2013 Proceedings

Microscopy AND Microanalysis

Part 5: Physical Sciences Symposia—I

Indianapolis, Indiana, USA
August 4–8, 2013

Edited by
J. Shields
S. McKernan
N. Zaluzec
T. Ruiz
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Microscopy Society of America
71st Annual Meeting

Microanalysis Society
47th Annual Meeting

International Metallographic Society
46th Annual Meeting

Published By
Cambridge University Press

Microscopy and Microanalysis, Volume 19, Supplement 2, 2013

1400
doi:10.1017/S1431927613008994

Microsc. Microanal. 19 (Suppl 2), 2013

Compositional Characteristics of Athenian Black Gloss Slips (5th c. B.C.)

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The ancient Greeks painted ceramics with dilute Fe-rich clay slips that when fired created decorative glossy surfaces with a deep black color (hence the name, black gloss). Understanding the material composition of black gloss is difficult since the clay used to produce these slips was highly refined by a variety of methods that are not perfectly known [1-3]. The refinement process, known as levigation, likely involved dispersing the clay into large vats of water and allowing the coarse grains to settle to the bottom of the tank leaving the fine grains suspended in the solution [4]. Understanding whether materials were added to water vats to aid in the refining process or otherwise used in the refined clay slips to improve the sintering behavior, is key to explaining black gloss technology. Elevated levels of potassium were detected in some black glosses by Kingery [1], who hypothesized this may be evidence for a plant ash or tartrate flux addition used to either promote deflocculation of the fine clay particles in the water bath or the sintering of the clay particles. The addition of ochre (Fe_2O_3) has been suggested by another study on Athenian pottery [4]. Whether or not clay dispersive agents (such as sodium hexametaphosphate or boric acid) were placed in the levigation vats, and what effect they would have had on the resulting slips is still under debate [1, 3, 5].

To better understand both the refining process and any possible additives to the black gloss material, 19 sherds from the collection of the J. Paul Getty Museum were interrogated by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS). Both major and trace element compositions were determined for the body ceramic and the black gloss slips from a single ablation pit on each sherd. Results indicate that the body and gloss material share many compositional characteristics suggesting that they are derived from similar geological sources. However, notably higher Zn and Pb levels were found in the gloss material than in the body ceramic (Fig 1a). Based on evidence from ancient treatises, it is speculated that the Zn and Pb entered the gloss through a process of pickling the clay in acid mine run-off which is rich in these trace metals. When examining the rare earth elements (REE) suite (Fig. 1b) it was found that the overall pattern for both the body and gloss are similar, but not identical. The pattern for the body ceramic shows strongly depleted heavy REE content, relative to chondritic meteorite, which is typical for clays and other weathered sediments [6]. The gloss follows the same trend as the body with the exception of Ce content that is significantly depressed relative to La and Pr. Most REE elements typically exist in a trivalent state. However, Ce can change oxidation state (*e.g.*, Ce^{+3} to Ce^{+4}) in conditions of low pH or in anoxic environments [7]. Oxidation of Ce can therefore lead to depletion of this element relative to the other REEs via preferential complexation and precipitation reactions. The Ce anomaly observed in the gloss REE pattern therefore suggests that this clay material has either been subjected to a different weathering environment than the clay of the body or that the gloss clay has been processed using methods that have not, as of yet, been fully elucidated.

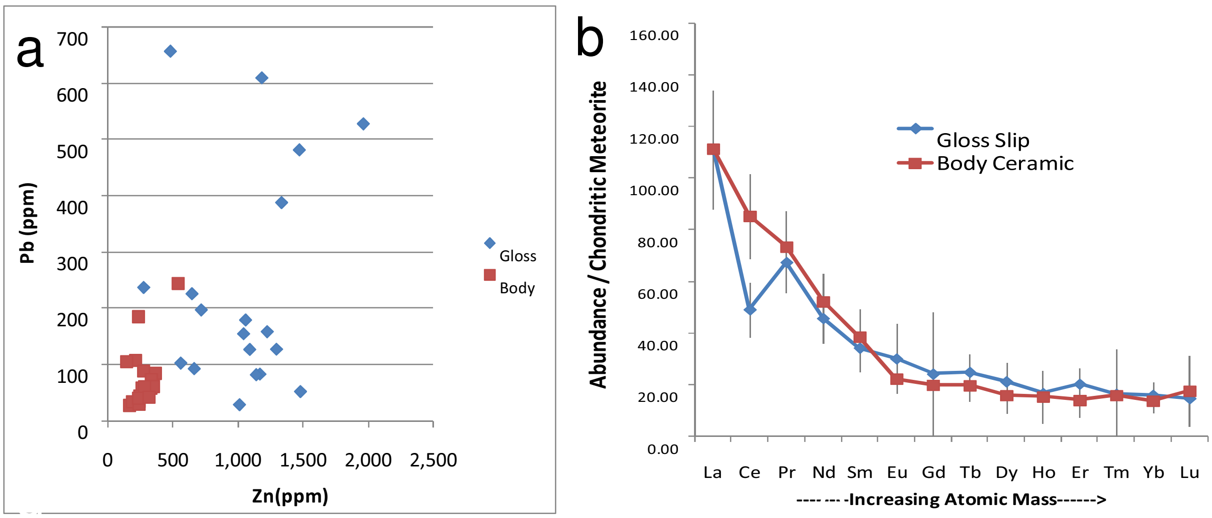

Figure 1. (a) Bivariate plot of Zn vs. Pb content in both body ceramic and black gloss material. (b) Averaged (n=19) REE data for both the body ceramic and gloss normalized to chondritic meteorite.

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