Through the Volcanic Glass

Obsidian Artifacts as Proxy for Investigating Land Use Dynamics in the Upper Greybull River Drainage

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Journey into the Absaroka hole

The Greybull River Sustainable Landscape Ecology (GRSLE) project investigates human ecology in the Absaroka Mountains and Greater Yellowstone Ecosystem. Research from four field seasons, 2002-2005, in the Shoshone National Forest has documented close to 40,000 flaked stone artifacts on nearly 200 sites. The database is composed of scattered surface observations and mostly palimpsest sites. As a high quality and relatively rare lithic material in the study area, the incorporation of obsidian in tool kits reflects broad social and ecological interactions distinct from extraction of local materials.

Preliminary results from obsidian source characterization, coupled with lithic analysis, suggest dynamic spatial and temporal patterns throughout the diverse sites recorded in the Upper Greybull drainage. The closest obsidian source to the study area is at Obsidian Cliff in Yellowstone and most of the GRSLE sample has been associated with this outcrop. Some samples were traced to distant outcrops as far as southwestern Utah. Obsidian artifacts consistently comprise 10% of GRSLE flaked stone assemblage. The maximum obsidian artifact size is, on average, smaller than artifacts of locally derived cherts supporting prehistoric curation prior to discard. Distribution of obsidian artifacts within this research area is indicative of prehistoric land use processes that were patchy and discontinuous. Further, the variability in the GRSLE obsidian assemblage suggests that behavioral and environmental change was episodic. The relationship of land use patterns between the Greybull River drainage and the surrounding region further elucidates the complexity of prehistoric landscapes.

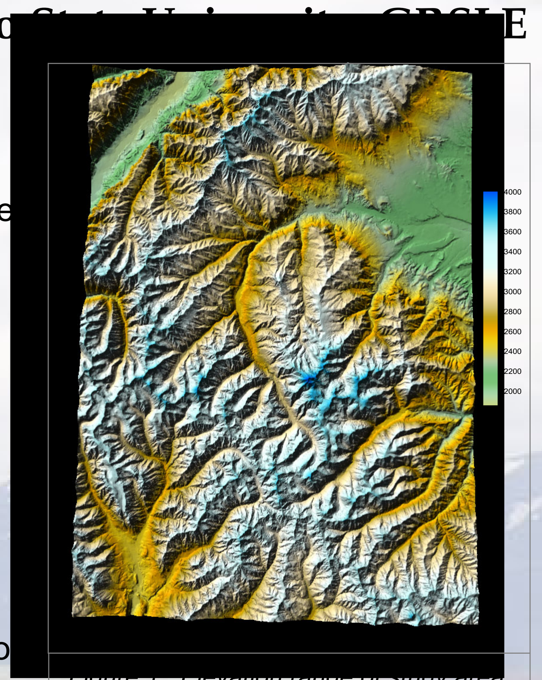

Figure 1. Elevation range of study area. Prehistoric life in this region required adaptations to a variety of ecological settings. Access to obsidian sources is bounded by drainages and high passes. The most direct way to sources was likely not the optimum travel route.

Source Characterization using edXRF

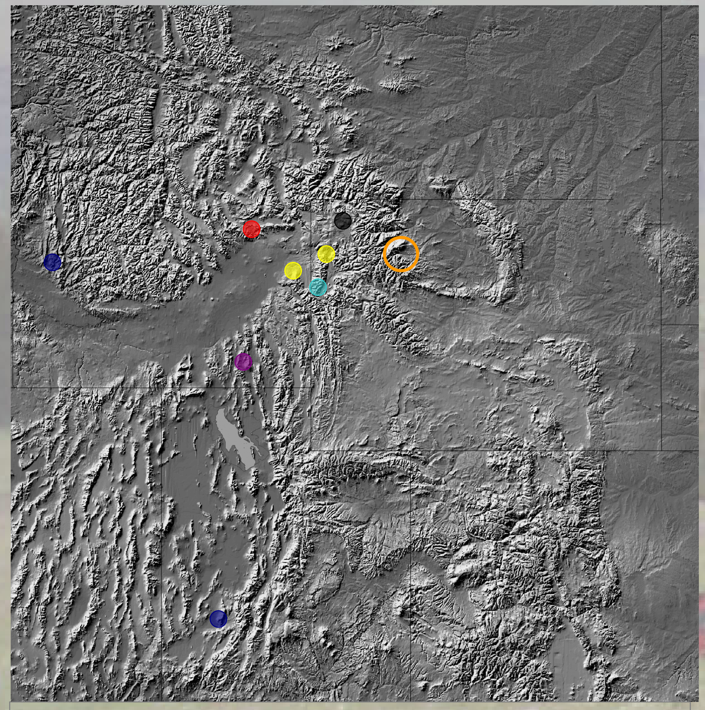

Figure 3. Distribution of identified obsidian sources. The approximately $50km^2$ study area is highlighted in the orange circle.

Non-destructive energy dispersive x-ray fluorescence spectrometry (edxrf) was used to analyze 127 artifacts from the surface of various archaeological sites collected during the 2004 and 2005 GRSLE field seasons. Analyses were performed at the Geochemical Research Laboratory on a QuanX-ECTM (Thermo Electron Corporation) edxrf spectrometer equipped with a silver x-ray tube, a 50 kV x-ray generator, digital pulse processor with automated energy calibration, and a Peltier cooled solid state detector. The instrument was operated to optimize excitation of several diagnostic elements.

X-ray spectra were acquired and elemental intensities extracted for each peak region of interest, then matrix correction algorithms were applied to specific regions of the x-ray energy spectrum to compensate for inter-element absorption and enhancement effects. After these corrections were made, intensities were converted to concentration estimates by employing a least-squares calibration line established for each element. Trace element measurements are expressed in ppm by weight, and matches between samples and known obsidian chemical groups are made on the basis of correspondences (at the 2-sigma level) in diagnostic trace element concentration values. Artifact-to-obsidian source (geochemical type) correspondences were considered reliable if diagnostic mean measurements for artifacts fell within 2 standard deviations of mean values for source standards.

The Greybull Flaked Stone Pattern

Researchers have recorded 1,561 obsidian artifacts with 127 artifacts collected for source characterization from 45 sites and one isolated find (Figure 2). Obsidian artifacts as a whole characterize only 3.90% of the total raw material assemblage. Of the sites containing obsidian, however, this material type comprises 9.54% of the observed flaked stone assemblage. Most of the obsidian artifacts, 98.6%, in the GRSLE database were identified in the field as having no visible cortex.

Artifacts in the study area have been sourced to Obsidian Cliff Wyoming (Figure 3. black), Bear Gulch Idaho (red), Malad Idaho (violet), Teton Pass Wyoming (light blue), Packsaddle Creek Idaho, Crescent H Wyoming, Park Point Wyoming, and the distant sources (dark blue) of Timber Butte Idaho and Wild Horse Canyon Utah.

Obsidian artifacts have the lowest average size at 10.03mm, further supporting a pattern of curation prior to discard. Most of the artifact sample, 63%, falls below this mean. The minimum size requirement for sampling is 10mm in length and approximately 1.5mm thickness.

The average non-descript chert artifact is 12.40mm in maximum dimension. Chert dominates the GRSLE assemblage with 16,221 artifacts classified as chert in the field.

Local materials have a mean size of 16.33mm. Those artifacts which fall into the unspecified category have a mean of 17.89mm indicating many have local provenance.

Quartzite is also exotic to the study area. It is readily available in the Bighorn Basin, 50-100km to the east. The large size range of these artifacts may reflect breakage, quality, and use patterns inherent in this material type.

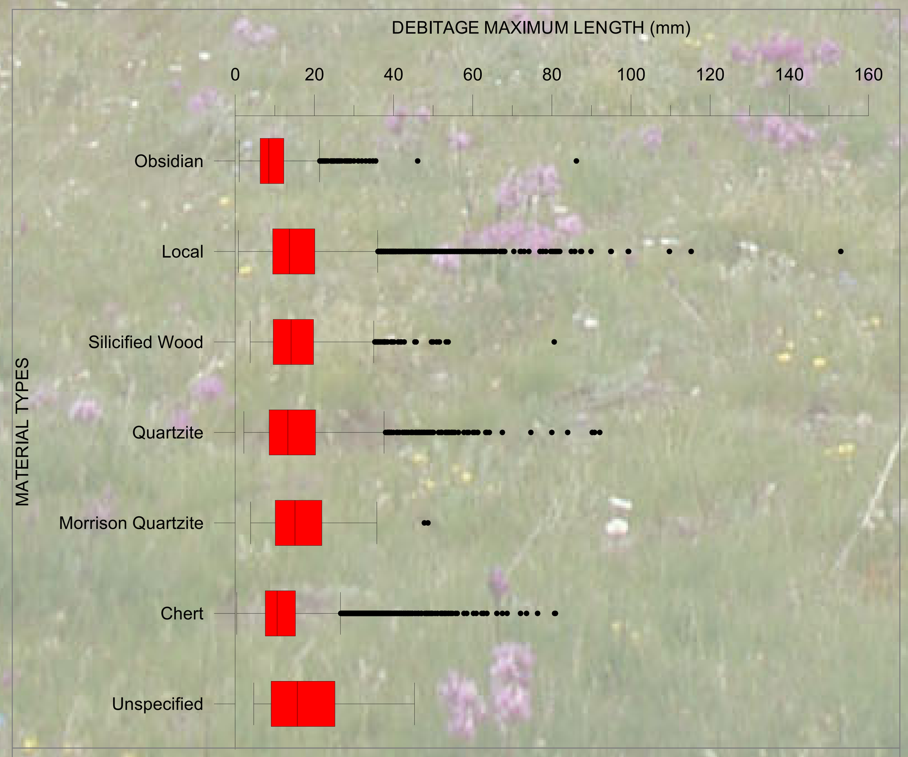

Figure 4. Maximum length of flaked stone debitage by material type.

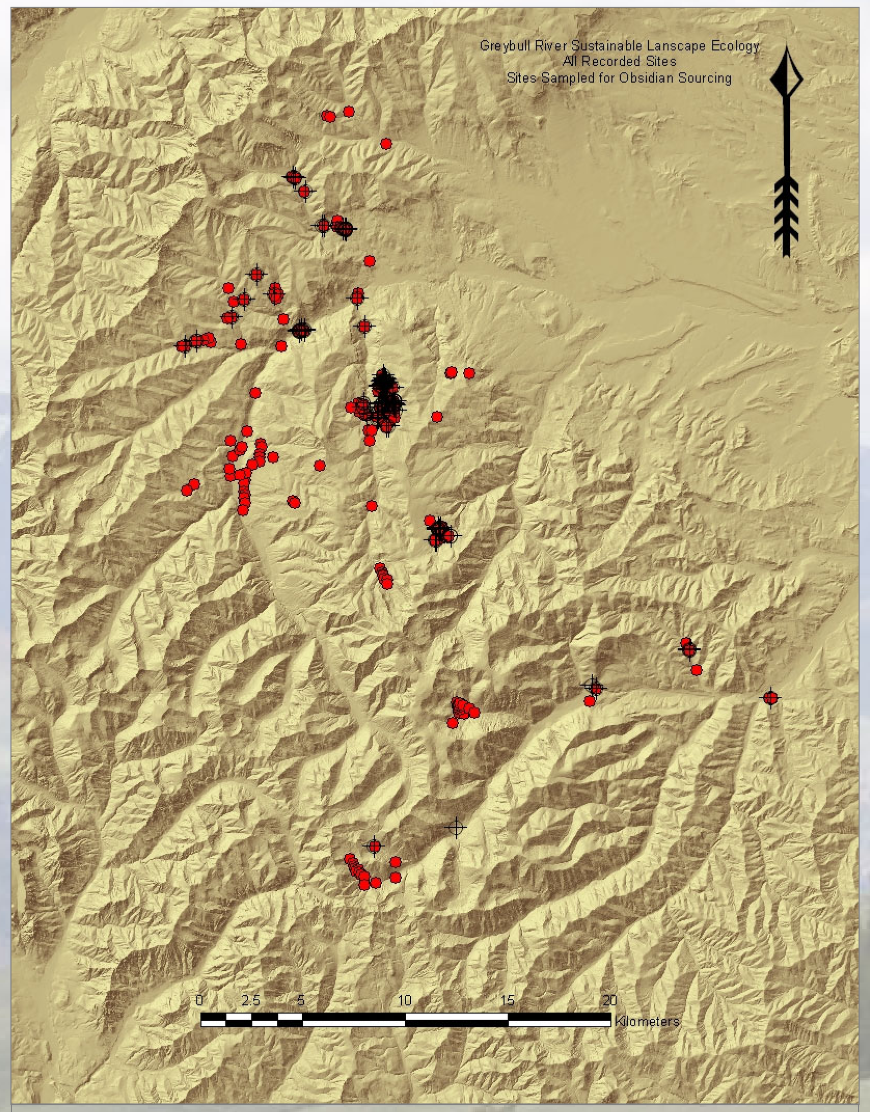

Figure 2. Map of study area. Red dots show sites investigated between 2002 and 2005. Black targets represent locations where obsidian artifacts were sampled for this study in 2004 and 2005.

Curiouser and Curiouser

In most of northwestern Wyoming, as in the study area, obsidian comprises a small percentage of most sites. It is a minor player in the larger game. Patterns in the Upper Greybull remain distinct from other sites in the immediate vicinity, possibly a result of the unique sampling design of this study. The following is suggested for future analysis:

- Establishing site specific patterns and comparing subsurface to surface assemblage in the Upper Greybull

- Unsampled, chronologically dated projectile points from the Greybull should be analyzed for trace element signatures

- Evaluating what makes prehistoric land use more complex than simple linear distance to lithic sources

- Investigating the interior mountains - moving away from modern influenced archaeological record

- Sourcing must be done more frequently, source materials should be readily available for establishing regional synchronicity and results of obsidian sourcing studies published.

Looking Northwest towards the perilous Carter Mountain from high along the Jack Creek drainage.

Must a Name Mean Something?: the Sourcing Results

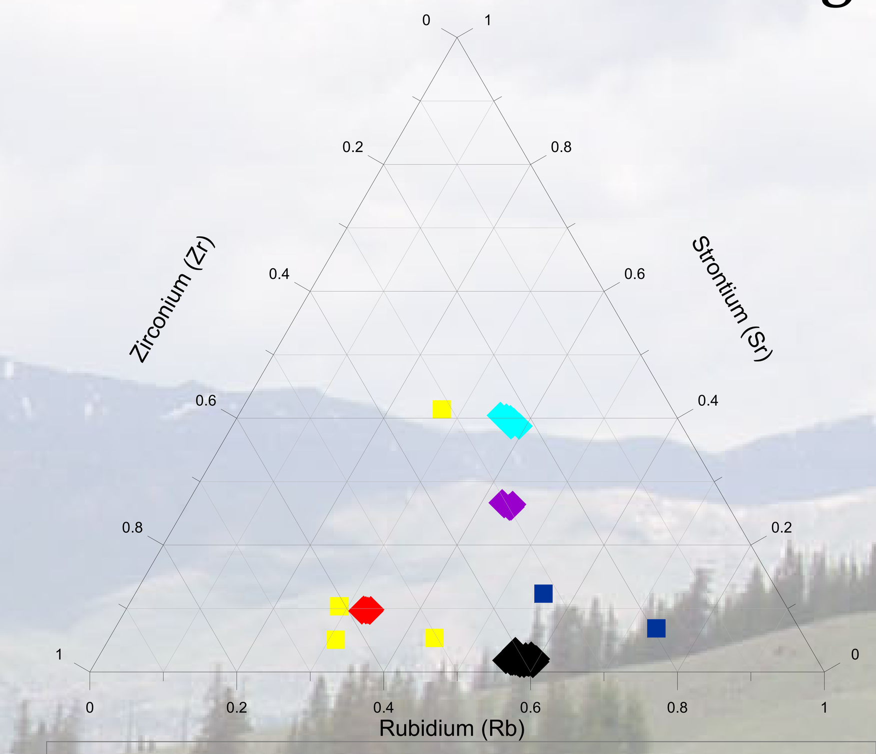

Figure 5. Ternary diagram of trace element signatures for all samples. Obsidian Cliff (black), Bear Gulch (red), Teton Pass (light blue), Malad (purple), Other western (yellow), Other distant (dark blue)

Source results are often shown on bivariate plots. A ternary diagram is used here to evaluate trace element grouping for all sources on one diagram (Figure 5). The trace element signatures must be standardized to fit the ternary distribution by the following equation: X + Y + Z=100% For example, sample number ADB6 from Obsidian Cliff is expressed as (Rb)257+(Sr)7+(Zr)165=429 or 0.60+0.02+0.38=1.

Most of the sampled artifacts, 78.7%, fit well within the range for Obsidian Cliff Wyoming in contemporary Yellowstone National Park. At approximately 150km linear distance from the GRSLE project area, Obsidian Cliff is the closest major source.

The other common sources fall far behind the frequency of Obsidian Cliff with Bear Gulch at 7.1%, Teton Pass at 5.5% and Malad at 3.9%. Many of the artifacts traced to the Teton Pass source appear to vary between opaque and translucent materials, almost giving the appearance of tiger stripes.

The yellow squares represent the obsidian sources from which only one sample has been traced. One unknown source is grouped within this sample as the signature is similar to secondary sources around Jackson Wyoming and Yellowstone Park.

The dark blue squares represent the most distant sources of Timber Butte and Wild Horse Canyon. Both sources are over 700km linear distance from the sites which contained their artifacts.

The distribution of tool types from each source is the expected for a curated material. As distance from source increases, the amount of waste material from that source decreases.

There was only one obsidian core identified in the field in the Greybull artifact assemblage. The provenance of this artifact is Obsidian Cliff. Obsidian Cliff artifacts are overwhelming composed of unmodified flaked stone debitage.

Materials other than Bear Gulch and Obsidian Cliff, are most often formed into projectile points or bifaces prior to their discard in the Greybull drainage. The Teton Pass sample is dominated by debitage, but 43% are projectile points.

The Bear Gulch artifacts were frequently worked, but to a minimal degree.

Figure 6. Frequency of tool type by source.

TABLE 1. Projectile Point Chronology by Source	Middle Archaic	Late Archaic	Late Prehistoric	Unspecified	Total
Bear Gulch	--	--	1	--	1
Malad	--	1	--	--	1
Obsidian Cliff	1	--	4	4	9
Other	--	3	--	--	3
Teton Pass	--	--	3	--	3
Total	1	4	8	4	17

Most of the GRSLE obsidian source sample is debitage, but 13% is chronologically datable. Obsidian hydration analysis may be difficult for artifacts in this area, as heat damage to many lithic materials indicates a history of fire exposure. It is possible for fire damage to "reset" the hydration clock. Four projectile points are not identifiable to a specific time period.

No obsidian artifacts can be directly attributed to the Paleoindian period (11,500 to 8000RCBP) or the Early Archaic (8000 to 5000 RCBP).

The one Middle Archaic/McKean (5000 to 3200 RCBP) projectile point is from Obsidian Cliff.

The obsidian sample from the GRSLE project reflects prehistoric land use that intersects four culture areas. Culture areas (Kroeber 1939) are largely defined by adaptation to broad environmental zones.

TABLE 2. Culture Area Significance

CULTURE AREA GROUPS	SUBSISTENCE (KEY RESOURCES)	HOUSING AND TECHNOLOGY	SETTLEMENT PATTERN	POLITICAL ORGANIZATIO N
GREAT BASIN	Gathering, some hunting fishing (seeds, roots, nuts, rabbits, grasshoppers)	Wickiup (brush hut), nets (for hunting), digging sticks, seed beaters, basketry	Dispersed extended family units, winter villages	Fluid bands, temporary leaders
PLATEAU	Gathering, riverine fishing, hunting (roots, salmon, deer)	Pit houses, pole-and-mat lodges, basketry, weirs	Permanent villages, (seasonal dispersal) fishing camps	Egalitarian village council
SOUTHWEST	Horticulture (rainfall or irrigated), hunting gathering, herding (corn/beans/squash , deer, sheep)	Adobe apartments, hogans, thatched huts, pottery, grinding stones, basketry,	Permanent villages (Pueblo), semi-nomadic (Athapaskans), seasonal weaving villages (others)	Clan leaders, village chiefs, sodalities (highly variable)
PLAINS (western)	Bison hunting	Hide tipis, earth lodges, travois, hoe, horse complex, buffalo robes	Nomadic bands with seasonal tribal encampment	Politically unified tribe, tribal council, military and ceremonial sodalities

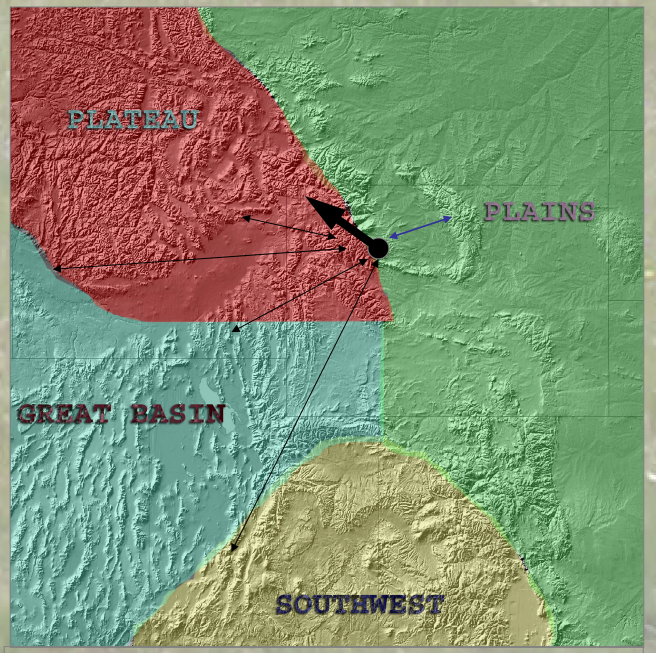

Figure 7. Black arrows indicate transport of obsidian artifacts. Blue arrow indicates movement of chert and quartzite materials.

It is intriguing that none of the Late Archaic (3200 to 1500 RCBP) points were sourced to Obsidian Cliff. This period is well known regionally as a time of high population density and montane use. Johnson (2001), reported an increased number of Late Archaic projectile points in the Yellowstone National Park. Burnett (2005) reported that most of the archaeological record in the Upper Greybull is attributed to the Late Archaic. Using cluster analysis, he found that the obsidian debitage was more frequently proximate to Late Prehistoric projectile points.

Most of the source sampled projectile points are from the Late Prehistoric period (1500 to 250 RCBP). This period is well represented by Obsidian Cliff and Teton Pass.

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