Assessing The Potential of pXRF Geochemical Analysis of Metarhyolite to Relate Artifacts with Geological Sources

Ross Owen

Abstract

This poster details a pilot study assessing the potential for geochemical testing to study the trade and exchange of metarhyolite from South Mountain, Pennsylvania to outlying areas in the Mid-Atlantic region and western Pennsylvania. Artifacts held in private collections along with samples of metarhyolite collected in the field were tested using a DELTA Professional hand-held X-Ray Fluorescence device to quantify the elemental composition of the stone. The data were analyzed using descriptive statistics and Principle Component Analysis in R to characterize the variability of the chemical composition of the samples. Data visualization was then used to identify trends in the data, looking at the relationship between sample groups to see if individual groups clustered together reliably. The variability was also explored spatially, providing information regarding the natural variation in metarhyolite throughout South Mountain. Methodologies detailed in this poster will inform and provide guidance to future studies attempting to source metarhyolite artifacts to their geological sources.

Methods

XRF analysis utilizes x-ray radiation directed at an object to cause light to fluoresce back towards a spectrometer which can identify elements within that object. The fluorescence created by the x-ray impacting the specimen produces unique wave-lengths of light that can be corresponded to elements based on their physical structure (Figure 7). In this study the DELTA Professional hand-held XRF device manufactured by Olympus was used with Innov-X Systems software to analyze the data (Figure 8). Testing of specimens consisted of three 15-second assays with the device operating in Soil Mode. Once completed, the results of the three assays were averaged.

Results

pXRF results comparing ratios of elements in parts per million (Top Left), and the results of Principle Component Analysis (Top Right). Nearly all of the metarhyolite samples fall within the range of the Michaux group distribution. The regional map displays the source of the artifacts or geologic specimens by group (Bottom Left). The map in the Bottom Right frame shows the distribution of geologic specimens taken in Michaux State Forest.

Conclusions

Although geochemical fingerprinting for other rock types such as chert and obsidian, has proven very successful (Carr and Boszhardt 2010; Field 2010; Parish 2013), it does not appear to work as well with more heterogenous rocks such as rhyolite. the archaeological interpretations drawn from this study are limited by the scope of the research design. Two key findings support hypotheses of Carr and Winters (2000) regarding the method of quarrying and the logic behind the method. The frequency at which quarries are dug into the bedrock as opposed to utilizing exposed outcrops or boulders, along with the weathering trends identified by petrographic analysis are consistent with the notion that quarries were designed to extract unweathered or “fresh” metarhyolite below the surface. This explains why the extra effort to quarry into the bedrock was worthwhile when there are exposed pieces of metarhyolite resting on the surface. Experimental studies attempting to replicate metarhyolite stone-tool production can further elucidate the factors influencing “knappability.”

Attempts to source artifacts to specific locations within South Mountain have been inconclusive to this point, although LIBS analysis is still ongoing. Identifying discrete geochemical fingerprint for metarhyolite within South Mountain is unlikely based on the post-processing and analysis of pXRF data. While there is variation in the metarhyolite samples, it does not result in discrete sources. Although sourcing at a local level was unsuccessful, it still may be possible to source metarhyolite artifacts more generally. Preliminary LIBS results show distinction between Maryland and Pennsylvania sources of metarhyolite. A study focused solely on geochemical sourcing could test a larger number of artifact collections and a larger number of individual specimens and allow researchers to place greater confidence in relating metarhyolite found throughout the region to the quarries in South Mountain.

Research Questions

Q1: What were the resource exploitation, lithic procurement, and trade patterns practiced by Native Americans at South Mountain?

Q2: Can geochemical analysis source metarhyolite artifacts to geologic outcrops in Michaux State Forest?

Acknowledgements

References


Michaux State Forest. 2010; Field 2010; Parish 2013), it does not appear to work as well with more heterogenous rocks such as rhyolite. the archaeological interpretations drawn from this study are limited by the scope of the research design. Two key findings support hypotheses of Carr and Winters (2000) regarding the method of quarrying and the logic behind the method. The frequency at which quarries are dug into the bedrock as opposed to utilizing exposed outcrops or boulders, along with the weathering trends identified by petrographic analysis are consistent with the notion that quarries were designed to extract unweathered or “fresh” metarhyolite below the surface. This explains why the extra effort to quarry into the bedrock was worthwhile when there are exposed pieces of metarhyolite resting on the surface. Experimental studies attempting to replicate metarhyolite stone-tool production can further elucidate the factors influencing “knappability.”

Attempts to source artifacts to specific locations within South Mountain have been inconclusive to this point, although LIBS analysis is still ongoing. Identifying discrete geochemical fingerprint for metarhyolite within South Mountain is unlikely based on the post-processing and analysis of pXRF data. While there is variation in the metarhyolite samples, it does not result in discrete sources. Although sourcing at a local level was unsuccessful, it still may be possible to source metarhyolite artifacts more generally. Preliminary LIBS results show distinction between Maryland and Pennsylvania sources of metarhyolite. A study focused solely on geochemical sourcing could test a larger number of artifact collections and a larger number of individual specimens and allow researchers to place greater confidence in relating metarhyolite found throughout the region to the quarries in South Mountain.

References


