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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM PREHISTORIC SITES IN KANSAS

by

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Report Prepared for

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INTRODUCTION

The analysis here of 38 obsidian artifacts from a number of prehistoric sites in Kansas exhibits a mix of source provenance typical of sites from this region. The assemblage is dominated by the two major source groups from the Jemez Mountains in northern New Mexico, and one artifact produced from the Malad, Idaho source.

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

ANALYSIS AND INSTRUMENTATION

All archaeological samples are analyzed whole. The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

The trace element analyses were performed in the Archaeological XRF Laboratory, Department of Earth and Planetary Sciences, University of California, Berkeley, using a Spectrace/ThermoNoran^{TM} QuanX energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with an air cooled Cu x-ray target with a 125 micron Be window, an x-ray generator that operates from 4-50 kV/0.02-2.0 mA at 0.02 increments, using an IBM PC based microprocessor and WinTrace^{TM} reduction software. The x-ray tube is operated at 30 kV, 0.14 mA, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (as FeT), zinc (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Zinc and gallium are only reported for the basalt artifacts, since they are generally in low quantities in western North American obsidian. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements but Fe where a derivative fitting is used to improve the fit for the high concentrations of iron and thus for all the other elements. Further details concerning the petrological choice of these elements in obsidian is available in Shackley (1995, 1998 and 2005; also Mahood and Stimac 1991; and Hughes and Smith 1993). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGV-1 (andesite), GSP-1, SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLO-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), all US Geological Survey standards, BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France, and JR-1 and JR-2 (obsidian) from the Geological Survey of Japan (Govindaraju 1994). In addition to the reported values here, Ni, and Cu, were measured, but these are rarely useful in discriminating glass sources, are poorly measured with the Cu target, and are not generally reported.

The data from the WinTrace software were translated directly into Excel for Windows software for manipulation and on into SPSS for Windows for statistical analyses. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 is analyzed during each sample run for obsidian artifacts to check machine calibration (see Table 1). Compilation and discussion of RGM-1 analyses are available at http://www.swxrflab.net/anlysis.htm. Source assignments were made with reference to the source standard library at Berkeley (Shackley 1995, 1998, 2005).

DISCUSSION

The provenance of the obsidian artifacts dominated by Jemez Mountains sources is not surprising, and is rather typical of late period sites in the Plains (Baugh and Nelson 1987;

Hawley and Hughes 1999; Hughes 1988; Hughes and Lees 1991; Hughes and Roper 1999; Tables 1 and 2, and Figure 1 here). The two major sources in the Sierra de los Valles is Valles Rhyolite, often called Cerro del Medio in the vernacular, and Cerro Toledo Rhyolite often called Obsidian Ridge in the vernacular (see Shackley 2005). The two sources have very different eruptive and depositional histories that are important for prehistoric procurement.

The Cerro Toledo Rhyolite glass was erupted slightly earlier in a caldera collapse creating Plinian events around the east side of the Cerro Toledo caldera (Shackley 2005). Because of the large ash flow tuffs directed to the east and south, a large portion of the ash and rhyolite glass was ultimately eroded into the Rio Grande system, and now can be found as marekanites as far as Chihuahua (Church 2000; Shackley 2005). It is generally impossible to determine whether raw material was procured from the primary domes in the Sierra de los Valles or in secondary contexts except by using a rough nodule size index. The slightly later Valle Grande caldera collapse that produced the Cerro del Medio and other domes producing Valles Rhyolite glass have not yet eroded outside the caldera, and so must have been originally procured in the caldera. For a distance as great as that between northern New Mexico and Kansas, this may not be an issue, but procurement in the late period in the Jemez Mountains likely required some payment, that may not have been necessary in the secondary deposits of the Rio Grande.

Generally, Idaho and Wyoming sources tend be associated with Woodland and Archaic period sites in the Plains, but they also occur in later period sites, either as scavenged raw material from earlier contexts or through exchange relationships with the northwestern Plains (Hawley and Hughes 1999; Logan et al. 2001).

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Table 1. Elemental concentrations for the obsidian archaeological specimens. All measurements in parts per million (ppm).

Sample	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Source
OS365-1	926	262	7820	34	107	65	28	75	18	Malad, ID
PA318-1	932	392	8478	48	138	8	32	146	55	Valles Rhy, NM
PT420-0-10	801	547	8679	85	190	8	58	170	83	Cerro Toledo Rhy, NM[1]
PT420-0-11	943	416	9030	60	145	14	42	154	55	Valles Rhy, NM[1]
PT420-0-12	965	536	8742	79	190	7	56	165	91	Cerro Toledo Rhy, NM
PT420-0-13	854	455	6753	84	137	9	52	142	83	Cerro Toledo Rhy, NM[1]
PT420-0-4	969	426	8546	60	152	11	38	152	64	Valles Rhy, NM
PT420-0-5	944	566	8987	90	198	11	54	166	102	Cerro Toledo Rhy, NM[1]
PT420-0-7	873	376	8539	54	153	14	39	165	47	Valles Rhy, NM
PT420-0-8	970	576	9653	93	211	5	63	184	98	Cerro Toledo Rhy, NM
PT420-0-9	933	509	7580	69	156	5	61	149	80	Cerro Toledo Rhy, NM[1]
PT420-1	895	583	9152	85	196	7	62	172	100	Cerro Toledo Rhy, NM
PT420-2	885	590	9289	93	196	8	65	183	91	Cerro Toledo Rhy, NM
RC303-4	904	497	8186	83	176	9	60	161	97	Cerro Toledo Rhy, NM
RC305-674	1095	450	8971	52	158	10	43	163	59	Valles Rhy, NM
RC305-675	20004[2]	572	8762	85	193	5	60	172	99	Cerro Toledo Rhy, NM
RC306-1469	879	525	8686	80	188	6	56	167	96	Cerro Toledo Rhy, NM
RC306-200	790	537	8525	79	187	6	57	160	91	Cerro Toledo Rhy, NM
RC306-2143	896	429	8644	58	148	10	45	161	57	Valles Rhy, NM
RC306-2306	893	435	8580	60	153	12	42	159	58	Valles Rhy, NM
RC306-58	907	512	8437	84	189	6	55	163	90	Cerro Toledo Rhy, NM
RC308-9	877	373	8226	58	140	9	37	151	48	Valles Rhy, NM
RC309-4	910	418	8872	64	169	11	43	162	54	Valles Rhy, NM
RC309-5	1044	509	10165	73	174	10	43	179	56	Valles Rhy, NM
RC309-6	959	610	9722	87	215	5	71	183	101	Cerro Toledo Rhy, NM
RC313-140	1009	529	9070	79	193	10	54	170	97	Cerro Toledo Rhy, NM
RC313-214	1057	497	9589	67	161	11	48	159	63	Valles Rhy, NM
RC313-262	1048	457	8885	63	156	9	34	163	45	Valles Rhy, NM[1]
RC313-414	901	402	8917	65	159	10	41	169	48	Valles Rhy, NM
RC313-64	858	583	9067	89	196	5	60	179	95	Cerro Toledo Rhy, NM
RC315-0-14	972	432	8956	61	151	10	39	158	39	Valles Rhy, NM
RC315-0-15	973	434	8761	61	152	10	41	160	57	Valles Rhy, NM
RC315-0-16	967	435	8726	61	157	14	44	169	58	Valles Rhy, NM
SC315-2	1139	422	8035	65	137	12	34	144	53	Valles Rhy, NM[1]
SD410-212	934	635	9624	94	194	10	56	168	106	Cerro Toledo Rhy, NM
SN307-2	980	435	8592	64	146	7	40	161	60	Valles Rhy, NM
SN307-9	894	578	8831	85	197	8	52	169	102	Cerro Toledo Rhy, NM
TO313-111	10906[2]	407	7927	44	144	9	39	151	49	Valles Rhy, NM
RGM1-S1	1539	310	13301	36	149	111	24	217	0	standard
RGM1-S1	1590	341	13292	32	150	111	24	218	8	standard

[1] These samples were slightly smaller than the optimum sample size for EDXRF and the concentrations may be somewhat outside the source standard data (see Davis et al. 1998).

[2] The high Ti concentrations in these samples is likely due to the labeling (white out) that has a high titanium content. The other concentrations appear to be unaffected.

Table 2. Obsidian source provenance by site.

			Source			
			Cerro Toledo Rhy, NM	Valles Rhy, NM	Malad, ID	Total
Site	OS365	Count	0	0	1	1
		% within Sample	.0%	.0%	100.0%	100.0%
		% within Source	.0%	.0%	100.0%	2.6%
		% of Total	.0%	.0%	2.6%	2.6%
	PA318	Count	0	1	0	1
		% within Sample	.0%	100.0%	.0%	100.0%
		% within Source	.0%	5.3%	.0%	2.6%
		% of Total	.0%	2.6%	.0%	2.6%
	PT420	Count	8	3	0	11
		% within Sample	72.7%	27.3%	.0%	100.0%
		% within Source	44.4%	15.8%	.0%	28.9%
		% of Total	21.1%	7.9%	.0%	28.9%
	RC303	Count	1	0	0	1
		% within Sample	100.0%	.0%	.0%	100.0%
		% within Source	5.6%	.0%	.0%	2.6%
		% of Total	2.6%	.0%	.0%	2.6%
	RC305	Count	1	1	0	2
		% within Sample	50.0%	50.0%	.0%	100.0%
		% within Source	5.6%	5.3%	.0%	5.3%
		% of Total	2.6%	2.6%	.0%	5.3%
	RC306	Count	3	2	0	5
		% within Sample	60.0%	40.0%	.0%	100.0%
		% within Source	16.7%	10.5%	.0%	13.2%
		% of Total	7.9%	5.3%	.0%	13.2%
	RC308	Count	0	1	0	1
		% within Sample	.0%	100.0%	.0%	100.0%
		% within Source	.0%	5.3%	.0%	2.6%
		% of Total	.0%	2.6%	.0%	2.6%
	RC309	Count	1	2	0	3
		% within Sample	33.3%	66.7%	.0%	100.0%
		% within Source	5.6%	10.5%	.0%	7.9%
		% of Total	2.6%	5.3%	.0%	7.9%
	RC313	Count	2	3	0	5
		% within Sample	40.0%	60.0%	.0%	100.0%
		% within Source	11.1%	15.8%	.0%	13.2%
		% of Total	5.3%	7.9%	.0%	13.2%
	RC315	Count	0	3	0	3
		% within Sample	.0%	100.0%	.0%	100.0%
		% within Source	.0%	15.8%	.0%	7.9%
		% of Total	.0%	7.9%	.0%	7.9%
	SC315	Count	0	1	0	1
		% within Sample	.0%	100.0%	.0%	100.0%
		% within Source	.0%	5.3%	.0%	2.6%
		% of Total	.0%	2.6%	.0%	2.6%
	SD410	Count	1	0	0	1
		% within Sample	100.0%	.0%	.0%	100.0%
		% within Source	5.6%	.0%	.0%	2.6%
		% of Total	2.6%	.0%	.0%	2.6%
	SN307	Count	1	1	0	2
		% within Sample	50.0%	50.0%	.0%	100.0%
		% within Source	5.6%	5.3%	.0%	5.3%
		% of Total	2.6%	2.6%	.0%	5.3%
	TO313	Count	0	1	0	1
		% within Sample	.0%	100.0%	.0%	100.0%
		% within Source	.0%	5.3%	.0%	2.6%
		% of Total	.0%	2.6%	.0%	2.6%
Total		Count	18	19	1	38
		% within Sample	47.4%	50.0%	2.6%	100.0%
		% within Source	100.0%	100.0%	100.0%	100.0%
		% of Total	47.4%	50.0%	2.6%	100.0%

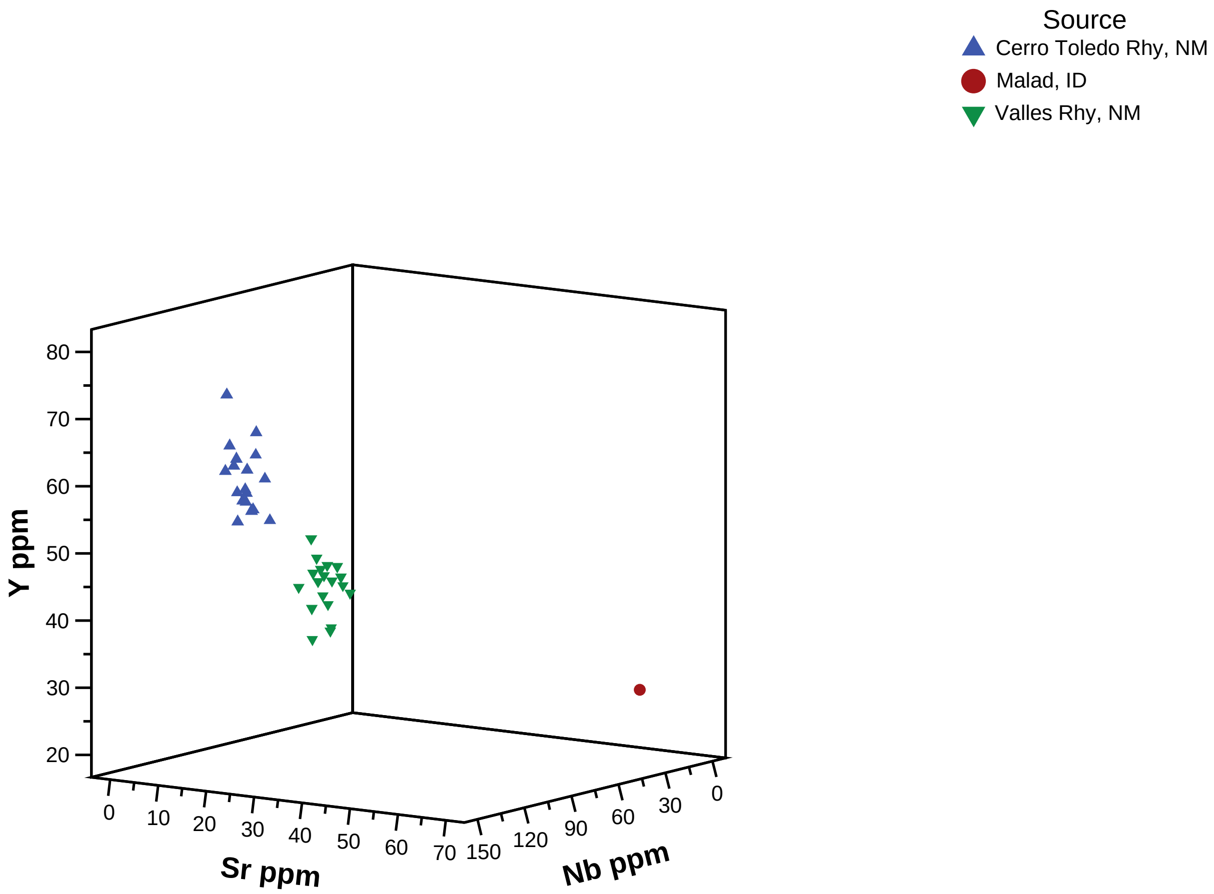

Figure 1. Y, Sr, Nb three-dimensional plot of elemental concentrations for obsidian archaeological samples from all sites.