



## High concentrations of Acheulean handaxes from the Kariandusi, Gadeb and Olorgesailie prehistoric sites: reworked artifacts or in situ tool factories?

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Several archaeological excavations of Acheulean technology (ca. 1.6-0.2 Ma BP) in East Africa have revealed high concentrations of handaxes, such as the prehistoric sites of Olorgesailie (South Kenya, ca. 0.9 Ma BP), Kariandusi (Central Kenya, ca. 0.9 Ma BP) and Gadeb (East Central Ethiopia, ca. 1.6 Ma BP). These oval shaped stone tools with a distinct pointed end typically occur in fluvial deposits in the vicinity of large paleolakes. Therefore, the null hypothesis of our analysis is the interpretation that the handaxes were picked up in a larger area and redeposited by a river. The alternative hypothesis, however, explains the high concentration of the stone tools by a high population of *Homo ergaster/early erectus* and a factory-type handaxe production center. To falsify either the null hypothesis or the alternative hypothesis, we developed an automated image analysis routine to automatically determine the orientation statistics of the elongated stone tools. The MATLAB algorithm, capable of classifying handaxes, bones and elongated pebbles, calculating their orientation and testing for a random distribution in the orientation data by applying a rayleigh test, was applied to the original archeological drawings from four Acheulean sites: Kariandusi and Olorgesailie in Kenya, as well as Gadeb and Melka Kunture (ca. 1.6 Ma BP) in Ethiopia. We derived mixed results from our analysis: while the stone tools from Kariandusi and Melka Kunture are randomly distributed, the handaxes from Gadeb and Olorgesailie show a preferred orientation in agreement with the paleocurrent direction of the paleoriver in the area. Our results suggest that the handaxes at Kariandusi, consisting of more than 100 handaxes, were deposited *in situ* by the tool makers, ca. 80 m away from the most likely source of raw material. This finding indicates a larger population, eventually a settlement of *H. ergaster/early erectus* on the shores of paleolake Kariandusi at ca. 0.9 Ma BP, rather than reworking as the most dominant process to create the high concentrations of stone tools. Instead, the Olorgesailie and Gadeb sites indeed indicate a preferred orientation and therefore the null hypothesis can be rejected from a statistical point of view. Further research is required to bolster our conclusion, such as provenance analysis of the embedding deposits and flume experiments with handaxe-shaped objects.