

Scientific methodology in palaeoart studies

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Introduction

Most of the world's surviving paleoart (art-like productions of pre-literate societies) occurs in the form of rock art, which is found in nearly all countries of the world. Its study by scientific methods is a historically recent development, especially of the last three decades. In this short time the scientific methodology applied to rock art has evolved with the help of several disciplines. Foremost among these are nuclear physics, forensic science, geochemistry, geomorphology, conservation science, ethnography, semiotics, but many others have also contributed. As a result a number of specific approaches have been developed. This emerging methodology is briefly defined here.

Because of the perceived need to integrate rock art in archaeological constructs or narratives it has long been a high priority to ascertain its age. The archaeologically favored method, excavation and age estimation of sediments concealing rock art, has several limitations. Over the past 120 years, archaeological excavation has succeeded in only twenty-two instances in providing credible minimum antiquities by this method. The age of a sediment deposited after the creation of rock art can at best offer minimum ages, and these may be very conservative. Moreover, these determinations depend upon a chain of unfalsifiable deductive propositions: that the sediment has not been subjected to disturbance or re-deposition; that the dating criterion actually relates to the event of deposition (e.g. charcoal used in radiocarbon analysis may have been dislocated through turbation; quartz grains used in OSL analysis may have been displaced without exposure to light occurring etc.); and that the dating method has yielded valid results (Bednarik 2001).

One of the rationales of the scientific approach in rock art research is to supplement this indirect dating method with direct methods, which are defined by direct physical relationships of rock art and dating criterion and the formulation of falsifiable propositions concerning this relationship.

Definition

The epistemology of rock art science requires that all

propositions be rendered testable and that interpretations not be dependent upon etic assumptions in the absence of emic evidence. This narrows the range of admissible practices and methods, of which those listed below have so far been pursued. Ultimately, most are in some fashion reminiscent of the techniques of forensic science (Montelle 2009) (Fig. 1). This definition excludes, for instance, reliance on interpretations of rock art (on what it supposedly depicts), and on etic taxonomies of it, such as those based on perceived styles, or on the statistical treatment of non-representative samples. Therefore one of the pivotal principles in a scientific paradigm is to treat all rock art as taphonomic residue, whose quantitative properties are determined by taphonomic logic (Bednarik 1994a) rather than by the characteristics inherent in a living tradition.

Current issues

The demand in direct dating of rock art for secure physical relationship between the rock art and the dating criterion is illustrated by the following example. The bulk radiocarbon content of rock paint residues is in most cases not an acceptable criterion, because all rock surfaces and surface deposits contain organic matter of many different types, as do all mineral accretions over or under petroglyphs. Such dates are only viable if they derive from materials sealed in by impervious deposits (silica or oxalate), or if the analysed matter is identified at the object or molecular level. The latter condition has only been met once so far (Ponti and Sinibaldi 2005). The most reliable carbon dates are those from beeswax figures (so far only reported from northern Australia), followed by charcoal pictograms. Radiocarbon dates from paint residues dominated by mineral pigment are not credible, because the dating criterion's (carbon age of unknown matter, in this case) relationship to the age of the paint cannot be demonstrated.

The nano-stratigraphy of paint residues or mineral accretions is determined by microscopic



Figura 1. Example of forensic work: determining the tools used in the creation of deep cupules in a cave (Ngrang Cave, Victoria, Australia; photo by Yann-Pierre Montelle).

excavation of very thin layers (Fig. 2), either for chemical analysis of strata or their radiometric dating (Bednarik 1979; Watchman 1992). It has been applied to ferromanganese accretions, carbonates, silicas and oxalates, providing testable data for age estimation and other scientific information about rock art. Similarly, the analysis of the composition of, and inclusions in, paint residues (such as brush fibers or pollen; Cole and Watchman 1992) can provide a wide range of empirical information about rock paintings, and of the circumstances of their production.

The most promising methods of determining the age of petroglyphs utilize variables of geomorphology providing sequential contexts. Each rock panel features numerous forensic traces of events and processes, some of which may be datable, and each rock art motif is situated within a chronological framework they provide. Exfoliation or spalling scars, macro-wanes, fissures, patination, weathering rinds, glacial striae, fluvial or marine wear, and fire or lightning damage are among these traces and need to be recorded, locating the rock art within their relative sequence. Some of these processes, such as rock surface retreat and microerosion, are amenable to quantification. The latter involves microscopic erosion criteria (Fig. 3), including the micro-wanes gradually forming on fracture edges of mineral crystals (Bednarik 1992) or the relative retreat of a more soluble rock constituent (such as the colloid silica cement of sandstone). Both this dating method and the estimation of fluvial degree of erasure of low-grade metamorphics by suspended load in rivers (Bednarik 2009a) have been calibrated against sidereal time, providing sound approximations of petroglyph ages.

Another promising method is colorimetry of ferromanganese accretions on petroglyphs (Fig. 4). The gradual colonisation of rock surfaces by patina-forming matter appears to be a relatively constant and regular process as a function of time (Bednarik 2009b). The detection of splattered paint in sediment below rock painting panels or of mineral dust and fractured grains deriving from the production of petroglyphs seem comparatively less promising.

The technology of rock art—how it was made—is an important aspect of rock art science (Bednarik 1998). It proceeds primarily by

forensic methods in tandem with replication studies and gestural research (biokinetics). Especially the intensive study of impact or abrasion marks in petroglyphs can lead to propositions about technology that can then be subjected to testing by replicating the traces under controlled conditions. This can yield information about the tools used; the direction and energy of impact or abrasive action; and, in combination with spatial aspects and accessibility of rock panels, about the circumstances of production. Similar considerations apply to rock paintings, drawings and stencils, albeit to a lesser degree. Replicative studies of considerable variety have been attempted, and they form one of the principal approaches of scientific rock art research.

The discrimination of anthropic from natural rock markings has engendered much confusion in the past. Particularly the separation of petroglyphs from numerous types of natural and even other humanly made rock markings resembling them requires specialist attention, notably when relatively simple markings are involved (Bednarik 1994b). Potholes,

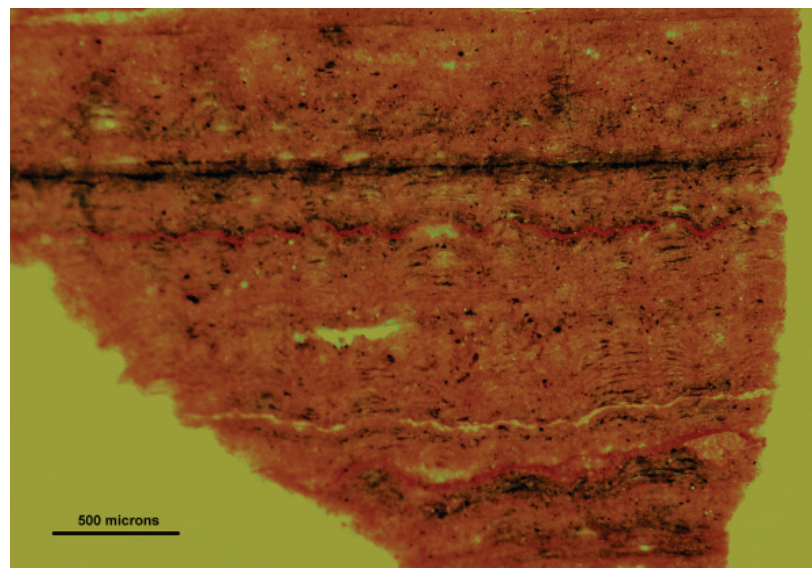


Figura 2. Nanostratigraphic section of mineral accretions of 2.11 mm thickness, containing several paint layers and spanning 26,000 radiocarbon years as determined by ten AMS dates from the section (Walkunder Arch Cave, Queensland, Australia; photo by Alan Watchman).



Figura 3. Microerosion analysis at Penascosa, Côa valley, Portugal (photo by author).



Figura 4. Calibrated colorimetric study of differences in petroglyph patination indicating differences in age (Najd Sahī, Jabal al-Kaubab East, Saudi Arabia; photo by author).

sandstone erosion pits, and solution scallops in caves have been mistaken for cupules (Figure 5); animal scratches and other limestone cave features have been interpreted as cave petroglyphs; anthropic marks such as bulldozer scrapes, steel cable grooves and core drill circles were described as open-air petroglyphs; and natural coloration of rock surfaces as rock paintings; the latter was even radiocarbon dated in one case. This frequent confusion of natural rock markings with rock art is of concern because there is no value in treating such phenomena as rock art and then invent meanings for them.

Only a small proportion of surviving paleoart consists of portable material. Some of the methods specifically developed for this corpus, especially traceology (the microscopic study of abraded or incised marks), have been successfully adopted by rock art science; other technological analyses are specific to mobiliary paleoart. Traceology derives from “internal analysis” as developed by Marshack (1972) to examine suspected notations and other incised markings on Palaeolithic portable objects. Besides its application to engraved plaques, microscopy also provides the most important analytical tool in the scientific study of beads, pendants and figurines, and is crucial in the detection of fakes and misidentifications. This can include the identification of a wide variety of taphonomic markings, such as those acquired by transport or caused by plant rootlets on carbonaceous materials. In the scientific analysis of portable paleoart, replication is

again of particular importance (Bednarik 2001).

Future directions

The recording of rock art has come a long way since the iconographic, interpretation-driven endeavours of the past. It now involves a rapidly evolving and complex methodology based on state-of-the-art technology (e.g. Plets et al. 2012; López et al. 2016). To be comprehensive and scientifically relevant it needs to provide not only the most accurate record of the rock art, but also of all other traces preserved on the rock panel (Soleilhavoup 1985). Such detail is required not only for realistic evaluation and empirically based interpretation, but also for the purposes of conservation and preservation science. This field has since the 1980s advanced from a common-sense approach to a scientifically based discipline with its own extensive methodology (Rosenfeld 1985). It is also developing rapidly and is becoming increasingly important in view of the ongoing degradation of all of the world’s rock art. Different conservation methodologies are being designed for open air sites and deep cave sites, because the environmental constraints differ inherently between these two site types.

The scientific study of rock art draws heavily on many of the hard sciences, but it is a relatively new approach and remains in a comparatively embryonic state. Nevertheless, it has emerged as a discipline in its own



Figura 5. Pothole surrounded by cupules and other petroglyphs (Bola Chanka, Santivañez petroglyph complex, Bolivia; photo by author).

right¹ and is likely to develop in unexpected directions. Most of the work so far is much in need of refinement and standardisation, and a sound epistemology is not sufficient to have a significant practical impact. It needs to be translated into new methods and approaches. Some of the most exciting recent developments are the endeavours to introduce scientific fields such as the cognitive and neurosciences. This approach is likely to centre on the role of exograms, the memory traces stored outside the human brain. From a scientific perspective the most important aspect of palaeoart is that it represents the only comprehensive and dependable source of information about the cognitive evolution of hominins. That potential has so far remained almost unexplored. This is one development suggesting that, rather than serving as a source of etic archaeological narrative, rock art and other palaeoart need to serve a variety of other disciplines if their full research potential is to be realised.

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¹ Of particular relevance is the recent appearance of Bednarik et al. (2016) because of the volume's specific focus on South America.

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