

Geochemical Characterization of Rhyolite Sources: A Search for Prehistoric Toolstone

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1.0 Introduction and Purpose of Work

Lithic sourcing studies are an untapped and understudied resource in Alaska archaeology, and have focused largely on obsidian (Cook 1995; Reuther et al. 2011). They offer a way of addressing prehistoric mobility, landuse, and in some instances trade. Common in archaeological site assemblages are fine-grained volcanic rocks (e.g., obsidian, rhyolite, basalt, and andesite) which are amenable to a variety of geochemical characterization techniques. This study continued to focus and build on an ongoing rhyolite sourcing project (cf. Coffman and Rasic 2015), with the intent of documenting and geochemically characterizing rhyolite sources in Denali National Park and Preserve and Wrangell St. Elias National Park and Preserve and attempt to match bedrock sources to prehistoric artifacts. The problem with rhyolite, and most igneous rocks in general, is that it tends to be common and widespread geologically, making it challenging to locate the “high-quality” or “tool-quality” rock within a formation on the landscape.

Portable XRF (pXRF) technology has been used to geochemically characterize 1000 rhyolite artifacts from over 100 archaeological sites in interior Alaska. The results of these analyses have assisted in the characterizing of 10 distinct geochemical groups (i.e. the geologic sources). While the sources have not been identified, it is believed that the majority of the material is originating in the Alaska Range, where rhyolite outcrops are plentiful. Given this information, the 2015 research focus was to collect rhyolite samples from selected outcrops as described in a 1963 report by Plafker et al.

2.0 Test Sampling Locations and Methods

Plafker et al. (1963) described a significant number of rhyolite sources occurring in the vicinity of known perlite (a form of obsidian) outcrops of the Alaska Range. These descriptions shared many similarities to some of the rhyolitic artifacts and served as a guide of where to collect rhyolite. It was thought that rhyolite adjacent to the perlite might be better suited for manufacture of stone tools.

In early August the research team hiked up the Teklanika River to the Calico Creek drainage. From there the team was able to locate the previously described perlite and rhyolite sources. In all, our research team collected rhyolite from three locations in the upper Teklanika River; two up the Calico Creek drainage and one in an unnamed drainage to the Teklanika River. In addition to these outcrops the research team collected samples from Sugarloaf Mountain located in the Healy area and from four locations in Wrangell St. Elias National Park and Preserve (Boyden Creek, Jack Creek, Lost Creek, and Skookum Creek).

Samples were collected in one-meter grid intervals. A simple sequential numbering system was used when collecting samples. Each location was recorded with a GPS unit and bedrock exposures and sample locations were photographed. In all, the general geological maps from Plafker et al. (1963) assisted greatly in relocating these outcrops.

At the conclusion of fieldwork all of the samples were then geochemically characterized. To accomplish this, samples from all of the source locations were subjected to non-destructive x-ray fluorescence (XRF) analyses. These analyses were conducted at the University of Alaska Museum Archaeology Department using a portable Bruker Tracer III-V portable XRF analyzer (serial #510) equipped with a rhodium tube

and a SiPIN detector with a resolution of ca. 170 eV FWHM for 5.9 keV X-rays (at 1000 counts per second) in an area of 7 mm². Methods follow those described by Philips and Speakman (2009). Analyses were conducted at 40 keV, 15 μ A, using a 0.076-mm copper filter and 0.0305 aluminum filter in the X-ray path for a 200 second live-time count. Eleven elements were measured: Potassium (K), Manganese (Mn), Iron (Fe), Zinc (Zn), 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 (Figure 1). Raw spectra was then converted from x-ray emitted energy to part per million (ppm).

Once characterization was complete, scatter plots (Figures 2 and 3) were created to assist in visually observing the source material. Principle component analysis was performed on the samples to test if there was a link between samples collected during fieldwork and prehistoric artifacts.

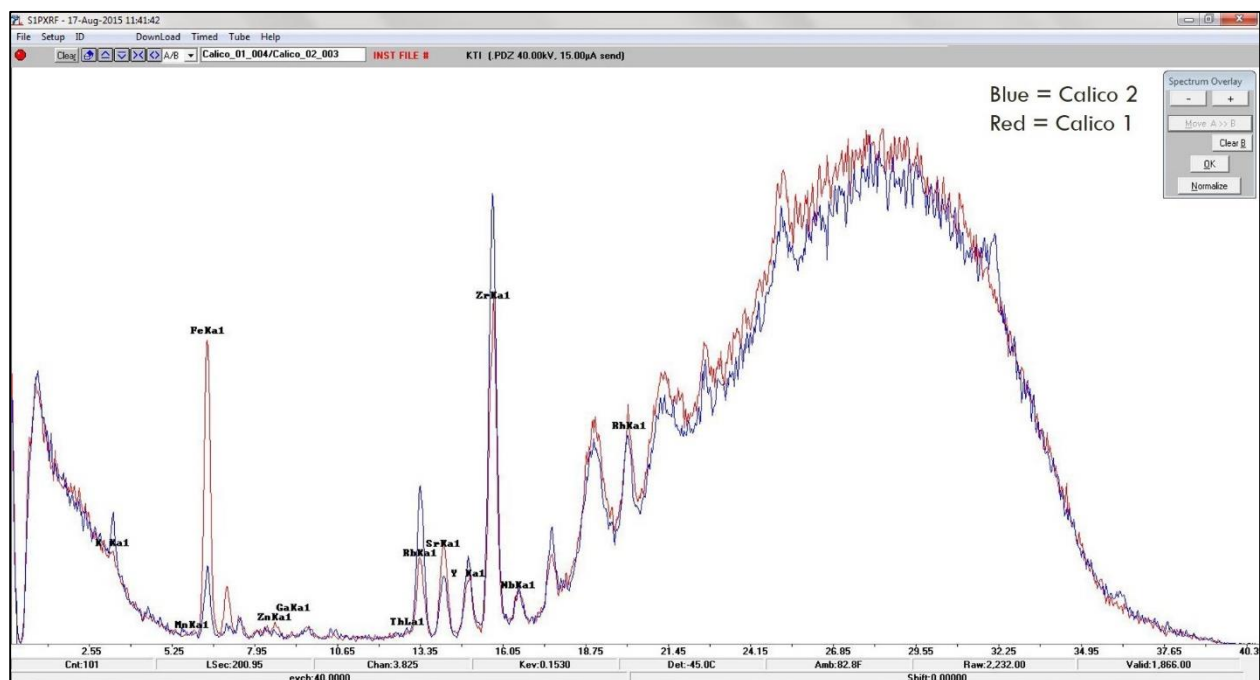


Figure 1. Example of a pXRF spectra of the Calico Creek drainage samples.

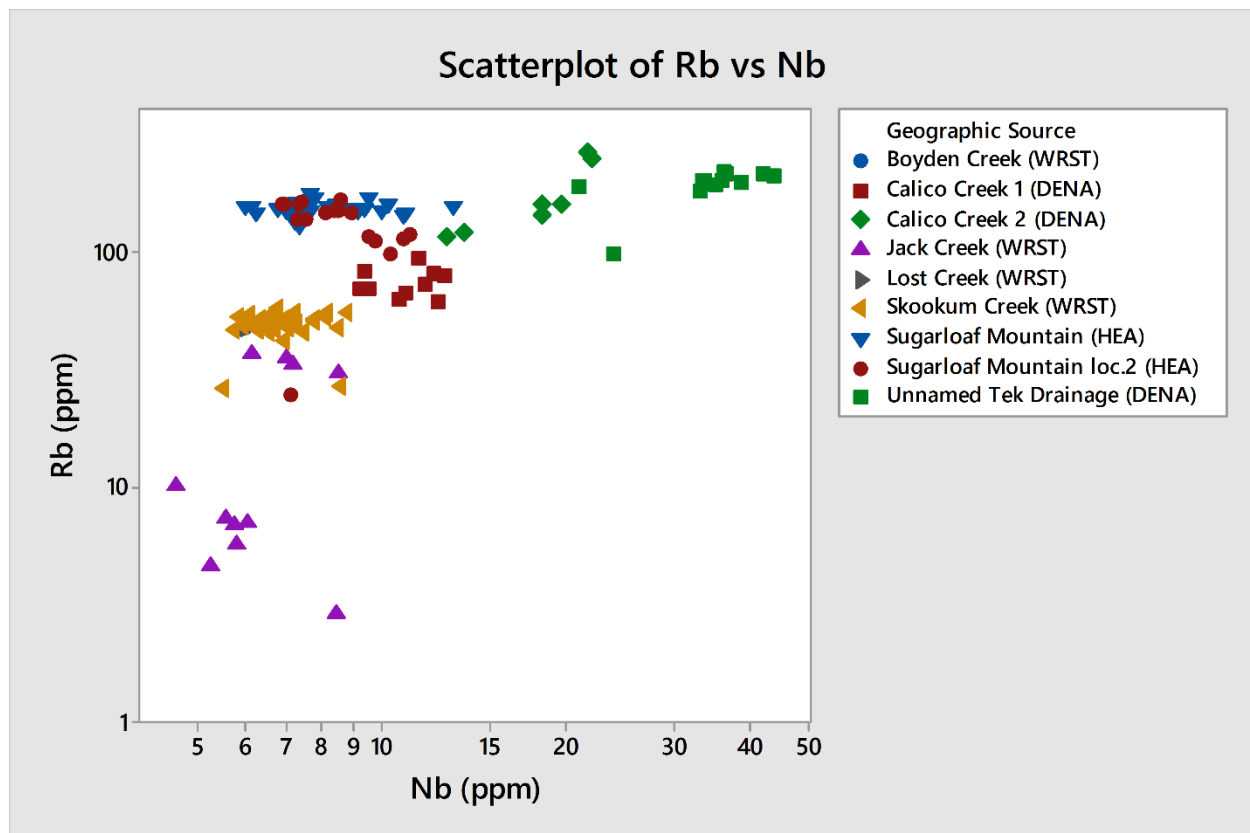


Figure 2. Example of a scatter plot showing groups by trace elements Rb and Nb.

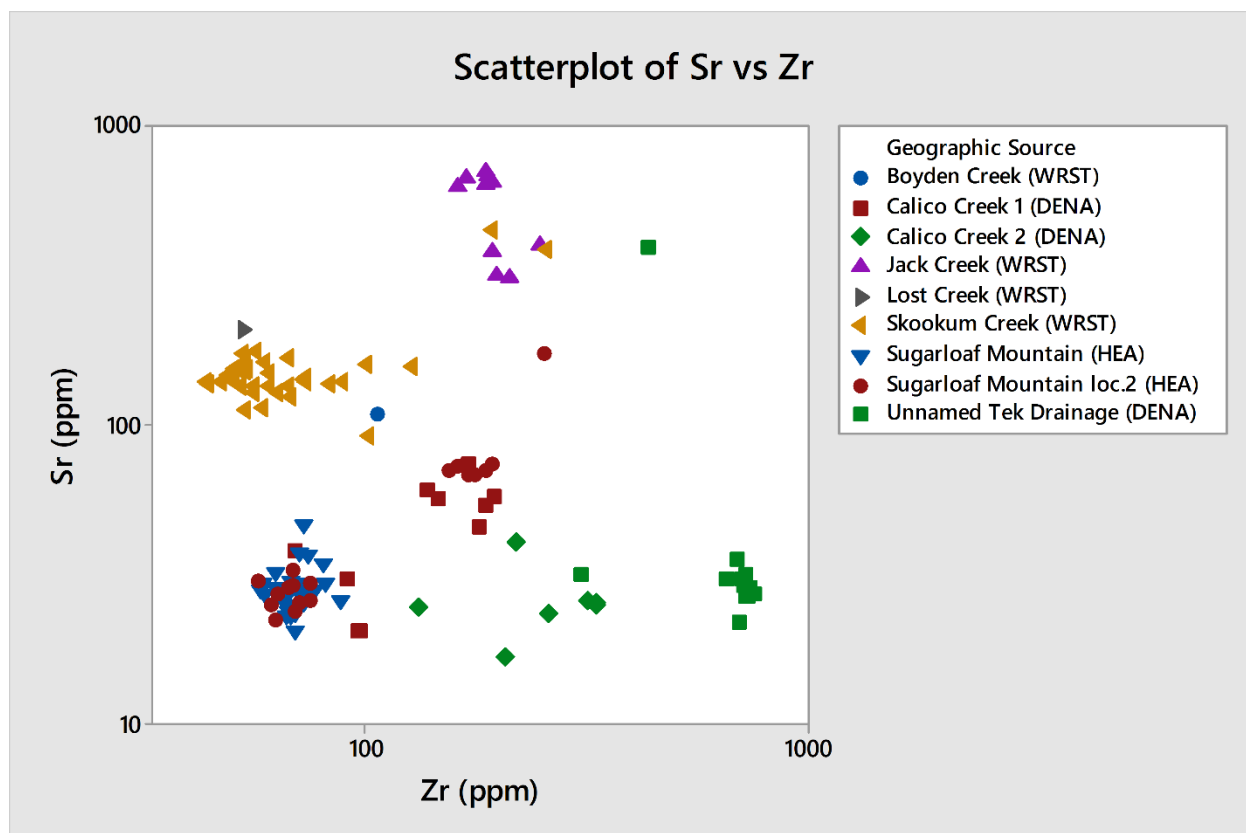


Figure 3. Example of scatter plot showing groups by trace elements Sr and Zr.

3.0 Geochemical Results and Discussion

After characterizing the samples, descriptive statistics were generated showing the mean and standard deviations of each source location (Table 1). Several series of principle component and multivariate analyses were performed testing the relationship between these source samples and analyzed artifacts. Results of these indicated there were no similarities between the 10 groups identified during artifact characterization and the geologic source samples analyzed within this study.

Table 1. The geochemical characterization of the source material.

Geographic Location	Rb (ppm)	Sr (ppm)	Y (ppm)	Zr (ppm)	Nb (ppm)
Boyden Creek (WRST) (n=1)	48+/-0	108+/-0	23+/-0	106+/-0	6+/-0
Calico Creek 1 (DENA)	74+/-10	46+/-18	33+/-6	137+/-46	11+/-1
Calico Creek 2 (DENA)	174+/-61	26+/-7	44+/-10	256+/-75	18+/-4
Jack Creek (WRST)	16+/-14	550+/-161	6+/-5	193+/-23	6+/-1
Lost Creek (WRST) (n=1)	47+/-0	209+/-0	12+/-0	53+/-0	6+/-0
Skookum Creek (WRST)	49+/-7	158+/-66	17+/-2	72+/-42	7+/-1
Sugarloaf Mountain (HEA)	154+/-10	28+/-5	34+/-13	69+/-7	8+/-2
Sugarloaf Mountain loc. 2 (HEA)	132+/-34	50+/-37	30+/-5	113+/-62	9+/-1
Unnamed Tek. Drainage (DENA)	194+/-30	55+/-97	42+/-12	666+/-131	34+/-6

Overall the 2015 field season was successful in revisiting and collecting geologic samples from the targeted locations. However, ultimately answering the question of where early Alaskans procured their rhyolitic toolstone remains unanswered. Of the nine bedrock outcrops visited this summer, none of them geochemically and statistically matched any of the artifact groups. Despite this, this study documented and geochemically characterized nine rhyolite sources. These data may be important as more artifacts are characterized and may potentially link to these sources, only time will tell.

4.0 Acknowledgements

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