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THE NEW HAMPSHIRE SPHERULITIC RHYOLITES: ROCKS OF IMPORTANCE TO PREHISTORIC NATIVE AMERICANS

By

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INTRODUCTION

New Hampshire's characteristic granite bedrock brings in thousands of visitors each summer as a major attraction for the casual geologist or climber, but over 10,000 years ago the first inhabitants of North America found themselves drawn to New Hampshire for its high-quality volcanic rocks. The fine grained varieties of materials necessary to create a tool with a sharp edge are found only in very isolated pockets of geology in the northeast. Therefore, the handful of locations where these materials are naturally occurring appear to have been well known and frequently visited by the earliest people of New Hampshire and its neighbors.

Outcrops of rhyolite, a volcanic rock of granitic composition, can be found in the outskirts of New Hampshire's White Mountains. Obsidian, or entirely glassy rhyolite, is ideal for tool making but not available locally. While not all rhyolite is glassy in texture, some varieties are glassy enough to be useful for tool making. There are two known archaeological sources of flow banded, and sometimes spherule bearing rhyolites in New Hampshire, located in the towns of Berlin and Jefferson. A location map showing where these rhyolite sources are within the state of New Hampshire is shown in figure 1, and fluted points made from both rhyolite sources are photographed in figure 2.

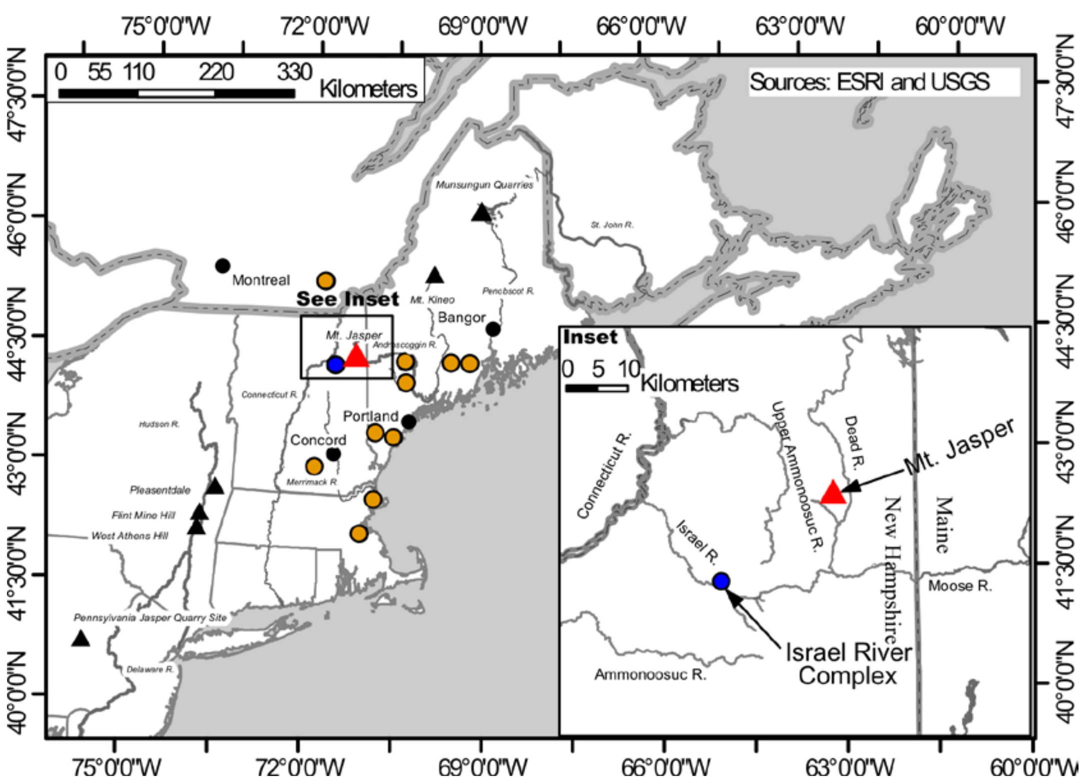


Figure 1. Index map showing the location of selected archaeologically significant quarry areas in northeastern North America. Yellow circles show the locations of archaeological sites from which spherulitic rhyolite has been recovered.

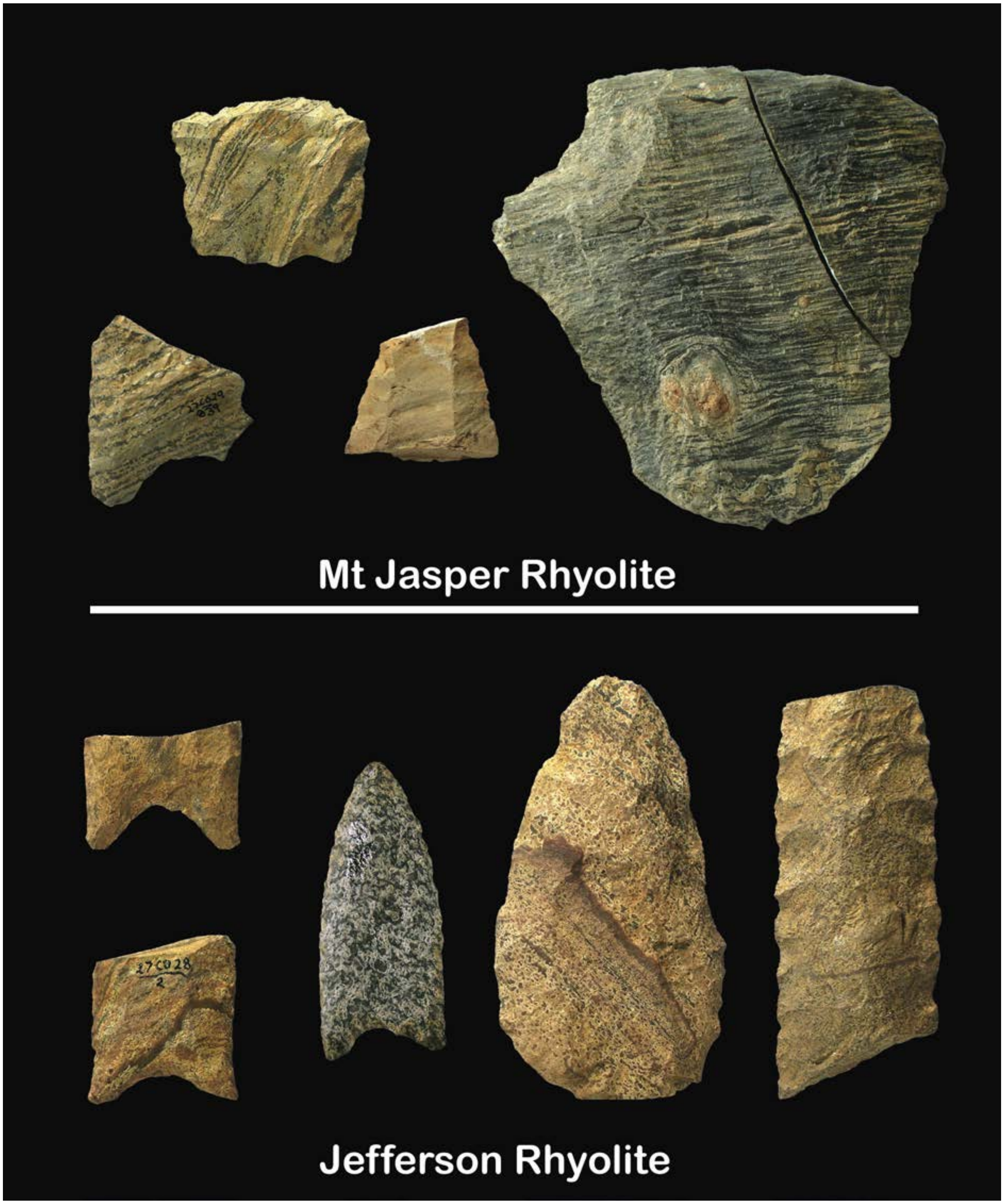


Figure 2. Photographs of each of the sources of New Hampshire flow banded spherulitic rhyolites found as artifacts.

MOUNT JASPER

Previous Work

The earliest mention of the Mount Jasper mine appears in an 1869 publication titled "Mineralogy Among the Aborigines of Maine," where the source is described as "a variety of ribbon jasper, found in Berlin, [that] was extensively employed by the Androscoggin Indians." The author also noted that "this locality has been rediscovered within a few years, where the chips were found which they had left," suggesting it was still a place of importance to residents in the 19th century (True, 1869). Those living in the 19th century also seem to have recognized the widespread distribution of Mount Jasper material beyond the immediate area of the dike. H.W. Haynes reported an instance where flakes of spherulitic rhyolite of archaeological significance were found along the Androscoggin River approximately 11 km north of the Mount Jasper (Haynes, 1888).

Nearly a century passed before the Mount Jasper mine was explored any further in terms of its archaeological importance. Interest in the mine, however, resumed in the early to mid 1980s, when there were several workshop sites excavated at the base of Mount Jasper, as well as an excavation of the dike at the summit and the mine itself (Gramly 1980, 1984). In the early 1990s, the lithic source was placed on the National Register of Historic Places (Boisvert, 1992).

Archaeology

The dike here was mined during the late Paleoindian through Archaic period before gradually falling into disuse during the Woodland period. While researchers believe that this source was exploited predominately between 6000 and 7000 years ago, inhabitants were visiting this source for a period spanning over 11,500 years (Boisvert, 2009). Mount Jasper is a small hill that overlooks the confluence of the Androscoggin River and the Dead River, and therefore situated on a major path that links the Androscoggin and Connecticut Rivers. The location of the source between these two major throughways, providing easy access through much of the northeast, is likely one reason the site was exploited for such an extensive period of time (Pollock et al, 2008a). The small but significant hill also likely acted as a useful landmark for navigation purposes.

Interestingly, no tools of Paleoindian tradition have actually been recovered at the Mount Jasper site itself (Boisvert, 2012). Therefore dating of the site relied upon the discovery of several diagnostic projectile points manufactured from Mount Jasper material found at sites across the northeast (Boisvert, 1992). Some projectile points made from other regional materials that were recovered by Gramly were also useful in dating the site (Gramly, 1984) It appears that occupations at Mount Jasper focused primarily on tool manufacture, without many other aspects of life carried out at this location.

During the Archaic and Woodland periods the distribution of artifacts mined from Berlin was largely confined to the Androscoggin drainage. Paleoindian sites in Maine and Massachusetts, and at least one site each in New York and Quebec have recovered artifacts of spherulitic rhyolite (Pollock et al, 2008a). Mount Jasper is a very unique example of mining by Native Americans to acquire stone material for tool making. While at other sites throughout the northeast stones may have been quarried, Mount Jasper is the only instance where there is an actual mine.

Geology

The Mount Jasper lithic source is a 0.75 – 1.3 m wide dike of flow banded rhyolite (Boisvert, 2009). The mine here is by definition an adit, cutting straight into the vein of desirable material and creating the famous "Jasper Cave" as H.W. Haynes described it. Billings and Fowler - Billings (1975) identified four types of dikes that intrude the Ordovician Ammonoosuc Volcanics at Mount Jasper: 1) very coarse-grained to pegmatitic granitic dikes, 2) a biotite granofels dike, 3) basalt dikes and 4) the flow-banded spherulitic dikes of archaeological importance (Pollock let al, 2008 b). Starbuck describes Mount Jasper material as belonging to the Moat Volcanics (2006).

Previous Work

R. W. Chapman made the first geologic map of the Pliny Range, home to the Jefferson Rhyolite, in 1942. Chapman built upon this work in 1946 with Marland Billings, who later mapped the Mount Washington Quadrangle at the scale 1:24,000 in 1956. The Jurassic ring dike complex was also the subject of a master's thesis by MIT student Eichelberger in 1970.

The Jefferson rhyolite was first recognized as a distinct source in the 1990s. When the base of a Paleoindian fluted point was recovered from the Jefferson I site in 1996, archaeologists believed the point was made from Mount Jasper rhyolite due to visual similarities. The point was in fact from the visually similar, and likely closely related source in Jefferson that had yet to be observed in outcrop (Boisvert 1996; 1999). Researchers in geology and archeology have since collaborated in several attempts to distinguish Mount Jasper rhyolite from the Jefferson rhyolite, both visually and geochemically (Pollock, Hamilton, and Boisvert, 2007, 2008). Previous studies have examined artifacts and flakes made from these rhyolites, as well as blocks of till that were found nearby to archaeology sites and therefore characterized as "source" material for the artifacts. While an archaeological source in the form of large blocks transported by glaciation has been previously identified and studied, this study aims to identify the original geological source outcrop location that the blocks of till would have come from.

Current Work

A handful of small dikes of rhyolite were found in the Pliny Range during fieldwork in 2015, located on the slopes overlooking the Israel River valley. Samples were taken from these outcrops and compared using x-ray fluorescence (XRF), which confirmed that the Jefferson source was distinct from the Mount Jasper source, and that it was indeed geochemically related to artifacts that were visually and macroscopically characterized as Jefferson material by archaeologists and geologists (Baker, 2016).

Although an archaeological source in the form of large blocks transported by glaciation has been identified and studied, the 2016 study aimed to identify the original geological source outcrop location that the blocks of till would have come from. While researchers have no reason to believe the newly discovered rhyolite dikes were exploited by Native Americans directly at the outcrops in Randolph and Jefferson, these are the first discovered outcrops of the distinct variety of spherulitic rhyolite found as artifacts at local archaeology sites. Because these outcrops are so small, just a few meters wide, it is possible and even probable that more rhyolite dikes remain undiscovered in the Pliny Range and nearby areas.

Archaeology

The Israel River Complex consists of six sites (named Jefferson I – VI), all within an area less than one square kilometer. The Israel River is a tributary to the Connecticut River, and the two converge about 15 kilometers to the northwest of the Israel River Complex. It was here that the Jefferson source was first discovered as artifacts, and as blocks of till that littered slopes of the Pliny Range after the last glaciation. The Jefferson Source has also been found at the Potter site in nearby Randolph, New Hampshire (figure 3). The Jefferson source was used for a short time relative to the lengthy exploitation of the Mount Jasper

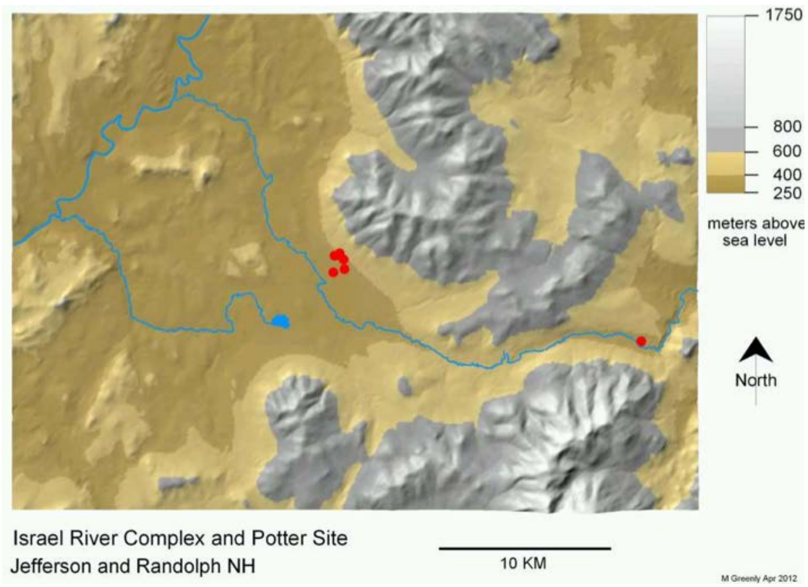


Figure 3. Relative locations of the Israel River Complex (red dots to west) and Potter site (red dot to the east).

source. The Jefferson source was used exclusively in the Paleoindian period between approximately 12,000 and 9,500 years ago (Pollock et al., 2008).

Both the Mt. Jasper Rhyolite and Jefferson Rhyolite were used by some of the first inhabitants of present day North America. People living during the Paleoindian period used these sources and many others to make characteristic fluted points for hunting big game megafauna, likely caribou. These people likely came to the northeast as the glaciers retreated after the last glacial maximum during the late Wisconsin, following herds along their migratory paths which often coincided with river valleys and bodies of water (Starbuck, 2006). The location of the Israel River Complex was very conveniently placed on the landscape for observing herds of migrating Caribou. It has recently been proposed by Boisvert that the sites actually consist of several specific “vantage point” sites that were used to looking out across the landscape, as well as habitation areas on lower lying parts of the landscape, as shown in figure 4.

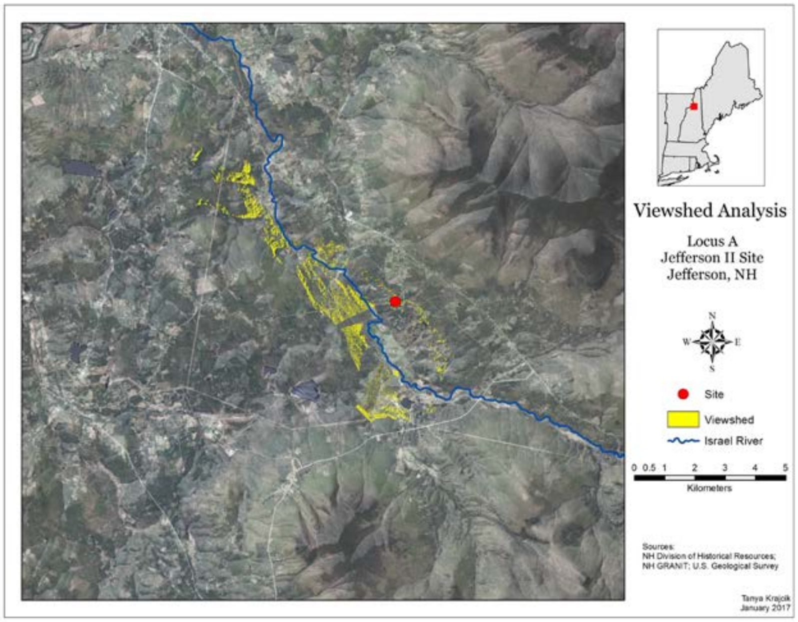
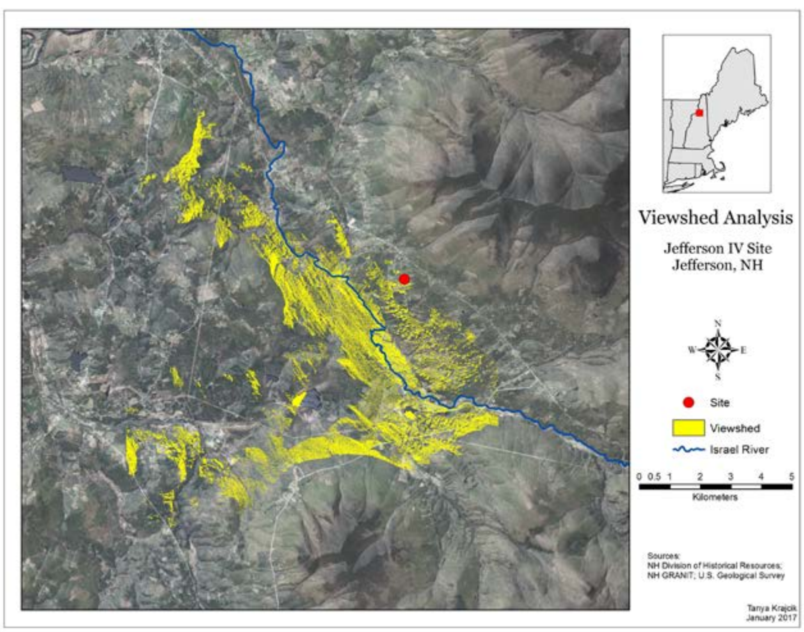


Figure 4. Viewshed analysis of one of the habitation sites (above) and one of the vantage points (below) located within the Israel River Complex.



Geology

The major topographic feature in the Jefferson quadrangle is the Pliny Range, whose arcuate shape is the result of Jurassic cone sheet intrusions through the underlying Ordovician Oliverian dome rocks. The more resistant mafic units that intruded along the ring shaped fracture after caldera collapse remained intact, while older rocks eroded away easily over time. The Jefferson rhyolite likely represents a final surge in magmatism fairly close to the surface before volcanic activity ceased completely in this area. This activity could be related to the stocks of Conway granite that outcrop in the Jefferson 7.5' quadrangle. The most recent bedrock geologic mapping effort of the Jefferson 7.5' quadrangle by Hillenbrand is shown in figure 5.

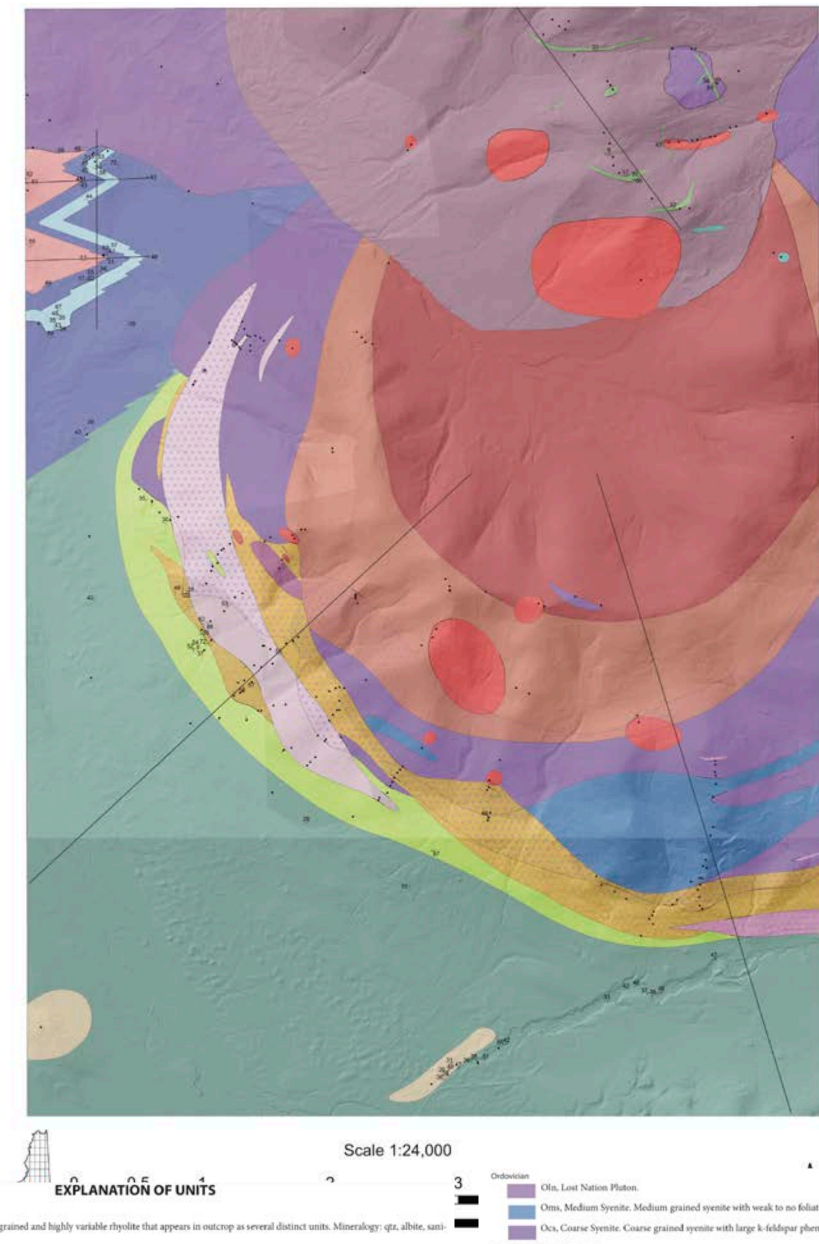


Figure 5. Bedrock geologic map of the Jefferson 7.5' Quadrangle by Eusden and Hillenbrand (2017)

GEOCHEMISTRY OF THE JEFFERSON SOURCE

We must be careful when using the term “source” as Harbottle (1982) explains on the matter of provenance research, as

> “*. . . with a very few exceptions, you cannot unequivocally source anything. What you can do is characterize the object, or better, groups of similar objects found in a site or archaeological zone . . . A careful job of chemical characterisation, plus a little numerical taxonomy and some auxiliary archaeological and/or stylistic information, will often do something almost as useful: it will produce groupings of artifacts that make archaeological sense. This, rather than absolute proof of origin, will often necessarily be the goal.”*

This is important to keep in mind in relation to studies of rhyolites, because these volcanic rocks can be highly variable in both appearance and geochemistry, especially in flow banded and/or spherulitic varieties like those from Berlin and Jefferson. Because rhyolites are not as homogenous as some units typically observed in lithic sourcing studies, such as obsidian, rhyolites can not always be easily “fingerprinted” using compositional data alone (Fraser-Shapiro, 2007).

For reasons described above, results of this study were compared to those of previous studies of other volcanic rocks from New England. An earlier study comparing the Mt. Jasper Rhyolite to the Jefferson Rhyolite compared the outcome of non-destructive analysis to destructive analysis of artifacts and source materials (Pollock and Hermes, 2000). This study was the only additional study that used XRF to geochemically classify the Jefferson source for archaeological purposes. The Jefferson rhyolite source and artifact material was “fingerprinted” in the 2016 study, and then compared to results from the 2000 and 2013 studies, consisting only of artifact and loose “source” material from the valley. While only four artifacts and four source samples were analyzed in this 2016 study due to limited availability, several samples were processed in previous studies, which were very useful for comparison to new data.

The XRF data for major elemental geochemistry plotted on a TAS diagram suggests that all samples collected in the field and in archaeology are indeed rhyolites. The rhyolite is fairly chemically homogenous, with SiO_2 values ranging from approximately 71% to 76%, values nearly identical to those observed in the Mt. Jasper Rhyolite (Boisvert and Pollock, 2009). Comparison of relative amounts of certain immobile trace elements and rare earth elements confirmed that the Jefferson rhyolite was indeed geochemically distinguishable from the Mount Jasper rhyolite. Plots of some of the results of geochemical analysis, compared to those of several other sources, are shown below in figure 6.

Some discrepancies in the new data when compared to previous studies could be due to variable weathering, or human/instrument error, but this is not likely the major cause of large discrepancies. More likely, the Jefferson source, which is highly visually variable, is also highly variable in composition, possibly even derived from multiple magmatic sources. This notion is strengthened by XRF performed by Williams (2013), which concluded that multiple compositions exist within the samples determined to be of Jefferson origin.

While these data do not definitively show that the outcrops of Jefferson rhyolites are the same as those used by Paleoindians to make stone tools, they do suggest that this outcrop is geochemically distinct from other local sources, and very similar to those determined “Jefferson” by previous studies. It is reasonable to conclude that the Jefferson Rhyolite observed in the Jefferson study area is indeed closely related to the blocks of till quarried duringthe Paleoindian period. This interpretation is supported by the proximity of the rhyolite dikes to the Paleoindian sites.

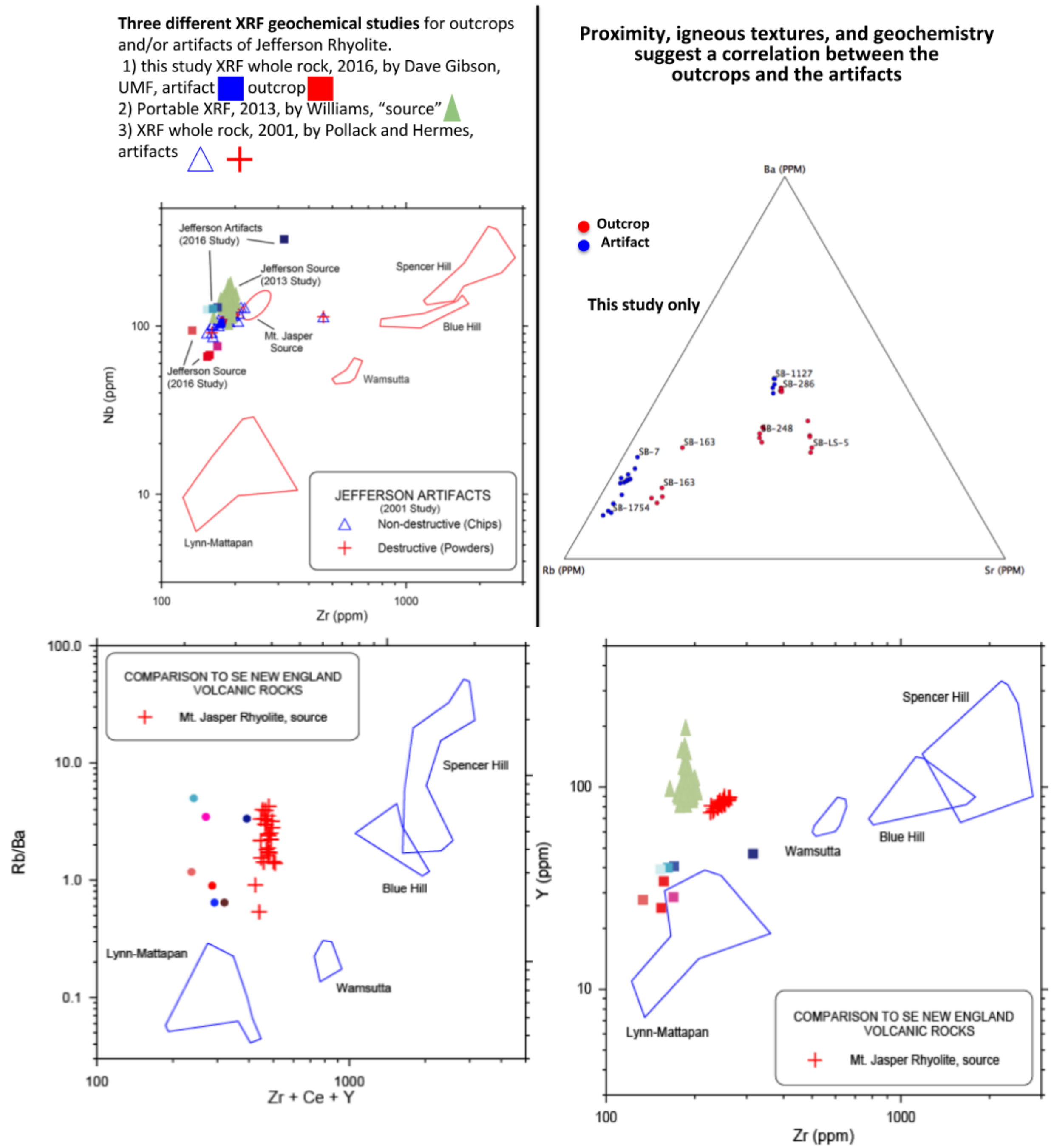


Figure 6. Comparison of geochemical compositional data for the source from Mount Jasper, the newly discovered source from Jefferson, and artifact material previously determined as derived from the Jefferson source.

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ROAD LOG

MEETING POINT. The trip will meet at the Meet Burger King Restaurant along Route 2 and 16 in Gorham, NH (UTM 0325844W 4917498N) at 8:30 AM on Sunday, October 1st.

Mileage. *All UTM Coordinates are in NAD 1927 CONUS*

0.0 Meet Burger King Restaurant along Route 2 and 16 in Gorham, NH (UTM 0325844W 4917498N). Turn left onto NH Routes 2 &16. Drive west on NH Route 2 & 16

0.7 Turn right onto NH Route 16 north at the intersection. Proceed north on NH 16 to Berlin. In Berlin, NH Route 16 is labeled Glen Avenue. This is a one way street northbound.

5.00 Turn left onto NH 110. **NOTE:** Roads have been recently reconstructed and there are some curves in the road in this area. Some maps show that Green Street turns into First Avenue which then becomes Wright Street.

0.3 Turn right onto Hillside Avenue. Follow Hillside Avenue north to Mount Calvaire Cemetery.

1.9 Turn left at the first entrance into Mount Calvaire Cemetery. This area of the cemetery currently has no monuments. Proceed to the back of the cemetery.

0.1 **STOP 1. (2 HOURS) Park and proceed to the access path.**

From here we will hike to the top of Mount Jasper, a distance of approximately 1.0 kilometer. The hike involves a gradual 35 meter vertical ascent. Portions of the path are primitive and stout foot wear is recommended. (25 minutes)

Path entrance UTM is 19 T 326351 4928056. The access path is currently blocked with large boulders. In June 2017, this is an ATV track. Walk along the path approximately 290 meters to a gate at UTM 19 T 0326067 4928111 (approximate). Proceed past the gate. Continue another meters to a small cairn on the left (southwest) side of the ATV path at UTM 19 T 0325818 4928227. The cairn which was present in June 2017 is small and easily missed. It marks the entrance to a small foot path to the top of Mount Jasper. If you reach a large clear cut area on the right of the ATV path you have gone too far.

Turn south onto this path and follow it to the top of Mount Jasper. The path is marked by yellow blazes in June 2017. At waypoint 19 T 0325824 4928133 there is a wooden foot bridge across a small brook. Another waypoint is 19 T 0325616 4928104. This is the intersection with an orange blazed path (as of June 2017) Please see end note regarding this trail. Continue following the yellow blazes to the top of Mount Jasper.

Retrace route back to vehicles. Retrace route back to Intersection of Route 2 and 16 in Gorham, NH.

8.0 At the Intersection of Routes 2 and 16 turn right onto U.S. Route 2.

12.8 Turn right onto Ingerson Road. Six Gun City will be on your immediate left.

1.9 Intersection of Ingerson Road and Pond Safety Road. Proceed on Pond Safety Road

0.9 GATE

0.8 Logging Road on left

0.6 Bridge. Hunting camp with tar paper siding

0.1 Parking at the intersection of Pond Safety Road and snow mobile path (19 T 309975 4918188).

STOP 2 (2.5 HOURS) JEFFERSON RHYOLITE DIKE

This is an approximate 1.2 kilometer one – way walk from where we are parked to the exposure. This is a woods hike, NOT a path. We will be bushwacking! Stay together and do not leave the group! Outcrop coordinates are 19 T 0310576 4919241.

End of trip! Pending permission and if time allows, the members from the group can join on a hike to a clear cut area if they wish to see panoramic views of Mount Jasper and the Israel River Valley.

END NOTE: *The top of Mount Jasper can also be reached via two trails that are marked with orange and blue blazes. These trails are part of those maintained by the town of Berlin. A trailhead is located to the rear of Berlin High School. Park in the lot closest to the track field. There is a descriptive board showing the trail set. A trail marked by blue blazes is immediately in back of the board. Additionally there is a nearby ATV trail that links to the ATV trail behind Mount Calvaire Cemetery. There are several other unmarked trail sets in the area.*

The trail behind the high school to the top of Mount Jasper is approximately 1.2 kilometers long with an elevation gain of approximately 470 feet. This trail is steep in parts and should be attempted by persons in reasonably good physical condition. Stout boots are recommended. The blue trail splits at 19 T 0325876 4927997. If ascending the unmarked trail will be on your left. This unmarked spur is a short cut and rejoins the trail with orange blazes at 19 T 0325842 4928057. If you remain on the trail with blue blazes you will reach an intersection with a trail marked by orange blazes at 19 T 325901 492802. Blue blazes cease at this point. The orange blazed trail to your left will take you to the top of Mount Jasper. The trail with orange blazes joins the trail from Mount Calvaire Cemetery at 19 T 0325616 4928104. If you reach this point turn left to complete the climb to the top of Mount Jasper.

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