MAPPING THE PREHISTORIC METARHYOLITE QUARRY SITE 36AD0201 ON PENNSYLVANIA'S SOUTH MOUNTAIN

Paul Marr
Department of Geography and Earth Sciences
Shippensburg University
1871 Old Main Drive
Shippensburg, PA 17257

ABSTRACT: *Metarhyolite found on South Mountain in Pennsylvania and northern Maryland was an important resource for prehistoric tool making, especially from the late Archaic to early Woodlands periods (c8000 – 2000BP). Prehistoric inhabitants quarried metarhyolite intensively at several locations on South Mountain, creating very distinct quarry complexes often containing hundreds of individual quarry pits. Site 36AD0201, one of the smallest quarry complexes, was used as a test-bed for developing and formalizing the specific techniques needed to document and analyze prehistoric metarhyolite quarrying activity. Field measurements of quarry pit locations; pit length, width, and depth; morphology, and metarhyolite type were collected in 2018. Analysis of these data suggest that small, shallow test pits were dug in an effort to locate useable material. Once located, it appears that quarrying was focused on a relatively small area (0.75ha). Detailed site analysis suggests that the exposed bedrock is similar to the material quarried, but that subsequent weathering alters the appearance of the cultural debitage to such an extent that field classification can be challenging or even misleading.*

Keywords: *Prehistoric quarry, metarhyolite, South Mountain, Pennsylvania.*

INTRODUCTION

Metarhyolite found on Pennsylvania's South Mountain had been used for several thousand years as a source material for stone tools. Although the physical characteristics of metarhyolite can vary greatly, on South Mountain there are locations where the rock is extremely hard and of a very fine texture, characteristics that are ideal for tool-making. The discovery in the late 1920s of a large quarry and associated sites on South Mountain ridgetops and along nearby creeks is credited to Dr. Norman Keefer, although local residents likely knew about these sites long before this time (Deisher, 1933). In recent years additional large and small quarrying areas have been discovered (Marr and Wah, 2017). The few investigations of the South Mountain quarries suggest that these quarry sites were used for thousands of years, although the intensity of use waxed and waned.

Metarhyolite occurs over a large portion of South Mountain, with over 250km^2 of mapped surface exposure in Pennsylvania. However, metarhyolite suitable for tool making appears to be much less common. Areas of prolonged quarrying activity appear to be quite rare, with only 10 sites registered with the Pennsylvania State Historic Preservation Office. These few sites cover a scant 28ha, with the bulk of them situated atop a single long ridge. Yet at these quarrying sites or *complexes* prehistoric activity was intense, with hundreds of large and small pits covering the surface. As old quarry pits played out they were buried by refuse from newly opened pits, giving these sites a cratered appearance that differs dramatically from the surrounding landscape.

Although these sites have been known for generations, there has been little basic research on South Mountain metarhyolite quarries. A few quarry-associated sites have been described in northern Maryland (See Geasey and Ballweber, 1991 and 1999) and a few good overviews have been published (See Stewart, 1984a, 1984b, 1987), but no systematic examination exists for any of these sites. This research will address this knowledge gap through the basic site analyses of a single quarrying complex on South Mountain in Pennsylvania. An important goal of this research is to provide a formal site description. A second goal is to use this site as a test-bed to develop and formalize the techniques and descriptive framework needed to record and analyze metarhyolite quarrying activity.

BACKGROUND

In Pennsylvania, Native American prehistory is generally broken down into three technological and cultural periods: the Paleo-Indian Period, the Archaic Period, and the Woodland Period, which can then be subdivided further (Figure 1). The Paleo-Indian Period (up to ≈ 11,500 year Before Present (BP) began with the earliest people arriving in North America during the Last Glacial Maximum (LGM) or earlier (Kent, 1980). The Archaic Period began around 11,500 BP and coincided with the end of the last Ice Age. Native Americans during this time continued to live as hunters and gatherers, traveling in small bands but over smaller territories. Trade between small groups apparently became more common during this time (Stewart, 1984b). From the end of the Archaic Period until approximately 3,000 BP a Transitional Period occurs, with changes in technology and shifts in subsistence strategies appearing in the archaeological record. During this time groups became less mobile and began to shift to more riverine environments, with an increased focus on fishing and manipulation plant communities or early horticulture. New technology, particularly cooking and storage vessels made from steatite - a soapstone locally available in southeastern Pennsylvania, is first seen during this period. The Woodland Period (3,000 BP – 1550 AD) was marked by increased group sizes, sedentism, and continued development of horticulture and agriculture. Fired pottery, which is not easily transported, replaced steatite and is evidence of the increasing permanence of settlements. It is during this period that large villages with extensive agriculture were built. The Contact Period, after approximately 1550 AD, saw indigenous tools replaced by European tools or indigenous tools made of European materials as colonists spread west across Pennsylvania (Kent, 1980).

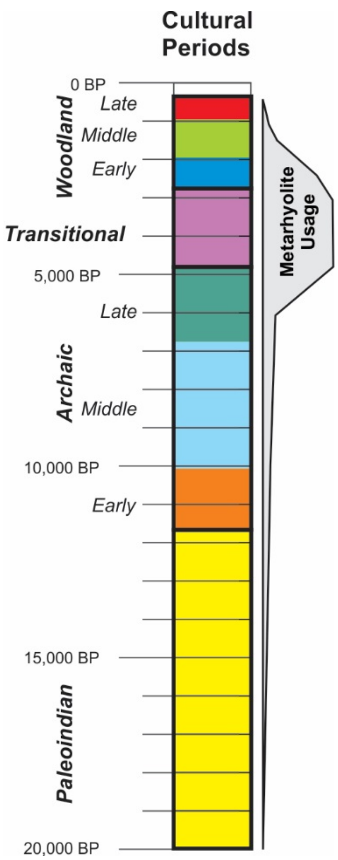

Figure 1. Cultural periods and relative metarhyolite usage

Evidence suggests that the earliest entrants into the New World found and used metarhyolite from South Mountain in tool production (e.g. Stanford et al., 2014). During the Paleo-Indian Period metarhyolite was used to make projectile points, though not in great abundance (Stewart, 1984b). Use of metarhyolite increased through the Early and Middle Archaic Periods culminating during the Late Archaic or Transitional Period (Stewart, 1984b; Carr, 1998). Witthoft (1953) noted that by the end of the Archaic Period almost all Susquehanna Broadspears were made of metarhyolite. Metarhyolite use decreased through the Woodland Period, although Late Woodland metarhyolite projectile points can be found (Witthoft, 1953; Stewart, 1984b). Trading patterns mirror usage, and artifacts made of South Mountain metarhyolite are found at great distances from the source area (Stewart, 1984b).

Metarhyolite varies in chemical composition, texture, and color across South Mountain. Fauth (1968, 1978) categorized the rock based primarily on groundmass color, with the most common types consisting of aphanitic blue, red porphyritic, and mottled metarhyolite (Figure 2). This classification scheme is only a rough guideline since there is a significant amount of overlap among the various metarhyolite types. Very fine to fine phenocrysts are common in surface exposures and the rock fractures in thin sheets along flow laminations, which can become more apparent as the material weathers. At its most useful for tool making metarhyolite is hard, fine textured, has few inclusions, and fractures conchoidally. These characteristics allow it to break in a controlled and predictable manner, to form and hold sharp edges, and made it an important raw material for stone tool manufacture in the Mid-Atlantic and Northeastern United States. There is some evidence that weathered metarhyolite exposed at the surface may have been unsuitable for tool-making and that moisture within the material improved its working qualities (e.g. Carr and Winters, 2000). Although metarhyolite outcrops are often present near the complexes, it does not appear that these outcrops were used directly, possibly due to a degradation in material workability caused by weathering. It appears that accessing tool making quality material could only be accomplished by quarrying, although Stewart (1987) suggests that quality material could be found at the surface.

Research on South Mountain quarries has been meager and little is known about metarhyolite quarrying activity, largely because of the difficulties involved in gleaning information from the archaeological excavation of quarry sites. Unlike habitation sites, quarries show little differentiation between use periods. Most metarhyolite quarry sites were used simply for resource extraction and the cultural debitage left behind shows little variation over time. In terms of quarry excavation, work has only been completed on a single quarry pit by Carr and Winters (2000). Surface surveys of metarhyolite quarry locations in Maryland have been done by Geasey and Ballweber (1991, 1999), while Stewart (1984a, 1987) has provided some context for quarry usage and metarhyolite trading patterns.

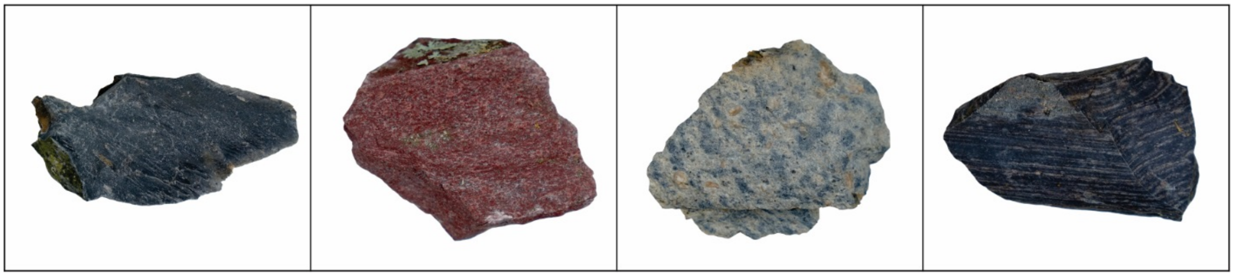

Figure 2. Common metarhyolite types (after Fauth 1968, 1978). Left to right: aphanitic blue, red porphyritic, mottled, and flow banded.

Although research has been rather limited, we can make some general statements concerning metarhyolite as a prehistoric resource. The aforementioned research suggests that surface material and outcrops were not likely the source areas and that quarries were utilized as early as 8000BP. Quarry pits were dug down close to the bedrock interface, where large pieces of metarhyolite were extracted. Once suitable material had been obtained it was taken to sites closer to water and food resources, where the stone was reduced in size and weight—finished tools were rarely produced at the quarrying sites (Stewart, 1987). Quarry pits often overlapped, with refuse from newly opened pits being moved into their depleted counterparts. Natural infilling commenced almost immediately after abandonment, masking the true depth of the pits. Each quarrying location on South Mountain appears to have one or more associated sites where lithic reduction occurred. The distance from the source area of metarhyolite tools mirrors its occurrence in the archaeological record. For example, during periods where metarhyolite use was low, associated archaeological finds tend to be nearer to the source and as use increases the areal distribution expands.

STUDY SITE AND METHODS

Study Area and Site

Artifact collecting at these quarrying complexes and associated archaeological sites is a significant issue. The author and colleagues have documented dozens of locations where collectors have seriously damaged archaeological sites looking for artifacts. The best methods of minimizing site damage are through educating and engaging collectors, and not revealing the coordinates of undisturbed sites. Therefore no specific information as to the location of the study sites discussed herein is provided.

South Mountain is located in south-central Pennsylvania in parts of Adams, Cumberland, Franklin, and York counties. Traditionally, South Mountain has been included in the in the Blue Ridge physiographic province because of its landform and bedrock similarities, forming the northern most extension of the mountain range that stretches from northeastern Georgia through Maryland (Fauth, 1968; Clark, 1991). More recently, however, some researchers have included South Mountain as the southeastern most division of the Ridge and Valley physiographic province citing differences in the underlying structures that form South Mountain in Pennsylvania compared to the Blue Ridge of Maryland and Virginia (Faill, 1998; Sevon, 2013). South Mountain formed during the Alleghany Orogeny (approximately 300-250 Ma) when the collision of the North American and African continents produced the Ridge and Valley Province and Blue Ridge Mountains. The bedrock composition of South Mountain includes rocks formed from sediments deposited in an environment that was shifting from terrestrial to shallow marine during the Upper Precambrian (~650 Ma) to the Lower Paleozoic (550 Ma). These overlie an igneous formation deposited in subaerial eruptions during the Precambrian (~700 Ma) that were subsequently metamorphosed (Fauth, 1978; Blewett and Wah, 2011).

The general study area covers approximately 4km^2 and is dominated by a north-south trending ridge rising from 50 to 150 feet above the valley floor (Figure 3). The ridge partly within the study area is approximately 4.5km in total length, sloping gently to the west and more steeply to the east, with its highest elevation near its southern end. Both the northern and southern extents of this ridge were quarried, however only the southern extent falls within the current study area. Elevations within the study area range from approximately 425 to 450m. First and second order streams drain the area and there are several large springs around the base of the ridge. The majority of the study area falls within Michaux State Forest, although there are a several small private inholdings.

The specific study site (36AD0201[1]) is located on a small knoll on a bench east of the main ridge at an elevation of 475m. The average slope in the study site is between 0 and 5 degrees. Surface rock sampling indicates that this knoll is composed of much harder and finer grained metarhyolite than the surrounding areas. There are two small surface exposures of bedrock on the knoll that were identified based on their axial plane cleavage (See Fauth, 1968; 1978). Quarrying activity at 36AD0201 is rather modest when compared to the largest of the quarrying sites on South Mountain, covering only about 0.75ha. The quarry pits are aligned roughly north-south, running parallel to the elongated knoll. The site is heavily forested—primarily oak and pine—and was logged in the recent past, as evidenced by several logging roads in and around the site and the large number of young trees. Although situated only 150m from a moderately used gravel road, the site does not appear to have been subjected to artifact collecting activities so common at other quarry sites in the area. Records from the Pennsylvania Historic and Museum Commission's Cultural Resources Geographic Information System (CRGIS) note a lithic reduction site (36FR0351) approximately 150m west of the site near the gravel road.

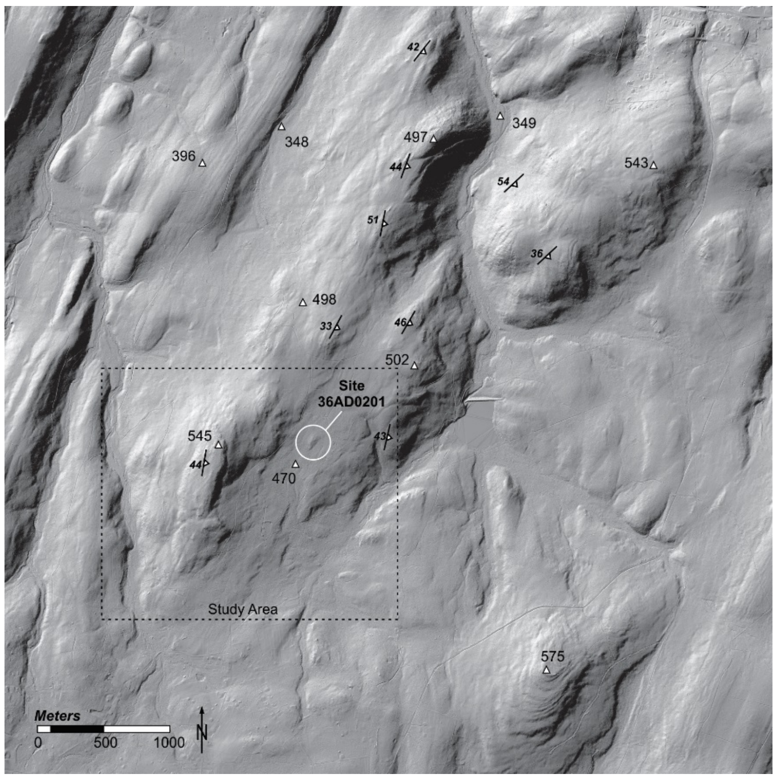

Figure 3. South Mountain study area. Axial plane cleavage strike and degrees of dip are noted. Elevation is in meters above MSL.

Methods

Quarry locations were recorded using a Trimble Geoexplorer 6000® and a minimum of 300 readings were recorded for each pit. These data were differentially corrected resulting an average horizontal accuracy of 0.3m (SD = 0.125m). Pit length and width measurements were made using a high-visibility target and laser rangefinder. Depth measurements were taken with the laser setup bisecting the pit perpendicular to the slope. Every pit examined contained a significant amount of leaf litter. A small area of leaf litter was removed from the central part of each pit and depth measurements were taken at this location. As per Pennsylvania State Historic Preservation Office (SHPO) and Michaux State Forest project guidelines, this leaf litter was replaced. To facilitate pit volume calculations, pits were categorized into three groups based on their generalized shapes: conical, bowl, and trough (Figure 4). The distinguishing characteristics of conical pits are that they are roughly circular and slope evenly to a central point. The

[1] 36AD0201 is the Pennsylvania Archaeological Site Survey identification number. The specific name of the site indicates its location, so only its ID number will be used when referring to the site.

depth of conical pits range from shallow to fairly deep. Bowl shaped pits are also circular, but have a flat bottom and steeper sides. Some bowl shaped pits may have been conical pits that have experienced substantial infilling, and it is unclear how common this may be. Trough shaped pits were dug directly into the slope and may be elongated or nearly circular. While not all quarry pits fall neatly into a single category, none of the pits examined fall beyond the range of the proposed classification scheme. A depression was considered to be a quarry pit if primary flakes or spalls were found within or on the edge of the depression. Primary flakes and spalls are identified by cortex (rough stone exterior), striking platforms, and percussion bulbs (see Sullivan and Rozen, 1985). Metarhyolite samples were coded and taken from each pit for subsequent visual analyses.

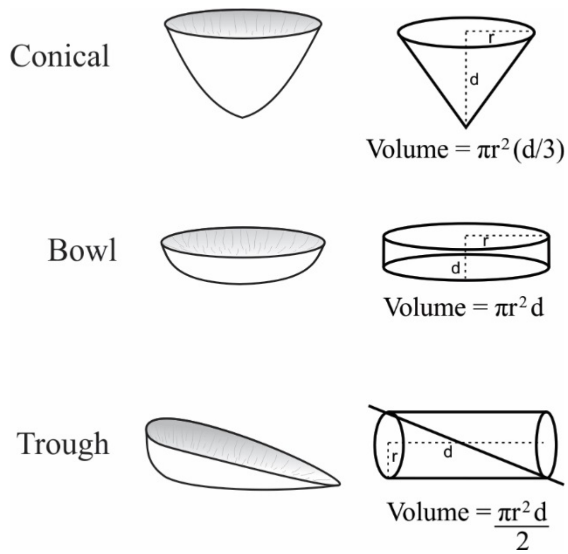

Figure 4. Site 36AD0201 quarry pit morphology and volume estimates.

RESULTS

Eighteen individual quarry pits were identified: two trough, two conical, and 14 bowl shaped pits (Figure 5). These quarry pits run parallel to the slope and roughly along the crest of the small knoll. Other depressions were noted which could have been quarry pits near pit 14 but no primary flakes were found. Several small depressions were seen west of pits 13 and 17, but these were on the path of an old logging road and were likely altered. None of the quarry pits at the site appeared to overlap or have been partially backfilled during subsequent quarrying. The total area of the quarry pits was measured at 445m^2, although this should be considered the minimum quarrying area. Individual quarry pits ranged in surface areas from 5.7m^2 (pit 11, a bowl shaped pit near the southern end of the site) to 77.9m^2 (pit 8, a trough pit near the middle of the site). The total calculated volume of material excavated was 121m^3, but again, this measurement is based on the current pit morphology and should be considered the minimum volume (Figure 6, left). The smallest quarry volume was pit 18 (0.62m^3), a bowl shaped pit at the far northern end of the site. The largest volume was pit 3 (23.3m^3), a bowl shaped pit also near the northern end of the site. Current pit depths are fairly shallow, ranging from 0.25 to 0.75m deep. The pit depths, at least through the center of the site, were likely influenced by logging in the area, and it seems clear that some debris from construction of the logging road ended up in a few of the pits (pits 3, 4, 12).

Blue metarhyolite develops a dull gray patina quickly and determining its color (as proposed by Fauth 1968, 1978) in the field can be difficult. At the site the two small outcrops were determined to be medium textured aphanitic blue metarhyolite with < 1% very fine light colored phenocrysts when examining freshly exposed surfaces. However, debitage samples from each quarry pit examined in the field were classified as being fine textured mottled metarhyolite containing 1 to 5% fine to very fine nearly black phenocrysts, with a blue to dull gray groundmass and dark mottles. Fresh rock samples from both outcrops and surface debitage samples were gathered from 36AD0201 for subsequent visual analysis. Additionally, surface debitage samples from site 36FR0351 (a nearby site where quarried material was reduced in size and weight) were gathered for comparison. In the lab, fresh surfaces on the debitage samples from both 36AD0201 and 36FR0351 were created for comparison with the outcrop samples. For all three sample locations the fresh surfaces were classified as fine grained, smooth textured blue metarhyolite with 1 to 5% phenocrysts (dark and light combined), with no apparent mottling or flow banding.

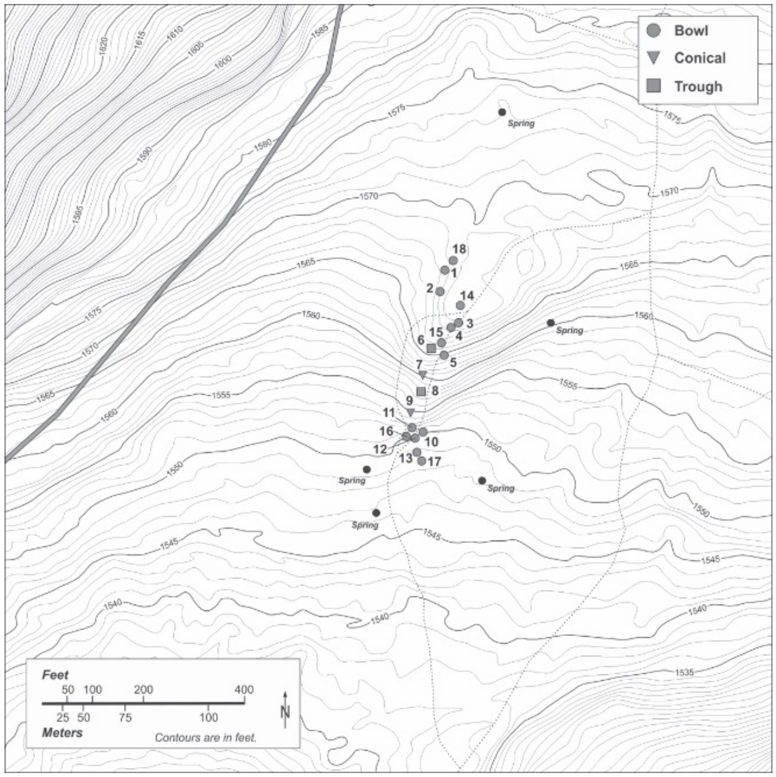

Figure 5. Quarry pit morphology. Pits are labeled with their unique IDs.

The results suggest several potentially important site characteristics. Many of the smallest and shallowest pits are found at the southern end of the site, and pits appear to become progressively larger moving north. Once the desired quality of metarhyolite was found, it appears that quarrying activity then focused on a relatively small area. Recent logging may have removed any evidence of smaller pits around the periphery of the site. The surface exposures appeared different in both color and texture from the weathered cultural debitage found in and around the quarry pits. Finally, it appears that the site was used only to acquire raw material and that the reduction in size and weight of larger pieces took place at another location nearby.

Of the 18 known quarry pits, 9 are quite small both in terms of their area and volume. These 9 pits account for less than 20% of the total quarry volume. The southern-most of these small quarries give every indication of being 'test pits'. They average only 2.5m^3 in volume, but also deep relative to their width. Conversely, another 20% of the total volume quarried at the site was from a single pit (#3), which was twice the volume of the next largest pit. Over half of the volume quarried came from a little over a quarter of the pits. This suggests that quarrying activity was concentrated most heavily on just a few quarry pits, focused primarily on the central portion of the site. With 20% of the total volume quarried being from a single pit, the amount of usable metarhyolite at the site may have been rather limited.

It is unclear as to amount of damage or alteration that may have been caused by recent logging in the area. The logging roads do not appear to have been built directly upon any of the quarry pits in the main site area, and it appears that the larger pits were avoided (Figure 7, left). Based on other recent timber extraction sites in this area, it is also clear that a substantial amount of debris is created by logging operations and the forest floor is significantly altered (Figure 7, right). Logging debris could certainly change the current morphology of the quarry pits by filling in the deepest parts, resulting in a misclassification of the 'bowl' category and errors in subsequent volume calculations. Evidence of logging is most apparent around rather than on the knoll, with the most of the logging activity occurring at the northern end of the site. Any small pits located at the periphery of the site, especially at the northern end, would likely have been damaged or destroyed. At the northern end of the site there is only a single pit small pit found, although others may have once existed.

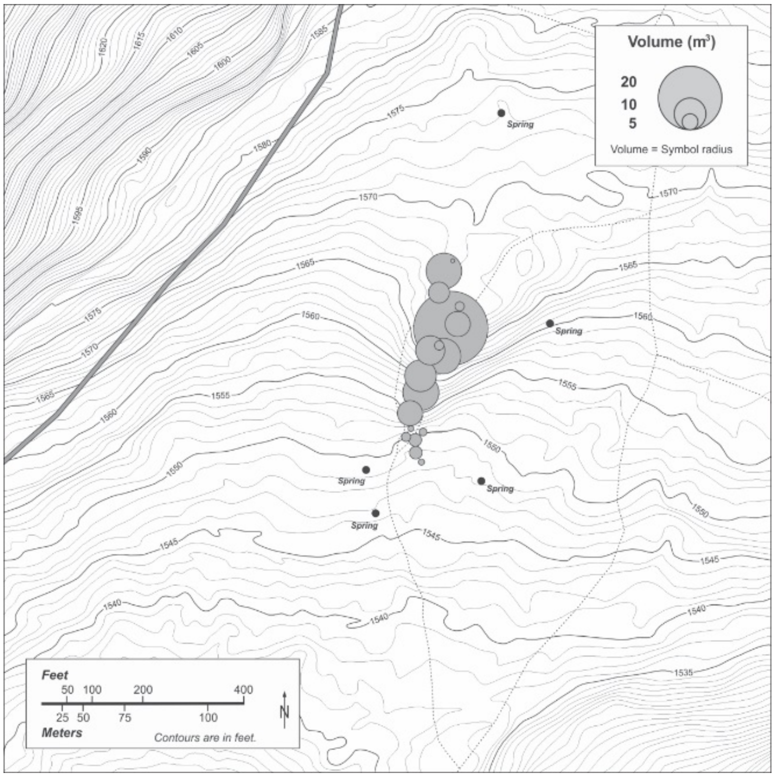

Figure 6. Quarry pit volume estimates.

Figure 7. Logging road crossing the site and quarry pit #4. The quarry pit measurements are 4.8m wide by 0.44m deep (*left*). Recent timber sale and logging activity (*right*).

DISCUSSION

Differences between the texture and color of the surface exposures and the quarried material is of particular importance (Figure 8). Field classification of the debitage was mottled metarhyolite with 1 to 5% phenocrysts, which differed significantly from the exposed bedrock. Visual analysis of both bedrock and debitage samples in the lab revealed the extent that weathering had altered the appearance of the debitage. The presence of mottling on the weathered surface of the debitage samples (Figure 8, right) is apparent; however, once a fresh surface is created no mottling is visible. Fauth (1968, 1978) distinguishes blue and mottled metarhyolite, and fresh surfaces of true mottled metarhyolite show a clear distinction between the groundmass and mottles (See Figure 2). It is unclear whether the apparent mottling on the exposed surface of the debitage is caused by unevenness in mineral leaching during weathering, or if there is extremely subtle mottling within the rock that only becomes apparent after weathering. Given the generally obvious interior mottles in most mottled metarhyolite, the former would seem the more likely scenario. If this is the case, then field misclassification of debitage samples becomes a significant issue. The most expedient course of action would be to create clean, fresh surfaces on debitage samples in the field prior to classification; however, this technique is not without consequences. Due to the highly variable nature of metarhyolite on South Mountain a large number of samples across a site would have to be sacrificed and disposed of off-site[2], especially when mapping the larger quarry sites. Samples could be taken to the lab for analysis, but for larger sites this would require the removal of a large number of samples. Because 36AD0201 is a small quarry complex, a limited number of samples could be removed for analysis while keeping within the SHPO guidelines. However, when the larger quarry complexes are mapped, field classification will be a significant issue.

Figure 8. Comparison between 36AD0201 outcrop sample (left), quarry debitage with fresh surface (center), and the same sample showing apparent mottles (right).

Although the site is locally elevated and dry, close to several large springs, and is well-protected by the surrounding ridges—the type of location often used for lithic reduction—no evidence of early stage tool manufacturing (e.g. preforms, thinning flakes, etc.) was found at the site. At other lithic reduction sites in the area thinning flakes, broken/rejected preforms, and hammerstones are common and easily found on the surface (Carr and Winters, 2000). At 36AD0201 this does not appear to be the case, although several possible digging tools were located. An examination of the surface debitage suggests that the location was only used for resource extraction, what Stewart (1987) would classify as a quarry-only site rather than a combined quarry-workshop site. The nearby lithic reduction site (36FR0351) is situated at the same elevation on a low bench above several springs (Figure 9). Debitage that appears to be from metarhyolite similar to that found at 36AD0201 was found at 36FR0351, along with metarhyolite similar to other quarrying sites nearby. It is unclear why quarried material would be moved such a short distance to a very similar location to be refined. The knoll that the site occupies is covered with quarry pits and the surrounding area is very wet. It may simply have been that there was not enough dry space on the small knoll, even for a short-term camp typical of the lithic reduction sites on South Mountain.

CONCLUSIONS

It has been assumed by researchers that the characteristics of the surface material was used as a guide to locating usable metarhyolite by prehistoric people (e.g. Stewart, 1987, Geasey and Ballweber, 1991). The current model postulates that surface stone or outcrops would be tested and examined for workability or possible defects. When suitable material was located on the surface, small test quarry pits would be dug until the source was located.

[2] SHPO guidelines for this project stated that there could be no digging at the quarry sites, a limited number of surface samples be taken, debris removed from quarry pits be returned to the pits, and that no modern debitage (broken rocks) be left on site.

If Carr and Winters (2000) and Stewart (1987) are correct that surface material was generally avoided in favor of buried material, then we can assume new pits would be opened as old pits were exhausted. The overall pit layout at the site appears to bear this out—there is a clear trend in pit size and volume from one end of the site to the other suggesting that once the best material had been located there may have been little attempt to determine its extent. It should be noted that additional 'test pits' may have been obscured by recent logging, especially at the northern end of the site, but a careful site survey failed to find any significant debitage beyond the current site extent. Field classification of the type of metarhyolite found at the site (surface exposures and debitage) proved more difficult. Weathering of the debitage was significant enough to cause misclassification. The only means of accurately classifying the

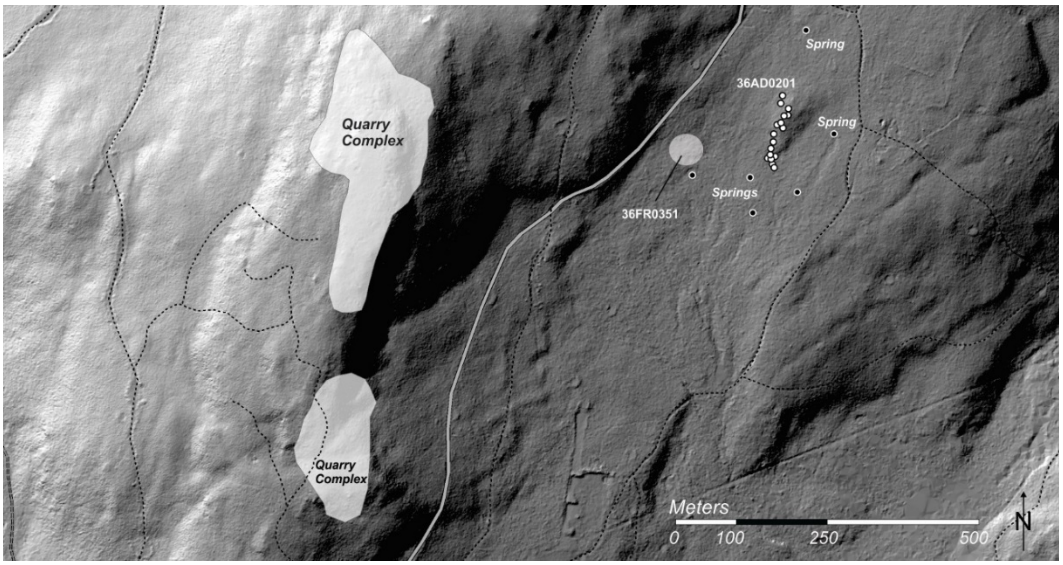

Figure 9. 36AD0201 relative to other important prehistoric sites in the area.

metarhyolite type of the debitage was in the lab where fresh surfaces could be exposed. This may make accurate field classification of debitage much more challenging and require a large number of surface debitage samples be removed from the sites for further analyses. Larger quarry complexes will require several samples from across the site, especially those sites where the characteristics of the metarhyolite are highly variable. Buried cultural debitage samples may display less weathering, thereby allowing fewer samples to have to be removed from the site. This would require a special permit from the SHPO, and even limited digging at the sites may simply be too destructive.

The techniques developed for field classification of pit size and morphology were found to be efficient and effective, and will be used when mapping larger quarry complexes. The field equipment assembled performed well in a wide range of conditions, and usable GPS data was acquired even under a very dense tree canopy. Width and depth measurements using the laser rangefinder were quick and accurate. One of the most important aspects of the research was the development of a descriptive framework. The three proposed categories (conical, bowl, trough) appear to adequately describe quarry morphology, although additional categories may need to be added as large quarry sites are analyzed. The magnitude of error in the volume measurements is currently unknown. Future work at these sites will address this by taking multiple width-depth transects across several quarries from each quarry morphologic category and compare these results to the estimates using the techniques described above.

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