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Source Provenance of Obsidian Artifacts from 19 Sites in Northern and Central Colorado

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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM 19 SITES IN NOTHERN AND CENTRAL COLORADO

by

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Report Prepared for

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INTRODUCTION

The analysis here of 51 artifacts from various period sites in central and northern Colorado is similar to the earlier study in southwestern Colorado, although with the larger sample size, source diversity is greater (Shackley 2006). No attempt was made here to separate the source provenance by site.

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

ANALYSIS AND INSTRUMENTATION

This assemblage was analyzed on a Spectrace/Thermo *QuanX* energy-dispersive x-ray spectrometer at the Archaeological XRF Laboratory, Department of Earth and Planetary Sciences at the University of California, Berkeley.

All samples were analyzed whole with little or no formal preparation. 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 spectrometer is equipped with an electronically 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™ 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 Fe^T), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), and thorium (Th). Weight percent iron ($Fe_2O_3^T$) can be derived by multiplying ppm estimates by 1.4297(10-4). 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). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1992, 1995, 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, JR-1 and JR-2 (rhyolite) from the Geological Survey of Japan, and BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). In addition to the reported values here, Ni, Cu, Zn, and Ga were measured, but these are rarely useful in discriminating glass sources and are not generally reported.

The data from both systems 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. Multiple analyses of RGM-1 are included in Table 1. Source references come from Haarklau et al. (2005), Nelson (unpublished), Shackley (1995, 2005), and source data at Berkeley. Further information on the laboratory instrumentation can be found at: http://www.swxrflab.net/ and Shackley (1998). Trace element data exhibited in Table 1 are reported in parts per million (ppm), a quantitative measure by weight (see also Figures 1 and 2).

SUMMARY AND CONCLUSIONS

The source provenance of the obsidian in these sites is certainly diverse (Tables 1 and 2; Figure 3). The dominance of sources from western Wyoming and eastern Idaho is rather typical in this region. The only northern New Mexican source identified was from El Rechuelos located on the northern side of the Valles Caldera (see Shackley 2005).

A number of objects could not be assigned to known sources in western North America, due to very small sample sizes (< 10mm in minimum length and 2 mm thick; see Davis et al. 1998). One group of unknowns is designated "unknown, high Rb" here. Craig Skinner at Northwest Obsidian Lab, has never seen this group before either. The composition suggests a non-rhyolite glass, although it appears to be a good quality toolstone. It may be a "local" source near these sites.

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Table 1. Elemental concentrations and source assignments for the archaeological specimens.

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
07-1	739	661	6373	741	9	86	98	108	unknown, high Rb
07-10	1029	341	7730	103	69	24	106	1	Malad, ID
07-11	1116	264	9605	228	9	71	165	41	Obsidian Cliff, WY
07-12	1109	230	7667	199	14	60	140	33	Obsidian Cliff, WY*
07-13	1173	287	10829	256	13	85	164	34	Obsidian Cliff, WY
07-14	1173	254	9682	232	13	78	170	41	Obsidian Cliff, WY
07-15	869	815	7746	842	10	98	120	112	unknown, high Rb
07-16	1166	346	11953	202	24	60	234	50	Fish/Partridge Cr, ID
07-17	1046	251	8230	127	79	20	91	11	Malad, ID
07-18	1201	257	8218	112	79	42	88	21	Malad, ID*
07-2	816	749	7308	839	14	91	118	119	unknown, high Rb
07-20	823	276	7942	111	71	28	82	19	Malad, ID
07-21	885	255	7800	119	77	24	84	16	Malad, ID
07-22	911	216	7717	112	75	28	82	6	Malad, ID
07-23	1052	294	8847	122	79	28	101	15	Malad, ID
07-24	922	234	9486	230	12	72	164	36	Obsidian Cliff, WY
07-25	813	256	9388	212	5	77	163	43	Obsidian Cliff, WY
07-26	950	403	8564	113	117	28	74	13	Teton Pass, WY
07-27	1012	407	9419	124	133	21	77	16	Teton Pass, WY
07-28	1045	256	8985	133	82	30	87	30	Malad, ID
07-29	1064	421	9573	126	127	20	80	11	Teton Pass, WY
07-3	754	1052	5441	260	10	44	76	81	unknown
07-30	978	291	7494	95	107	17	69	16	unknown
07-31	1729	348	7956	96	98	16	49	18	too small
07-32	1018	475	9986	128	134	32	84	16	Teton Pass, WY
07-33	1094	529	9816	124	137	17	71	12	Fish Cr/Teton Pass, WY
07-34	932	489	10359	133	138	24	77	12	Teton Pass, WY
07-35	1298	488	10145	127	130	16	77	8	Teton Pass, WY
07-36	915	435	9944	135	133	16	80	19	Teton Pass, WY
07-37	1172	489	10538	124	130	21	70	14	Teton Pass, WY
07-38	1341	597	11144	123	128	2	67	19	Teton Pass, WY
07-39	1663	505	10500	123	101	24	66	0	too small
07-4	1032	698	7375	782	13	94	107	112	unknown, high Rb
07-40	1266	441	9451	128	124	23	66	2	Fish Cr/Teton Pass, WY
07-41	978	313	8492	117	81	23	87	25	Malad, ID
07-42	1054	385	9086	104	115	15	65	29	Fish Cr/Teton Pass, WY*
07-43	1087	281	7906	101	78	36	86	15	Malad, ID*
07-44	1132	384	8130	109	107	16	54	17	too small
07-45	1474	538	9834	109	110	30	57	24	too small
07-47	986	266	9175	126	75	29	92	16	Malad, ID
07-48	1834	360	13615	184	50	35	296	60	Fishing Bridge, Yellowstone, WY
07-49	1028	266	8314	122	75	28	88	22	Malad, ID
07-5	995	233	8093	120	74	32	98	16	Malad, ID
07-50	1094	413	6905	194	40	20	114	21	Grassy Lake, WY
07-51	1257	487	6163	155	13	11	64	40	El Rechuelos, NM
07-52	1164	442	7936	209	47	16	103	25	Grassy Lake, WY
07-53	953	263	8233	128	82	28	95	13	Malad, ID
07-6	1228	233	12172	177	39	64	258	31	Reas Pass, ID
07-7	705	701	7193	815	11	87	120	123	unknown, high Rb
07-8	777	733	7117	804	11	91	123	111	unknown, high Rb
07-9	797	785	7661	825	10	91	116	116	unknown, high Rb

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
RGM1-S3	1517	308	13287	151	114	19	224	7	standard
RGM1-S3	1636	302	13439	155	109	27	220	4	standard
RGM1-S3	1620	309	13343	151	109	30	223	6	standard
RGM1-S3	1727	324	13588	152	111	18	221	13	standard

* These samples are slightly outside the range of elemental concentrations, mainly due to small sample sizes (see Davis et al. 1998).

Table 2. Frequency distribution of obsidian source provenance for all sites.

		Frequency	Percent
Source	El Rechuelos, NM	1	2.1
	Fish Cr/Teton Pass, WY	3	6.4
	Fish/Partridge Cr, ID	1	2.1
	Fishing Bridge, Yellowstone, WY	1	2.1
	Grassy Lake, WY	2	4.3
	Malad, ID	14	29.8
	Obsidian Cliff, WY	6	12.8
	Reas Pass, ID	1	2.1
	Teton Pass, WY	9	19.1
	unknown	2	4.3
	unknown, high Rb	7	14.9
	Total	47	100.0

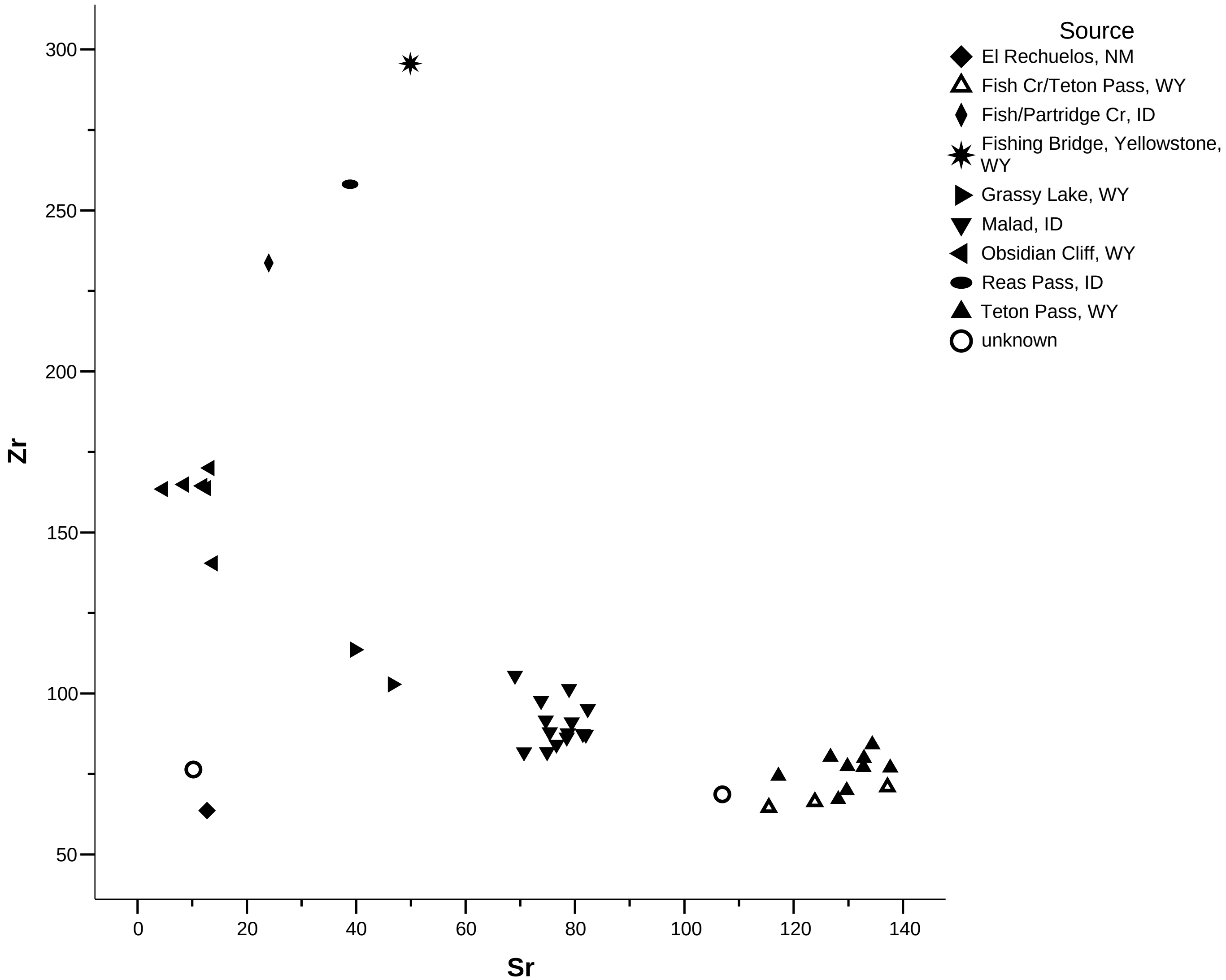

Figure 1. Sr versus Zr plot of the elemental concentrations for the archaeological specimens.

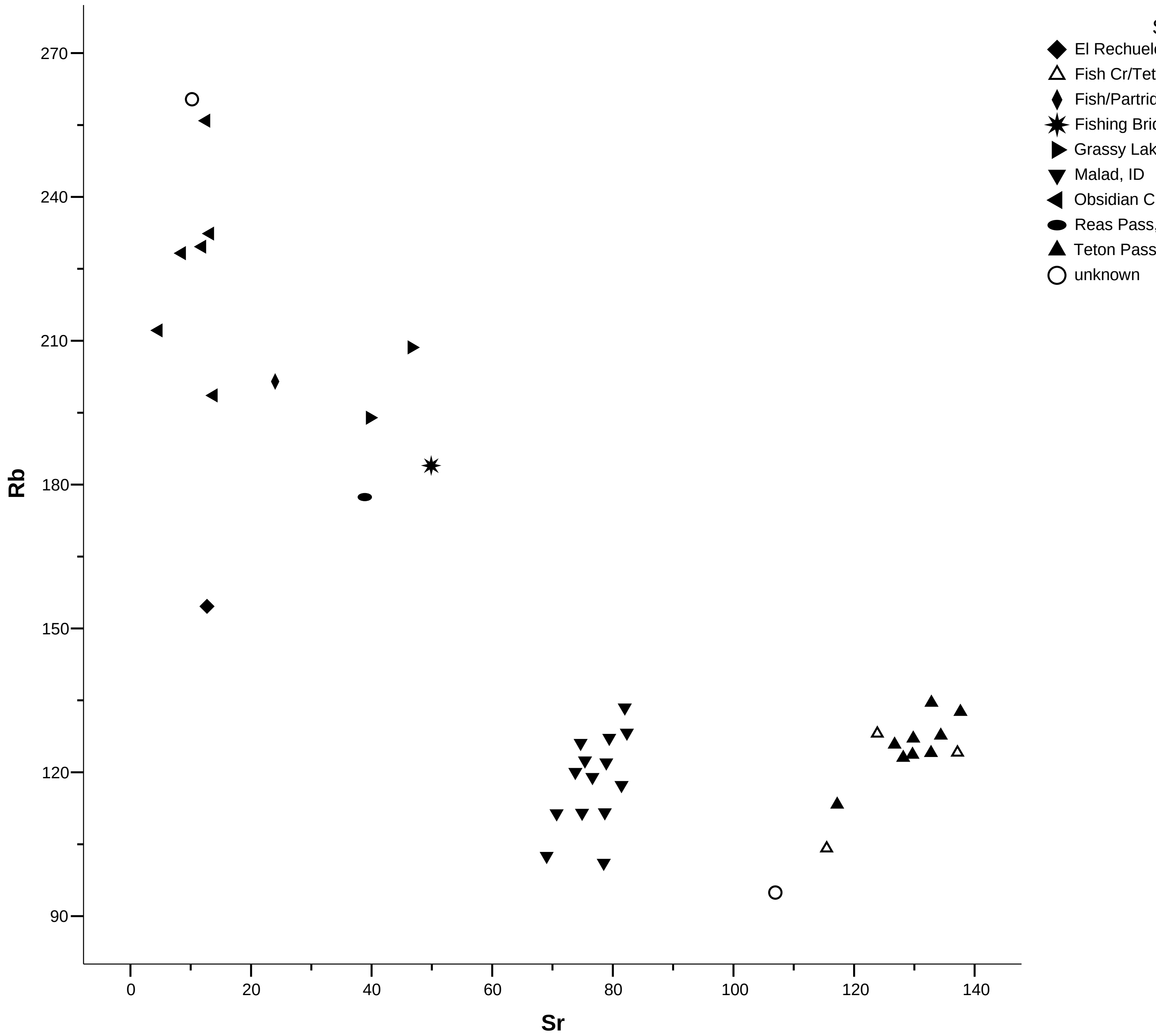

Figure 2. Sr versus Rb plot of archaeological specimens.

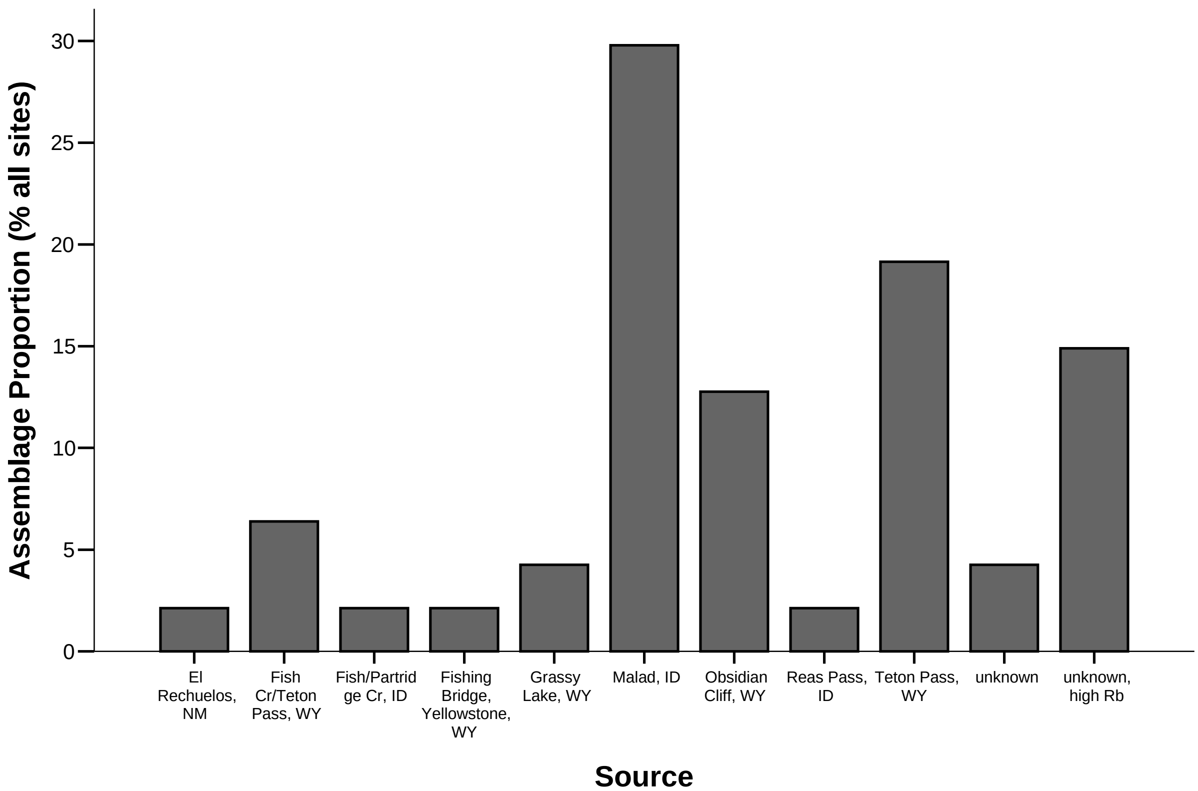

Figure 3. Frequency distribution of obsidian source provenance for all sites.