The Value and Availability of Quality Obsidian at Antelope Creek

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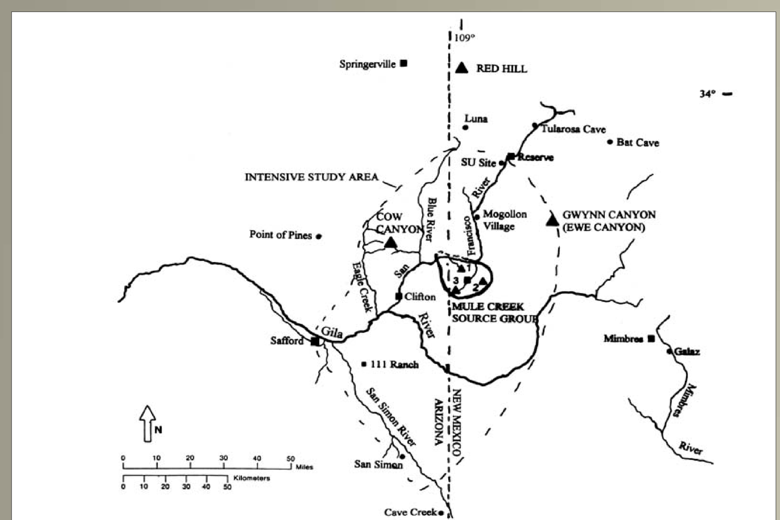
Introduction to Antelope Creek

Antelope Creek is a part of a large obsidian source in southwest New Mexico known as the Mule Creek source. Good quality obsidian is abundant in the Mule Creek area but something peculiar occurs in the smaller Antelope Creek area. Obsidian nodules (marekanites) with good and poor flaking qualities are found scattered around the area together. Earlier research completed by Steven Shackley suggested that the good and poor quality obsidian is chemically the same, meaning that they were created in the same volcanic event, but something occurred at the time of the event that resulted in some of the obsidian having very poor flaking qualities (Shackley, 2005)

We completed an experiment which showed that one could differentiate the good and the poor quality obsidian by the cortex, allowing prehispanic people in the area to avoid the poor quality obsidian. The nodules of poor quality obsidian are shiny, black, more rounded, and lack good platform angles for flaking. Often when attempting to strike flakes off these pieces it takes multiple blows to break the rock, and sometimes the piece just explodes like a bomb. The good quality obsidian found at this source has a matte brown cortex, and tends to have better facets that make it easier to strike off flakes for making arrow points. Flaking the good quality obsidian produces much less small debris, and primarily nice flakes.



Antelope Creek locality within the Mule Creek source area (after Shackley 2005)


Marekanites eroding out of perlite bank

First Experiment

Research Questions:
- How easy is it to tell the difference between the good and bad ("bomb") quality Antelope Creek obsidian?
- Can you tell the difference just by looking at the cortex or do you have to try to drive a flake?
- Can you get any usable flakes out of the poorer quality "bomb" obsidian?
- How do the two types of obsidian compare?

Hypothesis:

There is a noticeable difference in the cortex (or skin) of the good and bad quality Antelope Creek obsidian; therefore one could pick out only the higher quality obsidian and avoid the poorer quality obsidian when collecting for tool making.

Procedure:
- Locate the Antelope Creek source and collect samples from various areas around the creek
- Categorize the obsidian nodules by differences in cortex (15 each)
- Measure and weigh all nodules and compare their sizes
- Test sorted obsidian by flint knapping each individual nodule to see which the poorer quality is and which the good quality is.
- Draw conclusions on the relationship between the core and the quality

Results:
- Our hypothesis about which was the better quality obsidian and which was poorer quality obsidian was correct.
- The obsidian with the matte, cloudier, brown cortex with more accessible platform angles (Group A) was the better quality and the obsidian with the shiny black cortex was the poor quality "bomb" obsidian (Group B). The knapper was able to drive flakes from all of the Group A obsidian nodules, but did have some trouble with some of the smaller and rounder nodules in Group A.
- Flaking the obsidian in Group B was much more difficult. It took much longer to break open each nodule and the knapper was only able to get reasonable flakes out of 4 of the 15 nodules tested. The other 11 nodules either had pieces shatter in all directions (bombs), or little shards would pop off without any usable flakes.

Conclusions:

There is a noticeable difference between the good quality obsidian and poor quality obsidian found in the Antelope Creek area. The majority of the black shiny nodules (Group B) did not produce quality flakes. However, not all of the Group A obsidian was excellent quality. The smaller, rounder nodules are still difficult to drive good quality, usable flakes from and would only be good for small points. Nevertheless, the larger nodules of the Group A obsidian do produce large, good quality flakes for tool making.


Safety glasses!

Second Experiment

A second experiment with fourteen Antelope Creek nodules may be more telling of the variation in the obsidian found at this locality. This sample seems to show a much larger range of variation than the sample in the first experiment. This sample was collected in a different location that contained both the good and bad nodule varieties.

New Research Questions:
- What could have caused such variation within one source with one volcanic event?
- Could we really categorize the obsidian found at this source as "good" or "bad," or is the quality on more of a spectrum?
- How can we test the flaking patterns of these rocks in a more systematic way? Is there any patterning?
- How could this variation have affected how the obsidian source was used by prehispanic populations?
- What further research could be completed with more time and resources?

Hypothesis:

It will take more energy to break open the nodules predicted to be "bad," and they will create more debitage and less (if any) useable flakes, whereas the obsidian predicted to be "good" will take less energy to break and will produce more useable flakes. We will also see a more erratic flaking pattern in the "bad" obsidian, and a more predictable flaking pattern in the "good" obsidian.

Procedure:
- Document characteristics of each obsidian nodule:
  - Weight, length and width, Munsell color of cortex
- Predict whether the nodules will be "good" or "bad" based on cortex texture and color
- Break the nodules by dropping a set weight from certain heights
  - Drop the weight on each nodule and record the lowest height it took to break it open
- Calculate the energy it took to break each nodule and look for any patterning or differences in those predicted to be "good" or "bad"


Good nodule: no shatter


Points


Bad nodule: lots of shatter


Unusable shatter

Group Statistics				
Variable/index	Prediction	N	Mean	Std. Deviation
Energy (joules); with unbroken pieces coded as missing data	bad	4	18.95	3.8574
	good	8	19.89	12.1032
Energy (joules); with unbroken pieces coded as max. achieved energy (45.86 joules)	bad	6	27.92	14.2134
	good	8	19.89	12.1032
Flake count	bad	4	17.75	4.0311
	good	8	21.25	18.9868
Flake weight (grams)	bad	4	6.463	1.7393
	good	6	8.970	9.6937
Debitage weight (grams)	bad	5	4.670	1.6864
	good	8	7.901	6.6960
Flake count/Original whole sample weight (grams)	bad	4	0.279	0.1087
	good	8	0.319	0.2109
Flake count/Whole sample size (sum of whole sample's length and width)	bad	4	0.209	0.0273
	good	8	0.264	0.2140
Flake count/Debitage weight (grams)	bad	4	3.283	0.6879
	good	8	5.083	5.5766
Flake weight/Debitage weight	bad	4	1.214	0.3878
	good	6	2.348	1.8043

Good nodule


Lots of debris and some flakes

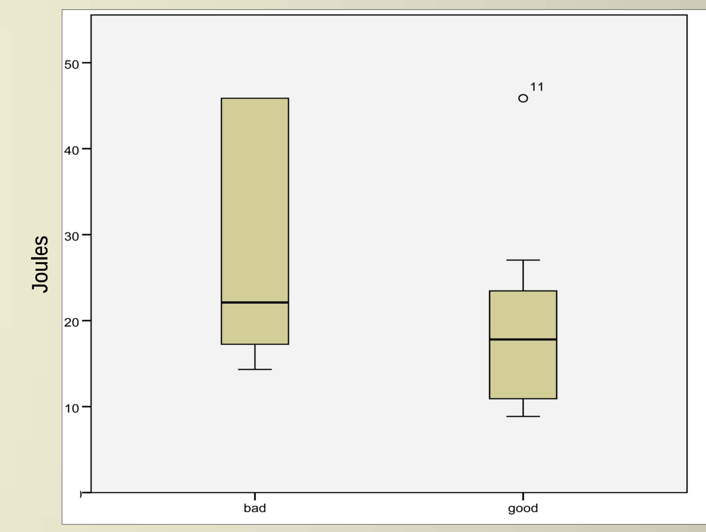

Kaitlyn preparing to drop the weight

Bad nodule

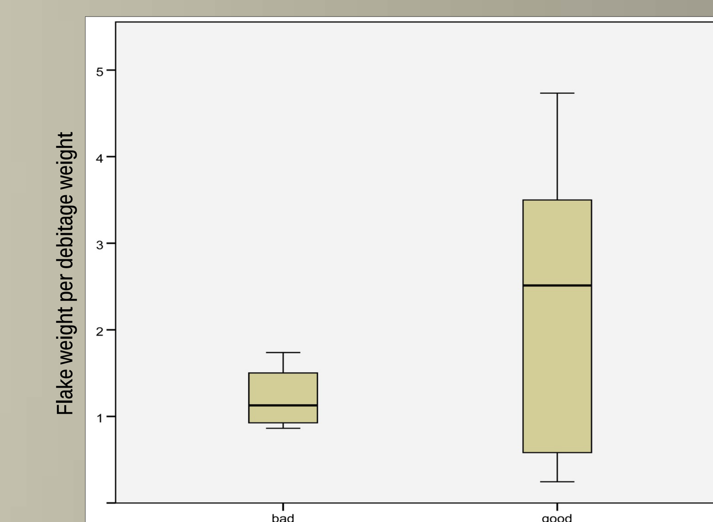

Lots of angular debris, and no flakes

Conclusions

- The results seem to trend in the direction predicted, but none of the results achieved statistical significance because of the small sample size and high variation.
- On average, more flakes were produced from the "good" nodules, but there is too much overlap to statistically demonstrate this patterning.
- The mean energy to break the "bad" nodules was 27.92 joules, versus 19.89 joules for the "good" (left graph). But again, there were too few samples and too much overlap to approach statistical significance.
  - In this calculation, the two nodules that did not break are coded as if they broke at the maximum energy attained in the experiment (45.86 joules).
- One result we did not expect was that there was more variation in the nodules predicted to be "good", especially when it came to flake weight per debitage weight.
  - The flake weight per debitage weight for the "bad" nodules forms a cluster with a much smaller standard deviation than the "good" (right graph); several measures of the range of the distribution obtain strong statistical significance despite the small sample size.
- Overall, some of the measures point in the direction of the predicted patterning, but we would need a much bigger sample size to be able to say anything for certain.
- It seems clear that there are both good and bad varieties of this chemically identical obsidian on the landscape, and it is clear ancient people were avoiding the bad obsidian, as there are places where it covers the modern ground surface with no evidence of tested pieces amongst it.
- The Munsell test did show a clear difference in color between the predicted "good" and "bad". All those predicted to be bad have 7.5YR 3/0 or 3/1 as dominant colors and while there is more variation in those predicted to be good, 7.5YR or 10YR 3/2 or 5/2 (dark brown, dark grayish brown) dominate.
- Some trending can be seen between angularity (versus roundness) and height broken, but again there are outliers skewing any definite conclusions.
  - The five nodules that needed added weight to break (two still didn't break) were all more rounded with one or no potential platform angles, but one nodule that was rounded with no angles broke at only 65 cm.
  - Two of the more angular nodules with 2 or more potential platform angles broke at 35 cm, but two other angular nodules with 2 or more potential platform angles broke at 50 cm and 70 cm, overlapping with some of the others that were rounder.
  - A potential trend, but there is a fair amount of overlap
- Although this experiment was a controlled way to test this sample, the measurement of the energy needed to break these samples by bipolar percussion is probably too crude of a way to capture the variation in flaking properties. Percussion flaking like we used in the first part of the experiment worked much better to test our hypotheses.



Energy required to break predicted good and bad nodules.



Flake weight per debitage weight for predicted good and bad nodules.

Possible Causes of Intrasource Variability

Hydration
- Meteoric – hydration which took place after the formation of the rock
  - Could vary based on the location within the lava flow
  - More exposure over a longer period of time would result in a higher meteoric hydration
  - Obsidian that is exposed to the sun hydrates faster than obsidian still buried (Friedman and Long)
  - Temperature, pressure, and chemical content all effect the rate of hydration
- Magmatic – H2O content of magma
  - Variation in the H2O present in the magma at the time of formation
  - Could be a result of phases of eruption (Friedman and Long, 1976)

Pre-existing fractures
- There is a possibility that hitting a nodule multiple times causes internal fractures within the rock. The harder the rock is to break open, the more pre-existing fractures there may be when the rock finally does crack open, resulting in more debitage made up of smaller pieces and less usable flakes.

What further research can be done?
- Test the H2O content of various nodules to see if they are hydrating at different rates, resulting in variation in flaking qualities
  - Observe and compare hydration rinds of various nodules
- Detailed mapping of the entire Antelope Creek source
  - Is there any correlation between quality of obsidian and the location within the lava flow?
  - Is there a difference between the obsidian that remains in the bedrock and the obsidian that has eroded out of the bedrock?
  - Is there even more variation in nodule size? Does this factor in to flakeability?

Citations:

Shackley, M. Steven,. 2005. *Obsidian : Geology and archaeology in the North American southwest*. Tucson: University of Arizona Press

Friedman I, Long W.,. 1976. Hydration rate of obsidian. *Science (New York, N.Y.)* 191 (4225): 347-52.

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