GPR Analysis of the Mortuary Features at Pillar Sites in the Turkana Lake Area, Kenya

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Abstract

Four sites with standing pillars, often in clusters or circles, which are estimated to be 8,000 years old, were constructed on the margin of a large freshwater lake in northern Kenya in the early Pliocene. Limited excavations of one of them showed abundant human remains associated with these monuments. GPR surveys were carried out within and around the pillars to map possible subsurface features. It was found that skeletal remains, associated pottery and many other artifacts are found within well-defined excavated areas that are about 1 meter or more in depth. The GPR analysis was used to calculate the area of these interment excavations at one of these sites to arrive at an approximate number of individuals who were buried, which numbers in the thousands.

Introduction

Ground-penetrating radar (GPR) data were collected at four the four pillar sites from June 14-18, 2014 in order to determine what buried features might be preserved below and near the pillars and their associated cairns, pavement surfaces and other surface features (Figure 1). Data were collected at Lothagam North, Lothagam West, Kalakol and Manemanya (Hildebrand et al. 2018). The most interesting and potentially significant GPR results were obtained at Lothagam North, which are discussed in detail here, but similar features were mapped at all four.

Figure 1: The 4 pillar sites studied with GPR.

A Subsurface Interface Radar (SIR) control system #3000 was used for all collection (Figure 2), manufactured by Geophysical Survey Systems, Inc. (GSSI). The 400 MHz antennas were used for all surveys, which were excellent at transmitting and receiving radar waves up to 1.5 meters maximum depth in the ground, with a spatial resolution of about 20 cm of most stratigraphic interfaces and objects.

The GPR data collected at each site consisted of many reflection profiles, all of which were recorded within a 40 nanosecond (ns) time window that correlates to about 2 m depth in the ground when corrected for radar velocities. All reflection profiles were collected with 40 traces per meter and frequency filters of 800 MHz (LP) and 200 MHz (HP) were applied. A survey wheel was used for distance calibration (Figure 2), and tape measures were used to lay out grids, with ropes used to identify transect lines on the ground surface. Grid corners surveyed with a RTK GPS system and placed into the site survey with corresponding drone aerial photos. The reflection data were processed using ***GPR Viewer*** and, ***GPR Process*** software (Conyers 2023) with image mapping using ***Surfer 12***.

Figure 2: Collection of GPR profiles at Lothogam North using the 400 MHz antenna and a survey wheel for distance calibration. The trench for velocity and stratigraphic calibration is just beyond the antenna.

Lothogam North

Reflection profiles were collected adjacent to the trench being excavated at the time (Figure 3). This trench exposed a surface cobble and gravel pavement, underlain by early Holocene beach and fluvial sand, which was deposited on Pliocene age calcareous sandy bedrock. The Holocene and Pliocene units were truncated by the emplacement of burials and the excavated area is filled by the human remains surrounded by a matrix of breccia derived from local stones. Each

of these stratigraphic units was directly tied to those layers visible in the trench walls, with these depth correlations used to convert all radar wave travel times, measured in nanoseconds, to real depth. In the GPR reflection profile the truncation of the undisturbed stratigraphic layers is obvious, with the fill materials within the burial incision mostly jumbled and homogenized sediment and human remains. Only the surface fill layers within the incision produced distinct planar reflection surfaces in the GPR profile.

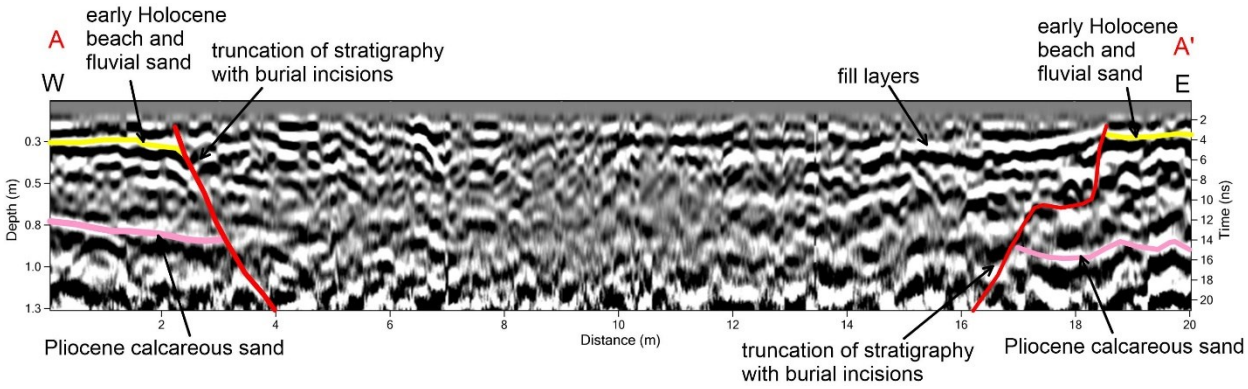

Figure 3: Stratigraphic tests showing sedimentological units of interest, with the truncation by prehistoric burial excavations in the middle of the ring at Lothogam North.

All reflection profiles were further processed into three-dimensional volumes of data, a process that re-samples all the digitally recorded reflections into amplitudes and then produces horizontal maps of the relative strength of those reflections in horizontal thicknesses in the ground (Conyers 2013). Slices were generated for each 7 nanoseconds (ns) of two-way radar travel time correlative to 40 centimeters in the ground (Figure 4). The strength of reflections (radar wave amplitudes) were then assigned colors of the rainbow, with the larger stones and stratigraphic interfaces that generated strong reflections displayed as red and orange, and the low amplitudes that are showing areas of homogeneous fill as blue and white.

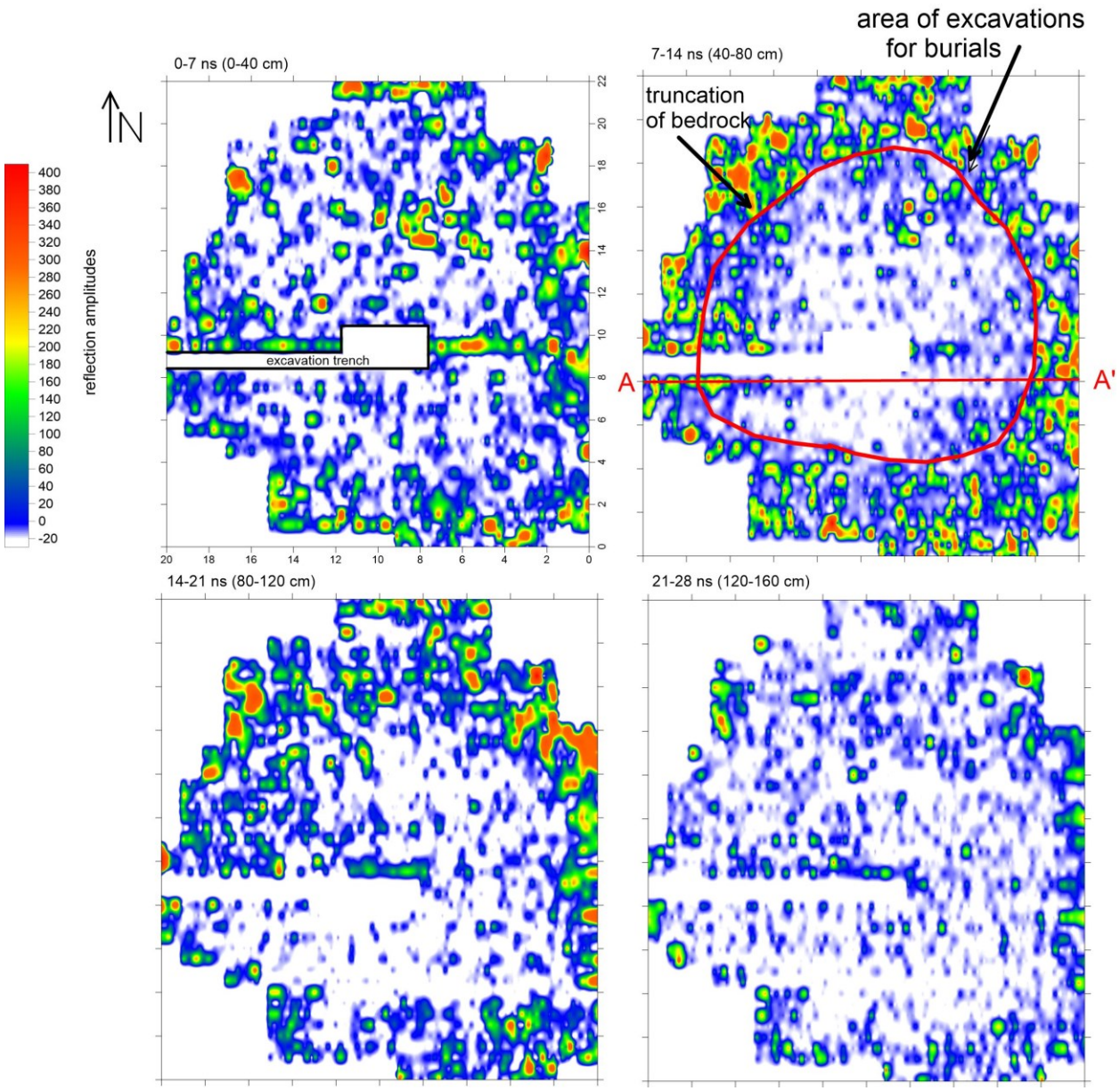

Figure 3: Amplitude slice-maps at Lothogam North site showing area of truncation of bedrock for burials.

The area where bedrock was truncated for burials can be seen starting in the 40-80 cm depth slice. The intact sedimentary units are visible on the margins of the grid as high amplitude (red and yellow) reflections. This truncated area that includes the human remains is within the surface stone circle is not circular (Figure 4). This suggests the surface architecture was placed here after the burials had been emplaced, perhaps after the exact location of some of the individual bodies had been forgotten.

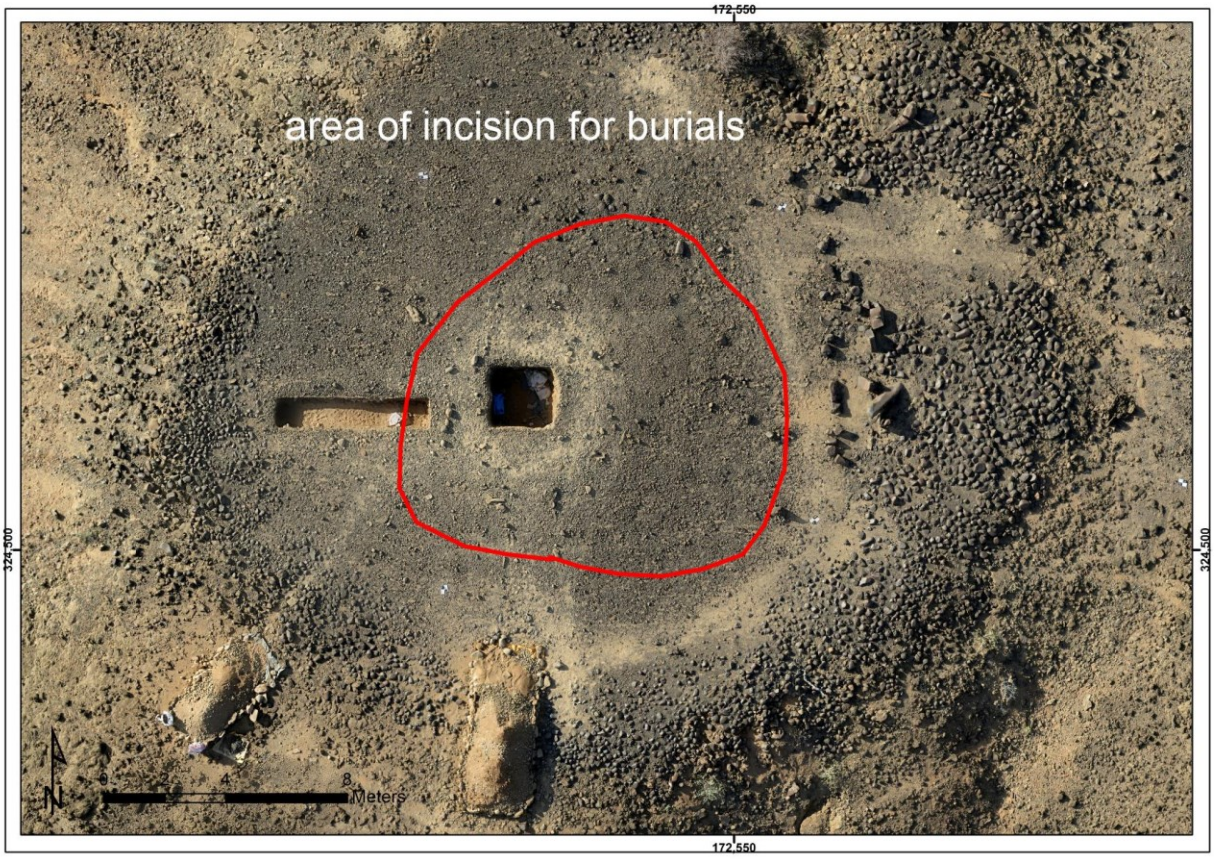

Figure 4: Location of the burial incisions as it truncates early Holocene sand at Lothogam North site.

The total volume of the burial area at Lothogam North site can be calculated by analyzing the GPR amplitude maps and reflection profiles, which accurately show the incision and back-fill matrix. The surface area of the burial area shown in Figure 4 is approximately 130 m^2 with a total depth of incision for for burials of about 2 meters, as can be measured in the reflection profiles. The total volume of bedrock that was removed during emplacement of burials is therefore about 260 m^3. In the limited excavations (Hildebrand et al. 2018) totaling a little less than 18 m^3 of material was removed, within which between 200 and 400 individuals were uncovered. This is between 11 and 22 individuals per cubic meter. Projecting to the total area excavated prehistorically for burials, as can be determined in the GPR volume calculations, somewhere between 2860 and 5720 individuals are likely to have been interred within the boundaries of the surface stone circle at Lothogam North.

Conclusions

A three-dimensional analysis of the ground at these pillar sites using GPR demonstrates the importance of these burial locations, based on the number of individuals who were interred. It

appears that people first came to this area from the north, bringing with them livestock that were likely domesticated in what is now the Sahara Desert and the sub-Saharan Sahul area of Africa. They were likely fleeing progressively drying conditions there and searching for pasture and water for their herding existence.

While it has not been published or included in an ancient landscape analysis of the pillar sites, a few days geological analysis showed that all these sites were located on the banks of the large ancient Lake Turkana. Just a few tens of meters away from each site can be found thick beach deposits of fresh water shells, which were deposited on the margin of this lake (Figure 8). While the extant Lake Turkana (which is highly saline) is today located many tens of kilometers to the west, at the time these sites were being used, it was a much larger freshwater lake that covered much of this area of northern Kenya and southern Ethiopia Feibel (2011). This would have made it a magnet for herding people, and it was along its shore that monumental architecture related to the burial of important people was constructed.

Excavations were conducted in the summer of 2025 at another of the pillar sites, Manemanya, where similar features were found. At this site a large excavated area was originally interpreted, which appeared to be similar to Lothogam North. After excavations it now appears to be much more complex. This large excavated area instead seems to be an area that was disturbed to emplace many individual burials, with the addition of other (as of now) confusing artifacts such as stone slabs and pavement stones. The Lothogam North model of burial does not appear to be consistent with those at Manemanya, for reasons that are not presently understood. In collaboration with Brenna Fennessey from University of Florida, we are correlating the excavated features with reflections in GPR profiles, in the hope that we can map these other important, but somewhat different burial features. This work is ongoing as of September 2025.

Figure 8: Beach shell deposits showing the freshwater lake margin near the pillar sites.

The GPR analysis of the dimensions of the burial incisions, when coupled with skeletal analysis of the interred individuals, shows how many people were buried here over some centuries at Lothogam North. The burial practices began with few above-ground monuments, but over time large stone pillars were placed in various positions as part of ritual behavior related to burials. The GPR analysis shows that many of these pillars were placed over top of existing burials, likely because their locations had been lost over time. The presence of the large pillars shows an increase in social complexity with increased social stratification as population grew and wealth (perhaps measured by heads of livestock as it is with the local people today) increased.

References

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