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Late Pleistocene protein residues from the Mahaffy cache, Colorado

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ABSTRACT

This paper reports the analysis of protein residues from tools recovered in a cache within the city limits of Boulder, Colorado, USA. This cache included a total of 83 artifacts, all of which we subjected to cross-over immunoelectrophoresis (CIEP). Four of the 83 produced results, with residues from each of these reacting with antigens from a different taxon: one tool shows evidence of use on sheep, one on bear, one on horse, and one on camel. Varieties of sheep and bear have been present in Colorado throughout human history, but horses and camelids have been in the state either during the Pleistocene or the last 200 years. Several lines of evidence indicate that the cache cannot be recent, and our CIEP results therefore imply that the cache date to the late Pleistocene. Typological aspects of the artifacts in the cache are consistent with artifacts known to be Clovis, and the combination of CIEP and typological data thus indicate that the cache is Clovis as well. These data contribute to an increasing dataset documenting the broad range of animals other than elephants hunted by Clovis groups in North America.

Archaeologists debate almost every aspect of our reconstructions of the ways of life of the earliest occupants of North America, but much of this debate focuses in one way or another on their diet. One school of thought with deep roots in the archaeological literature views the earliest North Americans, particularly Clovis groups, as specialized big game hunters, possibly with a major emphasis on extinct species of elephants (*Mammuthus* spp., in particular); the other argues that the data underlying this view are highly biased and that these early groups are more likely to have been, in some sense, subsistence generalists.

There is evidence supporting both of these positions. For example, Waguespack and Surovell (2003) have shown that proboscideans are overrepresented in the overall early (Clovis) archaeological record, perhaps implying specialization on them. On the other hand, these authors assert that there is no bias toward investigating sites containing large mammals in the Clovis record—in effect, that the set of known Clovis sites constitutes a representative sample of all of the sites Clovis people produced—but offer neither evidence nor analysis that this is so. In fact, as Meltzer (2009) observes, archaeologists have almost always discovered Clovis and other Paleoindian sites by digging in places where they saw large mammal bone, thereby often discovering kill sites, a category of archaeological site that is more or less guaranteed to direct our attention to large mammal procurement. It is just not plausible that there is no bias in the known sample of early sites, and evidence from sites other than kills tends to be more consistent with a less specialized view of the Clovis diet. This is particularly true of evidence from campsites—places where Clovis people lived, in contrast to sites where they slaughtered and butchered large animals. Campsites like Sheaman (Frison and Stanford, 1982), Aubrey (Ferring, 2001) and Gault (Collins, 2002) uniformly show exploitation of a variety of large and small species, and Byers and Ugan (2005) show that optimization arguments indicate that we should expect such a pattern (also see Cannon and Meltzer, 2004).

However, evidence of Clovis diets to date has depended almost entirely on the preservation of animal bone. Much of the early North American archaeological record consists either of isolated flaked stone artifacts (particularly projectile points) or of site assemblages from localities where bone was not preserved. Even at sites such as Gault (Collins, 2002), where we do have faunal evidence of Clovis dietary choices, the available bone is sometimes in poor condition, limiting analysis and interpretation. However, increasing attention to the possibility that stone artifacts can preserve residues of animal blood or other proteins offers evidence that is increasingly contributing to this debate (i.e., Gramly, 1991; Kooyman et al., 2001; Loy and Dixon, 1998; Newman and Julig, 1989; Seeman et al., 2008).

This paper contributes to this evidence, presenting the results of cross-over immunoelectrophoresis (CIEP) analysis of flaked stone artifacts in the Mahaffy cache, recovered in Boulder, Colorado, in, 2008. Bamforth (in press) discusses the discovery, stratigraphic setting, and contents of the cache in more detail; we focus here on

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the CIEP results. Our discussion presents an overview of the discovery and stratigraphic setting of the cache, followed by background on immunological work on ancient proteins in general, the specific analysis applied to the Mahaffy cache artifacts, and the results and implications of this analysis.

1. The Mahaffy cache

Landscapers working in the front yard of a house in the western part of Boulder, Colorado, uncovered the cache in the spring of 2008. These workers carried out their initial excavations with a backhoe, and noticed the artifacts when they were following this up with shovels and heard the sound of metal on stone. Digging by hand into the sediment where they heard this sound, they pulled out a mass of artifacts packed into an area approximately 30–40 cm across.

Archaeologists arrived the next day at the homeowner's invitation. The workers indicated the locations of the cache and also of the spoils piles left by the backhoe excavation above the location of the cache and at the level of the cache. Screening the former recovered no additional artifacts; screening the latter produced four small flakes. In addition, careful inspection of the ground surface around the work area, where sediment has been scattered, produced five additional flakes. All of these were likely dispersed over time out of the cache and removed by the backhoe; recovery by a child visiting the project of one additional flake in place in the sidewall of the landscaper's pit, some 40–50 cm away from the location of the main mass of artifacts confirms such dispersion. Otherwise, close inspection of exposed sediment in the immediate area of the cache and elsewhere in the work area revealed no additional evidence for the existence of any archaeological material. In particular, although it is possible that there may be a few other small pieces still in place, there are no indications of the existence of a larger site: the cache appears to be an isolated feature.

1.1. Physical and stratigraphic setting

The landscaped area is on the northern edge of the drainage of Gregory Creek, a small tributary of Boulder Creek. Gregory Creek runs out of the foothills of the Rocky Mountains, incising a channel into the surface of an east-west trending ridge; the cache was in an A/AC/C soil sequence formed on a coarse sand near the top of a Late Pleistocene/Holocene fill within this channel (P. Birkeland,[1] personal communication, 2008; 2010). Twentieth century construction of roads and houses makes it effectively impossible to examine the details and chronology of this fill, although it is clear that the cache was located several meters above the modern gradient of Gregory Creek. The A/AC/C sequence is overlain by a surface layer of highly disturbed sediment that was mixed and presumably redeposited as a result of twentieth century road and residential construction. The contact between this layer and the underlying A horizon is very sharp, suggesting that the upper portions of the A horizon have been truncated by recent construction, but there is no way to determine this for certain. Radiocarbon dates on organics from the A horizon indicate that the soil itself formed during the 14th century (V. Holliday, University of Arizona, personal communication, 2011), but this does not tell us the age of the sediment that contained the cache.

The landscapers who removed the cache said that the concentration of artifacts was wholly contained within the sand, and traces of sediment from this layer were visible on a number of the artifact surfaces before they were cleaned. However, they excavated a maximum of a meter into the sand, and the artifacts are also stained with organics from the A horizon. This means that the cache was in the upper part of the sand, although it is not possible to tell exactly where the pit containing the cache originated. It is also not possible to determine the exact depth at which the cache was buried below the natural ground surface. At present, the top of the sand is approximately 45 cm below the surface, but searches of construction records at the City of Boulder have not produced any information regarding the configuration of the surface prior to twentieth century modification. Given the landscapers' descriptions, it is likely that the cache was at the base of the A or the top of the AC horizon.

The available information thus indicates that the Mahaffy cache was located on the edge of a stream, most likely (given the slope of the contact between the uppermost sediment and the sand) just above the point where the bank sloped down into the active channel. We cannot know the details of the landscape at the time when the cache was buried, particularly those details that might have marked a cache location. However, Gregory Creek runs out of the mountains at the north end of a distinctive geologic formation known locally as the "Flatirons", which is visible from a great distance away. This formation, and the course of the creek, could have helped mobile groups to return to the cache location.

1.2. Cache contents

The Mahaffy cache includes a total of 83 objects (Table 1; Bamforth (in press) describes these in detail). The artifacts in the cache are diverse, and include bifacial knives and choppers (some of them large and exceptionally well-made), true blades (Type 1 blades in Table 1), typological blades (Type 2 blades in Table 1), large flakes (a few of them unifacially retouched), flakes chosen to serve as backed pieces, and unmodified flakes that appear to have been selected from debris produced while reducing cores and bifaces. There are also two small pieces of unmodified chert in the collection. It is very likely that there were originally at least a few more small pieces in the cache, because all of the pieces recovered in screens and on the ground surface were small flakes and because the landscapers had used some of the sediment from the cache area as fill before archaeologists arrived at the construction site. However, we are confident that no larger pieces escaped notice. Virtually all of the artifacts in the cache are well-suited to cutting and, in our experimental experience, especially to butchery. One artifact is fairly clearly designed as a hand-held chopper (Bamforth, in press, Fig. 6), and one of us has used a very similar tool to disarticulate a medium-sized mammal. A single biface from the cache (Bamforth, in press, Fig. 2) is uncomfortably large to hold, but appears to have been in use as a core (one large flake in the cache refits to it, and many of the others appear to have been struck from it). With some additional reduction, this piece would be an effective cutting tool.

The Mahaffy cache artifacts are made from four distinct raw materials. A total of three bifaces were flaked from quartzite. Two of these, one showing exceptional flintknapping skill and the other of more everyday quality, are in a fine-grained orange quartzite flecked with red that appears to derive from the Uintah Mountains on the border between Colorado and Utah (Fig. 1). The other, also extremely well-made, is in a fine-grained purplish-gray quartzite whose exact source is unknown. However, it is very similar to quartzite from quarries in Middle Park in the central Rocky Mountains (Bamforth, 2006) and is likely from this area. The remainder of the collection is made from two distinctive sources of chert. One of these (including a total of 23 objects) is Kremmling

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