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Exotic Minerals or Ostrich Gastroliths? An Alternative Explanation for Some Evidence of Hominin 'Non-Utilitarian Behavior' at Wonderwerk Cave, South Africa

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Identifying the onset of symbolic or non-utilitarian behavior remains one of the most important issues in the modern human origins debate, and as such, early evidence requires careful scrutiny. 'Exotic minerals' dating to >350 ka are one of several possible indications of hominin non-utilitarian behavior from Wonderwerk Cave, South Africa. Ecological data suggest an alternate hypothesis that these 'exotic minerals' are ostrich gastroliths accidentally introduced into the cave rather than the result of hominin collection and transport.

Keywords: MIDDLE PLEISTOCENE, SYMBOLIC BEHAVIOR, OSTRICH, GASTROLITH

Introduction

Primates are highly social animals, investing substantial time in grooming and other activities not directly related to subsistence that in humans are expressed through other media, most prominently language (e.g. Dunbar, 2003: Smuts *et al.*, 1987). Based on the strong relationships among neocortex size, group size, and grooming time in primates, Aiello and Dunbar (1993) suggest that by the later portion of the Middle Pleistocene (<400 ka) symbolic language would have been necessary to navigate the complex social relationships among large hominin groups. According to this hypothesis, it is during this period that we might expect to find the earliest material traces of non-utilitarian behavior that find fuller expression in the symbolic artifacts of the later portions of the Middle and Late Pleistocene record (< 300 ka) (e.g. d'Errico *et al.*, 2003; Watts, 2002; White, 2003; see also Whallon, 2006). In this context, recent reports from Wonderwerk

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Cave, South Africa are particularly important (Figure 1). Beaumont & Vogel (2006) infer the hominin transport of small pebbles (which they term 'exotic minerals') not used for tool production from sources >45 km away. These occur in strata (Major Units 2-4) with a suite of uranium-series age estimates on speleothems that range from ~97 ka to >350 ka (Figure 1). This implies great time depth for non-utilitarian behaviors that provide possible insights into the social fabric of earlier hominin populations, and therefore these data require careful scrutiny. Like all good hypotheses, the idea that the 'exotic minerals' at Wonderwerk Cave are the result of deliberate human selection and transport requires testing through the consideration and falsification of alternative explanations.

The evidence from Wonderwerk Cave

Wonderwerk Cave (27°50'46"S, 23°33'19"E) is a large solution cavity with Pleistocene-Holocene sedimentary deposits containing an important sequence of Early, Middle, and Later Stone Age artifacts that have been extensively sampled during more than 50 years of intermittent excavations (see Beaumont, 1990; Beaumont & Vogel, 2006 for historical reviews; Chazan *et al*., 2008) (Figure 1). In addition to Holocene and recent paintings and engravings (Beaumont, 1990; Thackeray *et al*., 1981), the Middle and Later Pleistocene strata at Wonderwerk Cave include various pigments (specularite and hematite) introduced into the cave and stone slabs with incised lines (Beaumont & Vogel, 2006). Beaumont & Vogel (2006:222) also note the existence of several 'exotic minerals':

"It was found that MUs [Major Units] 2-4 contained thin scatters-clusters of unmodified stones that tend to vary in Excavation 1 from small quartz pebbles in MU2 to small chalcedony pebbles in MU4… whereas those same MUs in Excavation 6 yielded mainly small [15-21 mm] quartz crystals in single or rosette form. It appears, therefore, that this patterned and possibly non-utilitarian collecting practice was sustained from ~400 kyr, despite the effort that must have been involved in retrieving those items from their nearest known occurrences, which, in the case of the chalcedony pebbles, is along the Kuruman River, over 45 km away."

There is no clear utilitarian explanation for the hominin use of these pebbles or crystals, examples of which are shown in Figure 2a.-b. However, the relevance of these finds to discussion of the origin and evolution of material expressions of non-utilitarian behavior rests on the assumption that the pebbles in particular were introduced by hominins at a significant cost, as implied by their source distance. This assumption is examined in greater detail by providing an alternative hypothesis.

Avian gastroliths as an alternative explanation?

As natural shelters, caves are attractive to a wide range of animal species that regularly transport and deposit food remains in them (e.g., Andrews, 1990; Brain, 1981). Not all elements accumulated in caves are intentionally introduced by hominins, carnivores, or other taxa. The *Coronula* sp. barnacles found in some Middle and Later Stone Age coastal sites in South Africa provides an important example, as the presence of this genus likely indicates hominin exploitation of stranded whales (the barnacle's biological host) rather than shellfish collection (Jeradino & Parkington,

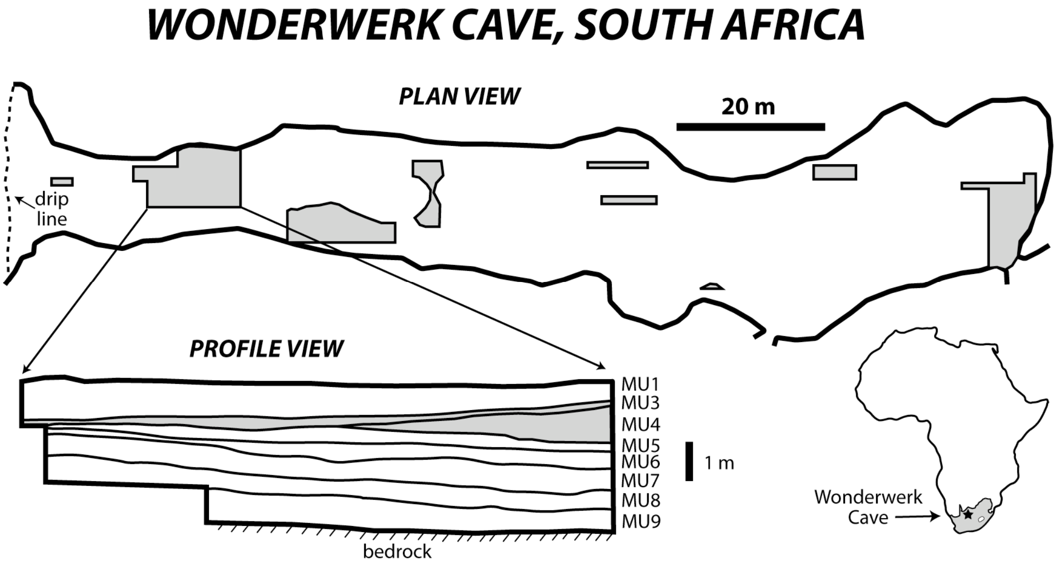

Figure 1. Schematic plan and profile views of Wonderwerk Cave, South Africa. Shaded areas in the plan view mark the various excavation locations. The profile view shows the various stratigraphic major units (MUs); MU2 is present in adjacent excavations but absent from the profile shown. Strata with 'exotic minerals' are shaded. Adapted from Beaumont & Vogel (2006).

1993; Klein *et al.*, 2004; Marean *et al.*, 2007). Such accidental introductions suggest an alternative explanation for the pebbles at Wonderwerk Cave termed 'exotic minerals,' which I suggest could instead be ostrich gastroliths. A range of animals intentionally swallow stones, or gastroliths, in most cases to aid in food processing. These include crocodilians, pinnipeds, and a number of primarily herbivorous and insectivorous terrestrial birds (Gionfriddo & Best 1999; Wings, 2007), as well as some falcons (Cade, 1982; Fox, 1976) and particularly ostriches (*Struthio camelus*) (Wings, 2004). *Struthio camelus* has been the only ostrich species in Africa since the Pliocene (Harrison & Msuya, 2005), which allows some confidence in the use of the modern taxon as an analogue for Middle to Late Pleistocene representatives.

Ostrich eggshell fragments occur throughout the Wonderwerk Cave Pleistocene-Holocene stratigraphic sequence, and ostrich are well-documented in historic accounts of the area and are still visible in wall paintings in the cave (see Beaumont, 1990), attesting to the long-term presence of *S. camelus* in the region. Aside from eggshell, there are no avifaunal remains reported from Wonderwerk Cave. However, only the micromammals (Avery, 2007) and a small sample of the larger mammalian fauna have been published (Klein, 1988). As avian skeletal elements weather rapidly relative to those of mammals and are therefore rarely preserved (e.g. Behrensmeyer *et al.*, 2003), the significance of this absence is as yet unclear. The paucity of carnivores and carnivore damage and the abundance of archaeological traces suggests that hominins were the primary agents responsible for the accumulation of macromammalian remains at Wonderwerk Cave (Cooke, 1963; Klein, 1988), whereas the abundant microfauna are likely introduced by the barn owl *Tyto alba* (Avery, 1995:461, 2007), a species not known to use gastroliths.

Several lines of archaeological and ecological evidence support the hypothesis that the Wonderwerk Cave 'exotic minerals' are accidentally introduced ostrich gastroliths. I focus on the size, spatial distribution in the cave, color, lithology, and provenance of the 'exotic minerals.'

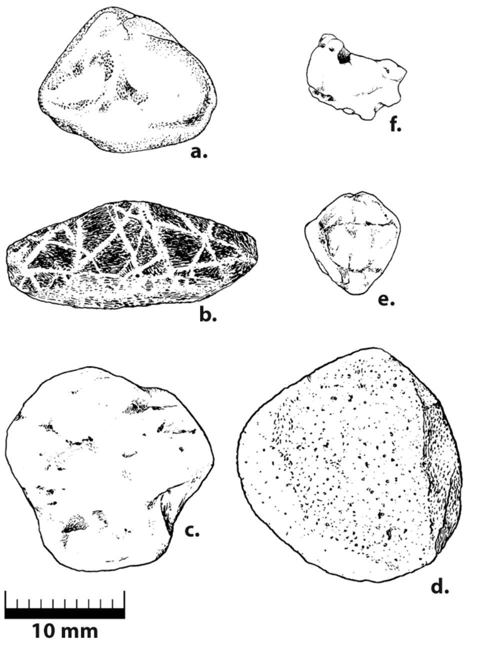

Figure 2. a.-b. 'Exotic minerals' from Wonderwerk Cave major units 3 and 4, redrawn from Beamont and Vogel (2006). c.-f. Gastroliths from a South African ostrich, redrawn from Wings (2007).

(1) Most ostrich gastroliths are ≤25 mm in dimension (Figure 2c.-f.), with >0.5 kg of gastroliths in the gastrointestinal tract of a single adult ostrich (Meinertzhagen, 1964; Milton *et al*., 1994; Wings, 2004; Wings & Sander, 2007). Individual clast size is well within the range of the illustrated finds from Wonderwerk Cave (Figure 2; see also Wings, 2004:74; Wings, 2007:3). Given the concentration of gastroliths within the ostrich stomach and their relatively rapid release from the body cavity after death during decomposition (Wings, 2003), ostrich could well explain the scatters or clusters of stones noted by Beaumont and Vogel (2006). Comparative ethnographic and archaeological data from Australia (Cane, 1982) and New Zealand (Anderson, 1989: 147-148) suggest that gastrolith concentrations result from human processing for consumption of large birds such as bustards (*Eupodotis australis*) and moa (Dinornithiformes).

(2) Detailed studies of ostrich populations throughout southern Africa have shown that they exhibit a clear preference for white (particularly quartz) or colored stones for ingestion as gastroliths. Milton *et al*. (1994) demonstrated statistically significant differences in the abundance of ostrich gastrolith rock types relative to the local geological substrate observed in the gut contents of ten individuals, with selection of white quartz or colored stones at the expense of darker sandstone or shale clasts. Controlled feeding experiments by Wings and Sander (2007) suggest that highly siliceous rocks such as quartz may be overrepresented as gastroliths as these more durable stones are less subject to chemical and mechanical decomposition while in the ostrich gut. Whatever the cause (selection or differential weathering), the outcome is often a concentration of rounded white or bright-colored stones.

(3) Although conditioned by environment, ostriches may move upwards of 18 km per day with home ranges >150 km (Williams *et al.*, 1993), and thus by foraging even a modest distance from Wonderwerk Cave, hominins could readily have encountered ostrich that sampled the Kuruman River sources for the chalcedony pebbles posited by Beaumont & Vogel (2006).

Data from several sources suggest that Wonderwerk Cave functioned as a 'central place' for the transport and consumption of food by hominins, including the dense collections of artifacts and fauna, multiples lenses of hearths, and most strikingly, a layer of carbonized grass interpreted as hominin bedding material (Beaumont, 1990; Beaumont & Vogel, 2006). Given the presence of ostrich eggshell fragments throughout the sequence, the occasional inclusion of ostrich meat and thus the accidental introduction of ostrich gastroliths into Wonderwerk Cave by hominins is plausible. However, it is worth noting that although collecting ostrich eggs is relatively straightforward as the nests are often exposed and undefended, hunting ostrich is difficult in the absence of firearms, horses, or motorized vehicles. Historically, African foragers hunt ostrich only with bow and poisoned arrows, and then rarely and with great difficulty (Bleek, 1931; Lee, 1979; Marlowe, 2002; Sampson, 1994; Tanaka, 1980, cf. Darwin's 1832 account of the hunting of the 'South American ostrich,' *Rhea*, using bolas and horses [Keynes, 1988:105-105] and Teddy Roosevelt's [1910:298-300] descriptions of the difficulties associated with gun-assisted hunting). This argues against ostrich hunting (and the accidental introduction of gastroliths) as a *regular* venture in the Middle and perhaps Late Pleistocene (e.g., prior to the advent of the bow), although given the large temporal range sampled by the Wonderwerk Cave sequence, rare successful hunting or scavenging of ostrich remains possible.

Combined, these observations suggest that ostrich gastroliths are a viable alternative explanation for the 'exotic minerals' because (1) ostrich gastro-intestinal tracts usually contain usually >0.5 kg of white or brightly colored pebbles in the observed size range (≤25 mm), and (2) eggshells in Wonderwerk Cave demonstrate hominin interaction with ostrich throughout the Middle and Later Pleistocene that may have resulted in rare acquisition of ostrich meat, and (3) deposition of stomach contents including gastroliths would mimic spatial patterns reported from Wonderwerk Cave. Importantly, the ostrich gastrolith hypothesis can be directly tested through detailed comparative analysis of the 'exotic minerals' and other clasts in Wonderwerk Cave using morphological and other criteria (e.g., degree of polish) used to identify gastroliths in sediments (see Cox, 1998; Johnston *et al.*, 1994; Wings, 2004), or by bone surface modification studies should ostrich be found among the fauna, the analysis of which is ongoing.

Discussion and conclusions

My goal in this note is not to detract from the excellent past and ongoing research at Wonderwerk Cave. Nor is my aim to refute the hypothesis that the 'exotic minerals' represent early hominin non-utilitarian behavior, and I do not include in my discussion the strong evidence for such behavior from pigments or incised stone slabs found in the Wonderwerk Cave (see Beaumont & Vogel, 2006). In fact, the idea of hominin-introduced pebbles provides the basis for interesting ethnographically-based speculation as to what role such items might have played in past hominin societies, including parts of rattles (e.g., Frisbie, 1971) or components for *mancala* or similar games now widespread throughout Africa and elsewhere (e.g., Driedger, 1972). It is also possible that the 'exotic minerals' are gastroliths yet were deliberately selected by hominins, suggesting their use in non-utilitarian behavior but substantially reducing their potential transport distance and cost (for an interesting parallel from the 18th and 19th centuries, see Goode, 2009). Rather, following the logic of Henshilwood & Marean (2003), my purpose in presenting an alternative hypothesis built on archaeological and ecological data is simply to demonstrate that the presence of 'exotic minerals' in Wonderwerk Cave does not provide *unambiguous* evidence for hominin non-utilitarian behavior. The published data are insufficient to support or refute either the 'deliberate hominin transport' or the 'accidental introduction of ostrich gastroliths' hypotheses, but accepting the Wonderwerk Cave data into broader discussions of the hominin cognitive and social evolution requires falsifying alternative explanations such as the one presented here. As in other cases of possible Middle Pleistocene non-utilitarian behavior from Early Stone Age/Lower Paleolithic sites (e.g., Goren-Inbar *et al*., 1991; Rigaud *et al*., 2009), a more cautious reading of the available evidence recognizes multiple possible explanations for the Wonderwerk Cave 'exotic minerals,' some excluding a role for hominins.

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