

**X-Ray Fluorescence Analysis of Artifact Obsidian from the
Cal Schmidt Clovis Site (35-HA-850), Harney County, Oregon**

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Fourteen obsidian artifacts from the Cal Schmidt Clovis Site (35-HA-850), Harney County, Oregon, were subjected to energy dispersive X-ray fluorescence trace element provenance analysis. The samples were prepared and analyzed at the Northwest Research Obsidian Studies Laboratory under the accession number 2013-04.

Analytical Methods

X-Ray Fluorescence Analysis. Nondestructive trace element analysis of the samples was completed using a Thermo NORAN QuanX-EC energy dispersive X-ray fluorescence (EDXRF) spectrometer. The analyzer uses an X-ray tube excitation source and a solid-state detector to provide spectroscopic analysis of elements ranging from sodium to uranium (atomic numbers 11 to 92) and in concentrations ranging from a few parts per million to 100 percent. The system is equipped with a Peltier-cooled Si(Li) detector and an air-cooled X-ray tube with a rhodium target and a 76 micron Be window. The tube is driven by a 50 kV 2mA high voltage power supply, providing a voltage range of 4 to 50 kV. During operation, the tube current is automatically adjusted to an optimal 50% dead time, a variable that is significantly influenced by the varying physical sizes of the different analyzed samples. Small specimens are mounted in 32 mm-diameter sample cups with mylar windows on a 20-position sample tray while larger samples are fastened directly to the surface of the tray.

For the elements that are reported in Table A-1, we analyzed the collection with either an 8.8 or 3.5 mm diameter beam collimator installed - smaller diameter collimators are employed with smaller specimens and the tube voltage is adjusted accordingly. Instrument control and data analysis are performed using WinTrace software (version 7) running under the Windows 7 operating system.

The diagnostic trace element values used to characterize the samples are compared directly to those for known obsidian and fine-grained volcanic (FGV) sources reported in the literature and with unpublished trace element data collected through analysis of geologic source samples (Northwest Research 2014). Artifacts are correlated to a parent obsidian, FGV, or basalt source (or geochemical source group) if diagnostic trace element values fall within about two standard deviations of the analytical uncertainty of the known upper and lower limits of chemical variability recorded for the source. Occasionally, visual attributes are used to corroborate the source assignments although sources are never assigned solely on the basis of megascopic characteristics.

Results of Analysis

X-Ray Fluorescence Analysis. Five geochemical source groups, all of which were correlated with known obsidian sources, were identified among the 14 artifacts that were characterized by X-ray fluorescence analysis. The locations of the site and the identified obsidian sources are shown in Figure 1. Analytical results are presented in Table A-1 in the Appendix and are summarized in Table 1 and Figure 2.



Figure 1. Locations of the project site and the sources of the characterized artifacts.

Table 1. Summary of results of trace element analysis of obsidian artifacts from 35-HA-850.

OBSIDIAN SOURCE	N=	PERCENTAGE
Beatys Butte	2	14.3
Double H/Whitehorse	1	7.1
Hawks Valley	8	57.2
Massacre Lake/Guano Valley	2	14.3
Surveyor Spring	1	7.1
TOTAL	14	100.0

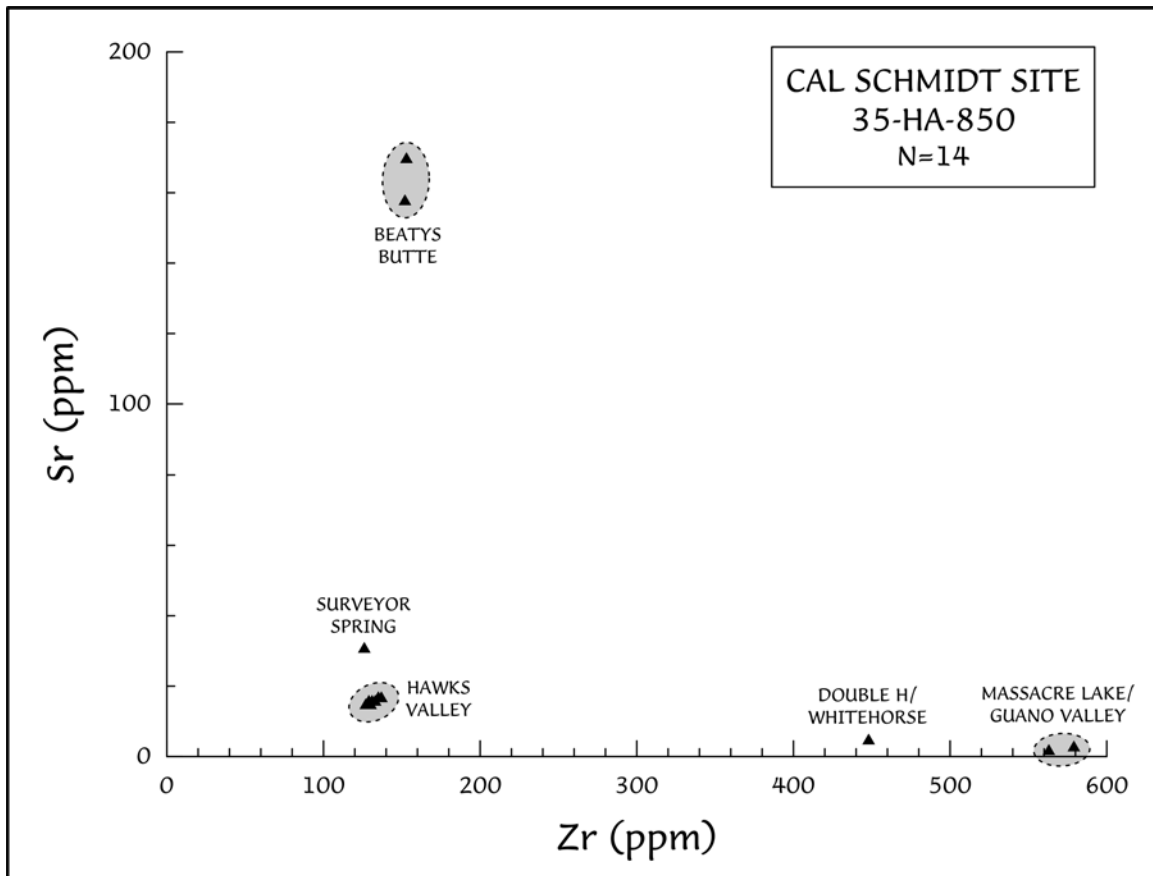


Figure 1. Scatterplot of zirconium (Zr) plotted versus strontium (Sr) for all analyzed artifacts.

Information concerning the locations, geologic setting, and prehistoric use of the obsidian sources identified in the current investigation may be found at www.sourcecatalog.com (Northwest Research 2014b).

References Cited

- Northwest Research Obsidian Studies Laboratory
2014a Northwest Research Obsidian Studies Laboratory World Wide Web Site (www.obsidianlab.com).
2014b Northwest Research U. S. Obsidian Source Catalog (www.sourcecatalog.com).

Appendix

Results of X-Ray Fluorescence Analysis

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Table A-1. Results of XRF Studies: Cal Schmidt Clovis Site (35-HA-850), Harney County, Oregon

Site	Specimen No.	Catalog No.	Trace Element Concentrations									Ratios		Geochemical Source
			Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe ²⁺ O ^{3T}	Fe:Mn	Fe:Ti	
35-HA-850	1	CAL1	122 ± 2	158 2	14 1	152 2	10 1	NM NM	NM NM	887 27	NM NM	NM NM	NM NM	Beatys Butte
35-HA-850	2	CAL2	119 ± 2	170 2	14 1	153 2	8 1	NM NM	NM NM	974 31	NM NM	NM NM	NM NM	Beatys Butte
35-HA-850	3	CAL3	227 ± 3	17 1	44 2	135 2	28 2	NM NM	NM NM	0 22	NM NM	NM NM	NM NM	Hawks Valley
35-HA-850	4	CAL4	225 ± 3	17 1	46 2	135 2	28 2	NM NM	NM NM	0 23	NM NM	NM NM	NM NM	Hawks Valley
35-HA-850	5	CAL5	193 ± 3	2 1	83 2	563 4	31 2	NM NM	NM NM	0 22	NM NM	NM NM	NM NM	Massacre Lake/Guano Valley
35-HA-850	6	CAL6	210 ± 3	15 1	46 2	130 2	26 2	NM NM	NM NM	0 21	NM NM	NM NM	NM NM	Hawks Valley
35-HA-850	7	CAL7	209 ± 3	16 1	42 2	131 2	26 2	NM NM	NM NM	0 22	NM NM	NM NM	NM NM	Hawks Valley
35-HA-850	8	CAL8	214 ± 3	16 1	43 2	129 2	26 2	NM NM	NM NM	0 22	NM NM	NM NM	NM NM	Hawks Valley
35-HA-850	9	CAL9	201 ± 3	15 1	44 2	127 2	28 2	NM NM	NM NM	0 22	NM NM	NM NM	NM NM	Hawks Valley
35-HA-850	10	CAL10	213 ± 3	17 1	43 2	137 2	27 2	NM NM	NM NM	0 20	NM NM	NM NM	NM NM	Hawks Valley
35-HA-850	11	CAL11	212 ± 3	3 1	89 2	579 3	33 2	NM NM	NM NM	0 0	NM NM	NM NM	NM NM	Massacre Lake/Guano Valley
35-HA-850	12	CAL12	177 ± 3	5 1	80 2	448 3	26 2	NM NM	NM NM	0 23	NM NM	NM NM	NM NM	Double H/Whitehorse
35-HA-850	13	9-2003-1	146 ± 2	31 1	25 1	126 2	13 1	NM NM	NM NM	260 26	NM NM	NM NM	NM NM	Surveyor Spring
35-HA-850	14	9-2003-2	215 ± 3	16 1	44 2	133 2	28 2	NM NM	NM NM	0 23	NM NM	NM NM	NM NM	Hawks Valley

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide. NA = Not available; ND = Not detected; NM = Not measured; * = Small sample; FGV = Fine-grained volcanic specimen.

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Site	Specimen No.	Catalog No.	Trace Element Concentrations										Ratios		Geochemical Source
			Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe ²⁺ O ^{3T}	Fe:Mn	Fe:Ti		
NA	RGM-1	RGM-1	152 ± 2	108 2	27 1	220 2	11 1	NM NM	NM NM	753 30	NM NM	NM	NM	RGM-1 Reference Standard	

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
 NA = Not available; ND = Not detected; NM = Not measured; * = Small sample; FGV = Fine-grained volcanic specimen.