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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM A NUMBER OF PREHISTORIC SITES IN PARK COUNTY, WYOMING

by

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INTRODUCTION

The analysis here of 118 stone artifacts from 48PA2646, PA2665, PA2706, PA2860, PA2861 and the Spring Site at Boulder Ridge indicates a dominance of artifacts produced from one of the three chemical groups of the Obsidian Cliff dome complex in Yellowstone National Park, Wyoming (79.3%), and a few procured from Teton Pass to the southwest (8.6%). One significant group of unlocated sources in these sites suggests that the major group is relatively nearby, but has not been located and/or entered the published record (12.1%) .

LABORATORY SAMPLING, 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; Shackley 2010a).

All analyses for this study were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer, located in the Archaeological XRF Laboratory, El Cerrito, California. It is equipped with a thermoelectrically Peltier cooled solid-state Si(Li) X-ray detector, with a 50 kV, 50 W, ultra-high-flux end window bremsstrahlung, Rh target X-ray tube and a 76 μm (3 mil) beryllium (Be) window (air cooled), that runs on a power supply operating 4-50 kV/0.02-1.0 mA at 0.02 increments. The spectrometer is equipped with a 200 l min^{-1} Edwards vacuum pump, allowing for the analysis of lower-atomic-weight elements between sodium (Na) and titanium (Ti). Data acquisition is accomplished with a pulse processor and an analogue-to-digital converter. Elemental composition is identified with digital filter background removal, least

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squares empirical peak deconvolution, gross peak intensities and net peak intensities above background.

The analysis for mid Zb condition elements Ti-Nb, Pb, Th, the x-ray tube is operated at 30 kV, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity Ka-line data for elements titanium (Ti), manganese (Mn), iron (as $Fe_2O_3^T$), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). Not all these elements are reported since their values in many volcanic rocks are very low. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter 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 iron and thus for all the other elements. When barium (Ba) is analyzed in the High Zb condition, the Rh tube is operated at 50 kV and up to 1.0 mA, ratioed to the bremsstrahlung region (see Davis 2010; Shackley 2010a). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1995, 2005; also Mahood and Stimac 1991; and Hughes and Smith 1993). Nineteen specific pressed powder standards are used for the best fit regression calibration for elements Ti-Nb, Pb, Th, and Ba, include G-2 (basalt), AGV-2 (andesite), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (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), NOD-A-1 and NOD-P-1 (manganese) all US Geological Survey standards, NIST-278 (obsidian), U.S. National Institute

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of Standards and Technology, BE-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).

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 a USGS obsidian standard is analyzed during each sample run of 20 for obsidian artifacts to check machine calibration (Table 1).

Source assignments were made by reference to the Berkeley data base and information supplied by Fred Nelson, Brigham Young University, Skinner's Yellowstone study (2007), and the previous Indiana University study (Shackley 2007). Little source data for some of these sources is available in print or on the web. Further information on the laboratory instrumentation can be found at: http://www.swxrflab.net/. 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).

This assemblage, contained a number of samples that were near the smallest size that can be reliably analyzed with EDXRF (see Davis et. al. 2011; Table 2 here). For those samples below approximately 8 mm in smallest dimension, a 3.5 mm tube collimator was used. The instrument settings in this case were the same as for the standard 8.8 mm collimator used on the rest of the assemblage.

DISCUSSION

At only about 119 mean linear kilometers from these sites, the dominance of Yellowstone obsidian as a raw material is certainly expectable. It was one of the most dominant obsidian raw materials throughout prehistory and early history in the northern Plains, and has been found as

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far south as the Gulf of Mexico and throughout the eastern States particularly during the Hopewell period (Hughes 1992; Mills 1907; Shackley 1997).

Teton Pass obsidian is available at Teton Pass and Fish Creek in Teton County, Wyoming and appears to be an excellent raw material and is only about 135 km southwest of these sites, approximately the same as the Yellowstone sources. Teton Pass obsidian comprised 8.6% of the assemblage from all the sites.

The large group of unknowns is vexing. I conferred with Craig Skinner, and he has no published data on this source either. This group was not detected in the previous analyses of PA2665 and 2706 and occurred here in all the sites but Boulder Ridge (PA2665; Shackley 2007; see Table 3 here).

In this study, and attempt was made to discriminate the three major chemical groups previously assigned to Obsidian Cliff. In addition to the major dome complex at Obsidian Cliff, two other magmatically related sources occur in close proximity to Obsidian Cliff, Cougar Creek and Tanker Curve (Skinner 2007). Cougar Creek and Tanker Curve apparently have not eroded any distance away from the eruptive vent, while Obsidian Cliff has eroded through various stream channels including areas near the other two sources (Skinner 2007). Skinner notes that Cougar Creek and Tanker Curve appear rarely in archaeological contexts, presumably due to the numeric superiority of Obsidian Cliff, and much greater nodule sizes. Based on the elemental concentrations of Skinner's study, Cougar Creek and Tanker Curve obsidian does occur in these sites, but in relatively low proportions (Tables 2 and 3). This does suggest the possibility of an extended time that the prehistoric knappers may have spent in the Yellowstone area.

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Table 1. Recommended values for USGS RGM-1 obsidian standard and the mean and central tendency analyses from this study. ± = 1st standard deviation.

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba
RGM-1 (Govindaraju 1994)	1600	279	12998	149	108	25	219	8.9	807
RGM-1 (USGS recommended)[1]	1619±120	279±50	13010±210	150±8	110±10	25[2]	220±20	8.9±0.6	810±46
RGM-1, pressed powder standard (this study, n=6)	1577±31	281±4	13141±38	146±2	108±2	23±2	217±2	8.7±1.3	798[3]

[1] Ti, Mn, Fe calculated to ppm from wt. percent from USGS data.
[2] information value
[3] only one analysis for Ba

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Table 2. Elemental concentrations and source assignments for the archaeological specimens. All measurements in parts per million (ppm).

Site	Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba	Source
PA 2646											
North Sheep Trap	13	1610	285	14195	270	15	74	157	41		Obsidian Cliff
North Sheep Trap	27	1425	389	12453	105	177	23	156	12	1294	unknown
North Sheep Trap	41	1339	381	13583	128	177	21	114	16	1299	unknown
North Sheep Trap	47	1606	414	15479	133	188	23	124	13	1257	unknown
North Sheep Trap	65	1210	162	7026	0	12	1	15	3		not obsidian
North Sheep Trap	72	1375	295	12908	236	11	63	136	33		Cougar Creek
North Sheep Trap	76	988	134	6524	0	16	3	11	1		not obsidian
North Sheep Trap	87	1131	256	12295	245	11	71	153	42		Cougar Creek
North Sheep Trap	89	1707	242	11544	212	13	58	124	33		Cougar Creek
North Sheep Trap	90	864	251	10845	242	11	78	168	44		Obsidian Cliff
North Sheep Trap	93	1812	391	14641	114	151	21	95	7		unknown
North Sheep Trap	99	1489	432	13068	125	132	20	77	10		Teton Pass
North Sheep Trap	101	1455	411	14934	131	188	26	122	14	1319	unknown
North Sheep Trap	109	1260	277	13617	252	12	79	162	40		Obsidian Cliff
North Sheep Trap	112	1371	362	13357	126	167	22	119	14	1342	unknown
North Sheep Trap	134	1459	251	11962	236	10	74	153	37		Cougar Creek
Spring Site											
Spring Site	2	1040	343	10114	122	127	28	77	15	1416	Teton Pass
Spring Site	4	1068	336	10021	119	127	30	74	11		Teton Pass
Spring Site	5	945	246	11340	257	10	81	174	51		Obsidian Cliff
Spring Site	6	1187	393	11127	124	127	25	69	10		Teton Pass
Spring Site	10	1045	309	12895	237	16	89	230	76		unknown
Spring Site	14	1067	353	10330	127	132	31	79	14	1530	Teton Pass
PA 2665											
Boulder Ridge Camp Site	922	923	279	11837	265	12	77	178	48		Obsidian Cliff
Boulder Ridge Camp Site	947	1096	322	11213	242	17	78	169	36		Obsidian Cliff
Boulder Ridge Camp Site	951	987	244	11400	250	13	75	161	44		Obsidian Cliff
Boulder Ridge Camp Site	959	1012	291	11467	267	14	83	177	47		Obsidian Cliff
Boulder Ridge Camp Site	1422	936	252	11330	258	12	80	169	47		Obsidian Cliff
Boulder Ridge Camp	1857	867	244	1138	253	13	81	179	46		Obsidian Cliff

Site				6							
Boulder Ridge Camp	891	1127	264	1145	248	9	81	162	47		Obsidian Cliff
Site				2							
Boulder Ridge Camp	944	817	231	1060	249	11	79	163	46		Obsidian Cliff
Site				6							
Boulder Ridge Camp	945	896	245	1108	253	13	82	175	43		Obsidian Cliff
Site				4							
Boulder Ridge Camp	968	874	271	1136	262	11	82	170	49		Obsidian Cliff
Site				8							
Boulder Ridge Camp	999	897	232	1062	239	11	75	161	43		Obsidian Cliff
Site				3							
Boulder Ridge Camp	1000	976	259	1249	287	11	82	180	45		Tanker Curve
Site				5							
Boulder Ridge Camp	1002	964	276	1258	278	11	87	190	48		Tanker Curve
Site				3							
Boulder Ridge Camp	1018	1022	256	1264	289	13	81	178	45		Tanker Curve
Site				2							
Boulder Ridge Camp	1019	918	258	1227	282	11	83	175	48		Tanker Curve
Site				7							
Boulder Ridge Camp	1030	944	275	1185	262	12	83	171	48		Obsidian Cliff
Site				9							
Boulder Ridge Camp	1041	1041	268	1337	294	12	86	176	43		Tanker Curve
Site				2							
Boulder Ridge Camp	1097	944	256	1179	266	12	82	173	47		Obsidian Cliff
Site				3							
Boulder Ridge Camp	1098	914	230	1126	254	12	79	175	48		Obsidian Cliff
Site				9							
Boulder Ridge Camp	1206	906	240	1166	272	8	84	181	48		Obsidian Cliff
Site				5							
Site	**Sample**	**Ti**	**Mn**	**Fe**	**Rb**	**Sr**	**Y**	**Zr**	**Nb**	**Ba**	**Source**
Boulder Ridge Camp	1221	927	238	1136	256	9	82	171	51		Obsidian Cliff
Site				3							
Boulder Ridge Camp	1331	1090	381	1096	133	136	26	80	13		Teton Pass
Site				8							
Boulder Ridge Camp	1343	933	234	1159	263	11	79	171	45		Obsidian Cliff
Site				5							
Boulder Ridge Camp	1361	1286	368	1062	122	130	26	79	13		Teton Pass
Site				8							
Boulder Ridge Camp	1363	1048	383	1083	127	129	24	78	13		Teton Pass
Site				7							
Boulder Ridge Camp	1373	1157	414	1171	133	135	31	76	16		Teton Pass
Site				8							
Boulder Ridge Camp	1416	968	253	1217	272	12	88	186	49		Tanker Curve
Site				5							
Boulder Ridge Camp	1421	954	249	1124	255	13	80	172	46		Obsidian Cliff
Site				5							
Boulder Ridge Camp	1524	866	235	1068	241	11	80	166	45		Obsidian Cliff
Site				6							
Boulder Ridge Camp	1544	936	226	1125	255	12	80	175	45		Obsidian Cliff
Site				7							
Boulder Ridge Camp	1593	1109	250	1256	269	14	82	171	44		Obsidian Cliff
Site				6							
Boulder Ridge Camp	1594	911	243	1127	260	8	75	169	45		Obsidian Cliff
Site				3							
Boulder Ridge Camp	1595	917	242	1182	267	12	81	173	48		Obsidian Cliff
Site				8							
Boulder Ridge Camp	1599	892	225	1054	243	8	73	161	48		Obsidian Cliff
Site				8							
Boulder Ridge Camp	1608	1083	249	1123	252	9	76	162	46		Obsidian Cliff
Site				7							
Boulder Ridge Camp	1621	1267	349	1222	111	162	21	115	12		unknown
Site				2							

Boulder Ridge Camp Site		1641	934	262	11728	257	11	76	171	44	Obsidian Cliff
Boulder Ridge Camp Site		1653	1234	352	12343	116	164	25	118	13	unknown
Boulder Ridge Camp Site		1681	1260	330	12109	114	155	25	105	14	unknown
Boulder Ridge Camp Site		1686	945	233	10508	235	9	74	159	43	Cougar Creek
Boulder Ridge Camp Site		1698	922	234	10261	232	11	74	161	43	Obsidian Cliff
Boulder Ridge Camp Site		1716	926	237	11243	264	11	83	177	48	Obsidian Cliff
Boulder Ridge Camp Site		1861	1184	368	8953	193	48	19	113	28	unknown
PA 2861											
Late Archaic Pt		1	926	227	11443	256	10	83	173	51	Obsidian Cliff
Late Archaic Pt		2	907	225	11400	253	13	86	171	47	Obsidian Cliff
Late Archaic Pt		3	902	222	10887	252	10	77	167	45	Obsidian Cliff
Late Archaic Pt		4	963	257	12210	281	11	87	183	52	Tanker Curve
Late Archaic Pt		5	939	254	11145	257	11	80	169	43	Obsidian Cliff
Late Archaic Pt		6	996	251	12337	279	11	82	180	51	Tanker Curve
PA 2860											
Sugar Bear	1		911	241	11493	257	11	77	173	45	Obsidian Cliff
Sugar Bear	2		907	237	11086	251	12	82	171	45	Obsidian Cliff
Sugar Bear	3		910	246	11285	256	11	79	172	51	Obsidian Cliff
Sugar Bear	5		1151	338	14874	251	15	90	230	74	unknown
Sugar Bear	4		881	226	11017	245	8	75	168	48	Obsidian Cliff
PA 2706											
Downhill		130	1058	240	10602	242	11	77	170	46	Obsidian Cliff
Downhill		181	1132	262	12189	259	17	81	174	49	Obsidian Cliff
Downhill		274	1064	246	11033	247	12	80	175	48	Obsidian Cliff
Downhill		442	961	259	11604	257	10	79	171	44	Obsidian Cliff
Downhill		443	911	221	10264	231	11	76	162	45	Obsidian Cliff
Downhill		583	904	219	10169	234	12	76	166	44	Obsidian Cliff
Downhill		585	938	242	11460	264	11	81	178	50	Obsidian Cliff
Downhill		588	1021	247	11276	261	9	86	180	49	Obsidian Cliff
Downhill		609	1541	423	12666	137	147	27	93	15	Teton Pass
Downhill		623	1189	271	11655	185	25	77	189	64	unknown
Site	**Sample**		**Ti**	**Mn**	**Fe**	**Rb**	**Sr**	**Y**	**Zr**	**Nb**	**Ba**	**Source**
Downhill		625	992	236	1157	252	10	81	166	49	Obsidian Cliff

Downhill	627	949	247	11142	258	8	83	174	46		Obsidian Cliff
Downhill	628	1066	248	11664	262	13	82	180	47		Obsidian Cliff
Downhill	629	909	244	11376	262	13	77	173	45		Obsidian Cliff
Downhill	630	955	257	12103	282	11	86	183	49		Tanker Curve
Downhill	631	970	234	11488	253	8	80	171	46		Obsidian Cliff
Downhill	632	876	212	10086	226	8	76	162	43		Obsidian Cliff
Downhill	633	917	221	10249	234	13	76	164	43		Obsidian Cliff
Downhill	634	914	245	11413	264	9	84	178	48		Obsidian Cliff
Downhill	635	1186	283	12358	261	12	81	180	46		Obsidian Cliff
Downhill	636	1817	273	12260	268	13	85	182	49		Obsidian Cliff
Downhill	637	950	235	11977	258	12	82	174	52		Obsidian Cliff
Downhill	641	917	235	11496	264	11	80	176	45		Obsidian Cliff
Downhill	643	939	253	12013	273	10	86	184	51		Tanker Curve
Downhill	644	995	256	12476	280	9	82	181	48		Tanker Curve
Downhill	645	947	231	11037	259	8	75	168	49		Obsidian Cliff
Downhill	646	913	233	10909	248	10	78	169	45		Obsidian Cliff
Downhill	658	846	254	10896	251	11	79	172	46		Obsidian Cliff
Downhill	659	949	254	11457	260	11	81	176	48		Obsidian Cliff
Downhill	660	919	242	10880	243	14	79	170	46		Obsidian Cliff
Downhill	684	1010	247	11134	263	10	82	181	46		Obsidian Cliff
Downhill	890	974	267	11861	267	12	80	179	46		Obsidian Cliff
Downhill	912	939	223	11068	248	12	85	169	48		Obsidian Cliff
Downhill	936	993	249	12145	269	11	77	181	51		Obsidian Cliff
Downhill	938	932	243	11470	259	11	77	172	49		Obsidian Cliff
Downhill	939	944	241	11361	255	11	79	177	45		Obsidian Cliff
Downhill	940	930	245	11235	248	10	79	167	45		Obsidian Cliff
Downhill	1074	932	233	11076	248	9	76	171	43		Obsidian Cliff
Downhill	1075	1004	243	11739	255	9	77	171	46		Obsidian Cliff
Downhill	1076	948	210	10752	253	11	77	167	45		Obsidian Cliff
Downhill	1149	1149	329	11349	108	149	22	111	15	1412	unknown
Downhill	1073	905	226	1059	236	8	74	169	45		Obsidian Cliff

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Table 2. Crosstabulation of obsidian source provenance by site. Includes only obsidian artifacts.

			Source						
			Cougar Creek	not obsidian	Obsidian Cliff	Tanker Curve	Teton Pass	unknown	Total
Site	Boulder Ridge Camp Site	Count	1	0	28	6	4	4	43
		% within Site	2.3%	.0%	65.1%	14.0%	9.3%	9.3%	100.0%
		% within Source	20.0%	.0%	36.8%	54.5%	40.0%	28.6%	36.4%
		% of Total	.8%	.0%	23.7%	5.1%	3.4%	3.4%	36.4%
	Downhill	Count	0	0	36	3	1	2	42
		% within Site	.0%	.0%	85.7%	7.1%	2.4%	4.8%	100.0%
		% within Source	.0%	.0%	47.4%	27.3%	10.0%	14.3%	35.6%
		% of Total	.0%	.0%	30.5%	2.5%	.8%	1.7%	35.6%
	Late Archaic Pt	Count	0	0	4	2	0	0	6
		% within Site	.0%	.0%	66.7%	33.3%	.0%	.0%	100.0%
		% within Source	.0%	.0%	5.3%	18.2%	.0%	.0%	5.1%
		% of Total	.0%	.0%	3.4%	1.7%	.0%	.0%	5.1%
	North Sheep Trap	Count	4	2	3	0	1	6	16
		% within Site	25.0%	12.5%	18.8%	.0%	6.3%	37.5%	100.0%
		% within Source	80.0%	100.0%	3.9%	.0%	10.0%	42.9%	13.6%
		% of Total	3.4%	1.7%	2.5%	.0%	.8%	5.1%	13.6%
	Spring Site	Count	0	0	1	0	4	1	6
		% within Site	.0%	.0%	16.7%	.0%	66.7%	16.7%	100.0%
		% within Source	.0%	.0%	1.3%	.0%	40.0%	7.1%	5.1%
		% of Total	.0%	.0%	.8%	.0%	3.4%	.8%	5.1%
	Sugar Bear	Count	0	0	4	0	0	1	5
		% within Site	.0%	.0%	80.0%	.0%	.0%	20.0%	100.0%
		% within Source	.0%	.0%	5.3%	.0%	.0%	7.1%	4.2%
		% of Total	.0%	.0%	3.4%	.0%	.0%	.8%	4.2%
Total		Count	5	2	76	11	10	14	118
		% within Site	4.2%	1.7%	64.4%	9.3%	8.5%	11.9%	100.0%
		% within Source	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	4.2%	1.7%	64.4%	9.3%	8.5%	11.9%	100.0%

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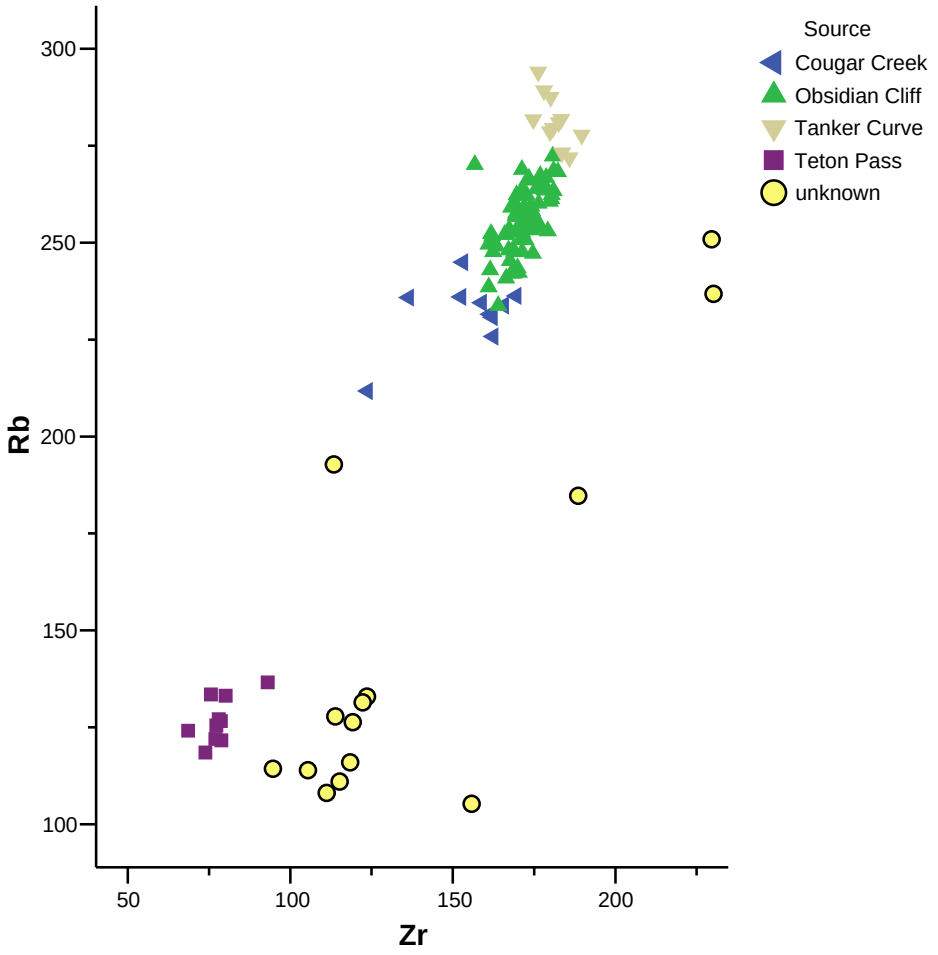


Figure 1. Zr versus Rb, bivariate plot of the elemental concentrations for all archaeological specimens. Non-obsidian removed.

www.escholarship.org/uc/item/4hn0086j

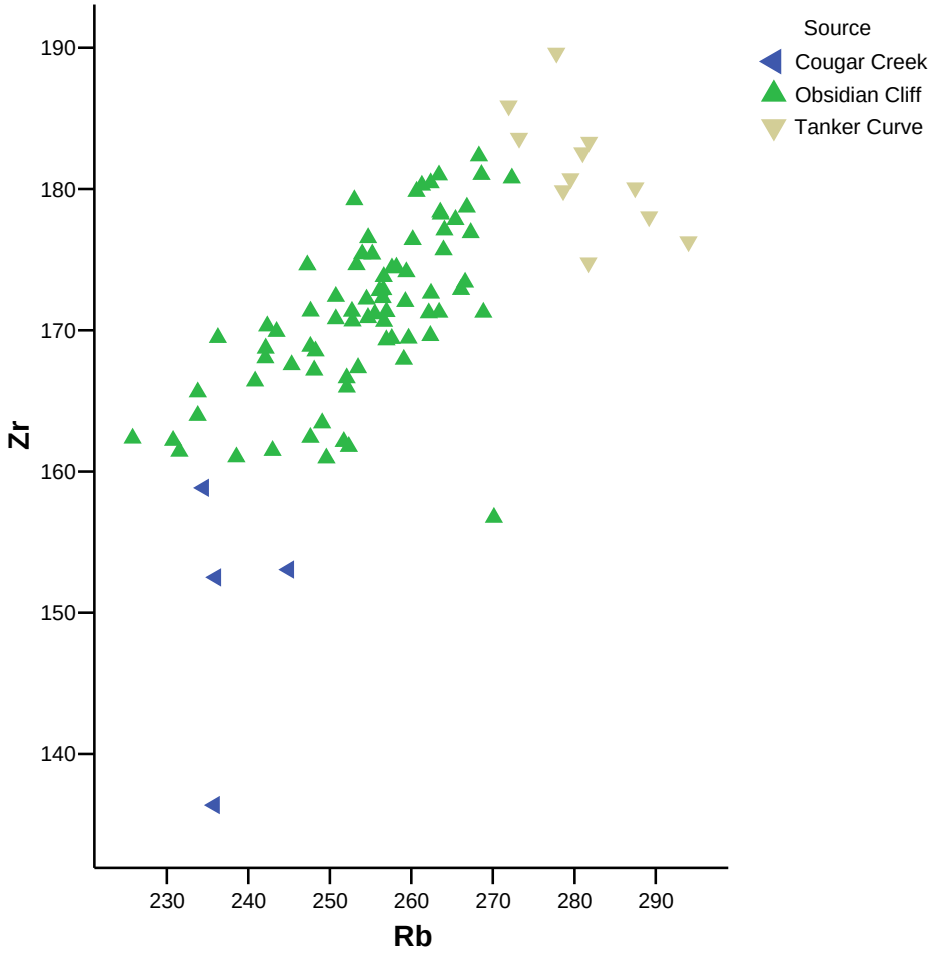


Figure 2. Rb versus Zr bivariate plot of the specimens assigned to the Yellowstone dome complex obsidian sources. Subsource assignment based on data in Skinner (2007).