Luminescence dating of samples from recent contexts in southern Africa

INTRODUCTION

The last 500 years was a formative period of the southern African past, during which hunter-gatherers, agropastoralists and colonists interacted frequently and intensely on the shared landscape. This archaeological and historical data from this era is inextricable; tying the material remains into the oral record requires the chronological sequence of archaeological site settlement, use and abandonment to be read and understood ideally as a generational task.

The prominent site Smelterskop, in Rosh山坡, Limpopo Province, South Africa (Figure 1), was in the center of the only major precolonial tin mining and smelting industry in southern Africa. When colonists settled in the area at the beginning of the 19th century, it was estimated that earlier African miners extracted 200,000 tons of tin with hand tools. The mined tin was alloyed with copper to produce bronze, a metal traded widely in the region. Systemic archaeological research at Smelterskop began in 2004, and a major goal of this project was to establish a chronology of tin production in southern Africa.

LUMINESCENCE DATING

Using optically stimulated luminescence (OSL) dating on single quartz grains, chronological results with good resolution were obtained for multiple samples from two archaeological middens at Smelterskop (Figures 3 and 4). A Yeoman white-heart bead was isolated from the CW midden. This type of small glass trade bead appeared in southern Africa in the first decades of the 19th century, and the OSL ages corroborated this terminus post quem based date. The ages for Midden 1 substantially overlap archaeological evidence from stone wall architecture and ceramic decoration that suggest the feature relates to an earlier occupation of Smelterskop.

Some samples in OSL dating of young samples are due to short burial time, yielding a low OSL signal. With low signal, even a small degree of partial bleaching in a sample can be significant. A high percentage of over-deposition ($D_o$) of individual grain measurements around the equivalent dose ($D_e$) of the sample is an indicator of a mixed-age sample. This may be due to post-depositional mixing, partial bleaching, or inclusion of grains of different ages in the sample during collection. Where there is high over-deposition and evidence for partial bleaching or grains from different strata, the sample $D_o$ is calculated with a minimum age model (MAM). Samples with low over-deposition represent a single statistical population, and the sample age is calculated with a central age model (CAM).

We measured hundreds of grains to obtain statistically significant samples of sensitive grains, performed stepped preheat tests and determined the frequency of regeneration to assess at thermal transfer occurred (Figure 5). Recovery was a term for the transfer of electrons from a light insensitive to a light sensitive trap during the preheat, and it can be a problem for young samples. Recovery can cause age overestimation. A significant OSL signal following a bleach and preheat is some indication of its presence (Figure 6). We calculated $D_o$ on sample grains with and without recuperation to determine if it has an effect on age (Figure 7).

In addition, in young samples, a relatively high proportion of measured grains yield $D_o$ values close to or even less than zero. This is a significant, because the common statistical method for calculating $D_o$ from the population of accepted single grains are lognormal models. A lognormal model does not characterize a $D_o$ population close to zero well and corrects incorrect results where $D_o$ $\geq$ $D_e$. Performing a lognormal analysis, plus systematically dating grains where $D_o$ $\leq$ $D_e$, will bias the sample $D_o$ and result in weaker ages. We compared the Smelterskop OSL ages using both lognormal and unlogged radiometric models (Figures 3 and 7).

CONCLUSION

The Smelterskop OSL dates demonstrate that for the recent past, luminescence dating is significantly more accurate than is possible with radionuclide. Unlogged statistical models better reflects the range of $D_e$ values typical in a young OSL sample. The results from Smelterskop indicate that the use of the kiln in a zone for tin production provides the intended exploitation of tin from the Rosh山坡 valley by 500 years or more. Refined chronologies using luminescence dating will enable us to map out ancient trade networks, identify centers of political economic power, explore the nature of relationships between communities and identify technological innovations in metalurgy and agropastoral production over the last 200 years - a major contribution to the historical record of southern Africa.