Drone Mapping of Isimila, Tanzania: The Implications for Future Research into Mid-Pleistocene *Homo* Behavior

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ABSTRACT

Located in the southern highlands of Tanzania, the Middle Pleistocene site of Isimila contains one of the most abundant Acheulean stone assemblages in Africa, if not the world. Although the extensive riverine erosional beds are littered with innumerable artifacts which include hand-axes, hammerstones, and flaked tools, few faunal remains have been discovered. The sheer density of artifacts, exceeding that of Olorgesailie in Kenya, has made it difficult to ascertain the behavioral patterns and site formation processes that led to their accumulation. Dated at ~260ka, Isimila represents an important juncture in the evolution of the genus *Homo* and the emergence of our species; therefore, understanding Isimila as a product of Mid-Pleistocene *Homo* behavior remains crucial. To the best of our knowledge, there have not been any extensive excavation projects conducted at the site in decades; instead smaller excavations have taken place. Recent advances in technology have allowed for fresh approaches to survey of large sites such as Isimila, allowing for greater ease when establishing large-scale research questions. Through the use of a remote-controlled aerial drone and photogrammetry, a high-resolution map of the Isimila Korongo system was created. This includes a southern section that does not appear on earlier maps, where in situ stone tools were discovered during pedestrian survey. This map allows for an absolute visualization of stone tool deposits, aids in determining future excavation locations and identifies outlier deposits. The map presented here serves as an important tool in determining the roles of natural processes versus *Homo* behavior, determines possible usage patterns of the site, examines the distribution of artifacts, and enables future large-scale excavation at Isimila

BACKGROUND

❖Isimila was recognized for its archaeological potential and extensively excavated in the late 1950s by F. Clark Howell (Howell 1961), with further investigations conducted in the late 1960s by Carl Hansen and Charles Keller (Hansen and Keller 1971). These are marked on the map with orange dots.

❖The Isimila beds consist of an ~18m sequence of low-energy sandy fluvial sediment layers (labeled Sands 1-5) interspersed with corresponding periods of clay deposition, that have been interpreted as marshland or standing pond sediments caused by the cyclical silting up of the ancient Isimila river system (Howell, et al. 1962; Hansen and Keller 1971). The site is estimated to only span a few thousand years of time.

❖Due to the nature of the sediments and the lack of organic matter within them, dating has proven to be difficult. Based on similarities with the fauna from the Kalambo Falls site in Zambia, the upper beds at Isimila were roughly dated to 60kya in age. However, uranium-series dates on a hippopotamus bone fragment from the Sands 3 yielded an estimated age of ~260,000±70,000 (Howell, et. al 1972), which has led to an estimated age of ~100kya for Sands 1, the upper most layer (Cole and Kleindienst 1974).

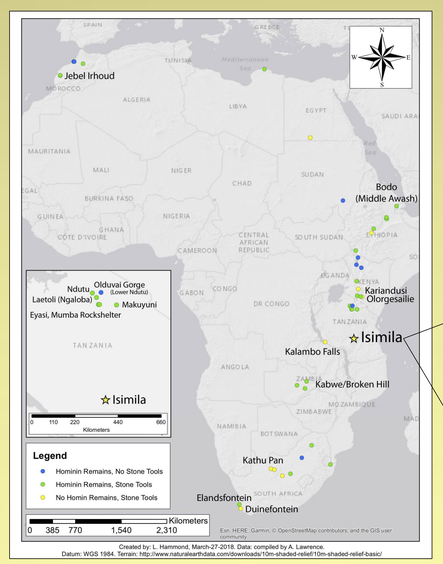


Fig. 1: Contextual map of Africa depicting Middle Pleistocene sites similar to Isimila in either age and/or archaeology.

METHODS

During the summer 2017 field season, our team utilized a DJI Phantom 4 Pro+ remote controlled drone to aerially map the Isimila korongo system from 40 meters above the basin floor. This altitude was high enough to give a wide range of video capture and overlap, but also low enough to reveal distinct features such as stone tools and sediment changes. Several 15-20min GPS guided/manually piloted sessions were conducted over the course of 10 days. The geo-referenced video and photo data (roughly ~5,000 images) was extracted and processed within the Agisoft Photoscan photogrammetry software. Several lower-altitude sessions of 15-20 meters were also conducted.

Fig. 4: Isimila as seen from air looking east.

Fig. 5: Drone's eye-view of a newer horseshoe feature that likely covers Howell's former excavated trench.

Fig. 6: Odd formations not plainly seen from pedestrian survey, such as the arrangement of cobbles in the upper left corner (red line), are more apparent from drone.

Fig. 2a: Previously unmapped exposures

Fig. 2b: Southern exposures from eye-level

Fig. 2c: Retouched flake found within a sediment wall

Fig. 7: Heavily eroded exposures of tools, and the site of extensive excavations by Howell, et al. on the left.

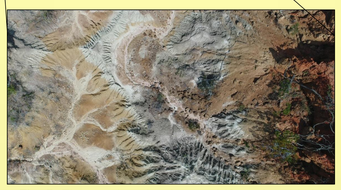
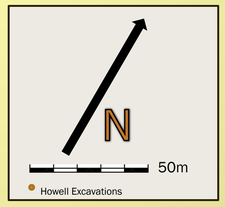


Fig. 8: The geology begins to shift noticeably in this area of the basin



INITIAL OBSERVATIONS

❖When comparing to the originally published maps (such as Howell, et al. 1962), its clear the stream has has changed course in a couple different locations, particularly in the north.

❖One of the newly created horseshoes has presumably washed away the location of one of the original 1959 trenches (Fig. 5).

❖The footprints of past excavations are apparent in a few locations, particularly the large H20 trenches, from which a good deal of faunal material was recovered (Fig. 7).

❖The limits of close-range drone photogrammetry are apparent when attempting to render the more vegetated and low-feature areas, which results in an inability to create an accurate render, resulting in several areas of the map with point cloud gaps. The videos and photos remain an important tool.

❖The greatest concentrations of stone tools remain in the heavily eroded central northern branch, decreasing substantially in the far north.

❖Pedestrian survey confirmed the continued existence of surface and *in situ* stone tools in all areas of the korongo, including in the previously-unmapped southwestern exposures (Fig. 2c).

❖Notable shifts in geology occurred within the southern branch (Fig. 8), particularly in the exposures to the south of the junction, which more closely resemble the sediments in the pillar area, but also maintain a degree of heterogeneity, neither of which resemble the Isimila Beds proper.

ARCHAEOLOGICAL CONTEXT

❖While no hominin remains have been recovered from Isimila, an extensive array of late-Acheulean tools litter the surface.

❖According to Howell's (1961) initial description of the site, the stone tools are found continuously throughout the Sands layers, suggesting a long-term seasonal occupation of the site.

❖The vertical and horizontal positioning of both tools is varied across the site, some of which have been argued to represent potential singular "occupation floors" (Howell, et al. 1962).

❖The tools themselves are comprised of a variety of materials, such as hard quartzes, granites, and mylonite (Fig. 3), with little evidence of long-range transport (Kleindienst 1961; Cole and Kleindienst 1974).

❖A variety of implement types are found at Isimila, including some notable differences in tool composition between layers. However, this variation cannot be definitively attributed to micro-environmental or developmental shifts in technique (Cole and Kleindienst 1974).

Fig. 3: Examples of Acheulean tools strewn across the basin surface

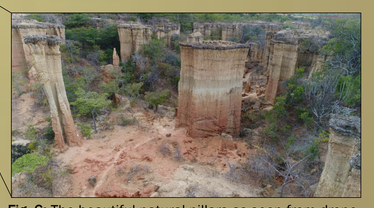


Fig. 6: The beautiful natural pillars as seen from drone

FUTURE DIRECTIONS

❖Expand the map in the following areas:
- •The south-eastern branch
- •Potential sediment exposures further southwest
- •Missing transects in the north

❖Utilize GIS software to:
- •Expand the utility of the map by marking the extent of different bed exposures
- •Plot concentrations of tools and faunal remains in an attempt to elucidate erosional patterns, potential areas for future excavation and better interpret behavior

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