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Early Levallois Technology and the Transition from the Lower to Middle Paleolithic in the Southern Caucasus

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The Late Middle Pleistocene (LMP) was a period of profound biological and behavioral change that witnessed the evolution of *Homo sapiens* in Africa and the Neanderthals in Eurasia, and the transition from the Early Stone Age/Lower Paleolithic to the Middle Stone Age/Middle Paleolithic. This latter change can be broadly characterized by the gradual replacement of large cutting tools and bifaces by points, flakes and blades produced through a variety of hierarchical core strategies, among which the Levallois method is most prominent. Within the Southern Caucasus, a pivotal geographic region between Africa and Eurasia, virtually nothing is known about the archaeological record of this period. Nor Geghi 1 (NG1) is a LMP open-air site located within the Hrazdan valley north of Yerevan, Armenia. During 2008 and 2009, over 3,000 obsidian artifacts were recovered from a paleosol (Unit 2) that developed on the floodplain of the paleo-Hrazdan. These artifacts document the variable behaviors of the site's occupants and chart the local transition from the late Lower Paleolithic (Mode 2) to the early Middle Paleolithic (Mode 3) (Adler et al. 2014). Ar⁴⁰/Ar³⁹ dating of an underlying (Basalt 7, 440 ka) and overlying (Basalt 1, 200ka) lava flow, and sanidine grains from cryptotephra (Unit 1, 308 ka) suggest an age for the Unit 2 assemblage of 335–325 ka. These data indicate that NG1 is among the oldest Eurasian transitional industries with bifacial and Levallois technology recovered from a secure archaeological context, and the oldest stratified site in Armenia. At NG1, the early synchronic use of bifacial and Levallois technology is consistent with the hypothesis that developments in the technological realm of LMP hominins resulted from deep-rooted evolutionary processes based on a common technological ancestry rather than the expansion of a particular species armed with Mode 3 technology.

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Timing and Nature of Neanderthal and Modern Human Overlap in the Balkans

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The Balkans between 50–30 kcal BP is a likely context for encounters between Neanderthals and modern humans. Based on the archaeological record, it has long been suggested that modern humans dispersed both along the Mediterranean coast and Danube River valley, while Neanderthals persisted in the western mountains (Conard and Bolus 2003; Mellars 2006). However, this model has been difficult to evaluate due to the low number of reliably dated fossils and archaeological assemblages in the region. Here we present a chronology and geography of directly dated fossils and archaeological assemblages for the Balkans between 50–30 kcal BP. The spatial and temporal distributions are based on a systematic review of published radiocarbon dates as well as new radiocarbon dates from three sites in Serbia: Pešturina, Hadži Prodanova, and Smolučka. Our results suggest that Initial Upper Paleolithic and Uluzzian traditions overlap with Middle Paleolithic traditions for ~5000 years, ending ~39 kcal BP, coincident with the Campanian Ignimbrite eruption. If these assemblages are taken as proxies for Neanderthals and modern humans, the spatial distribution of the assemblages fits the model of late Neanderthals in the mountainous hinterlands and early modern humans along aquatic routes of the east and south. After ~39 kcal BP only Upper Paleolithic assemblages are found throughout the region.

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***In utero* Sources of Skeletal Variation: The Role of Maternal Prenatal Stress**

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Fossilized bones are the primary evidence we have of our lineage's evolutionary history. As such, the morphological variation of these bones is our main source of information about what they looked like, where and when they lived, and possibly, how selection operated on them. While many biologists focus on genetic underpinnings of skeletal shape variation, it is equally as important to understand the non-genetic factors that influence the shape and histological structure. Non-genetic influences include bone remodeling in response to stresses and strains faced during life. An increasingly recognized non-genetic source of variation is the influence of prenatal environment. Biologists are finding that *in utero* experiences can influence the phenotype long into adulthood. This study tested the hypothesis that maternal stress during pregnancy will have negative effects on offspring's skeletal development. Twenty-eight female and seven male Wistar rats (*Rattus norvegicus*) were purchased and bred to produce 176 offspring. During pregnancy, dams were randomly divided into four groups (n=7, per group) and immobilization stress induced as follows; Group 1: immobilization stress on days 1–7 of pregnancy, Group 2: on days 8–14, Group 3: on days 15–21, Group 4: left undisturbed. Maternal cortisol hormone, food intake, and weight gain were monitored during pregnancy. Pups were raised under normal laboratory conditions and sacrificed at ages: 4, 8, 12, and 16 weeks to determine the effect of prenatal stress. At necropsy, the tibia was removed and processed for histology. Differences among groups were determined by T-test or analysis of variance. Linear regression analysis was performed to establish the relationship between stress *in utero* and indicators of bone development in offspring. P values ≤ 0.05 were considered significant. Stress during pregnancy resulted in increased cortisol and reduced food intake in mothers, but a higher rate of bone formation and higher weight gain in offspring compared to controls.

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The Impact of Late Glacial Landscape Changes on the Formation Processes of Cave Sites in the Swabian Jura: Results from an Ongoing Project

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The Ach and Lone valleys of the Swabian Jura, in the State of Baden-Württemberg (southwest Germany), represent two key areas for the study of the first anatomically modern humans in central Europe, dated to 40,000 years ago. Previous and current excavations conducted within Hohle Fels Cave, in The Ach Valley, have shown the presence of an extensive erosional surface affecting the Gravettian and underlying layers. We hypothesized that this erosional phase was linked to changes in fluvial dynamics outside of the caves. Following this erosion, the caves were subsequently infilled by sediments containing Magdalenian artifacts. The sedimentary processes postdating the Last Glacial Maximum (LGM) are characterized by a shift in the sediment source likely related to the initiation of colluviation originating from outside the cave entrance. Interestingly, a similar sequence has also been documented by excavations conducted in the Hohlenstein Cave in the Lone Valley. During the LGM, Swabia was likely depopulated owing to the extreme cold condition and the proximity of the region to the northern extent of the alpine glaciation. Repopulation of the region first occurred during the Magdalenian. The aim of our project is to investigate how major environmental and geomorphological changes occurring during and after the LGM shaped the record of the human reoccupation in the Swabian region. Ground Penetrating Radar (GPR) coupled with field surveys conducted in front of Hohlenstein and Hohle Fels reveal colluvial deposits, river channel migrations, and eroded surfaces. By tracing these buried features we were able to produce 3D models that help reconstruct past landscapes. The subsequent coring campaign has allowed us to verify these models and collect samples for dating and micromorphology. Finally, the data from the cores is compared to the results of micromorphological studies of the deposits within Hohle Fels and Hohlenstein. By integrating different scales of observations, we are able to identify the formation processes of the sequences deposited within the caves and determine correlations between them and the major sedimentation processes active in the valleys.

Trabecular Bone Structure in Forefoot and Rearfoot Endurance Runners: Implications for Interpreting Fossil Hominin Morphology

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Direct fossil evidence for endurance running in early *Homo* has yet to be presented. Because bone remodels in response to specific patterns of strain, it is likely that endurance running leaves a reliable signature in bones of the feet, presenting the possibility for inferring locomotive behavior from hominin fossils. The aim of this study is to identify trabecular properties in regions of the calcaneus and first metatarsal that may result from endurance running in general and the loading regimes of forefoot and rearfoot running

specifically. Midstance produces the greatest talo-calcaneal forces in the region of the calcaneus we sampled, differences that are unlikely to differ based on footstrike. Achilles forces at the calcaneal tuberosity, however, are significantly higher in forefoot runners, leading us to hypothesize that forefoot runners will show greater bone functional adaptation (BFA) in the calcaneus as compared with rearfoot runners. We recruited forefoot runners (FFS), rearfoot runners (RFS), and non-runners, all males aged 25–40 for this institutionally approved study. Footstrike method was confirmed for each runner using a motion-capture system, and high resolution computed tomography scans were taken of regions of the calcaneus and 1st metatarsal for both runners and non-runners. Preliminary data are presented here on the calcaneus. FFS have greater average trabecular thickness than RFS (FFS=0.065 mm, SD=0.006, n=4; RFS=0.056 mm; SD=0.006, n=5) approaching statistical significance ($p=0.06$, effect size 0.6). No significant difference was found in trabecular number or trabecular bone density. These preliminary results suggest that greater Achilles forces result in increased BFA in the trabeculae of FFS calcanei, presenting the possibility to infer hominin running patterns from fossils. Non-runner and 1st metatarsal data will also be presented.

Chicaza Rockshelter (Niassa, Mozambique): A Preliminary Report on Stratigraphy and Chronology

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Due to its naturally strategic location between regions that are well-known for their extensive Stone Age records—southern Africa and the southern tip of the Great Rift Valley—Mozambique offers a clear potential to inform on various scenarios about recent biological and cultural human evolution. Its Stone Age sequence remains, however, largely unknown in the broader context of African Pleistocene prehistory. A recent project, aimed at investigating the Middle Stone Age of Mozambique, has developed, during the last couple of years, extensive and systematic survey in several regions of the country. In 2014, the core area for the fieldwork was the Niassa province located at the eastern side of the Lake Malawi, during which we were able to locate more than 100 Early, Middle, and Late Stone Age archaeological sites. Limestone/dolomitic areas are restricted in this region and thus most of the recorded sites were open-air surface deposits. Yet, a reasonable number of caves and rockshelters with high potential for stratified sequences and good material preservation were identified. This poster reports on the preliminary results of one of the recently discovered and tested locations, the Chicaza rockshelter, situated in the Chitete river valley at c. 45km from the Malawi Lake shore. We will focus mostly on the general description of relevant archaeological materials, stratigraphy, and absolute chronology including 10 new sample results. From a 1 square meter test pit we were able to recover abundant lithic materials, charcoal, and fauna, including at least two levels attributable to the regional Late Stone Age, making this one of the few directly-dated Pleistocene sites in the region.

Evidence of Early Middle Stone Age Technology and Long Distance Transport of Obsidians by Later Middle Pleistocene Hominins at the ~300 ka Sibilo School Road Site (GnJh-79), Kapthurin Formation, Kenya

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Long distance transport (>100km) of high quality knapping stone is an aspect of modern human behavior linked to exploitation of more diverse habitats, development of new technologies and, possibly, the establishment of social and trade networks^{1,2,3}. This behavior is documented from the Middle Stone Age (MSA) of Africa, but primarily from Late Pleistocene (< 130 ka) sites^{2,4}. Excavations at the Sibilo School Road Site (SSRS), Kapthurin Formation, Kenya, have produced MSA artifacts dating to ~300 ka. Geochemistry of the obsidian artifacts suggests obsidian transport >140km and from two distinct sources in the Kenyan Rift. Excavated artifacts (n=2506) from below a tuff dated by ⁴⁰Ar/³⁹Ar to 284±12 ka^{5,6}. at the SSRS show minimally disturbed knapping debris preserved *in situ*. MSA artifacts include 22 triangular points, including 13 Levallois points, and diverse core preparation observed on 21 cores. Six Levallois cores exhibit the preferential method (n=4) and the recurrent centripetal method (n=2). The majority of SSRS artifacts are made of two locally available macroscopically distinct phonolites and a yellow welded tuff. However, 44.43% of the assemblage by individual pieces (0.06% by weight=471.39g) is obsidian. Obsidian artifacts include three cores, of which two are Levallois preferential cores. Electron microprobe analyses (36 analyses on 4 samples) distinguish two obsidians, one of trachytic composition and another of rhyolitic composition, at the site. The SSRS rhyolitic obsidian matches sample MER 100 from Eburru7, ~140km south of the SSRS. The trachytic SSRS obsidian is most similar to obsidians sampled by Ambrose from Paka ~25–40km northwest of the SSRS. SSRS artifacts and geochemical data show long distance mobility associated with MSA technology were a part of the hominin behavioral repertoire in East Africa ~ 100 ka before the first documented appearance of *Homo sapiens*⁹.

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The Application of Proteomics Techniques to the Study of Ancient Human Tissues

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We have previously demonstrated the ability of using peptide mass fingerprinting using soft-ionization mass spectrometry as a high-throughput technique of species identification of the collagen that survives in fragmentary archaeological and paleontological bone. In this presentation we emphasize the potential of collagen fingerprinting using methods called ZooMS (Zooarchaeology by Mass Spectrometry) for distinguishing between human and animal bone fragments in application to archaeological sites ranging from the Upper Paleolithic site of Pin Hole cave (Derbyshire, UK) to the Neolithic site of Domuztepe (Turkey). More advanced proteome sequencing methods have also been used to study the potential causes for variations in nitrogen stable isotopes observed between different tissues such as skin and bone recovered from mummified remains.

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Bovid Mortality Patterns at Elandsfontein, Western Cape Province, South Africa, and Implications for the Hunting Capability of Acheulean-Age Hominins

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Elandsfontein preserves fossil fauna, a *Homo heidelbergensis* partial cranium, over 160 Acheulean bifaces, and thousands of flake tools and fragments in an early Middle Pleistocene, marsh-side paleoenvironment. Fauna comprise a surface-collected, time-averaged set of nearly 13,000 identifiable specimens from 50 species and several hundred individuals, notably of carnivores and ungulates. Klein et al. (2007) report few butchered bones and conclude that death at Elandsfontein marsh "... was probably mainly by attritional factors such as predation, accidents, and endemic disease that disproportionately affect the very young and the old." Providing mortality patterns for only two taxa, of which one, *Equus*, directly contradicts their overall site characterization, they nevertheless suggest "... limited Acheulean ability to obtain large mammals" and "... Acheulean-age hominins obtained few large mammals, whether by hunting or scavenging". Elandsfontein's taphonomic complexity and provocative implications for the evolution of hominin hunting prompted a recent reanalysis of the Elandsfontein fossils and mortality patterns. New analysis of large, size group 3 bovids—abundant in the original fossil collection and prominent in younger and older anthropogenic Pleistocene sites and in modern analogues—facilitates comparisons. Specimen-by-specimen comparisons yield significantly higher comprehensive estimates of the minimum number of individuals (six commonest size 3 bovid species MNI=125) than previously reported, and reveal high representation of young juveniles for some taxa and a strong living structure/catastrophic mortality pattern for individual species and "in aggregate," contra previous reporting. New data differ from expectations for carnivore predation, accidents, and endemic disease but compare well with anthropogenic sites (Bunn and Gurtov 2014), raising the likelihood of a detectable anthropogenic component at Elandsfontein. Without butchery evidence, new findings close no debates about Elandsfontein but may contribute to future research at the site and more broadly to understanding the evolution of hominin hunting in the Pleistocene.

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Drilling Campaign Summary and Preliminary Results of the Hominin Sites and Paleolakes Drilling Project (HSPDP)

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Between May 2013 and December 2014, the HSPDP successfully completed all five of its drilling campaigns and collected more than 1,700m of core. Despite the challenges associated with a large-scale multinational project, we have accomplished our goal of collecting lacustrine dominated cores proximate to key paleoanthropological sites. At our oldest site, 600m of Pliocene-age core was collected from 3 boreholes at 2 sites in the northern Awash, Ethiopia. This resulted in a composite depth of ~285m with significant overlap between cores and >96% core recovery. Several unexpectedly thick basalts were interbedded with lake sediments and drilling ceased prior to reaching our original target depth when rehydrated clays made advancing impractical. A single 228m borehole with ~95% core recovery was drilled at the Plio-Pleistocene Tugen Hills, Kenya, location. Documenting both lacustrine and terrestrial environments, preliminary comparisons with outcrop records suggest that this core may cover a time interval of ~2.5–3.45 Ma, longer than our original target of 2.5–3.1 Ma. A single 216m borehole with ~93% core recovery was drilled at the early Pleistocene West Turkana, Kenya, location and documents a fluctuating paleolake. Drilling ceased prior to reaching our original target depth due to complications associated with penetrating a hydrothermal fracture system. Nonetheless, tephrostratigraphic data indicates that the core covers our original target interval of ~1.45–2.0 Ma. 202m of modern to Middle Pleistocene core was collected from 4 boreholes at 2 sites at Lake Magadi, Kenya. Challenging lithologies to core/collect (alternating trona, chert, and clay) resulted in core recovery of 55–60%. Contact with the basement trachyte (~800 ka) at each site (137m and 197m), shallower than original estimates from low-resolution geophysical surveys. Recently, 480m of modern to Middle(?) Pleistocene core was collected from 2 boreholes at Chew Bahir, Ethiopia to a maximum depth of ~281m where a zone of artesian aquifer sands halted further progress.

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Stone Age Occupations in Northern Mozambique: New Evidence from a Survey Project in the Lunho River Valley (Niassa)

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The importance of the Lake Malawi area in the broader context of African Pleistocene prehistory, particularly in the movement of people along the Great African Rift, has long been recognized. Important but scarce MSA occupations have been referenced, particularly in the open-air sites of Mikuyu and Mvumu (Mercader et al. 2008, 2012). One of the sections that revealed aged-appropriate geological deposits for the occurrence of Pleistocene archaeology is the Lunho valley, one of the most important rivers of the Malawi Lake sub-basin. It has an average width of c. 4km and a course of more than 50km, flowing from east to west into the shores of the Malawi Lake. Both valley margins are marked by the presence of terraces and other fluvial deposits with irregular extensions of gravel floors. Through a new project of field survey and testing along these deposits we were able to identify and record close to 100 open-air locations with Stone Age artifacts and a very significant section with numerous sandstone rockshelters. Here, we report the results of the 2014 survey in the Lunho with particular emphasis to the spatial distribution of surface sites across the valley and throughout the various levels of erosive origin mudstone terraces, focusing also on the corresponding patterns of chronological attribution of the locations to the Early, Middle, and Late Stone Age. Although most of these sites are composed exclusively of thousands of local milky quartz pieces, chronological assignment is possible given the apparent association of techno-typology markers with specific terrace levels. In one particular case, the site of Ncuala, we were able to record a sample of more than 4000 lithic remains that clearly indicates a LSA chronology given the high frequency of bipolar and small blade production and the lack of the typical MSA prepared core technology.

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The Spatial Distributions of Lithic Artifacts within Middle Paleolithic Sites: A Comparative Study of Seven Sites

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In this study I examine the distributions of different technological categories of lithic artifacts at seven Middle Paleolithic sites. Two criteria are used to evaluate spatial arrangements: 1) the location of lithics within high, medium, and low density zones; and, 2) the location of lithic refits relative to other lithics in their refitting group. These dual approaches provide both a static assessment of where artifacts were found and, for the portion of the assemblage that was refit, a glimpse at the movement of different kinds of artifacts. By utilizing multiple sites certain robust patterns emerged. The results show that certain artifact categories are consistently overrepresented in the high density areas, whereas other categories tend to be overrepresented in the low density zones. Still other artifact forms display mixed results. The clearest signal comes from debris and cores, which show opposite associations. Debris, predictably, are overrepresented in the high density zones, while cores are overrepresented in the low density zones. Tools, Levallois flakes, and blades also tend to be overrepresented in the low density areas, although there are some interesting exceptions. These results indicate that activities leading to the deposition of artifact classes were overlapping and were not confined to specific spatial areas. However, clear spatial relationships can be established when dividing the site by density area (i.e., low vs. high density), rather than comparing only high density clusters. These patterns can also be used to assess spatial consistency of the archaeological assemblages. An assemblage is considered to be spatially consistent when the results from the two criteria agree with each other and with patterns displayed at the other six sites. This can give information about the duration of occupation and re-use of the site—the more spatially consistent the assemblage, the shorter the duration and fewer the number of reoccupations.

The Still Bay and Pre-Still Bay Fauna from Sibudu Cave (South Africa): Implications for Understanding Behavioral Variability in the Southern African Middle Stone Age

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Research on human behavioral evolution during the Later Pleistocene has increasingly focused on characterizing variability in behavior within the Middle Stone Age (and the Middle Paleolithic), and on the uncovering the impetus behind the emergence (and disappearance) of innovative behaviors during this period. These studies are critical to our understanding of the development of a fully modern cultural system and should ultimately provide insight into similarities (and differences) in the adaptive capabilities/strategies of MSA/MP populations. As one of the few known sites to preserve deposits from the Still Bay (SB; ~75–68 ka) and the Howiesons Poort (HP; ~65–58 ka)—two phases of the southern Africa MSA showing evidence for a suite of innovative behaviors—and from the periods immediately preceding and post-dating these industries, Sibudu Cave offers a unique opportunity to directly engage with these issues in a meaningful way. This paper presents the results of a recently completed study of the SB and pre-SB fauna excavated at Sibudu Cave under the direction of Lyn Wadley—more than 90kg of fauna comprising >200,000 fragments were processed; with an NISP (number of identified specimens) of ~3,800. In addition to presenting basic taphonomic and taxonomic information, I will explore whether the Sibudu data are consistent with hypotheses linking the onset of the SB with environmental change. No significant changes in the relative frequency of open vs. closed dwelling species were identified in the pre-SB vs. SB fauna, suggesting that at Sibudu, the onset of SB was not associated with climate change; however, these data should ultimately be compared to environmental data deriving from the botanical record. I will close by exploring how these new data contribute to our understanding of the relationship between subsistence and technological change spanning from the pre-SB through the post-HP MSA at Sibudu.

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Spatial Approaches to Site Formation and Carnivore-Hominin Interaction at Dmanisi, Georgia

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The spatial association of various types of taphonomic and faunal sub-assemblages can offer valuable insight into behavior-related formation processes and post-depositional movement. With great preservation, accurate provenience recording, and a taphonomically interesting faunal assemblage, the early *Homo* site of Dmanisi, Georgia, is the focus of this spatial analysis. In this paper, we provide visualizations and analyses of the spatial distributions of faunal and lithic material at Dmanisi in order to examine previous hypotheses regarding site formation (e.g., Gabunia et al. 2000; Lordkipanidze et al. 2007; Tappen et al. 2007). We analyze two main excavation areas of the site (Block 2 and M6), concentrating primarily on the most prolific layer, B1, and its pipe/gully fill facies: B1x, y, and z. Orientation

and dip data, along with distributions of skeletal element portions with different bone densities, different orders of Mammalia, and taphonomic modifications to bone, show that multiple lines of evidence support the hypothesis that little post-depositional movement/ bone transport has occurred and carnivores accumulated much of the faunal material, with hominins making a small imprint. Faunal articulations also show that there are close associations between the pipe/gully fill facies of the B1 layer, in which all of the hominin fossils were uncovered. The spatial relationships of different sub-assemblages at Dmanisi show that certain areas have differential patterning of behavioral agents, mainly carnivores. Used in tandem with the lithic data, the spatial analysis of the faunal assemblage also tests hypotheses surrounding the hominin contribution to the assemblage.

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Exploratory Survey and Landscape Archaeology in the Karonga District, Northern Malawi

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Since 2011, archaeological surveys have been undertaken in northern Malawi to test hypotheses about Middle Stone Age (MSA) human mobility patterns and technological responses to climate change at the landscape scale. Data were collected over a region measuring approximately 70km x 20km to understand artifact attributes relative to different geological deposits and landscape attributes. The 2012 and 2013 surveys consisted of attribute collection of surface exposed raw materials and artifacts within archaeological areas of interest with an emphasis on sampling geological exposures where many artifacts are visible on the surface. During these surveys, data were only collected from cores. This resulted in a large dataset that shows distinctive patterns in raw material use and core reduction within different river catchments. In 2014, the survey procedure was broadened into a formal landscape survey using systematic linear transects oriented through major river catchments and designed to sample multiple geological formations. All cores along the transects were recorded, and data from all surface artifacts were collected from 2m x 2m areas placed at 100m intervals along the transects. The 2014 survey also provided an opportunity to apply and refine our methodology in the field, including integrating tablet-based transect navigation and artifact attribute recording with digital elevation model construction using Unmanned Aerial Vehicle imagery. Results showed that at the landscape scale, lithic artifacts are comparatively scarce in the river catchments south of Karonga except where erosion of Middle-Late Pleistocene alluvium created isolated "islands" of artifact-bearing sediment. Surface artifacts were also comparatively rare relative to the abundance of subsurface artifacts recovered during an accompanying test-pitting program. The survey also identified new areas of interest for further investigation, including sediment packages relatively unaffected by modern disturbances and at least one potential MSA site that appears to preserve *in situ* knapping floors.

Quantifying the Habitat Preference of Extinct Mammals, Including Hominins, in Plio-Pleistocene Eastern Africa

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Properly classifying extinct taxa as habitat generalists or specialists is important for our understanding of how ecological and evolutionary mechanisms functioned in the past. Previous studies have inferred habitat preference from proxies such as functional morphology, stable isotopes, dental wear, and/or habitat preferences of extant relatives. These measures, however, are all indirect habitat indicators and do not measure the direct association between the taxon of interest and its inhabited environment. Here, we classify fossil taxa as habitat generalists or specialists based on their observed associations with open- or closed-vegetation sites in the geological record. We jointly analyzed an online pedogenic carbonate database (1) with published records of fossil large mammal abundances from eastern African sites divided into two one Myr time bins: 3.5–2.5 Ma and 2.5–1.5 Ma. One Myr time-averaged bins were justified to explore the full range of sites/habitats that were occupied by each taxon. Stable carbon isotope values were transformed into fraction woody cover (2), and sites were categorized dichotomously as closed or open based on a 0.4 cut-off. We conducted our main analyses at the genus level and calculated relative abundances of each taxon found in open and closed habitats. Following a new statistical method (3), we then classified each genus into one of four categories: 1) open habitat specialist, 2) closed habitat specialist, 3) generalist, or 4) too rare to classify. This method corrects for biased relative abundance estimates due to unsampled genera and differences in sampling intensities between the two habitats. Results show that more genera are classified as generalists than expected based on previous research. This has implications for the ecological plasticity of mammals on evolutionary timescales and/or may reflect the different spatio-temporal

scales at which fossil mammals and pedogenic carbonates record environmental signals.

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Lithic Raw Material Procurement in Qafzeh and Amud Caves: Implications for Mobility Patterns in the Levantine Middle Paleolithic

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Settlement and mobility patterns can be deduced from studies of lithic technology and the raw materials found on-site. This study focuses on raw material procurement and inferred aspects of mobility in two stratigraphic layers of Qafzeh Cave (XIX and XIII) dated ~100,000–90,000 ka and associated with modern humans, and two stratigraphic layers of Amud Cave (B4 and B1) dated to 68–55 ka from Israel, linked with Neanderthals. The lithic assemblages in both sites are made exclusively on flint and occur as many different visual raw material types, distinguished by their colors and textures. An ArcGIS model is used to create a topography-sensitive predictive model for Daily Exploitation Territories (DET) around each site. This model was used to designate local vs. nonlocal outcrops. By linking the visual data with geochemical information (ICP-MS, ICP-AES), using a battery of statistical methods (e.g., ANOVA, Principle Component Analysis, and Cluster Analysis) to establish the relationship between the two types of observations, the analysis shows that in both sites local materials are most abundant and were brought to the cave to ‘provision the place.’ Additionally, distant raw materials, some from a distance of over >60km, were brought to the caves in particular typo-technological forms, suggesting ‘provisioning of individuals.’ Distant raw materials are more pronounced in Amud Cave, suggesting relatively long-distance transport and high mobility. We discuss the implications of these observations in the context of reconstructing territoriality and mobility patterns of Levantine MP groups.

Detailed Dynamic Modelling of Glacial Climate over the Cape South Coast of South Africa

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The south coast of South Africa is the location of important Middle Stone Age (MSA) sites that have revolutionized our understanding of modern humans. For most of the time span of modern human origins the earth was in a glacial state that varied from strong to weak glacial conditions, interspersed with shorter interglacials. Reconstructing glacial paleoscapes is central to understanding modern human evolution. Paleoscientists normally use fragmented paleoarchives from points on the landscape (sites) to inductively project past climates and environments. Here we describe a high-resolution dynamic downscaling of global paleoclimate glacial simulations to obtain a detailed description of regional climate over the Cape south coast during times of glacial maxima at the paleoscape scale. The Climate Studies, Modelling and Environmental Health (CSM&EH) research group of the CSIR has developed an extensive regional climate modelling capacity in South Africa, through the application of a high-resolution, dynamic climate model. The variable-resolution global climate model CCAM (conformal-cubic atmospheric model) is the only regional climate model developed in the Southern Hemisphere. Forced with the sea-surface temperatures and sea-ice fields provided by global climate models, the high resolution model uses a multiple-nudging procedure to simulate regional climate in detail. In our study we implemented CCAM on the Blacklight supercomputer system at the Pittsburgh Supercomputing Center (PSC) of XSEDE to extensively simulate strong glacial conditions on the south coast of South Africa. Downscaling coupled climate model projections for the Last Glacial Maximum, these simulations (of about 8km resolution in the horizontal) describe in detail the local response of rainfall, temperature and wind-patterns to the large scale circulation forcing during times of glacial maximums. This unprecedented paleoclimate model allows high resolution projections of flora, fauna, and other resources important to MSA humans across the paleoscape and can be validated with our point-based paleoarchives.

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The Use of the Ascending Ramus in Hominoid and Hominin Phylogeny

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The relative width and height of the ramus, coronoid, and condylar processes, and the width and depth of the sigmoid notch, vary between hominid and hominin taxa. These morphological differences have been argued to be useful in phylogeny by Rak et al. (2002, 2007) and Terhune et al. (2014). Rak and colleagues argued that superior ramal morphology can partition Neandertals from other members of the genus *Homo* and that the similarities between *Paranthropus* and *Australopithecus afarensis* has phylogenetic implications that may preclude the latter from being the sister taxon to the genus *Homo*. More recently, Terhune et al. revisited this question. They found that gorillas and humans could clearly be distinguished, with chimpanzees and orangutans intermediate between the two morphologies. While they agreed with some of Rak et al.'s conclusions, they argued that humans have a uniquely derived morphology and similarities to chimpanzees are due to homoplasy. Here I have used similar techniques to Terhune et al. but included fossils in the analysis as Rak et al. did. I did not find support for the ability to separate Neandertals and other members of the genus *Homo* using ramal morphology, but *Au. afarensis* did group with *Paranthropus* rather than with other, more recent hominins. It does not appear, from my analysis, that ramal morphology is a useful tool in creating phylogenies as it does not recreate the known hominoid phylogeny nor clearly partition hominins into more primitive or derived groups.

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The Kinematics of Knuckle-Walking: To What Extent is Gait and Posture Conserved in the African Great Apes?

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Bipedalism is a defining characteristic of humans and our ancestors. The African great apes, our closest living relatives, engage in knuckle-walking during terrestrial locomotion and provide a point of reference for understanding the evolution of bipedal locomotion in early hominins. To test if the footfall sequence, timing, and joint angles of knuckle-walking apes will look similar across body sizes and despite ecological differences we analyzed video of zoo-housed subjects walking perpendicular to a high speed camera (240 frames/sec). We recorded footfall sequence, timing, and joint angles from digital high speed videos of *Gorilla gorilla* (n=6), *Pan troglodytes* (n=7), *Pan paniscus* (n=10), and *Pongo pygmaeus* (n=1). Contrary to inter-limb timing patterns of many other primates, we found that knuckle-walking apes exhibited a variable footfall sequence and changed between diagonal sequence and lateral sequence gaits. This result was not driven by speed, and limb phase was not correlated to speed relative to size ($R^2=0.036$). This variability in footfall sequence appears to be characteristic of all knuckle-walkers and possibly all great apes. Furthermore, differences in wrist posture could not be explained by ecological differences. Take off and mid-stance wrist angles significantly differed according to species (ANOVA $p=0.041$, $p<0.0001$). However, contrary to the assumption that extended wrist posture is associated with increased arboreality in knuckle-walkers, gorillas exhibit an extended wrist posture during the stance phase to a greater degree than both chimpanzees and bonobos, despite greater terrestriality. These results may suggest that patterns of locomotion are conserved in extant knuckle-walking apes and that wrist posture and gait sequence are not under strong selection according to local ecological differences.

300,000 Years of Coastal Occupation in Pondoland: Recent Findings of the P5 Project and Future Directions

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There are significant gaps in our understanding of when, where, and how humans first began to exploit nutrient-rich foods like coastal resources. These foods may have had a significant impact on the health, well-being, and survival of hunter-gatherers in the past and there is an equally strong interest in the legacy effects of eating foods like shellfish on the diets, health, and wellbeing of people today.

South African Middle Stone Age sites have revolutionized our understanding of when these marine resources were first collected and the role they played within larger cognitive, cultural, and technological changes. However, the current record is dominated by sites located in areas with unstable coastlines and this is thought to explain the gaps in occupation. The first step to fixing this problem is developing robust chronologies of coastal foraging and occupation in areas with stable coastlines. Here, we present the current findings of the P5 project, which is studying the origins and development of coastal foraging in Pondoland, Eastern Cape Province, South Africa. Due to the narrow continental shelf, Pondoland is one of the few southern African locations where one can expect to find continuous records of coastal foraging that have not been influenced by coastline changes. In particular, we focus on the archaeology, geology, marine and terrestrial fauna from four near-coastal rock shelters and one coastal open-air site that we intend to test in the near future. We also provide the first direct ages of the coastal red sands that contain *in situ* late Early Stone Age and early Middle Stone Age flaked stone tools. These optically stimulated luminescence ages show that humans have inhabited Pondoland for over 300,000 years, predating the currently known origins of the modern human lineage as well as the earliest known evidence for systematic coastal foraging.

Zooarchaeological Analysis of Newly Excavated Middle Pleistocene Deposits from Elandsfontein, South Africa

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The Early-Middle Pleistocene transition represents an important time in human evolution marked by global climatic shifts, the extinction of *Homo erectus* in Africa, and the appearance of more derived Middle Pleistocene hominins. Archaeological assemblages of this age typically lack well preserved faunal remains in primary association with artifacts, so studies of hominin behavior have largely focused on lithic technology. The Acheulean locality of Elandsfontein, South Africa (1Ma–600 ka) is a rare exception with a large faunal sample that has figured prominently in several important studies. Initial collections recovered ~13,000 mammalian fossils and <300 artifacts. These collections were interpreted as representing natural mortality events which attracted both hominins and carnivores. Low frequencies of cut marks (<1% of limb surfaces) were taken as evidence that hominins had little impact on the mammalian community and limited ability to obtain large carcasses. However, these collections are from deflation surfaces and are biased toward well-preserved specimens, lack sufficient contextual information, and represent an amalgamation of fossils from two separate horizons. We present a comprehensive zooarchaeological analysis of the (~800,000 year old) fauna from four recent systematic excavations at Elandsfontein. These excavations are distributed across a paleolandscape (~6km²) and contain fauna (~20,000) in primary association with artifacts (~3,800). New analyses suggest multiple agents of accumulation with varying degrees of hominin and carnivore activity distributed across this paleolandscape. Frequencies of hominin induced butchery are higher (up to 2.9% NISP) than reported for previous collections. These are likely underestimates, as bone surface damage and green bone fracture appear to be obscured by several taphonomic and diagenetic processes related to the depositional environment (aeolian sands). Our work indicates that behavioral interpretations based on previous faunal collections at Elandsfontein underplay the degree of hominin modification and do not take into account the complex taphonomic history across the paleolandscape.

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Developing Geochemical and Magnetic Studies of Obsidian Lithic Assemblages: A Case Study in the Hrazdan Valley, Central Armenia

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The “Obsidian Resources and Landscapes of Palaeolithic Armenia” project has focused on the development and implementation of innovative techniques for geochemically and magnetically characterizing obsidian sources and artifact assemblages. Many lithic assemblages in Armenia were made primarily, if not entirely, from obsidian, an abundant resource in this region. At least 18 distinct compositions of obsidian were produced by a dozen volcanic centers. Developing a better understanding of geochemical and magnetic variations in the obsidian sources and their spatial expression on the landscape can enrich interpretations of artifact assemblages. To that end, we have conducted intensive source surveys and characterization. For example, we have geochemically and magnetically characterized the Gutansar obsidian complex using more than five times as many specimens as all prior studies combined. Such efforts have permitted us to develop, for instance, methods to chemically identify artifacts’ origins in just 10 seconds using a portable X-ray fluorescence (pXRF) instrument (Frahm et al. 2014a; Frahm 2014). Consequently, artifacts can be sourced as they are collected on a survey or excavated at a site, offering feedback in the field. Using pXRF also enables geochemical sourcing of many more artifacts in a local field lab than could be exported (Frahm and Doonan 2013). In addition, methods based on magnetic properties of obsidian that vary within an individual flow are promising for insights at smaller spatial scales (Frahm and Feinberg 2013; Frahm et al. 2014b).

An application we are pursuing is using the properties to investigate provisioning strategies, specifically whether humans preferred material from a particular outcrop or quarry or instead collected material as it was randomly encountered during hunting-gathering activities. Another application is combining magnetic properties with a raw material unit (RMU) approach as a means to recognize artifacts produced during reduction of a single obsidian nodule. Two sites in the Hrazdan valley—Nor Geghi 1 (Lower Paleolithic) and Lusakert Cave 1 (Middle Paleolithic)—serve as case studies.

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Hominin Population Dynamics and Dispersals in the Armenian Highlands and Anatolia: New Data from Barozh 12, a Middle Paleolithic Open-Air Site on the Edge of the Ararat Depression, Armenia

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At the boundary of Africa and Eurasia, the Armenian Highlands and Anatolia are pivotal regions for the study of Pleistocene hominin population dynamics, land use, and technology. Models of hominin dispersals require archaeological data to complement a sparse hominin fossil record, especially in these understudied regions. Recent excavation at the open-air Middle Paleolithic (MP) site of Barozh 12 in Armenia yielded 16,551 obsidian artifacts from just seven 1m x 1m trenches, preserved in a c. 1m thick stratified sequence. Techno-typological analysis of this assemblage indicates a focus on uni-directional convergent Levallois core reduction and point production, with basal truncated – faceted modification of points. The assemblage bears technological similarity to all other dated MP assemblages in Armenia, spanning an age range of c. 100–40 kya, and those in the Levant, Syria, and Iran. Obsidian sourcing at Barozh 12 and other Armenian MP sites suggests raw material transport distances of c. 200km at their maximum observed extent, implying a population range centered in the Ararat Depression and the Armenian Highland. In contrast, the Central Anatolian Volcanic Province (CAVP), separated from the southern Caucasus by c. 800km, preserves many obsidian MP assemblages in similar contexts, but there Levallois point production is never observed. Regionalized, long-standing core reduction and tool production technologies in Eurasia may be explained with a structured metapopulation model for hominin dispersals, typified by small isolated populations, local extinctions, and multi-directional migrations. The Ararat Depression straddling the Armenian – Turkish border and the CAVP may be locations of persistence of such isolated populations during the MP, with migratory links to different regions of Eurasia. In light of increasing chronologically controlled MP data from Armenia and Turkey, a ‘culturally mediated’ metapopulation model is a suitable framework for considering regionalized technological patterns to investigate hominin population dynamics and dispersals.

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The Evolution of Developmental Plasticity in Human Brains

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Studies of human brain evolution have classically focused on differences in endocranial size and shape between different hominin species, in part because this is the information that can be gleaned from the fossil record. We still lack, however, a clear understanding of the brain modifications that have allowed for the acquisition of modern human behavior. Developmental plasticity is a fundamental property of human brains, which can be linked to individual’s adaptability to particular environmental conditions and can be traced from molecular to gross anatomical levels. Previously, we have shown that high levels of anatomical fluctuating asymmetry characterize human brains as compared to chimpanzees, which might be indicative of increased levels of plasticity in the former. In the current study, we used quantitative genetic methods to estimate the heritability of brain anatomy, which corresponds to the proportion of phenotypic variance that is attributable to genetic variation. We used a sample of more than 200 chimpanzees for which a well-documented pedigree is available, and a comparative sample of more than 200 humans including monozygotic twins, non-

monozygotic twins, and non-twin siblings. We used structural MRI scans and three-dimensional reconstructions of the cortical surface to measure different traits, including brain size, major lobar dimensions and length of the primary sulci. Chimpanzees show very similar heritability for measures of brain size and cortical organization. On the contrary, humans show high heritability for brain size, moderate values for general lobar dimensions, and very low and non-significant heritabilities for the lengths of most cortical sulci. These results show that human brains are characterized by a low level of genetic control on sulcal organization in comparison with brain size. Assuming a similarity between the brain architecture of chimpanzees and stem hominins, we suggest that an increased level of environmental influence on cortical organization evolved in later hominins.

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Early Tools from West Turkana, Kenya

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Recently, there has been increasing openness in paleoanthropology to the possibility of hominin tool manufacture before 2.6 Ma. The earliest artifacts from the sites of Gona, Hadar, and Omo in Ethiopia, and especially Lokalei 2C in Kenya already demonstrate hominin knappers' planning depth, spatial coordination, manual dexterity, and raw material selectivity. It has been argued that artifacts before 2.6 Ma might be of too low densities or that archaeologists have not recognized such stone tools because they might not directly resemble known Oldowan lithics. In 2011, the West Turkana Archaeological Project began new survey in the Lomekwi member (3.44–2.53 Ma) of the Nachukui Formation in Kenya, to search for evidence of earlier hominin lithic behavior. We report the discovery of Lomekwi 3 (LOM3), an archaeological site where stone artifacts have been found *in situ* in spatiotemporal association with Pliocene hominin fossils and from a wooded environment. The LOM3 knappers, with a developing understanding of the fracture properties of stone, and using simple bipolar and passive hammer techniques, were combining battering activities with core reduction. The LOM3 tools mark a new beginning to the known archaeological record.

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Was the Younger Dryas of the Southern Levant Dry, or Just Cold? Stable Isotope Evidence from Gazelle Teeth

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The Younger Dryas (YD) is a North Atlantic cooling event that interrupted an otherwise warm post-glacial period at ~12,800 cal BP due to the disruption of the North Atlantic thermohaline circulation. Over the course of its brief 1300 year duration, climates returned to glacial-like conditions in high latitudes, however the impact of the YD on climates in the southern Levant is highly contested. Regional climatic proxies provide contrasting evidence—dry conditions are indicated by positive cave speleothem oxygen isotope values among other indicators, while wet conditions are implicated by higher water levels in the Dead Sea Basin. Because environmental change associated with the YD figures prominently in influential explanations for the transition to agriculture in this region, high-resolution reconstructions of local conditions based on proxies from *in situ* anthropogenic contexts are needed to resolve conflicting interpretations. To examine this question, a large sample of gazelle tooth enamel from the Early and Late Natufian occupations of Hayonim Cave and the Late Natufian site of Hilazon Tachtit Cave was studied. Seasonal stable isotope ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$) values recorded in gazelle tooth enamel carbonate were used to reconstruct environmental and climate conditions before and during the YD. The $\delta^{13}\text{C}$ values measured in gazelle teeth show that water availability during the growth season of C_3 vegetation, did not decrease between the Early and Late Natufian. Thus, a significant positive shift in $\delta^{18}\text{O}$ values during the YD is interpreted as a result of changing water source composition rather than a decrease in the amount of precipitation. Our new data should be incorporated into higher-resolution

environmental and climatic models that can predict the distribution and abundance of key food resources during the Natufian and their significance in the onset of the forager-producer transition.

Taphonomic History of the *Homo erectus* Site at Trinil, Java

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The Indonesian site of Trinil, located along today's Solo River in eastern Java, marks the place where in 1891 Eugene Dubois discovered the first *Homo erectus* fossils. Although tens-of-thousands of other vertebrate and invertebrate fossils were recovered from this meter-thick conglomeratic bone bed, earlier studies of the non-hominin material focused on the taxonomy and biostratigraphy. Despite the importance that the discoveries at Trinil have had in documenting the presence of *Homo erectus* in Java, no detailed taphonomic analysis of the collection has been conducted to address the formation of the site, including possible involvement of *Homo erectus* in site generation. We investigated the taphonomic history of the Trinil vertebrate assemblage using the fossils in Dubois Collection at the Nationaal Natuurhistorisch Museum (Leiden, the Netherlands). We applied standard taphonomic approaches to quantify skeletal element representation, weathering stages, transport history, patterns of bone breakage and modification, and age profiles in order to reconstruct the formational history of Trinil. The assemblage consists primarily of disarticulated elements of large terrestrial herbivores, some fresh-water taxa, and rare taxa including carnivores and hominins. The material is notable for the large body-size diversity represented, a limited amount of pre-burial weathering and transportation damage, spiral long-bone fracturing, occasional crocodile-tooth marks, and uniform fossilization. These data support the conclusion that the bone bed is the product of short-term deposition from hyper-concentrated river flow, capable of transporting the large and small bioclasts with minimal damage. We find no evidence of *Homo erectus* involvement in generating the site.

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Deep Cave Foraging by Late Pleistocene Hominins in Northwestern Bulgaria

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Although deep cave use by Pleistocene hominins has been linked to burial or disposal of the dead and possible ritualistic activity and art, evidence of Paleolithic hominin subsistence behaviors is rare in such settings. The late Pleistocene site of Magura Cave in northwestern Bulgaria provides evidence that Paleolithic hominins ventured into deeper caves to access meat. Stone tools and cut-marked animal remains were excavated *in situ* approximately 200 meters inside of the entrance, and geomorphological analyses demonstrate that the material was not washed in by water. Cave bears (*Ursus spelaeus*) represent the most abundant faunal remains, although other carnivores and artiodactyls were recovered. Most *Ursus* are older adults with heavily worn teeth, but very young juveniles are also present in the assemblage. These findings indicate that the bears (both adults and infants) most likely died of natural causes during hibernation. Twenty percent of the bear elements display tooth marks suggesting that carnivores were the primary consumers of ursids. However, hominin butchery left a taphonomic signature with 6% of the bear bones exhibiting cut marks and 3% showing both tooth marks and cut marks. Among non-ursid faunal remains, 43% of bone fragments contain tooth marks, 7% have cut marks, and 7% display both tooth marks and cut marks. These results indicate that although carnivores were the primary accumulators of non-ursid remains and had first access to ursid carcasses, some butchery took place, and probably occurred in the context of hominin scavenging. The possibility that these activities took place outside the cave and that bones were subsequently transported to the interior by carnivores or other agents can be discounted with respect to the ursid bones. Excavations at Magura therefore provide a rare opportunity to evaluate patterns of deep cave usage by Pleistocene hominins.

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New Dates on Middle Paleolithic Sites of the East European Plain: Implications for Human Paleogeography

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Because of the scarcity of diagnostic skeletal remains, the presence of Neanderthals on the East European Plain is based almost entirely

on archaeological proxies, i.e., Middle Paleolithic artifact assemblages. Many of the latter contain Levallois products similar to those of the Initial Upper Paleolithic, however, while others comprise flake scrapers, various bifacial implements, and other artifacts that might represent expedient tools of modern humans (similar to many Paleoindian sites in North America). Sites on the East European Plain that contain these assemblages and postdate the appearance of modern humans in northern Eurasia (~45,000 cal BP) could have been occupied either by Neanderthals or modern humans. We obtained new radiocarbon dates on three major open-air sites on the central and southern plain of Eastern Europe assigned to the Middle Paleolithic. Betovo, which is on the Desna River near Bryansk and contains an assemblage dominated by denticulates, notches, and side-scrapers (Tarasov 1977), yielded eight dates on ultra-filtered bone collagen between 28,800±390 cal BP and 36,600±800 cal BP. Shlyakh, located near the Middle Don River, contains Levallois blades that yielded three dates on ultra-filtered collagen of ~36,100–49,000 cal BP, but overlie the Laschamps Excursion (~44,000 cal BP) (Nehoroshev 2006; Nehoroshev and Vishnyatsky 2000). Khotylevo 1, also located on the Desna River and containing Levallois products and various bifacial forms (Zavernyaev 1978), produced dates on soil organics (~46,500±3160 cal BP) and charcoal (51,485±3810 and 55,255±5400 cal BP) (Ocherednoi et al. 2014). On the basis of the new radiocarbon dates, Betovo is as likely to have been occupied by modern humans as by Neanderthals, regardless of the artifacts. Shlyakh also appears to be problematic in this respect. On the other hand, Khotylevo 1 still appears too early to have been occupied by modern humans.

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The Late Middle Paleolithic Open-Air Site Complex of Ein Qashish, Northern Israel

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Ein Qashish is an open-air Middle Paleolithic (MP) site located geographically among the of the major MP cave sites in northern Israel. A small excavation and extensive geological testing (Ekshtain et al. 2014; Greenbaum et al. 2014; Hovers et al. 2014; Malinsky-Buller et al. 2014) revealed a site that extended over at least 1300m². In 2013, a large salvage excavation exposed >500m² and revealed four archaeological horizons in a 4.5m long sequence, all situated on the flood plain of the paleo-Qishon stream, in a dynamic context of secondary tributaries flowing into the main channel. OSL dates place all the archaeological horizons between 60–70 ka, comparable in age to the MP occupations of Kebara and Amud Caves. The archaeological horizons at Ein Qashish differ in their depositional micro-environments, taphonomies, artifact densities, and the characteristics of lithic and faunal assemblages. Levallois technology is present in all the occupations, but in some cases pointed and elongated items dominate, whereas in others the whole reduction sequence is preserved, inclusive of numerous refits. The faunal assemblages, containing cut marked bones, include species known from caves (gazelle, fallow deer) as well as large mammals (e.g., aurochs) that are rare in cave sites, representing open as well as wooded habitats. Special finds include a *Hexaplex trunculus* shell from the Mediterranean, ochre, pitted stone anvils, and human remains. The series of occupations on the paleo-Qishon banks provides an opportunity to study late Levantine MP settlement systems from a landscape perspective, emphasizing their diversity and illuminating ecological and social factors that shaped these systems.

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Did Trinil Femur I Originate from a Younger Formation than the *Homo erectus* Skullcap? Implications of Early Site Photographs and Other Provenience Records

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Some investigators contend that Trinil Femur I is not *Homo erectus*, but *Homo sapiens*, and instead of originating from the Trinil-skullcap bonebed as Eugène Dubois reported, came from a second, younger formation. However, scrutiny of early site photographs and other records support Dubois' provenience account, not this two-formation alternative. In 1891, Dubois' field supervisors unearthed the skullcap from a fossiliferous-sandstone ledge jutting into the Solo River. In August 1892 they found Femur I, also well-fossilized, ~15m west of the skullcap, after first removing sufficient bedrock to trench the bonebed below river level. Although Dubois missed seeing the femur *in situ*, he had investigated the near-flat-lying strata being dug in July, and accepted his supervisors' assurances that femur and skullcap came from approximately the same elevation. No real-time contextural drawings are known, but Dubois' famous 1895 cross section places both fossils at one level within the horizontal bonebed. The bed is underlain by conglomerate and claystone, and overlain by conformable sandstone beds, capped by soil. The claystone-conglomerate-bonebed-sandstone sequence, ~12m thick, is now the Kabuh Formation (Middle Pleistocene faunally). Dubois' sandstone stack is plainly visible atop the bonebed in high-quality photographs taken in 1894, 1900, and 1907 (as Dubois and the Selenka Expedition excavated southward ~50m). In 1894, sandstone is just meters from the skullcap-femur discovery points; only soil overlies sandstone in adjacent high banks. In the ~130-m-long (~7.5-m-high) 1900 wall, there is a westward-thickening wedge of channel-fill sandstones resting discordantly on the horizontal stack. The wedge reaches river level ~70m southwest of the discovery points. However, these deposits are unlikely to be the postulated alternate source for Femur I. They probably did not extend to the 1892 discovery point (e.g., they are missing in the 1894 back wall), and later geological investigations included them in the Kabuh.

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Schöningen 13 II-4: A Middle Pleistocene Horse Opera in Several Acts

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The discovery of wooden hunting spears at the Sch ningen 13II-4 site conjured images of an organized group of Middle Pleistocene hominins intercepting and dispatching an entire herd of horses along the shore of an interglacial lake in what is now Lower Saxony, Germany (Thieme 1997, 2005). These spears, abandoned together with stone tools and butchered bones, stimulated a reappraisal of early human behavior to account for these systematic hunting practices aided by sophisticated weapons. In 2013, MONREPOS began a multidisciplinary analysis of the complete archaeological record and sedimentary sequence at Sch ningen 13II-4 Spear Horizon within the broader context of human behavioral adaptations to interglacial environments. In this presentation, we describe new results of our taphonomic, spatial, and paleoenvironmental analyses toward a holistic reconstruction of the depositional history and associated hominin activities at this important site. Recent work by Stahlschmidt and Miller (2014) suggests the Sch ningen 13II-4 find horizon does not represent an *in situ* deposition, but rather a subaqueous palimpsest accumulation with little interpretive value. We disagree with this assessment as it is based largely on the evaluation of individual finds from limited depositional contexts. Based on our comprehensive analysis, we propose the Sch ningen 13II-4 Spear Horizon does represent an *in situ* deposit and preserves a very unique and informative record of Middle Pleistocene hominin behavior. We propose a complex process of site formation, a scenario that entails multiple, overlapping hunting episodes along the lakeshore during all seasons of the year. Despite multiple occupations of the site, consistencies in the spatial arrangements of artifacts, regular butchery patterns, and the pervasive use of bone tools suggest some level of behavioral continuity among these repeated site visits. This revised interpretation reveals a successful formula of adaptation that implies considerable foresight and social organization involved with hominin subsistence behaviors during the Middle Pleistocene.

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A High-Resolution Single Grain Optically Stimulated Luminescence Chronology for Pinnacle Point Site 5-6

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Few archaeological sites show detail of past occupation in as much detail as Pinnacle Point site 5-6. This site documents three broad types of sedimentary deposit. The first chronicles occupations characterized by small groups and short visits in the form of single and intact hearths in a roof-spall dominated matrix. The second is represented by thick palimpsests of burnt remains, often disturbed by small gravity flows. The third correspond to predominantly aeolian sediments, sometimes deplete of any archaeological evidence. It has been proposed that these differences may be directly related to the relative level and proximity of the ocean to the site, and how intense occupation of the site might have been. We have applied single grain and single aliquot optically stimulated luminescence (OSL) dating to ~110 sediment samples collected from individual stratigraphic units along the >14m Long Section and the Northwest Remnant. In addition, we have also sampled geological deposits from the landscape surrounding the site, both above and below current sea-level. In this presentation, we will provide a robust OSL chronology for site occupation and abandonment and elucidate the timing of complex human-environment interactions that were at play in the past. We will also compare our chronology for PP5-6 with the high resolution speleothem record from the nearby Crevice Cave to add a climatic dimension to the record. Internal and external checks to confirm the accuracy of the record will be discussed and previous criticisms of our systematic dating study will be addressed and explained. Finally, this detailed record will be integrated with previous OSL chronologies of other southern African MSA sites to provide an update and extension of previous chronological models.

Exploratory Excavations at Bizmoune Cave (Essaouira): First Results on the Aterian of the South Atlantic Coast of Morocco

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There is striking diversity in evolutionary trajectories across Africa and Eurasia between 200,000 and 30,000 years ago. North Africa was home to a distinctive population of humans as well as a unique archaeological complex, the Aterian, characterized by “precocious” appearance of traits such as personal ornaments. Recent research has done much to clarify (though not resolve) the temporal limits and climatic associations of the Aterian. However, it is widely recognized that understanding the uniquely derived cognitive and behavioral features of late Pleistocene hominins requires documenting their behavioral flexibility and societal resilience. Consequently, the next challenge is to understand the nature and causes of variability in the Aterian (and contemporaneous complexes). Bizmoune cave was originally discovered and tested by the second author during a regional survey. We returned in 2014 to expand test excavations and better understand the site’s stratigraphy and cultural sequence. The site was chosen in part because it is ecologically and geographically removed from the better-known Aterian sites in Morocco, which are situated on the north Atlantic and Mediterranean coasts, Rabat and Oujda. Bizmoune is situated well to the south, about 20km inland from Essaouira. Bizmoune cave contains Neolithic, Upper Paleolithic (Ibero-Maurusian) and MSA/Aterian components. The MSA/Aterian layers yield typical Aterian artifacts, including bifacial foliates and pedunculate pieces, endscrapers, small Levallois cores, and ornaments made from marine mollusk shells. Many layers are separated by carbonate crusts. Preliminary results suggest that the intensity of occupation declined markedly toward the end of the Aterian occupations. In addition to large mammal remains, fragments of edible marine shellfish (*Mytilus* and *Solen marginatus*) were recovered from Aterian/MSA levels. Given the site’s distance from the modern coastline this suggests longer transport of shellfish than is typical in other Paleolithic or ethnographic contexts.

Patterns and Parameters of Morphological Variation in the South African Australopith Jaws

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This paper outlines a holistic and quantitative description of the australopith maxilla-mandibular morphology, which has been made possible by the continuing advances in shape analysis. The analysis of 3D data with geometric morphometric methods (GMM) has enhanced our ability to understand morphological variation and covariation beyond the use of traditional linear measurements. However, such analysis of early hominins has been limited to only the most complete specimens since GMM does not readily lend itself to analyses with missing data. South African australopith morphology is commonly represented in GMM studies by a few key specimens such as Sts5, MLD37/38, Sts71, and SK12. This study combines GMM (111 landmarks) and linear analysis (80 measurements) to include a broad range of *A. africanus* (n=69, 3D data for 28) and *A. robustus* (n=78, 3D data for 33) original fossil specimens. Morphological units within the preserved maxilla-mandibular complex are compared to homologous regions in extant genera (Gorilla, n= 33; Chimpanzee, n=30; *Homo*, n=52). This combination of techniques exploits the advantages of each. With GMM, this means the preservation of geometric relationships within the dataset, the ability to examine size and shape independently, and the visualization of shape variation. At the same time, linear measurements allow the extraction of corroborating information from the more fragmentary specimens. The results reveal a clearer picture of the australopith “mosaic” morphology. For example, a Principal

Components Analysis (PCA) of the upper jaw shows that australopiths fall within the chimpanzee range of shape variation (PC1:46.9%, PC2:13.2%), while their maxillary tooththrow shape is distinct (PC1:42.3%, PC2:9.6%). A PCA of the maxillary and mandibular linear measurements show that the australopith variation is separate from (and lies between) the human and great apes ranges (PC1:66.2%, PC2:9.1%). These findings are discussed in light of morphological modularity and integration with implications for the fossil record.

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Technological Sequence and Origins of Prepared Core Technology at Canteen Kopje, Northern Cape Province, South Africa

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Alluvial deposits at the site of Canteen Kopje near Barkly West, South Africa, have provided an invaluable collection of Earlier Stone Age artefacts. A 2007 to 2009 excavation in Pit 6 recovered an assemblage of over 15,000 artifacts that have been dated using the cosmogenic nuclide burial method. Three distinct assemblages show a progression of technological changes through time in the earlier Acheulean industrial complex. The youngest alluvial gravel layer contains Victoria West prepared core technology. Beneath it is the Organized Core Assemblage which is void of Victoria West, but contains cores that demonstrate more organized knapping techniques in the form of asymmetrical control. Finally, the underlying basal Early Acheulean Assemblage lacks both prepared cores and organized cores. The abundance of large angular clasts of andesite in the area made multiple knapping strategies effective for the manufacture of large flakes. A technological sequence in the knapping strategies spanning the Calabrian (1.8–0.8 Ma) has emerged in this excavation, from simple cores to organized cores and finally prepared cores. Older technologies clearly display the roots of prepared core technology in the asymmetrical control of the organized knapping methods.

Reconstructing Middle Pleistocene Landscapes in the Kapthurin Formation Using Biomass Productivity and Stable Isotope Proxies

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The Middle Pleistocene of East Africa documents significant technological and human biological change that may have been influenced by changing environments (1, 2, 3, 4). The Kapthurin Formation is a Middle Pleistocene sedimentary sequence in the Kenyan Rift Valley that records the transition from Acheulian to Middle Stone Age (MSA) technology, and provides an ideal setting to test the relationship between environmental and technological change (5, 6, 7). Methods of environmental reconstruction with a landscape focus are ideal to test such relationships because they offer a broad perspective to study the habitats in which Middle Pleistocene hominins lived and created Acheulian and MSA technology (8). Stable isotope analysis of fauna and soils provides a fitting method to reconstruct past environments, and is independent of taxonomic identifications of fossil fauna and their presumed habitat preferences. Here we present environmental reconstructions of two time slices within the Kapthurin Formation, dating to 543±4 ka – 509±9 ka and 509±9 ka – 235±2 ka by the ⁴⁰Ar/³⁹Ar method (9). These reconstructions are based on stable isotope values of carbon (δ¹³C) and oxygen (δ¹⁸O) derived from fossil bovid tooth enamel, pedogenic carbonate, and soil organic carbon. We also present a new technique for correlating modern biomass productivity, assessed with a Normalized Differential Vegetation Index (NDVI) and derived from satellite imagery, with isotopic values of modern soil organic carbon and pedogenic carbonate samples. We are then able to extrapolate NDVI values for Middle Pleistocene landscapes based upon fossil stable isotope values and begin to predict their carrying capacities. These environmental reconstructions provide detailed landscapes to assess the ranging patterns of Acheulian and MSA hominins, and to examine whether the makers of MSA and Acheulian technology differed in their exploitation of landscapes, habitats, or resources.

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Neanderthal Local Raw Material Utilization and Transport in Southwestern France

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Studies of Neanderthal mobility rely largely on the sourcing of distant raw material types to measure the extent of artifact transport (e.g., Féblot-Augustins 1993; Geneste 1985). In areas such as the Aquitaine region of southwestern France, on average over 95% of the artifacts in the Middle Paleolithic assemblages were made on flint materials obtained in the local environment, typically within a 4km radius of the site (Turq 2000; Turq et al. 2013). Although raw materials from sources up to 100km away do occur, their quantities tend to be minimal. This flint-rich context, where workable materials were relatively abundant, poses a challenge to the study of the ways Neanderthals utilized and transported local lithic resources. This research applies an alternative approach for measuring artifact transport through quantifying the cortex proportions of lithic assemblages (Dibble et al. 2005). Based on estimates of the size and shape of originally worked nodules, it is possible to calculate an excess or deficit of cortex surface area relative to the artifact volume present within a given assemblage—this relationship is expressed as the Cortex Ratio. The imbalance between assemblage cortex and volume, in turn, indicate artifact transport to and from the assemblage locality. Here, Cortex Ratios are calculated and statistically validated for three Middle Paleolithic sites in the Aquitaine region of France—Roc de Marsal, Pech de l’Azé IV, and Combe-Capelle Bas. The ratios suggest a tendency of homogeneous transport pattern during Marine Isotope Stage (MIS) 5 and more heterogeneous patterns in MIS 4 and 3. The findings of this study support recent observations on the dynamic nature of Mousterian lithic technology and the importance of artifact transport in the formation of the Middle Paleolithic record (Turq et al. 2013).

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Elliptical Fourier Analysis of Two Hominoid Teeth from Middle Pleistocene Sanxieshan Cave, Daxin, Guangxi, China

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Shape analysis of tooth crowns has proved to be a useful method for taxonomic classification of fossil hominins. This study uses elliptical Fourier analysis of crown outlines to investigate species affinity in two recently discovered permanent molars from the Sanxieshan Locality 2 cave site in Daxin, Guangxi, China. One left lower molar (SX15) and one right upper molar (SX09) were found *in situ* directly below travertine deposits securely dated to ~300 ka (uranium series dated). The molars were compared to upper and lower first, second, and third molars of extant hominoids (n=225), *Gigantopithecus*, and Early to Middle Pleistocene hominins including *Homo heidelbergensis*, *Homo neanderthalensis*, *Homo ergaster*, and *Homo erectus* (n=97). Canonical variates analyses (CVA) of molar shape were conducted using elliptical Fourier coefficients (60 cosine and sine components of x and y increments) from 15 generated harmonics that describe outline shape with positional translation and size normalized away. CVA results of 158 extant and fossil lower molars assign SX15 as a lower *Pongo* molar with 99.95% (98.1% assigned correctly) and as a *Pongo* lower second molar with 93.4% probability (96.2% assigned correctly). CVA analyses of 164 extant and fossil upper molars assign SX09 as an Asian *Homo erectus* upper molar with 86% probability (93.1% assigned correctly), and as an upper Asian *Homo erectus* first molar with 77.8% probability (94.5% assigned correctly). These results indicate that SX15 and SX09 are similar in aspects of their crown outlines to *Pongo* and *Homo erectus sensu stricto*, respectively. Implications of the tentative classification of these new fossils will be discussed in a paleoanthropological and biogeographical context.

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Another Facet of Behavioral Variability in the Levantine Middle Pleistocene: The Age and Paleoenvironment of the Lower Paleolithic Site of Kefar Menachem West, Israel

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Kefar Menachem West (KMW) is one of several Lower Paleolithic localities that were discovered near Kibbutz Kefar Menachem in the southern coastal plain of Israel. KMW was excavated in 2005, revealing an archeological layer embedded on top of hamra sediments, upon an unconformity, overlain by thick dark clay sediment, ca. 3–5m below the present day surface. The lithic assemblage is characterized by production of flakes from hierarchical cores, without a bifacial component. While dozens of handaxes were discovered since the 1950 following agricultural activities (plowing), none were identified in KMW excavation. Being a chronological marker within the Lower Paleolithic, the absence of handaxes left the chronology of KMW unresolved. Dating efforts were conducted in 2012 and 2013 in order to resolve the chronology of the site and reconstruct its palaeoenvironment. The results of several dating methods—paleomagnetic analysis, optically stimulated luminescence, and thermally transferred optically—yielding a chronological range between 780,000 to 460,000 ka. The paleoenvironmental reconstruction, based on isotopic compositions in soil carbonates, indicates the persistence of Mediterranean vegetation at the site's area during the last 780,000 ky. Fluctuations from drier conditions into a more humid one were observed in the sedimentary sequence coinciding with the time of hominin settlement. In the presentation, we discuss the KMW locality, its techno-typological characters, the lateral distribution of low-density patches vs. higher-density clusters as well as the few faunal remains in order to reconstruct Middle Pleistocene life ways within a landscape perspective. These characteristics are then placed in the broader context of Middle Pleistocene behavioral variations in the Levant. We suggest that the patterns observed at MWW correspond to variations in modes of exploitation of the immediate habitats and ecological niches within a Mediterranean coastal plain.

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Impact Fracture Patterns on Experimental Basalt Points—Towards a More Robust Macro-Fracture Method

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The origins and development of hunting systems are important archaeological research topics that require the integration of multiple lines of evidence. Macro-fracture analysis is one of the most widely applied, but controversial, methods for identifying weapon use in stone tool assemblages. I present the results of a controlled projectile experiment that builds upon recent studies aimed at refining the macro-fracture method. This experiment expands experimental reference samples to include basalt and investigates whether impact fracture patterns can be distinguished from published patterns of knapping- and trampling-related damage. Fifty-one convergent points were fired at measured velocities into a flat bone target (cut from a cow scapula), positioned between two ~3cm thick meat slabs. The basalt points formed the same range of impact fracture types as have been demonstrated on other rock varieties, but showed subtle differences in fracture patterns. Quantitative GIS-based analysis and qualitative evaluation of fracture types is used to explore fracture formation, size, and co-occurrence in relation to point location, edge shape, edge angle, and penetrating angle. In the face of recent criticisms demanding a more robust macro-fracture method, expanding the range of experimental reference samples and combining population-level analysis of fracture patterns with consideration of tool morphology and taphonomy is a productive line of research. In addition, this experiment highlights the potential of basalt assemblages, which are prevalent in East African MSA assemblages, for investigating early hunting technologies.

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The Origin of the Levantine Emiran and Implications for Modern Human Dispersal into the Levant

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The origin of the Levantine Emiran is entangled with the question of modern human expansion. The Out of Africa paradigm predicts a modern population influx into the Levant, coinciding with the appearance of the Emiran around 50 ka BP. There is debate, however, whether Emiran's roots were autochthonous or exogenous. Initial Emiran core technology employs a distinct bidirectional Levallois point production system that can be traced back in time through Arabia and ultimately into Africa. On the other hand, Emiran tendencies for artifact elongation, an emphasis on point production and a preference for UP tools over MP ones are essentially long standing Levantine traits. While some affinities may be found in the African Taramsan and the Arabian Mudayyan, these seem to be

synchronic and parallel developments, rather than ancestral forms. Overall, a fusion model centering on Levantine/Arabia interactions is suggested that is parsimonious with the archaeogenetic proposition for interbreeding between humans and Neanderthals in the Near East between 100 and 50 ka BP.

Shell Beads and “Decorated” Bones at the Early Upper Paleolithic of Manot Cave, Israel: Symbolic Expressions of Early Modern Humans in the Levant

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The Levantine Upper Paleolithic reflects the emergence, dispersal, and adaptations of early Anatomically Modern Human populations. The Early Upper Paleolithic (EUP) material culture known from the Levant is crucial for understanding the exploitation of animal raw materials to produce personal ornaments and symbolic artifacts, major innovations of this period both in the Levant and in Europe. The recently discovered cave site of Manot (western Galilee, Israel) is one of a few sites representing the EUP, dated to ca. 30–45 ka BP. Within this project, we present the first results of the study of personal ornaments and symbolic items made of marine shells and bone from EUP levels. Shell beads include perforated *Nassarius gibbosulus*, *Columbella rustica*, and *Antalis* spp., as well as two cowrie beads found in association with human bones. “Decorated” bones comprise of incisions on both awls and limb bone fragments, as well as a notched hyoid gazelle bone. The characteristics of the shell bead and decorated bone assemblages, along with the lithic, bone and antler industries, support a strong Aurignacian affinity.

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Lumbar Vertebral Shape and Trabecular Structure in African Papionini

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The shape and internal structure of vertebrae have been studied in relation to locomotor behavior in a wide range of taxa using many different methods. This study combines a 3D geometric morphometric analysis of external vertebral shape with an internal structure analysis (degree of anisotropy and bone volume of trabeculae) in the terminal lumbar vertebra of five genera of African Papionini (*Papio*, *Mandrillus*, *Theropithecus*, *Cercocebus*, *Lophocebus*). The sample consists of a mixed assemblage of male, female, adult, and sub-adult individuals. Unlike most previous studies, the taxa in this study are very closely related. However, they engage in different locomotor and positional behavior and utilize different substrates which allows for a detailed analysis of the impact of behavioral differences on internal and external features of lumbar vertebrae, as bone tissue is constantly remodeled to counteract strain on, and damage of, the bony structure. Both the bone density and the orientation of the internal trabecular rods are constantly adjusted and remodeled to meet the requirements put on the bone by physical stress. The results showed that vertebral shape and the degree of anisotropy of trabecular microstructure can be considered as reasonable separators between arboreal and terrestrial quadrupedal locomotion in primates. Trabecular bone volume did not allow a separation between the groups, indicating that the amount of force acting on the spine due to differences in locomotion does not differ significantly. Differences between the studied vertebrae are attributed to different requirements placed on, and forces acting on the spine in different environments. Shape differences between arboreal and (semi-)terrestrial groups seem to be related to back stabilizer and extensor muscles. The results of this study are a useful step towards distinguishing between relatively broad locomotor types of fossil Cercopithecidae and could thus help in the estimation of paleoenvironments.

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The Social Transmission of Oldowan Lithic Technology

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Flint flakes appear in the archaeological record from 2.5 mya and the skill to produce them is believed to have been socially transmitted. However, how this occurred remains a mystery. In an experiment involving 184 participants, we investigated how effectively five different forms of transmission facilitate the acquisition of the ability to produce Oldowan flakes. We compared: i) reverse engineering of discarded flakes, ii) observational learning, iii) basic “ape-like” teaching, iv) gestural teaching, and v) verbal teaching. We found that teaching, particularly verbal teaching, allowed participants to produce a greater number of flakes from a single piece of flint, to do so more rapidly and with more efficient use of raw materials and energy, than did reverse engineering. There was no evidence that observational learning improved performance relative to reverse engineering. We conclude that reliance on stone tools during the Oldowan would have generated selection for enhanced means of communication and it is likely that forms of teaching were present during the Oldowan. We also suggest that the appearance of Acheulean technology 1.7 mya relied, in part, on the prior evolution of novel forms of communication, which, given the complexity of Acheulean tool making, plausibly involved a simple form of symbolic communication.

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Lithic Technologies of the Malawian Middle Stone Age: Building a Chrono-Spatial Framework for Early Modern Human Behavior in Central Africa

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The Middle Stone Age (MSA) was a significant period of human behavioral innovation and elaboration, as evidenced primarily by finds from southern and eastern Africa. Inter-regional patterns of MSA behavior—and their relationship to the evolution of modern cultural complexity—have been more difficult to discern. New data from the Karonga District of northern Malawi provide fresh insight into these behaviors at a landscape scale, with the first quantification and depositional/geochronological context for the MSA of this part of central Africa. Twenty-one 1m x 2m test pits were excavated in and around the town of Karonga, and an additional 17 test pits ca. 10km to the south at the Sadala South locality. These test pits demonstrate the abundance of lithic artifacts in the Chitimwe Beds, with 34 of 39 producing MSA assemblages (one-third with refitting lithic artifacts), two producing LSA assemblages, and only two without any finds. Between the two study areas, significant differences exist in raw material choice, lithic reduction strategies, and depositional integrity, providing essential data on MSA technological and land use behavior over an evolving landscape. These data suggest one of two possible conclusions about MSA behavior in this area: 1) contemporaneous MSA populations in the two study areas were relatively isolated from one another, insofar as similarities in technological repertoires may reflect relative connectedness of groups; or 2) deposition of the lithic artifacts was asynchronous, with each study area revealing a different time slice of MSA behavior. Based on combined artifactual, sedimentological, geomorphological, and geochronological analyses, the latter scenario is favored, and demonstrates the strength of the northern Malawi deposits for building a long chronology of MSA behavior in central Africa.

A Fractographic Method to Distinguish Hominin vs. Carnivore Broken Bone: Improving Estimates of Hominin and Carnivore Involvement in the FLK-Zinjanthropus Fossil Assemblage, Olduvai Gorge, Tanzania

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Interpretations of the evolution of meat-eating are based on relatively rare tool and tooth marks in Oldowan (2.5–1.7 mya) fossil assemblages. Consequently, accurately estimating the extent of hominin and carnivore involvement is difficult, and the carcass-acquisition debate (passive vs. confrontational scavenging vs. hunting) continues (Plummer 2004). One suite of damages are ubiquitous, but largely unstudied—bone fracture surfaces. The fractographic (study of fracture surfaces) method developed here aims to improve

our ability to diagnose hammerstone- and carnivore-induced fracture in zooarchaeological assemblages. The fractographic and fracture mechanics literature forms the foundation for this method. 1) When agents differ fundamentally in the mode and amount of force application, the resulting damages differ (e.g., Fréchette 1990; Quinn 2007). Impact loading with high force levels creates more fracture features than created by static application of less force with smaller indenters. Hammerstone impact force is estimated (~10300N, minimum) to be considerably greater than the maximum static loads recorded for carnivores (4500N). 2) Fracture feature frequencies, including fracture lines, flake scars, incipient flakes, cones, lateral stress, hackle marks, and radiating cracks at loading points and their configurations, are likely to distinguish high and low levels of force application. The method is tested via analysis of experimental hammerstone broken bones, the Amboseli Hyaena den assemblage, and two fossil assemblages, FLK-NN2, and FLK-Zinjanthropus, Olduvai Gorge, Tanzania. Principal component analyses of fracture features in the assemblages support material science predictions. Hammerstone fracture generates more damage creating features rarely observed on carnivore broken bones (i.e., cones, lateral stress, radiating cracks, and incipient flakes). This method increases the estimate of hominin involvement with the FLK-Zinjanthropus fossil assemblage over that defined by percussion marks alone. In contrast, the very low frequency of carnivore broken bone supports Dominguez-Rodrigo and Barba's (2006) argument that most surficial lineations in this assemblage are not referable to carnivores.

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Wadi Madamagh (Jordan): Behavioral Diversity during the Last Glacial Maximum in the Eastern Levant

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Wadi Madamagh, a small rockshelter in the Petra region of the western highlands of Jordan, was first excavated by Diana Kirkbride in 1956. She briefly described the cultural materials, emphasizing the microliths (Kirkbride 1958). Our 2011 excavations documented two sets of occupations, between which Kirkbride did not distinguish, but that were noted in a small test unit in 1983 (Schyle and Uerpmann 1988). We report for the first time on new radiocarbon dates for these occupations during the Initial (Nebekian) Epipaleolithic and underlying Late Upper Paleolithic, as well as phytolith, faunal, and lithic analyses that allow for a better understanding of hunter-gatherer-forager behaviors at Wadi Madamagh. The occupations occurred during the Last Glacial Maximum, with phytolith data indicating a heavy reliance on dicot resources, supplemented by wetland taxa. Unlike Ohalo II in the western Levant (Kislev et al. 1992), hunter-gatherer-foragers at Wadi Madamagh do not appear to have focused their plant exploitation activities on grass or cereal taxa, but on other locally available plant resources. Notably, the Nebekian levels yielded a ground stone cupmark boulder, suggesting some food processing. Groups at Wadi Madamagh primarily hunted wild goat (probably ibex), which also was noted by Perkins (1966). This is not unexpected given the rugged topography of the Petra region. Approximately 10% of the bones are those of birds and there are no tortoise remains. This vividly contrasts with sites of the Late Upper Paleolithic and Initial Epipaleolithic in the Wadi al-Hasa region of the western highlands to the north, indicating species distributions that are at least partially related to quite different habitats. In combining analyses of the Kirkbride collections (Byrd and Reese 2014) and the 2011 assemblages, we address behavioral diversity in the eastern Levant through comparison of Wadi Madamagh to the Wadi al-Hasa sites.

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Small Things Considered: Examining Processes and Definitions of Southern African Microlithization at Rose Cottage Cave and Sehonghong

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Microliths are variably defined as small retouched tools, small flakes or bladelets made from small cores. They are a major component of Late Pleistocene lithic technologies in many parts of the Old World. Microliths enabled humans to optimally exploit a variety of rock types, enhanced the use of composite technologies, and provided increasing freedom of movement to foraging communities. Southern Africa is a region with an especially rich and variable record of microlithization. There, a uniquely rich pulse of microlithization occurring c. 44–12 ka marks the beginning of the Later Stone Age. In this period, archaeologists define microliths from 44–22 ka as small, unretouched flakes, whereas in contexts from 22–12 ka, they define microliths as unretouched bladelets using a variety of arbitrary size limits. Unfortunately, comparing microlith production across this period is complicated by current typological approaches that use variable definitions for microliths and general uncertainty about how microliths were made. This study compares new technological and morphometric data from Rose Cottage Cave and Sehonghong, two key long-sequence rock-shelters documenting early (>22 ka) and late (<22 ka) phases of microlithization in southern Africa. These results begin to unpack the concept of microlithic technology in southern Africa and to discuss its importance in the Late Pleistocene prehistory of the region.

A GIS Image Analysis of Bone Surface Modification Patterns in the FLK 22 (FLK Zinj) Assemblage, Olduvai Gorge, Tanzania

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In this study, we present a taphonomic examination of the ca. 1.84 Ma bovid fauna from FLK Level 22 (FLK Zinj), Olduvai Gorge, using a new GIS image analysis technique. This site contains some of the best preserved evidence for hominin meat eating and has been used extensively in reconstructions of early hominin behavior. Despite numerous previous interpretations of site function, there is currently no consensus regarding how hominins acquired carcasses at FLK Zinj. Some interpretations argue Oldowan hominins had early access to fleshed carcasses through hunting or active scavenging, while others argue hominins had late access to largely defleshed carcasses through passive scavenging. We used GIS to record bone preservation in the FLK Zinj assemblage as well as in several modern, experimentally-modified bone assemblages, which we used for comparison. We documented the placement of hominin- and carnivore-produced modifications on bones from these assemblages, and with the GIS Spatial Analyst, we identified where particular types of modifications clustered. Our analysis suggests hominins had early access to fleshed carcasses at FLK Zinj, particularly of smaller prey, which they may have acquired through hunting. Damage patterns on larger carcasses are more difficult to interpret, but are consistent with early access (hunting or aggressive scavenging). Our analysis of carnivore tooth mark frequencies on the FLK Zinj bovid fauna corroborates the frequencies cited by Domínguez-Rodrigo and Barba (2007), lending additional support to an early access scenario. Compared to evidence from the ca. 2.0 Ma site of Kanjera South, Kenya, the fauna at FLK Zinj is more heavily processed by both hominins and carnivores; however, patterns of bone fragmentation are similar at both sites. The similarities in fragmentation patterns but the differences in the levels of bone surface damage may reflect hominin behavioral differences related to how they processed carcasses at these two sites.

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A New (Semi-) Automated Method to Quantify Primate Phalangeal Curvature from 3D Virtual Models: New Estimates for Fossil Hominin Phalanges

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Extant primates that habitually use suspensory behaviors (e.g., *Pongo*, *Hylobates*, *Pan*, *Ateles*) have more curved phalanges than those that are quadrupedal or bipedal. Accordingly, the high degree of phalangeal curvature observed in fossils, such as *Australopithecus* and *Hispanopithecus*, have been used to infer suspensory behaviors in these early hominins and apes. Although very useful, the published data of phalangeal curvature (as measured as the included angle [IA] of the diaphysis) often differ in absolute values among studies. Whether this variability is a result of different comparative samples and/or different methods of quantification remains unclear. But it is

certain that end users of these published data should proceed with caution. To remedy this issue, the goal of this study was to develop a (semi-) automated method—with minimal user input such as choosing landmarks—to quantify bone curvature from 3D virtual models of primate proximal phalanges. We developed new routines in AMIRA and MATLAB software to quantify the curvature of the central axis of the bone using several metrics including: IA, second order polynomial equations, and area under the curve (AUC). Our sensitivity analyses reveal that these methods are robust and highly repeatable with regards to model construction (e.g., laser vs. CT scan), resolution (i.e., number of mesh triangles), and other variables with curvature values for a single specimen never differing more than one degree between trials. While our results are consistent in pattern with previous studies of phalangeal curvature, our absolute values for IA and second order polynomials differ. Despite this discrepancy, we have created a method that produces repeatable measurements for phalangeal curvature that can be used by paleoanthropologists in future studies and we provide here new estimates of phalangeal curvature for early hominins from East and South Africa.

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New Multiproxy Investigations into the Ecosystem at Elandsfontein, South Africa: Implications for Mid-Pleistocene Hominin Paleocology on the Western Cape

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Despite numerous Mid-Pleistocene archaeological sites in eastern and southern Africa, our current understanding of the ability of hominins to adapt to diverse habitats during this period is poorly understood. The Quaternary record of the west coast of South Africa has the potential to provide the archaeological and paleontological record necessary to understand the dynamics of cultural and ecological changes in the Mid-Pleistocene. The site of Elandsfontein (EFT) preserves *in situ* lithic and faunal materials found in direct association with one another and provides the rare opportunity to examine the relationship between hominin behavioral variability and a heterogeneous landscape in a winter rainfall ecosystem. We present a multi-proxy analysis that integrates the geochemical, paleontological and archaeological record preserved at EFT to assess the ecological context of this Mid-Pleistocene landscape at various geographic and temporal scales. Specifically, this study represents the first examination of the stable carbon and oxygen isotopic signature of a large sample of micromammals (n=81) and macromammals (n=176) from across the site. We find that disparity in the isotopic signature of small and large mammals provides insights to the diversity of this ecosystem. Additionally, these new data suggest a complex vegetative community that, although dominated by plants utilizing the C₃ photosynthetic pathway, included C₄ and CAM vegetation. These data suggest the presence of an ecosystem that may be distinct from the current fynbos that dominates the west coast of South Africa. We propose that this diversity of resources provided a specific context that significantly influenced the site formation processes at EFT. This may provide keys to the previously documented high level of Quaternary mammalian biodiversity at EFT that contrasts that of the modern ecosystem.

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Cobrinhos, A New Mousterian Site in Vila Velha de Ródão (Portugal)

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Vila Velha de Ródão (central inland Portugal) is best known for well-preserved open Mousterian campsites such as the Foz do Enxarrique (33.6 ka) or Vilas Ruivas (54 ka) that yielded evidence of highly preserved occupational layers with abundant faunal remains (the first) and features interpreted as hearths and windshields (the second). The region is also rich in other periods, namely Acheulean and, during the Holocene, Pre- and historical sites, rock art, dolmens and mines. Here we report another site, Cobrinhos, located 2.3km upstream from Foz do Enxarrique and 2.5km from the Pleistocene course of the Tagus River. Cobrinhos is an open-air site found in the fall of 2014 during the construction of a new building for a paper factory. The assemblage is composed of more than

four thousand artifacts, from cores to chips, ~99% in quartzite and ~1% in milky quartz. Cortex in the artifacts is congruent with the debris, suggesting an exclusive or almost exclusive local exploitation. The industry is typically Mousterian, with a predominance of Levallois and discoidal debitage, but also some retouched tools, such as sidescrapers and retouched Levallois points. In contrast to what is usual in open-air sites, there are no remains associated with other time-periods, suggesting a good integrity of the assemblage. Several samples were taken for geological analysis and absolute dating, and the assemblage is presently under study for technological, typological, refitting and special analysis. Preliminary data suggests that Cobrinhos is a coherent Neanderthal occupation with a presently indeterminate time-span, eventually related with the exploitation of a dense quartzite debris-flow just a few meters uphill. The original deposit seems to have moved a few dozen meters downslope, as a colluvium, which presently occupies 2500m². In short, Cobrinhos represents a novel type-site in Portugal with important information to understand Neanderthal ecological and technological behavior.

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Neanderthal Mobility in the Northeast of the Iberian Peninsula: The Patterns of Chert Exploitation at the Abric Romaní Rock-Shelter

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An important aspect of studies of human evolution is an understanding of the factors that caused prehistoric hunter-gatherers to change their knapping strategies, and the benefits that these changes brought to their subsistence activities. During the Middle Paleolithic, the coexistence or the replacement between Levallois and discoid technologies has frequently been recorded, but there is still no clear understanding of the reasons for their alternating and fragmented use in the archaeological record. This paper aims to contribute with new data to the current debate, by exploring the chert assemblages from levels O and M of the Abric Romaní rock-shelter. The technological analysis reveals a change in the flake production from Levallois in level O to discoid in level M. This modification in Neanderthal technical behavior is accompanied by the use of different axes of mobility, a reduction in the foraging radius and a more careful management of raw materials. A cross comparison with other archaeological evidence indicates a similar pattern in the northeast of the Iberian Peninsula during the late Middle Paleolithic, in which the use of Levallois technology is associated with chert and high mobility patterns whereas discoid technology is more closely linked to the use of local raw materials and a lower degree of mobility. Climatic fluctuations and changes in the distribution of preferred prey animals may have influenced the Neanderthals' mobility patterns and contributed to modifying their technical behaviors in order to obtain better foraging incomes.

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Modeling Differential Access to Meat with Experimental Butchery: Implications for the “Hunting/Scavenging” Debate

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The nature of access to animal-based resources at the origin of hominin carnivory remains a lively area of research in reconstructing hominin dietary behavior and ecology. While the timing of access to meat and marrow has been much discussed, we still do not have actualistic models based on experimental butchery that link some behavioral traces to the behavioral context of butchery. Here we present the results of an experiment designed to examine whether quantitative characteristics of cut marks made by Oldowan flake tools vary with timing of access to meat, using the quantity of meat present on domestic pig limb bones prior to butchery to simulate primary or secondary carcass access. We found that the number and length of cutmarks on entire bones as well as bone portions (epiphyses and shafts) did not vary significantly with the amount of meat removed prior to butchery, though average cutmark length and number of cutmarks was higher on partially defleshed bones. We also found no correlation between the number of tool strokes during butchery and the number of cutmarks inflicted, nor the amount of meat present on the bones prior to butchery. These results accord with some previous studies, and indicate that these variables cannot currently be used to evaluate the timing of access to meat at the emergence of tool-mediated hominin carnivory. We must continue to conduct actualistic studies manipulating additional variables as we search to experimentally model links between cutmarks and carcass acquisition strategies in the Early Stone Age.

The Origins of Stone Tool Reduction and the Transition to Knapping: An Experimental Approach

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A reassessment of many of the archaeological assemblages older than two million years has resulted in a general consensus that the earliest Oldowan artifacts were made by skilled toolmakers who had a clear understanding of the fracturing mechanics of different toolstone materials. This has led several researchers to propose a simpler lithic reduction stage that occurred prior to 2.6 Ma. Three

lithic reduction techniques that are within the behavioral repertoire of our closest living relatives in the genus *Pan* are proposed as potential intermediate stages between the percussion behaviors of the last common ancestor of chimpanzees and humans and the skilled knapping of the Oldowan toolmakers. These include direct and indirect projectile percussion and bipolar flaking techniques. Measures of productivity, expediency, and efficiency were obtained and compared between these three reduction techniques and novice freehand knapping in order to better understand some of the factors that influenced how early hominins with little to no understanding of lithic fracturing mechanics achieved sharp flake tools. The results of this experiment indicate that, of these four conditions, dropping or throwing a large hammer stone on a brittle core is the most efficient way to exploit a core, while bipolar flaking is the most expedient method; however, novice freehand knapping creates the most productive flakes with large, sharp cutting edges. Thus, the transition to knapping in the late Pliocene may have been due to a shifting emphasis on productive toolmaking over expediency or efficiency.

Eagle Claw Jewelry from Krapina at 130,000 Years Ago

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We review cut marks and other modifications on white-tailed eagle (*Haliaeetus albicilla*) talons and a phalanx from the Krapina Neandertal site. Eight talons, from at least three different eagles, were recovered by Gorjanović-Kramberger in 1901 in the top level at Krapina, which only preserves Neandertal human remains, Mousterian tools and MIS 5e fauna. They were identified and figured by Lambrecht in 1915, but neither he, nor Gorjanović-Kramberger, nor anyone else who has subsequently studied the talons, recognized human manipulations on them. In a survey of the remains from the site, one of us (DR) noticed cut marks on a few of the talons and subsequent analysis revealed multiple cut marks on the proximal end of four talons, abraded/polished areas on seven talons and nicks on the margins of three of the largest talon blades. The cut marks are V-shaped and similar in appearance and position to cut marks on single eagle talons at other, later Neandertal sites, such as Combe-Grenal and Fumane. Some cut marks are likely related to disarticulation with stone tools, but many have smoothed margins, possibly indicating the effects of binding. Abrasion and densely polished areas suggest they were part of an assemblage as documented (on shells) at Blombos. The associated phalanx 3 has at least 21 cut marks on the proximal and distal surfaces. How these talons and the phalanx were organized into jewelry is difficult to reconstruct, but together as an assemblage they represent a powerful sign that Neandertals used symbols. Personal ornaments are commonly attributed to anatomically modern *Homo sapiens* and are considered evidence of complex behavior. Dated at 130 kyr, it is clear that Krapina Neandertals composed ornamentation without the influence of modern humans.

PaleoCore: A Web-Based Data Management System for Paleoanthropology

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PaleoCore is a web-based data management suite for paleoanthropology. The initiative fosters: 1) a data standard built around the Darwin Core and ABCD data standards for biodiversity; 2) an online data repository for paleoanthropological collections; and, 3) open-source software tools and workflows for field data collection. The PaleoCore data standard combines a select list of the most useful elements for paleoanthropology drawn from the Darwin Core and ABCD data standards developed for biodiversity informatics. The PaleoCore implementation of these standards provides a common vocabulary for data interchange between projects and a common basis for building new data sets. PaleoCore further provides an online data repository hosted by the Texas Advanced Computing Center, an NSF funded super computing site in Austin Texas. The PaleoCore data repository provides real-time web access to paleoanthropological data sets and because the underlying database is spatially enabled, there is ready access to the data from dedicated GIS software such as QGIS or ArcGIS. The repository also provides an API for easy access to data using the R statistical programming language. The data stored in the repository is built on an open-source software stack that includes PostgreSQL (with PostGIS) as the database backend, Django (with geoDjango) as the web application server providing web access, and GeoServer to serve spatial data layers via the web. PaleoCore is also actively developing software tools and workflows for field data collection. Currently, two workflows have been developed, an ArcGIS workflow using ArcPad and Windows Mobile devices, and an iOS workflow that uses the GIS Pro iOS app in conjunction with QGIS. A fully open-source workflow for Android is in development. The PaleoCore initiative is nascent, but demonstrates the ways that open source software and data management tools can fundamentally change how paleoanthropological data is collected, maintained, and shared. This abstract features a live demonstration of the PaleoCore suite.

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Paleoanthropology of the Ledi-Geraru, Afar Regional State, Ethiopia

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The lower Awash Valley (LAV) has yielded numerous specimens of the genus *Australopithecus* from 3.8–2.95 Ma (Woranso-Mille, Hadar, Dikika), in addition to evidence of tool use at 2.6 Ma (Gona), and early *Homo* by at least 2.33 Ma (Hadar). Sedimentary deposits and evidence for human evolution between 2.95–2.7 Ma, however, were missing from the LAV record. Indeed, the entire fossil record of Africa during this time is sparse. The Ledi-Geraru Research Project (LGRP) area contains fossil deposits ranging from 3.4–2.5 Ma, filling a significant temporal gap in the fossil record of the Afar and offering the potential for insights into hominin and mammalian evolution. Here we report on 2.95–2.5 Ma deposits that fill this temporal gap and contain hominins and other mammalian fossils. These fossils have enabled us to analyze species turnover and habitat change in the LAV. We reconstructed the habitats of each stratigraphic unit in the Hadar Formation (3.4–2.95 Ma) using fossil mammal assemblages recovered from both the Hadar and LGRP areas, in addition to the fauna from the younger 2.95–2.5 Ma deposits at Ledi-Geraru. Species were assigned a categorical trophic and locomotor adaptation based on craniodental measurements, mesowear, stable isotopes, and taxonomy. The adaptations of fossil communities were used in a correspondence analysis (CA) with 182 modern African communities to identify the most likely habitat reconstruction for each stratigraphic unit. This synthetic record from the LAV suggests substantial habitat change between 2.95–2.8 Ma, recording a transition from more closed to very open habitats. This dramatic habitat shift is also accompanied by species turnover in some lineages and the appearance of immigrant taxa.

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Landscape-Scale Patterning in Hominin Behavior in the Okote Member at East Turkana, Northern Kenya: Pairing Behavioral and Paleoecological Data

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There is a long held acceptance that hominin behavior is best understood at landscape scale. However, recognizing broader behavioral patterning and the spatial and temporal scales under which it is best observed has significant difficulties. (1) A general lack of approaches that are tailored for large spatial scales. (2) Collection methods that account for a variety of geomorphological processes that influence the formation of archaeological assemblages. In this study, we combine lithic and paleoecological data to investigate patterns of hominin behavior at multiple spatial and temporal scales within the Okote Member of the Koobi Fora Formation at East Turkana northern Kenya. We focus our study on a 15km² collection area within the spatially extensive and well dated Ileret Tuff Complex (1.52–1.55 Ma). The wide spatial extent and relatively brief period of time represented by these deposits provides a unique opportunity to test hypotheses related to hominin land-use. By placing these data within a high-resolution spatial framework obtained by combining GIS and new aerial mapping surveys, we explore the notion that hominin behavior varies at disparate spatial and temporal scales. Specifically, lithic data were analyzed through the use of geospatial statistical methods in conjunction with faunal data collected within the area of study. Finally, we assess the overall ability to compare paleoecological and behavioral data while taking into account variance related to site formation processes, stone tool discard patterns, and paleo-landscape ecology. This study represents a rare attempt to merge lithic and paleoecological datasets from East Turkana and will undoubtedly serve as the foundation for future multi-proxy analyses of hominin behavior in the region.

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A New Hominid Fossil from Olduvai Gorge, Tanzania: OH 83, an Early Modern Human Calvarium from the Ndutu Beds

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Here we present the first description OH 83, a partial hominid calvarium found in 2009 at archaeological locality PLK, situated on the north side of Olduvai Gorge. OH 83 was found by the Conservation Olduvai Project and excavated by the University of Dar es Salaam field school, both under the direction of F.T. Masao. This early modern human calvarium is mainly composed of the frontal and left parietal. The fossil was recovered from the upper unit of the Ndutu Beds 180–220cm below the surface and dates to approximately 60–15 kya. We photographed and 3D laser scanned the specimen at the National Natural History Museum, Arusha, to facilitate digital measurement and morphological comparison in addition to collecting standard measurements by hand. While incomplete, preservation is sufficient to assess frontal bone morphology and overall vault shape, enabling us to collect metric data to assess morphometric affinity. Aspects of this calvarium including its high, vertically oriented forehead, and medially divided supraorbital torus are well within the range of morphological variation found in modern humans. Although some of the preserved morphological characters of this specimen, such as its long cranial vault and slight post-orbital constriction are similar to *Homo rhodesiensis*, the overall morphometric affinities of OH 83 are essentially modern. This specimen augments the African early human fossil record, providing additional information about the range of cranial variation of early humans.

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Hominin Paleoecology and Land Use Based on 1.5 Ma Footprint Surfaces at Ileret, Kenya

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Early Pleistocene footprint assemblages from northwestern Kenya provide a unique opportunity to examine animal communities and hominin habitat composition over a very short time interval. The silt layers bearing these footprints are tightly bracketed within the Ileret tuff complex (1.51–1.53 Ma) and experimental data show that each surface likely accumulated prints over no more than a few days. Excavations of 106 square meters of print surfaces over four years have recovered 483 identifiable footprints, including 99 hominin prints. The prints of aquatic taxa, such as hippos, crocodiles, and wading birds, are consistent with geological evidence suggesting these footprint layers were deposited in a low energy, deltaic setting near a lake margin. The presence of large numbers of medium-sized bovids travelling in the same direction further suggests this deltaic system was bordered by an open grassland. Here, we test the hypothesis that hominins are more abundantly represented on the footprint surfaces than expected based on their scarcity in the fossil record. To do this, we used a random sampling procedure to target footprint-bearing outcrop, excavated 20 one-meter test squares and identified and recorded all taxa present. The relative abundances of taxa found within the footprint test squares were compared to both the targeted footprint excavation data and expected frequencies derived from systematic sampling (“bone walks”) of dental and skeletal fossils from the same area and stratigraphic interval. Results show that when compared with other taxa, hominin prints occur significantly more frequently than expected, providing the best evidence yet that they spent disproportionate amounts of time in near-water habitats, relative to where they died and were preserved. Furthermore, the clustered presence of hominin prints, their directionality and size profiles all suggest that hominins were likely moving through this lakeshore environment in groups.

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First Evidence of Neandertal Cannibalism in Northern Europe: The Case of the “Troisième Caverne” of Goyet (Belgium)

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Almost 150 years after the discovery of Neandertals, their cognitive and symbolic capacities are still a topic of heated debates. Adding to our knowledge of this fossil group, we present 99 new Late Neandertal specimens identified among the collections from the “Troisième caverne” of Goyet (Belgium), which show numerous anthropogenic marks. We identified these remains and their context through the implementation of an original, multidisciplinary approach combining the results of morphometrics, taphonomy, stable isotope, dating, and genetic analyses. The Goyet Neandertal collection encompasses a series of fragmentary remains with elements from the cranial and infracranial skeleton of at least five different individuals radiocarbon dated to ca. 44–45.5 ky cal BP. The anthropogenic traces present on the Neandertal specimens are similar to those found on the faunal remains from the site, showing that they were subjected to butchery activities and that some of them were used for technical activities. Goyet is the first site to have yielded several Neandertal retouchers and provides the first evidence of Neandertal cannibalism in Northern Europe. A review of the regional context shows that the Goyet Neandertals add to the known diversity in mortuary behavior of the Northern European Late Neandertals.

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Fossil Mammals Reveal Patterns of Inter- and Intra-Basinal Endemism in Eastern Africa, ca. 4 to 1 Ma: Implications for Hominin Biogeography

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The potential role of basinal endemism in structuring patterns of hominin biogeography remains largely unexplored. Here we attempt to bridge this gap by analyzing patterns of endemism across eastern Africa during two periods in human evolution, one in which a single lineage (*Australopithecus anamensis-afarensis*) is patchily distributed, and the second in which multiple lineages (early *Homo* spp., *Australopithecus boisei*) are comparatively widespread. We hypothesize that: 1) the uneven distribution of the *Au. anamensis-afarensis* lineage was coincident with strong regional endemism; and, 2) the comparatively widespread early *Homo* and robust *Australopithecus* lineages were concurrent with weaker regional endemism. To test these hypotheses, we collected presence/absence data for 159 large-bodied (>500g) fossil mammalian species in 10 families from ca. 4–1 Ma in eastern Africa. Geological members were used as replicates and were grouped into two roughly 1 million-year-long temporal bins, 4.2–2.95 Ma and 2.3–1 Ma. Exploratory analyses showed our data could be grouped into five spatial bins (“Afar,” “East Turkana,” “West Turkana,” “Omo,” “Laetoli/Olduvai”) for subsequent analyses. We used beta diversity (i.e., how many species are not shared between two samples) to quantify endemism through time. However, because beta diversity metrics can be biased by between-sample differences in sampling intensity and alpha diversity (i.e., the number of species within each sample), we employed Monte Carlo null models to calculate pairwise dissimilarity matrices with unbiased beta diversity estimates. From these dissimilarity matrices, we constructed PCA ordination plots and cluster dendrograms to visualize and compare the degree of endemism between both time periods. Finally, we used pairwise null models to quantify the likelihood that species were non-randomly distributed between two subregions. Our results support both hypotheses, demonstrating strong regional endemism during the Pliocene coincident with a patchily distributed hominin record, while these same regions share many more taxa in the Pleistocene.

Spatial Analysis of Broca’s Cap Asymmetry in Endocasts Using ArcGIS

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Endocasts are the best-preserved archaeological materials for estimating gross changes in brain structure through hominid evolution. Because endocast surface features correspond to surface features of the cerebral cortex, topographic changes within endocasts can be used to infer differences in cortical structure between individuals and through time (Broadfield and Holloway 2001). By studying endocast areas associated to specific anatomical divisions within the brain, we can also infer the expansion of cognitive functions. Although various qualitative and quantitative methods have been used to assess hominid endocasts, geographic information systems (GIS) provide a robust and underutilized suite of quantitative tools that can be used to analyze the features of endocast surfaces. This study is an intraspecific comparison of asymmetry in Broca’s cap in *Homo sapiens* using ArcGIS. Broca’s area has a well-established trend for leftward asymmetry in living humans, so modern human endocasts should show leftward asymmetry in Broca’s cap. In order to test this, we scanned 34 human inferior prefrontal endocast molds using a Next Engine 3D Laser Scanner at high definition, and examined the topography of Broca’s cap in ArcMap 10.1. A ratio of left-to-right hemisphere surface area was calculated to allow intersample comparisons of asymmetry. Twenty-nine samples (85%) displayed left lateralization, and five samples (15%) displayed right lateralization. Overall, the left Broca’s cap was found to be an average of 11% larger. Among the left- and right-lateralized subsets, the larger cap was an average of 16% and 14% larger, respectively. The full sample and the left-lateralized subset varied significantly from a symmetrical distribution around $\mu=1$ at $\alpha=0.005$ for a one-tailed t-test, while the overall distribution was approximately normal. These figures are consistent with expectations and provide an impetus to carry out interspecific and temporal comparisons of Broca’s

cap asymmetry in hominid endocrasts using GIS spatial analysis.

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Micromorphology of Middle to Later Stone Age Sites in Northern Malawi

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Alluvial fan sediments along the shores of Lake Malawi contain a wealth of information about early modern human life in the area. Thousands of Middle Stone Age (MSA) lithic artifacts were recovered during recent excavations near the town of Karonga in northern Malawi, and in several cases conjoined pieces suggest that post-depositional reworking of the artifacts has been very limited. Here we present the results of a micromorphological and infrared spectroscopic study of the formation processes of both culturally rich and culturally sterile deposits. A detailed micromorphological analysis enables us to examine features in the sediments that result from depositional changes as well as changes in humidity and biological activity. Similarities in the formation processes of artifact-bearing horizons suggest that humans may have preferentially selected certain environments within the landscape. For example, fresh, non-rounded artifacts on top of coarse stream deposits suggest that abandoned stream beds were particularly attractive to the inhabitants of Karonga during the MSA. These data are in accordance with micromorphological evidence for clay coatings and other soil-forming features related to repeated wetting and drying below a similar layer of pebbles and cobbles at the nearby intact Middle to Later Stone Age site of Mwanganda's Village Area I. Such features indicate that *in situ* soil formation has taken place and that stream beds likely formed upon a land-surfaces that were stable for an extended period of time. Micromorphological study of these paleosols has the potential to clarify past environmental conditions associated with human occupations, and also provides a valuable resource for establishing the context of samples collected for optically stimulated luminescence dating.

The Paleocological Reconstruction of Area 123 and Area 6/6A, Koobi Fora, and the Implications for the Habitat Preferences of *Homo* and *Paranthropus boisei*

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For this study, the paleoecology of two areas within the Koobi Fora Region of Kenya are being compared; each contains different Plio-Pleistocene hominin populations with presumably different diets and behavior. Area 6/6A contains mostly *Paranthropus boisei*, a robust hominin whose morphology suggests a specialized vegetation based diet, while Area 123 contains *Homo*, a more gracile hominin who was likely using stone tools and thus utilizing more diverse resources. By understanding the hominin's habitat preferences we can hope to gain further insight regarding their behavior. The fauna of each area were analyzed and put into geological context. This was to better understand what the landscape looked like, who was living in it, and what was the difference that led one hominin to prefer one area over the other. Ternary diagrams representing the breakdown of the bovid populations were the main method of analysis. Based on the results it appears that both areas were similar environmentally, with mixed habitats and a high percentage of water dependent bovids. However, Area 6/6A where *Paranthropus boisei* was living, appears to contain more distinct grasslands. This is supported by the fact that the sediment from the area suggests a drying of the lake and a transition to a crevasse system as well as the relative bovid abundance.

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Reconstructing Dietary Diversity in Primates Using Variation in Dental Microwear Textures

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Dietary diversity, a measure of the number and evenness of food types incorporated into the diet, is an important component of species's ecology that often relates to the abundance and distribution of species. Additionally, dietary diversity has been cited in many hypotheses regarding the geographic distribution and evolutionary fate of fossil hominins. Here I present data testing the hypothesis that species with greater dietary diversity have greater variation in dental microwear textures. I collected dental microwear scans from Phase II molar facets of eight species of extant African monkeys (Cercopithecidae) with differing dietary diversity, which was calculated based on average annual food type consumption frequency at study sites of wild populations. Variance in the individual microwear variables of complexity (Asfc) and scale of maximum complexity (Smc) differed among groups in a manner consistent with differences in dietary diversity. A better indicator of dietary diversity, however, appeared to be the overall variance in microwear textures, since this variance for each species was positively correlated with the species's dietary diversity. However, the overall variance in these

textures was also strongly correlated with the frequencies of fruit and foliage in the annual diet of each species. These results show a relationship between greater variation in microwear textures and greater dietary diversity in Cercopithecidae, but the results also show that the frequency of consumption of fruit and foliage may be more important in the creation of microwear variation. The results also suggest that it is more informative to analyze all microwear variables simultaneously when examining variation in diet than simply analyzing individual variables. These methods can be used in fossil primates to compare dietary diversity and frequency of fruit and foliage consumption among related taxa.

Neanderthals in the Eemian Lakeland Landscape of Neumark-Nord 2 (Germany)

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Much of our knowledge about Neanderthal subsistence behavior and adaptation comes from sites situated within cold or cool environments. Sites with full interglacial conditions are much rarer and we have limited information about Neanderthal behavioral adaptations within these “warmer conditions.” Recently, however, several sites from the north German Plain have been discovered and systematically excavated yielding high-resolution paleoenvironmental and archaeological archives allowing for a more detailed understanding of Neanderthal behavior. The site of Neumark-Nord 2 (NN2), excavated between 2004–2008, has yielded c. 20,000 lithic artifacts and c. 120,000 faunal remains recovered from sediments in and around a lake basin structure across an area of 500m². A wide variety of dating methods and paleoenvironmental proxies have been used to correlate the main find bearing level to the Last Interglacial period, the Eemian. The depth of deposits at NN2 has allowed for extensive correlation between terrestrial and marine records (Sier et al. 2011) but also between this site and the larger basin at Neumark Nord 1 (Mania et al. 2010). These data confirm that the NN2 basin was a smaller “puddle” on the margins of the larger (24ha) NN1 basin. The high resolution archives from both localities have made it possible to extensively reconstruct and compare Neanderthal behavior within this broader lakeland. Our paper will focus on the Neanderthal behavior around the smaller NN2 basin and detail our ongoing archaeological analyses illustrating the primacy of Neanderthal groups in this area. This paper will discuss the first results of extensive lithic, faunal, and GIS analyses of NN2 and compare this to the larger NN1 basin and address what this means in terms of our understanding of Neanderthal interglacial adaptation and subsistence behavior.

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Finding a Common Band-Width: Causes of Convergence and Diversity in Paleolithic Beads

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Ornaments (a.k.a. beads) are the most common and ubiquitous art form of the Late Pleistocene. This fact suggests a common, fundamental function somewhat different to other kinds of Paleolithic art. While the capacity for artistic expression could be considerably older than the record of preserved (durable) art would suggest, beads signal a novel development in the efficiency and flexibility of visual communication technology. The Upper Paleolithic was a period of considerable regional differentiation in material culture, yet there is remarkable consistency in the dominant shapes and sizes of Paleolithic beads over >25,000 years and across vast stretches of space, even though they were crafted from diverse materials and, in the case of mollusc shells, diverse taxonomic families. Cultural and linguistic continuity cannot explain the meta-pattern. The evidence indicates that widespread adoption of beads was not only about local and sub-regional communication of personal identity or group affinity, but also an expansion in the geographic scale of social networks. The obsession with rounded basket-shaped shells in particular related in part to their light weight, wearing comfort, and visual attractiveness. The conformity of the beads grew spontaneously, in a self-organizing manner from individuals’ interest in tapping into the network as a means for managing local risk.

Analysis and Re-Evaluation of the Middle Stone Age Howiesons Poort Sequence from Montagu Cave, Western Cape, South Africa

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The site of Montagu Cave in the Western Cape of South Africa represents an important site with respect to our understanding of both Early and Middle Stone Age occupation in the region. More specifically, the site is recognized for the high density of Acheulean and later MSA lithic material, in particular lithics associated with the Howiesons Poort industry (HP). Montagu Cave was previously excavated in 1964–65 by then doctoral student Charles Keller from the University of California, Berkeley, primarily to recover data associated with the Acheulean sequence. Keller also carried out a comparatively smaller study of the MSA assemblage and concluded that material from the MSA 'Layer 2' was associated with HP period occupation. This presentation provides a review of the on-going re-examination of the lithic material from Keller's MSA Layer 2, which was originally assigned to the HP. Current evidence indicates the presence of MSA materials potentially preceding the HP, the HP itself, and the post-Howiesons Poort. Here I describe the analyzed MSA assemblage thus far including changing patterns in raw material exploitation and diachronic technological variability.

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Extraction and Exploitation of Silcrete Outcrops during the Paleolithic at Saint-Pierre-Eynac, France

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The study of siliceous raw materials in the European Paleolithic has frequently focused on flint and chert (more broadly, siliceous) as the materials most often encountered in archaeological sites. This poster provides new data on the use of silcrete, a lithic material that is little known in the European Paleolithic (although familiar in Australian, African, and South Asian contexts). Results are presented from the first two seasons of fieldwork at the newly discovered Saint-Pierre-Eynac (SPE) silcrete extraction site, France, as part of a long-term Paleolithic landscape project within the Massif Central. The SPE silcrete (a silicified material formed within Tertiary palustral context) represents a high quality lithic resource within a region of predominantly volcanic geology and sparse flint sources. It had previously been identified in both Middle and Upper Paleolithic cave sites up to 40km distant from the site, and local collectors had found lithic artefacts in the surroundings of SPE. However the actual focus of Paleolithic activity, and the location of silcrete outcrops exploited, were not known until fieldwork in 2014. This work determined that there is a large open-air extraction locale at the very summit of the hill, with rich spreads of knapping waste. Following test excavations, results are reported here on the lithic material. This research therefore represents new data on Paleolithic use of an unusual raw material, as well as examining the archaeology at the source itself, something often impossible where there is uncertainty about precise locations that stone was extracted.

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Site Formation and Interactions between *Homo* and the Mammals from Dmanisi

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The fauna from Dmanisi preserves important clues regarding hypotheses for Out of Africa, how the site formed, and how hominins behaved. Nearly 10,000 bones have been examined for taphonomic information. Geological and biological processes contributed to the formation, preservation, and alteration of the site. While there was some downhill movement and slumpage of bones by gravity into gullies and pipes, downhill movement only explains the last moments of bone deposition; it is not enough to explain such a large and diverse concentration of bones at this spot. Biological-behavioral concentrating mechanisms were also at work. The biological processes evident include carnivore hunting, feeding, and probably denning; hominin feeding, and natural deaths. Multiple processes such as these are the norm in well-studied large fossil accumulations. The most common forms of bone modification are by carnivores, especially in Block 2 B1 sediments. Carnivora amount to over 18% of NISP, mean tooth pit sizes overlap with lions and hyenas, and 95 coprolites are present in this area. Hominins also ate meat at the site, but evidence of it is much less common than carnivore modification of bone. Stone tool cut marks have been found on 1% of the specimens, in a variety of anatomical locations and taxa. The evidence for human alteration of the fauna such as cut marks, hammer-stone marks, and notches supports an interpretation that hominins had early access to carcasses through hunting or power scavenging, and that they also ate marrow and possibly skinned animals. Hominin-carnivore interaction at the site is indicated by cut marks on *Canis* bones, the short duration of bone accumulation,

and the overlap of tool and tooth modified bones across the site. Increased consumption of the meat of large mammals remains the most plausible hypothesis for human spread out of Africa.

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Multi-Functionality and Stone Tool Re-Use in the ESA: An Example from the Nachukui Formation of West Turkana, Kenya

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The Nachukui Formation of West Turkana (Kenya) is remarkable for preserving numerous Early Stone Age localities that have greatly enhanced our understanding of Plio-Pleistocene hominin technical and cognitive abilities. Yet in spite of high resolution insights drawn from reconstructions of Oldowan lithic *chaînes opératoires*, on the western shore of Lake Turkana wider issues concerning stone artifact life history and function(s) remain unexplored. Here we report on a case of complexity in tool use and re-use in the earliest technological repertoire so far identified by the West Turkana Archaeological Project (WTAP). A combined approach harnessing techno-typological, experimental, refitting, and macro- and microscopic analyses reveals unexpected temporal discontinuities in the exploitation and use of lithic resources, including episodic percussive activities (both active and passive) and several distinctive core reduction phases. These interim results suggest an as-yet unrecognized degree of tool multi-functionality in the initial ESA record; a behavioral signature that warrants further investigation.

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Taphonomy of Fossils from the Hominin-Bearing Deposits at Dikika, Ethiopia

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Two fossil specimens from the DIK-55 locality at Dikika, Ethiopia, predate the earliest documented stone tools by more than 800 thousand years, yet they collectively bear twelve marks interpreted to be characteristic of stone tool butchery damage. This interpretation challenges established models in which early *Homo*, regular stone tool use, and incorporation of large ungulate tissues into the diet all emerged together at the beginning of the Pleistocene. However, alternative interpretations of the marks being caused by non-hominin agents show that it is imperative to resolve the agencies that created marks on fossils in the Dikika area in order to understand the ecological and taphonomic contexts of hominin-bearing deposits in this region. Results are reported here of analysis of surface modifications on all non-hominin fossils that have been collected from the Dikika deposits, including additional fossils from DIK-55 and five assemblages of controlled, sieved surface sediment samples. This provides an overview of the size, frequency, and morphological character of marks on fossils in the area for comparison to those from the DIK-55 site. Although surface marks are both abundant and variable, no marks on any other fossils resemble those on the two specimens interpreted to be stone-tool-inflicted. Taphonomic modifications also provide insight into the variable depositional histories of different fossil localities, for example, revealing those that were periodically inundated in comparison to those with more subaerial exposure. These data represent the first taphonomic description of Pliocene fossil assemblages from the Afar that have not been subjected to collection bias, and this facilitates nuanced interpretation of the taphonomic processes that were in operation across the landscape in the Dikika area.

New Hominin Tarsals from Swartkrans, South Africa

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Here we describe two newly recognized, early Pleistocene hominin tarsals, a cuboid and a navicular, from Swartkrans Cave, South Africa. The SKX 31899 cuboid, from Member 3 of the Swartkrans Formation (dated 0.96±0.09 million years old), is poorly preserved, represented by roughly its distal two-thirds. Its fragmentary condition precludes derivation of all standard measurements except overall depth. However, qualitative and quantitative analyses still allow the fossil's diagnosis as a hominin, rather than sympatric papionin. SWT/UNE-2 is a complete navicular from an undated, highly disturbed, secondary underground deposit. Despite its poor

context, the specimen is entirely mineralized and was recovered in broad association with a *Paranthropus robustus* upper canine. Tightly adhering breccia obscures parts of the dorsal aspect of the cuneiform and talar articular facets of SWT/UNE-2, but did not interfere with our generation of standard measurements. All ten of these measurements fall within the range of those for modern human naviculars. Overall, SWT/UNE-2 is small compared to modern humans, with a somewhat large tuberosity (relative to its body). That said, we do not ascribe any particular significance to this notably large tuberosity. In sum, both tarsals fit comfortably within the range of modern humans. But, given the facts that each was found as an isolated element and that *P. robustus* and *Homo* fossils co-occur throughout the Swartkrans Formation, we do not believe that assigning either fossil to genus or species is justified, and for the time diagnose both as simply Hominidae gen. et sp. indet.

The Olduvai Geological Coring Project (OGCP): Providing a New Paleoenvironmental Context for Human Evolution at Olduvai Gorge, Tanzania

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During August 2014, the Stone Age Institute initiated the first core drilling project for scientific research at the crucial paleoanthropological location, Olduvai Gorge in northern Tanzania. This followed a planning workshop at the Stone Age Institute in Bloomington, Indiana, during April 2014, involving 25 participants from multiple disciplines and six countries, including Tanzanian cultural heritage managers and scientists. The Olduvai Geological Coring Project succeeded in drilling four boreholes at three strategic locations in the Olduvai sedimentary basin, including, at one locality, a vertical and an angled borehole for detailed paleomagnetic reversal studies. Almost 600 meters of high-quality core were yielded, sampling the incredibly well-preserved lacustrine and lake marginal sediments of the Olduvai sequence. Downhole logging included natural gamma ray, magnetic susceptibility, and electromagnetic induction (conductivity and resistivity). Drill core samples are yielding critical information about the paleoclimatic and paleoenvironmental setting and chronological sequence covering a timespan of more than two million years, contextualizing hominin occurrences and activities and other evolutionary events throughout this sector of the East African Rift. An international team of researchers is currently involved in a range of analyses, including lithofacies/stratigraphy, chronometric dating, paleomagnetism, volcanology and tephrostratigraphy, carbon and oxygen isotopes, organic geochemistry, invertebrate and vertebrate paleontology, and micro- and macro-plant remains. Unexpected and surprising results have already emerged from this coring project.

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Renewed Investigation of the Late Pleistocene-Holocene Archaeological and Paleoenvironmental Sequence from Kiseke II Rockshelter, Tanzania

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There is a general consensus that during the Late Pleistocene, eastern Africa played an important role in the origin and dispersal of modern humans. However, we still have only a poor understanding of the environmental context of these early populations of *Homo sapiens*. What data are available demonstrate that many behaviors characteristic of recent human foragers first appeared in environments without modern analog, exemplified by fossil faunas from Middle Stone Age (MSA) and Later Stone Age (LSA) sites from Kenya in the Lake Victoria basin and at Lukenya Hill. These are characterized by the presence of species adapted to dry grassland environments, including extinct taxa (e.g., the alcelaphine bovid *Damaliscus hypsodon*) or extant fauna found well beyond their current range (e.g., *Equus grevyi*). Here we describe the southernmost limit of both *D. hypsodon* and *E. grevyi* from the Kiseke II rockshelter in central Tanzania, where they occur within deep (6-m-thick) stratified deposits. This sequence contains evidence for lithic technologies characteristic of MSA and LSA sites (e.g., Levallois cores and backed pieces), well-preserved fauna (including human remains), abundant ochre and ostrich eggshell beads, and Holocene-aged rock art, all originally excavated by L.S.B and M.D. Leakey and R. Inskeep in the 1950s. Published details of these earlier excavations are scattered, sparse, and often contradictory or unclear, but suggest a rich sequence spanning the Holocene to perhaps >33 ka based on conventional radiocarbon dates on burnt ostrich eggshell from the 1960s. Our reanalysis of previously excavated collections now at the National Museums of Tanzania, our discovery of new archival records, and the construction of a new robust AMS radiocarbon chronology serve to return Kiseke II to its prominent position as a key sequence for understanding behavioral and environmental change in Late Pleistocene eastern Africa.

Tool-Making Bones from the Schöningen 13II-4 Spear Horizon

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The use of bone, antler, and other osseous materials to shape lithic tools is widely known from European Middle and Upper Paleolithic contexts. The earliest examples of tool-making bones suggest this behavior arose in tune with the development of post-Acheulean technologies across parts of the Old World during the Middle Pleistocene (Blasco et al. 2013). Here we describe a large collection of bones used to manufacture and sharpen lithic tools from the Schöningen 13II-4 Spear Horizon, dating to approximately 300 ka. During the course of our zooarchaeological and taphonomic analysis of the faunal assemblage, we identified over 100 specimens that preserve traces of use as bone tools for the purposes of lithic tool manufacture and maintenance, implements variously described as retouchers, compressors, and percutors (Patou-Mathis 2002). The large assemblages of Schöningen bone tools reported elsewhere by van Kolfschoten et al. (2013) were not available for study. Retouchers made from small, limb bone mid-shaft fragments are well represented, but retouch damage also occurs on large portions of limb bones, complete bones, and ribs. Some retouchers were intentionally modified to suit particular tasks, while others were used spontaneously with no modification beyond breakage for bone marrow. Also included are a number of bones used as soft hammers, some fashioned out of fresh or defatted bone, whereas others were used in a dry state. The high variability related to bone tool form implies a variety of functional uses during different stages in the lithic reduction and resharpening sequence. Based on the large quantity of bone tools at Schöningen, these tools represented an important component of the Middle Pleistocene technological repertoire. Furthermore, the wide diversity of bone tools at Schöningen indicates the use of bones to shape lithic tools was a well-established behavior with its origin well beyond 300 ka.

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Function and Morphology in the Hominid Cervical Spine: Postural Influences on Integration

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Patterns of integration (covariation) affect the ability of structures to evolve. Integration is generally weaker in humans than in other apes, which may have contributed to the evolution of human morphologies (e.g., brain expansion, ecogeographical adaptations). This reduction in integration, for the postcranial skeleton, is often attributed to the acquisition of orthograde bipedalism. The hominin transition to bipedalism is linked to morphological changes in the cervical vertebrae, which support the head vertically on an upright body, and a reduction of the neck musculature. This configuration likely alters patterns of functional integration in the cervical column of hominins. To test this hypothesis, I collected linear measurements of the cervical vertebrae (C1–7) of extant humans (n=80) and chimpanzees (n=44). Magnitude of integration was determined using MANOVA-corrected correlation matrices and standardized, averaged, Pearson's R², a unitless measure of the strength of the relationship between variables. Mantel tests indicate that humans and chimpanzees have significantly different patterns of integration in the cervical vertebrae (p=0.001). These differences are due to two trends: greater overall integration in the cervical column in chimpanzees (overall R²=0.1877 versus R²=0.1267), and a difference in integration patterns, in which humans display a steady increase in strength of integration from C1 to C7, whereas chimpanzees display strong integration between cranial and caudal ends of the cervical column but not at C2 or C3. In concert with this trend, integration is generally stronger in humans than in chimpanzees between C3 and other vertebrae, and the difference is greatest between C3–C5 (R²=0.1934 versus R²=0.1604), C3–C6 (R²=0.1428 versus R²=0.1189), and C3–C7 (R²=0.1508 versus R²=0.1100). This pattern is likely linked to the presence of cervical lordosis in humans, which contributes to maintaining head balance during upright posture, and suggests a direct link between the functional changes of bipedalism and changes to patterns of integration.

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Late Glacial Rapid Climate Change and Human Response in the Western Mediterranean

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Pleistocene rapid climate change had a major impact on human occupation in Late Glacial Europe. The Western Mediterranean on both sides of the Straits of Gibraltar is an excellent test case to study human - environment relationship during that time. Within the CRC 806 "Our Way to Europe" we evaluate by our fieldwork and a database of the published record climate proxies from off-site archives of the study area in relation to a sample of 500 radiocarbon dates from more than 200 archaeological sites from Iberia and the Maghreb. Our study covers the time slice from the HE 2 event to the end of the Pleistocene. Iberia displays a classical Western European sequence of techno-complexes from Solutrean to Magdalenian to Azilien/Epipaleolithic. In the Maghreb, the cultural sequence is characterized by a twofold Iberomaurusian and an Epipaleolithic. Our study suggests a subdivision of the Western Mediterranean into three different zones: Northern Iberia, Southern Iberia south of the 40° latitude, and the Maghreb. Site density/demography of Southern Iberia and the Maghreb follows the same pattern although different cultural complexes are involved. Troughs of the radiocarbon curve during dry and cold climate spells such as HE 1, the Older Dryas, and the Younger Dryas run synchronically on both sides of the Mediterranean and are interpreted as population busts. At the same time, a comparison between Northern and Southern Iberia, although the same techno-complexes are involved, shows significant differences. Compared to the two other regions, in Northern Iberia signals of rapid climate change are weak in the archaeological record. We have strong evidence to conclude that Southern Iberia and the Maghreb were high risk environments for hunter gatherers during phases of rapid climate change in the Late Glacial while Northern Iberia was a low risk environment with stable populations.

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Sedimentological Characteristics and Depositional Context of c. 2 Million-Year-Old Oldowan Archaeological Occurrences at Kanjera South, Kenya

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The terrestrial sediments at Kanjera South, Kenya, preserve a significant assemblage of Oldowan artifacts associated with an abundant, well-preserved fauna. Previous analyses of the sedimentary units indicate a depositional context of alluvial and lake marginal environments for Beds KS-1 to KS-3 at approximately 2 Ma. Here we aim to clarify and synthesize the depositional contexts using existing environmental data (Ditchfield et al. 1999; Plummer et al. 2009) alongside newly obtained sedimentological analyses and particle size data. We studied the particle size distribution of 50 samples from beds KS-1 through KS-3 of the Southern Member of the Kanjera Formation, using a laser granulometer. Results suggest that the alluvial facies preserved an environment dominated by relatively quiescent alluvial activity. This is characterized by lateral expanses of fine grained (sand to silt/clay grade) sediments deposited as unconfined flow events, interspersed with relatively small (c. <1–2m wide), weakly incised channels in-filled with breccia/conglomeratic cobble to granule grade sediments. Massive, clay rich sediments with sub-aerial pedogenic horizons are indicative of lake margin or of alluvial slackwater deposition. Statistical analyses of particle size distribution and diatoms further refines the environmental interpretation. Overall the area is interpreted as a relatively low gradient, hillslope environment at the foot of the Homa Mountain volcanic edifice, characterized by an alluvial/pediment type morphology. Hominin activity can be considered in light of the sedimentological analyses combined with refined magnetostratigraphy, and GIS spatial analyses of the artifact and faunal assemblages. Rapid sedimentation, minimal bone weathering, and the vertical distribution of bones through the sequence suggests that hominin activities were carried out on site for tens to hundreds of years, and that fossils and artifacts were buried rapidly in a primary depositional context. Zooarchaeological and use-wear analyses indicate that hominins were repeatedly attracted to the site locale and carried out animal and plant processing tasks.

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Paleolandscape Context for Lower-Middle Paleolithic Activity in the Hrazdan Valley, Central Armenia

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The Hrazdan River in central Armenia is the sole drainage of Lake Sevan and links that feature with the Arax River on the present Turkish-Armenian border. Investigation of the central 25km stretch of the valley by the Hrazdan Gorge Palaeolithic Project (HGPP) has revealed a complex history of Middle–Upper Pleistocene basin infilling and channel incision, both of which are consequent on regional tectonism. These depositional changes have profound implications not only for the nature and location of Lower and Middle Paleolithic hominin activity, but also for taphonomy of the resulting sites. Volcanic domes in the western Gegham range to the east of the Hrazdan valley are thought to have formed around 700 ka, a process that was accompanied by the extrusion of perlite and obsidian lavas—the latter providing raw material resources for Paleolithic populations. Geomorphological mapping and outline geochronological studies carried out by the HGPP suggest that between at least 550 and 193 ka seven basaltic lavas were erupted from the western Gegham volcanoes, all of which passed along the Hrazdan valley. The basalts sandwich terrestrial, fluvial, and lacustrine strata at various locations along the valley thereby preserving Middle Pleistocene landscapes. Subsequent downcutting since 193 ka has exposed the sedimentary stack in the valley sides thereby enabling the discovery of Nor Geghi 1 (NG1), a Lower–Middle Paleolithic site (Adler et al. 2014), and the investigation of paleoenvironmental archives. Data collected from such localities suggest that hominin activity took place during warm phases of the Middle Pleistocene (e.g., MIS 9e at NG1) during which time the Hrazdan was a meandering river with an extensive floodplain. Upper Pleistocene hominin activity during MIS 3 was in cooler climates, while by this time the Hrazdan River had become confined within its present gorge.

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A Reassessment of Vertebrae Associated with the *Australopithecus afarensis* Partial Skeleton A.L. 288-1 (“Lucy”)

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One of the most remarkable and famous discoveries in paleoanthropology, an *Australopithecus afarensis* skeleton (A.L. 288-1) popularly known as Lucy, was discovered over 40 years ago and preserves a partial vertebral column. Lucy is associated with nine free vertebrae (six thoracic and two lumbar vertebrae of varying degrees of completeness) and a nearly complete sacrum. Recent treatments of some of the vertebral material (e.g., the nearly complete lumbar vertebra) differ from earlier descriptions, so for the sake of future comparative analyses, we re-examine the attribution and serial position of vertebrae in the A.L. 288-1 series. We propose revised serial positions for two of Lucy’s vertebrae (mid-thoracic vertebra A.L. 288-1ag and middle lumbar vertebra A.L. 288-1ak) and conclude that one vertebra (upper thoracic vertebra A.L. 288-1am) does not belong to the same individual as the other elements. The latter element, represented only by a neural arch, differs taphonomically from the other vertebrae and its morphology does not fit predictions of size and shape based on comparative vertebral series of chimpanzees, gorillas, modern humans, and other fossil hominins. Consequently, this vertebra does not appear to belong to Lucy and must belong to a second, smaller individual. Although it appears that one partial vertebra was erroneously attributed to Lucy, we confirm that other A.L.288-1 vertebrae were correctly attributed.

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Alluvial Fan Sedimentation and Late Pleistocene Climate Change in the Northern Malawi Rift: Context and Evidence for Middle Stone Age Demographic Change

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The Middle Stone Age (MSA) record of central Africa occupies a critical geographic location for understanding the movements of early modern human populations between southern and eastern Africa, and eventually out of Africa. Geomorphic, geochronologic, archaeological, and paleoenvironmental data from 60 archaeological and 30 geological excavations in the Karonga District of northern Malawi have been synthesized to form the first detailed examination of MSA occupation in central Africa on the landscape scale. Paleoclimatic and lake level data from Lake Malawi show that a series of megadroughts during the early Late Pleistocene heavily impacted local plant and animal resources, while new geomorphic data show that the adjacent landscape concurrently underwent significant alteration. Episodic alluvial fan formation, cessation, and soil formation were dominant processes for archaeological site deposition and modification. These processes began by at least 100 ka and continued into the Holocene. They resulted in the preservation of MSA to Later Stone Age (LSA) deposits, many of which are demonstrably intact. Landscape colonization by MSA people appears to have been the most intense by ca. 65 ka, following the megadrought period. Occupations were ephemeral and focused on streamways, shown by numerous intact localities with stratified assemblages. The focus of MSA subsistence and tool production occurred within riparian areas, while LSA activity areas are more broadly distributed across the landscape. The MSA and LSA occupations appear to have been mutually exclusive in both space and time, although at least one LSA locality predates later MSA occupation in the region. These alternating pulses of MSA-LSA-MSA settlement in northern Malawi suggest that different land use strategies were adopted within the fluctuating cultural and physical environments. Understanding the landscape processes provides an opportunity to assess if this pattern is one of true demographic variability, or increased archaeological visibility owing to differences in regional depositional conditions.

The Effect of Growth on the Shape of the Dikika *Australopithecus afarensis* Scapula with Implications for Hominin Evolution

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The juvenile skeleton of the *Australopithecus afarensis* specimen DIK-1-1 preserves largely intact scapulae. Here, we project the shape of the right scapula of DIK-1-1 to adult size under a range of ancestral assumptions utilizing estimated ontogenetic trajectories for *Pan*, *Pongo*, and *Gorilla* and assess variation in outcomes to determine the magnitude and direction of change. In addition, we assess the three-dimensional shape of the projected DIK-1-1 right scapula in the morphospace containing all extant hominoid taxa and notable fossil hominins, and use results as a test of alternative phylogenetic hypotheses for the morphotype of the human-chimpanzee last common ancestor (LCA). Consistent with previous reports, postnatal growth is conservative among hominoid primates and ontogenetic projection moves the juvenile scapula shape closer to the morphospace intermediate between African apes and humans regardless of the shape-size vector employed. The projected DIK-1-1 scapula is most similar in shape to *Gorilla*, as previously reported. The most parsimonious interpretation of these results is that early hominin shoulder morphology reflects directional selection for a more lateralized spine and glenoid from an African ape-like LCA, and would imply that similarities of *Homo* and *Pongo* are convergent. Similarities to *Gorilla* either approximate the ancestral African ape morphotype, or alternatively, result from early hominins “moving” through a region of morphospace from a more chimpanzee-like shoulder morphotype.

Nesher Ramla Karst Depression, Israel: Middle Paleolithic Occupations (170–80 ka BP) in a New Type of Site

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A recently discovered eight-meter-thick open-air sequence at Neshar Ramla (Israel) provides a novel evidence regarding Levantine Middle Paleolithic adaptations during most of MIS 6 and 5 (OSL dates: 167 ± 11 – 78 ± 6 ka). The site is located in a karst depression formed by gravitational deformation and sagging into underground voids. The site formation involved episodic deposition of eroded soils, water-logging, and pedogenesis. Such a geomorphological context and formation mechanism are profoundly different from the Levantine Middle Paleolithic cave and open-air sites. Excavations at the site yielded large and well-preserved lithic and faunal assemblages, different types of combustion features, hominin-induced concentrations of lithics, bones, and manuports, and ochre. The eight-meter-thick archaeological sequence was divided into six stratigraphic units, in which several horizons and distinct concentrations of lithics and bones were identified. The site shows clear diachronic changes, with pulses of intensive occupation separated by low-density stages and a general tendency toward reduced occupation intensity and more expedient lithic technology in the upper part of the sequence. The Neshar Ramla industry lacks true laminar and elongated Levallois components and is dominated by short and broad flakes. Several reduction sequences were identified among which Levallois is the most common. Preliminary study of the lithic assemblages shows distinctive traits that were previously undocumented in the Levantine Middle Paleolithic (high frequency of heavily retouched sidescrapers; *in situ* sidescraper resharpening and recycling; high frequency of naturally backed knives possibly produced by a specific reduction sequence). The Middle Paleolithic occupation in the Levant is known mostly from caves and ephemerally used open-air sites. The discovery of the new type of site at Neshar Ramla allows us to attain more complete picture of the Middle Paleolithic settlement systems, site functions, and land-use dynamics during the important period when the Levant was inhabited by both anatomically modern humans and the Neanderthals.

Everything You Always Wanted to Know About Skull 5 (D4500/D2600)*

*but were afraid to ask

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The early Pleistocene site of Dmanisi, Georgia, has yielded a large sample of cranial and postcranial remains documenting the presence of early *Homo* outside Africa around 1.8 million years ago. The recently described “Skull 5” from Dmanisi (cranium D4500 and mandible D2600) constitutes the best-preserved adult early *Homo* skull known to date. While Skull 5 is a key to understanding the morphological consequences of hafting a large and robust *Homo* face to a surprisingly small braincase (546 cc), the sample of five Dmanisi crania is a key to understanding patterns of morphological variation within versus among paleospecies of early *Homo*. Here we review the morphological and morphometric evidence from Dmanisi and largely contemporaneous fossil specimens from Africa and Asia, and elucidate methods of comparative analysis used to test hypotheses about species diversity in early *Homo*. Results indicate that morphological and morphometric variation among the Dmanisi individuals is wide, but well within the range of variation seen in demes of closely related extant species such as modern humans, chimpanzees, and bonobos. Furthermore, the Dmanisi ensemble shows close morphological affinities with largely contemporaneous specimens from Africa. Together these results imply that the five Dmanisi crania represent a paleodeme of a single species, *Homo erectus*, which expanded from Africa while maintaining phylogeographic continuity across continents.
