KEYWORDS: *Rock art science – Epistemology – Methodology – Mindset*

CHANGE OF MINDSET: THE NEED FOR DEVELOPING SCIENTIFIC APPROACHES TO ROCK ART STUDIES

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Abstract. Questions in rock art studies need to be answered scientifically, including how can we use it for understanding the cognitive, cultural and epistemological development of humans, place rock art in proper chronological order, or effect its conservation and protection. After so many decades of applying the traditional archaeological approach, it has helped us little to answer significant research questions. For answering these questions correctly, we have to change our mindset and adopt a scientific approach. That means our studies should be based on testable propositions. We need to understand the lithology, taphonomy, topography, sedimentology, palaeoclimate of the sites and the epistemology of our ideas about rock art. We also need to be able to effectively discriminate between natural and anthropogenic rock markings and use modern recording methodology, apply scientific dating methods and learn how to conduct rock art replication.

Introduction

Rock art consists of intentionally produced anthropic markings and forms concept-mediated externalisations of 'conscious' awareness of some form of perceived reality (Bednarik 2007: 1). It is a global phenomenon executed on the natural surface of the rock in caves, rockshelters and on boulders, cliffs and bedrock in the open. Rock art is one of the aspects of human creativity and cultural activities which has survived and is available to us; hence it is a vital source for understanding the cognitive, intellectual and cultural development of the early humans.

The origins of human constructs of reality could be studied through the examination of physical remains of the processes that formed early expressions of symbolism, such as rock art. The significant corpus of such evidence is collectively called as palaeoart, and it occurs mostly in the form of rock art. Therefore, if we were capable of studying rock art objectively, we might discover how humans developed their ontologies. It will be the most important pursuit in a science serving our species because it would illuminate how the conceptual constructs human have perceived as realities came into being (Bednarik 2007: 2). Therefore, it is most unfortunate that rock art, the principal store of information we have for the quest of understanding the ontologies of their producers, has so far been considered as a source of creative mythologies about its authors (Bednarik 2016).

Archaeology has long retarded the development of rock art studies

Robert G. Bednarik has explained the development of the discipline of rock art research in his book on *Rock art science* (Bednarik 2007). Archaeologists took a long time even to accept the genuineness of early rock art of Altamira in Spain (Cartailhac 1902). Initially, they denied the existence of Pleistocene rock art and dismissed it as a forgery for many decades. The 20th century is characterised by an increasing influence of archaeology on rock art research in most of the world. Archaeology as a discipline depends greatly upon the invention of styles, be they of stone tools, ceramic pots or arrowheads. Rock art is a fertile field for the invention of styles. However, stylistic markers are not self-evident, and they may not be detectable in the way the alien researchers often imagine. Once published, these constructs took on a life of their own, and they were used to prop up a series of hypotheses, often guided by diffusionist concepts or far-flung cultural connections. Such stylistic constructs were most particularly valued in the creation of chronological sequences. Those of the Upper Palaeolithic cave art are especially important because they influenced model-building elsewhere. Generations of researchers have modelled their thinking on the now-discredited chronology, and there is strong opposition to reform within the discipline (Bednarik 2007: 11).

While this was a local European issue, it determined the direction of the rock art discipline elsewhere.

European Upper Palaeolithic rock art research has for a century served the rest of the world as an implicit model of how to conduct research. For instance, Asian and in some cases, even North American researchers have searched for 'stylistically Upper Palaeolithic' rock art in their quest to locate Pleistocene traditions, failing to find similar traditions. However, there is almost no evidence that the Final Pleistocene graphic arts of most of Eurasia, east of a line through Germany and Italy, resembled those of Franco-Cantabria, so this search inspired by an inappropriate and now discredited model was entirely in vain. Consequently, what we know today about the Pleistocene arts of the rest of Eurasia is minute, disjointed and profoundly incomplete (Bednarik 1994).

The European procedure of archaeologically inventing styles, giving them labels and attaching them to archaeologically perceived traditions was also widely adopted. Nevertheless, archaeology is incapable of defining emic cultures reliably. It merely classifies material residues of human populations and then makes the untestable assumption that those taxonomic constructs define distinctive peoples or cultural traditions. This used to be taken so far that the perceived movement of technological traits or behaviour patterns was equated with the migration of actual peoples, in the absence of any other evidence (Bednarik 2007: 11).

Besides, major rock art sites usually consist of cumulative records of successive traditions, and without identifying these traditions individually, archaeology can only create false concepts of traditions. This practice is comparable to excavating the tools of many traditions, and then lumping them all together and defining them as a single cultural assemblage. This is the most anti-archaeological way one could treat the layers of an excavation, yet in rock art, this is precisely how many archaeologists treat the evidence. For instance, many such cumulative site inventories in Australia are described as 'Panaramitee style', even though they consist of many chronologically discrete components (Bednarik 2007: 11). A better-known example is that of the rich rock art of Lascaux Cave in France which consists of a cumulative record spanning Palaeolithic and post-Palaeolithic traditions of at least 10 000 years (Bahn 1994), yet for over half a century it has been held up as a paragon of one single tradition.

For many Indian archaeologists, it is still very difficult to accept cupules as a form of rock art. Bednarik published the cupules on Chief's Rock (in Auditorium Cave, Bhimbetka) and their significance as the earliest petroglyphs which might be associated with an Acheulian tradition, in 1993 (Bednarik 1993, 1996). For Indian archaeologists who are considered as experts in Stone Age archaeology, it took 25 years to accept the cupules on Chief's Rock as something anthropogenic in nature. However, their significance is yet to be accepted, and the requisite care for their protection is lacking even today.

If archaeology defines its traditions of rock art in this haphazard manner and then bases all kinds of secondary hypothesis on such fallacious data (e.g. that another corpus of rock art must be the same age as that of rock art of Lascaux, because it comprises stylistically similar elements), then these invented traditions are probably misleading constructs and can only lead to further errors (Bednarik 2007: 11–12).

Rock art science

If the right reliable empirical evidence were available, rock art science could serve the endeavour of understanding the cognitive, intellectual and cultural world of past and present societies, and ultimately perhaps in determining how our species acquired its very concepts of reality. The main focus of archaeology in rock art study has been on observing forms and attempting to determine their antiquity and meaning. Thus, the ultimate research potential of rock art is not closely connected with archaeology.

Centuries of neglect and abuse of rock art, including by researchers, became the subject of debate, and eventually, rock art specialists found themselves involved in pitched battles with state archaeological agencies and organisations in a few countries. These dramatic changes in the way the rock art discipline operated occurred under the auspices of a representative body, the International Federation of Rock Art Organisations (IFRAO), established in the first world congress of rock art researchers organised by AURA at Darwin in Australia in 1988. IFRAO was led by very dedicated and resourceful scholars who co-ordinated their strategies so effectively that it caught an antiquated establishment off-guard in some cases. Today, the needed changes are far from complete, but it has already become adequately clear that the progress made in the discipline in the last fifteen years of the 20th century exceeds in magnitude that of the previous 200 years (Bednarik 2007: 12).

Within these last few decades, rock art research has adopted a plethora of new methods, all contributed by scientific disciplines. They include a wide range of physical and chemical analyses of rock art-related materials, such as the identification of inclusions in paint residues and mineral accretions, ranging from fibres to pollen. Much of this work is directed at questions of antiquity, but numerous other issues also attract attention now. For instance, the technology of paints used in rock art, as well as of their application, are being analysed. The nano-stratigraphy of paints and mineral accretions has shown how sequences of rock art can be studied scientifically rather than by archaeological intuition. Numerous approaches are being developed in the ever-crucial question of the age of rock art. Field microscopy of rock art has been developed for several purposes, including microerosion dating, petrography and technological analyses. The discrimination between anthropogenic and non-anthropogenic rock markings, which has been a significant difficulty for archaeologists, has been developed into a fine art. Much the same has been developed for portable art objects, as well as the detection of fakes. Replication studies have been attempted, although they remain still in their infancy. The related subject of production processes of petroglyphs has received some close attention. Of particular importance is the development of taphonomic logic, which is crucial in developing a science of rock art (Bednarik 1994). Rigorously framed statistical approaches are being developed. In all of these many new approaches to rock art, the epistemology applied to the formulation of theories and interpretation of palaeoart has become central.

In this new development, the archaeologist has a role to play in the future development of the discipline as one of the members in a team of several researchers, and will no longer be able to dictate the terms of research priorities or the direction of the discipline. Archaeologists, like colleagues from art history, anthropology, ethnography, geography, semiotics, geomorphology, geochemistry, palaeoecology, palaeoenvironmental sciences, nuclear physics, conservation science and so forth will contribute their diverse talents to this complex discipline if they have the flexibility to collaborate in such ways. However, the agenda will no longer be that rock art is to explain archaeology (Bednarik 2007: 13).

However, the traditional or non-scientific approaches to rock art and inventing mythologies have also in some ways benefitted the discipline, rendering rock art interesting and valuable, drawing public attention to it. Thus, they have assisted in its appreciation and preservation. It is entirely legitimate for modern-day societies to re-interpret rock art from their perspectives, and science certainly has no right to discourage such practices. It may comment on them, it may analyse them, and it may demand that such pursuits not be labelled 'scientific'. They are not, and to claim so is to misrepresent and discredit science (Bednarik 2007: 3). The only propositions that are scientific are those that are testable or falsifiable.

The need to change our mindset

In order to proceed further in the field of rock art research, we need to change our mindset and adopt the epistemology of science (which deals with disconfirmation, scientific methodology and experiment). To just report discoveries of rock art sites, subjectively describing the motifs depicted in them and proceeding straight to their interpretation by imposing our conditioned mind has been standard practice throughout the world. After so many decades of applying this traditional archaeological approach, it has helped us little to answer significant research questions. Sometimes scholars are even unable to differentiate between the anthropogenic phenomena of rock art and natural features on rock surfaces resembling them. In preparation to accurately answer these questions our studies need to be based on logic and testable propositions.

How can we expect to understand the cognition of the authors of rock art, when we know virtually nothing about those people? Nearly all of the world's rock art remains undated, so we cannot know who the people were who created rock art. We have no idea of their cognition or perception, of how they experienced reality or how their brain worked. However, traditionally all we have done is assumed that they experienced the world the same way as modern academics do. We know that even the people of the Middle Ages existed in realities quite different from ours and that the brains of literate people differ significantly from our own (Bednarik 2016: 158).

The most important question that can be asked in our discipline is: how can the origins of human constructs of reality be studied through palaeoart? This goes right to the heart of the epistemology of science. Because of the primitive nature of our work with this body of evidence, such insights will not occur in our lifetimes or this century. Perhaps in a few centuries from now? That must not, however, deter us from moving in the right direction of asking such fundamental questions. However, we shall need to learn to walk before we try to run. At present we are only crawling, because of our breath-taking ignorance resulting from generations of using a mindset foisted upon our discipline by archaeology (e.g. of creating mindless taxonomies of perceived entities such as styles, meanings, iconographic identifications, cultural affiliations, behaviours). Part of the mindset we need to acquire involves recognising how ignorant we are about palaeoart. This academic humility is essential to the mindset required (R. G. Bednarik, pers. comm. 15 April 2020).

Our inadequate understanding of rock art is well expressed by our inability to define the 'development' of it through time. We have almost no secure chronology of world rock art; we have nothing but a cacophony of competing claims, most of which have no credible basis (Tang et al. 2020). Nevertheless, the central issue in acquiring the mindset needed in rock art science is a much more fundamental core element of that discipline. Scientific data are frequently misused to create scientistic myths about rock art (Bednarik 2016), in claims based on associative or 'magical thinking', as neuroscientists call it (op. cit.: 7, 135, 158). This has been the default system in people's brains for many millennia. Cause and effect reasoning, the mode of scientific thought, does not come naturally; it has to be acquired by training. Combined with an all-pervasive and profound scepticism and demand for falsifiability, this mindset is neither easy to attain by a scholar nor to explain to those not attuned to it, but it is the basis of a scientific approach.

Science is not defined by method, precision, terminology, equipment, even though these may assist a scientific approach. It is defined by a specific mindset rejecting notions of common sense, intuitive thought and traditional taxonomies. The good scientists know nothing with total certainty. There are no facts in science; there is only the uncertainty of falsifiable propositions. Therefore, nothing one assumes is necessarily true, and everything one believes is the creation of one's brain. The scientific method is to posit propositions and test them, forever, because the human mind is too feeble and distorted to rely upon. The kind of questions that one may ask of science are those whose answers are based on logic and can be tested without using intuition, authority, fantasy or belief systems. Good scientists abhor authority, whereas archaeology relies on it so much. That is precisely why it is the most error-prone field in all of academia (Bednarik 2003: 58, 2019a).

This paper aims to show the reader why a scientific approach to rock art is required. If we wish to ask the questions about rock art that are on our mind and, perhaps, secure credible answers to them, we first have to abandon the primitive mindset of the past. Then we need to replace it with one that secures reliable and testable empirical data related to the rock art. This approach has already been applied most successfully by some researchers wishing to replace the failed archaeological approach. It would, among other strategies, engender the following essential components:

1. Differentiation between anthropogenic and natural rock markings. It involves the careful observation of the object under consideration and a detailed understanding of the vast range of non-anthropogenic rock markings (Bednarik 2007: 15–36)
2. The geology, geomorphology, geochemistry and palaeoenvironment of the site and region. Rock art sites form part of the natural environment, modified by the rock art's authors. Rock art cannot be studied without considering the rock, and the often-heard excuse of archaeologists that they were not trained in geology is pathetic if they want to work with rock art.
3. The effects of different climatic factors and weathering processes that the rock surface and the rock art have undergone need to be understood in-depth, to form a chronological framework into which the rock art can be placed.
4. Observation of the rock art, rock art site and its surrounds must be conducted in the way a forensic scientist observes an activity area. Every site underwent processes which affected the rock and rock art, such as exfoliation, weathering of the surface and paint, accretion of deposits and formation of patina, effects of heat and lightning and so forth.
5. The tangible and intangible processes that were responsible for the creation of rock art.
6. As explained above, major rock art sites usually consist of cumulative records of successive traditions, and we have to identify these episodes by a thorough study of the superimpositions, implements used, technique used etc., at a particular site and in the region.
7. Replication of the process of rock art production.

At a more elaborate level, rock art science involves the study of the influence of taphonomic factors (the processes affecting rock art after it has been executed, determining its present appearance and statistical properties subject to taphonomic considerations, i.e. broadly the effects of climate and environment affecting the rock surface and rock art; Bednarik 1994). The replication of rock art is also important for understanding the technology of its creation, the strategies developed, skills adopted and behaviour responsible for executing it (Kumar and Krishna 2014). Archaeology continues to serve as a support discipline through providing excavation where required, and the use of radiometric and chemical methods as well as field microscopy, already well developed, will continue for a variety of purposes, ranging from age estimation to pigment characterisation, the identification of inclusions and for tribological work (Bednarik 2019a). Finally, scientific work at a rock art site includes consideration of how we can effectively conserve and manage the site.

Based on the observations made and data collected, we can formulate some soundly based hypotheses that have to be tested by further scientific investigations. However, our propositions must be testable by anyone at any time. Rock art study needs to be a multidisciplinary science, not a simplistic interpretation game. We may obtain answers to some questions and not to others. The latter will give direction for further research in rock art science. Some of these aspects can be considered in light of the author's experience while working in India and China.

Observations made at Daraki-Chattan

Daraki-Chattan (DC) is a Lower Palaeolithic cupule site in the river Chambal basin in India (Kumar 1996). It is a narrow cave in the quartzite buttresses of Indragarh Hill near Bhanpura, district Mandsaur, Madhya Pradesh. It features more than 500 cupules on its two walls and has been intensively studied, initially by the author and afterwards under the multidisciplinary and multinational EIP Project by Indian and international scientists from 2002 to the present. Here the author presents some of the observations made at DC (Bednarik 2012a, 2012b; Kumar et al. 2016).

Taphonomic observations

1. We observed that the DC Cave is rich in Palaeolithic cupules, but the front walls are blank and bear exfoliation scars. It meant the front portion of the cave might have been bearing cupules, and the fallen cupule-bearing slabs should be lying buried in the sediments in front of the cave (Kumar and Krishna 2014: Fig. 2). Secondly, numerous hammerstones would have been used, and at least some of them must also be lying buried in the sediments. This observation led us to the systematic excavation of the site from 2002–2006 and its further scientific study. The excavations yielded slabs bearing 28

Figure 1. *Slab pieces bearing cupules fitted together. They were obtained from Acheulian pseudo-layer 3 in the excavation at DC.*

cupules (Fig. 1) and ten hammerstones used for making cupules, from arbitrary layer 3 down to the interface of 5 and 6 (Fig. 2) (Bednarik et al. 2005; Kumar et al. 2005, 2012; Kumar 2008).

2. In DC Cave, we observed different shapes and sizes of cupules. The size and form of the cupules have been modified (truncated) by superficial weathering when rock mass was removed from the surrounding surface but not from within the cupules (Kumar and Krishna 2014: Figs 6 and 7). The taphonomic history of the site has effected such significant changes to the rock art that current metrical data do not describe the phenomenon adequately (Krishna and Kumar 2012a, 2012b, 2012c, 2016; Kumar and Krishna 2014).
3. DC, a Lower Palaeolithic cupule site, would not have been an isolated phenomenon of human cultural behaviour. Cupules might have also been produced around, and nearby DC, as well as elsewhere, but might have been lost to weathering. We explored the surrounding area and found one boulder in front of the cave. However, the cupules on it were so deeply weathered that only one or two could be recognised (Kumar et al. 2016; Kumar and Bednarik 2016). They might have been as old as those in the cave but were not preserved because they have not been in a protected environment like that in the DC Cave. There are deeply weathered depressions visible on two more blocks, also in front of DC, but it could not be established whether they are remains of cupules.

Besides, we also found three more cupule sites on the plateau above DC and ten cupule sites on the nearby Chanchalamata Hill. These, however, are of significantly younger cupules and relatively well preserved, despite being in the open. Six more cupule sites were also observed on the plateau along the left side of nearby Bara Mahadev Nala. There are many more archaic cupule sites in the region on the large quartzite boulders along the Gandhisagar water reservoir (Kumar et al. 2006). It should be kept in mind that the preservation of archaic cupules is related directly to the hardness of the rock and the environmental conditions (Bednarik 1994), and specifically to the development of kinetic energy metamorphosis products (Bednarik 2015).

Figure 2. *Hammerstone obtained from arbitrary layer 4 (Acheulian) in the excavation at DC. It has wear-facets at angular aspects.*

Replication of cupules for understanding the technology of cupule production

When we were excavating at DC in 2002, renowned archaeologists, experts in Stone Age archaeology, visited the site and gave impractical, immature and unscientific opinions about the production of cupules, such as cupules can be produced by alternately rotating stone flakes clockwise and anti-clockwise. Such a production method would be impossible to apply to very hard quartzite rock like that of DC. It was due to the mindset of the archaeologists giving illogical and unscientific opinions without appreciating the nature of rock art and also that of the rock bearing it. In order to decide the matter scientifically, the author undertook cupule replication experiments on a vertical rock in a nearby associated rockshelter to the south of DC. The experimental rock is an extension of the bedrock stratum in which DC is located. One research scholar and two workers were put to the task. Employing direct percussion technique and also attempting indirect percussion, we were able to produce several cupules under controlled conditions (Fig. 3) (Krishna and Kumar 2012a, 2012b, 2012c, 2016; Kumar and Krishna 2014).

We learned that it is incredibly difficult to replicate cupules on hard quartzite rock. It requires immense skill and precision, especially to produce small-size

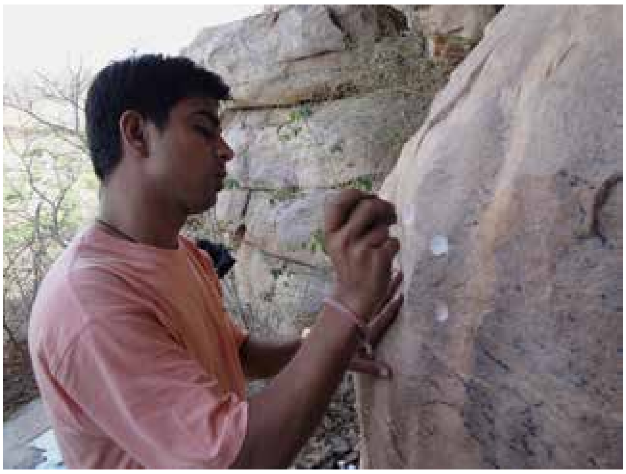

Figure 3. *Ram Krishna at work replicating cupules on hard quartzite bedrock south of Daraki-Chattan.*

Figure 4. *Cupules at Chanchalamata hill with kinetic energy metamorphosed surface highly resistant to weathering.*

cupules (Kumar and Krishna 2014; Krishna and Kumar 2016). Experiments have been carried out elsewhere on replication of rock paintings (Blanco and Barreto 2016) and petroglyphs (Bednarik 1998).

Producing petroglyphs, such as the cupules on very hard rock, is a tedious and strenuous task. We needed 28 327 strokes using multiple hammerstones to produce a small cupule of the size 32.0 × 31.5 × 9.0 mm in two days. The process can lead to the metamorphosis of the amorphous silica (material binding the quartz grains) into harder material (Bednarik 2015, 2019a, 2019b). On full metamorphosis, it becomes essentially crystalline quartz (Bednarik 2019b: Fig. 6). This metamorphosed layer is highly resistant to weathering in comparison to the parent rock (Fig. 4).

Scientific dating of rock art

The scientific dating of rock art is essential to place it in a proper time frame and evaluate its cognitive and cultural significance and to relate rock art to archaeology. The estimation of the age of rock art remains a ferociously complex subject at the best of times. We have observed this also in the task of determining the age of the DC Lower Palaeolithic cupules, which are of Mode 1 and 2 stone tool assemblages (Kumar and Bednarik 2012). Estimating the age of rock art is, in most cases, even more difficult with rock paintings than with petroglyphs (Bednarik 2001). Scientific attempts of dating rock art by direct methods were first applied to rock art in the early 1980s (Bednarik 1985). Except the rock paintings created with charcoal in the caves in Europe and at a limited number of other sites worldwide, and the beeswax figures of Australia, the rock paintings of the world remain scientifically undated by credible methods. In a few dozen cases of carbonate encrustation, researchers have attempted to date laminae either pre- or postdating painting events, but not the actual activity of the creation of rock art. The dates obtained through U/Th analysis of the carbonate accretions on or beneath pigment layers in different countries are sometimes spectacularly early and need to be cross-checked. All projects conducting such cross-checking since the 1980s have reported that U/Th results are often too high. The current controversy between supporters and opponents of these results has itself been subjected to scientific testing in China when multiple samples of the same accretions yielded results that not only contradicted one another, but that were also substantially too high. Moreover, blind testing by using different laboratories to process split samples resulted in significantly diverging dates. It has thus been shown that U/Th analysis of thin carbonate skins yields erratic results and the reasons for this have been explained (Tang et al. 2020).

Direct dates of some petroglyphs can be obtained by using the microerosion method, but it has its limitations. At present it can only be applied to rocks having quartz or feldspar crystals (no other minerals have been calibrated); the petroglyphs need to have been exposed to the rain, and the method's maximum limit is thought to be in the order of 50 000 yrs BP. Moreover, its tolerance margins can be as high as 25% to 30% (Bednarik 1992, 2001, 2007; Tang et al. 2014, 2018). Besides, there are only a few specialists of microerosion analysis in the world.

To understand the technique and antiquity of the Lower Palaeolithic cupules at DC and the Auditorium Cave at Bhimbetka in central India (Bednarik 1993) involves pioneering work. We have made great efforts to obtain scientific dates for the petroglyphs in both the caves. At DC we have tried AMS^{14}C, OSL, SLD (surface luminescence dating), palaeomagnetic and microerosion analysis (Kumar et al. 2005; Kumar and Bednarik 2016; Bednarik et al. 2018; Kumar 2018b; Liritzis et al. 2018), yet we remain in an experimental stage about the dating of the early petroglyphs at DC. To illustrate one of the many problems we faced, when we attempted AMS ^{14}C dating of accretions formed in cupules we discovered that the taphonomy of these deposits is far too complicated. They are continuously recycled and yield only very young dates (Bednarik et al. 2005; Kumar et al. 2005; Kumar and Bednarik 2012; Kumar 2015: 48–57).

Establishing a world register of direct rock art dating

While working on rock art dating in China in 2014, it was realised that a protocol had to be established for effectively storing and retrieving the large quantity of information now becoming available on direct rock art dating. The most critical need is for scientific data to be testable, to be accessible to falsification. This means, in practical terms, that at any time a researcher with the appropriate means and experience must be able to go to the rock art site in question, locating and securely identifying the previously dated motif for re-analysis. This requirement is illustrated here with the example of the microerosion method. In that case, the analyst must be capable of identifying, using field microscopy, within the motif, the particular micro-wane that was previously sampled. He or she can then re-measure the wane widths of that very same wane. This is essential if the original measurements are to be rendered testable, which is the only way that they can be rendered scientific. Therefore, a system was developed for recording and storing the original analyses at the International Centre for Rock Art Dating (ICRAD) at Hebei Normal University in Shijiazhuang University (Tang et al. 2014; Bednarik 2017). Necessarily, there are six aspects to be covered comprehensively in such a dating event identification system:

1. The location of the site.
2. The motif sampled.
3. The location from where the sample or measurement was taken.
4. The method applied.
5. The time of the method's application, to identify successive attempts using the same, or an alternative method.
6. Calibration data need to be identified.

These considerations apply to any dating method applied, and they are reflected in the unique identification number of each dating attempt. For example, a hypothetical dating event identification number might be 'India-Daraki-Chattan-12345(N-wall)-2-UT-28/8/2015'. This would identify a uranium-series result secured from calcite in a cupule in Daraki-Chattan Cave, northern wall, which was sampled twice on this day; the 2 refers to the second sampling site.

Concluding remarks

The ultimate research potential of rock art is not closely connected with archaeology. Instead, rock art science serves the endeavour of understanding the cognitive and intellectual world of past societies, and ultimately perhaps in determining how our species acquired its very concepts of reality. It leads us to the conclusion that the scientific study of rock art is a discipline of a multidisciplinary approach, and we need to change our mindset accordingly. We have to incorporate many scientific disciplines in it and have to innovate many new scientific systems to attain the goal. If we were capable of studying rock art objectively, we might discover how humans developed their ontologies. It will be the most crucial pursuit in a science serving our species because it would illuminate how the conceptual constructs humans have perceived as realities came into being.

Acknowledgments

Thanks are due to Archaeological Survey of India, Indian Council of Historical Research, Rock Art Society of India, Australian Rock Art Research Association, Australia India Council in Canberra, International Centre for Rock Art Dating and Conservation in China, and all my friends and colleagues involved in the EIP Project. Thanks also to the anonymous *RAR* referees of this paper whose comments helped me to improve it.

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