RHYOLITE SOURCING IN CENTRAL ALASKA – PRELIMINARY RESULTS

Sam Coffman[1] and Jeffrey T. Rasic[2]

[1] University of Alaska Museum of the North
[2] National Park Service, Fairbanks Administrative Center

INTRODUCTION

Lithic provenance analyses are an untapped resource in Alaska. Fine grained volcanic rocks are common in lithic assemblages in interior Alaska and are amenable to geochemical characterization using a variety of sourcing techniques. For these reasons our study focused on rhyolite with the intent of identifying and delineating geochemical groups, while constructing a database. We focused on identifying and sourcing rhyolite from sites located in the Nenana River Valley. Human occupation in the Nenana Valley spans from the late Pleistocene through late Holocene and offers a chance to look at changes in raw material procurement, tool manufacture, and mobility strategies among prehistoric foraging groups.

Portable x-ray fluorescence (PXRF) technology was employed and 207 rhyolite artifacts were analyzed from 30 sites from the Nenana River Valley, central Alaska (Figure 1). Our preliminary results demonstrate use of two major, geochemically distinct types of rhyolite. While their geological origins have not been identified, technological aspects of the assemblages suggest they originate locally, probably within 30km of the study area.

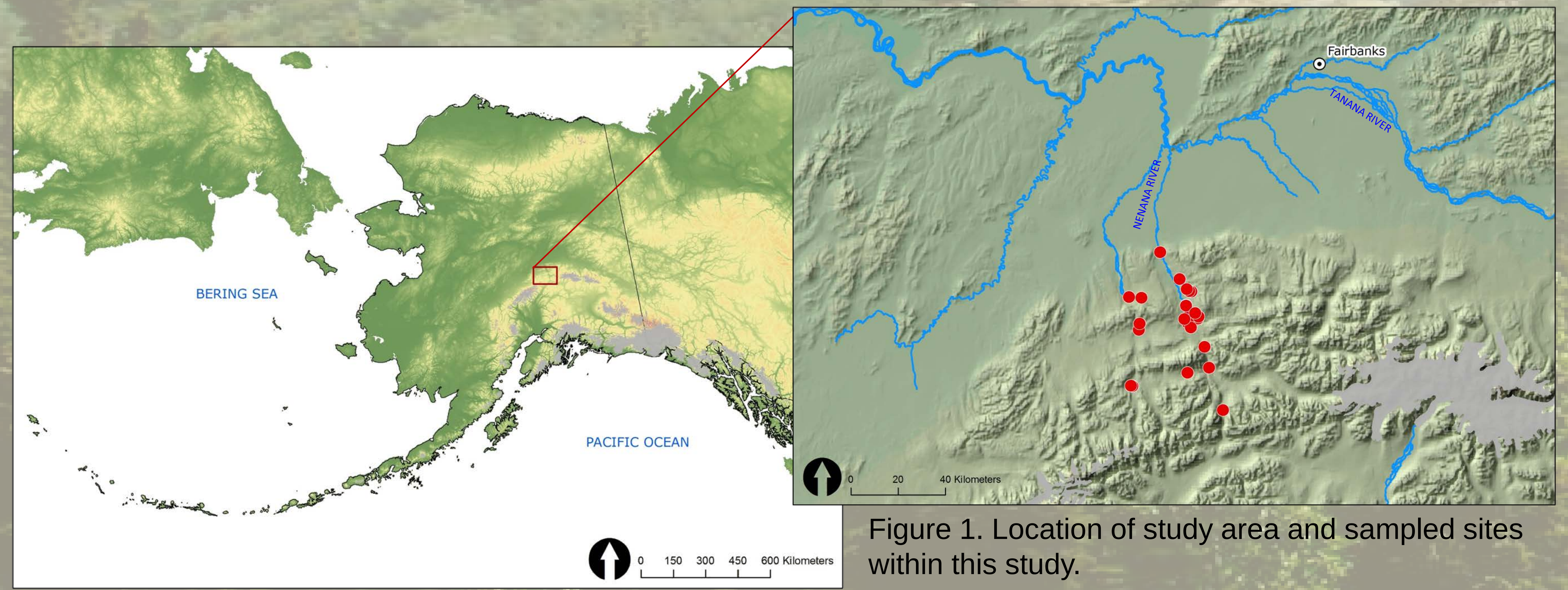

Figure 1. Location of study area and sampled sites within this study.

RHYOLITE

Rhyolite is a felsic igneous rock that forms when magma of granitic composition erupts at the Earth's surface or intrudes the crust at shallow depths. Owing to the rapid cooling of the lava flow, only small crystals (mostly of microscopic size) are able to develop. Because of its forming process, rhyolite is the chemical equivalent of granite, and contains a similar chemical makeup to that of obsidian (Le Maitre et al. 1989). Rhyolite usually contains more than 70% silica (SiO_2). This high silica content gives the rock its general light color (usually light grey, pink or rose in color), and relative low density. The rock tends to be brittle and fracture conchoidally, making it optimal for tool manufacture.

Acknowledgements

The following people provided thoughtful and meaningful comments to this project: Scott Shirar, Jacob Adams, and Lori Hansen. Jeff Speakman was instrumental in developing analytical methods used in this study.

METHODS

Non-destructive x-ray fluorescence (XRF) analyses were conducted at the University of Alaska Museum Archaeology Department using a portable Bruker Tracer III-V portable XRF analyzer equipped with a rhodium tube and a SiPIN detector with a resolution of ca. 170 eV FHWM for 5.9 keV X-rays (at 1000 counts per second) in an area of 7 mm^2. Methods followed those described by Philips and Speakman (2009). Analyses were conducted at 40 keV, 15 μA, using a 0.076-mm copper filter and 0.0305 aluminum filter in the X-ray path for a 200 second live-time count. Ten elements were measured: Potassium (K), Manganese (Mn), Iron (Fe), Gallium (Ga), Thorium (Th), Rubidium (Rb), Strontium (Sr), Yttrium (Y), Zirconium (Zr), and Niobium (Nb). Peak intensities for these elements were calculated as ratios to the Compton peak of rhodium, and converted to elemental concentrations using linear regressions derived from the analysis of 15 well-characterized obsidian samples analyzed by NAA and/or XRF and were reported in parts-per-million (ppm).

A total of 207 artifacts consisting of debitage and formal tools from 30 sites were sampled from collections at the UA Museum of the North from October 2012 to January 2013. Sample size varied depending on the number of rhyolite artifacts found in each site assemblage. At a minimum thirty artifacts were sampled from each site, more when possible.

GROUP DELINEATION

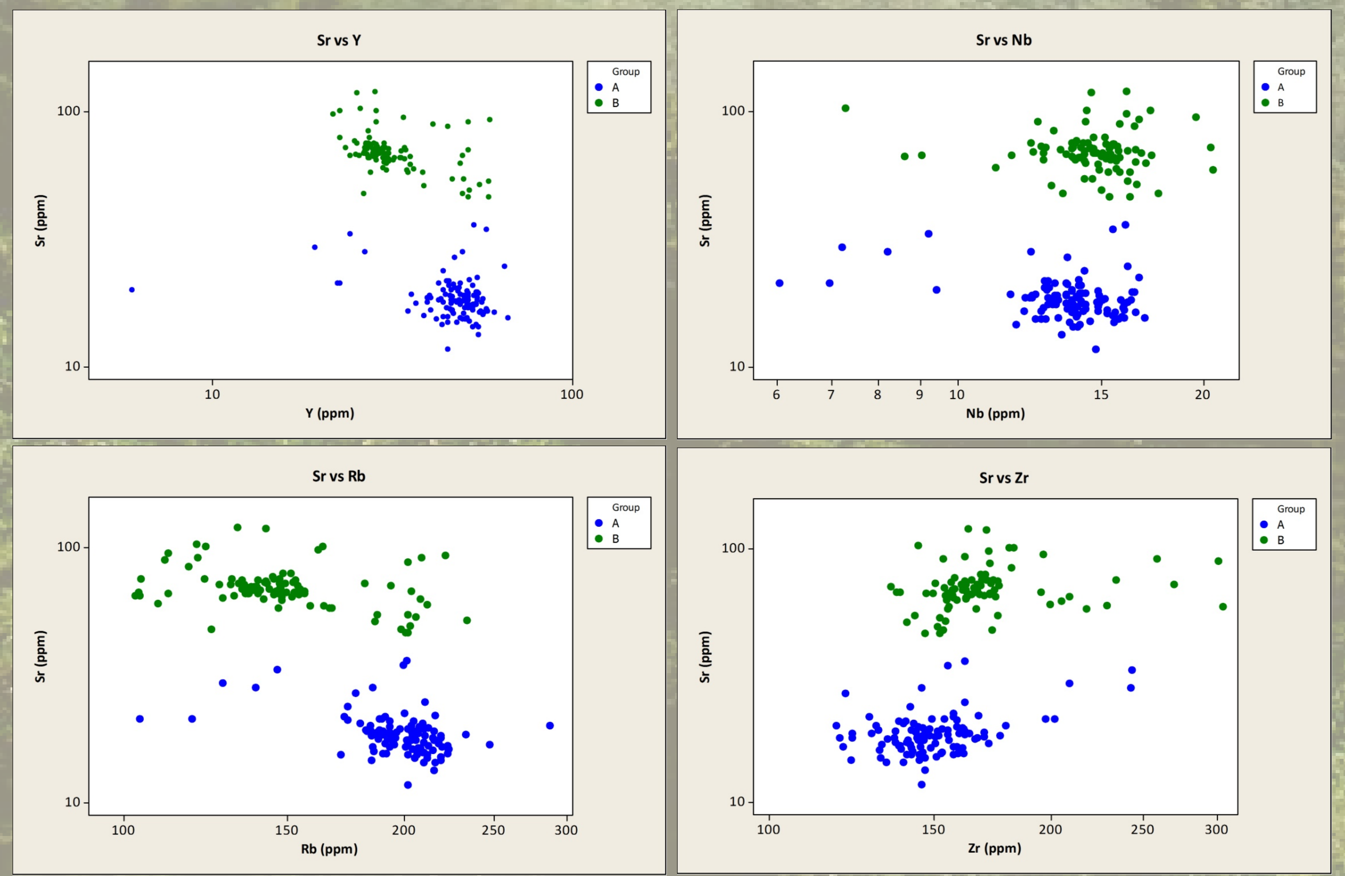

Figure 2. Bi-plots of key element compositions.

Groups were initially identified by aid of bi-plots (Figure 2) and histograms of key elements measured by PXRF. Once basic characteristics of these groups were observed principal component analysis was used to test the validity of these groups.

Table 1 lists the two groups with the average and standard deviation values for the five trace elements measured.

References

Le Maitre. R.W., Bateman, P., Dudek, A., Keller, J., Lameyre, J.. Le Bas, M.J., Sabine, P.A., Schmid, R., Sorensen, H., Streckeisen, A., Woolley, A.R. & Zanettin, B.
1989. *A Classification of Igneous Rocks and Glossary of terms: Recommendations of the International Union of Geological Sciences Subcommission on the Systematics of Igneous Rocks.* Blackwell Scientific Publications, Oxford, U.K.

Phillips, S. C. and Speakman, R. J.
2009 Initial source evaluation of archaeological obsidian from the Kuril Islands of the Russian Far East using portable XRF. *Journal of Archaeological Science* 36(6):1256-1263.

PRINCIPAL COMPONENT

"Source" groupings were defined on the basis of principal component analysis. In performing our statistics we used the following elements: Rb, Sr, Y, Zr, and Nb to delineate clusters. Two components yielded Eigenvalues greater than one: Component 1 (Group A) = 2.790; Component 2 (Group B) = 1.138. These two distinct groups are demonstrated in the Scree Plot (Figure 3) and in the Principal Component Score Plot (Figure 4).

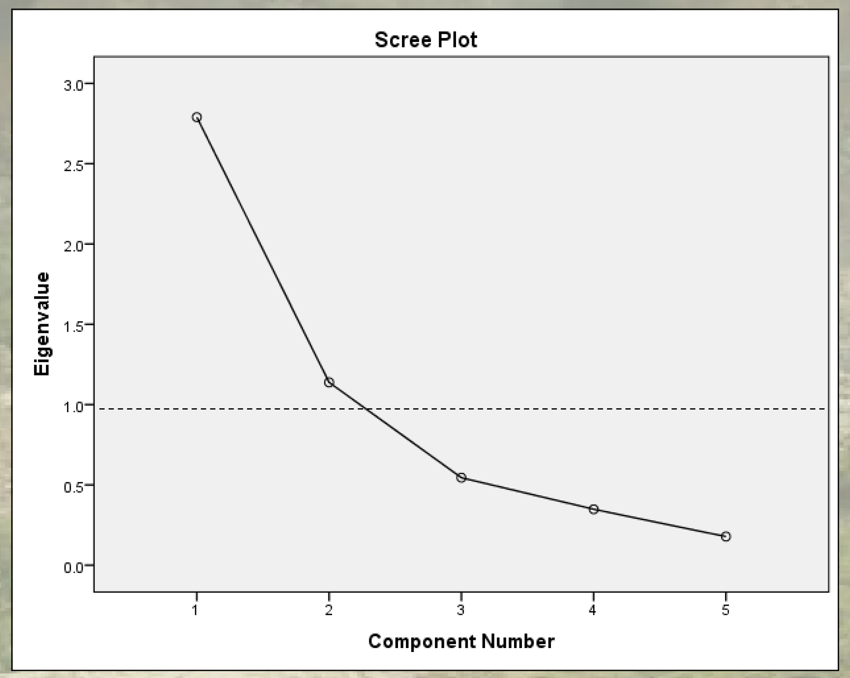

Figure 3. Scree plot for principal component.

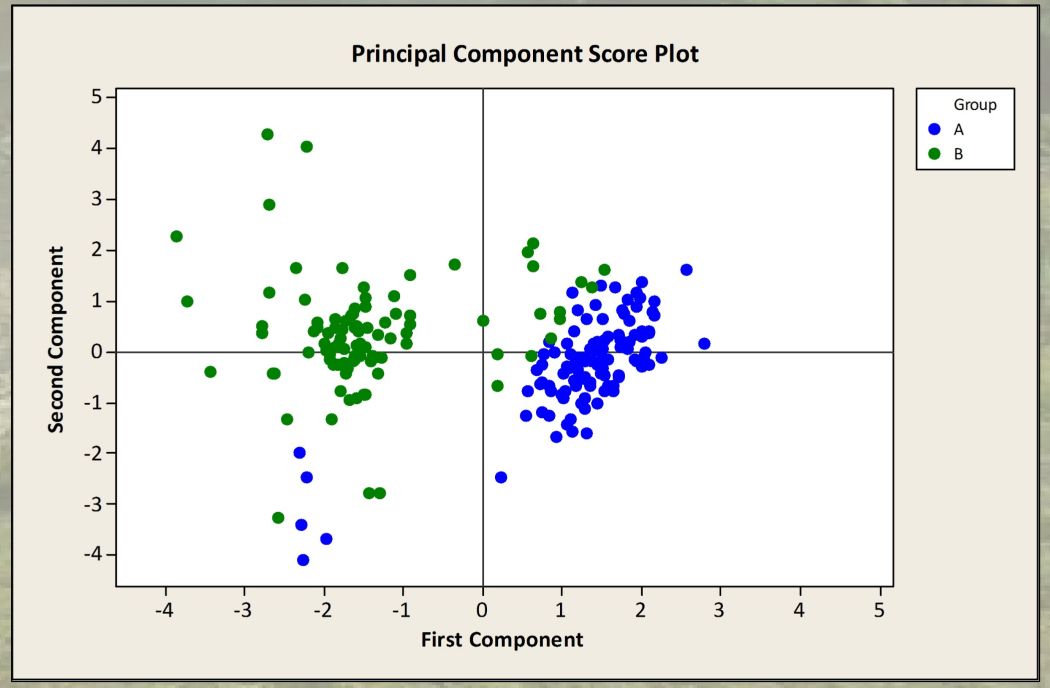

Figure 4. Principal component score plot, with groupings

Table 1. Means and standard deviations of trace element concentrations (in parts-per-million) for Groups A and B.

	Rb	Sr	Y	Zr	Nb
Group A N=110	199 ± 23	19 ± 4	48 ± 9	150 ± 20	14 ± 4
Group B N=97	150 ± 29	71 ± 13	33 ± 9	171 ± 29	15 ± 4

RESULTS AND DISCUSSION

The earliest these presumed "sources" appear in the archaeological record is during the late Pleistocene with continued used through the later Holocene. Although these two groups are geochemically distinct they appear to have been used similarly by people. Tables 2 and 3 show the similarities between each group in regards to the presence/absence of cortex (Table 2) and the number of spalls (those artifact containing cortex), interior flakes (artifacts lacking cortex), and tools (all types) (Table 3) for all samples analyzed.

Table 2. Presence/absence of cortex by geochemical group: $X^2 = 0.067; DF = 1; P = 0.796$

Group	Cortex Presence	Cortex Absence
A (n=110)	20 (18%)	90 (82%)
B (n=97)	19 (20%)	78 (80%)

Table 3. Artifact class by geochemical group: $X^2 = 1.121; DF = 2; P = 0.571$

Group	Spall	Interior Flake	Tool
A (n=110)	6 (5%)	71 (65%)	33 (30%)
B (n=97)	9 (9%)	60 (62%)	28 (29%)

Future directions for research will focus on comparing the artifact compositions to geological sources around the Alaska Range. Additional archaeological samples from more central Alaska sites will be added to analysis. Since most of the sites shown here are multi-component, inter-and intra-site analyses of the temporal differences of the samples is a possibility for future research.