Exploratory survey and landscape archaeology in the Karonga District, northern Malawi

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Overview:

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 70 x 20 km to understand artifact attributes relative to different geological deposits and landscape characteristics. The 2012 and 2013 surveys consisted of attribute collection of surface exposed raw materials (typically river cobbles) and artifacts within archaeological areas of interest, with an emphasis on sampling geological exposures where many artifacts were visible on the surface. During these initial surveys, data were only collected for artifact cores. This resulted in a large dataset that shows distinctive patterns of raw material use within different river catchments. In 2014, we broadened our procedures into landscape survey using systematic linear transects oriented through major river catchments and designed to sample multiple geological formations. All cores encountered along the transects were again recorded, in addition to all surface artifacts found in total collection areas placed at 100 m 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 (UAV) 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 (Chitimwe Beds) created isolated "islands" of artifact-bearing sediment. Surface exposed 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 Chitimwe Bed sediment packages relatively unaffected by modern disturbances and at least one potential MSA site that appears to preserve *in situ* knapping floors.

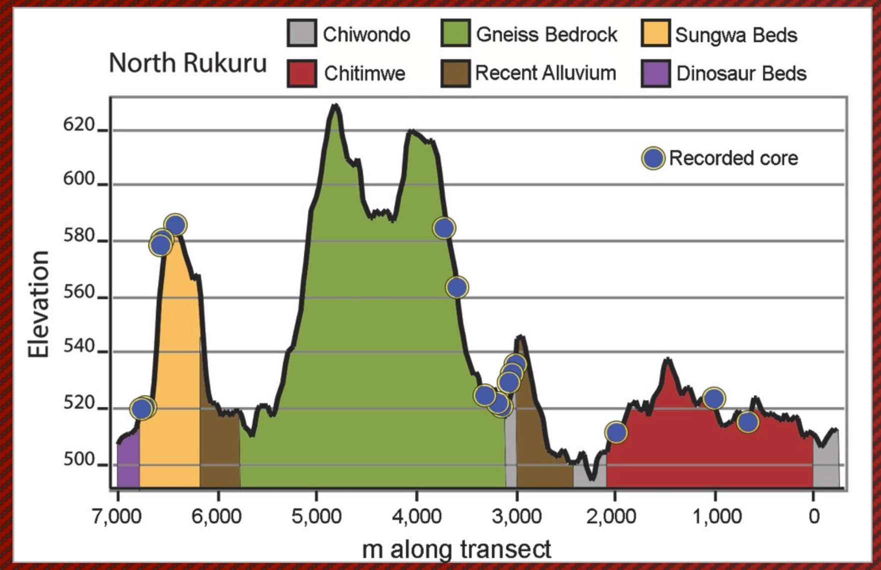

Figure 3 (left): map of transect 2, showing changes in elevation relative to geological units and distribution of cores. Geology was digitized from Geological Survey maps from 1979, and error ranges are estimated to be ~100m.

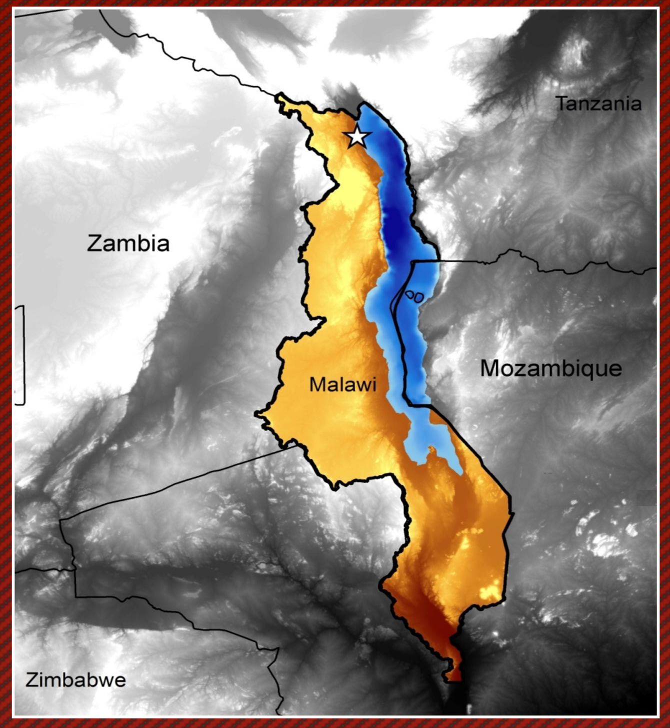

Figure 1 (above): Location of study area near the town of Karonga (star) in Karonga District, northern Malawi.

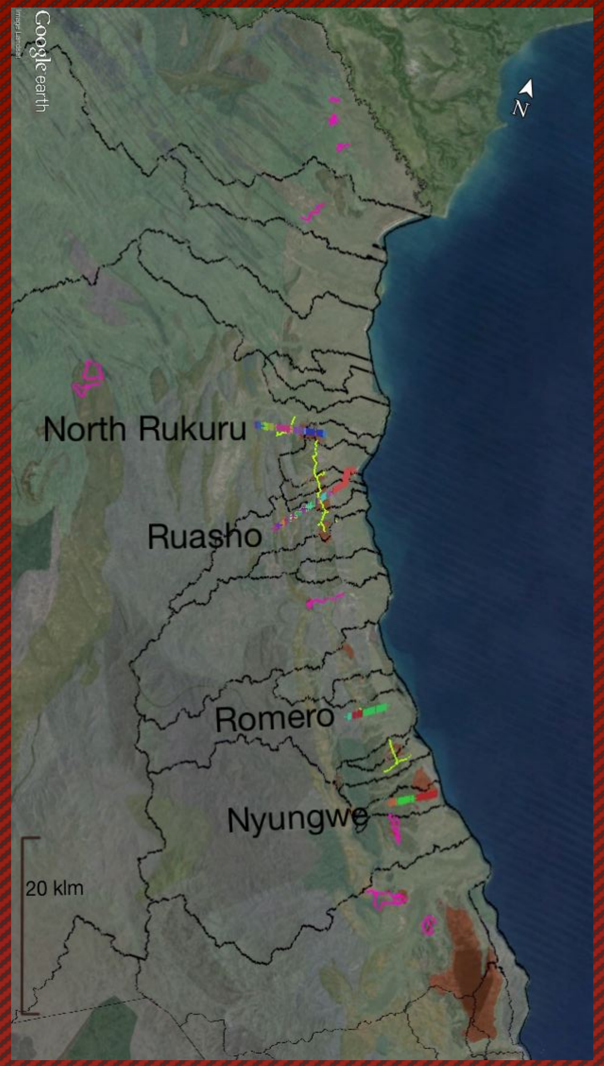

Figure 2 (right): geological map with four transects in the Karonga District showing multicolored 2014 transects over different geological formations. Thin yellow transects from 2013 and pink from 2012.

	Single Platformed	Other
Below Foothills	10	35
Above Foothills	28	34
Fisher's Exact p-value	0.0155	
Above foothills = 3500 - 6500 m away from current lakeshore		

Table 2: proportion of single platform cores in the assemblages that were recorded from the lake side of the foothills compared to those recorded from the foothills.

Landscape Survey:

The survey consisted of four main transects, each of varying distances and covering different water catchment areas, in order from north to south: North Rukuru, Ruasho, Remero, and Nyungwe. While walking the transect, changes in landforms and geologic environment were noted and a new section number was created for each distinct area. A sample of up to ten cobbles of raw material were collected and characterized for each of these areas. Additionally, within each transect, regardless of landform or geologic area, every 100 m a total surface recording was completed, in which every exposed artifact ≥ 2 cm in maximum dimension found in a 2 x 2 m area was recorded and then returned to its original place. During the survey, all cores encountered were examined and recorded, regardless of geologic or landform area, before being replaced in their original find location.

	Distance from lake in bands of 500m					
	Cortex	Flaking on Perimeter	Number of Scars	Number of Cores	%Quartz	Core Mass
Spearman's Rs	0.1876	-0.0433	0.0882	-0.0664	-0.1506	0.0915
p-value	0.0818	0.6575	0.36605	0.81404	0.5922	0.3484

Table 1: Spearman's Rs shows no distinct correlations between core attributes over distance bands from Lake Malawi.

Discussion:

In previous surveys, we found that there are significant differences in raw material characteristics (material, crystal size, flaws) between catchments in the study area. This is likely related to the differing geologic formations that are drained by each, leading to distinctive raw material and geomorphic profiles for each catchment. A clear pattern emerged where quartz was both more available and more frequently used in the southern catchments relative to the northern catchments. This pattern suggests a highly "local" mode of raw material exploitation, with raw material selection having occurred amongst cobbles found in the immediate vicinity. A pattern of hunter-gatherer land use may be inferred from this in which local catchments were exploited along the environmental gradient leading to and including the foothills of the Nyika and Misuku Plateaus lying to the west of the study area.

To test this, we examined how cores were reduced along an east-west transect leading from the lakeshore and up into the foothills of those highlands. We found that core reduction intensity does not differ by any measure when distance from lake (in bands of 500 m) was correlated against %cortex, flaking on perimeter, or number of scars (Table 1). There was a slight (but not quite significant) tendency for %cortex to correlate positively with increasing distance, which suggests that more reduction may have taken place in the lower portions of the catchments. Fisher's Exact Test (Table 2). confirms that there is a highly significant difference between the percentage of single platform cores recorded relative to other core types that experienced more intensive reduction (e.g. multiple-platformed, radial, etc.) in the upper parts of the catchments when compared to the lower parts (0.0155). This indicates that reduction patterns do differ between the two areas, and future work will explore this interpretation further.

We also found that there are differences in raw material availability, although not raw material use, between the upper and lower aspects of the catchments. Most notably, "unusual" raw materials such as chert, siltstone, and mudstone are available in larger packages in the foothills, while fine-grained quartzite cobbles are more common in the lower reaches. This is especially true in the North Rukuru catchment, where the Sungwa conglomerates provide a wealth of fine quartzite cobbles. As a more general pattern, however, more quartz appears to be available in the form of cobbles below The foothills than it is above the foothills (Fisher's p = 0.0142). This contradicts what is known from geological maps, where large quantities of vein quartz occur in more mountainous regions. These become quartz cobbles in the southern part of the catchments, where they are not as commonly exploited when fine-grained quartzite is available. The preliminary patterns found in this survey suggest that a larger sample with the same approach of bisecting the catchments will reveal more nuance in this patterning across the landscape, and also suggests that future analyses should use GIS buffers based on slope or geological units rather than distance from lake as a potential variable that can be extended back into the Middle Stone Age.

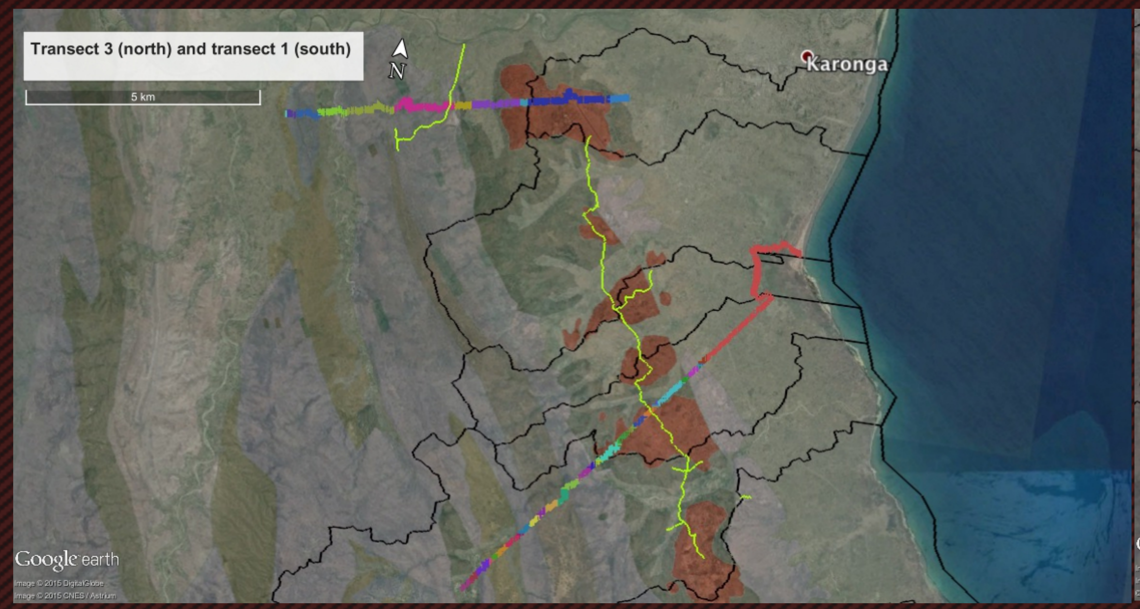

Figure 6 : the 2014 multi colored transects demonstrating change in geology through the survey for transects 3 and 1. 2013 transects areLight yellow. Map has lightly shaded geological changes for better understanding of the region

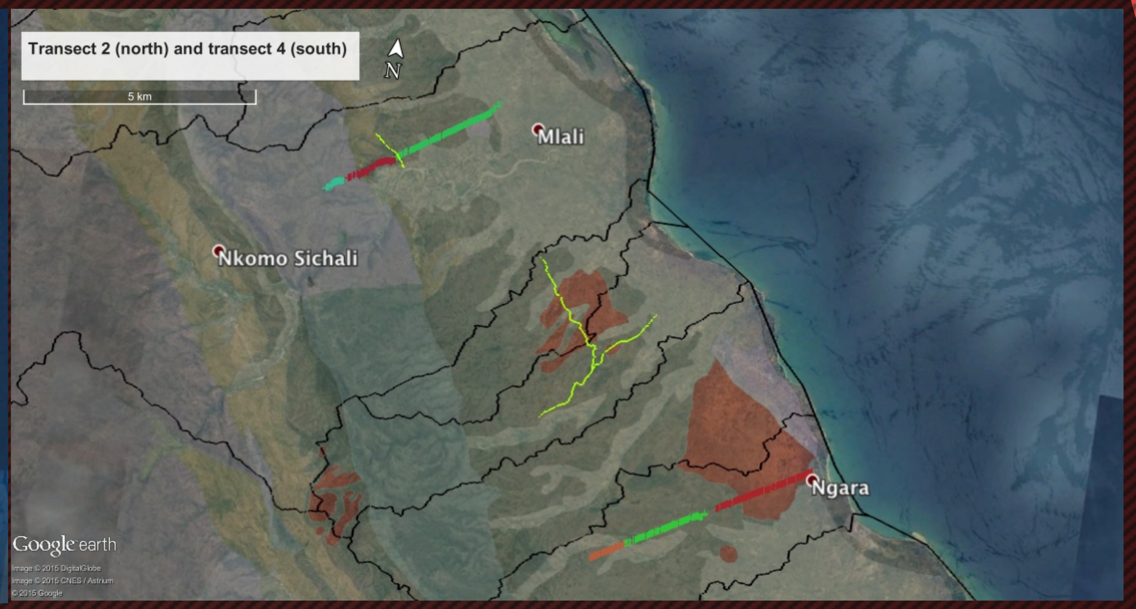

Figure 7: the 2014 multi colored transects demonstrating change in geology through the survey for transects 2 and 4. 2013 transects areLight yellow. Map has lightly shaded geological changes for better understanding of the region

Figure 8: core on flakes are rare, but show diversity in technological approaches

Figure 9: radial core, diagnostic of the MSA artifacts that dominate the surface finds

Figure 10: retouched crystal quartz flakes are rare and suggest a minimal LSA presence

Unmanned Aerial Survey

For the 2014 survey, a Quadcopter UAV was used for aerial survey along the transect lines, and also to capture high resolution images of test pits and excavations within their surrounding environments. Although the UAV proved challenging to maintain under field conditions, the use of an onboard GPS navigation system tied to Android mobile devices with Google Earth imagery provided an efficient mechanism for navigation and the programming of automated flight paths. The UAV completed aerial surveys of three excavations, 650 meters of a survey transect, and four test pit locations.

Figure 11: view west over the UAV photo scans, after rendering

While the UAV was an excellent tool when operating as intended, the navigation software included with the device was prone to abrupt and unexplained errors which curtailed our aerial data collection activities, before the completion of the field season. Fortunately, the data already acquired had been downloaded on a regular basis prior to the terminal failure of the UAV.

The aerial images were stitched together and georeferenced to datum points on the ground to create a 3D model of the landscape. This high resolution imagery combined topographic and photographic data set could then be associated with geological and archaeological information collected during excavation, test pitting, and landscape survey.

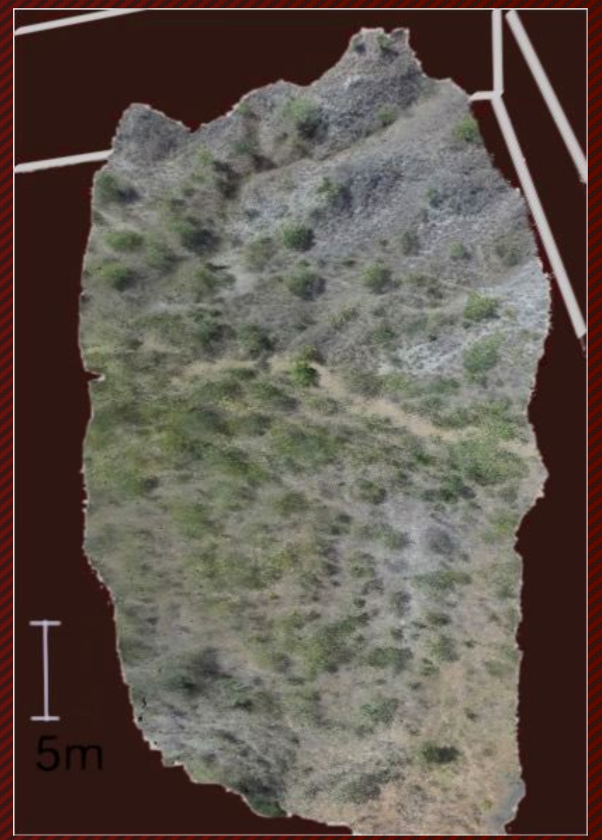

Figure 12: looking along the length of a section of transect after photo rendering

Figure 13 (above) UAV in flight

Figure 14 (left) making adjustments before UAV flight

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Conclusion:

The surveys from 2012-2014 have yielded results about land use, resource use, and archaeological change over different geological areas that suggest future work in this vein will be fruitful. They have also guided the research methodology to a solution that is optimal for this specific context. For example, the total recordings done every 100 meters gave an overview of the archaeology across the landscape, but were not sufficient to represent the density and diversity of archaeological occurences. Core attributes did not have any significant incremental change over the landscape, but differences can be detected even with a small sample between the foothills assemblages and the alluvial plain assemblages. This hints at cores being used as an "on-demand" resource for quick flake manufacture in some areas, whereas in others different techniques were applied that could create more standardized flakes (e.g. radial cores). The survey also revealed new sites of potentially high significance. Overly rigid survey methods in these deposits can miss many of the sites that are buried under alluvium from the high mountains to the west, which adds a protective layer from the elements, but also from discovery. Future survey will build upon the methodologies implemented in 2012, 2013, and 2014 to enhance flexibility and better represent the distribution of archaeological materials, while maintaining more formalized approaches that maximize comparability between catchments.