The significance of the Upper Sand Island mammoth depictions near Bluff, Utah, USA

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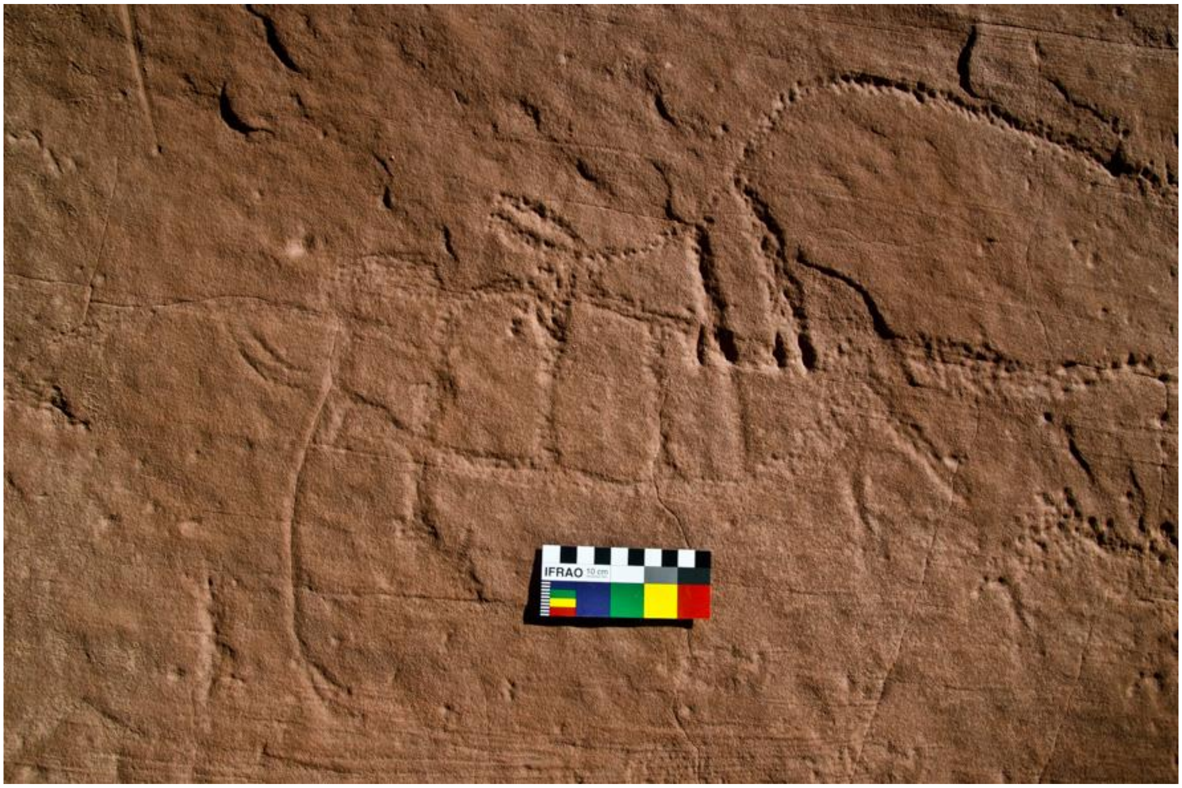

Close-up of Mammoth 1 with partially overlain bison. Note V-shaped tip of the trunk marking the animal's "fingers." Photo: © Ekkehart Malotki.

Near the town of Bluff in southeast Utah, about 1km from the impressive Lower Sand Island Petroglyph site, is a massive rock art gallery extending intermittently for several hundred meters along the vertical Navajo Sandstone cliffs bordering the northern side of the San Juan River floodplain. Truly a "giant" of rupestrian art in the American West, the gallery, known as the Upper Sand Island Petroglyph site, includes some of the most significant paleoart the Americas have yielded to date (Malotki & Wallace 2011; Malotki 2012).

In addition to elements or clusters of Western Archaic Tradition, Glen Canyon Linear, Basketmaker, San Juan Anthropomorphic, Ancestral Puebloan, Ute and Navajo iconography, the gallery includes a remarkable paleopanel featuring two engravings that are readily identifiable as Columbian mammoths. These establish the site as the only currently reported rock art location in the Western Hemisphere with figurative imagery attributable to the Ice Age.

The discovery of authentic art datable to the late-terminal Pleistocene is a watershed event for North American rock art studies. It transforms the Upper Sand Island site into a unique archaeological laboratory and an unequaled cultural resource for both Native Americans and the public at large. The entire San Juan corridor, then, with its thousands of spectacular images between Upper Sand Island and the mouth of the Butler Wash area some 8km further downstream, deserves to be listed on the National Register of Historic Places, if not nominated for UNESCO's World Heritage designation.

Since no absolute dating method currently exists that can determine the precise age of petroglyphs, sound circumstantial evidence in the form of archaeological and paleontological findings and observations must be relied upon instead. The primary evidence is the self-evident identification of the proboscidean images as Columbian mammoths (*Mammuthus columbi*) with their established extinction threshold of approximately 13,000 to 12,500 calendar years ago. After a lengthy forensic investigation at the site, Jean Clottes of France, a specialist in European Pleistocene art, confirmed the interpretation of the two images as mammoths "without the slightest doubt" (Clottes 2013: 9). Taking into account the anatomically diagnostic features portrayed (distinctive top-knots, dorsal ridges, paired tusks, and prehensile "fingers" at the tips of the trunks), the engravings were unquestionably modeled on living animals.

Secondary evidence for the Pleistocene antiquity of the images is seen in the discovery of numerous Clovis culture projectile points, all found in the general vicinity of Upper Sand Island, that date to the Paleoindian period around 13,200 – 12,800 calendar years ago, as well as the presence of several mammoth fossil sites (complete skeleton, dung, tusk fragment and femur) on the southeast Utah portion of the Colorado Plateau, all dated between ca. 13,800 and 12,200 calendar years before present.

On the basis of this evidence (mammoth portrayals coupled with an inventory of Clovis culture artifact and megafossil distribution) the best estimate is that these mammoth depictions were created about 13,300 – 12,500 calendar years ago. This would make them the oldest presently known *figurative* petroglpyhs in the Americas.

There is no way of knowing what the images meant to their makers. As culturally alien modern observers, we have no access to the cognitive universe of the prehistoric artist. Still, considering that markmaking most likely was a ritual activity, one can surmise that the creation of the images was accompanied by the creator's wish for certain desirable outcomes in his own or his group's struggle for survival. Markmaking was one of the suite of modern behaviors that undoubtedly aided the Paleoamerican entrants in colonizing an empty continent.

While some of these interpretive conclusions remain speculative, the Upper Sand Island mammoths are of paramount significance because they *pictorially* attest to the co-existence of early Paleoamerican colonizers and now-extinct Pleistocene megafauna. The images are unique because at this time no other bona fide Ice Age animals have been identified in the earliest North American rock art, which, so far at least, overwhelmingly consists of abstract-geometric motifs. The mammoth portrayals are thus anomalies in the known body of the earliest North American rock art.

Close-up of Mammoth 2. Note pronounced top-knot, characteristic of Columbian mammoth, and heavily eroded "fingers" at the tip of the animal's trunk. Photo: © Ekkehart Malotki.

As one might expect, this tantalizing discovery of *representational* Ice Age art with clearly far-reaching importance for Native American cultural patrimony has been met with a few skeptical or contrarian voices. While some can readily be dismissed due to lack of evidentiary support—for example the suggestion by Sundstrom (2011) that the two mammoth images and some of the unidentifiable bordering glyphs depict the transformational stages of a moth, or the accusation by Schaafsma (2013) that our interpretation of the imagery was the result of a "Rorschach" approach—two other critiques are of a more serious nature and deserve more detailed replies.

Robert Bednarik is one of these critics. Based on the results of microerosion dating which he applied to the petroglyphs in question, he contests their pre-Holocene production. Specifically, he concludes that Mammoth 1 with the overlain bison, the central motif of the entire paleocomplex, is "well under 4000 years old" (Bednarik 2013: 5). Obviously, this age estimate is incompatible with our own interpretations, as the presently accepted Pleistocene extinction range for this megaspecies lies at around 12,500 years ago.

Microerosion dating, as originally described by Bednarik (1992), is a technique based on determining the degree of rounding of angular irregularities along fracture surfaces of mineral grains that were broken at the moment a petroglyph was produced. The method requires measuring the width of the rounded part of initially straight-sided ridge-shaped features (microwane width), which critically depends on being able to accurately identify the point where a surface changes from straight to slightly curved. For numerical derivation of a production date, a second requirement is that a relationship can be established between the degree of rounding (expressed as microwane width) and time.

Microerosion analysis has been applied to obtain age information for petroglyphs at various localities worldwide (Bednarik 2007: 131). However, the technique has only been applied by its inventor, and it is not discussed in any academic textbooks on geochronology and archaeometry. Although general criticism of the method can be formulated (e.g. Zilhão 1995), our comments are limited to the application of microerosion analysis to the mammoth depictions near Bluff (Bednarik 2013).

Bednarik (2013: 5) reports microwane widths ranging from 500 to 1000 µm for a Pueobloan anthropomorph, and an average of "about 3 mm" for a bison motif overlying Mammoth 1 (Bednarik 2013: Fig. 4). No information is available as to how these widths were actually measured. Based on a survey of some of the literature on microerosion dating, no technical description of this aspect has been made available. For other petroglyph sites (e.g. Bednarik 2002), reported microwane widths are in the range of 0.1 to 1 µm. Measurement of such small features is a technical challenge that merits being well documented, especially when they are obtained using a technique that is applied in field conditions with a stationary optical microscope. Microwane widths are much greater for the Upper Sand Island site (up to 3 mm), but they were apparently determined using similar equipment, which must therefore allow observations over a wide range of magnifications. Information is also lacking on how the microscope was calibrated, which is typically done using a micrometer scale and an eyepiece reticule, to be repeated or calculated for each magnification when a zoom system is used that allows a continuous range of magnification. As long as no information on microscope methodology is divulged, the accuracy of the reported microwane widths used to derive age estimates is questionable.

An assessment of the significance of the reported values also requires information on the number of measurements and their reproducibility (as indicated by a standard deviation), which is not provided by the author.

While observations of weathering characteristics might allow establishing age relationships between petroglyphs from an individual site, obtaining meaningful numerical absolute age information requires the establishment of a relationship between microwane width and age. In chronometric parlance, it is a method that requires calibration, based on measurements for petroglyphs of known age. In all published microerosion dating studies, a linear relationship between microwane width and age has been assumed, although weathering rates depend on climate and exposure conditions, both of which will generally have varied over time (e.g. Lowe & Walker 1997). For more information on the use of the degree of rock surface weathering as a basis for establishing a chronology, reference is made to Walker (2005).

For any type of calibration, Upper Sand Island is exceptional in that it contains petroglyphs from different stylistic periods, and is therefore ideally suited for calibration based on multiple pairs of ages and microwane widths. However, Bednarik (2013: Fig. 3) used only a single petroglyph (an anthropomorph attributed to the Puebloan period) to calibrate the application of microerosion dating at this site. This implies that the calibration line is based on a single data point, whereby a zero wane width is assumed to correspond to a zero age (i.e. the present). A second assumption is that the relationship between wane width and age is linear, enabling the derivation of the age of a petroglyph through extrapolation. These two assumptions are quite tenuous, but without them, and with only one data point, it is difficult to establish a relationship of any kind. Given the apparent richness of the site, the potential importance of the finds (e.g. Malotki & Wallace 2011; Malotki 2012), and the crucial role of calibration in microerosion dating, it is regrettable that the calibration curve relies on a single data-point, for which, moreover, an age estimate was obtained from the site's investigator without making it clear how it would affect the outcome of the dating exercise. For these reasons, the experimental design of this particular study is not readily understood.

A specific problem for the Upper Sand Island study is the reported great microwane width, which is up to 3 mm. The local rock substrate is a fine to very fine sandstone (Gillam & Wakeley 2013: 153), which implies that it mainly consists of grains with a size between 62.5 and 250 µm. Therefore the features for which microwane widths were measured are not irregularities of surfaces along which individual mineral grains were fractured, for which the method was originally developed. Instead, they represent features of a surface that developed when the sandstone fractured along grain boundaries. Features of this size, which are only the rounded top of wider structures, are large for petroglyph lines, and it is questionable whether their initial microwane width could have been zero at the time of production. This compromises the use of a calibration based on a single data point (see above).

With respect to microerosion analysis of the mammoth engravings themselves, it should be noted that the method has only been applied to a bison motif that is superimposed on the portrayal of Mammoth 1. No data are presented for the mammoth glyph itself, and no other evidence is provided to corroborate the statement that the "mammoth figure is 'slightly older' than the 'bison', but still well under 4000 years old" (Bednarik 2013: 5). No direct or indirect age determination appears to have been attempted for Mammoth 2 (for a photo see Clottes 2013, Fig. 3), so the paragraph about that figure (Bednarik 2013: 6) is entirely speculative and unsupported.

Pre-Holocene age of the petroglpyhs is also rejected by Mary Gillam and Lillian Wakeley. Aware that the petroglpyhs could not be dated directly, they conducted a geological and geomorphological study to evaluate whether the Navajo Sandstone cliff bearing the imagery could have existed in final Pleistocene times and could have remained stable up to the present. Based on their findings they concluded that "it is very unlikely, and perhaps impossible, for the 'mammoths' to depict living animals" (Gillam & Wakeley 2013: 167).

Part of the Gillam-Wakeley study focuses on Late Quaternary alluvial sedimentation and river incision, based on the identification of a number of terrace levels in the study area. This includes terrace T2, with associated deposits for which a preliminary Optically Stimulated Luminescence (OSL) date of approximately 18,000 years BP is reported. The authors argue that T2, originally much more extensive, was largely removed by river erosion, and that present cliff positions, including that of the rock face with the mammoth petroglyphs, were established much more recently. However, none of these events are in any way firmly dated, and even the existence of T2 and the cliff at the foot of the lower terrace can be questioned, because of its local and aberrant occurrence within the surveyed area.

Overall, the sedimentary record is very fragmentary and poorly preserved at the petroglyph locality (see Fig. 6b in Gillam & Wakeley 2013), and interpretations rely heavily on spatial and temporal correlation. The reported OSL date for T2 deposits does not necessarily exclude a pre-Holocene age for the petroglyphs. The date simply demonstrates that sediment was deposited somewhere along the river at some point in time, and that, at this particular locality, the sediment has been preserved until the present day. This conjecture does not provide sufficient information to determine the time of sediment deposition and/or erosion at other localities. It should also be noted that no technical information has been made available on how the OSL age was determined, which is required to assess its reliability.

Another part of the paper by Gillam & Wakeley is devoted to a description of various indications that the local rock substrate is susceptible to degradation, which in their view demonstrates that the cliff is unlikely to have remained stable since the late Pleistocene. The authors' emphasis in this section on the setting and substrate being extremely unfavorable for the preservation of rock art panels seems incompatible with their observation elsewhere (Gillam & Wakeley 2013: 160) that the same site contains petroglyphs with an age of "several thousand years" or older. The unlikelihood of cliff stability since the late Pleistocene is argued in this section, but no conclusive evidence is provided. The reported qualitative observations therefore provide no chronometric information for the cliff and the petroglyphs.

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