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# Chronological and behavioral contexts of the earliest Middle Stone Age in the Gademotta Formation, Main Ethiopian Rift

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ABSTRACT

There is a general consensus that our species emerged first in Africa. Currently, the best-known skeletal evidence for the earliest anatomically modern *Homo sapiens* (AMHs) derives from sites in the rift valley in Ethiopia. However, archaeological evidence from cave sites in southern and northern Africa largely dominates discussions on behaviors that characterize the dawn of modern humans. Later Middle Pleistocene open-air sites in East Africa present unparalleled geochronological control and thus a better chance to study hominin behavior. Here, we present results of a multidisciplinary investigation of the archaeology and geochronology of one of the oldest-known Middle Stone Age (MSA) occupations from the Gademotta Formation (Fm.) in the Main Ethiopian Rift. Renewed excavation, lithic analysis, fracture mechanics, and tephrochronological investigations at Gademotta provide a better understanding of the chronological and behavioral contexts during the critical period immediately preceding the origin of our species.



## 1. Introduction

The African *early* MSA, prior to ~130 ka (*sensu* McBrearty and Tryon, 2006), is an important period to examine the beginnings of behavioral patterns commonly considered "modern". The fossil evidence for the earliest candidates of AMHs derives from the open-air sites of Omo Kibish and Herto in Ethiopia, spanning the period between 200 ka and 150 ka (Clark et al., 2003; White et al., 2003; McDougall et al., 2005) while most of the behavioral evidence interpreted as modern comes from cave sites in southern and northern Africa that mostly span the Upper Pleistocene (e.g., Henshilwood et al., 2004, 2009, 2011; Vanhaeren et al., 2006; K.S. Brown et al., 2009, 2012; *but see* Marean et al., 2007). For behavioral attributes to form the key features on which the uniqueness of our species is to be defined, it remains important that we look into the behavioral context at the dawn of AMHs and the period immediately prior to it more closely and rigorously (Lombard, 2012).

Later Middle Pleistocene sites are generally very rare on the African continent (Clark, 1982, 1988; Tryon and McBrearty, 2002; for site-specific examples see; Clark et al., 2003; Marean et al., 2007; McBrearty and Tryon, 2006; Shea, 2008; Van Peer et al., 2003). Fewer among these sites provide confident radiometric chronological frameworks that allow addressing questions pertaining to behavioral patterns in the early MSA (e.g., Wendorf et al., 1975, 1994; Deino and McBrearty, 2002; Clark et al., 2003; McDougall et al., 2005, 2008; Morgan and Renne, 2008; F.H. Brown et al., 2012). Detailed investigations of such sites are imperative to contextualizing behavioral patterns during the broader period when the earliest *Homo sapiens* appeared on the continent (e.g., Lahr and Foley, 1998; Clark et al., 2003; Shea, 2008, 2011; Sisk and Shea, 2008; Beyene, 2010).

The trajectories of the transition into the MSA of sub-Saharan Africa are shown to be multidirectional and time-transgressive, thereby requiring a revision of previous thoughts that these were rather simple and straightforward. In the Kapthurin Fm., the earliest MSA appears in interstratification with final Acheulean assemblages and is represented by a rare occurrence of pointed

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artifacts, retouched tools and the Levallois core preparation method at 284 ± 12 ka (Deino and McBrearty, 2002; McBrearty and Tryon, 2006). Although rare in the excavated assemblages, large cutting tools characteristic of the Acheulean have been recovered in the early MSA contexts of the Kibish Fm. dating to ~195 ± 5 ka (Shea, 2008). In the Sai Island, Sudan, final Acheulean and Sangoan assemblages are reported to have been interstratified with the early MSA in contexts broadly bracketed between 223 ± 19 ka and 150 ka (Van Peer et al., 2003). At Herto, similarly, the early MSA at 160 ± 2 ka to 154 ± 7 ka contains Acheulean components (Clark et al., 2003; Beyene, 2010). In contrast to these sites, even the oldest MSA in the Gademotta Fm. contains assemblages that are technologically as well as typologically exclusively attributed to the MSA at 276 ± 4 ka (Morgan and Renne, 2008). That the earliest MSA at Gademotta is recovered in a context where no trace of an Acheulean occupation could be identified (Wendorf et al., 1975) adds further complexity to the trajectory of transition into this period.

In the present paper, we present results of multidisciplinary investigations that in particular focused on the chronological and behavioral contexts of the oldest MSA occupation in the entire Gademotta Fm. Through additional geochronological analysis, we establish the stratigraphic placement of the oldest occupation horizon in this Fm. Our analyses of the technological behavior of hominin populations at the onset of the MSA show that although the site now represents the earliest known clearly MSA occurrence (cf. Deino and McBrearty, 2002; *see also*; Porat et al., 2010; Wilkins et al., 2012), certain claims by previous researchers concerning the behavior of inhabitants of the site are not strong enough to dictate acceptance.

## 2. Regional and research background

Within the Main Ethiopian Rift (MER) alkaline and peralkaline rhyolitic lava flows and domes, associated with pumice and ash, represent late silicic volcanic events (Di Paola, 1972). These lavas were erupted during the Late Pliocene to the Middle Pleistocene. In some places the eruption events were marked by remnants of large calderas. The Gademotta Ridge is one such remnant, with the volcanics of the basal formation dated to 1.30 Ma to 1.27 Ma (Laury and Albritton, 1975; Mohr et al., 1980; WoldeGabriel et al., 1990; Vogel et al., 2006).

Middle Pleistocene–Late Quaternary fluvio-lacustrine sediments cover a large area of the central sector of the MER (Fig. 1; Le Turdu et al., 1999; Benvenuti et al., 2002). Most of these sediments were laid down in a mega-lake which, in the past, occupied most of the rift floor. The present-day lakes (including Lake Ziway; Fig. 1) are remnants of that ancient lacustrine basin.

The Gademotta Fm. is located on the flanks of the ancient collapsed Gademotta Caldera, west of the modern Lake Ziway area in the central sector of the MER (Fig. 1). This formation rests unconformably on the volcanics of the Kulkuletti Fm. (Laury and Albritton, 1975). The Gademotta Fm. is found in the Gademotta type-site as well as in the Kulkuletti area, some 2.5 km away to the north-east (Fig. 1). At the type area, the Gademotta ridge rises to >1900 m a.s.l. and overlooks the floor of the Main Ethiopian Rift, including the modern Lake Ziway, which lies ~300 m lower (Fig. 1). The elevation drops off more abruptly in the Kulkuletti area, where volcanics of the Kulkuletti Fm. are more acutely dipping and extensively exposed. An obsidian flow, named the Worja source, is also exposed at Kulkuletti (Vogel et al., 2006; Negash et al., 2010). Located in an ecotonal zone (Basell, 2008) and close to an amplifier lake (Trauth et al., 2010), the wider Gademotta ridge is believed to have ameliorated environmental fluctuations and provided relatively stable habitats.

Research in the Gademotta Fm. started in the early 1970s by an international team led by F. Wendorf of the Southern Methodist University and R. Schild of the Polish Academy of Science. This team discovered and excavated several sites within the formation, recovering lithic as well as fossil assemblages (Wendorf and Schild,

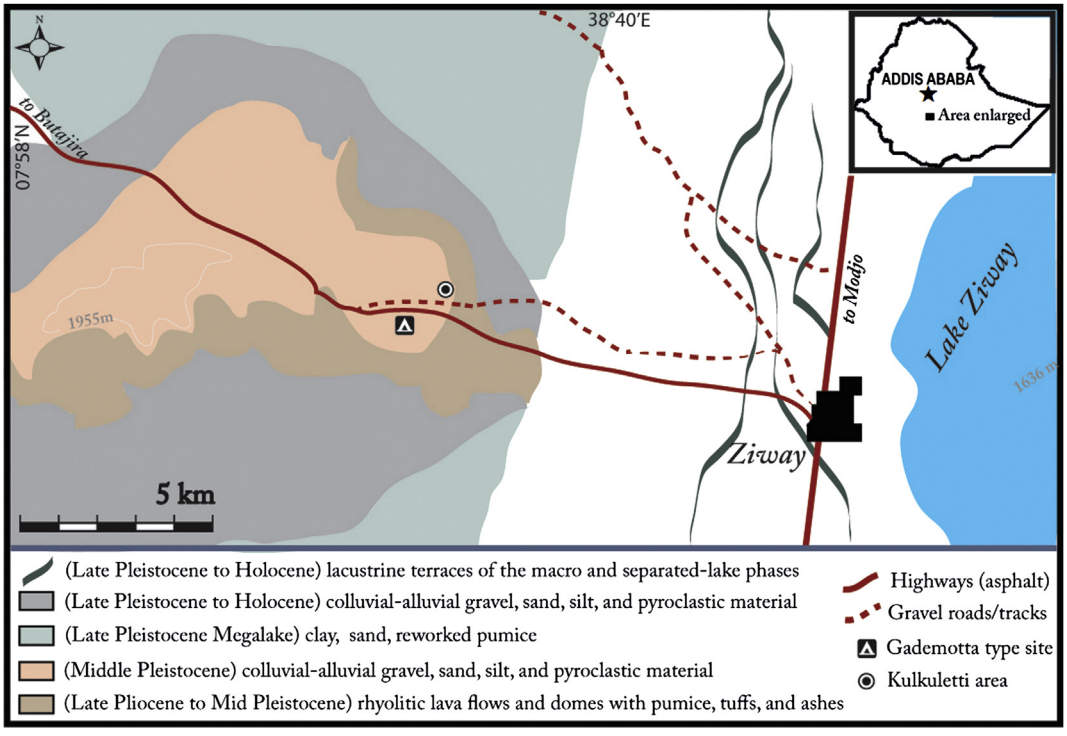


**Fig. 1.** Map showing the relative location of the study area with major stratigraphic boundaries (Redrawn from Dainelli et al., 2001).