1. PUBLISHABLE SUMMARY

Understanding the impact of intensified production technologies on human society and the environments in which they live is an increasingly pertinent issue on a global scale. Technological change is often held responsible for environmental degradation, whether that comprises agricultural expansion or a change in intensity of a production technology; news stories of the environmental burden of industry and farming are reported on a near-daily basis. Yet in order to anticipate the impact of present-day technological activity, it is important to understand the impact of activity in the past. Iron production is one such technology that has often been attributed with causing significant environmental change. To flourish, an iron production industry needs a ready supply of fuel, water, clay and ore. The development and intensification of iron production is thus often linked to significantly increased – and sometimes highly detrimental – pressure on local fuel resources.

As such, this programme of research seeks to address a single core question: ***how can we measure the relationship between past iron production and environmental change in a given setting?*** As a case study, this research examines the archaeology of iron production in the Pare Mountains, Tanzania to ask what impact the intensification of iron production had on the ecology of the Pare Mountains in the 2nd millennium AD, and how sustainable this industry was in terms of the production and consumption of charcoal for fuel? It will also consider how the social ecology of the Pare Mountains influenced the relationship between iron smelters and their natural environment, and what roles trade, craft specialisation and gender played in the intensification and organisation of this industry. Were management strategies employed to mitigate the impact of iron production on forest resources? These questions have important implications for understanding how societies interact with their industries and environments, and how indigenous knowledge and values influence this relationship.

This research requires a thorough reconstruction of Pare's past iron technologies, and to do so it integrates archaeological fieldwork, interviews with local community members who remember traditional technologies, and metallurgical and charcoal analyses. Together these data will allow us to develop a better understanding of the chronology, distribution, technological development, fuel selection criteria and social contexts of the iron smelting and smithing activities that may have shaped the landscape of the Pare Mountains.

Initial objectives in the outgoing phase at the University of Arizona included provision of training in a suite of scientific techniques (chemical and physical

mineralogy, optical petrography, ore microscopy, metals analysis, Raman spectroscopy, AMS dating), which was provided by the School of Anthropology, the Department of Mining and Engineering, the Department of Space Sciences, the Department of Physics and the Department of Geosciences. The application of these techniques will enable a deeper interrogation of the archaeological remains encountered as part of this research. At the start of 2014, this training phase was followed by a period of archaeological fieldwork in Pare, Tanzania, working with colleagues from the University of Arizona and the Department of Antiquities, Tanzania. Over the course of two months, this fieldwork first comprised a walking survey to locate potential archaeological sites. Once sites had been selected for excavation – at Mwanga, Ngalanga and Kampi ya Simba – gradiometer survey was undertaken to understand the distribution of sub-surface features. Excavation units were positioned in areas of interest, and samples were taken of slag, ceramics, charcoal and ore for archaeometric analysis. During the fieldwork, interviews were carried out with members of the WaShana smithing clan, and presentations were given to individuals and groups of school children who visited the archaeological sites whilst work was underway.




Most samples were taken back to the University of Arizona for the analyses outlined above, although some were sent to the University of Cape Town for WD-XRF analysis. During the concluding months of the outgoing phase, the chemical and microstructural compositions of the slag and ceramic samples were determined, and a picture is emerging both of the ingredients used in the past smelting industries at Pare, and the finer details of the smithing techniques employed there. Radiocarbon dates generated from the excavated remains place the sites of Mwanga and Kampi ya Simba in the 11th-13th centuries AD, whilst Ngalanga was in operation in the later 2nd millennium AD. These dates are in agreement with those from previous archaeological research, and will refine the chronology that is available for the development of iron technologies in the Pare area.

In the coming months, a full understanding of the iron industries of Pare will be drawn together from these results. Once a report of the results has been finalised – and building upon a literature review that critiques previously applied approaches to understanding the link between forest depletion and metallurgy – I will model the impact of this industry on the Pare landscape within the constraints of the available archaeometallurgical and geoarchaeological data. This will provide a valuable framework for other scholars to refer to when attempting to estimate industrial fuel consumption and the effect of that consumption on renewable forest resources, not only in sub-Saharan Africa, but across the globe.

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