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Rhyolite characterization and distribution in central Alaska

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ABSTRACT

Fine grained volcanic rocks are common in lithic assemblages of interior Alaska and are amenable to geochemical characterization using a variety of analytical techniques. Our study focuses on rhyolite with the intent of identifying and delineating geochemical groups that may correlate to specific geological source areas. PXRF technology was used to analyze 676 rhyolite artifacts from 123 sites in interior Alaska. Our preliminary results recognize ten distinct geochemical groups that appear to correlate with distinct geological sources. While geological origins of eight of the ten groups identified remain unknown, two geological sources have been pinpointed, one (represented by Group H) is located in the central Alaska Range and the second (Group G) is in the Talkeetna Mountains. The provisional framework of geochemical variation among tool quality rhyolite sources in this region is an important first step toward a more robust understanding of prehistoric landuse in interior Alaska.

1. Introduction

Interior Alaska has long been considered the "Gateway to the Americas" with a long record of human occupation that is documented in the archaeological record to have begun at least 14,000 years ago (Holmes 2001) (Fig. 1). This long and continuous occupation offers archaeologists a prime opportunity to address changes in tool-stone procurement, tool manufacture, and mobility strategies among prehistoric foraging groups. One way to address these questions is to use data from lithic source provenance analyses. Such analyses are an important tool for examining prehistoric behaviors associated with raw material procurement, mobility, and for reconstructing landuse strategies. In Alaska, such studies are in their infancy and have largely been confined to obsidian (cf. Cook, 1995; Reuther et al., 2011), yet other kinds of fine-grained volcanic rocks are even more common in lithic assemblages of interior Alaska and are well suited to geochemical characterization using a variety of techniques. Our study focused on rhyolite, a fine grained volcanic material, with the intent of identifying and delineating geochemical groups and proposing a provisional framework for describing the identified groups, while attempting to "pinpoint" the source origin of the material. It is clear rhyolite was used prehistorically, but to what extent and was there preference given to different types rhyolite for the manufacturing of different tools? Here we present results of an initial attempt to describe geochemical variation among rhyolite artifacts from interior Alaska with the intent of identifying and delineating geochemically similar sets of artifacts, and linking these geochemical groups to geological sources of rhyolite. In addition, we seek to address the relationship between tool stone elemental analysis and lithic technological organization of these rhyolitic artifacts in central Alaska.

Portable X-ray Fluorescence (pXRF) technology was used to analyze 676 rhyolite artifacts from 123 sites in interior Alaska (Fig. 1). Many of the artifacts analyzed in this study derived from stratified or dated contexts that range in age from the late Pleistocene through the late Prehistoric period (ca. 200 BP). In addition, we have established a growing body of geological source samples in an attempt to link geochemical groups known from archaeological context to the geologic origin of primary and secondary sources of lithic raw materials, a first in Alaska and Beringia.

2. Pre-contact use of 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. The conditions of its formation make rhyolite a felsic rock, and

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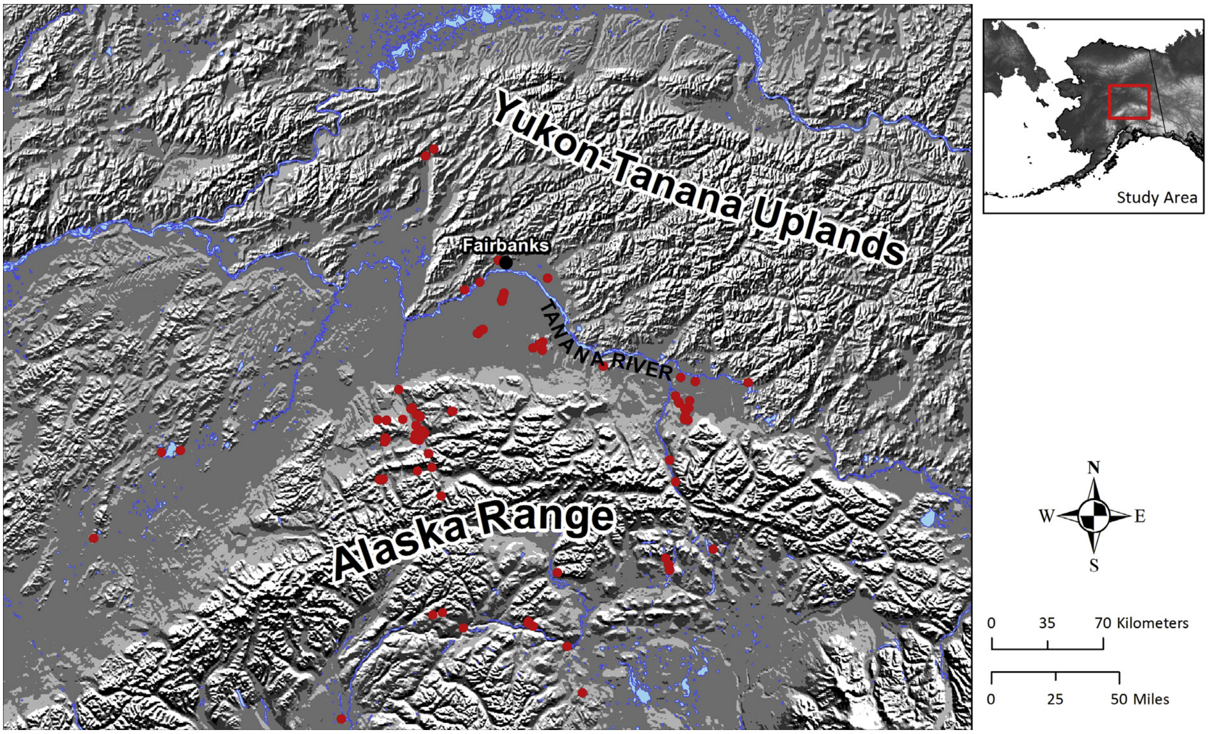

Fig. 1. Interior Alaska, the focus area of this research with analyzed sites containing rhyolite.

contain 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 generally light color (usually light gray, pink or rose in color), and relative low density. It also contributes to the properties that made rhyolite a useful raw material for flaked stone tool production.

Rhyolite is a common rock type in interior Alaska and was one of the most commonly used lithic raw materials in central Alaskan prehistory. Rhyolitic calderas known from east central Alaska (near Tok, Alaska) were studied by Bacon et al. (1990) and date to the mid-Cretaceous. The central Alaska Range (around Healy, Alaska) has been subject to a greater number of geological studies, due to easy access of roads and other infrastructure (e.g. train). Most important of these are studies conducted by Gilbert et al. (1976) and Nye (1978) both of which spent considerable time mapping and describing the Teklanika formation which contains many felsic (of rhyolitic and andecitic) volcanic flows and have been dated to the Paleocene (~57 Ma.). Additional metarhyolitic formations were documented in 1998 by T. Bundtzen (unpublished data 1998 cf. Wilson et al., 1998) in the Mount McKinley quadrangle and dated to ~370 Ma. However, rhyolite and other rhyolitic calderas in western interior Alaska have not been widely studied and most importantly rhyolite of knappable, or stone-tool quality rhyolite is largely unknown. Geological mapping in the region, on the whole, is not detailed and many unmapped rhyolite deposits likely exist. Prior to this study not a single specific rhyolite quarry or primary procurement location with evidence from prehistoric human use had been documented in central Alaska. However, in respect to the previous statement, no one has ever looked for rhyolite sources in an archaeological context.

3. Methods

A total of 676 unaltered artifacts consisting of debitage and tools from 123 sites were sampled largely from collections housed at the University of Alaska Museum of the North, as well as from a few active field research projects being conducted in the Tanana River basin and in southcentral Alaska. Site assemblages derive from archaeological sites throughout interior Alaska. We emphasized analysis of collections from well-dated, stratified deposits whenever possible, but also included collections from surface contexts with little or no chronological control in order to expand our geographic coverage and sample size. The number of rhyolite artifacts from each assemblage varied depending on the number of artifacts within each site assemblage. We targeted a sample of 30 artifacts from each site component when sufficient samples were available and in many cases we examined additional artifacts. Thirty artifacts were sampled from each site, and more whenever possible. Sample selection largely consisted of conducting pXRF on every artifact within a given collection. However, this was dependent upon two factors; size and thickness of the artifact. Artifacts at least 1 cm in maximum dimension were selected to ensure consistent coverage of the pXRF detector and samples at least 3 mm in thickness ensured consistent absorption of the X-Ray spectrum (see Hughes, 1998; 2010) and provided reliable results. We used maximum dimension and average weight measurements as a way to identify distance of the geological source locations to the point of discard (i.e. the site where the artifact was found). This was done primarily on the basis that heavier and larger artifacts would possibly indicate the source was nearby. Conversely, smaller, lighter artifacts may indicate the source was farther away. The data representing each group was not kept consistent in order to evaluate each identified group on their own merit.

3.1. pXRF analyses

Archaeological specimens were analyzed as whole rock samples, with non-destructive X-ray fluorescence (XRF) analyses conducted on each sample using a portable Bruker Tracer III-V portable XRF analyzer equipped with a rhodium tube and a SiPIN detector