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ESTIMATING THE AGE OF CUPULES

Robert G. Bednarik

Abstract. The dating of cupules presents the same challenges as does the dating of most petroglyphs, with the added difficulty that cupules, more than other petroglyphs, have often been subjected to reuse long after they were first created. This means that parts of their surface may derive from different periods, or all earlier surfaces may have been obliterated completely. Examples of this phenomenon are given, and a discussion of the currently available methods of estimating the antiquity of cupules is presented. It emerges that, since the dust created in making cupules or other petroglyphs is not realistically recoverable, the analytical possibilities in dating them are severely limited. One of the best options is not to date the rock art, but instead date the tools used in creating it. This has been successful in some cases. The use of field microscopy is shown to be indispensable in any analytical work with cupules.

Keywords: Petroglyph, Dating, Methodology, Early cupules, Microerosion analysis, Hammerstone

Introduction

While it is essential to establish some semblance of an initial working definition of cupules, this does need to be qualified by conveying that there are adequate ambiguities to banish any notion of finite or universal rules about such definition. Elsewhere in this volume I have explained the great difficulties archaeologists have in distinguishing cupules from other phenomena resembling them, both natural and anthropic. But even if these are resolved, there still remain concerns that cupules should be treated as a single class of evidence, and this needs to be borne in mind when considering issues of their spatial and temporal distribution. Cupules occur commonly in most parts of the world, and they can be found in astronomical numbers in many regions. Moreover, they first begin to appear in the Lower Palaeolithic period, and in some cultures, particularly in Australia, they were still made in the early 20th century. Their ubiquity, and especially their appearance so early in hominin history, renders it extremely unlikely that we are dealing with a culturally homogeneous phenomenon persisting through the ages. Rather, this class of artefact is probably only defined by its morphological homogeneity, and its apparently universal occurrence and characteristics are partly artefacts of our data-collecting strategies.

Cupules are unequivocally among the most perdurable of all non-utilitarian anthropic rock markings. It is of considerable significance that nearly all of the petroglyphs currently known of the Lower Palaeolithic are cupules (only four exceptions can be cited at present, three linear petroglyphs from Daraki-Chattan, one from Auditorium Cave, both sites being in India; Bednarik et al. 2005). Taphonomic logic (Bednarik 1994) decrees how very improbable it is that this was the first rock art produced, and it is highly likely that other forms of rock art were in use then, but have apparently not survived (see chapter in this volume on the taphonomy of cupules). This is confirmed by the occasional discovery of haematite crayons of the Lower Palaeolithic that were used to mark rock surfaces (Bednarik 1990), and by the finds from numerous sites of portable engravings and other palaeoart discoveries (Bednarik 2003).

The earliest object ever suggested to bear cupules is the pecked phonolite cobble from Olduvai FLK North 1 in Bed 1, Tanzania, about 1.74 Ma old (Leakey 1971: 269; cf. Bednarik 2003: Fig. 21). The rounded stone bears a deep cup-shaped, anthropic mark on one side, and a shallower such mark on the other. It does bring to mind a few very similar Middle to Upper Magdalenian quartzite and granite cobbles from France, from Laugerie-Basse and La Garenne (Lartet and Christy 1875; Tarel 1912, 1919; Peyrony 1918, 1920; de Beaune 1987, 1989). However, the Oldowan specimen may be the product of a utilitarian process. Vaguely cupule-like features on rock have on occasion been reported to be produced by chimps, and in South America even by monkeys, resulting from such activities as cracking nuts (McGrew 1992: 205, 1993). Joulian (1995: Fig. 5) presents a chimpanzee *percuteur* from Monogaga, Ivory Coast, that looks rather similar to Leakey's Olduvai specimen.

The first cupule demonstrated to be of the Lower Palaeolithic is one of two petroglyphs found on a quartzite

Figure 1. *Exfoliated cupules excavated in a Lower Palaeolithic occupation layer at Daraki-Chattan, India.*

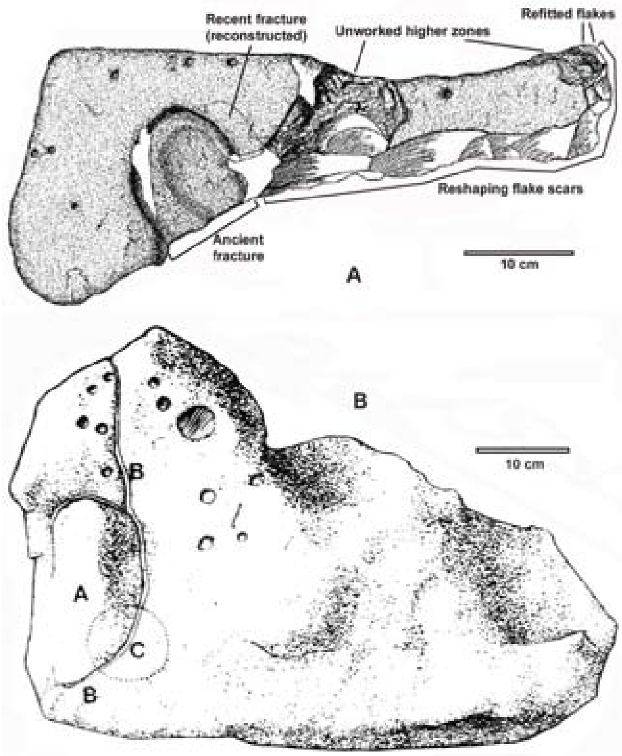

Figure 2. *The Lower Palaeolithic slab with cupules from Sai Island, Sudan, and the sepulchral limestone block with cupules placed over a Neanderthal burial in La Ferrassie Cave, France (after van Peer et al. 2003 and Peyrony 1934).*

boulder in an excavated trench in Auditorium Cave, Bhimbetka site complex, central India, covered by the top of the upper Acheulian horizon (Bednarik 1992a, 1993a, 1993b, 2001a, 2004) but probably of the lower chopping tool horizon. After detailed study of the site I proposed that nine further cupules nearby, but occurring above ground, were probably of similar antiquity (Bednarik 1996), but this was on the basis of largely circumstantial evidence. However, in the same year, Kumar (1996) reported the discovery of an assemblage of about 500 cupules in Daraki-Chattan, another Indian quartzite cave, which he suspected might also be of extremely great age. This was followed by further reports of Indian cupule sites of apparent Pleistocene antiquity, those of the Hathikheda sites (a series of outcrops of massive white quartz near Ajmer, including Moda Bhata), the large Morajhari cupule site (also in the vicinity of Ajmer), and the sites Bajanibhat and Jhiri Nala (near Kotputli). However, microerosion analyses at two of these sites has provided only Holocene ages so far (Bednarik and Kumar 2002; Bednarik et al. 2005), although the oldest phase of the complex Bajanibhat site does remain a viable candidate for Lower or Middle Palaeolithic antiquity. However, the substantial corpus at Daraki-Chattan has been clearly demonstrated to have been made by people with a chopping tool industry similar to the Oldowan, which underlies substantial Acheulian and Micoquian-like occupation layers. In the sediments at the entrance of this cave, some thirty exfoliated cupules (Figure 1) were excavated in and below the Acheulian deposit, extending all the way to the chopping tool layer, while numerous hammerstones used in the production of some of the approximately 540 cupules of the cave were concentrated in this lowest occupation deposit (Bednarik et al. 2005). This sound stratigraphical evidence suggests that the cupules in Auditorium Cave, too, are perhaps not of the Acheulian as previously suggested, but also belong to the chopping tool tradition found under the site's two Acheulian horizons, and separated from them by a sterile layer.

In addition to these two sites of Lower Palaeolithic cupules in India, a sandstone slab with seven small cupules and one very large cupule has recently been reported from Sai Island, Sudan, believed to be in the order of 200,000 years old (van Peer et al. 2003). This find from the Lower Sangoan (Figure 2A) immediately brings to mind the very similar limestone slab excavated in La Ferrassie, France, which had been placed over the grave of a Neanderthal child, with the cupules on the underside, i.e. facing the interment (burial No. 6; Peyrony 1934: 33–36, Fig. 33). The French specimen, which I have studied microscopically (Bednarik in prep.), bears one large cupule plus seventeen small ones, some of which are very faint, and sixteen of them are arranged in pairs (Figure 2B). It is usually attributed to the Mousterian, but this appears to be purely on the basis that the burial is of a

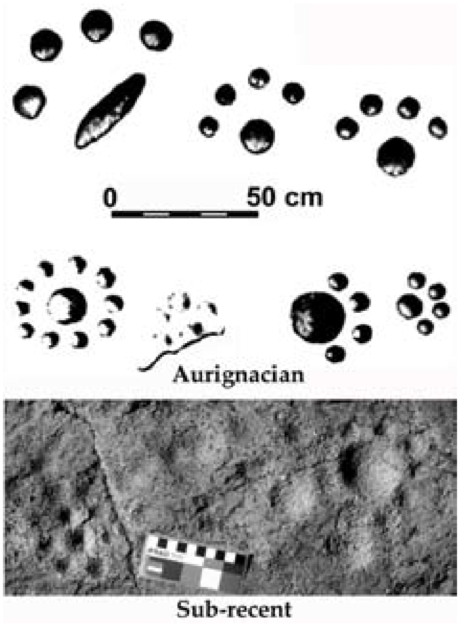

Figure 3. *Arrangements of Aurignacian cupules from Abri Blanchard, France (top), compared with others of recent age at Llave Chico, Bolivia (Below). The age difference between the two groups is in excess of 30,000 years.*

Neanderthal child. Since there are also Aurignacian cupules at this and other sites nearby, and since the Aurignacian also appears to be a tool tradition by robust humans rather than gracile moderns (Bednarik 2007a), the cultural placement of the sepulchral slab from La Ferrassie may need to be reconsidered.

Peter Beaumont has reported finding extremely early cupule sites also in the Korannaberg region, southern Kalahari (Beaumont in press; Beaumont and Bednarik in prep.; Bednarik 2003). Like those in India they occur on heavily metamorphosed and thus particularly weathering-resistant quartzite, and they appear to be either of the MSA (Middle Stone Age) or earlier. By the time of the Middle Palaeolithic, cupules had probably become very common. Tens of thousands occur just in Australia, where all Pleistocene and early Holocene rock art is necessarily associated with Mode 3 lithic industries (Foley and Lahr 1997), as is literally all rock art of Tasmania.

One might be tempted to see cupules as a '*Leitfossil*' of Middle Palaeolithic/MSA traditions, so dominant do they appear to be at that time, but they are found in even greater numbers in some of the most recent periods. They occur in the European Upper Palaeolithic, where they tend to be described as 'pitted blocks' because they are most often found on cave clasts or boulders. They seem to be particularly abundant in the earliest Upper Palaeolithic, and they are thought to be less common in the Upper Périgordian (i.e. the western Gravettian) than in the Aurignacian (de Beaune 1992). In all probability they were particularly associated with robust humans of the Final Pleistocene

Figure 4. *Cupules on the truncation surface of a menhir of the Almendres cromlech, Evora, Portugal.*

(Bednarik 2007a). Aurignacian examples (Figure 3) are abundant at Le Cellier, Castanet and Blanchard (Delluc and Delluc 1978). They have also been reported from sites of the Gravettian (Laussel), Solutrean (Badegoule) and from the Magdalenian, such as at Abri Reverdit (de Beaune 2000: 71). With the latter tradition, they even occur on small, round and very hard cobbles, such as the specimens from Laugerie-Basse and Abri de La Garenne (op. cit.: 101). Particularly noteworthy are two pieces, of the mid or upper Magdalenian, one of brown quartzite, one of granite, each bearing a cupule centred in a perfectly formed, deeply hammered circle. These well-rounded stones, under 10.5 cm, resemble the typical cup-and-ring features of much more recent times closely, and are thus unlikely to be utilitarian. At Limeuil cupules appear together with engraved lines (Capitan and Bouyssonie 1924: Pl. X), at La Ferrassie Peyrony (1934: 67–69, 75–78) reported them from the Middle Aurignacian levels, while in Cosquer Cave they occur on bedrock (Clottes et al. 2005: Figs 194, 195) and are probably of the mid-Upper Palaeolithic.

Figure 5. *Cupules on sandstone at Sandy Creek Shelter 1, Cape York Peninsula, Australia, possibly up to 40,000 years old.*

Cupules are much more common from apparent Holocene contexts, being most frequently described as Neolithic or Metal Ages features, for instance in western Europe (e.g. d'Arragon 1994; Steinbring and Lanteigne 1991). There they are frequently found with megalithic evidence (Figure 4). In some of these mid to late Holocene traditions it appears cupules were used with specific semiotic or syntactic meanings; for instance it is assumed that cupules placed between the legs of anthropomorphous petroglyphs denoted female sex. However, cupules are not restricted to pre-Historic times, they continue to be produced or re-used in Europe until well into the Historical periods (Mandl 1995; Rizzi 1995, 2007; Schwegler 1995: 112–113; Costas Goberna et al. 1999: 166). The most recently made cupules that have been convincingly dated in Europe are of the Middle Ages (Bednarik 2001b) and even more recent, up to the early 18th century C.E. (Rizzi 1995: 81).

In other continents, too, Holocene cupules are ubiquitous features of numerous rock art traditions. But before we consider these, it is appropriate to briefly return to the issue of 'Middle Palaeolithic' cupules. In accordance with Foley and Lahr's typological taxonomy, all of Australia's Pleistocene and early Holocene technological traditions are of 'Middle Palaeolithic' nature. The continent was initially settled by Middle Palaeolithic seafarers from Wallacea (Bednarik 1999), and the descendants of these colonisers retained their 'core and scraper' lithics until the mid-Holocene. Moreover, in Tasmania the human population became separated from that of the mainland about 12,400 years BP, i.e. when the sea-level passed about –56 m, and they retained this mode 3 technology right up to the time of British colonisation around 200 years ago. One may consider this tradition as the only 'Middle Palaeolithic culture' witnessed and described (however inadequately) in Historical times. More relevantly, in the present context, the petroglyph traditions of Tasmania seem to be dominated by mostly small cupules, among which occur rare large cupules (Bednarik et al. 2007), i.e. their pattern of occurrence resembles that found elsewhere with 'Lower' and 'Middle Palaeolithic' traditions. In some of the major petroglyph regions of mainland Australia, such as the Pilbara on the west coast, cupules are often very numerous, occurring in large numbers on individual boulders, and there is frequent evidence that they precede most or all other petroglyphs in those areas (e.g. McNickle 1991; Bednarik 1993a). On the other hand, the Jinmium controversy (Fullagar et al. 1996) demonstrated that it is impossible to generalise, and the weathered appearance of some of the cupules on softer sandstones may belie their true ages. Nevertheless, there can be no reasonable doubt that Pleistocene cupules occur in the tens of thousands in Australia, if not hundreds of thousands, from the Pilbara in the far west (especially the eastern Pilbara) via Carpenter's Gap in the Kimberley to the Cape York Peninsula in the east, where the cupule panel of Sandy Creek 1 (Figure 5) refers to an important Pleistocene site (Morwood 2002).

The age estimation of cupules

Globally there are not very many instances of the age of cupules having been estimated in absolute terms by credible methods. A few of them refer to archaeological predictions based on the excavation of cupules in roughly datable sediments. For instance in Africa, one vertical cupule panel has been minimum-dated by excavation. Clark (1958: 21–2) has obtained a carbon isotope age of 6310 ± 250 years BP from the sediment of Chifubwa Stream Rockshelter in northern Zimbabwe. At Daraki-Chattan in India, the two substantial cupule panels of the cave are securely linked to an occupation layer of Oldowan-like chopping tools occurring at the base of a deposit containing substantial handaxe-bearing deposits further up. This link is based on the presence of numerous exfoliated rock slabs from the wall panels, many with cupules, which occur down to this lowest occupation level. It is strongly reinforced by the presence of hammerstones within the chopping tool stratum, which are of the type used in cupule production. Although this link is secure, dating of the layer has not yet been accomplished, but the cultural attribution of the cupules by stratigraphy is adequate to designate this as one of the earliest of all known rock art sites.

Excellent archaeological dating of cupules has been achieved at several sites near Bressanone, in the northern Italian Dolomites. Egger (1948) excavated a cupule slab in the hearth of a middle Iron Age hut at Albanbühel. At a site in Plabach he managed to place another example in the middle Bronze Age (c. 3500 BP). Further excavations at the former site in 1989 yielded more cupule stones, dated to the 5th or 4th century B.C.E. (Rizzi 2007). Below the building foundation, five more occupation horizons were encountered, all of the middle Bronze Age, containing more cupule slabs. It was noted that some of the smaller specimens had been used as supports keeping pointed wooden posts in position, i.e. they were purely utilitarian. Much older are the small phyllite slabs found in the foundation of a Neolithic hut at the Plunacker site near Villanders, dating from the 5th to the mid-4th millennium B.C.E. (Rizzi 2007: 49). Stones with cupules have also been excavated from a Neolithic occupation floor at Feldthurn, in the same region. At that site, a Megalithic arrangement of the Chalcolithic

Figure 6. *Petroglyphs of Rupe Magna, Grosio, Italy. One of the cupules has been subjected to microerosion analysis and is only about 1000 years old.*

period included a block with cupules, and further small cupule-slabs were attributed to the Iron Age.

In a different part of northern Italy, Valtellina, microerosion analysis of a few petroglyphs of Rupe Magna, near Grosio, has included one fairly recent cupule (Figure 6). Its age has been estimated as being about E1030 years BP (Bednarik 2001b). Other preliminary microerosion results are available from two central Indian sites, Moda Bhata and Morajhari. Both are located in the vicinity of Ajmer, Rajasthan, but the former is unusual in that it occurs on a dyke of white crystalline quartz. It is part of a chain of several sites (Bednarik and Kumar 2002), the only reported occurrence of petroglyphs in the world on this hard rock. The gneissic rock of Morajhari is also quite hard, and both sites were considered to be good candidates for Pleistocene age. Both were subjected to microerosion analysis, which conclusively dispelled that expectation. One cupule at Moda Bhata yielded a microerosion histogram that clearly indicated the reworking of the feature long after it was originally created (Figure 7). Most of the fractures in this cupule were in the order of E9200 years old, but a small proportion centred on about E1800 BP. This raises a significant problem in the age estimation of such features that may have taken a long time to create, and that have been subjected to one or more episodes of reuse at a much later time. It is obvious that cupules on particularly hard rocks, such as granitic facies, heavily metamorphosed quartzite and crystalline quartz, were created over extended time spans. Once made, they may have been subjected to a variety of cultural uses, right up to the recent past in some cases, and these uses may have included more impact. Therefore the principal limitation of the use of microerosion analysis in estimating the age of cupules is not methodological, but relates to the fact that parts of the surface of a cupule can only date from the percussion it experienced most recently.

At the second Indian site yielding microerosion data, Morajhari, the ages of three cupule surfaces were estimated. One of them provided clusters of micro-wane widths

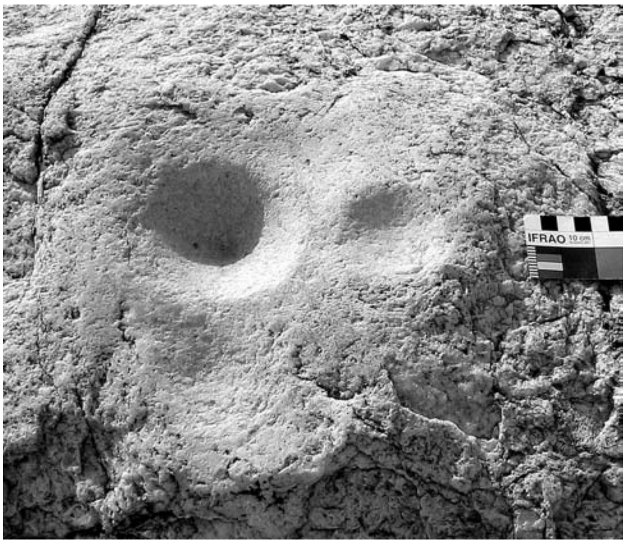

Figure 7. *Cupules on white crystalline quartz at Moda Bhata, Ajmer, India.*

Figure 8. *Cupules on gneissic rock at Morajhari, Ajmer, India.*

corresponding to E2600 years BP, E1750 years BP and E800 years BP, which again suggests re-working of this feature (Figure 8). Another cupule, on the underside of the same boulder, had to be made earlier because it was created before the boulder was turned upside down, and it yielded an estimate of about E5000 years BP. A third cupule 20 m away provided a tight cluster at about E1900 years BP.

Microerosion analysis has been applied since 1997 to cupules at several Bolivian sites in the region near Cochabamba, where it has yielded some surprisingly recent dates. In this case, the rocks the cupules have been hammered into contain no quartz or feldspar, and are therefore not amenable to the method. Consequently, a different approach has been introduced: instead of analysing the petroglyphs, quartz tools used in their manufacture, or tiny slivers that became detached from them at the time of impact, are analysed and the time of their fracturing is estimated (Bednarik and Querejazu Lewis in prep.). Unfortunately this approach, too, is limited by the fact that one can never securely relate the time of impact to any

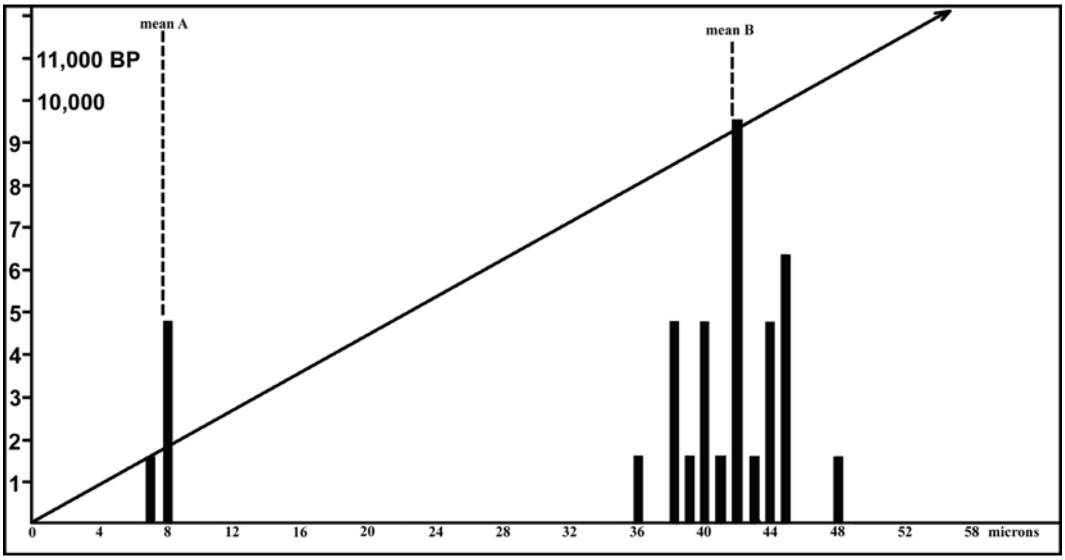

***Figure 9.** Microerosion histogram of micro-wanes, from one of the cupules at Moda Bhata, India. Note the widely separated clusters, indicating reuse of the cupule 7000 years after it was first made.*

phase in cupule production: did it occur early in the making of the cupule, or late? All one can postulate with adequate veracity is that the tool damage dates from one episode in the cupule's creation, whereas the cupule surface typically relates to its most recent phase. However, even this may be problematic, as best shown by the example of the Moda Bhata specimen.

About methodology

The following methods of estimating the ages of cupules have so far been considered or applied:

1. *Archaeological*: through the age of sediments in which the rock art occurs. This can be either by:

1a. Naturally exfoliated rock slabs bearing cupules that have fallen to the ground and become covered by sediments. The enclosing sediment thus provides a minimum age, and a quite probably very conservative minimum age.

1b. Where no petroglyphs other than cupules occur, and these appear in a large number, it should be possible to locate and identify the hammerstones used in their production. If this succeeds, the enclosing sediment should offer an approximate relative or absolute age for the cupules.

1c. Where rock slabs bearing cupules had been placed on an occupation floor or in the foundation of a datable building, this event is probably datable. The cupules themselves may be older, or they may be of the same antiquity, but they cannot be younger in the absence of sedimentary disturbance.

2. *Scientific*: through determining the age of surface features by:

2a. Quantifying the microerosion experienced by the surface of a cupule. This usually determines the most recent time it was hammered, and probably not the time it was first made, especially on hard lithologies (Figure 9).

2b. Quantifying the microerosion experienced by specific surface aspects of either the hammerstone used in making a cupule, or of small fragments spalled from it in the process. Where the analysed material can be securely attributed to an event of cupule production, it provides an estimate of when that event occurred, but not of when production commenced or finished.

2c. Finding the dust created when a cupule was made, and dating it via the sediment by OSL or radiometric determination of some other component, has been attempted by one archaeologist (G. Susino) in respect of other petroglyphs but does not seem possible realistically.

2d. Finding lichens covering a cupule and estimating the age of the thallus. This has not been attempted so far, and it would only yield very conservative minimum ages. Lichenometry does not extend back much more than several centuries (Bednarik 2007b: 128).

2e. Colorimetry of patinae covering cupules has also not been attempted so far, and can only be considered as a supplementary method (Bednarik and Khan 2005).

2f. Sampling an accretionary deposit that has formed over the cupule and attempting to determine its age via one of the radiometric methods.

This last-mentioned alternative can again only provide very conservative minimum ages and is probably not worth the effort for a variety of reasons. Not only tend such accretions to be very significantly younger than the petroglyph they cover, the estimation of their age is fraught with many difficulties. All rock substrates are subjected to an open carbon system (Bednarik 1979), therefore unqualified bulk determination of their carbon isotopes (without reference to molecular or object determination of what is being analysed) is misleading and does not provide valid results for the purpose. Uranium-series analyses may be somewhat better suited but have not been attempted. All methods of this kind, in the absence of a taphonomic history of the accretion (accretionary skins tend to have complex histories), are plagued by severe limitations. This also includes the XRF or $^{40}Ar/^{40}K$ methods, unfortunately (for a more detailed discussion of these issues, see Bednarik 2007b: 115–144).

On that basis the age estimation of cupules is perhaps best served, for the time being at least, by archaeological excavation and microerosion analysis. The major drawback of the first method is that it can only be applied in vary rare circumstances. Worldwide, cupules have been found in reliable archaeological settings in very few cases. Moreover, the relation between the 'archaeological age', however derived, and the age of the cupule is far from secure. With microerosion analysis, the drawbacks are different (Bednarik 1992b). Although the method is unusually reliable and robust, it is very imprecise and tolerance margins of 20% can occur. Moreover, the method is currently limited to rock types containing quartz or feldspar, and preferably both. While many cupules do occur on suitable lithologies, the majority does not. Finally, the method's specific applications, for instance to hammerstones or their fragments, remain experimental and need to be tested at many sites.

In short: the estimation of cupule age is certainly possible in some cases, but it remains an underdeveloped field, which we can only hope to be developed further in the present century.

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