

**Meetings Version of the March 28–29, 2017, Vancouver, BC  
Paleoanthropology Society Meeting Abstracts  
(this is not the published version [coming in April 2017])**

**Allan et al.**

### **How Do We Interpret Elevated Neanderthal $\delta^{15}\text{N}$ Levels?**

Stable isotope analyses of Neanderthal fossils have repeatedly yielded high  $\delta^{15}\text{N}$  values. This has led some researchers to argue that the Neanderthals were “hypercarnivorous.” Others have suggested that the high  $\delta^{15}\text{N}$  values indicate that the Neanderthals were specialist hunters of megafauna. However, both of these hypotheses has been challenged on the grounds that they are not supported by the zooarchaeological record. In the present paper, we report a study in which we sought to shed light on this disagreement. In the first part of the study, we re-analyzed the available stable isotope data for Neanderthals, paying particular attention to the position of each Neanderthal specimen relative to temporally and spatially proximate fauna. This analysis confirmed that Neanderthal  $\delta\text{N}$  values are high, not just in absolute terms but also relative to other species, including carnivores. This pattern does not reflect inter-tissue differences in fractionation. Nor does it seem to be a consequence of environmental factors, such as aridity. Having confirmed that Neanderthal  $\delta^{15}\text{N}$  values are high compared to those of contemporary carnivores, we evaluated potential explanations for this pattern. We began by considering dietary explanations, including the consumption of megafauna species, the consumption of other carnivore species, and the consumption of conspecifics. None of these hypotheses were supported by the faunal data we examined. Given this, we evaluated some alternative hypotheses. Of these hypotheses, the one that best fit the data holds that the Neanderthals experienced dietary stress on a regular—probably annual—basis. This hypothesis explains the discrepancy between the high  $\delta^{15}\text{N}$  values for Neanderthals and the mammalian species represented in Neanderthal-associated deposits because starvation can lead to tissue N enrichment. In addition, the hypothesis is supported by results of work on palaeopathology in Neanderthals and by research on the Neanderthals’ carcass processing behavior.

**Ambrose et al.**

### **Ethnography of Red Ochre Use by Pastoralists and Hunters in Kenya**

Ochre pigments occur in African archaeological sites from the later Middle Pleistocene to the ethnographic present. Ochre is used worldwide for diverse symbolic and functional purposes, and is frequently considered to be evidence for symbolic behavior by cognitively modern Paleolithic humans. However, determining whether ochre use is specifically symbolic rather than functional is problematic. Geochemical source provenience analysis, and ethnographic studies of ochre source exploitation, transport, and processing, and symbolic, aesthetic, and functional uses can help test these alternative hypotheses by determining whether culturally mediated source exploitation preferences differ significantly from a least-cost energetics (closest source) null-model of source use. Ethnographic evidence for ochre use in Africa is extremely limited. Therefore, in 2015–2016 we systematically sampled 52 ochre sources in the northern and southern Rift, guided by Maasai, Samburu, and Dorobo informants. Redundancy of information among informants suggests that we have collected most of the currently exploited ochre sources in the Kenya Rift Valley. We interviewed them about their traditional uses of ochre. We also collected samples from 12 rock art sites, and pigment fragments and artifacts with ochre residues from 10 Middle Stone Age, Later Stone Age, and Neolithic sites, and a Dorobo arrow shaft decorated with personal identifying marks. Some informants were able to identify images that they had painted at rock art sites, and showed us the geological sources of their pigments. Geochemical provenience analysis of ochre is the first step in the process of reconstructing artifact provenance (object biographies), and the geographic scale of social information and symbolic exchange networks. The diversity of pigment sources used at rock art sites provides evidence for reconstructing place biographies, including the scale of social catchment areas. We will illustrate the concept of place biography with evidence from two painted sites that were used by our informants.

**Aubin**

### **An Experimental Investigation into the Impact of Point Dimensions, Haft Morphology, and Fixing Method on the Effectiveness of Neanderthal Spears**

The performance of Neanderthal hunting weapons is still largely an unknown. The present paper reports an experiment designed to go some way towards addressing this gap in knowledge. Its aim was to assess the impact of point dimensions, haft morphology, and fixing method on the effectiveness of Middle Paleolithic spears. Six spear shafts were fashioned from common hazel (*Corylus avellana*)

and then replica Mousterian points were hafted to the shafts in several different ways (notch vs split, deer hide binding vs birch bark tar adhesive). Subsequently, the spears were thrust into the rib section of a dead pig and several variables recorded, including wound dimensions, acceleration, and accumulated damage to the spears. All the hafting morphologies and fixing materials made effective spears, but a combination of binding and tar proved significantly more durable than the materials separately, sustaining almost no damage over nearly 50 thrusts. Point morphology had a marked effect on penetration; large points with abrupt retouch regularly failed to penetrate the target. Haft morphology had no discernible impact on either survivability or penetration. Thus, this experiment suggests that point form has a bigger impact on spear performance than hafting morphology.

**Beaudet et al.**

## **A High Resolution Microtomographic Study of the StW 578 Pliocene Hominid Cranium from Sterkfontein Cave**

The Sterkfontein Caves are one of the most fossil-rich early hominid sites in Africa, with over 800 specimens recovered since 1936. The Jacovec Cavern contains a series of fossiliferous deposits that have yielded enigmatic hominid remains that may be pencontemporaneous with Sterkfontein Member 2, a deposit that provided the nearly complete *Australopithecus* skeleton StW 573 ("Little Foot"). The Jacovec Cavern is also fecund in hominid fossils, prominent among them is the StW 578 cranium, which preserves much of the braincase. Stw 578, excavated, cleaned and reconstructed by Clarke, is clearly an *Australopithecus* fossil, but has not yet been assigned to the species level (Partridge et al. 2003). Here we employ high-resolution microtomography to investigate taxonomically salient endostructural aspects of StW 578. Specifically: (1) we reported cerebral imprints on the endocranial surface of StW 578; (2) assessed the topographic thickness distribution of the cranial vault; and, (3) detailed the relative contribution of the outer and the inner tables and of the diploë to overall vault structure (Falk 1983; Copes and Kimbel 2016). The inner structural organization of StW 578 was then compared to that of cranium Sts 71 from Sterkfontein Member 4. Our virtual reconstruction of the StW 578 endocast reveals partial imprints of meningeal vessels and gyri on the inner surface of the parietal bones. Parietal and occipital bones are relatively thick in StW 578 and Sts 71 and both fossil specimens share similar structural bony arrangement in the parietal region (diploë>outer table>inner table). However, more specimens are needed to discuss the potential diagnostic implications of our results, especially given the substantial inter-individual variation in cranial thickness reported for African Pleistocene hominids, as compared to the extant human condition (Zanolli et al. 2016).

**Belmaker et al.**

## **Paleoecology across the Pleistocene- Holocene: The Small Mammal Assemblage of Kotias Klde, Georgia**

The shift from hunting-gathering to agricultural practices during the Pleistocene–Holocene transition is a critical time in human evolution. A cold and dry Younger Dryas may have served as an impetus for the development of agriculture. However, others propose that this period may not have exhibited an extreme climate and that social factors may have played a greater role in this transition. Thus, evidence for the severity of the Younger Dryas and its effect on human populations can be region dependent. In the lesser Caucasus, few studies have been conducted on the effect climate change had, if any, on the development of local agro-pastoralist communities. Here we present the first study of small mammal remains from the site of Kotias Klde, western Georgia. Two stratigraphic units are present at the site: Level B, a Mesolithic level (12,400–10,300 cal BP) and Level A, a Neolithic level. Small mammal remains from both levels were identified to the lowest taxonomic level possible; in addition, remains were subjected to a taphonomic study. Of a total of ca. 1500 specimens, 115 specimens were identified to species, spanning both periods. Results of the taphonomic study indicate that the two assemblages are isotaphonomic and allow for a paleoecological comparison among them. Results of this comparison point to a shift detected between the Mesolithic level in which an overwhelmingly proportion of the taxa are voles, and the Neolithic strata. During the Neolithic, woodland taxa such as wood mice and shrews dominate the assemblage. These results are consistent with pollen evidence from the Black Sea which suggests grassland environment in the Mesolithic and humid and warmer park woodland during the Neolithic. The amelioration of climate in the Pleistocene–Holocene transition in Georgia suggests that an increase in humidity may have had an effect on the Neolithization processes in the region.

**Benitez et al.**

## **The Implications of Faunal Abundance for Pleistocene Paleoenvironments in the Turkana Basin, Northern Kenya**

Much of the evidence for environmental change and hominin evolution in eastern Africa comes from fossil deposits within the Shungura, Nachukui and Koobi Fora formations of the Turkana Basin in northern Kenya and southern Ethiopia. The Shungura

Formation has been proposed to be a refugium for species that preferred well-watered and woodland habitats between 1.98–1.38 Ma. In this study, we use fossil bovid elements (n=29,132) to assess the spatial and temporal distribution of paleoenvironments in the Shungura and Koobi Fora Formations during this period. We hypothesized that differences in bovid abundance between the regions would be greatest at the end of the period (1.52–1.38 Ma) due to drastic changes in paleogeography in the southern portion of the basin. Abundances of *Metridiochoerus* and *Equus* also were examined as possible proxies for grassland environment. Our analyses suggest that the hypothesis of the Shungura as a refugium is oversimplified. Between 1.98 and 1.38 Ma, Shungura bovid abundances indicate the presence of a mix of habitats similar to those of Koobi Fora. Spatial analysis of Koobi Fora bovid abundances indicates that small areas within Koobi Fora may have been able to support species preferring well-watered habitats. Further detailed spatial analyses and systematic documentation of fauna are needed to better understand the response of faunal communities to paleogeographic and climatic changes in the Turkana Basin.

**Berna et al.**

## **Fire and the Genus *Homo*: New evidence from ESA Contexts at Wonderwerk Cave, South Africa**

Wonderwerk Cave, where an almost continuous hominin presence has been documented since the Oldowan, preserves abundant evidence of fire. Here we present new results from a preliminary study, undertaken using FTIR, electromagnetism, micromorphology and zooarchaeology, on the evidence for fire associated with Oldowan and Acheulean contexts, located ca. 25 meters behind the current drip line. Large amounts of burnt fauna associated with diffuse magnetic susceptibility anomalies have been documented suggesting burning of *in situ* fire inside the cave. These data complement previously published evidence for intentional fire in the cave (Berna et al. 2012). Evidence suggesting the anthropogenic origin of the burning will be contrasted to potential natural causes.

**Bicho et al.**

## **Txina Txina: A Later Stone Age Site from the Limpopo Basin in Southern Mozambique**

Southeast Africa has become an important region to better understand the development of Stone Age and Anatomically Modern Humans. Finally, in the last decade, Mozambique has received some attention from various researchers probably because it is located between the earliest finds of Anatomically Modern Humans in the Omo Kibish formation and those with early evidence for cognitive complexity in coastal South Africa. Starting in 2011 we carried out a series of field seasons in various regions of Mozambique, including the lacustrine settings of the Niassa Lake in the north and the fluvial environments of the Elephant and Limpopo Rivers in the Massingir area, and the southern coast of the Maputo lands. Non-systematic survey was carried out by foot, directed to specific areas where geomorphology and geology increased the chances to find open air and cave/rockshelter Stone Age sites. The team was able to locate over 200 Stone Age new sites. Here, we present preliminary data from testing, dating and material analyses (lithic, faunal, and ornaments) from the new Later Stone Age site of Txina Txina, discovered during the 2016 field season. The site is located in the Machampane river gorge, a small stream that runs to the major Elephant River, a tributary of the Limpopo. Three test pits recovered, from at least a 1 meter long sequence dated to the Late Pleistocene and early Holocene, a wide range of lithic raw materials (cherts, quartz, quartzite, silcrete, rhyolite and other volcanic local rocks), mammal bones, terrestrial gastropods and ostrich egg shell as well as some beads. The lithic assemblage is based on the production of flakes and bladelets mostly from centripetal, bipolar, and prismatic cores. Formal tools are rare, but nevertheless there are a few microlithic crescents, backed bladelets, scaled pieces, and denticulates and notches.

**Blackwell et al.**

## **ESR Dating Ungulate Tooth Enamel within the Paleolithic Layers at Velika Balanica, Serbia**

The Balanica cave complex sits in the cliffs on the north side overlooking the Sicevo Gorge, about 15km east of Niš, Serbia. Both Mala Balanica and Velika Balanica also yielded Middle Pleistocene mammal fossils and associated artifacts. A *Homo heidelbergensis* mandible, BH1, found in Mala Balanica dated to  $\geq 400$  ka. All the deposits in Velika Balanica exceed the  $^{14}\text{C}$  maximum dating limit, and post-date those that yielded the mandible in Mala Balanica. In Layers 2a–3c, Velika Balanica contains Middle Paleolithic archaeological deposits, including >10,300 bones, while Middle Pleistocene fauna occur in all layers. Velika Balanica Layers 2–3 show signs for intensive hominin habitation. The reddish brown silty clay and *éboulis* in Layers 2a–2c overlie Layers 3a–3c. Its compact brown, clayey silty sands also have darker lenses that may represent hearths. Layers 2b, 3b, and 3c2 all yielded lithic artifacts and charcoal. The thinly bedded Layers 4a–4c7 have several thin collapsed stalagmitic floors that dip toward the cave interior, suggesting

that karstic processes have caused local subsidence. The Layer 4 complex also contains coarse *éboulis* that show diagenetic alteration, weathering, root-etching, and post-dispositional carbonate rims, and lenses with secondary carbonate cements which solidify the deposits. Since ESR can directly date fossil teeth from 0.5 ka to 2.0 Ma with 2%–8% uncertainty, teeth were collected from Layers 2a–4c in Velika Balanica with associated sediment samples specifically for dating. From seven cervid teeth, 25 independent subsamples were independently dated by standard ESR. Associated sediment samples were measured by NAA to find time-averaged and volumetrically averaged sedimentary dose rates. U concentrations in the enamel ranged from 1.0ppm to 9.1ppm, while those in the dentines ranged from 38.3ppm to 95.0ppm, making it essential to understand the U uptake rates by doing isochron and coupled ESR-<sup>230</sup>Th/<sup>234</sup>U analyses to improve the ages' accuracy.

## **Blegen and Brown**

### **Through a Volcanic Glass Darkly: Viewing Modern Human Origins with the Lens of Raw Material Transport**

Long-distance transport (>50km) of raw materials is a feature of human behavior inextricably linked to increased intergroup interactions through higher mobility and/or trade. However, archaeological evidence of long-distance obsidian transport in East Africa mostly is known from Late Pleistocene sites dated to <50 ka. A synthesis of new obsidian data with a previously compiled geochemical database demonstrates early and consistent presence of long-distance obsidian transport in East Africa between ~50–400 ka, the period spanning *Homo sapiens* evolution and dispersals out of Africa. Obsidian artifacts (25 analyses on 5 artifacts) from five Late Pleistocene sites in the Lake Victoria basin dating between >50 and 100 ka show transport distances of 145km to 250km from Naivasha basin sources. In the Baringo basin, the Sibilo School Road Site, dated to 222.5 ka, shows transport of obsidians (160 analyses on 28 artifacts) from three sources located 25km, 140km, and 166km from the site with 95% of the obsidian deriving from the most distant source. New analyses of obsidian artifacts (149 analyses on 31 artifacts) from two Middle Pleistocene sites, Kapthurin site 'A' and Rorop Lingop, recently dated >380 ka, demonstrate seven obsidian compositions from at least three sources ranging distances between ~60–140km from these sites. The evidence available with a small number of sites suggests long-distance raw material transport is older than previously appreciated and predates technological innovations such as Middle Stone Age trimmed points by ~100 kyr as well as the first appearance of *H. sapiens* by ~180 kyr. By antedating important technological and biological features in human evolution, increases in intergroup interactions attested by long-distance raw material transport constitute potentially significant selective pressures on the development of modern human behavior and biology. A focus on raw material transport and its impacts on technology, biology, and human-environmental interactions can provide new insights into modern human origins in Middle and Late Pleistocene Africa.

## **Bourgeon et al.**

### **Archaeological Support for the Beringian Standstill Hypothesis: Human Occupation of the Bluefish Caves Site (Yukon Territory, Canada) During the Last Glacial Maximum**

The Beringian standstill hypothesis suggests that human populations reached Beringia (eastern Siberia, Alaska, and the Yukon Territory) during the Last Glacial Maximum (LGM) and persisted there from about 23,000 to 15,000 BP. During this time they were genetically isolated and diverged from East Asian ancestors, before dispersing south of the ice-sheets into North America. This hypothesis is indirectly supported by evidence of a relatively mild climate in Central Beringia and the presence of pre-LGM populations in Western Beringia. Until now, however, the archaeological record has not yielded evidence of a human presence in Beringia during the LGM. Previous to this research, the oldest accepted dates for the human occupation of Alaska and the Yukon Territory do not exceed 14,000 BP. We conducted a rigorous taphonomic analysis of the Bluefish Caves site (northern Yukon Territory) and dated six bone specimens recovered from Caves I and II bearing clear evidence of butchering activity. The dates obtained from the cut-marked bone prove that small groups of people occupied the Bluefish Caves site for brief periods of time on several occasions during and after the LGM. The earliest AMS date obtained indicates a human presence in Eastern Beringia at 24,000 cal BP (19,650±130 <sup>14</sup>C BP). These results, therefore, support the proposition that a human population existed in Beringia during the LGM. After ca. 16,000 BP, as climatic conditions improved, population size increased and people may have dispersed from Beringia into North and South America following a Pacific coastal route.

**Brandt et al.**

## **?Pre-MIS 3 Occupation of Mochena Borago Rockshelter, SW Ethiopia**

Prior to 2012, archaeological excavations at Mochena Borago Rockshelter in SW Ethiopia focused upon Late Pleistocene deposits in the northern section (BXA) of the ~ 70m wide rockshelter. Here three major artifact-bearing lithostratigraphic units are securely dated by over 40 charcoal radiocarbon ages to >50 ka – 36 ka. In 2012 excavations at the base of a then undated 2m+ geological test trench in the central part of the site (N41) revealed an occupation horizon of relatively large bifacial and unifacial points with residues adhering to them. The 2015 and 2016 field seasons focused upon excavations to the east of the geological test trench (N42). Four charcoal AMS ages date the uppermost layers of N42 deposits to >50 ka. Another 2+ meters of stratified archaeological deposits lie below these radiocarbon dates. The N42 stone artifact assemblages are almost all obsidian, but defy simplistic MSA/LSA designations as they reveal a remarkably diverse array of core reduction technologies in the same horizons that include preferential centripetal, Levallois Flake, preferential Levallois Point, Nubian Levallois Point types 1, 2, 1/2, and possibly a third type, discoidal, blade, bladelet, elongated flake, core-on-flake, and bipolar core technologies. Levallois and unifacial to bifacial points, drills, burins, scrapers, and other shaped tools also are present. A “heavy-duty” component of large basalt artifacts including various core types, naturally backed “knives,” as well as ground, pecked, and rubbing stones is found throughout the sequence but is more plentiful in the lower part of the sequence. New Obsidian Hydration dates suggest ages of ~100–60 ka. We conclude with a discussion of how the N42 assemblages may relate temporally and spatially to assemblages in the central test and main northern trenches, as well as to how they contribute to the testing of our “Highland SW Ethiopia OIS 4 Refugium Theory.”

**Cascalheira et al.**

## **Technological Variability in the Middle Stone Age of Mozambique: Preliminary Results**

Despite the presence of a large number of archaeological sites just outside of the Mozambique borders, some with very rich and long sequences for the Middle Stone Age (MSA) in southeastern Africa, previous research in the country has provided little to no hard data on the lithic technology of this phase (Bennett 2011). This poster presents the first results of the lithic analyses of MSA assemblages collected during the 2014–2016 survey field seasons in the Niassa (northeast) (Bicho et al. 2015) and Massingir (southeast) regions. Data from a total of 90 locations seem to indicate a wide inter-regional variability in terms of lithic technology and in the extent of presence of the broadly accepted southern Africa MSA cultural phases. Raw material use is radically different in the two areas. While quartz is largely used in the Niassa, quartzite is the preferred raw material in Massingir. Chert and other raw materials including silcrete are very rare in both areas. Technology show a common use of Levallois prepared core technology and simpler discoidal cores in both areas, although Levallois is more abundant in Massingir. Also, while in the latter area, Levallois points as well as the respective cores are frequent, they are basically absent in the northern region. Blade production although not very common, when present in Massingir seems to be associated with prepared core technology. No blades were found in the Niassa region. Finally, and while there is no absolute dating for the Massingir area, it seems that technology and typology are much more diverse than in the north, where lithic production seems to be uniform during all of the MSA. In Massingir there are common diagnostic materials, indicating that the sequence is similar to that known from further south, including the presence of Howiesons Poort occupations (Henshilwood 2012).

**Castelli**

## **Magdalenian Images and Notations**

The Magdalenian culture was the last Upper Paleolithic culture that developed in the Atlantic Europe refugial area during the last glaciation (final Pleistocene). My research has focused on the figurative images, notational sequences, and signs engraved on Magdalenian artifacts made of antler, bone, or ivory. Through an extensive review of published and unpublished artifact photographs, I identified eight frequently recurring subjects, six of which can be explained by the theory of seasonal meaning (Marshack 1972), that is, their symbolic meaning is a specific time of the year. These images may have been used to complement and extend spoken language. This is also true for the two series of images that are not seasonal, rather all the evidence indicates they were used symbolically for counting years (Castelli 2010) and counting moons (Castelli in press), respectively. All the notational sequences that I encountered belong to one of five main types, all more or less frequently associated with figurative images, while the signs I reviewed fall into two main types, one akin to notational marks and one the same as small stylized images. The three theories on the meaning of the main series of figurative images referenced above and the only theory we have on the meaning of notational sequences (Marshack 1972) reveal the same concern for keeping track of time, at different levels—from days or nights to moons, seasons, and years—and the use of a complex symbolic system.

Clark

## **Animal Exploitation Strategies during the Early Upper Paleolithic: The EUP Fauna from Mughr el-Hamamah, Jordan (45–39 k cal BP)**

Excavations at Mughr el-Hamamah (MHM) uncovered a single occupational horizon dating to the Early Upper Paleolithic (EUP, 45–39 k cal BP; Stutz et al. 2015). More than 40,000 fragments of bone were recovered from ~1 cubic meter of deposits, with a total NISP of ~4,800. Ungulates account for ~95% of the NISP; the rest of the assemblage is comprised of birds (~2%), small mammals (~2%), reptiles (<1%), and carnivores (<1%). Small ungulates predominate; gazelle alone accounts for 55% of the total NISP. The most common medium ungulates are *Dama mesopotamica* (fallow deer) and *Capra* sp.; analysis of horn cores suggests both wild goat and ibex are present. Large ungulates are rare (~2% of the total NISP) but include *Cervus elaphus* (red deer) and *Bos primigenius* (aurochs). *Procapra capensis* (rock hyrax) accounts for 88% of the small mammal assemblage, with only a single hare bone identified. Roughly half of the bird remains were identified as Columbidae (pigeons/doves), with one third identified as *Otis tarda* (great bustard). Taphonomic analysis indicates that humans were the primary contributor to the ungulate assemblage; three bird bones bear cut marks, implying humans were responsible for the collection of at least some of these remains. The focus on small ungulates, the frequency of juvenile gazelle (~30% of the NISP), and the fact that even low-yield marrow bones (gazelle first and second phalanges) appear to have been exploited for marrow suggest some degree of subsistence intensification. However, small game played only a minor role in subsistence; small game is present in similarly low frequencies in the IUP layers at Üçağızlı (Stiner, 2009). As a whole, MHM fits well within the broader Levantine sequence (Stiner 2005, 2009; Speth and Clark 2006), in which there appears to be a gradual increase in subsistence intensification across the Middle to Upper Paleolithic transition.

Coil et al.

## **The Depositional Context and Spatial Patterning in the Hominin-Bearing Layers of Block 2 at Dmanisi, Georgia**

The Lower Paleolithic site of Dmanisi is known for its well-preserved fossil fauna, including specimens attributed to *Homo erectus*, and associated lithic material. This study examines the depositional context of this archaeological material and the implications for carnivore-hominin interaction during the initial diffusion of hominins outside of Africa. Through studying bone orientations, articulations, and spatial distributions, we found that the majority of archaeological material within the excavation unit of Block 2 is either in or very near its original depositional location, which supplements previous taphonomic and geologic interpretations (Tappen et al. 2007). The distributions of stone and bone differ based on stratigraphic layer. Taphonomic sub-assemblages of bone (e.g. cut-marked bone, tooth-marked bone, etc.) follow the overall distribution of the faunal material, indicating no spatially distinct activity areas, with the exception of a large concentration of coprolites in one relatively bone free area.

Collard and Sandgathe

## **A Case for a Natural History of the Neanderthals**

Over the last century, perceptions of Neanderthals have altered markedly. Neanderthals have gone from being viewed as bestial to being perceived to have been just like us. This change has been reinforced in the last few years by ancient DNA work that is widely viewed as indicating that early modern humans and Neanderthals interbred. In this paper, we argue that this “humanizing process” may have gone too far. It is our contention that a number of lines of evidence are inconsistent with the idea that Neanderthals were just like us. These include the results of an analysis of Neanderthal fire-use in southwest France, and the results of attempts to reconstruct clothing use by Neanderthals and early modern humans. The former indicate that Neanderthals rarely used fire during cold periods suggesting an inability to make it, while the latter suggest that Neanderthals employed less effective cold weather clothing than did early modern humans. There is also a striking difference in the variation in the range of prey species taken by Neanderthals and early modern humans. Unlike early modern humans, Neanderthals seem not to have broadened the range of prey species they exploited regardless of availability. Based on these and other observations, we think it is unhelpful to view Neanderthals as simply another group of humans. It is equally unproductive to treat them as a more primitive species. Instead, we are in favor of abandoning the “how much like us are they?” approach to the Neanderthals, and replacing it with an approach that emphasizes understanding them on their own terms—an approach that might be called “a natural history of the Neanderthals.”

**Culley**

## **A Semiotic Approach to the Evolution of Symboling Capacities with Implications for Claims of 'Modernity' in Early Human Groups**

The evolution of sociality, technology, and culture-driven lifeways in the human lineage was necessarily constrained by hominin capacities for perceiving and transmitting symbolic information. Symbols allow the formation of abstract ideas and support the exchange and accumulation of information across space and time. They are the building blocks of language, art, and religion, leading researchers to use symbolic artifacts as definitive evidence of fully 'modern' cognition in hominin groups. Nonetheless, claims of symboling in the archaeological record often lack theoretical support, with interpretations of Neanderthal artifacts as symbolic particularly controversial. This study uses Peircean semiotics to define the formal attributes of objects that affect symbolic exchange and that allow symbols to be identified in the archaeological record. Semiotics is further used to model the evolution of symbolic behavior: Nascent capacities are characterized by the sporadic use of non-symbolic and symbolic material culture that affects information exchange between individuals. Symbolic exchange is rare. Mobilized capacities are defined by the constant use of non-symbolic and symbolic objects that support both interpersonal and group-level exchange. Symbolic behavior is obligatory, coherent, and widespread. The model was tested against the published record dating from ~200,000 to ~11,000 years ago, in three sub-regions of Africa and Eurasia. A number of Exploratory and Confirmatory Data Analysis techniques were used to compare patterning in artifact distributions with model predictions. The results indicate Nascent symboling capacities were expressed ~100,000 years ago in Southern Africa and the Levant, but were not Mobilized until ~17,000 years ago. Nascent symboling is not evident in Europe until ~42,000 years ago, but develops rapidly. The results further indicate both Anatomically Modern Humans and Neanderthals had the capacity for symbolic behavior, but expressed those capacities differently. This study pioneers deductive approaches to cognitive evolution, with significant implications for notions of 'modernity' driving human origins research.

**Davis et al.**

## **Foraging Along Blue Highways: Preliminary Faunal and Taphonomic Investigations at SM-1, a Late Middle Stone Age Site in the Blue Nile Basin of Ethiopia**

SM-1 is a late MSA (>50 ka) open-air site in the Blue Nile Basin of NW Ethiopia that documents exploitation of riverine resources and suggests structured seasonal occupation and resource use. Both of these behaviors have potentially important implications for the evolution of human adaptive strategies and social organization, because they have cascading effects on various aspects of foraging behavior, mobility, and technology, and both have been argued to be rare or absent in the MSA. Five seasons of controlled excavation at SM-1 have produced a rich MSA record consisting of thousands of chipped stone artifacts and faunal remains. The faunal assemblage includes >3900 skeletal remains from a diverse range of terrestrial mammals (e.g., bovids, suids, monkeys, rodents, carnivores), birds (e.g., ostrich, guinea fowl), and reptiles (e.g., crocodiles, lizards, snakes), as well as >1600 fish bones and >400 mollusk shell fragments. Preliminary taphonomic analysis of a subset of the vertebrate fauna (n=749) documents good bone surface preservation and minimal weathering damage. High proportions of oblique fracture angles and curved/V-shaped fracture outlines suggest most bones were broken while fresh. Frequencies of cut/percussion marks and carnivore toothmarks are low (~6% and 4%, respectively), while human-induced damage is slightly more common and, notably, probable cutmarks were identified on several fish bones. In sum, preliminary taphonomic data support the hypothesis that MSA humans were a primary agent of faunal accumulation and modification at SM-1, including both terrestrial and aquatic fauna. Future work will focus on better understanding the complex taphonomic history of the site and documenting MSA foraging behavior at SM-1, with a focus on determining if the site provides evidence for early riverine adaptations and structured seasonal resource use in the MSA.

**Dogandžić et al.**

## **Middle and Upper Paleolithic in Southeastern Europe: Preliminary Results from Excavations at Two Newly Discovered Sites in Serbia**

Across the European continent the processes of population replacement during the Middle to Upper Paleolithic transition probably followed regionally different scenarios in terms of when moderns arrived, how long Neandertals persisted, and whether the two populations interacted. As a geographical corridor for east to west population movements between SW Asia and Europe and as a potential refugium for flora, fauna, and hominins during glacial periods, southeastern Europe is of key interest in understanding human population history in the Pleistocene. The patterns of spatial and temporal presence of humans in the Middle and Upper Paleolithic, however, remain vague in this region due to the relative small sample of well-excavated sites. To address this, in 2012, we initiated a survey project in Serbia designed to discover new stratified Paleolithic sites. The survey of cave sites in limestone-rich areas

along Resava River, tributary of Velika Morava, one of the main river corridors in the central Balkans, resulted in discovery of numerous potential habitation sites. Initial tests at two these, Bukovac and Orlovača, demonstrated the potential for late Middle Paleolithic and early Upper Paleolithic layers. Subsequently we have conducted three seasons of excavation to generate high-resolution contextual data using modern excavation methodologies. The two sites together document successive Middle Paleolithic, Aurignacian, and Gravettian occupations. Here we report on preliminary results of the new excavations and present general description of stratigraphy, lithic and faunal analysis, and chronology. The Gravettian level demonstrates the highest occupation intensity, with hearths, abundant faunal material (bison and ibex prevailing), numerous backed bladelets, and bone tools. Aurignacian and Middle Paleolithic occupations demonstrate lower density of archaeological finds. Though the work is ongoing, preliminary results testify to a great potential of this region to yield new insights into human biogeography and cultural changes during the late Middle and early Upper Paleolithic.

**Doyon et al.**

## **Exploring Technological Organization through Geometric Morphometrics: The Case of Aurignacian Projectile Points Made of Antler, Bone, and Ivory**

Aurignacian projectile points hold a special place in the history of humankind as, for the first time, osseous materials such as antler, bone, and ivory were used to produce hunting armatures at a continental scale. The variability of these “index fossils” has long been studied from a typological and technological perspective. However, the volumetric templates of production that prehistoric artisans considered fit for hunting activities have rarely been studied (see however Albrecht et al. 1972; Clément and Leroy-Prost 1977; Knecht 1991). Our current research uses geometric morphometric analysis, a powerful tool for the quantitative analysis of form, to assess stylistic and functional variation in Aurignacian projectile points. A landmark-based approach was used to analyze 457 projectile points from 51 Aurignacian sites across Europe. Split-based and massive-based points were investigated to highlight their original volumetric template(s), the degree of standardization inherent in the manufacture of these armatures, and the effect of use and resharpening on morphometric variability. Results are used to identify regional trends. The variety of raw material used for the manufacture of massive-based points and their reduced morphological standardization compared to split-based points suggest that these two types of armatures were produced in different social contexts. Split-based points reflect more broadly shared rules of production, as attested by the consistency in the volumetric templates recorded over and across large regions of Europe. On the contrary, the manufacture of massive-based points appears more expedient (*sensu* Nelson 1991) and their volumetric templates more locally clustered.

**Dumouchel et al.**

## ***Australopithecus anamensis* Paleoenvironments in the Omo-Turkana Basin Using Stable Isotope Analysis of Tooth Enamel from Mixed Feeding Taxa**

*Australopithecus anamensis* is the earliest known species of *Australopithecus* and possibly the earliest obligate biped. The Omo-Turkana basin (ca. 4 Ma) preserves an exceptional record of *A. anamensis*. Most fossils attributed to this species within the basin have been found at Kanapoi (~75%), some have been discovered at Allia Bay (~25%), and no hominin remains have been found at Mursi. Does the difference in hominin abundance between sites correspond to environmental differences? To answer this question, we examined a total of 194 carbon and oxygen stable isotope ratios obtained from faunal dental enamel, including new data from Allia Bay (n=57), Mursi (n=27), and Kanapoi (n=3). This research focuses particularly on mixed-feeder herbivores which can adapt to different environments by eating foods that are more readily available, rather than limited to either strictly grazing or browsing. Their diet is likely to reflect more accurately the paleovegetation of an environment than the diet of taxa that have more restricted dietary preferences. The mixed feeders in our sample (n=123) include bovids from the tribes Tragelaphini, Hippotragini, Antilopini, Aepycerotini, and suids from the genus *Nyanzachoerus*. The distribution of carbon isotopic compositions of each taxon are generally more <sup>13</sup>C-depleted at Mursi relative to the same taxon at Kanapoi, with samples from Allia Bay generally intermediate between these endmembers. This trend is particularly strong in tragelaphin and aepycerotin δ<sup>13</sup>C values, suggesting important differences in use of C<sub>3</sub> and C<sub>4</sub> vegetation between these sites. In sum, the stable isotope data from mixed feeding herbivores corresponds to a broad north-south environmental gradient, from a more closed habitat at Mursi to a more open environment in Kanapoi with intermediate environments at Allia Bay. *A. anamensis* thus appears more frequently in more open environments.

**Favreau et al.**

## **Percussion Technology and the Potential for Residue Analysis at FLK N, Olduvai Gorge**

The reconstruction of the Oldowan paleodiet focuses on meat consumption based on the prevalence of butchered faunal remains and lithic artifacts which show technological strategies designed to obtain cutting flakes. While this behavioral trend is widespread, not all Oldowan occurrences show identical evidence. Such is the case at the Oldowan site of FLK N in Olduvai Gorge which dates to 1.8 Ma (Deino 2012). The site's paleoenvironmental reconstruction suggests that it was a dry promontory consisting of arboreal vegetation surrounded by a wetland environment (Ashley et al. 2010, 2014; Barboni et al. 2010). The stone tools from FLK N are atypical for an Oldowan assemblage because they are taphonomically unrelated to the faunal remains and are representative of percussion activities (Mora and de la Torre 2005; Diez-Martin et al. 2010). Based on modern analogues, the fundamental ecological niche of Olduvai Gorge in lowermost Bed II is suggestive of plant food availability (Copeland 2007). In extension, we can assume that some edible plants would have likely been available at FLK N during Bed I times. These converging lines of evidence support the hypothesis that hominins may have been processing plants at FLK N. In spite of this, direct evidence for hominin plant utilization is still lacking. This poster will present evidence of percussion technology at FLK N in light of newly excavated lithics by the University of Calgary. These stone tools were excavated inside a custom-built, HEPA ventilated, mobile cleanroom. We will conclude by introducing preliminary results of residue analysis and its potential to shed light on stone tool functionality and plant processing.

**Finestone et al.**

## **Preliminary Findings from Sare River, an Early Pleistocene Oldowan Site on the Homa Peninsula, Kenya**

Three Oldowan sites have been found on the Homa Peninsula, southwestern Kenya—Kanjera South, Sare River, and Nyayanga. Kanjera South (ca. 2 Ma) has been the most intensively studied, and has yielded evidence of habitual transport of high quality lithic raw materials, and carcass and USO processing in an early grassland-dominated ecosystem. Sare River is a recently discovered paleolandscape locality that has deposits extending over 2km. At this location a paleosol is bracketed by underlying basement granite and an overlying volcanic tuff capped by a tuffaceous silt. Artifacts were found eroding from all three beds above the bedrock. Magnetostratigraphy places these sediments within and just above the Olduvai Subchron, suggesting an age of ca. 1.77 Ma. Four excavations ranging in size from 4m<sup>2</sup>–10m<sup>2</sup> were laid out across a 200 meter transect in the tuffaceous silt, and yielded nearly 400 *in situ* artifacts. While fossils were rarely preserved, paleosol carbonates are abundant, allowing reconstruction of both Oldowan behavior and vegetation structure across the paleolandscape. Preliminary data indicate that hominins at Sare River were producing tools in open grasslands similar to those reconstructed for Kanjera South. However, hominins at Sare River had local access to high quality raw materials (e.g., rhyolite, quartz, quartzite, chert) preferentially transported by the Kanjera hominins. Small quartz clasts were favored over those of other lithologies, and their reduction led to an abundance of angular shatter. The frequency of shatter and the distribution of technological flake categories indicate that the artifact accumulations are relatively undisturbed. Moreover, there is variability in the distribution of artifacts across the four excavations (range: 12.0 artifacts/cubic meter – 83.6 artifacts/cubic meter). One particular locality had the highest concentration of materials. This suggests variation in the spatial dispersion of hominin activities on the landscape.

**Fitzsimmons et al.**

## **A Chronological Framework Connecting the Early Upper Paleolithic across the Central Asian Piedmont**

Central Asia has delivered significant paleoanthropological discoveries in the last few years. New genetic data indicate that at least two archaic human species met and interbred with anatomically modern humans as they arrived into northern Central Asia. However, data are limited; known archaeological sites with lithic assemblages generally lack human fossils, and consequently identifying the archaeological signatures of different human groups, as well as the timing of their occupation and relationship to environmental conditions, remains elusive. Reliable chronologic data from sites in the region, crucial to our understanding of the timing and duration of interactions between different human species, are rare. Here we present detailed chronologies for two open-air Middle to Upper Paleolithic sequences from the Tien Shan piedmont, which bridge the southern and northern parts of Central Asia. We demonstrate that technological developments in the two sites differ substantially over a similar time span, and that some of the innovations typically associated with the earliest UP in the Altai or other parts of northeast Asia also are present in the Tien Shan piedmont. We caution against making assumptions about the directionality of the spread of these technologies until a larger, better defined database of transitional sites in the region is available. Connections between the timing of occupation of regions, living area setting, and

paleoenvironmental conditions, while providing hypotheses worth exploring, remain inconclusive. We cautiously suggest a trend towards increasing occupation of open-air sites across the Central Asian piedmont after c. 40 ka, corresponding to slightly milder, more humid climatic conditions which were nevertheless still sufficiently dry for pulses of dust deposition. Human occupation persists into the initial stages of the LGM, despite cooler, and possibly drier, conditions. Our results reinforce this apparent trend and provide additional paleoenvironmental data to substantiate arguments for occupation of Central Asia.

**Goncalves et al.**

## **Applying Systematic Sampling Survey to Evaluate Stone Age Settlement in the Elephant River, Limpopo Basin, SW Mozambique**

This poster presents the results of an archaeological survey project conducted in 2016 in the Elephant River Valley, a tributary of the Limpopo, in Southwestern Mozambique. The project aimed to better understand the Stone Age settlement system in the region and thus a systematic sampling methodology was required that would allow us to characterize: 1) the distribution across the landscape of Stone Age dense occupations and areas with none or very few artifacts; 2) the relationship of these occurrences with the surrounding landscape and geology; and, 3) the dispersion of specific classes of lithic artifacts throughout the territory to infer mobility patterns or chronological differences in space use. Survey was carried out by two teams of three to four individuals using two transect lines separated by a modern human settlement. Following the methodology applied by Olszewski et al. (2005), at every 200 meters of each transect a 1m radius circle was placed on the ground and all stone tools, if present, were analyzed. Site and artifact recording were done using smartphones and two self-authored Android mobile applications (Casalheira et al. 2014), the first recording the contextual information of each location, the second allowing the on-site analysis of lithic artifacts, using digital calipers directly connected to the devices. A total of 106 locations were inspected across both transects, of which 28 were identified as containing Stone Age archaeological materials. Most of these locations, however, revealed low to very low frequency of materials, contrasting sharply with the contexts identified in previous campaigns in the eastern section of the Elephant River. In fact, survey results indicate that archaeological materials are only visible in areas where the Tertiary Mapai formation (a conglomeratic sandstone layer) is exposed, and do not appear on the surface of the areas where this formation is covered by Quaternary eolian sands.

**Gumrukcu et al.**

## **Assessing the Effects of Fluvial Abrasion on Bone Surface Modifications Using High-Resolution 3D Scanning**

Cut marks and tooth marks on fossil bones are important traces of the behavior and ecology of our ancestors. However, these traces are often obscured by other taphonomic processes such as fluvial abrasion. Previous studies on the effect of fluvial abrasion on cut marks suggest that sediment abrasion in fluvial environments can change the overall morphology of cut marks. Thus, analyzing the effects of fluvial abrasion on cut mark and tooth mark morphology is crucial to interpreting archaeological bone assemblages accurately. The objective of this research is to understand the effects of fluvial abrasion on cut marks and mammalian carnivore tooth marks using high-resolution 3D data. An experimental study was undertaken by tumbling cattle and deer bones in a rock tumbler filled with sand and water. Bones were abraded in a rock tumbler with a sand and water mixture for 152 hours. The 3D data from cut marks and carnivore tooth marks was collected and analyzed using a white-light confocal profilometer. Qualitative macroscopic analysis shows that bone surfaces became smoother and polished after tumbling. Most cut marks and tooth marks were still visible. However, 58 percent of the cut marks lost their characteristic features, such as fine parallel striations, and 20 percent of the cut marks were highly abraded and reduced to rounded indentations. Most tooth marks were still identifiable, and only 24 percent of the tooth marks were highly abraded and reduced to rounded indentations. Quantitative analysis based on the 3D data also indicates that fluvial abrasion has a greater effect on cut marks than tooth marks. Surface area, maximum depth, mean depth, maximum length, maximum width, roughness, angle, and radius values of the cut marks were changed significantly after tumbling. Statistical analyses demonstrated that cut marks became shallower and wider, while maximum depth values for tooth marks increased.

**Haaland et al.**

## **Middle Stone Age Ochre Contexts in Blombos Cave, South-Africa: A Macro- and Micro-Contextual Investigation**

The archaeological assemblage from the Middle Stone Age (MSA) deposits of Blombos Cave (BBC) (101–70 ka), including engraved bone, shell beads, polished bone tools, and bifacial points, has become central to our current understanding of the behavioral and cultural development of early humans in southern Africa during the Late Pleistocene. One of the most striking aspect of the BBC MSA assemblage is the quality and abundance of anthropogenically modified iron-rich rocks (i.e., ochre), which occur throughout the entire sequence. Of the more than 8,000 recovered ochre pieces, many show traces from intentional use and processing; including grinding striations for pigment powder production and deliberate engravings. Also, two ochre processing kits, consisting of two large shell containers, have been recovered from the oldest MSA levels of the cave (101 ka), in which a liquefied ochre pigment-rich mixture was produced and stored. While detailed studies of the MSA ochre assemblage from BBC demonstrate that ochre use and modification formed a long-lasting and significant part of the prehistoric inhabitants' behavioral repertoire, the sedimentary context in which the ochre was found, has not been studied in detail. Here, we present preliminary results of a macro- and micro-contextual field investigation of some of the ochre contexts within the MSA deposits of BBC. By employing both geo-archaeological and micro-analytical techniques, as well as high-resolution field documentation and 3D visualization methods, we describe sediment-based depositional and behavioral aspects related to MSA ochre use at BBC. Our multi-scale field investigation has direct implications for how the BBC ochre-rich macro and micro-contexts can be further investigated, interpreted, and contextualized, in particular regarding their spatial distribution, preservation, and temporal resolution. Our results showcase the exceptional preservation of ochre contexts at BBC and provide another benchmark for greater questions regarding the emergence of behavioral modernity during the MSA.

**Harvati and Roksandic**

## **A Geometric Morphometric and Non-Metric Analysis of the Oase 1 and Muierii 1 Mandibles from Romania**

The Upper Paleolithic human fossils from Romania have been proposed to show a mixture of modern human and archaic characteristics, possibly reflecting Neanderthal-modern human interbreeding. This hypothesis was recently confirmed through paleogenomic analysis for Oase 1 (Fu et al. 2015). We conducted 3D geometric morphometric and non-metric comparative analyses of the Oase 1 and Muierii 1 mandibles, to explore how their potential hybrid status manifests in their morphology. Oase 1 and Muierii 1 were digitized by KH. The comparative sample (25 fossil, 155 recent human mandibles) was digitized by Elisabeth Nicholson Lopez and KH (Nicholson and Harvati 2006). Twenty-eight 3D landmarks were registered with a Microscribe 3DX digitizer, processed with Generalized Procrustes Analysis and analyzed using Principal Components and Classification Analysis. Furthermore, a number of discrete traits (Oase 1: 29; Muierii 1: 22) were scored by MR following Mounier et al. (2009) from CT scans of the fossils. The comparative sample was derived from Mounier et al. (2009). A Principal Coordinate Analysis was conducted on a similarity matrix. Our results did not clearly reveal the recent Neanderthal ancestry for Oase 1 as revealed by paleogenomic work. The latter is only suggested by its unusually large size and by non-metric anatomical details. This might be due to the limited phylogenetic signal preserved in the mandible, but also highlights the difficulties of evaluating admixture from skeletal remains. The more fragmentary Muierii 1 presents an intermediate overall shape in the morphometric, but not in the non-metric analysis, suggesting potential hybrid status, but also consistent with primitive retentions.

**Haslam**

## **Primate Stone Tool Use for Paleoanthropologists**

This paper examines recent findings on wild non-human primate (NHP) stone tool use, looking for commonalities that also may apply to early hominin lithic technology. It raises the following discussion points: (i) not all populations or subspecies within a 'stone-tool-using' species use stone tools; (ii) lithic tools typically play the role of force amplifiers in the primate tool kit, while other materials (sticks, leaves, etc.) play complimentary roles; (iii) pounding stone size usually relates directly to the hardness of processed foods; (iv) cultural differences in stone tool use are best seen in differing relative frequencies of tool use, or functional differences, rather than in differences of tool form between groups; (v) lithic tool use is a group activity, practiced by females, males and children alike; (vi) reliable conchoidal flake production requires direct stone-on-stone percussion, not incidental anvil or hammer breakage during other tasks; (vii) brain size, hand morphology, and locomotion patterns have no clear relationship with whether a primate species uses stone tools; and, (viii) all stone tool use leaves an archaeological signature, although many are hard to identify. None of the extant NHP taxa with habitual lithic technology (bearded capuchins – *Sapajus libidinosus*, Burmese long-tailed macaques – *Macaca fascicularis aurea*, and West African chimpanzees - *Pan troglodytes verus*) have an unbroken line of stone tool use back to their ancestor with hominins, and all have close relatives at the species or sub-species level that never use stones. Each has its own idiosyncratic

technological trajectory, and choosing any one of them to model hominin tool use behavior, without considering the wider primate pattern, would therefore be unwise.

## **Heffter and Mihailović**

### **Insights into the Importance of Raw Material Availability for Paleolithic Settlement: Survey Results from the Resava and Jasenica River Valleys, Serbia**

Lithic surface scatters are an underappreciated source for evidence of hominin occupation and landscape use. This is especially true in areas of the world (such as the Republic of Serbia) where Paleolithic research is in its infancy and the potential ubiquity of these scatters can serve as important evidence for confirming whether hominin populations occupied a particular region and how frequent their presence was on the landscape. We present survey results from the Resava and Jasenica River Valleys in Central Serbia where we conducted high resolution reconnaissance for Paleolithic and Neolithic lithic surface scatters. In contrast to nearby regions of Serbia (particularly the Western Morava Valley) where Middle Paleolithic materials predominate, we found little evidence for Middle and Upper Paleolithic artifacts in our survey area. Instead, the artifact surface scatters consisted largely of Neolithic material. In addition to describing the results from our survey, we investigate why seemingly similar regions have such different lithic surface scatters and how geomorphological processes and raw material availability may have resulted in these apparent differences in surface artifact assemblages.

## **Hershkovitz et al.**

### **Manot 1 Calvaria and Recent Modern Human Evolution: An Anthropological Perspective**

The time range between 60 to 50 ka is one of the most dramatic phases in human biological evolution. During this period, the western part of Eurasia (Europe and the Near East) was populated by Neanderthals whereas the eastern part (Central Asia and Siberia) was inhabited by Denisovans. However, by 30 ka these two populations were replaced by anatomically modern humans (AMH). When did these newcomers arrive and from where? There is accumulating archaeological and genetic evidence suggesting that this demographic shift occurred at the end of MIS 4. Moreover, it is quite clear that a major dispersal of AMH out of Africa is the source of the new populations. In this study we examine particular morphological characteristics of Manot 1 (e.g., suprainiac fossa), and assess their similarities to corresponding traits found among Neanderthals. We show that albeit the terminology is similar, the traits in each hominin group are of different entities. We also show that Manot 1 and Early Upper Paleolithic skulls of Europe have many traits in common, although Manot 1 is much more gracile. Finally, the mosaic of archaic and modern traits seen in Manot 1 can be traced to the Late Pleistocene Aduma skull from Ethiopia.

## **Hill et al.**

### **Breakage Patterns of Long Bone Articular Ends, Hadar, Ethiopia: Implications for Assessing Cause of Death of A.L. 288-1 ('Lucy')**

Recent publication of a hypothesis that breakage patterns of several of the limb bones of the Pliocene fossil 'Lucy' (*Australopithecus afarensis*) indicates death induced by a vertical deceleration event caused by a fall from height (Kappelman et al. 2016), has generated a number of comments about the distinctiveness of articular end/adjacent shaft damage ascribed to compressive impact. Results of documentation that targeted AL288-1 long bone end fragmentation along with a variety of species from 139 other Hadar localities (n=410 specimens with emphasis on humeri and femora) demonstrates that the compressive fracture of Lucy's humeri and distal femur are clearly distinct from the baseline breakage patterns of other Hadar fossils. While not providing direct support for the specific cause of death of AL288-1, these data highlight the unusual breakage patterns on this specimen's limb bones and strengthen the observation that the breakage patterns on Lucy's bones represent forces other than the normal formational dynamics of carnivore damage, weathering, depositional loading, and fossilization cracking that alter many of the other specimens. Common fractures of articular surfaces include cracking and horizontal displacement with limited numbers of vertically displaced pieces. Compression and displacement of broken fragments along the long axis of the long bone as described by Kappelman et al. for AL288-1 are an extremely rare feature of the Hadar Pliocene fauna and point to a distinct difference between the fracture dynamics acting on Lucy's bones and those reflected in the more diverse regional assemblage.

**Hill et al.**

## **Stratigraphy and New ESR Mollusc Dates for Middle and Late Pleistocene Deposits at Bir Tarfawi, Western Desert, Egypt**

A small uninhabited oasis in Egypt's hyperarid Western Desert, Bir Tarfawi sits in a N-S elongated deflationary basin that receives <1mm/y of precipitation. Although groundwater lies near the surface in the southern area, Quaternary freshwater snails and herbivore teeth in carbonate marls, and palustrine and lacustrine silts and sands intercalated with eolian sediment demonstrate the region experienced alternating arid-wet-arid climatic cycles: During arid intervals, deflationary basins formed. Due to higher water tables in wetter periods, small waterbodies supported vertebrate and invertebrate communities. Pleistocene hominins left behind their Acheulean and Middle Paleolithic/Middle Stone Age (MP/MSA) Nubian Complex artifacts in marginal lacustrine or palustrine sediment. Stratigraphically associated with MP/MSA artifacts, *Melanoides tuberculata* shells were collected from the White Lake Basin (WLB) and Locality E-86-2 for ESR dating. In the central WLB, ~2m of carbonate-rich sediment was deposited in deeper water. At the WLB edge, higher clastic concentrations reflect a shallow marginal habitat. With two mollusc ESR dates averaging 236±19 ka assuming linear uptake (LU), the WLB waterbody likely existed during Marine (Oxygen) Isotope Stage (MIS) 7e. In another more southerly deflationary basin, excavations near E-86-2 and E-86-3 revealed sediment from two wet climatic episodes. At E-86-2, basal and hydromorphic sands underlie more calcareous sediment deposited in a near-shore basin edge facies during a wetter transgressive phase. The weighted LU mean, 81.8±4.8 ka, for two mollusc ESR samples suggests that these higher water tables occurred during MIS 5a. Therefore, at Bir Tarfawi, higher water tables fed waterbodies during both MIS 5 and 7. Ages for the wetter phases at Bir Tarfawi also agree well with those seen at Djara Cave, Dakhleh, and Kharga Oases, hinting that these wetter environments across the Western Desert permitted hominins to migrate into and inhabit the Sahara, which was precluded during the drier periods.

**Hlubik et al.**

## **Site Formation and Integrity of FxJj20 AB, Koobi Fora, Kenya: Implications for Interpretation of Oldowan Hominin Fire Use in the Early Pleistocene**

Assessing site formation and post-depositional processes of an archaeological site are critical to components of developing solid inferences about behavior in Paleolithic contexts. The site of FxJj20 AB, Okote Mbr. Koobi Fora Formation (Kenya), contains evidence of combustion features as well as stone artifacts and fossilized bones. To determine the behavioral significance of this spatial association, it is necessary to initially identify the formation of these assemblages and the subsequent modification of this area from various taphonomic processes. Previously conducted spatial analyses suggest a patterning of materials consistent with a single accumulation of material over a short period of time, however, an overabundance of microartifacts and high degree of homogeneity in raw materials makes refitting studies difficult to conduct. A large degree of vertical spread further confuses the issue. This study looks at site formation processes through artifact orientation, size profiling of the artifacts to determine whether artifacts are sorted, and comparison to ethno-archaeological and experimental data. Preliminary results suggest that the site is consistent with minimally disturbed materials found in low-energy depositional environments. Detailed comparisons with ethno-archaeological and experimental materials provide insight into behavioral processes that affected site formation while micromorphology provides pre- and post-depositional context and clues about the integrity of the site. The data gathered here should help to determine whether the site is the result of a single accumulation of materials or the result of rapid-accumulation palimpsests.

**Hodgkins et al.**

## **Arma Veirana: A New Site in Liguria (Northwestern Italy) Preserving the Middle-to-Upper Paleolithic Transition**

Arma Veirana is a recently discovered site that holds great potential to further our understanding of the population transition from Neandertals to modern humans in northwestern Italy. Our initial excavations indicate that this cave preserves a record of occupation with no obvious discontinuity or sterile layer between the Middle and Upper Paleolithic. Moreover, radiocarbon dates for the Mousterian (Middle Paleolithic) deposits at Arma Veirana (~41,500 years before present) are statistically indistinguishable from deposits at the nearby Protoaurignacian (early Upper Paleolithic) site complex of the Balzi Rossi. These results require further corroboration from future fine-scale chronological analyses, but appear to provide archaeological evidence for contemporaneous Mousterian and Protoaurignacian people living in close proximity. Insofar as these cultural traditions reflect biological differences in population composition, it is possible that Arma Veirana and the Balzi Rossi document Neandertals and modern humans living in parapatry (i.e., in adjacent regions). Separated by less than 100km, the Balzi Rossi is found near the present-day sea level along the Mediterranean coast, while Arma Veirana is a montane site found in proximity of the Ligurian Alps watershed. Thus, the sites are

located in ecologically distinct but geographically adjacent habitats, strongly suggesting that if Neandertals and modern humans overlapped chronologically in the region, the mountain-coast dichotomy may have acted to differentiate the niches of these two hominins. If true, Liguria will provide an exemplary “laboratory” for examining ecological factors that influenced human and Neandertal population dynamics.

## **Itambu et al.**

### **Phytolith Palaeolandscape during Bed II at Olduvai Gorge (Tanzania)**

In African paleoenvironments and palaeoanthropology, phytoliths have been used to understand phytolith production, to reconstruct past ecosystems, and to understand the composition of current vegetation. The most significant aspect of phytolith analysis includes archaeological and environmental reconstructions of hominin-utilized paleolandscapes [1]. In the vicinity of Olduvai Gorge, phytoliths have helped identify plants used by prehistoric populations, while providing a vegetation record that includes silicified macro-remains such as pieces of woods, leaves, roots, and silicified fruits [1, 2, 3, 4]. Although a bibliography exists on phytolith-based environmental reconstruction for Bed I [2], very little information exists for Bed II or the rest of the Olduvai sequence. The stratigraphic sequences investigated are found in the upper section of Bed II and include Sam Howard Korongo (SHK) (1.5–1.34 Ma), Bell’s Korongo (BK) (1.3 Ma), and Thiongo Korongo (TK) (1.3–1.1 Ma). The lithofacies represented in these sites include both lacustrine and fluvial deposits. The archaeological levels from SHK are found in a fluvial context that was an integral part of a wider lacustrine system. Thiongo Korongo stratigraphically represents a paleo-landscape context for the Oldowan–Acheulean transition [4]. It has yielded data that links human activities and stone tools manipulation to process food, and preserves the highest concentration of lithic artifacts in any site in Bed II. The BK archaeological deposits are located just above a volcanic tuff (Tuff IID), which was previously dated to 1.2 Ma, but more recently, to 1.35 Ma [4, 5]. This locality consists of alluvial and fluvial deposits of a medial-to-distal fan and associated floodplain facies. In this paper, we present information on vegetation structure, patterns of palaeohabitat change, and the general trend from wetlands to more xeric and open palaeohabitats between 1.5–1.3 Ma.

## **Jackson et al.**

### **The Evolution of Throwing: The Current State of Knowledge**

Humans are the only living species capable of throwing projectiles with speed and accuracy. The ability to throw in this way confers a number of undoubted benefits (e.g., hunting from a distance). Consequently, the development of this ability can be expected to have affected the course of human evolution. Despite this, the origin of the ability to throw and the way it has changed through time are under-researched compared to many other topics in paleoanthropology. Here, we report a study we carried out with a view to encouraging greater interest in the evolution of throwing. Because it is important to understand both the appearance of the traits that make throwing possible and the contexts in which those traits evolved, we consulted literature from a range of disciplines. The key findings of our study are as follows. Biomechanical studies indicate that most of the energy transmitted during throwing comes from the shoulder complex, while analyses of fossil hominin shoulder anatomy suggest that *Homo erectus* would have been able to throw with speed and accuracy. Research in developmental psychology and primatology links throwing with handedness and brain lateralization. Lastly, the ethnographic data on throwing suggest four contexts in which throwing is common. Two of these are obvious—hunting and warfare. The other two are more surprising—gathering and games of physical skill. These findings raise a number of questions. For example, claim that the shoulder of *H. erectus* was adapted for throwing implies that this behavior pre-dates 1.89 Ma, which is considerably earlier than the first incontrovertible archaeological evidence for projectiles. Similarly, the link between throwing, handedness, and brain lateralization may mean that throwing coevolved with language. In the final section of the paper, we will discuss these questions and suggest some potential directions for future research.

## **Keevil et al.**

### **Inferring Early Stone Age Tool Type from Cut Marks on Fossil Bones Using High-Resolution 3D Scanning**

Cut-marked animal bones in association with Oldowan stone tools suggest that Early Stone Age hominins butchered large mammal carcasses. There is a noticeable transition in lithic technology from Oldowan core and flake tools to more advanced Acheulean handaxes approximately 1.6 Ma at Olduvai Gorge, Tanzania, and earlier elsewhere. However, the function of Acheulean tools remains unclear and their use in butchery behaviors has not been established. Linking tool technology to butchery activities is best achieved through the analysis of traces left behind on fossils. Past attempts to establish a connection between cut mark micromorphology and stone tool technology have been limited due to a lack of standardized quantitative methods. This study offers a new approach for interpreting Oldowan hominin butchery activities in the archaeological record using high-resolution 3D scanning to link cut mark micromorphology to Early Stone Age tool technology. Molds of cut marks were collected from fossils within sites from Middle Bed

II, Olduvai Gorge, temporally situated near the Oldowan/Acheulean technological transition. Molds were scanned using a Nanovea white-light confocal profilometer to create 3D reconstructions of the marks. Measurements collected from the 3D cut mark reconstructions include volume, surface area, maximum depth, width, and length. Measurements recorded from 2D cross-sectional profiles include cross-sectional area, width, depth, and roughness. These measurements were compared to an experimental database of cut marks created using four raw material types (basalt, chert, quartzite, and phonolite) from Olduvai Gorge along with several Early Stone Age tool types that characterize the Oldowan and Acheulean industries at Olduvai. Linking cut marks on fossilized bone to the tool technology that created them will provide a better understanding of the butchery behaviors of Early Stone Age hominins.

## **Kitchell**

### **Evaluating Language-Related Asymmetry in Endocasts using Non-Rigid Diffeomorphic Image Registration**

Topographical features of the endocranial surface are thought to correspond to the brain surface, meaning that changes in these features throughout hominid evolution can be used to infer evolutionary changes in brain structure. By examining changes in endocranial regions that directly overlay brain areas related to certain behaviors (i.e., language), we may be able to estimate the temporal development of those behaviors. There is an established leftward asymmetry of Broca's area, one of the major language areas of the human brain, and previous qualitative research suggests that Broca's cap (a region on endocasts near Broca's area) is also larger on the left (Broadfield and Holloway 2001). However, recent research using geometric morphometrics (GM) found a rightward trend for Broca's cap in modern humans (Balzeau et al. 2014, Kitchell 2015). This study investigated language-related asymmetry of the modern human endocast using non-rigid diffeomorphic image registration, a method typically used in neuroscience to register individual brains to a reference atlas. Although other quantitative methods exist to assess endocranial asymmetry, this method is distinct in that it is automated and does not require the manual placement of points (as in GM) or manual delineation of a region of interest (as in GIS) and thus can avoid potential bias. Results based on 100 endocasts of modern humans indicate that Broca's cap is actually an average of 5% larger on the right in modern humans, contradictory to previous qualitative studies. However, a region directly above Broca's area is an average of 3% larger on the left side, suggesting it may still be possible to see language related asymmetries on an endocast. These results suggest that we must reevaluate previous assumptions that Broca's cap asymmetry is related to language lateralization and provide motivation for reexamining other qualitative claims about endocranial morphology using quantitative, relatively bias-free methods.

## **Leader**

### **Early Acheulean Large Flake Prepared Core Technology: Debating the Distinctiveness of the Victoria West Method**

The Victoria West prepared core appears in the archaeological record over 1 million years ago in southern Africa. Recent research has demonstrated the origins of this type of technology prior to its full appearance. Meanwhile, prepared core technology has been used as an indicator of increased cognitive abilities of early hominids when compared to simple knapping strategies. Less consideration, however, has been given to determining if there is increased usefulness in the final removal when compared to other, comparable flakes produced using less intricate methods. Presented here is comparative analysis of the large flakes produced preceding and during the incorporation of Victoria West knapping methods with aims of determining the technological purpose for adopting the Victoria West method.

## **Lee et al.**

### **Digging for the Past, Present, and Future: Bridging Maasai and Paleoanthropological Practices in Olduvai Gorge, Tanzania**

Paleoanthropological research in Africa is still largely carried out by foreign teams, echoing past accusations of archaeology being a colonial instrument for displacing local populations. Likewise, researchers have continually failed to inspire and attract African scholars to the discipline, and have neglected to meaningfully engage local communities. In Northern Tanzania, archaeologists routinely descend upon Olduvai Gorge, a key paleoanthropological research destination located in the multi-use Ngorongoro Conservation Area. The pastoralist Maasai also are inhabitants of the region, yet a variety of political-economic factors restrict their livelihoods. Furthermore, despite a century of excavations in Olduvai, the Maasai are still largely uninvolved with research in their land. Drawing on two seasons of ethnographic and ethnobotanical fieldwork, in which Maasai views and needs were attended to, this paper explores how practice gives rise to what Olduvai Gorge is. Both the Maasai and paleoanthropologists address drought by digging in the Gorge. Researchers dig in order to enact a deep past in which hominins adapted to drought-like conditions—the

fluctuating aridity of the African landscape. During the now-extended dry season, the Maasai take arduous trips across the relentlessly arid landscape to dig in the base of the seasonally dried-out Gorge, thereby ameliorating a present drought by harnessing the buried vestiges of water that was abundant in the recent past. There is a history of miscommunication and minimal collaboration between the Maasai and researchers. Nonetheless, there exists potential to nourish *eseriani*, a locally-valued Maasai concept of peacefulness and unity, through mutually beneficial collaboration in the future. In 2016, *Stone Tools, Diet, and Sociality* began a long-term commitment to collaboration by facilitating the excavation of a former Maasai homestead by a team of Maasai. Parting with paleoanthropology's neocolonial history, this dig broke new literal and symbolic ground by being completely guided and accomplished by Olduvai's dynamic inhabitants.

**Lin et al.**

## **Local Raw Material Utilization at the Upper Paleolithic Site of Shuidonggou Locality 2, Ningxia (China)**

Shuidonggou is a site complex containing multiple Upper Paleolithic localities in the Ningxia Hui Autonomous Region (China). It is also one of a few archaeological examples in China where 'core and flake' and blade-based assemblages comparable to the Initial and Early Upper Paleolithic from Mongolia and Siberia 45–30 ka have been found in stratigraphic context (Kuhn and Zwyns 2014). Since 2014, renewed excavation at Locality 2 has yielded numerous stone artifacts, bones, and ostrich egg shells, including beads, from a 12.5m thick stratigraphic sequence, composed primarily of loess-like, lacustrine deposits. Here we report patterns of raw material utilization across the upper four culture layers that contain the majority of the recovered artifacts. Previous radiocarbon and optically stimulated luminescence ages place these layers between ~35 to 20 kya (Li et al. 2013). Based on the ages, these layers overlap chronologically with the blade/bladelet technology of the Early Upper Paleolithic in Mongolia and Siberia. The described assemblages are, however, characterized chiefly by the production of flake blanks and an absence of laminar reduction. The stone artifacts were manufactured primarily from siliceous/dolomitic limestone, quartzite, chert, sandstone, and quartz, all of which are available in cobble forms within nearby conglomerates. Our analysis suggests that culture layer two has proportionally more quartzite and sandstone artifact volumes than the expected range of the overall assemblage. Quartzite assemblages also demonstrate a persistent departure in their cortex-to-volume ratio in comparison to stone samples collected nearby. This preliminary finding suggests that quartzite artifacts may have been subjected to greater degrees of post-production export over time at Shuidonggou Locality 2. In the context of climatic degradation associated with MIS 3–2, the transport of flake blanks could illustrate an increase in human group mobility, with technical and logistical behaviors that differ from the blade/bladelet solutions observed farther north.

**Maher et al.**

## **Living and Dying in the Epipaleolithic: A 20,000-Year-Old Cremation from Eastern Jordan**

The end of the Pleistocene in Southwest Asia is widely known as for the emergence of socially-complex hunter-gatherers—the Natufians—that herald the beginnings of village life and are accompanied by a rich material culture record, including elaborate burials and cemeteries. Human burials that predate the Natufian are extremely rare. In 2016, the Epipaleolithic Foragers in Azraq Project uncovered a hut structure at the 20,000-year-old Epipaleolithic aggregation site of Kharaneh IV, eastern Jordan. Excavation of the uppermost deposits of this brush hut structure revealed the grave of an adult individual, laid in a semi-flexed position on the uppermost floor of the structure. The structure that served as his/her grave was subsequently burned down, partially charring the remains and signifying the end of the life of the structure and the individual buried inside. This type of mortuary treatment or practice is unknown from eastern Jordan and other contemporary sites in the region, as well as from later Natufian and Neolithic sites. Analysis of the skeletal remains and the context of burial and cremation shed new insights into the emergent repertoire of cultural practices documented from these sites.

**Mant-Melville et al.**

## **Late Middle Stone Age Lithic Technology in the Eastern Lake Victoria Basin, Kenya**

Between 2009 and 2016, archaeological and geological surveys by the Lake Victoria Prehistory Project have investigated the Late Pleistocene sediments and Middle Stone Age (MSA) sites of the eastern Lake Victoria basin. The results of these pedestrian surveys have located at least 18 open-air MSA localities and produced a detailed chronological, geological, and environmental record for the region. The eastern Lake Victoria basin is now one of the few examples in the East African MSA that documents multiple late-occurring MSA localities—including some post-dating early Later Stone Age (LSA) technology elsewhere in Kenya—and that has a

well-established chronology with multi-proxy environmental reconstructions. This makes the region significant for understanding human responses to Late Pleistocene climate change and the MSA-LSA transition in East Africa. This poster expands on previous reports of the archaeology of eastern Lake Victoria to provide more detail on the character of the late MSA in the region. The Lake Victoria data are particularly suited to a landscape-archaeology approach as the artifacts come from stratigraphically controlled localities that lack Early and Late Stone Age occurrences and from sediments that represent a temporally constrained time period across the Lake Victoria basin. Open-air surface collections complement higher-resolution data sets as they can inform, and help formulate new, macro-scale hypotheses about hunter-gatherer activities which predominantly occur out on the landscape. This technological study compares two Lake Victoria sub-regions—Karungu to the south with Rusinga and Mfangano islands, and the neighboring mainland areas of the Winam Gulf to the north. The analysis focuses on consistently collected artifact categories, namely radial cores (discoïd and Levallois), convergent debitage (flakes, blades, and points), and Levallois products. A taphonomical study of the convergent debitage also examines whether edge damage patterns and distributions reflect post-depositional damage or use as weapon tips or knives.

**Mattox et al.**

### **3D Fracture Patterns in the Lumbar Vertebra and Tibia of A.L. 288-1 ('Lucy') are Consistent with Perimortem Trauma**

It was recently hypothesized that A.L. 288-1 ('Lucy') preserves a subset of perimortem fractures consistent with injuries in accident victims who suffer a vertical deceleration event (VDE) (Kappelman et al. 2016). Certain fractures, e.g., a four-part fracture of the right proximal humerus, and a dislocative compressive distal epiphyseal fracture of the left femur, suggest a high velocity impact following a fall from significant height. The severity of these fractures led Kappelman et al. (2016) to hypothesize that other skeletal fractures are also consistent with a VDE. The initial description of A.L. 288-1 (Johanson et al. 1982) detailed many surface "cracks" in other elements that were attributed to fossilization processes. We used high resolution X-ray computed tomography to further investigate the 3D nature of these surface features in two elements, the lumbar vertebra (A.L. 288-1aa, ak, al), and the right tibia (A.L. 288-1aq, ar). Scans had a slice spacing of 0.05754–0.07044mm and data volumes were loaded into Avizo (FEI) to produce the 3D element. Fracture planes were mapped in 3D, with planes displayed in color and the element displayed as a transparent object. The lumbar vertebra (likely L3: Meyer et al. 2015) preserves several fractures that appear to communicate through the body between its inferior and superior surfaces that, along with the fractures through the bases of both pedicles, are suggestive of high energy trauma. The proximal right tibia displays several fracture planes including a stepped fracture on the medial condyle that, along with other fractures, serve to depress its superior surface inferolaterally. The proximal distal tibial segment displays numerous fractured shaft fragments that were rotated and partially driven into the medullary canal. The tibial plateau and shaft fractures preserve evidence of axial compressive loading. 3D mapping of fracture planes offers a detailed approach to understanding the nature of bone damage.

**McGrath and Bernatchez**

### **The Symbolic Response: Middle Stone Age Ochre Use in its Social and Environmental Context at Pinnacle Point 5-6, Western Cape Province, South Africa**

Mineral pigments derived from archaeological ochres have long been considered a proxy for symbolic behaviors. While the capacity to symbol is believed to originate sometime during the African Middle Stone Age, little has been done to address the particular contexts of the symbolic behaviors during this period. The study presented here examines the utility of a Human Behavioral Ecology territoriality model grounded in Costly Signaling and Economic Defendability Theory for understanding the context of symbolic behaviors during the African Middle Stone Age. The ochre assemblage recovered from the archaeological site of Pinnacle Point 5-6 (PP5-6) near Mossel Bay, South Africa, is reviewed with this model. Results from PP5-6 suggest that there is an intensified production of mineral pigments during periods when this model predicts highly territorial behavior, small ranges, and population packing. Inversely, this study finds less evidence for mineral pigment production during periods expected to have lower population density, larger ranges, and less territorial behaviors. This is interpreted as indicating the early use of symbolic technologies in signaling group affiliation and differentiating social groups.

**McHenry et al.**

## **Using Tephrostratigraphy to Link Cores to Outcrops at Olduvai Gorge, Tanzania**

The Olduvai Gorge Coring Project (OGCP) recovered 612m of core from four boreholes (1A, 2A, 3A, and 3B), including abundant volcanics interlayered with lake and lake margin sediments. Contained tuffs provide an excellent opportunity to tie the paleoclimatic record emerging from the core to the Pleistocene paleoanthropological record of Olduvai Gorge, Tanzania. Tuffs from the cores were analyzed by microprobe and glass, feldspar, augite, hornblende, and Ti-magnetite compositions (and the presence/absence of other phases, including quartz, aenigmatite, and ilmenite) were compared to previously analyzed outcrop samples. Bed II tuffs are poorly represented in the cores, and at present no direct correlations between core and outcrop have been made based on their composition. However, a new tuff composition is seen in two cores; follow-up fieldwork will be required to locate its equivalent in outcrop. The strongest correlations between core and outcrop are in Olduvai Bed I. All major Upper Bed I tuffs (Tuff IF, Ng'eju Tuff, and Tuffs IB-IE) are identified in at least one core, though no single core appears to contain them all. Tuff IF is easily recognized in Cores 2A and 3A but absent in Core 1A, where part of lowermost Bed II and Upper Bed I are cut out. However, the underlying Ng'eju tuff is present in all cores. Tuffs IE and IC have similar compositions but can be distinguished stratigraphically when Tuff ID is identified between them, as it is in Core 1A. At present, Tuff IB is only confirmed in Core 2A. Core 2A includes a long record of Lower Bed I (and older) volcanics, including more than 18 previously undocumented pyroclastic units. The Naabi ignimbrite, which marks the base of the outcrop exposures at Olduvai, is identified at ~100m drilling depth. The core continues another 135m through older, previously unreported lacustrine and volcanoclastic materials.

**Merritt et al.**

## **FwJj70 – a Butchered Bone Surface Assemblage from the Okote Member of Koobi Fora, Kenya**

The zooarchaeological assemblage, FwJj70, sits atop the erosional apron of a three-meter-tall hillock of fining upward silt and clay strata below the Chari Tuff in the upper Okote member, suggesting a date of 1.39–1.53 million-years-ago. It includes 143 macromammal, fish, and reptile specimens collected from 48-square-meters, and ten specimens and four lithic artifacts from the rest of the approximately 800-square-meter hillock. The assemblage preserves aquatic taxa including crocodiles, turtle, and fish, along with suids, hippos, equids, and alcelaphin (cf. *Megalotragus*) and reduncin bovids. Over half of the assemblage displays weathering stage 0 or 1 surfaces, and 16% of specimens have adhering matrix or exfoliated surfaces, which allows observation of bone surface modification. Among 40 identifiable specimens from at least 21 elements and six mammalian individuals, eight specimens from a minimum of four elements and a single individual preserve evidence of hominin butchery and suggest early access to a size-three mammal. These include a cut-marked neural spine of a thoracic or lumbar vertebrae, ischial ramus, and cranial or mandibular fragment, a cut and percussion-marked humeral midshaft, and four cut-marked specimens not identifiable to element. Carnivore tooth marks occur on two refitting mandibular specimens from a size-three bovid, an equid radius, and a long bone midshaft fragment. A six square-meter test excavation revealed three bone and tooth specimens at 50 centimeters below the ground surface, which suggests the *in situ* origins of the surface assemblage. Bone walks along 400 meters of the outcrop surrounding FwJj70 indicate that it includes a similar composition of mammalian families and size classes, but possesses less weathered specimens with fewer post-fossilization and dry fractures. Overall, FwJj70 is a rapidly buried assemblage that includes butchered remains of a single large mammal.

**Miller and Werner**

## **You Know the Drill: A New Method of Differentiating Stone Age Bead Making Techniques**

In this paper, we present a new method of distinguishing between two techniques used to perforate ostrich eggshell (OES) beads during the Middle and Later Stone Age. OES beads first appeared at least 50 thousand years ago, and are considered to be an important marker of symbolically mediated culture. The proposed method permits a greater technological understanding of these artifacts, which may be important for identifying past manufacturing traditions. Ethnographic records of OES bead manufacture have previously been used as a basis for re-constructing Stone Age techniques. Building upon earlier research into bead manufacture, over 230 OES preforms were experimentally perforated using either a hand turned (incomplete rotation) or hafted (complete rotation) lithic drill. Subsequent examination of these preforms allowed for the isolation of significant morphometric variables and the development of a reliable statistical model that predicts drilling technique with a high degree of accuracy. This model is inexpensive, quick, and can be applied with very little experience. In addition, our model makes use of digital photographs allowing for analysis without

access to the physical collections. We are currently working to apply the model to a number of archaeological specimens from sites in Botswana, Namibia, Tanzania, and South Africa. Preliminary results from Apollo 11 Cave show that the majority of bead preforms feature complete rotation and thus were likely produced with the assistance of a hafted drill.

## **Miller-Atkins and Premo**

### **Time-Averaging and the Spatial Scale of Regional Cultural Differentiation in Paleolithic Assemblages**

Variation among archaeological assemblages from different regions but approximately the same time may serve as evidence for the existence of geographically-bounded, culturally-distinct groups (or societies) living side by side during the Paleolithic. Some have suggested the purported increase in cultural differentiation—marked by both an increase in the number of and a decrease in the spatial scale of such culturally-distinct populations—during the Upper Paleolithic might signal the appearance of so-called “modern human behavior.” However, it remains to be seen to what extent the regional cultural differentiation of a population of social learners can be recovered from the time-averaged assemblages they created. Here, we employ a spatially-explicit agent-based model of local group extinction and recolonization to begin to examine how time-averaging can affect the spatial scale of cultural variation in simulated Paleolithic assemblages. Our results show that time-averaging, alone, can increase the spatial scale of a “cultural region”—defined here as the area marked by assemblages that display similar relative frequencies of the most prominent cultural variant (or diagnostic tool type) on the landscape. Our finding that time-averaging increases the spatial scale of a “cultural region” in assemblage data has important implications for how we go about interpreting the signal (or lack thereof) of increased cultural differentiation in the Paleolithic record in terms of hominin behavior.

## **Morin et al.**

### **Synthesizing the Evidence on Middle and Upper Paleolithic Diets in Europe and SW Asia**

The number of faunal analyses examining Middle and/or Upper Paleolithic diets at individual sites is extremely large, although broad syntheses are few. Further, faunal and isotopic data appear to be poorly correlated in some instances. Here we examine dietary patterns across Europe and southwest Asia for both the Middle and Upper Paleolithic. The data confirm that a relatively narrow range of apparently high-ranked animal species—mostly medium- to large-sized ungulates—was hunted, with a preference for cervids, bovids, and equids. However, our review also stresses that, prior to the Upper Paleolithic, some regions show evidence of diet broadening, although some of these experiences were presumably ephemeral. Moreover, our analysis emphasizes the importance of considering fat procurement and the effects of transport constraints on diet breadth. Furthermore, faunal data seem to indicate that the exploitation of megafauna was more frequent in the plains of Northern Europe than at southern sites. Lastly, concerning the Mediterranean rim, the published information suggests that some groups—such as those of southern France—broadened their diets much later than those from other regions. Overall, the evidence hints at substantial regional and temporal variation in dietary patterns during the Late Pleistocene.

## **Munga and Braun**

### **Macroscopic Investigation of Raw Material Properties: Comparisons with Mechanical Properties Tests**

Selection of certain rock types for the production of stone artifacts is a consistent feature of Oldowan technological organization. One of the biggest challenges, however, lies in quantifying the technologically relevant characteristics of stone. Experimental knapping can provide some insights into the qualities of stone, however, given the variability in rock properties it is difficult to relate these to archaeological materials. Insights from knapping experiments often are difficult to quantify because of the difficulty of controlling the numerous independent variables. Visual inspection of rocks often has been used to identify key features related to stone knapping ability. These visual inspections are usually related to the size and variation of crystals, especially in igneous rocks. This is particularly evident in igneous rocks that make up the majority of Early Stone Age assemblages in East Africa. Visual properties of stones can be quantified using image analysis (ImageJ 4.x). Here we investigate the relationship between mechanical properties of specific raw materials (as measured by Leeb hardness and Young’s elastic modulus) and certain visual features related to the size and shape of phenocrysts. To investigate this, 66 sections of six raw materials used by Oldowan hominins at the site of Kanjera South (western Kenya) were prepared and 1,986 microscope images of these sections were analyzed with Image J to document features of the phenocrysts. The size and shape of crystals appears to be directly correlated with the elastic modulus of stones. Leeb hardness has a

weaker relationship with visual properties of these rock types. This methodology can be directly applied to archaeological materials and can provide a non-destructive proxy measure of the variation in rock mechanical properties in an archaeological context.

**Muttart et al.**

## **Taxonomic Distinctions in the 3D Micromorphology of Tooth Marks with Application to Feeding Traces from Middle Bed II, Olduvai Gorge, Tanzania**

Linking specific carnivore taxa to feeding traces found on fossil bones is critical to reconstructing the ecological and behavioral contexts of Early Stone Age archaeological sites, due to the paucity of carnivore remains in the archaeological record. Archaeological sites from Middle Bed II, Olduvai Gorge, Tanzania, provide abundant faunal remains bearing both hominin butchery marks and carnivore tooth marks, but few body fossils of carnivores. Analysis of these feeding traces can refine our knowledge of past hominin and carnivore interactions as hominins began encroaching on the carnivore guild by regularly consuming flesh and marrow. Previous research, that measured tooth marks from two-dimensional digital photographs, linked the body size of consumers to the size of the tooth marks inflicted on bone surfaces during feeding. These findings are limited by the 2D analyses on which they are based, but highlight the potential for more advanced techniques of data collection and analysis. This project utilizes high-resolution 3D scanning to more accurately characterize carnivore tooth mark morphology. Controlled feeding experiments were conducted for seven species of modern mammalian carnivores and a single species of crocodile. Scans of individual tooth marks were produced using a Nanovea white-light confocal profilometer, while 3D models of the marks were analyzed with Digital Surf's Mountains Software. Tooth marks found on fossils from Middle Bed II, Olduvai Gorge, were scanned and compared against the actualistic sample of tooth marks. Quantitative analysis and statistical comparison of 3D measurements can be used to identify taxonomic distinctions of tooth mark morphology between certain species as well as link some fossil feeding traces to specific carnivore taxa. This method provides a means to identify specific carnivore actors from their feeding traces, potentially enhancing our ecological reconstructions of Early Stone Age archaeological sites.

**Nasrollahi et al.**

## **Amino Acid Racemization (AAR) Dating of Ostrich Eggshell (OES): Experimental Testing of the Effect of Natural Campfire Burning on OES Values**

The Middle Stone Age witnessed several critical events in evolution of modern *Homo sapiens*, and understanding their timing (e.g., migration out of Africa and across the rest of the world, advances in stone tool manufacture, and changes in foraging strategies) depends upon a securely dated chronology. Techniques such as AMS  $^{14}\text{C}$  can only be applied to the youngest end of this interval. Because many human groups collected ostrich eggs, amino acid racemization (AAR) of indigenous protein residues preserved inside the calcite crystals of OES offers a method to date sites back to at least 100 ka. However, the AAR clock depends on both time and temperature. Soil burial temperatures can be estimated, but in archaeological context ostrich eggs were often cooked, and the eggshell fragments scattered in and around the cooking fire. To try to disentangle the effects of environmental temperatures (soil temperatures) and brief heating at the much higher temperatures of a campfire, we heated samples at controlled temperatures in the laboratory to develop a model of how the different amino acids would racemize. We compare these experimental data with ancient samples from SM-1, a MSA site in the lowlands of NW Ethiopia, to attempt to separate those samples heated in campfires that likely produce incorrect AAR ages, from those that were never heated in camp fires. Evidence for the controlled use of fire at the site is presented, as are soil temperature data collected at various depths over the annual wet and dry season. When sufficient material is present, OES splits permit the same eggshell to be dated by AAR, AMS  $^{14}\text{C}$ , and U-Th in order to evaluate the degree of correspondence among these techniques.

Niespolo et al.

## C and N Stable Isotopes in Late Pleistocene-Holocene Ostrich Eggshells Reveal Distinct Local Paleoenvironments in East Africa during the MSA-LSA Transition

The Middle to Later Stone Age (MSA-LSA) transition in East Africa ~60–30 ka has been considered a response to increased resource risk due to cooler, drier Late Pleistocene environments with greater short-term variability. Precisely dated local paleoenvironmental records can test such hypotheses. Ostrich eggshell (OES) fragments are common in African archaeological sequences, are amenable to  $^{14}\text{C}$  and U-series dating, and their  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values can be used to infer C isotopes of consumed vegetation and mean annual precipitation (MAP), respectively. Here we show that OES preserve primary stable isotope compositions for up to ~50 ka at rock shelters Gvjm-22 Lukenya Hill (Kenya) and Kisese II (Tanzania). At both sites, mean  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values indicate elevated MAP during the African Humid Period (AHP, ~14–3 ka) relative to previous intervals, increasing confidence in our paleo-MAP values. Temporal variation in  $\delta^{13}\text{C}$  values is modest and masked by short-term variability, but mean  $\delta^{13}\text{C}$  values tend toward more  $\text{C}_4$ -rich flora during intervals with lower precipitation. OES  $\delta^{15}\text{N}$  values at Lukenya Hill show overall increasing MAP from an arid MIS 3 (57–29 ka) to the AHP. In contrast, over the past 50 ka precipitation oscillated at Kisese II, with MIS 3 reflecting MAP as wet as the AHP and a drier MIS 2 (29–14 ka). Accordingly, we infer that distinctly different climatic trends prevailed during the MSA-LSA transitions at Lukenya Hill (~46–26 ka) and Kisese II (~36–34 ka). Our results suggest contrasting paleoenvironmental trends through time at sites separated by only ~300m elevation, 3° latitude, and 350km. Such site-specific records suggest a mosaic of local environments that is not apparent from global or regional paleoenvironmental records. This approach may allow closer examination of the relation between paleoenvironments and diverse patterns of behavioral change across the East African MSA-LSA transition.

Niewoehner

## Hominin, Gorilla, and Chimpanzee Opponens Pollicis Crest Morphological Variation

Neandertal first metacarpals (MC1s) are remarkable for their radially projecting opponens pollicis (OP) insertions which are referred to as OP flanges rather than as OP crests (OP crests are less projecting than OP flanges). The OP flange projects beyond the radial margin of the MC1 head and remains as a distinct, slightly concave, ridge as it courses towards the MC base. The MC1s of recent (Holocene) human males (n=73) and females (n=48), male (n=14) and female (n=8) gorillas, and male (n=10) and female (n=9) chimpanzees were examined for the presence of OP flanges. The OP insertion morphology on these MC1s was highly variable, ranging from barely discernable OP crests to OP flanges. OP flanges were present only on some recent human male MC1s (5% of males) and on some male gorilla MC1s (22% of males). All other male and female MC1s had variably developed OP crests that did not project beyond the radial margin of the MC1 head. For all samples, males had larger OP crests than females. The presence of an OP flange has been alternately regarded as either the byproduct of muscular hypertrophy due to habitual manipulative behaviors or as a phylogenetically relevant genetically-canalized trait (Kimura 1976; Trinkaus 2007). Clearly, OP flanges are not unique to Neandertals since they are present on some male recent human and gorilla MC1s. In addition, OP flanges are present on three Gravettian-associated MC1s (Niewoehner 2006), on an adult MC1 from the Sima de los Huesos (Arsuaga et al. 2015), and on at least three *H. naledi* MC1s (Kivell et al. 2015). Given the pattern of OP insertion morphological variation demonstrated here, the OP flange is best interpreted as evidence of muscular hypertrophy that it is without phylogenetic relevance.

Oestmo et al.

## Open-Air *In Situ* 72-Thousand-Year-Old Stone Tool Knapping Events at Vleesbaai, Pinnacle Point, South Africa

Our understanding of Middle Stone Age (MSA) behavior is skewed by the dominance of our sample from caves and rockshelters. *In situ* open air sites from the MSA are difficult to find, and are rarely in proximity to caves and rockshelters, where they sample the same mobility system. We have discovered such sites at Vleesbaai, near Pinnacle Point, South Africa (Oestmo et al. 2014), and here report on an *in situ* MSA site recently excavated. The artifacts are sealed below a post-depositionally cemented layer and come from sediments dated by optically stimulated luminescence to ~72 ka. Artifact orientation and dip indicates that there has been little disturbance since their deposition. Many artifacts refit and many of the refitting pieces are concentrated together along the boundary of voids in the artifact spatial distribution, which may represent the sitting or kneeling location of the knappers. The majority of the lithic assemblage results from early stage reduction of quartzite cobbles. Few non-quartzite lithic artifacts were recovered and those that are present are silcrete complete points, or fragments of points or blades. Some bone fragments of size 1 and 2 terrestrial faunal remains were also recovered. We interpret the site as a short-use extraction camp where expedient quartzite stone tools were

manufactured, used, and discarded. At this same location and potentially coeval with the quartzite reduction, tools with silcrete components were maintained/repared and small mammal kills may have been processed. These assemblage characteristics differ from those in contemporary levels at the Pinnacle Point 5-6 rockshelter ~ 9km away that are characterized by later stages of reduction and higher frequencies of silcrete. The Pinnacle Point - Vleesbaai complex offers an uncommon opportunity to examine early modern human behavior at a landscape scale.

**Olszewski et al.**

## **Early and Middle Stone Age Survey in the Upper Reaches of the Fourth Cataract, Sudan**

During the 2016 season of the Bioarchaeology of Nubia Expedition (BONE), we conducted a systematic site survey along the western side of 10 wadis and the area around a prominent mountain (Jebel Julud) in the Arizona State University concession (approximately 88km<sup>2</sup>), which lies upstream of the 4th Cataract on the north (right) bank of the Nile River. We surveyed from the concession boundary to the confluence of each of the 10 wadis with the Nile. Sites of all periods were recorded, but we focus here on the ESA and MSA. Survey data are combined with lithic information from surface collections at several sites within approximately 1km of the Nile where excavations into later period contexts occurred. Most of these sites are not far from Jebel Julud and yielded large collections of MSA lithics. Although the western portion of the concession has less modern development, fewer sites were found here; these include most of the identified ESA sites. MSA sites, in contrast, are relatively abundant in the more developed, eastern part of the concession. The highest concentration of MSA sites is along two wadis west of Jebel Julud, although no MSA sites occur at the top of Jebel Julud or on nearby hill tops. The patterning in the ESA and MSA site distributions appears to reflect, in part, the targeting of different stone raw material sources during the ESA (quartzitic flint and quartz outcrops in the western part of the concession). During the MSA, deposits of Nile River cobbles (flint, silicified mudstone, jasper, and quartz), which outcrop about 1km inland from the Nile, and near Jebel Julud, appear to be a prime resource. Some Nubian Levallois is present. MSA use of this region would have been mainly during the wetter periods of MIS 5.

**Orlikoff et al.**

## **A Quantitative Assessment of Trampling-Induced Modification to Bone Surfaces**

Analysis of bone surface modifications has the potential to illuminate the paleoecological and behavioral contexts of faunal assemblages through identification of the accumulating agents. However, this requires accurate diagnosis of the various bone-modifying actors and processes. Apparent equifinalities in the morphology of stone tool cut marks and trampling-induced abrasion are particularly problematic in assessments of bone assemblages based on surface modifications. Previous research examining the distinctive aspects of trampling marks has been conducted using 2D microscopic analysis of the morphological features. However, results have been inconclusive due to insufficient methods leaving analysts ill-equipped to distinguish between individual trample and cut marks. This has led to high-profile disputes about the origins of marks like those on the Dikika specimens from Ethiopia. This study is the first to use high-resolution 3D profilometry to distinguish between individual trample and cut marks and provides a new understanding of the quantitative differences between these superficially similar bone surface modifications. Trampling marks were induced by allowing humans and, in some cases, ungulates to repeatedly step on defleshed and demarrowed limb bone shaft fragments in a variety of sediment types. Cut marks were collected by slicing defleshed and demarrowed bones with stone flakes and bifaces. Bones were cleaned of debris and scanned using a white-light confocal profilometer to collect 3D data from surface modifications. Multivariate statistics are used to quantitatively discriminate between trample and cut marks based on measurements collected from both the 3D models and individual profiles. Isolation of the diagnostic signature of trampling-induced bone surface modifications will provide greater confidence in the identification of these and other surface marks and may allow for the resolution of disagreements about the origin of modifications in the fossil record.

**Paige and Perreault**

## **Assessing Likelihood of Convergence in Flake Attributes**

Archaeologists use similarities in core, flake, and tool attributes to reconstruct movements of populations and cultural relationships across the Pleistocene (Scerri et al. 2014; Shea 2014; Tostevin 2013). This approach is based on the assumption that similarities between assemblages are caused by their makers having common cultural ancestors. There are two issues with this approach. First, such reconstructions lack independent lines of evidence necessary to exclude convergence as a cause of technological similarities. Secondly, attributes are likely more or less prone to convergence depending in part on how freely they may vary. Late Holocene lithic

assemblages, for which we have some prior knowledge of the cultural-relationships of their makers, are an under-explored means of evaluating how prone to convergence different technological traits are. We gathered flake attribute data from culturally closely related sites in the Roosevelt area of Central Arizona dating to between 1200 and 1375 A.D. (N=470), and from assemblages produced by groups culturally independent of the Roosevelt population: one experimental assemblage and 20 Pleistocene assemblages spanning South Africa, eastern Europe, and the Levant (N=7109, gathered from Tostevin 2013 and Presnyakova et al. 2015). We measured the total range for each attribute predicting those with less room to vary should be more prone to convergence. We then statistically assessed which of the above assemblages could be distinguished from one another based on variation in each flake attribute (using Tukey HSD, Kolmogorov-Smirnov, and T-tests). We found that attributes differ in how freely they vary across assemblages. Attributes also differ in how reliably they statistically distinguish between assemblages produced by distantly related groups—some return more false positives of cultural relatedness than others. We discuss these findings in terms of cultural evolution, and the mechanisms likely to cause persistence, and loss of historical information in cultural data.

**Pante et al.**

## **The Feeding Behavior and Ecology of Early *Homo* at HWK-EE, Bed II, Olduvai Gorge**

The initial encroachment of our ancestors upon the larger carnivore guild has important implications for their feeding ecology and adaptive capabilities. The regular consumption of large mammal carcasses as evidenced by butchery marks on fossils recovered from Early Stone Age archaeological sites, roughly coincides with the appearance of *Homo habilis*. However, the significance of this niche expansion cannot be appreciated without an understanding of hominin carcass acquisition capabilities and their ecological interactions with mammalian carnivores. The Olduvai Geochronology and Archaeology Project (OGAP) has recovered a large and well-preserved fossil assemblage from the HWK-EE site, which was deposited just prior to the emergence of Acheulean technology at Olduvai Gorge and likely represents one of the last *H. habilis* sites at Olduvai. Here, we report for the first time, on the larger mammal fossil assemblage excavated from HWK-EE by OGAP. The HWK-EE site shows evidence of multiple occupations over a long period of time suggesting the site offered affordances attractive to hominins. There was a permanent water source indicated by the presence of crocodiles and hippos and possible tree cover in an otherwise open habitat. The site preserves several stratigraphic intervals with significant fossil and artifact assemblages within two of these intervals. The artifacts are Oldowan with no indication of Acheulean technology and the collection is one of the largest of any Oldowan site. Feeding traces on fossils from the earlier occupation of the site suggest secondary access to carcasses by hominins with a strong carnivore signal. A later occupation of the site has a lower carnivore signal and may indicate hominins had earlier access to carcasses. Both intervals show hominins exploited a wide range of taxa from bovids to elephants. The results suggest HWK-EE should be considered an important reference site for the behavior of hominins during the late Oldowan.

**Pargeter**

## **Lithic Miniaturization, Bipolar Reduction, and Late Pleistocene Lithic Technology at Boomplaas Cave, South Africa**

Technological miniaturization has revolutionized every aspect of contemporary life from biomedical sciences to agriculture, industry, and the storage of renewable energy. Seeing technological miniaturization as all about us, one might suppose it is a recent phenomenon, but it has deep roots in Stone Age technology. Lithic miniaturization, the production of small stone tools from small cores, provides the most enduring and arguably the most consequential example of Pleistocene technological miniaturization. Smaller toolkits enabled humans to exploit raw materials more efficiently, to produce composite tools more efficiently, to reduce a wider range of rocks, and to increase mobility by lightening toolkits. These benefits allowed humans to occupy a wide range of environments, to more effectively maintain resources within existing territories, and to disperse more efficiently. Archaeologists typically associate the production of miniature lithic toolkits with a range of skilled techniques requiring protracted learning and intensive cultural transmission such as pressure flaking and indirect percussion. Yet, ethnographic and experimental data show lithic miniaturization can be as effectively achieved using simple, but not simplistic, strategies such as bipolar percussion (hammer-and-anvil). This paper presents experimental and archaeological evidence for the role of bipolar technology in lithic miniaturization during the late Pleistocene in southern Africa. First, it presents experimental data that challenge the widely held perceptions about the wastefulness of bipolar reduction. Next, it applies these findings to the newly re-dated late Pleistocene lithic record from Boomplaas Cave in South Africa. The results show the integral role bipolar reduction played in lithic miniaturization at Boomplaas and the possible relationship between bipolar reduction and shifting mobility strategies at the site. These results overturn long-held assumptions about the costs of lithic miniaturization and question long-standing progressive models of change in lithic technology.

**Patalano et al.**

## **Molecular Isotopic Analysis Reveals Details on the Environmental Context of the Earliest Acheulean at Olduvai Gorge**

Paleoenvironmental studies focusing on human evolution provide insight into the effective hominin response to ecological variables in diverse habitats. Normal (*n*-) alkanes are excellent organic compounds to investigate human-environment interactions because they are chemically inert and resistant to biodegradation in sediments over geologic time. These molecules serve as proxy measures for the continental vegetation that synthesized them, while the isotopic signature of environmental carbon ( $\delta^{13}\text{C}$ ) and hydrogen ( $\delta\text{D}$ ) incorporated during plant biosynthesis represent changes in water availability, vegetation communities, precipitation or aridity, evapotranspiration of leaf and soil moisture, and the relative abundance of  $\text{C}_3$  and  $\text{C}_4$  plants in response to climate changes [1, 2]. The Frida Leakey Korongo West (FLK-W) archaeological site of Olduvai Gorge (Bed II) offers an opportunity to investigate climatic triggers and technological innovations, and the impact on human evolution. The FLK-W sequence is dated between  $1.698 \pm 0.015$  Ma and  $1.664 \pm 0.019$  Ma, is separated into six archaeological levels, and consists of fluvial conglomerates and sands fixed within a clay unit at the base of Bed II [3]. The site provides evidence of early Acheulean technology through one of the earliest known and most sophisticated symmetrical and bifacially flaked handaxes in the world. The lowermost levels (L5 and L6) are the most dense and important in terms of their archaeological contents. We present a high-resolution isotopic analysis of molecular  $\delta^{13}\text{C}$  of *n*-alkanes from a 130cm sedimentary sequence from FLK-W spanning 34,000 years to reveal climate changes that coincided with the early appearance of Acheulean stone tools. Our isotope data show environmental fluctuations throughout the sequence, but an overall drying trend through the upper archaeological levels. A drying/warming event, marked by more positive isotope values ( $\delta^{13}\text{C}$  carbon-31, -28.42‰), is evident in archaeological unit L6, whereas L5 is marked by wetter/cooler conditions ( $\delta^{13}\text{C}$  carbon-31, -31.02‰). Furthermore,  $\text{C}_4$  grasses dominate toward the top of the sequence (Level 1  $\delta^{13}\text{C}$  carbon-31, -24.16‰).

**Pazan and Stewart**

## **That High Lonesome Sound: Last Interglacial Lithic Technologies from Melikane Rockshelter, Lesotho**

Last Interglacial-aged (MIS 5) lithic assemblages from South Africa's Cape coasts have been well-studied. Less is known, however, about contemporary technological developments in the subcontinental interior. The MIS 5a lithic assemblages from Melikane, a highland rockshelter in the Maloti-Drakensburg Mountains (1870masl), currently represent Lesotho's oldest chronometrically dated archaeology. These assemblages have previously been purported to resemble the MSA 2a from Klasies River (Stewart et al. 2012) or the MSA 2b from Mossel Bay (Lombard et al. 2012). A new technological analysis of the Melikane assemblages reveals that the Melikane lithics share some features with both the MSA 2a and 2b, though broadly resemble neither technocomplex. The Melikane production strategy is aimed at producing flakes that are smaller, thinner, and narrower than those present in the MSA 2a and 2b. A greater emphasis is placed on the production of irregularly shaped flakes, and blades and triangular flakes are relatively rare compared to other MIS 5 sites. The assemblage is dominated by flakes with features indicative of soft-hammer percussion, and although retouch is rare, scrapers and borers are the most common formal tool types. There is also a greater preference for fine-grained raw materials than at other MIS 5 sites, particularly in the most recent contexts. These results support suggestions (see Mackay et al. 2014) that MIS 5 flaking systems in southern Africa were heterogeneous and reflect adaptations to local conditions. Caution is therefore warranted when constructing regional typologies, since regional information exchange during this period may have been limited and social networks circumscribed.

**Pena and Brooks**

## **Effect of Wrist Extension on Human Throwing Accuracy: A Case Study with Implications for *Australopithecus***

While many mammals have the capacity to throw, humans throw the most accurately and precisely. Part of what allows for this throwing accuracy is the radial extension and ulnar flexion of the wrist, or the so-called "dart-throwing motion" (Moritomo et al. 2007). Greater mobility in the wrist is a by-product of the unique morphology of the human wrist in which the distal end of the radius does not contain a distally projecting dorsal ridge (Richmond and Strait 2000). Chimpanzees and gorillas have this dorsal ridge which allows for more stability during knuckle-walking, which in turn reduces mobility in the wrist (Kivell and Schmitt 2009). *Australopithecus anamensis* and *A. africanus* (4–2 mya, respectively), like chimps and gorillas, have a dorsal ridge on the radius, thus limiting the wrist's extension capabilities, which is necessary for accurate throwing (Richmond and Strait 2000; Williams et al. 2010). The earliest stone-tool-assisted meat consumption is debated to be between 3.39 and 2.5 mya (Dominguez-Rodrigo et al. 2011; McPherron et al. 2010). Whether this morphological distinction in the wrist of *Australopithecus* may have affected its throwing accuracy

may have implications for tool-use and potential spear throwing and hunting behavior in *Australopithecus*. To evaluate the functional capabilities of the Australopithecine wrist, we conducted a preliminary throwing experiment examining the impact of limited wrist extension on throwing accuracy. Results suggest that human male accuracy in throwing is significantly decreased when wrist extension is restricted relative to the same individual's normal performance.

**Pereira et al.**

## **EcoPLis: Human Occupations in the Pleistocene Ecotones of River Lis (Portugal) – The 2015–2016 Results**

The coarse and dispersed information on westernmost Iberia does not allow a detailed understanding of the human behavioral ecology and ecodynamics during the Pleistocene and Early Holocene. The EcoPLis project aims to help solve this problem by focusing on a region rich in multiple resources that is an ecotone between different landscapes and in which are found sites with long sequences and good preservation of organic material: the Lis River Basin (Leiria, Central Portugal). In 2015, we started excavation of two rockshelters, Abrigo do Poço (AdP) and Abrigo da Buraca da Moira (ABM), and the coastal site of Praia do Pedrogao (PRP). Together these sites give a sequence from the Mousterian to the Final Neolithic/Chalcolithic. Besides the diversity of raw materials used and technological traits of the lithic assemblages, the most striking aspect of our sites is the abundance of organic material. This includes, at ABM, a Final Neolithic/Chalcolithic burial ground with adornments made on *Crassostrea angulata* and *Littorina* sp., overlying the Middle Solutrean and the Proto-Solutrean. At AdP, a breccia remnant below the roof with a Middle Paleolithic and, outside of it, an Early Upper Paleolithic (or Epipaleolithic) occupation covering a deposit that seems to be Solutrean. Besides thousands of charcoal fragments, there is also a large assemblage of *Scrobicularia plana*, *Ensis* sp., and *Cerastoderna edule*, that do not occur in the Solutrean layer, when the coastline was farther away. Finally, while no faunal remains were recovered there, PRP is located just a few meters from the sea and thus must have been a case of exploitation of marine resources. Overall, the three sites show a strong diachronic relation of these populations with coastal environments and also with inland mountains, especially in the cases of AdP and ABM that are located over 20km from the present seacoast.

**Picin**

## **Settlement Dynamics in Eastern Germany during the Middle Paleolithic**

Prehistoric hunter-gatherers frequently relocated in order to avoid foraging in previously depleted areas, and lakes and rivers played important roles in these movements as fixed locations on the landscape where foragers could have access to water and ambush parched animals. The types of human occupations along lakes and rivers could have been diverse according to the aims of displacements (e.g. logistical, residential) and the activities carried out at the shore (e.g. bivouac, hunting station, base camp). Repeated settlements in the same areas could have generated palimpsests rich with archaeological artifacts that are not always easy to disentangle and interpret. However, the discrimination of the raw materials and the comparison of the lithic assemblages with experimental knapping materials could be indicative of the integrity of the operative chains and the type of artifacts transported off-site. This paper aims to present new data on some Middle Paleolithic open-air sites located on lakeshores and riverbanks in Eastern Germany. The results indicate that the settlements were of short-term occupations and that Neanderthals applied different strategies of production and artifacts exports off-site.

**Plomp et al.**

## **Bipedalism Evolved from Knuckle-Walking: Evidence from 3D Geometric Morphometric Analyses of Thoracic and Lumbar Vertebral Shape of *Homo sapiens*, *Pan troglodytes*, *Pongo pygmaeus*, and *Papio hamadryas***

The locomotor behavior of the last common ancestor (LCA) of hominins and panins is a controversial topic. The main hypotheses posit that the LCA moved like (1) African apes, (2) orangutans, or (3) quadrupedal monkeys. In this study, we attempt to test these hypotheses by comparing the shapes of the final thoracic and first lumbar vertebrae of humans (*Homo sapiens*), chimpanzees (*Pan troglodytes*), orangutans (*Pongo pygmaeus*), and baboons (*Papio hamadryas*). We used 3D Cartesian coordinates to capture the shape of the vertebrae and then subjected the data to geometric morphometric analyses. Asymmetry was removed, and then allometry was minimized by regressing the landmark coordinates on log centroid size. Subsequently, the regression residuals were subjected to principal component analysis and canonical variates analysis. The analyses revealed a difference between the anterior and posterior parts of the vertebrae. They suggested that the anterior elements of both the thoracic and lumbar vertebrae of *H. sapiens* are more

similar in shape to those of *P. troglodytes* than to those of *P. pygmaeus* and *P. hamadryas*. The posterior elements of the final thoracic vertebrae returned the same pattern of similarity. In contrast, the posterior elements of the first lumbar vertebrae of *H. sapiens* are closer in shape to those of *P. pygmaeus* and *P. hamadryas* than to those of *P. troglodytes*. Given the species' phylogenetic relationships and locomotor behaviors, it is likely that the similarities between *H. sapiens*, *P. pygmaeus*, and *P. hamadryas* in the dataset pertaining to the posterior elements of the first lumbar vertebrae are convergent, while the similarities between *H. sapiens* and *P. troglodytes* in the other datasets are synapomorphic. This is consistent with the hypothesis that the LCA used knuckle-walking. Thus, the present study adds to the growing body of evidence indicating that knuckle-walking preceded bipedalism.

**Pop et al.**

## **A Promising New and Simple Estimator of Initial Mass for Retouched Flake Tools**

The ability to estimate the initial blank size of retouched flakes is important for assessing reduction intensity, itself a proxy measure for other aspects of past hominin behaviors such as curation and mobility. While our ability to predict initial flake attributes relevant to quantifying reduction intensity has improved over the years with the development of new and more complex estimators (e.g., Morales et al. 2015 and references therein) and a better understanding of the fundamental drivers of size and shape variability (e.g., Rezek et al. 2011), variables currently used to estimate initial flake sizes remain either difficult to measure or of limited use (e.g., Dogandžić et al. 2015). Indeed, experimental results presented here confirm previous findings that, using commonly recorded variables (e.g., platform thickness, exterior platform angle), random estimation errors are too great, relative to the actual size differences observed with even very heavily reduced artifacts (here up to 40% mass lost), to allow for meaningful comparisons. In this poster we introduce and discuss a new predictor of initial flake mass—the bilateral platform angle (BPA). This variable, which has significant predictive power by itself, which can be measured easily by hand on archaeological artifacts, and which is often preserved even after retouch, represents the mean angle formed by the platform thickness vector and the proximal edge sections on both sides of the platform, as seen from a profile view. We compare this attribute with exterior platform angle (EPA) in terms of ease/reliability of measurement and predictive power. We further discuss preliminary experimental results which suggest that this attribute, when used in conjunction with other easily recordable, or commonly recorded variables known to be useful predictors of flake size, may sufficiently reduce estimation errors to allow for meaningful inter-assembly comparisons in reduction intensity.

**Ranhorn et al.**

## **Gajj17: An MSA Lake Shore Site at East Turkana**

Current archaeological evidence of Middle and Late Pleistocene hominin behavioral evolution at Koobi Fora (KF) in the eastern Lake Turkana basin is scant, largely due to an extensive unconformity between the Chari Member (<1.39 Ma) and Galana Boi Formation (<10 ka). Building on the work of Kelly and Harris (1996) who reported surface scatters with Middle Stone Age (MSA) artifacts at KF, we surveyed the region for MSA occurrences. Here we present results from ongoing fieldwork at Gajj17, a lakeshore locality with MSA artifacts eroding from indurated sandstone. Artifacts, primarily basalt, include mainly flakes and a Levallois point. Two geotrenches and 3m<sup>2</sup> were excavated with the aim to obtain high-resolution contextual information of *in situ* artifacts and fossil fauna. Micromorphological analysis reveals that aeolian processes formed the artifact-bearing deposit. Below this unit are packages of upward fining sequences with diagnostic pebble lag deposits indicative of channel deposition. The upper portion of the aeolian deposit was subsequently subjected to fluid reworking, producing capping calcitic sandstone, which incorporates both bioclasts (marine and terrestrial) and artifacts. The indurated property of this sandstone unit served as an erosional buffer preserving the underlying archaeological deposit. We used fabric analysis of plotted finds to assess post-depositional taphonomic processes. Radiocarbon samples (n=6) failed due to minimal nitrogen/collagen (<0.05%) suggesting poor organic preservation and/or a lack of sufficient measurable <sup>14</sup>C. In-progress analysis of OSL samples should demonstrate the extent of sediment or matrix mixing and a possible age estimate, while tephrastatigraphy of underlying ash may provide a maximum age. Associated fauna samples are both aquatic and non-aquatic taxa, including hippopotamus, crocodile, turtle, bovids, and suids. Gajj17 offers paleoanthropological importance because it represents a unique depositional occurrence in Koobi Fora with *in situ* MSA lithic technology. The site has implications for investigating early modern human behavior and exploitation of aquatic resources.

**Ranlett**

## **The Relevance of 'Precious' Raw Material Engagements to Discussions of Group Cohesion and Interaction in the French Upper Paleolithic**

The practice of collecting, curating and/or modifying objects with rare, unusual, or novel material properties (e.g. amber, lignite, belemnite, ammonite, serpentine, calcite, and soapstone) is a practice with a deep evolutionary history in human and recent human ancestor groups across Eurasia and Africa since the Lower Paleolithic. During the Upper Paleolithic, collection and use of these materials increased along with, and usually in the framework of, the intensification of symbolic behavior witnessed across Eurasia at this time (a series of historical contingencies and, subsequently, a rich tradition of scholarship has made France—in particular SW France—a significant region for the study of Upper Paleolithic archaeology). During the Upper Paleolithic, several of these unusual materials became a habitual, if not particularly numerous or systematic, part of human technological and symbolic practices. As such, study of these materials has often taken a backseat to stylistic and technological analyses of more ubiquitous and easily comparable artifact classes, such as flint lithics, faunal remains, or 'art,' particularly in relation to the subject of cultural cohesion, and group movement. But, given the limited sources of these unusual materials, the wide variation in the manner of their use, as well as the unique technological challenges posed by their performance characteristics, these 'precious' materials, through a systematic regional study of their contexts of use and their find spots in relationship to known sources, provide another valuable line of evidence for identifying groups and their interactions on the landscape during the Upper Paleolithic in Southwest France.

**Riel-Salvatore**

## **A Comparative Empirical Analysis of Uluzzian Lunates and Coeval Backed Pieces**

This study presents an analysis of several key attributes of Uluzzian lunates, crescent-shaped microliths widely considered the type fossil of that controversial transitional technocomplex. Observations on the lunates from five Uluzzian sites from southern Italy (Cavallo, Mario Bernardini, Uluzzo, Uluzzo C, and Castelcivita) are compared to those drawn from the backed pieces from the transitional assemblages from La Fabbrica (Tuscany) and Fumane (Veneto). The first part of the analysis focuses on the dimensions of these implements; data from MSA and the Near Eastern Epipaleolithic lunates are used to contextualize the Uluzzian patterns. The second part of the analysis focuses on the angle of the active edge and the technological signature of the backing of the Uluzzian crescents analyzed by the author. Observations about the blanks used to manufacture these implements comprise the third and last part of the analysis. While the total number of pieces is low, our results indicate that the southern Uluzzian lunates comprise a distinctly homogeneous ensemble that is comparable in most respects to MSA and Epipaleolithic crescents, but differs significantly from the backed pieces from coeval assemblages from northern Italy. The paper concludes with a discussion of the implications of these patterns for ongoing debates over the definition of the Uluzzian and, more broadly, our understanding of the Middle-Upper Paleolithic transition in the Italian peninsula.

**Schoville and Sithaldeen**

## **Pleistocene Habitat Suitability Correlated with Genetic Variation in the Southern African Baboon (*Papio ursinus sensu lato*): Implications for Hominin Demography in Southern Africa**

The rise of grassland ecosystems ~2-million years ago coincides with the spread of the hominin genus *Homo*, as well as that of the baboon genus *Papio*. Glacial cycling substantially altered the distribution of grasslands and the animal communities that depend on them. Chacma baboons differ from typical grassland species in two fundamental ways that make them suitable analogues for early human populations: (1) they are well-adapted to grasslands but are not limited to them; and, (2) they have significantly more dietary flexibility. Given the similarities in environmental context and timing of their radiation, the impact of climate variation on *Papio* populations provides insight into the impact of climate variation on early human populations. Current models posit that interglacial phases were favorable and glacial phases unfavorable for both baboon and early human populations. One implication of this model is that increased genetic diversity should correspond to elevated habitat suitability during the climate phase associated with population expansion. To test this, variation in mitochondrial DNA sequence data was obtained from 29 baboon troop locations across southern Africa. The habitat-selection response of chacma baboons was modeled using modern bioclimatic data coupled with compiled species location information (n=750). By projecting the habitat suitability models to the last glacial maximum and last interglacial climate models, distributional shifts in habitat suitability can be linked to current genetic variability. In contrast to model predictions, our result suggests that interglacial phases were not uniformly favorable, nor glacial phases uniformly unfavorable for baboon populations. However, our results suggest that increased genetic diversity is positively linked with elevated habitat suitability

during interglacial phases, which is consistent with model expectations. It can be argued that hominin populations responded in similar ways and uneven habitat fragmentation may provide clues to interpreting the patchy archaeological record of behavioral milestones during the Pleistocene.

## **Siyabonga and Justin**

### **The Siliciclastic Deposits of Jacovec Cavern, Sterkfontein:**

#### **Reconstructing Depositional Environments in Karst Systems**

The Jacovec Cavern (JC), one of Sterkfontein's deepest chambers, attracted interest when an *in situ* *Australopithecus* sp. partial cranium (StW 578) ( $\pm 4$  Ma) was discovered. Initial macro-sedimentological work proposed an inverted sequence of deposits with a 3.76 Ma brown deposit underlying a 4 Ma orange deposit. Applying diverse sedimentological analyses (facies analysis, log descriptions, petrography, micromorphology, and microtomography), a higher resolution sedimentary sequence of the JC was established. Sedimentary facies analysis (following the scheme of Bosch and White [2004] and Flugel [2004]) revealed a variety of formation processes contributing to the contextual history of the deposits and fossil assemblages. Contrary to earlier stratigraphic work by Partridge et al. (2003), the study identified four lithologically distinct stratigraphic units—a basal fluvial slackwater facies (laminated rhythmites) overlain by a diamicton facies (perturbated gravels) concluded by 'common' slackwater laminae unit. This is overlain unconformably by a fossiliferous host-rock derived breccia facies which underlies the hominin-bearing, orange fossiliferous channel facies. Microscopic analysis helped revise the stratigraphic punctuation (contrary to Partridge et al. [2003]). Importantly, the presence of ghost rock remnant clasts contributed to refining interpretations of JC karst development by indicating phreatic stages of the cavern and subsequent deposit lithification. This study assisted in placing fossil material within a greatly refined stratigraphic context and demonstrated the benefits of multiscale and multidisciplinary stratigraphic studies in complex paleoanthropological contexts.

## **Smith et al.**

### **Temporal Link Established Between Two Middle Stone Age Sites (South Coast, South Africa) Using the Toba Isochron**

Precisely aligning Stone Age sites on the same time scale is a fundamental but elusive goal of geochronology. With Middle Stone Age (MSA) sites, our available geochronological techniques have precision at thousands of years, making such temporal alignment impossible. We previously identified rhyolite glass shards from the 74 ka youngest Toba Tuff (YTT) at Pinnacle Point (PP) 5-6 and report here YTT shards at an open-air site at Vleesbaai just ~9km distant. The Vleesbaai glass shards are well preserved and provide excellent major element chemistry that agrees remarkably well to YTT found in distal deposits at Lake Malawi, India, and Malaysia. Especially characteristic of YTT, Vleesbaai shards have  $\text{SiO}_2$  of 77 wt.%,  $\text{FeO}$ =0.81 to 0.88 wt.%,  $\text{CaO}$ =0.74 wt.% and  $\text{K}_2\text{O}/\text{Na}_2\text{O}>1$ . The glass shards are optically isotropic, 50 to 80 microns in size and commonly have bubble wall shapes; typical of distal YTT. To date, the shards have been found in sediments dated by OSL between  $71.4\pm 4.1$  and  $73.7\pm 7.6$  ka. We previously reported glass shards with a close chemical fit to YTT at PP5-6. While not as well preserved as those at Vleesbaai, and chemically altered, they still retain the YTT chemical signature and are in sediments dated by an OSL age model to 75.4–70.9 kyr (95.4% probability). The PP5-6 shards are rare but the first occurrence defines a 74 ka isochron. The Vleesbaai site is one of many in an open-air context in ancient paleosols that sample the now extinct Paleo-Agulhas plain. Vleesbaai is within the daily foraging radius of humans living at PP5-6, so with our Toba isochron we can be confident of sampling the contemporary activities of an ancient group of people who used this rockshelter and open-air site some 74,000 years ago.

## **Toffolo et al.**

### **Paleoenvironmental Reconstruction of the Florisbad Spring Site Based on a Micro-Geoarchaeological Approach**

The Florisbad spring site (Free State Province, South Africa) features a long, uninterrupted stratigraphic sequence that spans the last 300,000 years. The site has produced one of the earliest late archaic modern human fossils (*Homo helmei*) dated to  $259\pm 35$  ka, several assemblages of Middle and Later Stone Age artifacts, and a large faunal collection that defines the Florisian Land Mammal Age. One of the Middle Stone Age assemblages, dated to  $121\pm 6$  ka, was found *in situ* and in primary context. Such a rich archaeological and paleoecological record offers the opportunity to better understand the behavioral evolution of modern humans in the interior of southern Africa in relation to changing paleoenvironments, which are represented at the site by alternating layers of peat and sand. Previous studies investigated the genesis of such deposits using field descriptions and bulk sedimentological analyses. However, sediments were never studied within their original context, thus leading to difficulties in determining the formation processes of the site. Using a micro-geoarchaeological approach including sediment micromorphology, Fourier Transform infrared spectrometry

(FTIR), and X-ray diffraction (XRD), we were able to identify previously unnoticed, microscopic sedimentary structures typical of deposition by low-energy water, and thus determine the lacustrine origin of the sand layers. The cyclic occurrence of lacustrine and peat deposits represents the waxing and waning of bodies of standing water in response to variations in climatic conditions, with lake stands characteristic of wet phases and peat horizons related to drier stages. A large lake, paleo-Soutpan, covered the entire site from ca. 100 ka until the terminal part of the Pleistocene, where the stratigraphic sequence features thick deposits of aeolian sand representative of arid conditions. By reconstructing the formation and post-depositional processes of the site, we obtained insights into the local paleoenvironment during a crucial stage in the evolution of modern humans.

**Tourloukis et al.**

## **The Cultural Material from the Lower Paleolithic Site of Marathousa 1, Megalopolis, Greece: Preliminary Results**

The technological sophistication and behavior of early hominins in South-East Europe is poorly understood due to the scarcity of well-preserved, excavated assemblages. In this paper we present preliminary results from the study of the cultural material unearthed at the Lower Paleolithic site of Marathousa 1 (MAR-1), Megalopolis, Greece. The MAR-1 lithic assemblage is composed of small-sized flakes and flake fragments, retouched tools, cores that are commonly small and exhausted, as well as a large number of debris and retouch products, such as chips and resharpening flakes. So far, there are no indications of bifacial debitage and a key aspect of the material refers to its 'microlithic' character. The MAR-1 industry fits well in a group of important Eurasian sites with flake-based, small-tool, non-handaxe assemblages, such as Isernia, Ficoncella, Bilzingsleben, Schöningen, Vértezzölös, and La Polledrara, many of which, like MAR-1, have yielded evidence of elephant or other mega-fauna exploitation. On the basis of the on-going analysis of lithic material from three field seasons, we discuss aspects of assemblage composition and the role of raw material types, the main technological and typological traits of the industry, as well as the potential contribution of the MAR-1 evidence in broader discussions about Middle Pleistocene lithic techno-complexes and subsistence strategies in Europe. Finally, we briefly present faunal material with flake scars and bone flakes, which suggest that hominin exploitation of the carcasses was not restricted only to marrow extraction and bone processing for nutritional needs, but included also the knapping of bones, potentially with the aim of using the knapped products as tools.

**Tryon et al.**

## **The Archaeology of the 1929–1932 Excavations at Skhul (Israel)**

Skhul (Israel) has long provided a fundamental datum point for the origin and early African dispersal of *Homo sapiens*. Since its 1929–1932 excavation, multiple studies have focused on site chronology, the use of ~10 burials to address questions of hominin morphology, phylogeny, and behavior, and the examination of rare artifact types (e.g., ochre and shell beads). Nevertheless, there has been no systematic examination of the site's lithic evidence since the 1930s, in part because of the dispersion of the collection among multiple institutions. This is unfortunate as the lithic dataset provides the richest source of behavioral evidence from Skhul. To better integrate Skhul into current debates on hominin behavioral variability in the Levant, we draw on (1) previously unpublished archival material (fieldnotes and photographs), (2) micromorphological analyses of extant sediment blocks, (3) technological and geochemical analyses of lithic artifacts (n=3,349) from museum collections in the US, UK, and Israel, as well as samples from McCown's original backdirt excavated by A. Jelinek in the 1970s; and, (4) usewear analyses of a smaller sample (n=103) housed in the Peabody Museum (Harvard University). Artifacts and fossils at Skhul are embedded in a microsparite/sparite-cemented sand-sized matrix, with local springs active at least episodically during site occupation. Local Cenomanian flint sources were used, as were Eocene flint sources that were outside the daily exploitation territory. Levallois points in particular show increased use of non-local sources over time, but were consistently multi-purpose tools, showing more evidence for use in cutting tasks than impact damage diagnostic of their use as weapons. Comparisons of Skhul with other Levantine caves sites (Qafzeh and Amud) and open air sites (e.g., Ein Qashish) suggest complex patterns of landscape use in the Late Pleistocene that blur behavioral difference between Neanderthals and *H. sapiens*.

**Tucker et al.**

## **Preliminary Study of Bioavailable Strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) and Assessment of Diagenesis at Olduvai Gorge, Tanzania: Proposed Research and Methodology**

Stable strontium isotope analysis ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) of skeletal remains is a useful tool in assessing migration of prehistoric people and animals, and distinguishing local and non-local individuals. Geological bedrock composition and age are the primary factors which impact the local  $^{87}\text{Sr}/^{86}\text{Sr}$  value. Bioavailable strontium is strontium in groundwater taken up by plants during photosynthesis that is incorporated into animals' hard tissues when they consume said plants. As animals move, they carry with them the  $^{87}\text{Sr}/^{86}\text{Sr}$  signature of different areas. Post-depositional contamination called diagenesis can happen, where strontium in the matrix can overwhelm the  $^{87}\text{Sr}/^{86}\text{Sr}$  signature of the bone, making it difficult to determine what the original value of the bone was. In order to interpret  $^{87}\text{Sr}/^{86}\text{Sr}$  signatures from skeletal remains, variation in the region's bioavailable strontium values must be established. This can be done by analyzing plants, small herbivores, or land snail shells. Olduvai Gorge in northern Tanzania is an incredibly important area for paleoanthropological research, but there has not yet been a study done there on prehistoric mobility. In this study, we will analyze small portions of previously collected plants from known locations in northeastern Tanzania in order to determine their  $^{87}\text{Sr}/^{86}\text{Sr}$  signatures to create a bioavailable strontium isoscape: a map dividing up the landscape based on isotopic values. These samples will be from various Cenozoic (both sedimentary and volcanic) geological domains. As well, we will analyze bovid tooth enamel from David's Site at Olduvai Gorge, a 1.8 million-year-old site on the same paleosurface as FLK Zinj, to assess whether or not diagenetic contamination is a major issue at the site. This will determine if future studies on mobility of fossil fauna and hominins from Olduvai Gorge will be plausible. Here, we will outline our research plan and methodology to be used to conduct this study.

**Tuosto et al.**

## **Selectivity among Early Pleistocene Hominins: New Evidence from the Koobi Fora Formation**

Current perspectives on technology of the Early Pleistocene suggests that there are few features that all assemblages from this time range share. The ability of hominins to select certain rock types based on an understanding of mechanical properties of stone appears to be consistent across many Early Pleistocene sites. Here we investigate this pattern further with a focus on new archaeological data from the Koobi Fora Formation (FwJj 52). The site is stratigraphically above the Tulu Bor Tuff (3.43 Ma) and below a disconformity marking the transition to the Lorenyang Lake sequence (~2 Ma, Upper Burgi Member). The strata of the Tulu Bor and Lower Burgi Members here consist of coarse-grained clastics dominated by quartz and feldspar clasts characterizing slow episodic deposition with multiple disconformities. We describe the raw material variability of these assemblages in comparison to nearby gravels that represent rocks that were available to hominins at the time. In addition, we compare the selectivity seen at this assemblage to that expressed in Early Pleistocene assemblages throughout East Africa where similar studies have been conducted (e.g., Gona, Hadar, Kanjera South, Lokalalei). Evidence from numerous Early Pleistocene sites suggest that although hominins consistently select rock types for artifact manufacture at levels greater than would be expected based on their appearance in local gravels, the variance in the frequency of selected raw materials is great. This suggests that pressures on hominins to select certain raw materials depended on the context of various archaeological sites. Further work on the mechanical properties of stones at various Early Pleistocene sites may provide insights into this variability.

**Uy and Hawks**

## **Volumetric Differences in the Upper Ribcage of Extant Hominoids with Implications for Hominid Evolution**

Humans have expanded upper ribcages compared to great apes, a feature which may have first appeared in early hominins. Ribcage volume, an important unit of respiratory function, is determined by both costal and vertebral dimensions; however, investigations of hominin thorax evolution do not consider volume because fossil ribs are not often found with associated thoracic vertebrae. This study seeks to determine if costal dimensions alone can indicate a derived upper ribcage volume. Measurements from ribs one to three and vertebral bodies T1 to T3 in *Homo*, *Hylobates*, *Pan*, *Pongo*, and *Gorilla* were used to estimate upper ribcage volumes (RV) and upper ribcage cross-sectional areas (RA). RA relies solely on costal dimensions and RV relies on both costal and vertebral dimensions. Regression analyses investigated body mass relationships and residuals were compared to understand variation unrelated to body mass. *Homo* displays higher RV and RA compared to other hominoids; this confirms that *Homo*-like upper costal dimensions are quantitatively different from other apes. Further analysis shows that ribcage breadth contributes more to volume than ribcage depth. Costal dimensions alone can be reliable in separating humans and apes, but it largely cannot differentiate nonhuman hominoid taxa.

Body mass has significant effects on RA within *Homo* but not within *Pan*; the opposite is true for RV. De-emphasis of arboreal adaptations in the upper limb of *Homo* may have permitted the expansion of the upper thorax. Variation within *Homo* and *Pan* that cannot be explained by body mass may be due to specialized locomotor adaptations; specifically, vertebral size in the bipedal spine and rib size in the arboreal upper limb.

**Valdes et al.**

## **U-Th Dating of Ostrich Eggshell: Understanding the Relationship Between Eggshell Microstructure and Diffusion and Implications for Sample Preparation**

Dating the Middle Stone Age (~250–30 ka) is of great importance to studies of human evolution because this time period witnessed the origin of modern *Homo sapiens* in Africa, its migration out of the continent and across the rest of the world, advances in stone tool manufacture, and changes in foraging strategies. Techniques such as AMS <sup>14</sup>C can only be applied to the youngest end of this interval. Because many human groups collected ostrich eggs, U-Th dating of ostrich eggshell (OES) has often been used to establish the age of archaeological sites. Uranium from soil diffuses into the OES crystal structure after burial, and measurement of U and its Th decay product, along with an estimation of U diffusion rates (Sharp et al. 2015) into the OES enables a determination of the time of burial. However, age determinations can be complicated by the incorporation of detrital Th from soil into the OES. Sharp et al. (2014) showed that the external OES layers contain high detrital Th, and Loewy et al. (2016) demonstrated that the pores in the internal palisade layer also contain high detrital Th. Pores provide a critical avenue between the external and internal surfaces of the OES for Th to infiltrate the eggshell. We completed high-resolution CT scans of OES to map the number, 3D pattern, and volume of the pores. Rather than a single pore, the structure consists of numerous very small “satellite” pores oriented circumferentially around a large central pore. Total pore volume can be significant. In order to minimize the effect of detrital Th, we recommend that sample preparation combine the removal of the two outside layers of the eggshell with drilling out the area around each pore. Minimizing detrital Th diminishes the impact of the correction calculation, which is critical for precise age determinations.

**Veth et al.**

## **The Pleistocene and Early Holocene Archaeological Record of Barrow Island, Northwestern Australia: Early and Sustained Evidence for Mixed Use of Coastal and Arid Interior Settings**

Barrow Island in north-west Australia has revealed rich archaeological deposits from numerous rockshelter, cave, and open-air sites. Significantly, they provide critical insights into coastal settings of the late Pleistocene and early Holocene—time periods largely missing from northern Australia due to its extensive continental shelf. A mixed diet of terrestrial-arid and marine faunas is evident from initial colonization (42–50 kyr cal BP) continuing through to island abandonment (7.1 kyr cal BP). Early marine resources consist of sea urchin, gastropods, and bivalves and at >42 kyr cal BP, they are the oldest recorded marine dietary remains for modern humans in Australasia. While Pleistocene archaeofaunas consist mainly of medium-large macropods, a marked increase in both the volume and diversity of marine and terrestrial prey follows the LGM, as sea levels rise. Fauna are comprised mostly of small-medium game consistent with foraging by family groups and suggest a shift in cave function from a Pleistocene hunting bivouac to an extended family, residential base as the coast shifts closer. Stone artifacts are abundant in both cave and open-air sites and demonstrate use of both local limestone as well as non-local geologies from the arid interior. Non-local artifacts reveal high-levels of retouch and utilization suggesting long-distance transport. Barrow Island’s archaeological record simultaneously establishes the maritime competencies of the early colonizers of Sahul, as well as the rapidity with which people became familiar with the arid interior.

**Wall-Scheffler et al.**

## **Human Pelvic Morphology from an Integrative Context**

There is growing evidence that the overall structure of the human pelvis is not the result of any set of simple tradeoffs, and instead is the result of multiple factors. These factors include those related to the individual—such as age and locomotor patterns; those related to the niche—such as climate and terrain; those related to the population—such as phylogeny and subsistence strategy; and, those related to sex and gender. Additionally, each of these interactive and integrative factors might influence the overall pelvic structure differently depending on the context. In this poster we seek to summarize and elucidate the current places where we can unpack the variability of the human pelvis within the context of its evolutionary history. This will include the variation of sex-specific differences

across different human groups. We will suggest some key age- and population-related changes in the pelvis, as well as discuss current work in the functional morphology of the pelvis as it relates to locomotion.

**Wilkins et al.**

## **The North of Kuruman Project: Newly Discovered Middle and Later Stone Age Rockshelter Deposits in the Kalahari Basin at Gamohana Hill, Northern Cape, South Africa**

Investigations at Kathu Pan 1, South Africa support an early chronology (500 ka) for hafted spears (Wilkins et al. 2012), pigments (Watts et al. 2016), and Middle Stone Age (MSA) lithic technologies (Wilkins and Chazan 2012). These finds come from an open-air context and their chronology has not been replicated at other sites. If a population of hominins inhabited the southern Kalahari Basin ~500 ka, then there should be evidence at nearby locales that can be investigated using high-resolution excavation and dating methods. We report results of the North of Kuruman Project, which was developed to expand the domain of archaeological excavations in the Kalahari Basin. Reconnaissance identified several potential rockshelter and pan sites in the lesser-explored region north of Kuruman. Test excavations at two rockshelter sites, Gamohana Hill North (GHN) Shelter and Gamohana Hill South (GNS) Shelter, revealed *in situ* MSA and Later Stone Age (LSA) deposits. The MSA deposit at GHN includes lithic artifacts, fauna, ostrich eggshell, and charcoal within an ashy silt matrix. The lithic artifacts are in fresh condition, lay flat, and exhibit random orientations, consistent with little post-depositional disturbance. The assemblage is characterized by points and blades, prepared cores, and prepared platform flakes, consistent with an MSA-designation. Excavations vertically exposed nearly 1m of MSA deposit and bedrock was not encountered. GHS yielded ~40cm of an *in situ* LSA deposit immediately overlying bedrock. U-series analysis conducted on carbonate materials from the shelter walls and talus slope provides age constraints for the formation and evolution of the rockshelter system. Charcoal samples from the excavations provide age constraints for the archaeological deposits. Excavations at Gamohana Hill set the foundation for establishing a regional diachronic study of Pleistocene hunter-gatherer adaptation in the southern Kalahari Basin and further addressing the question of an early chronology for the MSA.

**Wyman et al.**

## **Ancient Middle Stone Age Climates at SM-1 in NW Ethiopia as Revealed by Stable Isotopic Sclerochronology**

The Shinfa River, a tributary of the Blue Nile located in NW Ethiopia, is the site of an archaeological and paleoecological research project investigating Middle Stone Age human adaptations. The river system is home to many riverine mollusk species. Today, the region is subject to brief but intense summer rains and an extended dry season. This extreme seasonality produces fluctuations in the river's water level, ranging from bank-full flows in the wet season to no flow during the dry season with isolated waterholes subjected to high evaporative rates. Because water level and temperature are guiding factors in mollusk shell formation, we hypothesize that evidence of wet and dry seasons is recorded in the  $\delta^{18}\text{O}$  levels of mollusk shells. Mollusk shells can provide a useful tool for reconstructing ancient climates because the shells grow in layers. The SM-1 MSA site, located along the Shinfa River, has yielded many fragments of ancient mollusk shells. We present isotope records of both  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  extracted from modern and ancient Shinfa mollusks. By sampling the layers incrementally, we can observe how temperature and water level fluctuated over time. The  $\delta^{18}\text{O}$  of the modern mollusk ranges from 7.15‰ to -1.679‰ vs. VSMOW. The very large range between the wet and dry seasons illustrates the extreme seasonality found in this region, and the pattern of fluctuations is cyclical. The SM1 MSA mollusk shells date from 30–>50,000 ka, and perhaps older, and range from -1.072‰ to 2.521  $\delta^{18}\text{O}$ ‰ vs. VSMOW. This smaller range indicates that at least some of the ancient SM-1 timeframe presented seasonality conditions somewhat less extreme than seen today, which potentially provided a more hospitable landscape for the people living in the region at the time.

**Zipkin et al.**

## **Construction of an Ochre Source Strontium Isoscape in the Kenya Rift Valley for Provenience Studies of Archaeological and Rock Art Mineral Pigments**

Strontium isotope ratios ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) are widely used to investigate prehistoric human mobility, residential biography, and provenience. We are constructing a radiogenic strontium isoscape to complement previous elemental composition-based provenience studies of ochre pigments in the Kenya Rift Valley (KRV). Our ultimate objective is to assess whether ochre geochemical provenience analyses

can contribute to reconstructing mobility, social and symbolic exchange, and interaction networks over the course of recent human cognitive evolution. Trace element characterizations have often, though not always, proven effective for ochre geologic source discrimination. Because  $^{87}\text{Sr}/^{86}\text{Sr}$  can distinguish geologic provenience as a function of bedrock age, we are investigating whether this variable can improve source discrimination. Guided by Kenyan Maasai, Dorobo, and Samburu informants who have used ochre sources, we sampled 46 geologic deposits between the Kenyan-Tanzanian border and Lake Turkana in 2015–2016. These sources are potentially relevant to sourcing studies of ochre artifacts from Middle Stone Age through Neolithic sites, and recent rock art paints, in the KRV. Three main modes of ochre formation were identified: (1) Late Quaternary hydrothermal vents, (2) later Neogene ferruginous hydromorphic paleosols thermally altered by overlying lava flows; and, (3) ancient Proterozoic metamorphic ferruginous ores and weathering products. These should all have quite distinct  $^{87}\text{Sr}/^{86}\text{Sr}$ . Whole rock powders were leached with aqua regia and Sr was purified from solution on cation exchange resin columns. Multiple Collector – Inductively Coupled Plasma – Mass Spectrometry (MC-ICP-MS) was used to measure  $^{87}\text{Sr}/^{86}\text{Sr}$ . These data were interpolated to construct isotope prediction surfaces using simple and ordinary kriging analysis in ArcGIS. Preliminary findings include identification of an isobaric interference during MC-ICP-MS of some samples due to high barium concentrations, although modified chemical separation procedures mitigate this problem. Geostatistical analysis indicates that ochres associated with young volcanics exhibit lower and more spatially homogenous Sr ratios than those from ancient Proterozoic contexts.