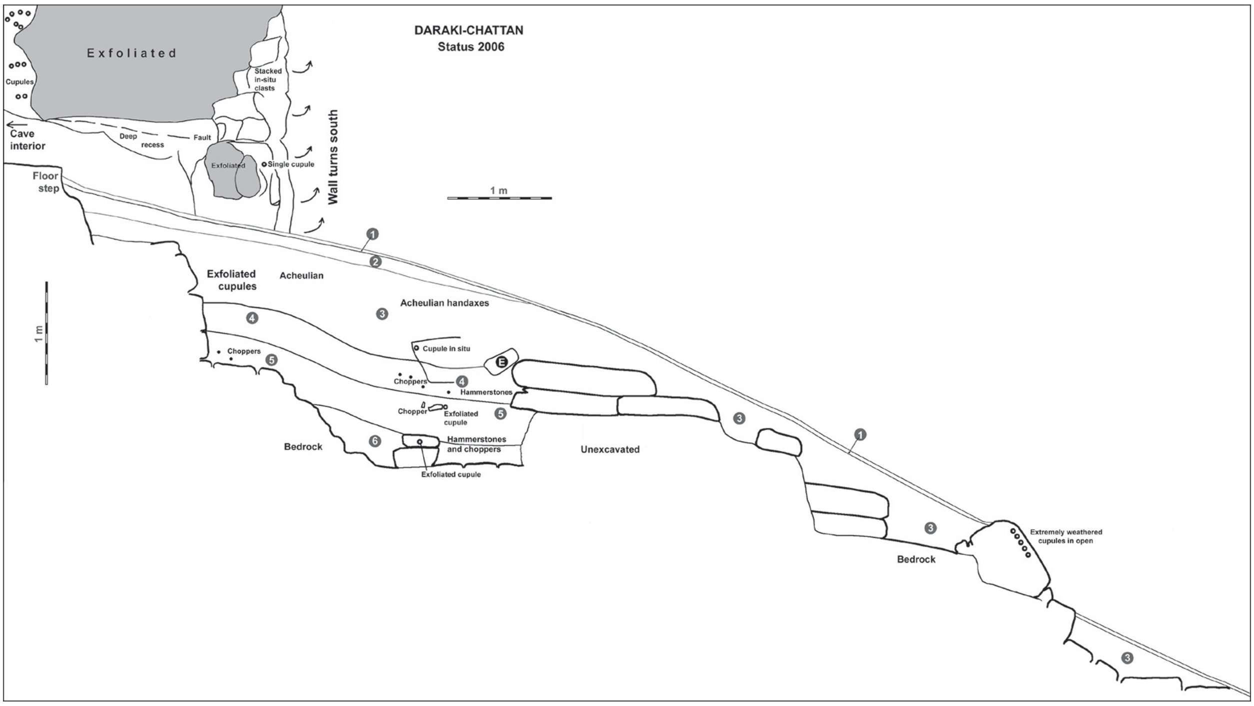

Figure 6. Schematic section showing the six arbitrary layers exposed in the excavations at DC and cupule bearing slabs and hammerstones obtained from different layers.

Figure 7. Weathered Oldowan-1Cobble tool on quartzite close to bedrock and just in the section facing north obtained in the excavation from square A1 in Daraki-Chattan Cobble tool on quartzite.

Figure 8. The zigzag edge of the same Oldowan-1 on quartzite.

arbitrary layers were distinguished in the sediment, becoming progressively more reddish in layer 5. The lowest sediment deposit is characterised by its red colour, the upper part of which contains severely weathered Mode 1 cobble tools (Figs 7–8) as well as hammerstones of the type used to produce the cupules (Fig. 9).

Arbitrary layers 3 and 4 contain LP flake artefacts, some made from river cobbles, but most made of the local purplish quartzite. A few artefacts are on patinated chert. Layer 5 contains still much the same industry, but increasing superficial iron content has affected a more reddish colour. Both the stone tools and clasts show increasing effects of weathering and iron induration, which on large clasts may take the form of thick mineral crusts of primarily ferromanganese composition.

The basal sediment layer features only very weathered stone tools and clasts. Tool types from the lower sediments include cobble tools (Figs 7–8), discoids, core choppers, flake scrapers and polyhedrons similar to the so-called Durkadian reported by Armand (1980). A few specimens resemble what have been called core-scrapers at Mahadeo-Piparia, another central Indian site, whose repertoire has been called the Mahadevian. These characteristic pieces are large blocks with a zigzagging edge produced by chunky flakes having been removed alternatively from each side.

Although LP and MP stone tool traditions are widespread in India, represented in massive quantities and typologically accounted for, 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. The cobble or chopping tools preceding the bifaces

Figure 9. Hammerstone from arbitrary layer 4. It is with multiple wear facets, one of which is visible above the millimetre scale.

of the Indian Acheulian have attracted comparatively little attention.

While the Lower Acheulian remains largely undated, preliminary indications suggest a late Middle Pleistocene antiquity for the Final Acheulian. Uranium-Thorium

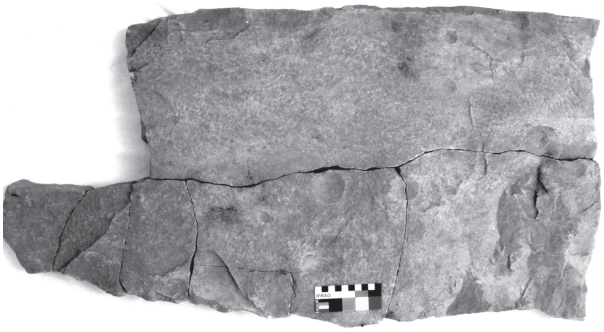

Figure 10. Six cupule slab pieces obtained from arbitrary layer 3, joined together to form the exfoliated slab.

dates from three calcareous conglomerates containing Acheulian artefacts (Nevasa, Yedurwadi, Bori) suggest ages in the order of 200 ka. The most recent date for an Indian Acheulian deposit is currently the uranium-series result of about 150 ka from a conglomerate travertine at Kaldevanahalli. There remains wide disagreement about the antiquity of the Early Acheulian and the Mode 1 industries. Some favour a date of 1.4 million years (Ma) from Kukdi valley for the earliest phase of the Acheulian; others reject it. The earliest phase of human presence in India, of Mode 1 assemblages, remains largely undated, but at Pabbi Hills, dates ranging from 2.2 to 1.2 Ma have been acquired by palaeomagnetism. The few flaked quartzite cobbles from Riwat (Pakistan) appear to be in the order of 2.5 Ma old, rather than 1.9 Ma as previously proposed. The claims from Labli Uttarani, ranging from 1.6 to 2.8 Ma, are viewed sceptically. However, the earliest data from China imply an occupation by hominins prior to 2 Ma, which implies human presence in India by that time. Reliably identified Mode 1 industries have been excavated from secure stratigraphies in very few cases in India, and they were found below Mode 2 (Acheulian) strata at the two early cupule sites, Auditorium Cave at Bhimbetka and in DC. These quartzite tools are partially decomposed at both sites and they were found in both cases below pisoliths and heavy ferromanganese mineral accretions indicating a significant climatic incursion. The details of typological context of the excavated tools from DC have been published by Bednarik and Kumar (2012).

The excavations at DC have established that DC was a Lower Palaeolithic site. During the excavations exfoliated cupules (Fig. 10) and hammerstones used for their creation (Fig. 9) were obtained from arbitrary layer 3 down to arbitrary layer 4, 5 and from the interface of 6/5. It means the cupules on the excavated slabs must have been much older than their stratigraphical antiquity, and this applies also to the cupules on the cave walls. Thus, the EIP Project has confirmed the evidence from Bhimbetka of Lower Palaeolithic cupules. It also established that with more than 500 cupules on its walls, DC is the richest known early Palaeolithic cupule site in the world (Kumar 1995, 1996; Kumar et al. 2005; Kumar 2006; Bednarik et al. 2005; Beaumont and Bednarik 2015).

In addition to housing some of the oldest known rock art in the world, DC is also an important Palaeolithic site because it is one of the very few Indian locations where Mode 1 (pre-Acheulian) occupation evidence has been excavated in a stratified context. Overlain by a typical Acheulian with hand-axes, this deposit has yielded very simple, Oldowan-like stone artefacts made mostly of the local quartzite. As a very early cupule site it is therefore of particular importance to exploring the LP industries of southern Asia (Bednarik and Kumar 2012).

The taphonomic dimensions of the extremely early rock art

It is highly relevant that the very earliest examples of the 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 in sheltered locations where they are either protected from precipitation, or experience only very limited run-off. In addition, cupules tend to be deeper than other forms of petroglyphs, which means that they survive granular exfoliation, laminar exfoliation and solution longer. It therefore seems justified to assume that these factors are directly related to the survival of the examples described, 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 1994) 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 always a function of taphonomy (Bednarik 2000/01: 42–46).

In the case of the DC cupules, the opportunity of testing this proposition has been realised, through the 2004 discovery of cupules outside the cave. These are located on a large block of quartzite about 8 m from the opening of the cave, in full exposure to precipitation (Figs 6, 11). The block is 100 × 125 × 45 cm in size, lying tilted at nearly 40^{o}, facing west. This rock bears a cluster of cupules which are so faint that they were only noticed after a decade of intensive research work at the site (Fig. 12). In fact they are so faint that their number remains unknown. These markings are only visible as faint traces of former cupules.

In the light of the debate following the presentation of this paper in the IFRAO Conference 2015, Caceres, Spain Kumar and Krishna went again to the site and tried to take photographs in oblique light under the shadow of a sheet in the day time, and also in the night on 26

Figure 11. Quartzite Block-1 bearing nearly 50 extremely weathered cupules. It is situated 8 m away from the opening of the Cave.

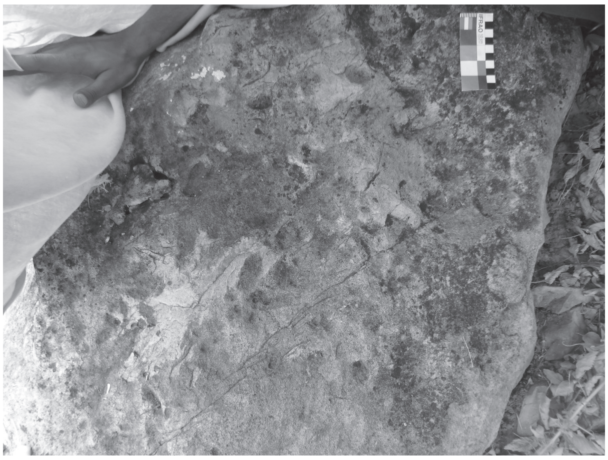

Figure 12. Extremely weathered cupules on Block-1.

September 2015. They were able to count the impressions of more than 50 cupules on it which were not properly visible in the day time. Circumstantial evidence indicates that these cupules are also of the same antiquity as those in DC where they survived much better because of the comparatively protected environment of the cave.

Although they are obviously very ancient, their contemporaneity with the cupules both on the cave walls and in the excavated sediments cannot be demonstrated. If it is accepted, their condition can be compared, and the effect of taphonomy illustrated. The cupules in the cave are nearly as well preserved as those on Chief's Rock at Bhimbetka (Bednarik 1996), which are almost unaffected by moisture. While those in DC are subjected to occasional water flow, which deposits silica precipitates, the cupules just outside the cave have only survived as 'cupule shadows'. This illustrates powerfully the effects of taphonomy.

The nexus between dating and taphonomy can be appreciated by considering that the similar cupules at two sites in the southern Kalahari Desert that are dated to 410 ka BP (Beaumont and Bednarik 2015) are almost as well preserved as those occurring inside DC. The South African specimens are on open quartzite pavements, and although they were probably covered by sediment in the past, they have also been exposed to rain for long periods of time. However, rainfall in the Kalahari Desert is extremely low, and has been so throughout the Pleistocene. Therefore, based on relative taphonomic effects, it would seem that the cupules of the two Indian sites are indeed of the Early Pleistocene — as, conversely, is also implied by the site's archaeology.

Besides, there are two more quartzite blocks, comparatively small in size and lying close to each other, nearly 6 m northwest of the first block and 4 m from the drip line of the shelter. They have been numbered blocks 2 and 3. Block 2 is a small triangular piece, 45 × 45 × 10 cm in size, while block 3 is 82 × 112 × 33 (visible) cm in size. The cupules on them are also extremely weathered; hence they were also photographed in oblique light under the shadow of a sheet in the day time and also in the night on 26 September 2015 (Figs 13–14). On block 3 more than 60 cupules are barely visible on the southern half of the rock surface and appear to have been arranged in pseudo-linear patterns. The cupules on block 2 are only faintly visible and their number defied estimation.

Other cupule sites in the associated region

Besides, 23 early cupule sites on quartzite blocks and bedrock exposures have been discovered in the region surrounding DC. These are located on Indragarh Hill, Chanchalamata Hill and on big quartzite blocks at Kanwala, Modi, Arnyabhau and Pola Bata. These cupule sites are distributed within a diameter of 20 km from DC (Kumar et al. 2006). Nearly half of them were found on Indragarh Hill and associated Chanchalamata Hill. All of them are in the open, except Pola Bata and Chhota Ramkund where the cupules are in a sheltered area. These cupule sites are littered with Lower Palaeolithic stone artefacts and other lithics. Most of the cupule sites in the open have been exposed to precipitation,

Figure 13. Extremely weathered cupules on small quartzite Block-2. It is lying in front of the excavated rock shelter associated with DC.

Figure 14. Extremely weathered cupules on quartzite Block-3. It is lying close to Block-2 in front of the excavated rock shelter associated with DC.

temperature fluctuation and aeolian erosion; hence the cupules on them are extremely weathered.

These cupule sites show different cupule patterns, from random distribution of the cupules to pseudo-patterns and from linear to bilinear and multilinear arrangements. They are in different states of weathering also. Thus, the taphonomic study of the early cupule sites, including DC, in the Bhanpura region indicate a special early human behaviour of cupule production in the region in space and time, showing different stages of cognitive and cultural development in the Pleistocene period, beginning from the Lower Palaeolithic age.

Conclusion

The taphonomic study of the early cupules in Daraki-Chattan and nearby region has brought out some pertinent issues as follows:

1. Documentation of the petroglyphs should be accompanied by the details of the state of weathering of the rock surface and the climatic factors impacting it.
2. Understanding the weathering effect and exfoliation process on the rock surface and on rock art is essential in collecting accretion samples for AMS ^{14}C and other radiometric dating.
3. Understanding the lithology of the rock bearing rock art (hardness of the rock and its resistance to weathering) and the environment responsible for its protection from precipitation is also indispensable. The chances of the survival of early rock art are greater on resistant rock in a protected environment, such as in a cave.
4. The early cupules in Bhanpura region also prove the taphonomic logic that rock art production was also practised in less protected locations near DC and in the associated region.
5. A quite distinctive type of human behaviour must have been continued for hundreds of millennia in the Bhanpura region of central India.

Why people chose to produce cupules on hard quartzite rock for hundreds of thousands of years is a challenging question. From the replication of cupules on hard quartzite rock we understand that cupule creation involves very substantial physical efforts and skill, as well as immense determination. This practice by early humans appears to have been deeply embedded in their cognitive and cultural development (Kumar and Krishna 2014). 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 those available to us presently (Bednarik 2000/01: 42–46).

References

Armand, J. 1980. The Middle Pleistocene pebble tool site of Durkadi in central India. *Palaeorient* 5: 105–144.

Beaumont, P. B. and R. G. Bednarik 2015. Concerning a cupule sequence on the edge of the Kalahari Desert in South Africa. *Rock Art Research* 32(2): 163–177.

Bednarik, R. G. 1994. A taphonomy of palaeoart. *Antiquity* 68: 68–74.
Bednarik, R. G. 1996. The cupules on Chief's Rock, Auditorium Cave, Bhimbetka. *The Artefact* 19: 63–72.
Bednarik, R. G. 2000/01. Early Indian petroglyphs and their global context. *Purakala* 11/12: 37–47.
Bednarik, R. G. 2001. The Early Indian Petroglyphs Project (EIP). *Rock Art Research* 18(1): 72.
Bednarik, R. G. 2009b. The global context of Lower PalaeolithicIndian palaeoart. *Man and Environment* 34(2): 1–16.
Bednarik, R. G. 2012a. Dating and taphonomy of Pleistocene rock art. In J. Clottes (ed.), *L'art pléistocène dans de monde*, Actes du Congrès IFRAO, Tarascon-sur-Ariège, Septembre 2010. Special issue, *Préhistoire, Art et Sociétés, Bulletin de la Société Préhistorique Ariège-Pyrénées* 65–66: 188–189 (1059–1060 on CD).
Bednarik, R. G. 2012b. Indian Pleistocene rock art in the global context. In J. Clottes (ed.), *L'art pléistocène dans de monde*, Actes du Congrès IFRAO, Tarascon-sur-Ariège, Septembre 2010. Special issue, *Préhistoire, Art et Sociétés, Bulletin de la Société Préhistorique Ariège-Pyrénées* 65–66: 150–151 (869–878 on CD).
Bednarik, R. G. 2016. The tribology of petroglyphs. This volume.
Bednarik, R. G. and G. Kumar 2012. Typological context of the Lower Palaeolithic lithics from Daraki-Chattan Cave, India. In J. Clottes (ed.), *L'art pléistocène dans de monde*, Actes du Congrès IFRAO, Tarascon-sur-Ariège, Septembre 2010. Special issue, *Préhistoire, Art et Sociétés, Bulletin de la Société Préhistorique Ariège-Pyrénées* 65–66: 154–155 (895–906 on CD).
Bednarik, R. G., G. Kumar, A. Watchman and R.G. Roberts 2005. Preliminary results of the EIP Project. *Rock Art Research* 22(2): 147–197.
Krishna, R. and G. Kumar 2012a. Understanding the creation of small conical cupules in Daraki-Chattan. In J. Clottes (ed), *L'art pléistocène dans de monde*, Actes du Congrès IFRAO, Tarascon-sur-Ariège, septembre 2010. Special issue, *Préhistoire, Art et Sociétés, Bulletin de la Société Préhistorique Ariège-Pyrénées* 65–66: pp. 216–217 (1229–1256 on CD).
Krishna, R and G. Kumar. 2012b. Physico-psychological approach for understanding the significance of Lower Palaeolithic cupules. In J. Clottes (ed.), *L'art pléistocène dans de monde*. Numero special des Acts du Congress IFRAO, September 2010. *Bulletin de la Société Préhistorique Ariège-Pyrénéés* 65–66: 158–160 and in CD 919–928.
Kumar, G. 1995. Daraki-Chattan: a Palaeolithic cupule site in India. *Purakala* 6: 17–28.
Kumar, G. 1996. Daraki-Chattan: a Palaeolithic cupule site in India. *Rock Art Research* 13: 38–46.
Kumar, G. 2006. A preliminary report of excavations at Daraki-Chattan- 2006. *Purakala* 16: 51–55.
Kumar, G. 2008. Lower Palaeolithic petroglyphs from excavations at Daraki-Chattan in India. In R. G. Bednarik and D. Hodgson (eds), *Pleistocene palaeoart of the world*, pp. 63–75. BAR International Series 1804, Archaeopress, Oxford.
Kumar, G. 2010a. Recent developments in rock art research in India with special reference to the EIP Project. In L. M. Olivieri, L. Bruneau and M. Ferrandi (eds), *Pictures in transformation: rock art research between central Asia and the subcontinent*, pp. 1–12. BAR International Series 2167, Archaeopress, Oxford.
Kumar, G. 2010b. Cognitive and creative abilities of Lower Palaeolithic hominins in India. *FUMDHAM Mentos* 9: 187–195. Fundaçào Museu do Homen Americano, São Raimundo Noñato, Brazil.
Kumar, G. 2010c. Understanding the creation of early cupules by replication with special reference to Daraki-Chattan in India. In R. Querejazu Lewis and R. G. Bednarik (eds), *Mysterious cup marks: proceedings of the First International Cupule Conference,* pp. 59–66. BAR International Series 2073, Archaeopress, Oxford.
Kumar, G. 2002. EIP Project Report-I: archaeological excavation and explorations at Daraki-Chattan-2002: a preliminary report. *Purakala* 13: 5–20.
Kumar, G., R. G. Bednarik, A. Watchman, R. G. Roberts, E. Lawson and C. Patterson 2002a. 2002 progress report of the EIP Project. *Rock Art Research* 20: 70–71.
Kumar, G., R. G. Bednarik, A. Watchman and C. Patterson 2002b. 2002- EIP Project report-II: sample collection for analytical study and scientific dating of the early Indian petroglyphs and rock paintings by the international commission. *Purakala* 13: 21–28.
Kumar, G., R. G. Bednarik, A. Watchman and R. G. Roberts 2005. The EIP Project in 2005: a progress report. *Purakala* 14–15: 13–68.
Kumar, G., P. K. Bhatt, A. Pradhan and R. Krishna. 2006. Discovery of early petroglyph sites in Chambal valley, Madhya Pradesh. *Purakala* 16: 13–34.
Kumar, G. and R. K. Prajapati. 2010. Understanding the creation of cupules in Daraki-Chattan, India. *FUMDHAM Mentos* 9: 167–186. Fundaçào Museu do Homen Americano, São Raimundo Noñato, Brazil.
Kumar, G., N. Vyas, R. G. Bednarik and A. Pradhan 2012. Lower Palaeolithic petroglyphs and hammerstones obtained from the excavations at Daraki-Chattan Cave in India. In J. Clottes (ed), *L'art pléistocène dans de monde*. Numero special des Acts du Congress IFRAO, September 2010. *Bulletin de la Société Préhistorique Ariège-Pyrénes* 65–66: 152–153 and in CD 879–894.
Kumar G. and R. Krishna 2012. Understanding the creation of early angular cupules on hard quartzite rock at Daraki-Chattan by direct percussion method: a preliminary study. *Purakala* 22: 17–28.

Kumar, G. and R. Krishna 2014. Understanding the technology of the Daraki-Chattan cupules: the cupule replication project. *Rock Art Research* 31(2): 177–186.

Pancholi, R. K. 1994. Bhanpura khetra me navin shodha (Hindi). *Purakala* 5(1–2): 75.

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