REEXAMINING THE EXTENT OF THE GREEN CABIN PREHISTORIC RHYOLITE QUARRY SITE (36AD0569), SOUTH MOUNTAIN, PENNSYLVANIA

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

ABSTRACT: The Green Cabin site was first recorded in 2018 and is perhaps the most unusual of the 25 known prehistoric rhyolite quarries on South Mountain in south-central Pennsylvania. The site is situated on a mass movement feature that was originally thought to extend ≈ 200m downslope. The extent of active quarrying was estimated to be ≈15m beyond the visible surface quarry pits where the surface appeared flat and undisturbed. In the fall of 2020 several soil test pits were excavated at the site. The downslope soil pits were situated in a location that was thought to be well off of the actively quarried area, but still on the mass movement feature. Artifacts were recovered from one soil pit down to a depth >1m, indicting the soil pit was most likely situated atop a prehistoric quarry pit. In an effort to accurately determine the site extent micro relief images were derived from recent LiDAR data for the site. The soil pits, micro-relief image interpretation, and field surveys suggest that the upper extent of the site coincides with the edge of the visible quarry pits. In contrast, the lower extent of the site—including actively quarried and stone-tool making areas—likely extends an additional 160m downslope beyond the last easily discernable quarry pit.

Keywords: Prehistoric quarry, rhyolite, South Mountain, micro relief visualization.

INTRODUCTION

Rhyolite was used for stone tool making in the Mid-Atlantic region from the Paleoindian Period (>c11,000BP) until the Late Woodland Period (c700BP). A significant source of this material was found on South Mountain in south-central Pennsylvania. South Mountain rhyolite was quarried in only a few locations, where the material was free of inclusions and sufficiently fine grained to fracture predictably and create a sharp edge. Quarrying sites tend to be located on ridgetop exposures where the surface overburden is minimal, but sites have also been found at midslope and footslope locations where overburden can be significant (Marr, 2020a). In 2018 the author recorded what has come to be known as the Green Cabin quarry site (36AD0569) in an area where prehistoric quarries were not thought to exist (Marr, 2020b). The site is unusual since at other quarry sites the largest quarry pits at other sites tend to be clustered in one or two areas, with a 'halo' of smaller and shallower pits surrounding them. The Green Cabin site has large, reasonably well-define pits scattered across its entirety; although it is also quite obvious that certain areas were quarried more intensely with pits packed closely together. The quarry pits on Green Cabin are very obvious and their extent was used to delineate a boundary separating the actively quarried area from the surrounding undisturbed areas. Based on field observations of the distribution of surface debitage (waste quarrying material) the site perimeter was estimated to extend approximately 15m beyond the obvious surface depressions. This boundary is used by the Pennsylvania State Historic Preservation Office (SHPO) and Michaux State Forest as the limits of the archaeological site.

In 2019 the SHPO and Michaux State Forest granted permission for the excavation soil test pits near the Green Cabin site. Stipulated in the permit was that the soil test pits must not be directly on the delimited archaeological site as defined by the boundary noted above. The test pits were part of a larger project to use ground penetrating radar (GPR) data to examine the internal structure of the mass movement feature and data were taken along a set of transects situated parallel and perpendicular to the long axis of the site. A series of six soil test pits were sited to coincide with these transects and act as means of field verification of the GPR radargrams. The GPR data were gathered in the early fall of 2020 and the soil test pits were opened shortly thereafter. Initially two test pits were opened on the lower (downslope) end of the mass movement feature, one pit very near the 15m site extent boundary and the other approximately 10m from the boundary. Two of these lower pits yielded tremendous amounts of quarry debitage down to depths well beyond normal surface accumulations. As work progressed it became clear that at least one of the soil test pits was located within a prehistoric quarry pit that had no surface expression that was discernable in the field. Quarry archaeological site boundaries have previously been determined based on the extent of visible surface depressions with an additional 15m buffer. The discovery of buried quarry pits with no visible surface expression suggests that other rhyolite quarry site boundaries on South Mountain may not cover the true site extent, an important consideration with regards to cultural resource management and protection.

THE GREEN CABIN STUDY SITE

Artifact collecting is a significant problem at all of the prehistoric quarries and to protect these sensitive sites no specific locational information will be included in the text or maps. The Green Cabin site is located toward the southern extent of the rhyolite surface exposures in Pennsylvania (Figure 1). It is situated on the southeastern slope of a small mountain that shows evidence of periglacial activity, although the age of the periglacial features is currently unknown (Figure 2). The quarries are located on a mass movement features that appears to overrun several possible gelifluction lobes (Benedict, 1976) or cryoplanation terraces (hereafter *lobes*) (Czudek, 1995). These landforms occur in a series of treads approximately 350-400m long, 120m wide, and with risers that average approximately 9m in height. The mass movement feature is approximately 200m long and 60-70m wide and appears to maintain this width downslope. The height of the feature above the surrounding terrain ranges from 2 to 3m (Figure 3). The toe of the feature is dominated by boulders and large rock fragments, but these are nearly absent on the main section of the feature where quarrying is most evident. The suspected origination area extends approximately 130m upslope with no obvious headwall or scarp. Large boulders are more common in this area and are primarily metabasalt rather than rhyolite, suggesting that downslope movement occurred at the boundary of the differing rock types.

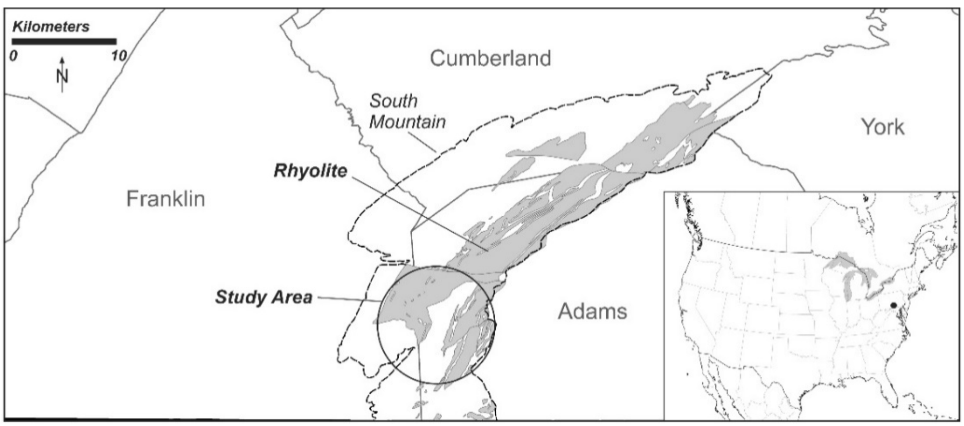

Figure 1. The approximate location of the Green Cabin study site in south-central Pennsylvania.

An initial survey of the quarries visible on the surface suggested that quarrying activity was restricted to the mass movement feature (Marr, 2020b). Quarry pits at this site are fairly obvious and there is little forest understory to obscure the view. Upslope and along the sides of the mass movement the limits of quarrying could be easily detected visually but the downslope extent was less apparent. Sixty-nine individual quarry pits were recorded at the site; however, these pit represent the visible extent of quarrying activity at the time the site was abandoned. Although subsequent erosion, infilling with organic matter, and disturbance due to tree falls have softened the edges of the quarry pits, they are still readily apparent in the field. The smallest identified quarry pits at the site are approximately 2-3m in diameter and 0.3m deep, while the largest are over 8m in diameter and > 1m deep.

The site is surrounded by several flat charcoaling platforms dating from the 19th century (Marr and Wah, 2019). Charcoal was produced by burning wood in an oxygen depleted environment which was created by covering a log ‘burn pile’ with soil. In steep terrain where the platforms were dug into the slope, covering soil was obtained as part of the construction process. In flatter or very rocky terrain soil was dug from borrow pits located nearby. Aside from their situation near charcoaling platforms these soil borrow pits are nearly indistinguishable from prehistoric quarry pits. This is especially the case where the borrow pits were dug through prehistoric quarrying debitage or waste material. In particular, the charcoaling platforms found at the lower end of the site appeared to have several nearby soil borrow pits, casting doubt that other pits in this area were prehistoric.

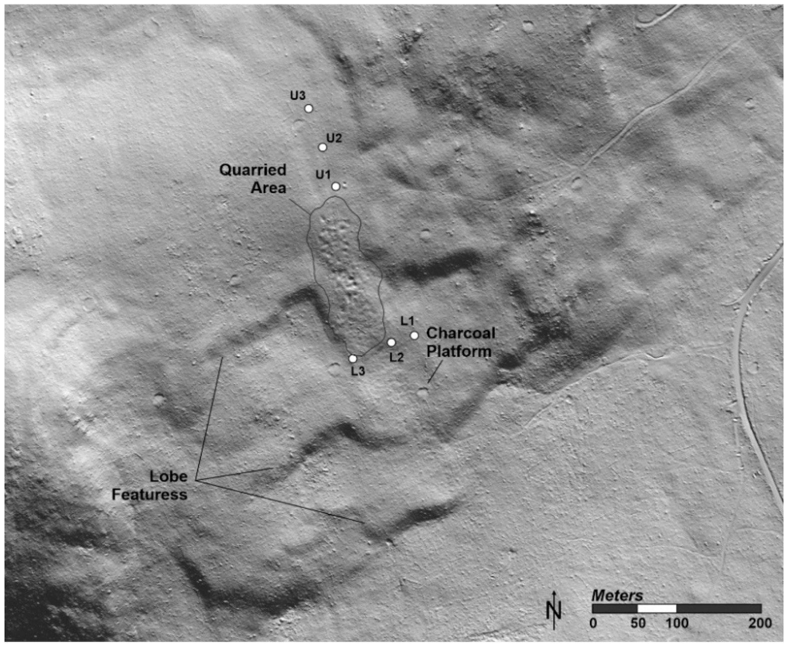

Figure 2. The Green Cabin study site. L1-3 are lower soil test pits, while U1-3 are upper pits.

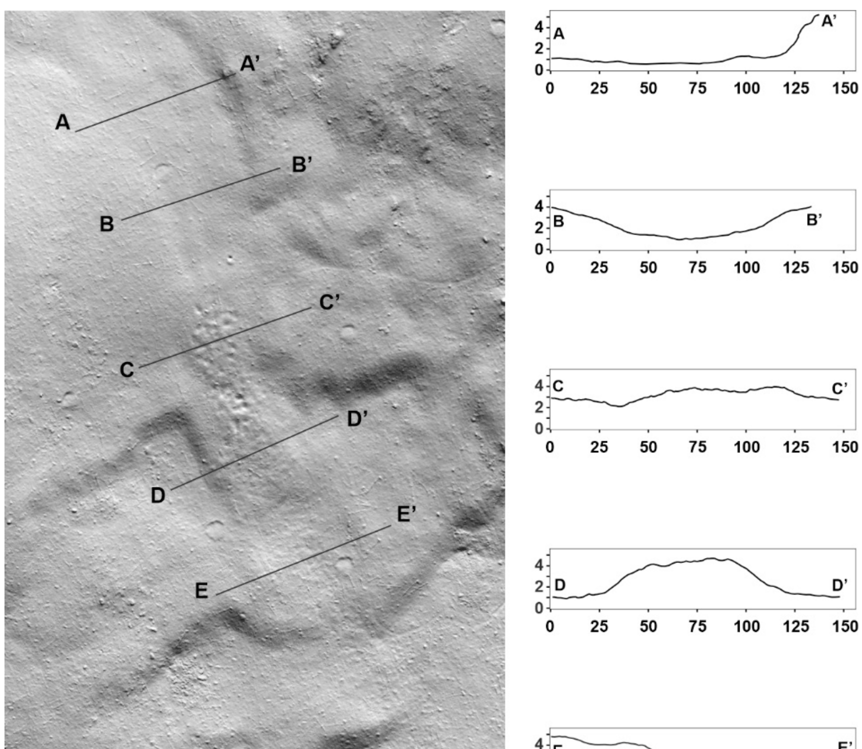

Figure 3. Topographic profiles of the suspected mass movement feature. Profile height and distance measurements are in meters. Multidirectional shaded relief image derived from LiDAR data.

SITE EXTENT REEVALUATION

Six soil pits were excavated at the site, the first two opened (pits L2 and L3, See Figure 2) were situated on the toe of the feature > 15m past the last visible quarry pit and outside of the recorded site boundary. The soil pits were excavated at 10cm increments and all material was screened using 0.635cm (1/4in) shaker boxes. All cultural material was placed in labeled one-gallon bags for future analyses and curation. It was anticipated that the uppermost levels (0 – 10 and 10 – 20cm) would contain a mix of cultural and noncultural material, and that cultural material would be limited to the uppermost excavation levels. Unexpectedly, in pit L3 cultural material was found at each 10cm level until excavation was stopped (≈90cm) due to encountering large boulders (Figures 4 and 5). Artifacts were also found at depth in pits 1 and 2. The depth of cultural material strongly suggested that quarrying activity extended downslope well beyond the visible surface depressions. The original site boundary was set based on careful field examinations and there were no surface indications that quarrying extended beyond that boundary. Yet the soil pit excavations clearly showed that quarry pits were dug past the site boundary and that these quarry pits displayed no surface expressions that could be detected in the field. A new method of site delineation was needed.

Figure 4. Green Cabin lower soil pit 3. Quarry debitage in this pit was found to a depth of 90cm. Meter stick is visible on the left side of the pit, Brunton is pointing north.

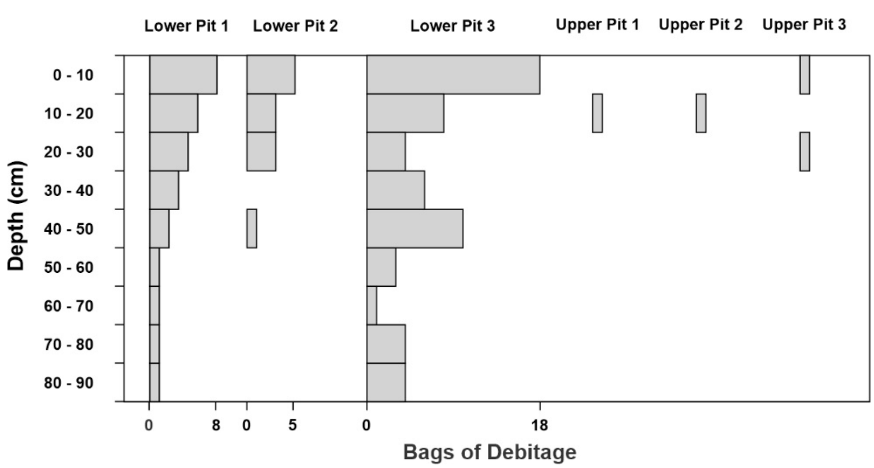

Figure 5. Cultural material per soil test pit. Each bag contained a 1 gallon volume of debitage material.

Terrain micro-relief analyses are a suite of processes that produce images from digital terrain model data (DTM) that capture very subtle changes in the landscape. The Relief Visualization Toolbox (RVT) is a public domain program that contains the most common techniques and has the added benefit of being able to merge several output images into a single image (Kokalj and Somrak, 2019). One common example of terrain analysis imagery are shaded relief maps; however, depending on the illumination azimuth and altitude these images can suffer from shadow artifacts in areas of steep terrain. Additionally, deviations in illumination azimuth and altitude too far from the NNW quadrant can produce unwanted visual effects, such as peaks appearing as valleys (Biland and Çöltekin, 2017). These issues can be minimized by using multidirectional shaded relief, which combines several images using multiple sun angles with the same illumination elevation (Mark, 1992; Kokalj and Hesse, 2017). The general absence of 'shadow artifacts' makes this method particularly well suited for producing a base map to be used in image merging, although research suggests that multi-directional shaded relief maps may provide too much detail (Farmakis-Serebryakova and Hurni, 2020). *Local dominance* is a terrain micro-relief technique that is computed as the average 'steepness' of a pixel to its surrounding pixels within the minimum and maximum radii of an annulus (Kokajl and Hesse, 2017). The size of the typical 'feature of interest' is represented by area within the minimum radius, which is compared to the area between the radii. This technique highlights both convexities and concavities, and even very slight deviations from the surrounding terrain can be detected. *Sky-view factor* calculates the amount of sky visible from a point under an evenly lighted hemisphere (Zakšek, Oštir, and Kokalj, 2011). Since the angle to the horizon is rarely uniform, angles are computed and summed for several directions out to a predetermined search radius. Prominences appear bright since more sky is visible, while depressions appear as shadows. Shallow depressions with sloping edges are easily distinguished from deep depressions with clearly defined edges, making this technique very useful for separating quarry pits from tree throws or the hollows between boulders. A DTM for the study area was created from QL1 level LiDAR data collected by the Pennsylvania Department of Conservation and Natural Resources (DCNR) Bureau of Geological Survey in 2018. The nominal pulse spacing for these data were 0.35m, with a vertical RMS of >0.1m (PA LiDAR Working Group). The RVT software was then used to derive the primary visualizations used in this research: multidirectional shaded relief, local dominance, sky-view factor, slope, and a composite image of these four (Figure 6).

The composite image for the quarry site reveals relief details that are not readily apparent in the field (Figure 7). Site investigations based on the terrain images located three potential quarry pits in Area 1 downslope and well off of the main quarry site. These pits are all approximately 4m in diameter and less than 0.3m deep, with rather indistinct edges. Quarry debitage is easily visible at the surface throughout Area 1 and is most dense in the areas immediately adjacent to the potential quarry pits, but the proximity of the nearby charcoal platform complicates their interpretation. Thus far no charcoal platform has been found with three soil borrow pits—even two borrow pits is very unusual. One or more of these pits may be associated with the platform; only excavating these potential quarry pits would shed light on this. However, the large number of shallow depressions and substantial amount of surface debitage in Area 1 strongly suggest that it was in active use, either for quarrying, lithic reduction, or both. Compare Area 1 to other areas surrounding the main site and the difference in the micro-relief is readily apparent. In the field the terrain in Area 1 certainly appears 'chaotic' and is distinctly different than the main quarrying area, but it is nearly indistinguishable from the far southern extent of the main site, especially in the vicinity of soil pits L2 and L3 where quarrying is now known to have occurred. Although the presence of the charcoal platform may call in to question whether an individual depression is a prehistoric quarry or an historical borrow pit, its presence should not negate the mounting evidence that this area was actively used for acquiring toolmaking material and should be considered for inclusion within the site boundary. Based on the micro-relief imagery and field investigations, Area 1 extends 160m downslope from the current site boundary and is approximately 50m wide, covering about 0.8ha. The addition of Area 1 would increase the size of the Green Cabin site to just under 2ha, effectively doubling its size.

Area 2 is more challenging to interpret. It extends 100m downslope from the end of Area 1, is approximately 50m wide, and covers about 0.5ha. The western section of this area, upslope from the last lobe feature, is very similar to Area 1; however, the terrain is more chaotic and surface boulders are somewhat more common. The eastern section is composed largely of closely spaced boulders while the southern section is a combination of widely spaced and smaller boulders. Shallow depressions are common throughout the southern section but surface debitage is very minimal. The section downslope of the last lobe feature has several seeps, springs, boulders, and tree falls—all of which can create surface depressions. The local dominance images proved to be very useful in areas where natural surface depressions are common since a minimum and maximum radius are input parameters. Quarry pits typically are larger in diameter than most boulder hollows or the root ball depressions left behind from tree falls. With the

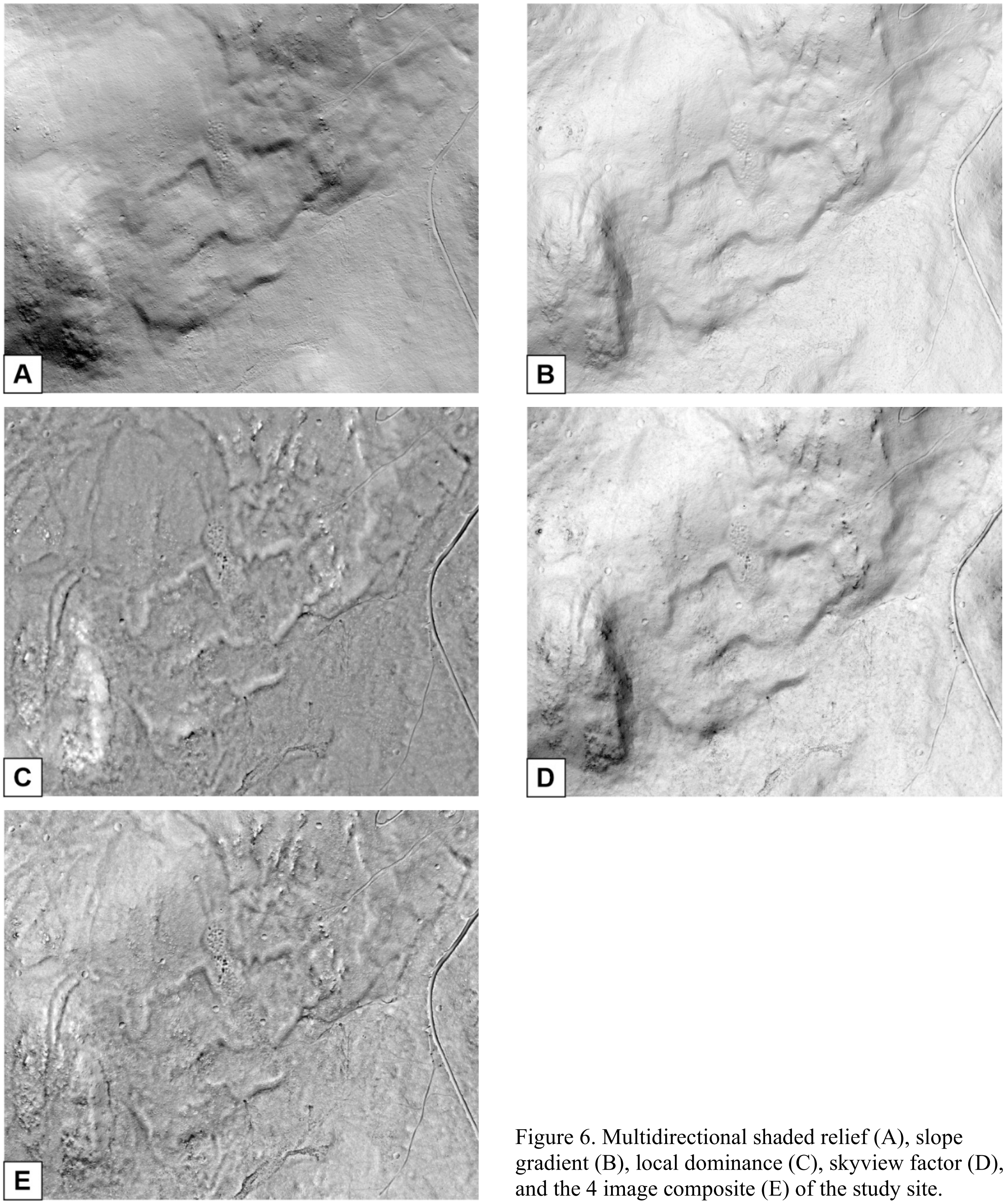

Figure 6. Multidirectional shaded relief (A), slope gradient (B), local dominance (C), skyview factor (D), and the 4 image composite (E) of the study site.

minimum local dominance radius set to 2.5m only larger quarries will be highlighted and most natural depressions excluded. Using this method very few large depressions were found in Area 2. Field visits determined that the few large depressions noted were probably not caused by tree falls but also could not be categorized as quarry pits since no significant debitage was found in the area. Although Area 2 appears hummocked, it does not appear to have been quarried.

There are subtle but definite differences and similarities in the character of the terrain between Areas 1 and 2 that are more obvious in the field than on the micro-relief imagery. The imagery suggest that both have likely been quarried, but in the field quarrying in Area 2 is less than compelling. The entire area is hummocked, but it is more pronounced upslope with easily definable individual depressions. Downslope the area is hummocked as well, but the depressions appear merged together. What likely connects these two areas is that they form the very end of the mass movement feature which produced a chaotic and hummocked landscape. There is a distinct break in the second lobe (Figure 7) and in the field it appears that material moving downslope has cut across the center of the lobe and has overrun the eastern end of third lobe. The upper section (Area 1) appears to have been actively used and quarried to some extent, as evidenced by the substantial surface debitage and individually distinct depressions, the lower section (Area 2) does not appear to have been actively used and the surface debitage found here is probably incidental.

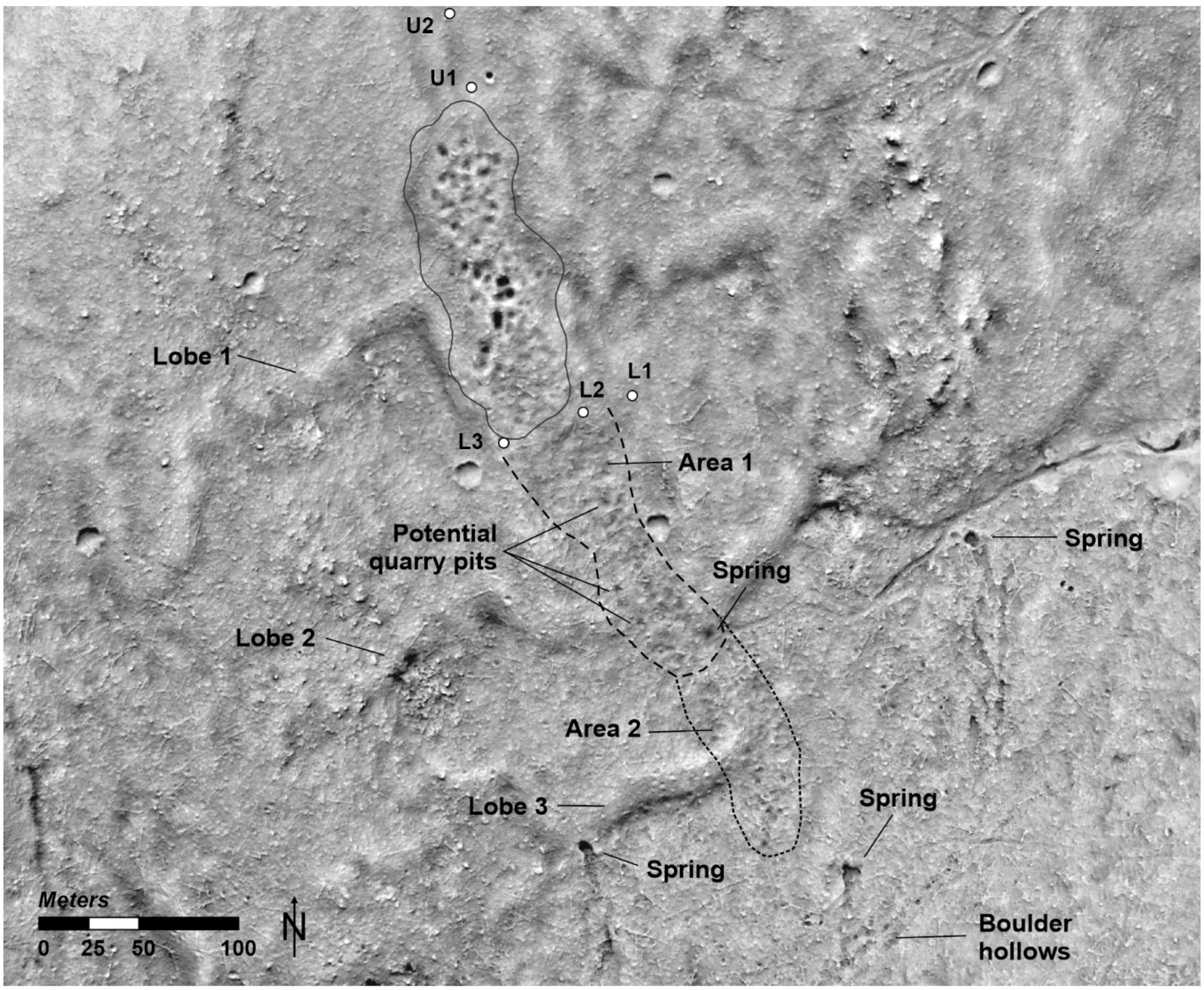

Figure 7. Micro-relief visualization composite image for the Green Cabin site. Area 1 contains multiple shallow depressions. Three potential quarry pits were field verified in this area. Area 2 contains subtle depressions but the potential for quarrying here is somewhat less compelling when examined in the field.

Area 2 should be considered an 'area of interest' that needs further investigation before being considered part of the quarry site. However, quarrying is not the only activity that took place near quarries. Most quarry sites have an associated lithic reduction site where useable material was reduced in size and weight for transport. While quarrying may not have occurred at reduction sites, the reduction process generates substantial debitage. Unlike a quarry, reduction site waste material should only be found at the surface. Digging through colluvium and debitage is difficult and excavating a single 1m^2 test pit to 1m can take several days and the chance of being refused by large boulders just below the surface is high. The level of effort needed to excavate a 1m^2 test unit for quarrying in Area 2 is probably not warranted and the time and money would be better spent investigating the main quarrying area. Perhaps a more appropriate course of action would be to dig one or two shovel test holes to 30cm. The upper soil pits (U1-3) held very little debitage and all of it was found in the first 20cm. If debitage is not found in significant quantities in the first 20cm, then in all likelihood the area was not actively utilized and there would be no need to consider this area further.

CONCLUSIONS

Through a combination of micro-relief image analysis and field verification it was determined that the Green Cabin rhyolite quarry site is significantly larger than the originally recorded site boundary, where quarry pits are easily discernable on the surface. Soil test pits just beyond the far southern end of the original site boundary encountered quarry debitage below 50cm, while test pits above the site contain few artifacts below 10cm. Micro-relief image analysis of site revealed that an area 50m wide and extending approximately 160m (Area 1) downslope from the current site boundary was similar in character to the area near the soil test pits. Field visits verified that Area 1 contained a large number of shallow depressions and substantial surface debitage and was likely quarried in the past, although easily discernable quarry pits were absent. Both Areas 1 and 2 appear to be part of the larger mass movement feature, and field investigations suggest that the mass movement overran the distinctive lobe features, terminating just downslope of the final lobe. Because of the physical similarities with the locations where soil test pits have shown quarries have minimal surface expression, Area 1 should be included in the site and protected from logging and other potentially destructive activities that occur nearby. Area 2, which extend another 100m downslope, also exhibited similar terrain characteristics but does not appear to have been actively quarried or used for lithic reduction and should not be included in the site boundary unless shovel tests detect non-incidental artifacts.

REFERENCES

Benedict, James B. 1976. Frost Creep and Gelifluction Features: A Review. *Quaternary Research*. 6: 55-76.

Biland, Julien and Arzu Çöltekin. 2017. An empirical assessment of the impact of the light direction on the relief inversion effect in shaded relief maps, NNW is better than NW. *Cartography and Geographic Information Science.* 44(4): 358-372.

Czudek, Tadeáš. 1995. Cryoplanation Terraces: A Brief Review and Some Remarks. *Geografiska Annaler. Series A, Physical Geography.* 77(1-2): 95-105.

Farmakis-Serebryakova, Marianna and Lorenz Hurni. 2020. Comparison of relief shading techniques applied to landforms. *International Journal of Geo-Information.* 9: 253-274.

Kokalj, Žiga. and Ralf Hesse. 2017. *Airborne laser scanning raster data visualization: A guide to good practice*. Institute of Anthropolgical Studies, Ljubljana, Slovenia. https://iaps.zrc-sazu.si/en/ publikacije/airborne-laser-scanning-raster-data-visualization-1#v.

Kokalj, Žiga and Maja Somrak 2019. Why not a Single Image? Combining Visualizations to Facilitate Fieldwork and On-Screen Mapping. *Remote Sensing.* 11(7): 747-772.

Mark, Robert. 1992. *Multidirectional, oblique-weighted, shaded-relief image of the Island of Hawaii*. U.S. Geological Survey Open-File Report 92-422, Version 1.0, 1-5.

Marr, Paul. 2020a. South Mountain Precontact Metarhyolite Quarrying: A Geographic Prospective. *Archaeology of Eastern North America*. 48: 139-156.

Marr, Paul. 2020b. The Green Cabin Prehistoric Metarhyolite Quarry Site (36AD0569), South Mountain, Pennsylvania. *The Geographical Bulletin*. 61(1): 19-28.

Marr, Paul and John Wah. 2019. Remote Identification of Cultural Features on the Landscape - Assessing the Accuracy of Using LiDAR to Detect Charcoal Hearth Platforms. *Archaeology of Eastern North America*. 47: 51-62.

PA LiDAR Working Group. https://www.srbc.net/pennsylvania-elevation-working-group/. Accessed 3/9/2021.

Zakšek, Klemen, Kristof Oštir, and Žiga Kokalj. 2011. Sky-view factor as a relief visualization technique. *Remote Sensing.* 3(2): 398-415.