A Preliminary Archaeometric Analysis of Archaeological Ceramics and Possible Clay Sources on the INL Site

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Introduction

Despite its utility in addressing a range of relevant research questions, non-destructive X-ray fluorescence (XRF) spectrometry has not been employed in eastern Idaho for archaeological ceramic analysis until now. This project implements in-field analysis of a sample of precontact ceramics found at three sites on the Idaho National Laboratory (INL) Site. In addition, geological samples from possible clay sources across the INL site were collected to examine how their geochemistry matched with the archaeological ceramics, i.e., if ceramic artifacts can be matched to specific clay sources or river basins within the INL boundary. XRF data on the impact of sand tempering in ceramics was additionally explored.

Research Questions

1. How can distinct geochemical groups be recognized within the analyzed ceramic assemblages and what does it imply about pottery production in the Eastern Snake River Plain?
2. Where can ceramic geochemical groups be matched to specific clay sources or river basins within INL?
3. How is XRF an appropriate technique to study precontact ceramics in eastern Idaho? What are its strengths and limitations?
4. What is the impact of sand tempering on XRF measurements on ceramics?

Methods

Component One: A sample of 40 sherds (**Fig. 1**) from three Late Holocene archaeological sites, BEA-23-14-68 (n=13), 10BT2833 (n=14), and 10BT0094 (n=13), were analyzed in the field with an Olympus Vanta M-series portable XRF spectrometer. It is equipped with a 4 W X-ray tube, a Rh anode, and 40 mm^2 silicon drift detector. The instrument operates using a factory "Geochem" mode that relies on fundamental parameters, calibration and a combination of three beam settings to optimize measurements for strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), barium (Ba), iron (Fe), zinc (Zn), rubidium (Rb), titanium (Ti), and manganese (Mn). Each sample was analyzed for 180 seconds. Three measurements were taken per ceramic, (front, back and profile), and averaged to address common heterogeneity issues with ceramic geochemistry. Ceramic characteristics such as element, interior/exterior color, inclusions, thickness, diameter, and temper percentage were also recorded. Sherds were returned to their original locations when analysis was complete, and Heritage Tribal Office (HeTO) members from the Shoshone-Bannock Tribes accompanied CRMO staff in the field when possible.

Figure 3. Clay tablets created from The Sinks: SNK-02, Terreton Lakebeds: TRN-03, and The Big Lost River (BLR-02).

Figure 1. Archaeological ceramics from BEA-23-14-68, 10BT2833, and 10BT0094.

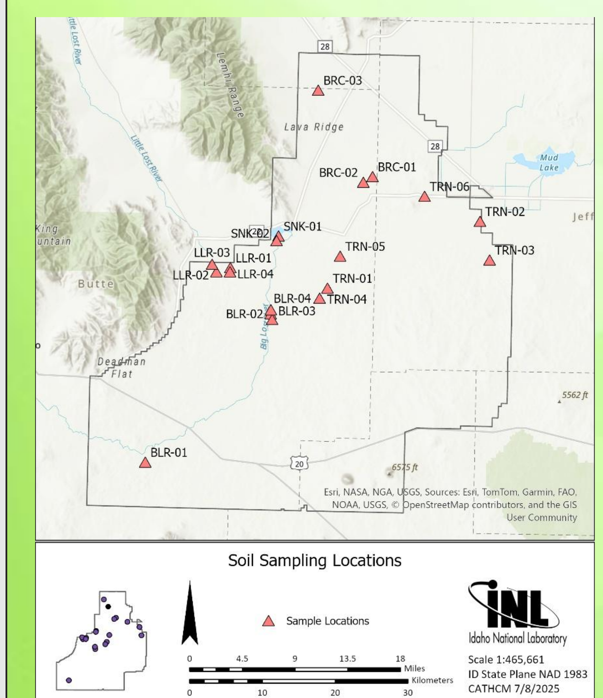

Figure 2. Map of clay and sand collection points.

Component Two: Using a bucket auger, clay and corresponding sand samples when available from 17 locations across the INL (**Fig. 2**) were gathered. These samples acted as comparative material to which ceramic geochemical groups could be compared. Through previous soil studies, clay-rich collection localities were identified and are associated with the Big Lost River Floodplain, the Lost River Sinks, and Terreton Lakebeds (in association with Birch Creek and the Little Lost River). Dry clay was crushed and formed into three thin domino sized tablets through the addition of water (**Fig. 3**). For samples with corresponding sand, (n=5), three additional tablets were created at 4:1, 5:1, and 6:1 ratios of clay to sand to mimic the ceramic tempering. Tablets were analyzed in the lab using the same XRF procedures as the artifacts, with two measurements (front and back) taken and averaged.

Results

Three geochemical groups were identified within the ceramic dataset and were best distinguished by a Rb vs Nb biplot (**Fig. 4**). These findings imply the presence of three distinct paste recipes, likely indicating the use of different clay sources. The correlation between geochemical groups and archaeological sites is particularly interesting, as artifacts from each site overwhelmingly clustered together, forming the basis of geochemical groups.

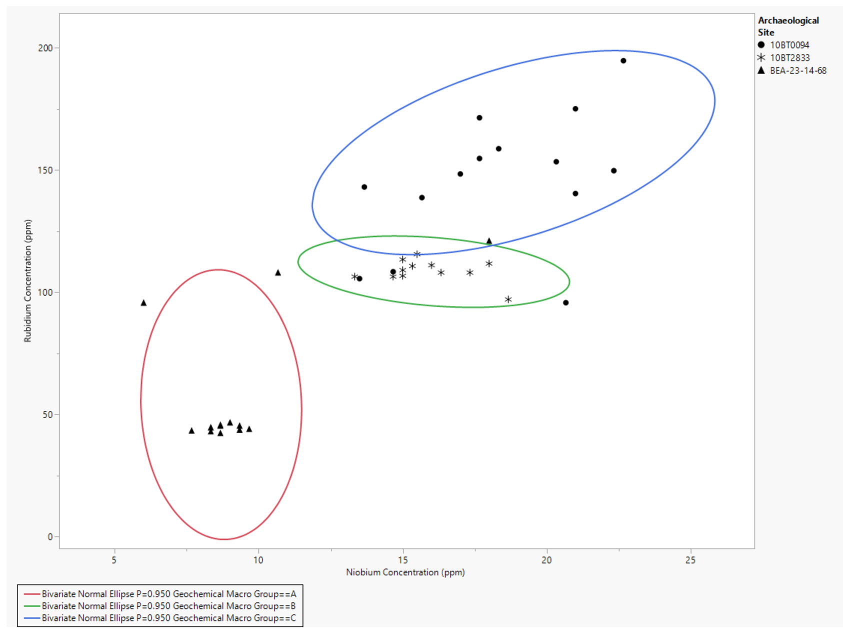

Figure 4. Bi-plot of Rb vs. Nb (in ppm) of archaeological ceramics and associated geochemical groups. Ellipses represent 95% confidence intervals.

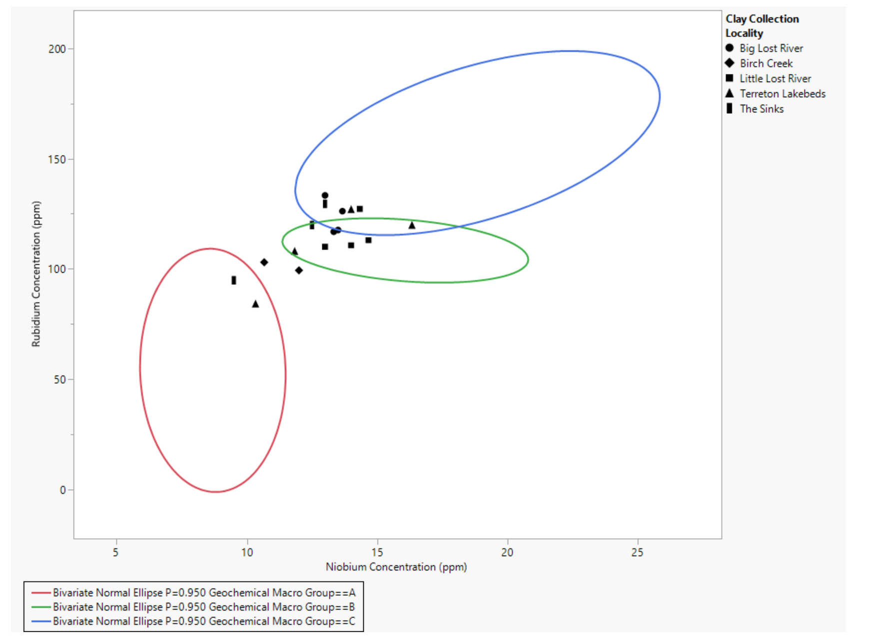

Figure 5. Bi-plot of Rb vs. Nb (in ppm) showing overlap of clay sources and ceramic geochemical groups. Ellipses represent 95% confidence intervals.

Unlike the ceramic XRF data, distinct geochemical groups across clay samples did not emerge, which is possibly indicative of our limited sample size and the overlap of alluvial systems on the INL site. Despite this, there is overlap between the artifact and geological clay sample geochemistry (**Fig. 5**). For example, as seen in **Figure 5**, geochemical group A overlaps with clay samples from the Terreton Lakebeds and the Lost River Sinks. Though our findings show overlap, our reference database is incomplete, and further clay collection efforts are needed from a wider range across the Pioneer Basin and Snake River Plain before more definitive conclusions can be drawn.

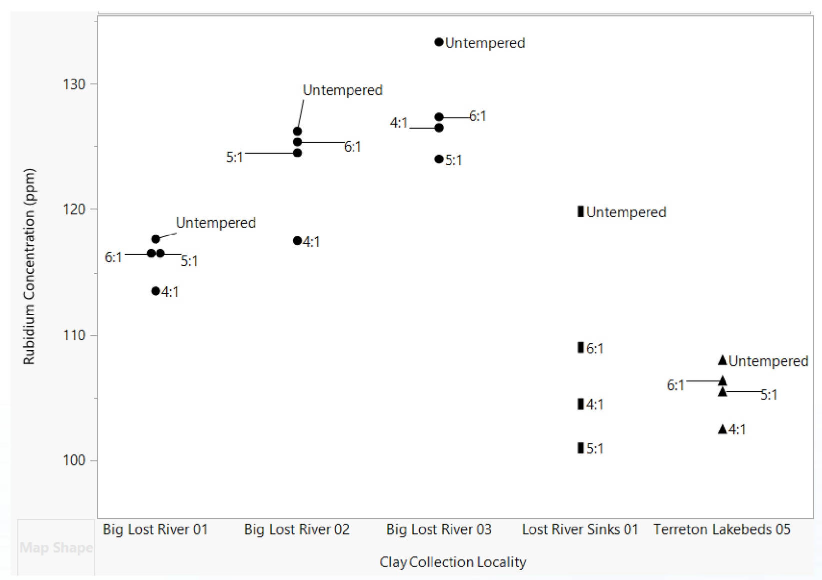

Figure 6. Rb measurements at different tempering ratios.

Non-parametric Kruskal Wallce tests were utilized to determine whether there were statistically significant differences in the elemental concentrations of tempered and untempered clay tablets. Our tests demonstrate that there were no significant differences in elemental values of the 10 elements at 4:1, 5:1, or 6:1 ratios when using an alpha of 0.05. Though the tempered tablets were not significantly different from the untempered, possible dilution effects were observed in tiles with more sand (**Fig. 6**).

Conclusions

This study provides an empirical foundation for identifying geochemical groups within the archaeological ceramics found on INL and demonstrates that XRF is an appropriate, fast, and non-destructive method for studying precontact ceramics in eastern Idaho. Further, this study reveals that sand tempering does not significantly alter geochemical composition at 4:1, 5:1, or 6:1 clay to sand ratios, however, elemental dilution effects may still be present.

While our figures provide evidence that some ceramics were produced with clay sources within the INL, our small comparative collection should be expanded upon in future studies to encompass a more comprehensive sample. Sites including ceramics on the INL may not be the original production locations, as our limited evidence for the use of the nearest clay sources supports the hypothesis that the INL acted as a travel corridor for groups moving between destinations on the seasonal round. In all, our study's results should be viewed as a preliminary foundation for exploring these questions more in depth in future projects.

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