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

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

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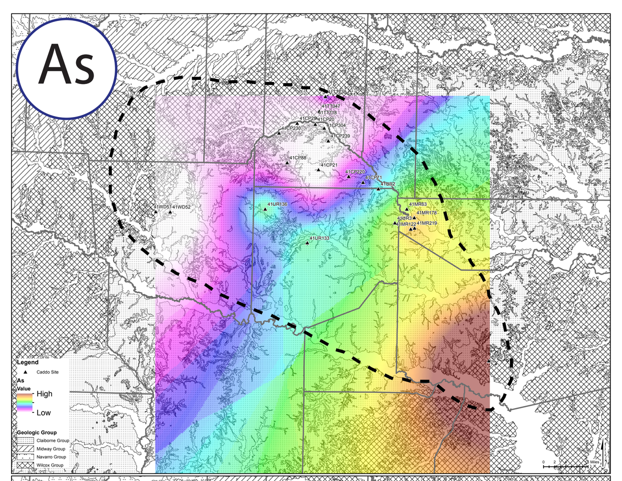
## Introduction

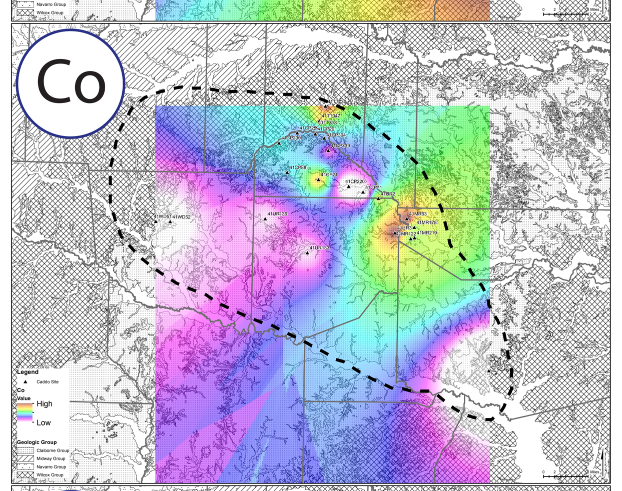
Over the last 17 years, 1308 instrumental neutron activation analysis (INAA) samples have been run on Caddo ceramic vessels recovered from 186 archeological sites throughout the ancestral Caddo region. The Caddo INAA sample was produced by the University of Missouri Research Reactor (MURR), and is only surpassed in size by datasets from the Valley of Mexico and the Mimbres and Jornada Mogollon regions of the American Southwest. However, the complex nature of this dataset has created substantive challenges regarding the interpretation of geochemical results (see Ferguson 2010). Those difficulties have led to a recent reinterpretation of the Caddo dataset by MURR (Ferguson et al. 2010), 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 Glascock 2011; Perttula and Ferguson 2010).

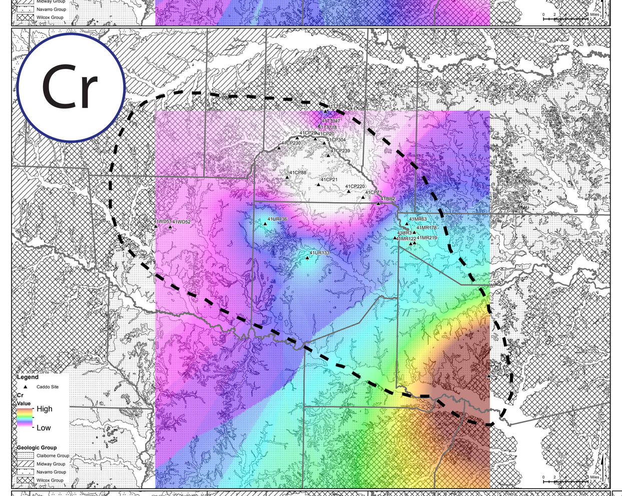
Selden (2013:Figures B.2-B.34) created a series of 33 geochemical maps, one for each rare earth element in the INAA dataset, that conversely illustrates a high degree of diversity in the geochemistry of clays used by East Texas Caddo potters. What follows is a discussion of these maps, and how unique 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 capacity of calcium-rich tempers to dilute certain elements associated with clays (Cogswell et al. 1998; Steponaitis et al. 1996). This deviates from MURR's current practice of applying the calcium correction to the entirety of the Caddo INAA dataset (see Ferguson 2010:6; Ferguson and Glascock 2006:3, 2007:3, 2009a:3, 2009b:266, 2010:93, 2012:3, Perttula and Ferguson 2010:11). The proportion of shell- and bone-tempered sherds in this dataset is small, and we consider the application of the calcium correction to the remainder of the sample to be unwarranted for the grog-tempered sherds since "such correction is unnecessary because the grog itself is made of clay, presumably the same clay that comprises the rest of the paste" (Steponaitis et al. 1996:559). The calcium correction was applied to shell- and bone-tempered sherds in version 3.2.2 of R, after which those data were recombined with the other-tempered data, where the log-10 for each element was calculated, after adding a value of one to each sherd/element in the database, effectively replacing all missing values with a zero (Selden et al. 2013a). Subsequently, the dataset was imported in ArcGIS10.2 where the Getis-Ord Gi* statistic was employed to calculate a z-score for each log-10 value.

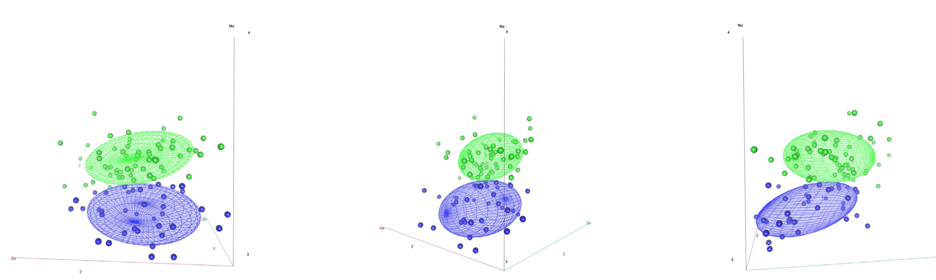


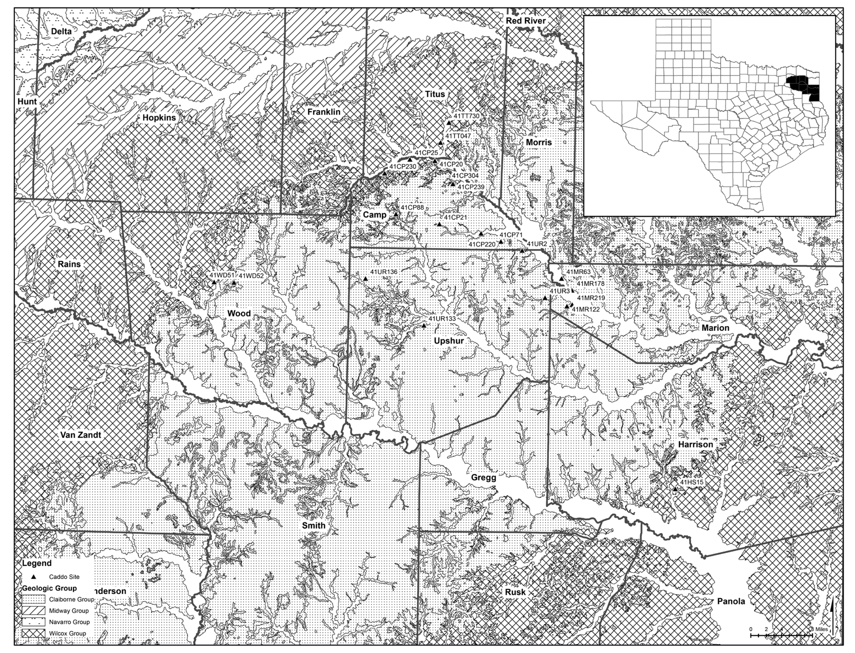



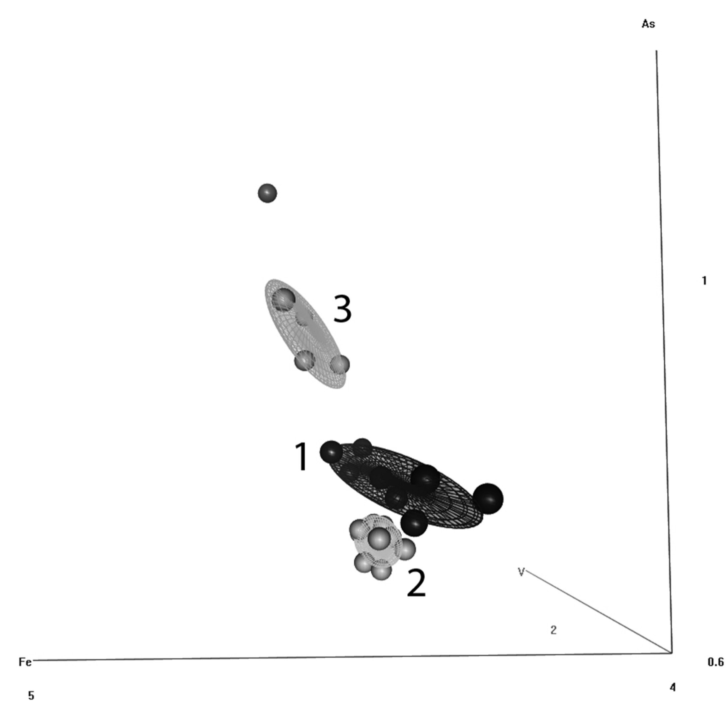

Following the calculation of z-scores for each element, these data were used to calculate the deterministic statistic of inverse distance weighted (IDW) for each element. This statistic illustrates whether discrete geochemical signatures exist close to one another, or in the same location.

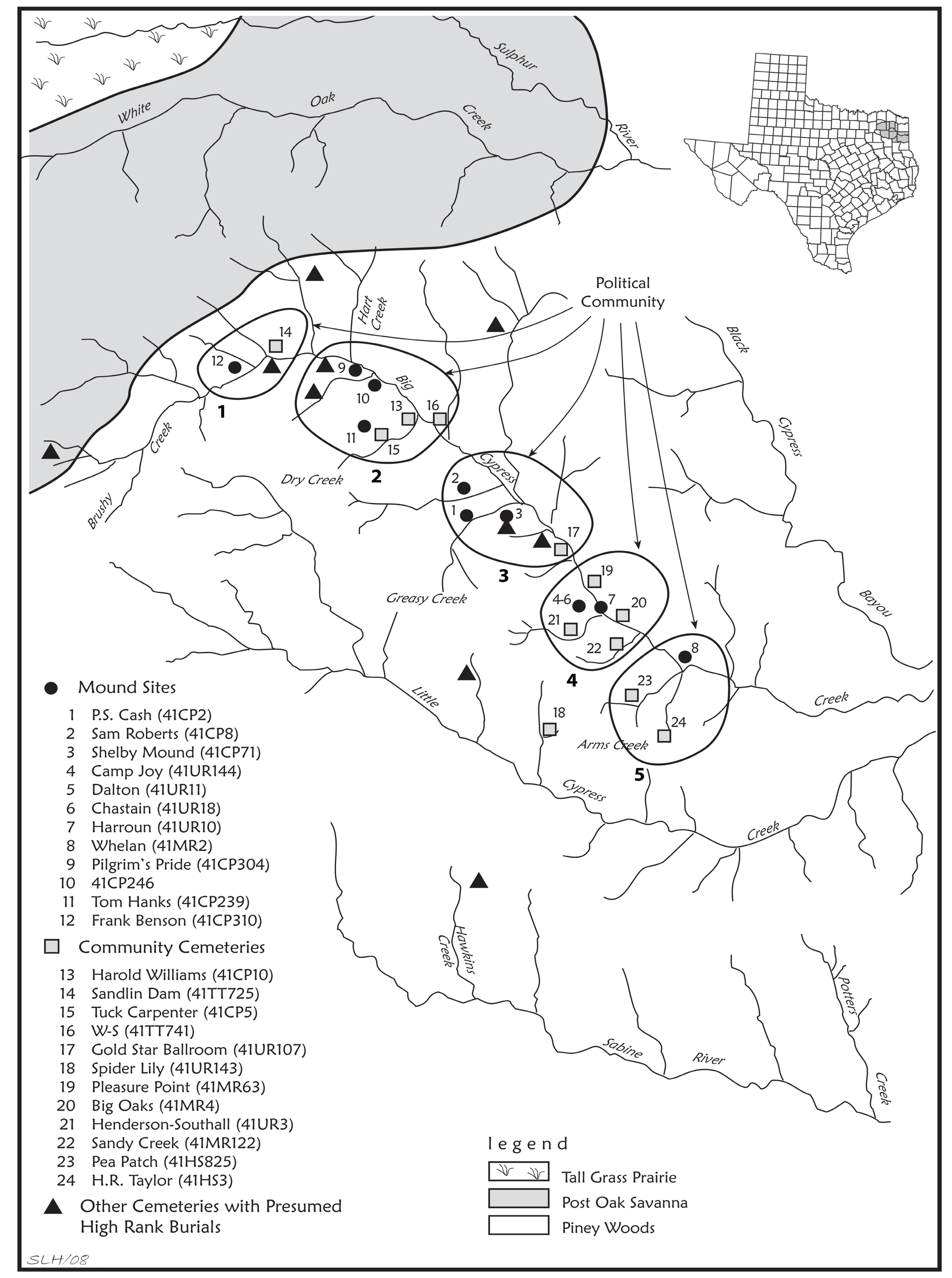
We begin with a sample of 98 Ripley Engraved sherds recovered at 24 Caddo sites in East Texas to establish links between local geology and geochemistry, and include sites in the Big Cypress, Little Cypress, and Sabine River basins. Then we employ a sub-sample of the dataset—23 Ripley Engraved sherds from 12 sites in the Big Cypress Creek basin—to focus on an analysis of their chemical composition within previously-defined political communities. We then return to the larger dataset from the Big Cypress, Little Cypress, and Sabine River basins to explore six spatial patterns identified during the analysis. In all cases, the maps are used to identify geochemical correlates.



Claiborne and Wilcox Groups demarcated in a 3D scatterplot using Ce, Na, and Z.






## 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—using clays with distinctive chemical constituents (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, 41MR219 and 41UR3.

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 basin. The results of the analysis indicate that ceramic sherds 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 preponderance of ceramic production in these Titus phase contexts using local clays. While As and Fe have very similar spatial distributions, the distribution of V is more comparable to chromium (Cr) and scandium (Sc).

These results are also consistent with the notion that social interaction existed between these three Caddo political communities (see Perttula 2012). With regard to inter-political community variability in ceramic chemical composition, the analysis places sherds from 41MR63, 41MR219, 41MR122, and 41UR3—all in the Lake O' the Pines area—in Group 3; these sites are considered to belong to a single PC. However, even within this group, there appears to be greater variability that may represent at least two different groups of potters; one group is represented by sherds from 41MR63 and 41UR3 while the other is represented by sherds from 41MR219 and 41MR122. The latter subgroup is higher in As, Fe, and hafnium (Hf), and lower in Ce, cobalt (Co), cesium (Cs), lutetium (Lu), samarium (Sm), and rubidium (Rb). More INAA samples could clarify whether two distinct groups of potters were manufacturing Ripley Engraved vessels within this community. The single outlier from this analysis (TKP381 from 41MR178) is assumed to be representative of either intra- (downstream from the currently-defined political communities since this sample is higher in both As and Fe) or inter-drainage basin interaction and ceramic vessel exchange between Caddo peoples, but more INAA samples are needed from a variety of sites in the Little Cypress and Sabine River drainages before this assumption can be fully evaluated.

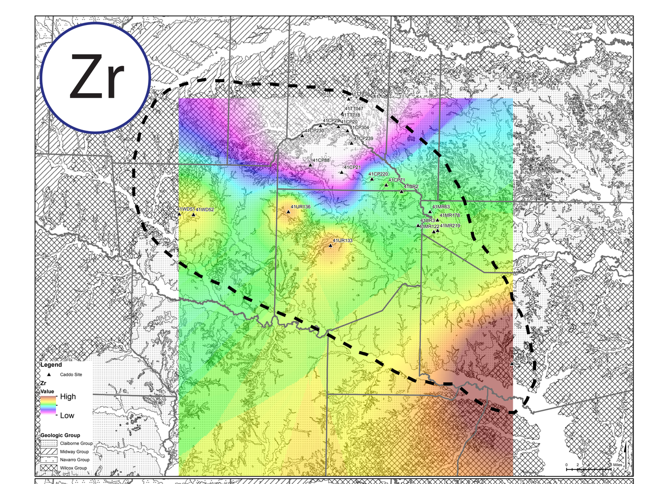
## Spatial Patterns in the Geochemistry of Ripley Engraved

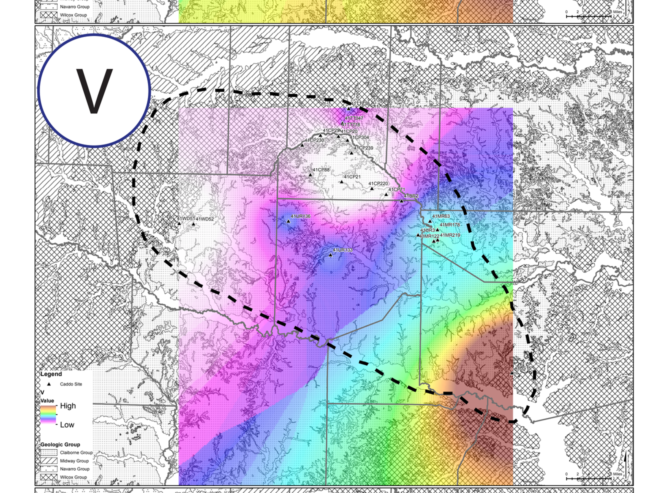
Three other spatial patterns exist that have not yet been discussed: Co and manganese (Mn); dysprosium (Dy), neodymium (Nd), Sm, and terbium (Tb); and Hf, Rb, and zirconium (Zr). The majority of the spatial trends in this dataset point to a gradual increase in geochemical values from the northwest to the southeast (upstream to downstream) within the Big Cypress, Little Cypress, and Sabine River drainages. In the case of Cr, Sc, and V, 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 ceramic sherd from 41CP88 in the Little Cypress Creek basin. In a contrasting pattern, Hf, Rb, and Zr values share similar geospatial patterns, although the pattern associated with Rb represents the inverse of Hf and Zr. This pattern demonstrates an increase in Hf and Zr from the northwest to the southeast (Rb is inverted) 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 41CP88. This latter pattern may hold the key to discriminating between clay compositions in ceramics from these three drainages as more samples from a greater number of sites become available.

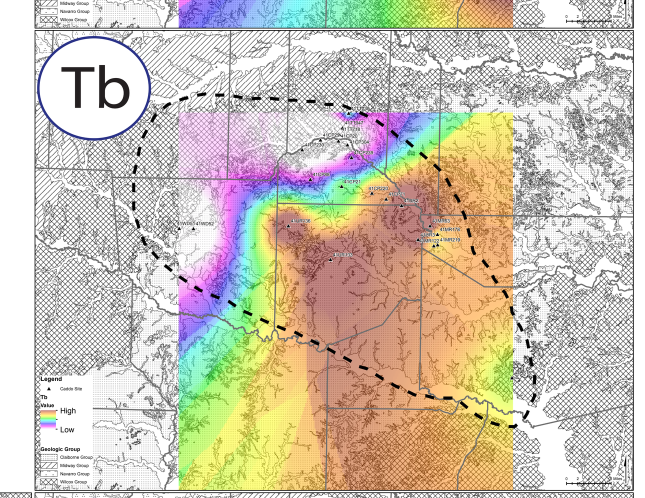
Four elements—Dy, Nd, Sm, and Tb—also increase in value from the northwest to the southeast, with the exception of the single Ripley Engraved sample (TKP318) from 41TT730, which has elemental values that are higher than sherds from other nearby sites like 41CP25, 41CP20, and 41TT47 in the northern part of the Big Cypress basin, which may represent an example of the trade of ceramic vessels with Caddo polities located to the southeast. The northwest-to-southeast trend continues with As and Fe, as both show increases in values downstream, but less so in the Little Cypress basin. One of the more unique geospatial trends is that of Co and Mn, which have high values in ceramic sherds in the upper Big Cypress Creek basin, a quick shift to lower values in the area of 41CP220 and 41CP71 on Prairie and Greasy creeks, and then a return to high values at 41UR2.

## 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 demarcate between Ripley Engraved ceramics from three previously identified political communities along Big Cypress Creek. Additionally, three chemical elements (Na, Ce, and Zn) were identified that successfully discriminate between clays in the Claiborne 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 constituents of ceramic pastes in the Caddo region, this analysis marks a substantive step toward furthering our understanding of this complex dataset.




## Acknowledgments

We wish to thank Mason Miller, Linda Ellis, and Ross Fields for access to geochemical data from their previous and ongoing East Texas projects, Nancy Kenmotsu for comments on earlier drafts, and Bo Nelson for the image of the Ripley Engraved, *var. McKinney* vessel.

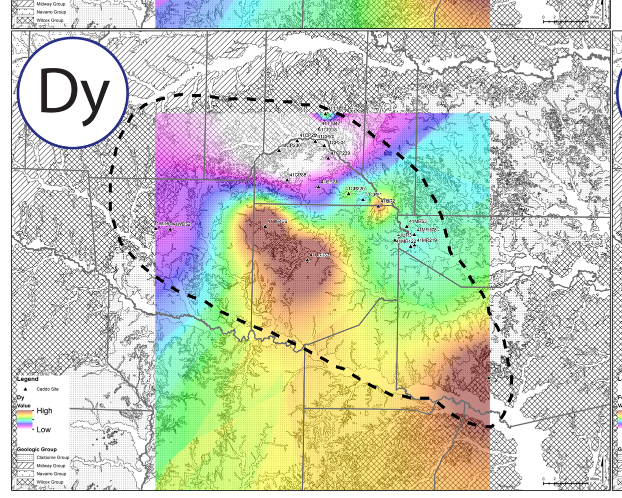
## Captions for Central Figures

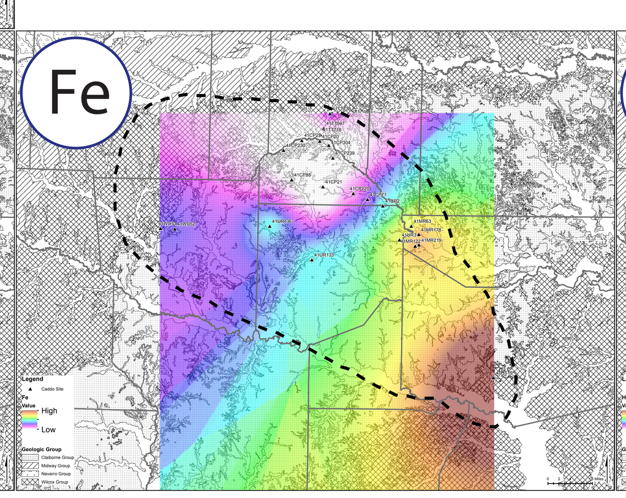
**Top Left** - Counties, archeological sites, and geologic groups mentioned in the text.

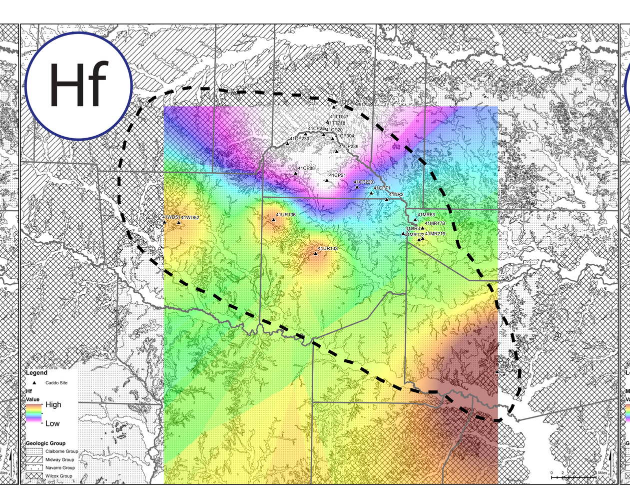
**Bottom Left** - 3D scatterplot of As, Fe, and V illustrating geochemical variation between Caddo political groups.

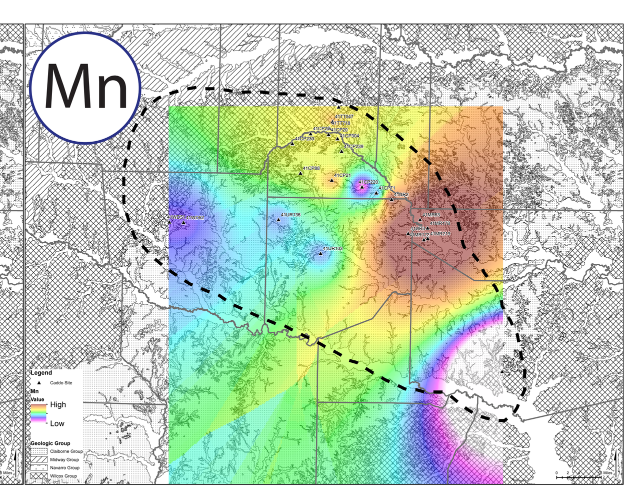
**Right** - Map of local political communities in the Big Cypress Creek basin.

**Bottom Center** - Ripley Engraved, *var. McKinney* vessel from the Patton site (41HS825).




*References available upon request.