At the Confluence of GIS and Geochemistry: Identifying Geochemical Correlates of Ripley Engraved Caddo Ceramics

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Over the last 17 years, 1308 instrumental neutron activation analysis (INAA) samples have been run on Caddo ceramic vessels recovered from 186 archeological sites throughout the ancestral Caddo region. The Caddo INAA sample was produced by the University of Missouri Research Reactor (UMRR), and is only surpassed in size by datasets from the Valley of Mexico and the Mississippi and Alabama Mississippian regions of the American Southwest. However, the complex nature of this dataset knows no substantive challenges regarding the interpretation of geochemical results (see Ferguson et al. 2010). Those difficulties have led to a recent re-interpretation of the Caddo dataset by MURR (Ferguson et al. 2015), but challenges in determining probable locations of ceramic production have become increasingly difficult due to a perceived homogeneity of local alluvial and upland clays used to manufacture the vessels (Ferguson and Glasscock 2001; Portella and Ferguson 2010).

Selden (2013:Figures B.2-B.34) created a series of 33 geochemical maps, one for each rare earth element in the dataset, that conveys a high degree of digitization in the geochemistry of clays used by Caddo陶器制作. What follows is a discussion of these maps, and how unique spatial patterns found to correlate with local geology and proposed political communities can be further highlighted using data from the well-known 15th to late 17th century A.D. Caddo ceramic type of Ripley Engraved (see Suhm and Jelks 1962).

**Methods**

The methods we employ to illustrate geochemical variability in clays from across the ancestral Caddo region relies first upon the identification of shell- and bone-tempered sherds in the INAA dataset (Selden et al. 2013a). Subsequent to this identification, a calcium correction was applied only to geochemical results from shell- or bone-tempered samples due to the calcium richness of these tempers. This allows for the dilution of certain elements associated with clays (Cogswell et al. 1998; Steponaitis et al. 1996).

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**Introduction**

We begin with a sample of 98 Ripley Engraved sherds recovered at 24 Caddo sites in east Texas to establish links between local geology and geochemistry, and includes sites in the Big Cypress, Little Cypress, and Sabine River drainages. This data was collected during the late 1980s and early 1990s, and includes low numbers of sherds from each site (Selden et al. 2013a). Subsequent to this analysis, the dataset was imported in ArcGIS10.2 where a sample of 98 Ripley Engraved sherds were used to calculate the deterministic of inverse distance weighted (IDW) for each element. This statistic illustrates whether discrete geochemical signatures exist close to one another, or in the same location.

Using a subset of the Ripley Engraved INAA data from sites in the Big Cypress Creek basin, as discussed above, three elements—arsenic (As), iron (Fe), and vanadium (V)—were found to share a similar spatial pattern with previously defined Caddo political communities in the Big Cypress Creek. The analysis results of the dataset indicates that geochemical results from three of the five Caddo political communities in this drainage basin can be successfully segregated using elements that share similar spatial patterns, suggesting a prevalence of community production in three Titus phase contexts using local clays. While As and Fe have very similar spatial distributions, the distribution of V is more comparable to iron ore and vanadium (V).

**Local Political Communities and Geochemistry in the Big Cypress Creek Basin**

Results of the geochemical analysis tentatively point to both the local manufacture of ceramics by Titus phase political communities—in this case with distinctive chemical characteristics (Groups 1-3 above)—and the movement of vessels between political communities. Geochemical Group 1 is represented by PC 2, including Ripley Engraved sherds from 41CP21; Group 2 by PC 3, including 41CP220 and 41UR2 Ripley Engraved sherds; and Group 3 by PC 4, including sherds from 41MR178, 41MR122, and 41UR3.

**Spatial Patterns in the Geochemistry of Ripley Engraved**

Three other spatial patterns exist that have not yet been discussed. Co and manganese (Mn), dysprosium (Dy), neodymium (Nd), Sm, and terbium (Tb), and Re and rubidium (Rb), and zirconium (Zr). The majority of this spatial trend has been expressed in geochemical values from the northwest to the southeast (upstream to downstream) within the Big Cypress, Little Cypress, and Sabine River drainages. In the case of Ce, Sm, and Tb, the increase in geochemical values from the northwest to the southeast is apparent in the Big Cypress, Little Cypress, and Sabine River drainages, with the sole exception of a ceramics sherd from 41CF96 in the Little Cypress Creek basin. In a contrasting pattern, Fe, Rb, and Zr share similar geospatial patterns, although the pattern associated with Rb represents the inverse of Fe and Zr. This pattern demonstrates an increase in Fe and Zr from the northwest to the southeast (Fe is mortared in the Big Cypress Creek basin, but values remain high in all areas of the Little Cypress and Sabine River drainages, again with the single exception of the sherd from 41C724. The latter pattern may hold the key to discerning between clay composition in ceramics from these three drainage basins as more samples from a greater number of sites become available.

Four elements—Nd, Sm, Tb, and Zr—also increase in value from the northwest to the southeast, with the exception of the single Ripley Engraved sample (41CP16) in 41TT730, which elemental values that are higher than sherds from other nearby sites like 41CP21, 41CP220, and 41TT718 in the northern part of the Big Cypress basin, which may represent an example of the trade of ceramic vessels with Caddo peoples located to the southeast. The northwest-to-southeast trend continues with As and Fe, as both show increases in value downstream, but less in the Little Cypress basin. One of the more unique geochemical elements, Rb, which has very high values in a ceramics sherd in the upper Big Cypress Creek basin, is shown to lower values in the area of 41CP220 and 41FT711 on Prairie and Drisker creeks, and then a return to high values at 41UR132.

**Conclusions**

This analysis represents the first ceramic type-specific discussion of INAA results from the ancestral Caddo region, and highlights the successful application of GIS to the analysis and interpretation of the Ripley Engraved dataset. In this case, GIS was used to examine the spatial patterns associated with geochemical elements produced from archeologically recovered ceramics in East Texas. Three different elements (As, Fe, and V) were employed to document variations in ceramic geochemistry from three previously identified political communities along Big Cypress Creek. Additionally, three chemical elements (Cu, Co, and Zn) were identified that successfully discriminate between sherds in the Gladewater and Wilcox Groups, and a total of six spatial patterns were documented in the geochemical data. While the Ripley Engraved INAA sample is small, and much remains to be learned with regard to the chemical composition of ceramic pastes in the Caddo region, this analysis may offer a substantive step toward furthering our understanding of this complex dataset.

**Acknowledgments**

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**Captions for Central Figures**

**Top Left** - Geographic, archaeological, and dense grouping assessments in the text.

**Bottom Left** - 3D scatterplot of As, Fe, and V illustrating geochemical variation between Caddo political groups.

**Bottom Center** - Ripley Engraved, var. McKinney vessels from the Pattons (41UR136).