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Linking Instrumental Neutron Activation Analysis (INAA) with Geology in the Ancestral Caddo Region

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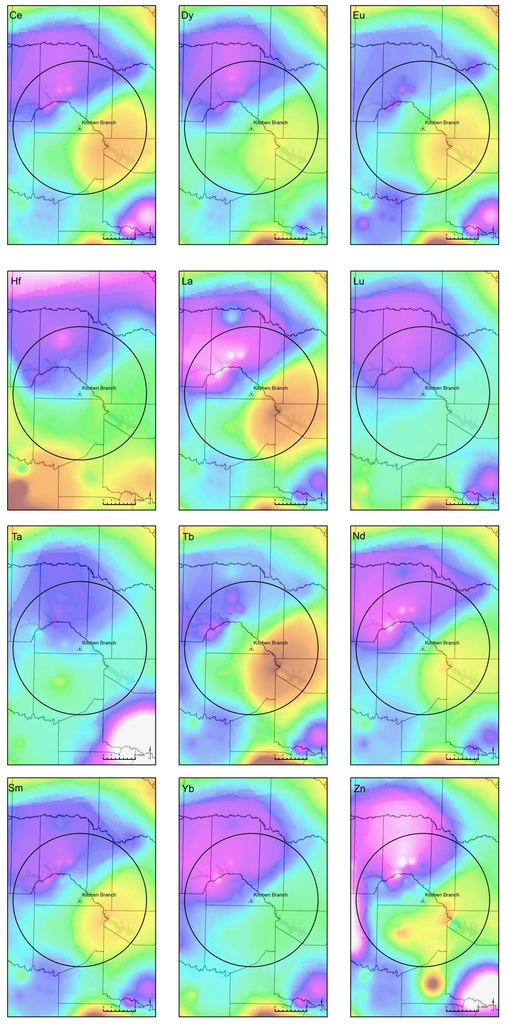
ABSTRACT

This poster illustrates the success of a novel method of INAA that was employed to reveal geochemical signatures in Caddo ceramic vessel sherds that correlate with local surficial geology. The geochemical data from the sherd assemblage were used within an exploration of potential ceramic provenance, which was successful at demarcating sherds from ceramic vessels made from clays in either the Claiborne or Wilcox Groups. Further geochemical segregation was also apparent between the Recklaw Formation in the Claiborne Group, and the Weches Formation in the Wilcox Group. These results point to a high degree of geochemical variability within the East Texas region, which stands in stark contrast with the numerous previous studies that seemed to indicate that the clays in the East Texas region were overwhelmingly homogenous. The analytical gains achieved through using this method seem to highlight an area of Caddo research where significant progress can be made with regard to the interpretation of analytical results in the future.

INTRODUCTION

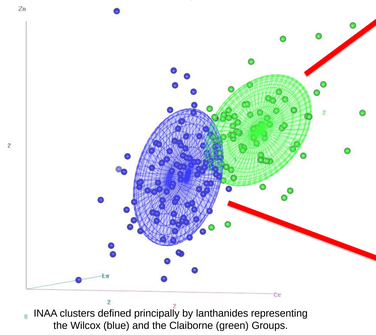
Ceramic provenance studies remain the basis of worldwide archaeological research concerned with reconstructing exchange networks, tracing migrations, and informing upon local and regional ceramic economy. Due to the vagaries of Texas geology, traditional geochemical techniques (instrumental neutron activation analysis in particular) have not achieved the degree of success in Texas as they have within other regions.

This analysis deviates from MURR's current method of applying the calcium correction (see Steponaitis et al. 1996:559) to the whole of the Caddo INAA dataset (Ferguson 2007:4, 2010:6; Ferguson and Glascock 2006:3; 2007:3; 2009a:3; 2009:266; 2010:93; 2012:3; Perttula and Ferguson 2010:11), and since the number of shell and bone-tempered sherds remains small, that process is found to be unwarranted due to the overwhelming majority of Caddo sherds being grog-tempered, and "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). Certainly one must remain skeptical of shell or bone-tempered grog within the sherds, and the inclusion of ceramic petrography can assist in highlighting shell or bone-tempered grog in ceramic paste (particularly when petrography and INAA are conducted on the *same* sherds). While the standard suite of multivariate statistics are employed within this analysis, those are augmented with 3D graphs and geographic representations that illustrate the distribution of geochemical data across space.

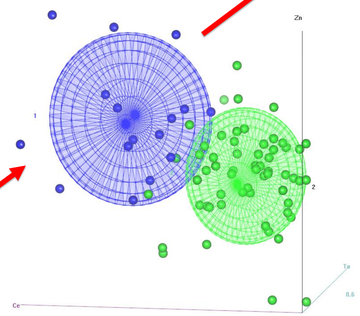


RESULTS

Employing the Geologic Database of Texas via the Texas Natural Resources Information System as a proxy, these data were plotted atop several geologic maps, and it appears that the following elements (cerium [Ce], dysprosium [Dy], europium [Eu], hafnium [Hf], lanthanum [La], lutetium [Lu], tantalum [Ta], terbium [Tb], neodymium [Nd], samarium [Sm], ytterbium [Yb] and zinc [Zn] – all but Ta and Zn are lanthanides) correlate with a spatial division between the Wilcox Group to the northwest and the Claiborne Group to the southeast. In particular, it appears that Claiborne Group components to the southeast, including the Queen City Sand, the Weches Formation, and the Sparta Sand possess higher values for these nine elements than the silty and sandy clay of the Wilcox Group to the northwest.



INAA clusters defined principally by lanthanides representing the Wilcox (blue) and the Claiborne (green) Groups.



Subdivisions of the Claiborne cluster illustrating a geographic increase in Ce that may correlate with the inclusion of tempering agents from the Weches and/or Sparta Sand formations.

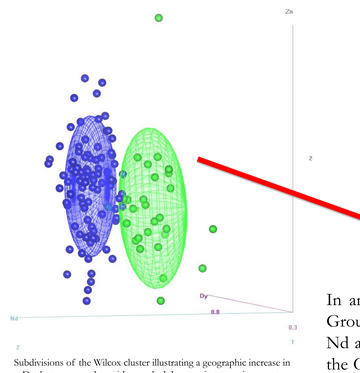
The division of these data based upon real measures of geologic variability makes it possible to demarcate—on a broad scale—between those sherds of local manufacture in the Claiborne Group, and those manufactured from clays within the Wilcox Group within clusters that have minimal overlap. Interestingly, those sherds associated with 41FK107—situated atop the Recklaw Formation—can be manipulated to plot independently of these two groups, highlighting a high degree of local geochemical variability within the region.

ILLUSTRATING GEOGRAPHIC DISTRIBUTION

The Getis-Ord Gi* statistic in ArcGIS10 was employed to calculate a z-score for each log-10 value, illustrating the spatial distribution and z-score values for each site (ESRI 2012).

Following the calculation of log-10 values for each element, these data were then used to calculate the deterministic statistic of inverse distance weighted (IDW) in ArcGIS10 for each element to better illustrate whether discrete geochemical signatures exist close to one another, or in the same location (Selden 2013:Figures A2-A34).

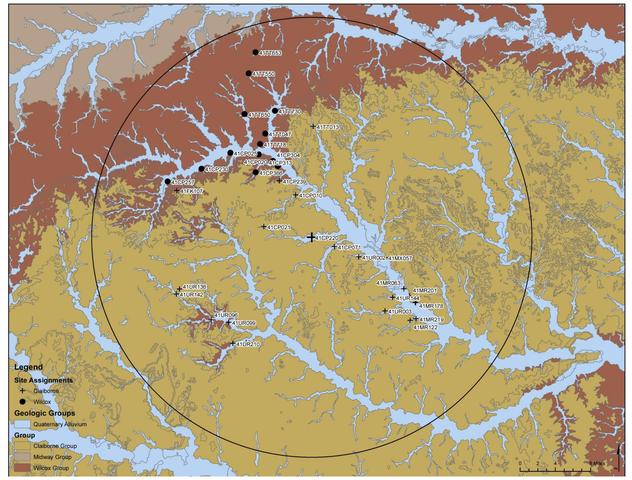
While initially an issue of sample size, deletion of neodymium (Nd) and zirconium (Zr) from the dataset prior to analysis is not necessary. While comparisons to the original NIST sample used by Steponaitis et al. (1996) should still follow this method, when dealing with the MURR dataset, the contribution of these elements needs to be further explored and not disregarded on the basis of their absence from 22 sherds analyzed at NIST (see Steponaitis et al. 1996).

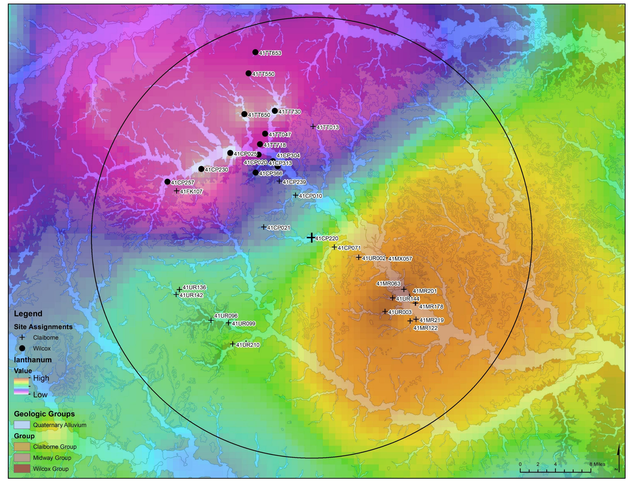


Subdivisions of the Wilcox cluster illustrating a geographic increase in Dy that may correlate with a gradual decrease in tempering agents from the Carrizo Sand through space.

CLAIBORNE GROUP

Looking only at those sherds found to be associated with the Claiborne Group, further separation can be achieved and point to the addition, perhaps in the form of temper or potentially from runoff, of elements associated with the Weches and Sparta Sand formations. The concentration of Zn and Ce found in Caddo ceramics increases to the southeast of the site, but more research will be needed to highlight which of the Formations—Weches or Sparta Sand—is contributing the bulk of this dynamic. The inclusion of a petrographic study may help to refine these assignments, particularly if glauconite—commonly associated with the Weches Formation—or perhaps the different inclusions known to occur within the Sparta Sand Formation—fine to medium grained, light to brownish gray quartz sand—and the Queen City Sand Formation—fine grained, grayish orange to pink quartz sand—are included within that analysis.





WILCOX GROUP

In an effort to explore the possible provenance of ceramics determined to have been produced within the Wilcox Group, those sherds assigned to this cluster were further subdivided based upon elemental values associated with Zn, Nd and Dy. Again, petrographic analyses may assist in further clarifying these divisions. Geologic traits associated with the Carrizo Sand Formation are a very fine to medium grained, medium gray, that weathers to various shades of brown and red quartz sand with—potentially—ironstone inclusions. The undivided Wilcox Group is characterized by silty and sandy clay with common ironstone inclusions that are various shades of gray.

*References available upon request.