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## Proximity and Provenance: A Lesson from the Sterling Cache, Idaho

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*Geochemical analysis of nine obsidian bifaces (“blanks”) from the Sterling Cache, southern Idaho, was undertaken and the results contrast with the source (chemical type) ascription advanced for the specimens in the original report (Pavesic 1966). Trace element data show that obsidian from the closest source was not used to manufacture any of the artifacts in the cache, although three more distant obsidian sources (chemical types) are represented. These results provide another object lesson that proximity to ‘source’ is no guarantee that local provenance for artifact materials can reliably be inferred.*

Nearly 40 years ago, the junior author reported the occurrence of obsidian bifaces that had been recovered on the Koopin family farm in Sterling, Idaho. The cache was found deposited in a Pleistocene terrace along the “northwestern edge of the American Falls reservoir in southeastern Idaho” (Pavesic 1966:52). At that time, obsidian ‘sourcing’ research in North America had barely begun; practically nothing was then known about the extent and number of local sources of obsidian, and a quantitative composition baseline for geological sources against which the compositions of obsidian artifacts could be compared was completely absent. It would be three more years until Wright et al. (1969) reported the results of the first pilot sourcing study on Idaho obsidian artifacts.

During the preparation of his report on the Sterling Cache, the junior author was able to consult with a regional geological authority (Donald Trimble, USGS, Denver) with considerable experience in the area. Based on discussions about the Sterling Cache artifacts it was concluded that:

All nine specimens were manufactured from an obsidian welded tuff; however two of the blanks are close

to being a “true” obsidian (Donald Trimble, personal communication). The source of the obsidian welded tuff is the Walcott formation which outcrops in the vicinity of American Falls, located 20 miles southwest of Sterling [Pavesic 1966:53].

In retrospect, this conclusion must have seemed patently obvious. Welded tuffs had long been known in the area (Mansfield 1952), Stearns and Isotoff (1956) had described ash-flow (welded) tuff obsidian from the nearby Walcott formation, and the material had been mapped (Carr and Trimble 1963) no more than 20 miles from the Sterling Cache site (see Morgan and McIntosh 2005: Fig. 2c).

The decision to conduct chemical analysis of the Sterling cache artifacts was made to complement ongoing analyses of other artifact collections from southern Idaho by the senior author. On reviewing the material, Pavesic observed that none of the artifacts, with the exception of a single flake on the site surface not directly associated with the cache, possessed the “few scattered white feldspar crystals [and] fine “granular” vesicular texture with no apparent lineation” (Carr and Trimble 1963:18) considered characteristic of obsidian from the Walcott formation. Although these diagnostic macroscopic attributes were not apparent in the Sterling Cache artifacts, this absence—by itself—was insufficient to reject a Walcott Tuff source attribution, because higher quality obsidian might well exist elsewhere in unmapped, or recently buried, portions of the unit. The issue could only be resolved by geochemistry, so the senior author conducted instrumental analysis of the artifacts.

### LABORATORY ANALYSIS

Non-destructive trace element analysis of the Sterling Cache specimens was performed by the senior author on a QuanX-EC™ (Thermo Electron Corporation) energy-dispersive x-ray fluorescence (edxf) spectrometer equipped with a silver (Ag) x-ray tube, a 50 kV x-ray generator, digital pulse processor with automated energy calibration, and a Peltier cooled solid state detector with 145 eV resolution (FWHM) at 5.9 keV. The x-ray tube was operated at differing voltage and current settings to optimize excitation of the elements selected for analysis. In this case analyses were conducted on all specimens for the elements rubidium (Rb K $\alpha$ ), strontium (Sr K $\alpha$ ), yttrium (Y K $\alpha$ ), zirconium (Zr K $\alpha$ ), and niobium

(Nb K $\alpha$ ), while certain artifacts required additional analysis for the elements barium (Ba K $\alpha$ ), titanium (Ti K $\alpha$ ), manganese (Mn K $\alpha$ ) and iron (Fe<sub>2</sub>O<sub>3</sub><sup>T</sup>). Iron vs. manganese (Fe K $\alpha$ /Mn K $\alpha$ ) ratios also were computed for some specimens. Trace element data for the Sterling Cache samples were compared to concentration values (i.e., ppm values for Rb, Sr, Y, Zr, Nb, Ba, Ti, Mn and Fe<sub>2</sub>O<sub>3</sub><sup>T</sup>) that appear in Anderson et al. (1986), Baugh and Nelson (1988), Hughes (1984, 2005), Hughes and Nelson (1987), Macdonald et al. (1992), Morgan (1992), Nelson (1984), and to unpublished data on other Idaho, Nevada, Utah, and Wyoming obsidians (Hughes 1995a, 1995b, 1997, 2001). The term “source” as employed here is shorthand for “chemical type” and “geochemical type” (see Hughes 1998:104), and artifact-to-obsidian source

(geochemical type) correspondences were considered reliable if diagnostic mean measurements for artifacts fell within two standard deviations of mean values for source standards. General discussions of calibration and element-specific measurement resolution appear elsewhere (Hughes 1988, 1994, 2005: 249–250).

## RESULTS AND DISCUSSION

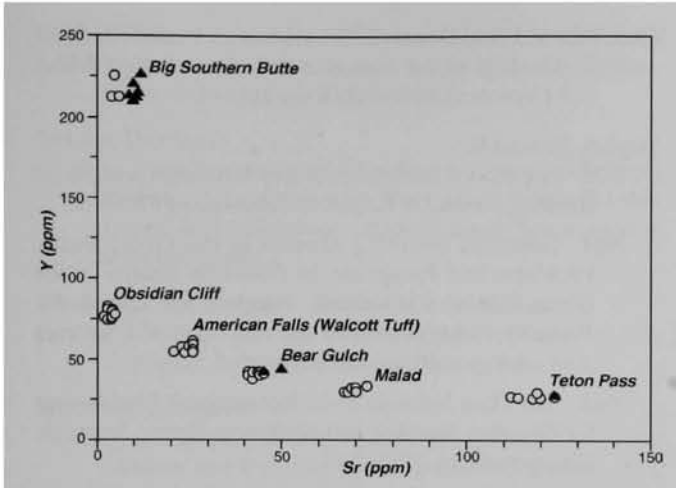
Edxrf data (see Table 1) indicate that six of these specimens (sample nos. K-3, K-4, K-5, K-6, K-8, and K-9) were manufactured from Big Southern Butte, Idaho, obsidian (cf. Nelson 1984: Table 5, source # 38; Macdonald et al. 1992: Appendix I, p. 142); two others (samples K-1 and K-7) were fashioned from Bear Gulch, Idaho,

**Table 1.**

### ENERGY DISPERSIVE X-RAY FLUORESCENCE DATA FOR ARTIFACTS FROM THE STERLING CACHE, IDAHO

Cat Number	Trace and Selected Minor Element Concentrations									Ratio	Obsidian Source (Chemical Type)	Illustrated
	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	Fe <sub>2</sub> O <sub>3</sub> <sup>T</sup>	Fe/Mn		
K-1	172 ±4	50 ±3	45 ±3	296 ±4	54 ±3	700 ±15	nm	nm	nm	nm	Bear Gulch	Pavesic 1966: Figure 3A
K-2	113 ±4	124 ±3	28 ±3	69 ±4	12 ±3	1141 ±15	510 ±27	419 ±10	1.27 ±0.02	30	Teton Pass	Pavesic 1966: Figure 3B
K-3	263 ±4	11 ±3	216 ±3	295 ±4	276 ±3	nm	nm	nm	nm	nm	Big Southern Butte	Pavesic 1966: Figure 3C
K-4	262 ±4	11 ±3	213 ±3	297 ±4	276 ±3	nm	nm	nm	nm	nm	Big Southern Butte	Pavesic 1966: Figure 3E
K-5	265 ±4	10 ±3	221 ±3	304 ±4	281 ±3	nm	nm	nm	nm	nm	Big Southern Butte	Pavesic 1966: Figure 3F
K-6	271 ±4	12 ±3	228 ±3	316 ±4	284 ±3	nm	nm	nm	nm	nm	Big Southern Butte	Pavesic 1966: Figure 3G
K-7	179 ±4	45 ±3	43 ±3	285 ±4	51 ±3	673 ±15	nm	nm	nm	nm	Bear Gulch	Pavesic 1966: Figure 3H
K-8	255 ±4	10 ±3	211 ±3	287 ±4	278 ±3	nm	nm	nm	nm	nm	Big Southern Butte	Pavesic 1966: Figure 3I
K-9	266 ±4	9 ±3	215 ±3	293 ±4	281 ±3	nm	nm	nm	nm	nm	Big Southern Butte	Pavesic 1966: Figure 3J
<b>U.S. Geological Survey Comparative Reference Standard</b>												
RGM-1 (measured)	152 ±4	113 ±3	25 ±3	222 ±4	9 ±3	808 ±15	1632 ±36	275 ±10	1.88 ±0.02	63	Glass Mountain	
RGM-1 (recommended)	149	108	25	219	9	807	1600	279	1.86	nr	Glass Mountain	

Note: All trace element values (except Fe/Mn ratios) in parts per million (ppm) or weight percent composition (Fe<sub>2</sub>O<sub>3</sub><sup>T</sup>); ± = estimate of x-ray counting uncertainty and regression fitting error at 120–360 seconds livetime; nm = not measured; nr = not reported.

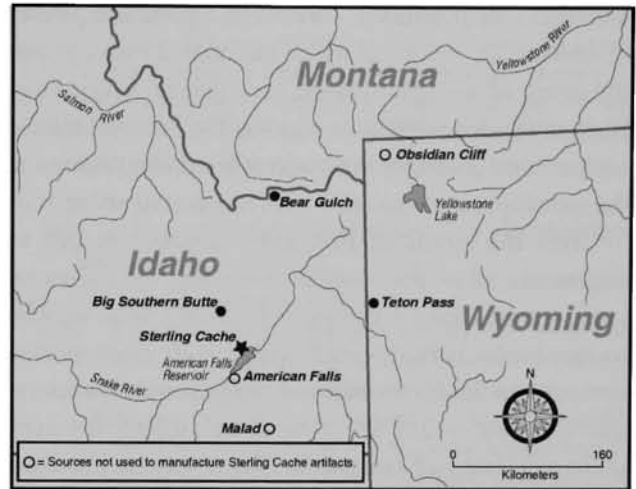


Note: Y and Sr concentration values for geologic obsidian standards from Big Southern Butte, Obsidian Cliff, American Falls (Walcott Tuff), Malad, and Teton Pass represented by open circles. Values for obsidian artifacts from the Sterling Cache appear as filled triangles.

**Figure 1. Y vs. Sr composition of obsidian artifacts from the Sterling Cache in relation to values for selected geologic source standards.**

volcanic glass (Hughes and Nelson 1987:Table 1); and that one specimen (sample K-2) was made from obsidian of the Teton Pass, Wyoming, chemical type (cf. Hughes 1995a, 2001:Table H-4). Other element contrasts could be employed to make the same intersource distinctions, but artifact-to-source (chemical type) assignments can be illustrated in this instance by using a bivariate composition plot (Figure 1) which shows the correspondence in Y and Sr composition among the Sterling Cache artifacts and major archaeologically-significant regional geological source reference standards.

These geochemical data document that the material employed to manufacture the Sterling Cache obsidian artifacts came from three different sources, all located north of the site; Big Southern Butte is approximately 45 km. north-northwest, obsidian of the Bear Gulch chemical type could have been obtained from redeposited contexts around Camas Creek over 150 km. to the north-northeast, while geological occurrences of Teton Pass material are more than 150 km. distant to the east-northeast (see Figure 2). Given the presence of relatively distant glasses in the cache, it is noteworthy that high-quality obsidian of the Malad chemical type, located < 80 km to the southeast, was not employed to make any of the Sterling Cache specimens.



Note: The American Falls locality is the best known occurrence of artifact-caliber Walcott Tuff obsidian, but obsidian of similar quality may exist elsewhere in the unit (see Morgan and McIntosh 2005: Fig. 2c for the unit's inferred areal distribution).

**Figure 2. General location of the Sterling Cache and archaeologically significant obsidian sources in Idaho and Wyoming.**

The reader will have noticed that, despite its suitability for manufacturing prehistoric stone tools, not one specimen analyzed from the Sterling Cache was made from immediately available Walcott Tuff (American Falls) ash-flow tuff obsidian. These geochemical results flatly contradict the initial source assignment made on the basis of visual inspection by an experienced geologist. Despite the obvious conclusion that even a trained, experienced eye may err, the Sterling results once again caution against assuming provenance (i.e., source) on the basis of proximity.

While it may be that the majority of utilitarian artifacts at a particular site were made from obsidian from the closest available source—following what Jackson (1974:81) termed the “simple practicality in proximity”—there is empirical evidence that such was not the case for other categories of artifacts. For example, at certain archaeological sites in northwestern California and southwestern Oregon, different obsidian source materials were used to fashion ceremonial and utilitarian artifacts (Hughes 1978, 1990). Caches, which function as repositories for materials stored in anticipation of future use, may contain materials from either local or non-local sources, depending on the proximity to suitable toolstone, the extent to which territorial circumscription

impeded—or precluded—access to a particular source or sources, the extent to which the cached material was the result of a single-episode, task-specific action (e.g., Rick and Jackson 1992), or whether the material cached accumulated gradually as a result of some combination of the mobility and exchange factors mentioned above.

But the point of this modest paper is not to enumerate all of the possible mitigating influences on cache composition (cf. Thomas 1983:81–82). What we wish to emphasize is that—while empirically unsupported assumptions linking provenance and proximity are always questionable—they are even more suspect for non-utilitarian classes of artifacts. In 1966, it may have seemed reasonable to conclude that the material used to make the Sterling Cache artifacts came from the obsidian-bearing deposits in the nearby Walcott Tuff, but the results of several decades of sourcing research, showing the sometimes complex relationships that can exist between distance to source and assemblage composition, which can vary by artifact class and time, provide sobering counter examples.

In summary, none of the Sterling Cache artifacts match the trace element profile of the Walcott Tuff (exposed nearby at American Falls) as originally proposed (Pavesic 1966:53–54); instead, trace element evidence documents that three distinct obsidian chemical types (Big Southern Butte, Bear Gulch, and Teton Pass) are represented in artifacts contained therein. Geochemical analysis of the Sterling cache artifacts shows that proximity to a toolstone caliber location is a completely misleading predictor of artifact source. These results carry obvious implications for provenance studies in archaeology.

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