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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM LATE PERIOD SITES IN THE PERRY MESA AREA, CENTRAL ARIZONA

NOTE TO READER: "UNKNOWNS" ARE NOW ASSIGNED TO SOURCE BASED ON LATER DISCOVERIES

by

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INTRODUCTION

One of the largest obsidian studies in the region, the analysis here of over 200 obsidian artifacts from late period contexts in the Perry Mesa area of central Arizona indicates a reliance on Government Mountain obsidian almost exclusively to the exclusion of other sources in northern Arizona. Minor amounts of Mount Floyd Volcanic Field obsidian was also used, but in very low proportions.

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),

and niobium (Nb). 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, 2003; 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, 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, Th, 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. An analysis of RGM-1 is included in Table 1. Source nomenclature follows Lesko (1989) and Shackley (1988, 1995, 2005). Further information on the laboratory instrumentation can be found at: http://www.swxrflab.net/ and Shackley (1998). Trace element data exhibited in Tables 1 and 2 are reported in parts per million (ppm), a quantitative measure by weight (see also Figure 1).

DISCUSSION

While it is not unusual for Government Mountain obsidian to dominate central and northern Arizona assemblages, it is unusual to see a nearly complete dominance in a late period assemblage (Bayman and Shackley 1999; Shackley 2005; see Table 3 and Figure 2 here). It is one of the best obsidian media for tool production, and for the large nodule Quaternary sources the best in my estimation. This, however, does not necessarily explain the dominance in these sites. More likely it is an interface between raw material quality, access, and social factors. Perhaps more significant is the complete lack of obsidian raw material from Sonoran Desert sources (e.g. Vulture, Sauceda Mountains) which are approximately the same distance, but to the south. This northern dominance of raw materials may be mirrored in other data sets as well. The obsidian source provenance suggests that the procurement range or group interactions were to the north rather than south.

A note about the Mount Floyd Field sources: The sources in the Mount Floyd field have been named in a somewhat confusing way (Lesko 1989; Tables 2 and 3 here). This is, in part, due to the naming conventions similar to taphonomic conventions in biology. The first name used is normally the one kept, with some important exceptions. So, Partridge Creek is used for that chemical group derived from the Round Mountain dome, Presley Wash for the glassy rhyo-dacites recovered in the upper Partridge Creek system, and Black Tank for the marekanites from that feature north of Round Mountain. In Figure 2, I have used Round Mountain for the Partridge Creek locality, and Presley Wash/Partridge Creek for the Presley Wash locality. Partridge Creek (Round Mountain) glass is available throughout the Partridge Creek stream system at least as far as Chino Valley relatively near these sites. The relatively low proportion of Partridge Creek in these sites then is a further indication of raw material preference and/or social factors in procurement given the dominance of Government Mountain obsidian.

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Table 1. X-ray fluorescence concentrations for selected trace elements for RGM-1 (n=10 runs). ± values represent first standard deviation computations for the group of measurements. All values are in parts per million (ppm) as reported in Govindaraju (1994) and this study. RGM-1 is a U.S. Geological rhyolite standard. Fe^T can be converted to $Fe_2O_3^T$ with a multiplier of 1.4297(10-4) (see also Glascock 1991).

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb
RGM-1 (Govindaraju 1994)	1600	279	12998	149	108	25	219	8.9
RGM-1 (this study; n=10)	1585±72	308±16	13158±129	148±3	109±2	20±2	216±5	8±2

Table 2. Elemental concentrations and source assignments for the archaeological specimens.

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
NA 11434-1	735	555	7770	98	78	16	78	53	Government Mtn
2	804	555	7896	105	77	13	83	49	Government Mtn
3	766	522	7621	98	74	17	70	49	Government Mtn
4	756	599	7721	104	81	10	78	51	Government Mtn
7	749	545	7537	102	78	18	77	51	Government Mtn
8	763	551	7220	100	67	17	75	43	Government Mtn
9	1527	628	12460	67	351	12	94	28	Burro Creek
10	1673	330	14715	81	183	13	133	22	Presley Wash
11	855	542	8204	100	78	17	82	52	Government Mtn
13	890	632	8477	108	79	17	77	54	Government Mtn
14	1705	356	14580	78	179	6	135	16	Presley Wash
15	772	562	8182	111	82	18	80	58	Government Mtn
17	770	635	8047	107	76	24	79	58	Government Mtn
18	740	624	8336	109	81	14	80	50	Government Mtn
19	809	462	7290	95	70	14	69	52	Government Mtn
20	834	561	7973	91	71	21	68	50	Government Mtn
21	825	483	7538	236	8	35	87	58	Partridge Creek
22	743	570	7662	99	77	20	79	57	Government Mtn
23	721	601	8101	102	76	23	75	47	Government Mtn
24	791	579	7960	104	80	10	72	56	Government Mtn
25	793	622	8414	111	85	20	80	63	Government Mtn
26	1474	330	13514	86	183	5	128	9	Presley Wash
27	816	636	8445	104	83	15	74	46	Government Mtn
28	815	624	8532	110	83	18	76	45	Government Mtn
29	777	716	8424	109	77	18	71	39	Government Mtn
32	1699	393	14710	88	187	14	140	18	Presley Wash
33	917	570	7614	103	77	15	74	51	Government Mtn
34	772	542	8097	107	76	15	74	61	Government Mtn
35	932	615	7866	105	78	13	69	54	Government Mtn
36	1006	630	8392	101	81	10	70	48	Government Mtn
NA11439.5	811	553	7837	100	78	21	76	47	Government Mtn
1	831	488	7491	93	75	13	66	58	Government Mtn
6	858	541	7538	94	72	18	75	52	Government Mtn
9	809	892	10889	114	85	23	89	60	Government Mtn
10	746	635	8388	108	83	26	78	53	Government Mtn
11	798	569	7814	105	74	17	81	52	Government Mtn
12	745	516	7340	98	76	15	70	49	Government Mtn
NA11645.1	1040	640	9020	97	77	14	72	56	Government Mtn

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
NA11438.1	781	535	7882	108	78	21	73	52	Government Mtn
2	769	593	8245	107	79	21	81	54	Government Mtn
3	775	568	8014	106	79	11	78	56	Government Mtn
NA13312.1	836	522	7684	96	68	16	62	46	Government Mtn
NA13317.1	707	671	8093	98	77	19	72	57	Government Mtn
NA13317.1	748	528	7100	97	68	18	71	48	Government Mtn
NA5423.2	5530	602	9525	105	75	16	75	57	Government Mtn
3	731	575	7354	97	69	14	66	50	Government Mtn
4	786	631	8291	107	76	17	76	59	Government Mtn
5	759	634	8034	109	83	13	74	57	Government Mtn
6	827	552	7606	96	74	22	75	47	Government Mtn
7	1146	479	8590	221	15	34	82	41	Partridge Creek
8	843	589	7790	101	77	19	71	59	Government Mtn
9	783	608	8180	107	80	19	79	55	Government Mtn
10	800	565	7354	95	75	18	71	58	Government Mtn
11	802	605	8031	104	77	20	73	55	Government Mtn
12	769	498	7008	96	65	15	72	57	Government Mtn
13	870	515	7807	99	71	18	84	46	Government Mtn
14	802	630	7915	97	73	20	80	55	Government Mtn
15	861	629	8458	106	74	17	72	60	Government Mtn
16	716	577	7601	102	75	14	78	54	Government Mtn
17	719	529	7964	103	78	14	77	55	Government Mtn
18	798	499	7336	91	67	17	75	50	Government Mtn
19	841	586	8399	102	75	13	69	61	Government Mtn
20	770	560	7552	95	68	18	72	54	Government Mtn
21	760	485	7139	98	71	21	77	55	Government Mtn
22	739	577	7538	93	74	20	74	49	Government Mtn
23	786	548	7707	102	76	12	67	47	Government Mtn
24	862	643	9015	106	76	20	83	62	Government Mtn
25	799	613	8165	106	79	20	73	43	Government Mtn
26	739	594	8223	104	75	12	76	53	Government Mtn
27	744	546	7467	99	75	17	72	52	Government Mtn
28	795	517	8349	101	71	16	71	52	Government Mtn
29	1381	559	7726	99	66	19	79	49	Government Mtn
30	830	570	7612	101	75	16	71	57	Government Mtn
33	789	652	5141	120	28	16	41	74	Topaz Basin
NA11434.13	785	605	8396	112	83	13	81	55	Government Mtn
14	752	579	8029	106	79	18	80	48	Government Mtn
52	731	615	7935	105	78	14	71	60	Government Mtn
53	774	627	7902	101	79	16	78	61	Government Mtn
54	756	532	7540	97	73	14	74	46	Government Mtn
55	849	521	8138	103	77	11	71	50	Government Mtn
56	796	588	7836	103	73	19	76	51	Government Mtn
57	747	600	8414	110	83	11	79	48	Government Mtn
58	780	587	7891	106	76	17	80	53	Government Mtn
59	675	584	7873	102	75	17	77	46	Government Mtn
60	848	555	7706	94	72	21	74	53	Government Mtn
61	767	598	7826	102	84	23	69	51	Government Mtn
62	714	568	7601	100	72	15	79	49	Government Mtn
63	742	464	6645	90	69	19	77	50	Government Mtn
64	700	587	7496	99	76	17	72	50	Government Mtn
65	734	484	7577	97	71	13	69	38	Government Mtn
69	885	557	8336	96	68	16	73	57	Government Mtn
Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source

NA5422.2	725	568	8169	104	75	18	80	56	Government Mtn
3	823	487	8033	235	10	29	92	58	Partridge Creek
4	797	587	8196	98	74	18	82	49	Government Mtn
NA10022.1	739	611	8150	105	79	19	75	58	Government Mtn
2	789	563	8244	105	85	18	78	63	Government Mtn
22.3	863	581	8832	106	82	16	75	61	Government Mtn
22.4	776	581	8005	108	78	13	80	52	Government Mtn
22.5	30922	457	6757	95	66	14	74	48	Government Mtn
22.6	747	503	7306	97	71	13	73	47	Government Mtn
22.7	773	552	7707	97	77	17	78	53	Government Mtn
NA10066.2	970	591	7731	102	78	12	70	50	Government Mtn
66.3	913	553	8457	102	76	20	71	55	Government Mtn
66.4	856	554	8024	100	73	14	68	52	Government Mtn
NA10067.2	704	572	7336	97	77	15	77	42	Government Mtn
67.3	776	616	7735	107	69	13	79	48	Government Mtn
67.4	816	549	7547	98	69	17	70	56	Government Mtn
NA10070.1	712	468	7267	83	75	13	75	40	Government Mtn
NA 11648-64	743	603	8239	106	82	19	75	54	Government Mtn
73	901	611	8650	98	67	23	77	51	Government Mtn
88	704	595	7211	91	71	23	71	46	Government Mtn
98	768	492	7153	97	78	20	70	52	Government Mtn
105	713	623	8498	107	79	16	80	58	Government Mtn
117	718	508	7546	102	77	16	80	58	Government Mtn
143	774	559	7182	95	75	20	71	55	Government Mtn
148	793	627	7717	101	72	17	76	57	Government Mtn
155	692	575	7621	101	77	15	79	55	Government Mtn
175	740	506	6974	97	74	10	76	56	Government Mtn
179	910	530	7854	93	75	15	71	49	Government Mtn
181	785	567	7857	104	80	19	75	56	Government Mtn
182	1150	371	4811	91	70	7	104	108	Government Mtn
182	730	632	8159	111	81	22	77	53	Government Mtn
183	1018	3101	5302	31	29	9	281	18	not obsidian
183	759	601	8083	105	76	25	74	51	Government Mtn
191	870	3764	4663	21	15	0	330	8	not obsidian
191	690	550	7382	97	75	13	80	61	Government Mtn
194	687	554	8027	102	80	19	77	53	Government Mtn
235	798	582	8054	105	75	16	76	56	Government Mtn
115B	724	517	7398	99	72	22	75	46	Government Mtn
118B	784	542	7966	97	78	15	69	57	Government Mtn
135B	724	484	6818	87	70	20	72	50	Government Mtn
136B	776	598	7989	107	79	18	81	49	Government Mtn
13B	914	685	8929	109	75	20	80	60	Government Mtn
144B	748	661	8532	103	76	15	80	62	Government Mtn
146B	772	529	7054	91	69	21	68	48	Government Mtn
153B	768	533	7835	105	80	17	75	46	Government Mtn
154B	802	610	8322	106	86	22	83	51	Government Mtn
156B	811	591	8037	103	82	15	74	53	Government Mtn
157B	771	577	8221	111	79	17	79	59	Government Mtn
158B	666	591	7966	103	76	21	78	55	Government Mtn
161B	721	602	7974	104	77	20	69	53	Government Mtn
162B	777	598	7933	102	79	18	82	57	Government Mtn
165B	648	466	6412	86	71	11	62	45	Government Mtn
167B	733	573	7976	103	81	13	76	51	Government Mtn
Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source

171B	792	570	7790	109	78	22	77	55	Government Mtn
172B	688	554	7598	104	80	18	70	50	Government Mtn
176B	842	715	5566	118	30	18	50	70	Government Mtn
178B	795	532	7246	100	74	20	77	48	Government Mtn
17B	697	603	8074	104	79	18	76	55	Government Mtn
185B-1	911	3580	5239	24	26	-1	307	10	not obsidian
185B	759	597	7869	108	75	16	74	60	Government Mtn
187B	987	3529	4811	19	22	-3	312	18	not obsidian
187B	839	555	8263	102	76	20	75	46	Government Mtn
192B	810	584	7949	100	75	16	69	46	Government Mtn
193B	735	583	7936	108	84	17	76	47	Government Mtn
196F	909	567	8413	99	73	14	79	48	Government Mtn
19B	821	574	8074	105	75	15	67	58	Government Mtn
200B	829	611	8290	107	81	18	80	55	Government Mtn
203B	756	553	7264	95	73	19	74	50	Government Mtn
204B	749	590	8006	98	83	19	75	54	Government Mtn
208B	836	612	8934	102	82	18	77	54	Government Mtn
210B	784	573	7971	102	76	16	72	51	Government Mtn
212B	952	581	9266	106	78	19	73	49	Government Mtn
218B	766	453	6803	74	63	18	49	49	Government Mtn
229E	813	582	8730	116	81	18	78	53	Government Mtn
25B	931	600	8605	105	78	13	72	53	Government Mtn
36B	911	531	8517	102	80	15	77	49	Government Mtn
37B	727	570	7880	102	74	18	73	49	Government Mtn
39B	814	511	7074	99	78	13	63	41	Government Mtn
42B	735	612	8634	106	86	16	75	44	Government Mtn
63B	752	655	8570	110	84	19	76	66	Government Mtn
72F	868	562	7914	100	81	9	75	52	Government Mtn
77B	791	496	7738	102	73	17	74	44	Government Mtn
NA 12556-1	792	532	7887	95	72	16	75	50	Government Mtn
2	776	552	7545	105	75	13	74	48	Government Mtn
3	700	613	7846	102	78	17	74	54	Government Mtn
4	764	568	7627	104	76	20	81	55	Government Mtn
5	648	552	7608	97	70	21	69	44	Government Mtn
6	682	557	7630	98	75	20	74	47	Government Mtn
9	771	678	7937	97	74	11	78	49	Government Mtn
10	728	644	8615	108	77	18	82	57	Government Mtn
11	844	590	7875	102	73	17	69	46	Government Mtn
12	815	655	5152	119	27	11	47	71	Topaz Basin
13A	737	531	7574	100	77	13	76	59	Government Mtn
13B	738	597	7344	98	74	15	75	46	Government Mtn
14	714	571	7721	101	82	21	78	53	Government Mtn
15	841	524	7609	97	77	22	76	39	Government Mtn
16	884	573	7515	99	70	18	79	46	Government Mtn
17	729	679	8560	107	81	15	76	48	Government Mtn
18	711	595	8133	105	80	11	82	49	Government Mtn
19	786	690	8583	111	78	18	81	46	Government Mtn
21	737	612	8596	112	82	17	83	53	Government Mtn
23	733	581	7756	95	76	15	78	57	Government Mtn
25	813	677	8924	114	84	19	88	56	Government Mtn
26	800	574	8084	105	79	22	75	56	Government Mtn
27	739	611	7799	105	77	20	73	53	Government Mtn
28	752	650	8673	116	82	17	79	57	Government Mtn
Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
29	721	544	8026	105	76	14	78	59	Government Mtn

30A	814	599	7904	103	79	18	78	55	Government Mtn
31	693	582	7696	103	77	14	72	55	Government Mtn
32	1579	356	14043	84	178	11	137	14	Pressley Wash
33	733	628	8111	106	81	21	77	52	Government Mtn
34	754	618	8250	109	79	18	83	58	Government Mtn
35	746	541	7270	104	74	11	68	37	Government Mtn
37	1418	512	12862	119	126	14	99	33	Black Tank
38	706	565	7925	108	75	17	81	50	Government Mtn

Table 3. Crosstabulation of site by obsidian source provenance. Non-obsidian removed.

			Source					
			Black Tank	Government Mtn	Partridge Creek	Presley Wash	unknown	Total
Sample	NA 11434	Count	0	24	1	4	1	30
		% within Sample	.0%	80.0%	3.3%	13.3%	3.3%	100.0%
		% within Source	.0%	12.6%	33.3%	80.0%	50.0%	14.9%
		% of Total	.0%	11.9%	.5%	2.0%	.5%	14.9%
	NA 11648	Count	0	61	0	0	0	61
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	31.9%	.0%	.0%	.0%	30.2%
		% of Total	.0%	30.2%	.0%	.0%	.0%	30.2%
	NA 12556	Count	1	30	0	1	1	33
		% within Sample	3.0%	90.9%	.0%	3.0%	3.0%	100.0%
		% within Source	100.0%	15.7%	.0%	20.0%	50.0%	16.3%
		% of Total	.5%	14.9%	.0%	.5%	.5%	16.3%
	NA10022	Count	0	7	0	0	0	7
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	3.7%	.0%	.0%	.0%	3.5%
		% of Total	.0%	3.5%	.0%	.0%	.0%	3.5%
	NA10066	Count	0	3	0	0	0	3
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	1.6%	.0%	.0%	.0%	1.5%
		% of Total	.0%	1.5%	.0%	.0%	.0%	1.5%
	NA10067	Count	0	3	0	0	0	3
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	1.6%	.0%	.0%	.0%	1.5%
		% of Total	.0%	1.5%	.0%	.0%	.0%	1.5%
	NA10070.1	Count	0	1	0	0	0	1
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	.5%	.0%	.0%	.0%	.5%
		% of Total	.0%	.5%	.0%	.0%	.0%	.5%
	NA11434	Count	0	17	0	0	0	17
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	8.9%	.0%	.0%	.0%	8.4%
		% of Total	.0%	8.4%	.0%	.0%	.0%	8.4%
	NA11438	Count	0	3	0	0	0	3
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	1.6%	.0%	.0%	.0%	1.5%
		% of Total	.0%	1.5%	.0%	.0%	.0%	1.5%
	NA11439	Count	0	7	0	0	0	7
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	3.7%	.0%	.0%	.0%	3.5%
		% of Total	.0%	3.5%	.0%	.0%	.0%	3.5%
	NA11645.1	Count	0	1	0	0	0	1
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	.5%	.0%	.0%	.0%	.5%
		% of Total	.0%	.5%	.0%	.0%	.0%	.5%
	NA13312.1	Count	0	1	0	0	0	1
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	.5%	.0%	.0%	.0%	.5%
		% of Total	.0%	.5%	.0%	.0%	.0%	.5%
	NA13317.1	Count	0	2	0	0	0	2
		% within Sample	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within Source	.0%	1.0%	.0%	.0%	.0%	1.0%
		% of Total	.0%	1.0%	.0%	.0%	.0%	1.0%
	NA5422	Count	0	2	1	0	0	3
		% within Sample	.0%	66.7%	33.3%	.0%	.0%	100.0%
		% within Source	.0%	1.0%	33.3%	.0%	.0%	1.5%
		% of Total	.0%	1.0%	.5%	.0%	.0%	1.5%
	NA5423	Count	0	29	1	0	0	30
		% within Sample	.0%	96.7%	3.3%	.0%	.0%	100.0%
		% within Source	.0%	15.2%	33.3%	.0%	.0%	14.9%
		% of Total	.0%	14.4%	.5%	.0%	.0%	14.9%
Total		Count	1	191	3	5	2	202
		% within Sample	.5%	94.6%	1.5%	2.5%	1.0%	100.0%
		% within Source	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	.5%	94.6%	1.5%	2.5%	1.0%	100.0%

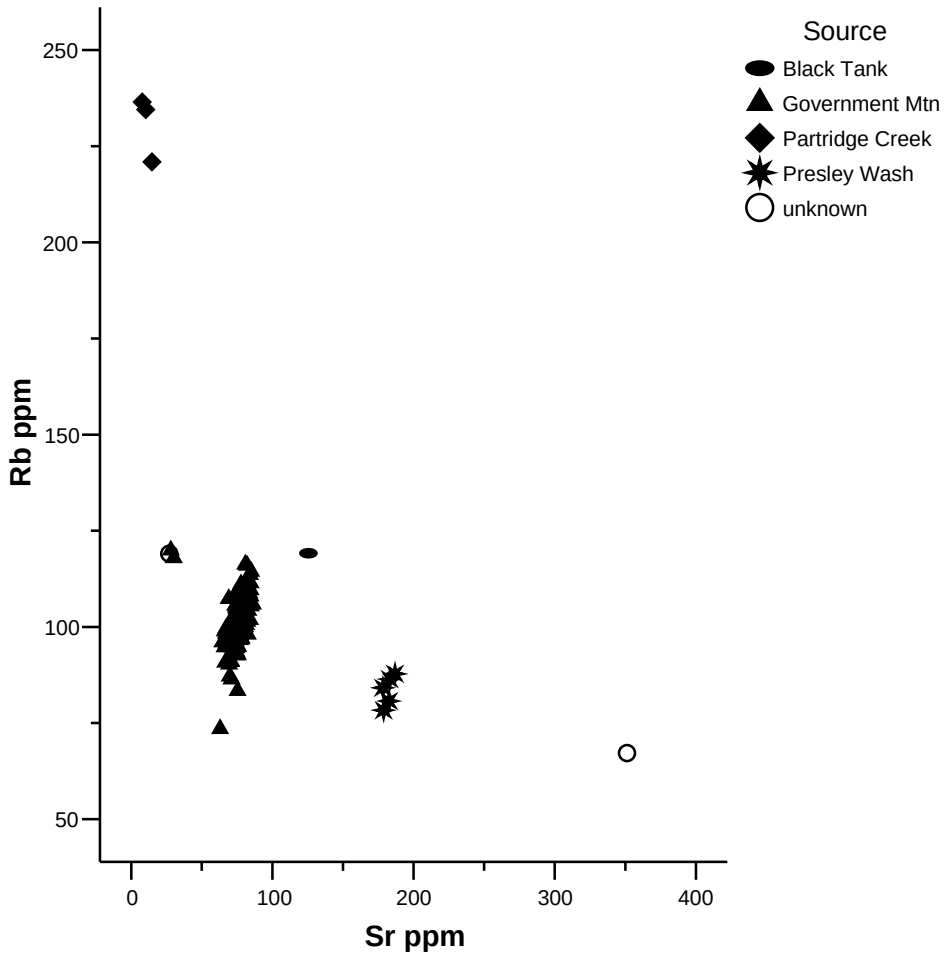

Figure 1. Rb versus Sr biplot of the elemental concentrations for the archaeological specimens. Given the distinctiveness of these sources, Rb and Sr are generally sufficient to discriminate the northern Arizona sources. The one "unknown" grouped with Government Mountain is quite distinctive in other elements.

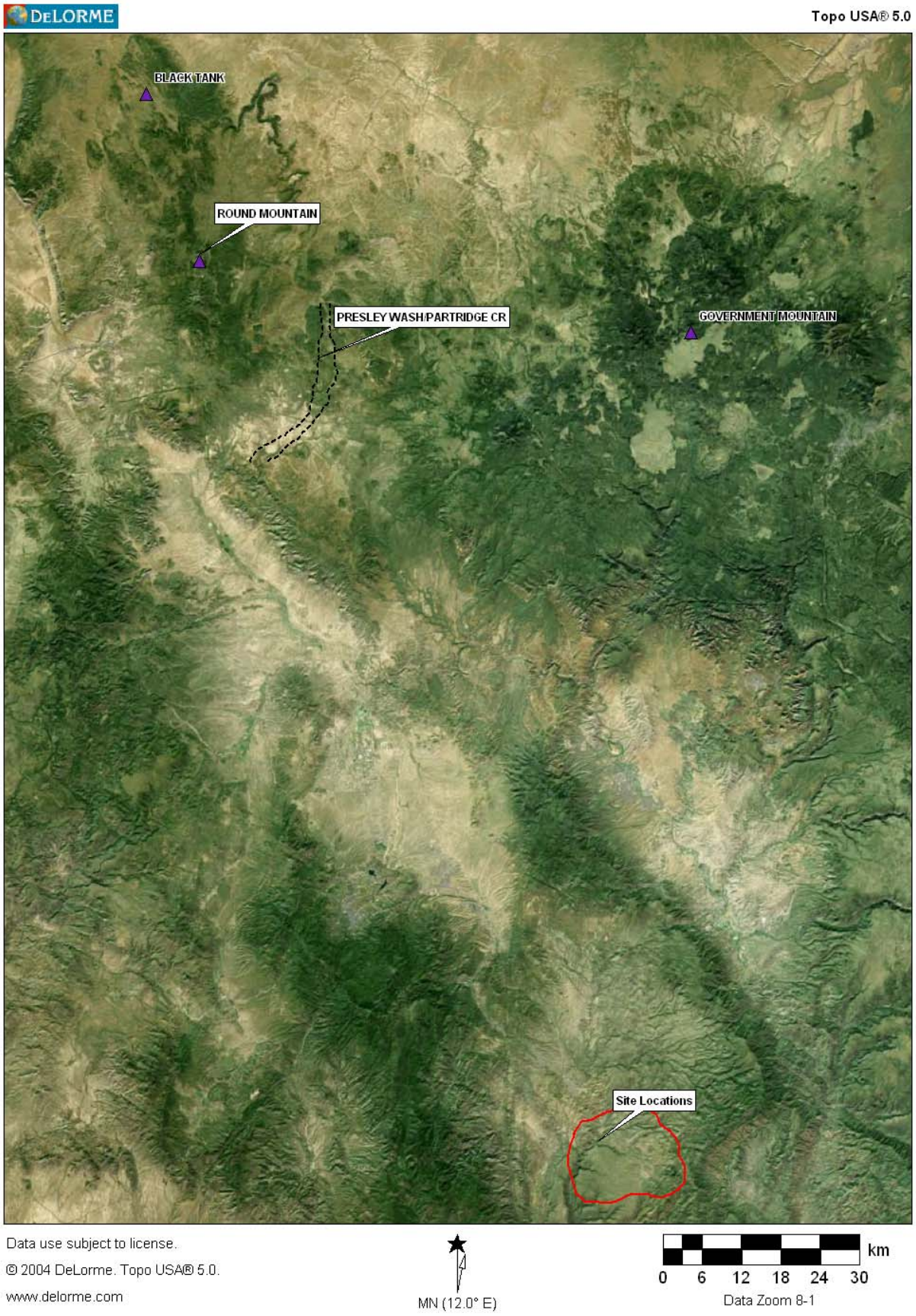

Figure 2. Landsat digital elevation model showing site locations relative to obsidian sources in central and northern Arizona.