INTRODUCTION

The Chaminade 1A (CH-1A) Middle Stone Age (MSA) site, located west of Karonga, Malawi, was excavated by J. Desmond Clark and colleagues in 1965.

• > 2 kg of ochre artefacts were recovered from the site and are now curated at the Stone Age Institute. Several artefacts exhibit macroscopic evidence of abrading and incising (below right) consistent with pigment production.

• In 2011 the Malawi Earlier-Middle Stone Age Project opened new excavations near the CH-1A site and began sampling geological sources of ochre in the region west and south of Karonga through collaboration with local guides.

• Conducting a provenance study of ochre artefacts will facilitate the study of procurement preferences, transport patterns, and early material symbolism.

• Rather than forming in situ from local weathering of iron-rich rocks, Malawian sources identified thus far are challenging to characterize sedimentary deposits with minerals transported from multiple parent rocks.

Research Questions

> What is the most effective method of distinguishing between ochre from different geological sources?

> What parent rocks weathered to form the extant sources of ochre in northern Malawi?

RESULTS

Sources Sampled and Neutron Activation Analysis Results

- 1 bulk analysis of homogenized ochre per sample for 22 analyses total
- Long count INAA element concentrations used in Principal Components Analysis (PCA) below
- 33 elements detected by INAA, 30 used in PCA, data normalize to Fe-content, then log10 transformed
- 90% confidence-ellipse for each group
- Intra-source variation in the Mulowe group is too great to separate it from the Malawian source group.

La-ICPMS Paint Chip Results

- 3 Immobile Element Ratio Plots (left): Each ochre sample plated 2 paint chips and each paint chip was analyzed 5 times for a total of 10 data points per sample.
- Curved shape indicates sample variation
- Each data point is in order to highlight sample variation.

Principal Components Analysis (below): 40 elements detected, normalized to Fe-content, log10 transformed

CONCLUSIONS

• INAA is not precise enough nor does it detect enough elements to distinguish between multiple sources of ochre in which each source has a substantial detrital mineral component. The Kayelekera source may be especially distinct because it overlies Chambe Gneisses while the other two sources are located above Karroo and Post-Karroo sedimentary rocks.

• Plots of immobile element ratios derived from La-ICPMS of Paint Chips indicate that the Malawian source is the most heterogeneous, reflecting diverse parent rocks and variability in each paint chip. The Kayelekera and Malowe groups are more homogeneous and indicate strongly alkaline and subalkaline parental rocks, respectively.

• Paint Chip La-ICPMS generated a 225 point dataset that was initially less effective than the INAA data in separating the 3 ochres sources. However, by reducing the ~5 ablations per chip to an average for each chip and running a PCA on the means, 3 very distinct and constrained groups appeared and ~99.4% of variation in the data set was explained by PC1 and PC2.

• Data processing rather than the data collection technique may be the key to characterizing heterogeneous ochres. Technical development should focus on reducing sample size to facilitate analysis of artefacts.

• For the first time, refractory mineral grains (zircon) have been isolated from an ochre sample and analyzed for Heavy Rare Earth Element composition. La-ICPMS targeted at zircon crystals may not be applicable to artefact sourcing due to the large sample mass of ochre required (0.5 – 1.0 kg). However, this technique may eventually facilitate the distinguishing of ochre sources from one another on the basis of the age of crystallization for zircons found in each source.

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REFERENCES

A list of references is available in hard copy below or by e-mail upon request. Please send inquiries to amzipkin@gwmail.gwu.edu