AN ENERGY DISPERSIVE X-RAY FLUORESCENCE (EDXRF) ANALYSIS OF 57 OBSIDIAN ARTIFACTS FROM SELIGMAN TO SUNSET CRATER, NORTHERN ARIZONA

by

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INTRODUCTION

The analysis of archaeological obsidian in northern Arizona lags somewhat behind other areas of the Southwest. This x-ray fluorescence analysis of 58 specimens through the Mount Floyd and San Francisco Volcanic Fields of northern Arizona constitutes the most extensive transect sample of prehistoric obsidian artifacts in the region.

Six obsidian sources are represented in the sample, highly dominated by the Partridge Creek source, one of the best artifact quality glass sources in the Southwest (Shackley 1988, 1990). In addition to reporting the results of this x-ray fluorescence analysis, some comments regarding the distribution over the transect is offered. All the sources mentioned here are discussed by Lesko (1989) and Shackley (1988, 1990).

ANALYSIS AND INSTRUMENTATION

Unlike the earlier study of Southwestern obsidians (Shackley 1988, 1990), these data are generated under different analytical conditions. These results 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 Department of Geology and Geophysics, University of California, Berkeley, using a Spectrace 440 (United Scientific Corporation) energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with a Rh x-ray tube, a 50 kV x-ray generator, with a Tracor X-ray (Spectrace) TX 6100 x-ray analyzer using an IBM PC based microprocessor and Tracor reduction software. The x-ray tube was operated at 30 kV, .20 mA, using a .127 mm Rh primary beam filter in an air path at 250 seconds livetime to generate x-ray intensity data for elements lead (Pb), thorium (Th), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from the analysis of up to 26 international rock standards certified by the U.S. Bureau of Standards, the U.S. Geological Survey, Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1989). Further details concerning the petrological choice of these elements in Southwestern obsidians is available in Shackley (1988, 1990).

In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards. Table 1 shows a comparison between values recommended for two international rock standards, one rhyolite (RGM-1) and one obsidian (NBS-278). One of these standards is analyzed during each sample run to insure machine calibration. The results shown in Table 1 indicate that the machine accuracy is quite high, and other instruments with comparable precision should yield comparable results.

Trace element data exhibited in Tables 1 and 2 are reported in parts per million (ppm), a quantitative measure by weight. Source probability is based on a comparison with 1-sigma levels of variability. Although Pb and Th ppm concentrations were reported, they generally are not used as diagnostic indicators given their general lack of inter-source variability. Table 2 exhibits the trace element concentrations for the 58 samples. Table 3 and Figure 1 display the frequency distribution of obsidian source provenience in the sample. All samples except the one discussed below were assignable to source.

One sample (ATX 47) appears to be a basalt based on the megascopic and geochemical attributes. It, like the obsidian, was probably procured in the northern Arizona region.

DISCUSSION

The distribution of the provenience of obsidian sources in the assemblage is rather diverse, but not surprising. All the material was derived from regional, northern Arizona sources (see Table 2, 3, and Figure 1). The assemblage is dominated by Partridge Creek material which is a high quality material that happens to be located nearest most of the sites in the sample. However, proximity to source is not completely operative here. Presley Wash obsidian, particularly the glassy gray material was recovered from sites near the source on the west end to sites quite distant from the source near Sunset Crater east of Flagstaff. Government Mountain, often considered the most frequently used northern Arizona material, was only third most frequent, tied with RS Hill/Sitgreaves Peak (see Table 3 and Figure 1).

The Black Tank source, not frequently mentioned in archaeological context, occurs in black and black and mahogany colors. Three specimens were noted in this transect, including one on the eastern end of the transect, a considerable distance from the source.

Perhaps most interesting is the presence of one piece of glass derived from the O'Leary Peak or Robinson Crater source near Sunset Peak. This is quite an inferior raw material, but was apparently used locally.

Based on this study, it appears that Partridge Creek glass may have been considered equal to Government Mountain glass as a raw material prehistorically. It is important to note, however that Government Mountain material was located in sites west of the source and Partridge Creek material was located in sites east of the source in an overlapping distribution suggesting that there was considerable transport of *many* obsidian source materials in the northern Arizona region in all directions.

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Table 1.

Table 2. X-ray fluorescence concentrations for obsidian artifacts from northern Arizona sites. All values are in parts per million (ppm).

SITE/SAMPLE	Pb	Th	Rb	Sr	Y	Zr	Nb	SOURCE
NA 20662								
1	26.329	16.624	87.124	186.458	14.227	150.09	19.304	Presley Wash
2	32.687	22.28	120.945	109.593	21.752	100.916	28.733	Black Tank
3	43.292	41.067	242.087	6.494	39.224	106.137	55.684	Partridge Cr
4	43.696	39.588	250.013	2.891	41.897	105.278	56.65	Partridge Cr
5	29.133	13.52	72.781	242.621	16.404	149.328	20.666	Presley Wash
NA 20663								
6	46.079	42.671	254.852	3.676	39.738	108.563	55.421	Partridge Cr
7	41.791	28.26	220.651	3.395	38.971	101.636	51.128	Partridge Cr
8	40.58	47.302	249.004	4.972	39.702	101.909	58.408	Partridge Cr
NA 20664								
9	45.639	48.622	265.737	5.451	39.08	108.083	53.51	Partridge Cr
NA 20666								
10	44.831	45.201	252.242	3.627	38.981	110.915	55.572	Partridge Cr
NA 20667								
11	24.814	6.814	78.776	169.804	15.253	140.141	17.82	Presley Wash
12	45.462	44.888	247.821	4.793	39.16	103.997	56.609	Partridge Cr
NA 20668								
13	45.279	43.613	247.067	4.598	40.874	106.138	54.96	Partridge Cr
14	42.351	38.478	238.516	4.878	42.681	102.407	52.286	Partridge Cr
NA 20670								
15	41.553	36.078	240.41	4.585	37.807	103.789	52.25	Partridge Cr
16	23.704	20.273	73.661	249.762	19.486	151.899	22.274	Presley Wash
NA 20671								
17	34.847	25.641	113.371	114.076	22.425	104.279	28.8	Black Tank
18	41.072	37.767	248.421	4.219	43.855	104.057	49.835	Partridge Cr
19	47.51	40.607	222.134	4.073	39.295	94.885	48.184	Partridge Cr
20	35.533	27.51	203.633	18.336	31.746	88.578	29.309	Partridge Cr
21	25.197	24.435	86.942	206.938	14.928	160.444	20.716	Presley Wash
22	39.316	36.767	214.089	3.191	35.811	100.882	50.502	Partridge Cr
NA 20672								
23	44.683	40.283	241.823	3.032	37.561	103.854	52.462	Partridge Cr
NA 20676								
24	38.698	37.557	230.199	3.511	39.801	103.123	51.209	Partridge Cr
25	44.183	39.686	245.637	2.697	39.848	105.169	52.076	Partridge Cr
NA 20680								
26	39.335	37.982	227.331	6.759	39.173	97.77	52.147	Partridge Cr
NA 20681								
27	36.392	34.27	225.51	3.76	39.784	103.564	54.966	Partridge Cr
NA 20682								
28	41.212	38.168	242.948	3.413	41.436	104.019	55.523	Partridge Cr
29	41.002	31.216	218.792	3.838	37.613	97.373	50.834	Partridge Cr
30	25.019	14.778	68.713	235.895	17.445	151.765	17.369	Presley Wash
NA 20684								
31	42.226	33.499	234.482	4.883	42.154	104.315	51.624	Partridge Cr
NA 20686								
32	26.127	15.172	89.486	191.335	14.105	150.175	20.155	Presley Wash
NA 20687								
33	75.034	41.531	374.14	2.997	86.469	178.587	254.691	RS Hill/Sitgreaves

SITE/SAMPLE	Pb	Th	Rb	Sr	Y	Zr	Nb	SOURCE
NA 20689								
34	33.991	16.172	113.234	79.771	21.754	96.12	55.19	Govt Mtn
35	39.305	33.493	230.844	2.538	40.953	103.089	55.898	Partridge Cr
NA 20691								
36	37.437	31.293	232.762	5.313	40.733	100.433	53.371	Partridge Cr
37	78.564	51.231	394.186	3.59	89.386	180.866	259.645	RS Hill/Sitgreaves
NA 20692								
38	42.195	41.129	238.892	3.093	39.444	102.577	50.544	Partridge Cr
NA 20693								
39	80.719	50.14	396.011	2.536	93.723	183.138	257.321	RS Hill/Sitgreaves
40	73.625	41.26	372.909	4.642	89.668	179.284	247.736	RS Hill/Sitgreaves
41	28.134	22.827	92.266	200.289	12.781	151.01	19.353	Presley Wash
42	75.359	55.438	396.427	3.196	92.337	181.146	258.38	RS Hill/Sitgreaves
NA 20694								
43	29.956	12.014	101.219	76.175	19.076	93.634	53.586	Govt Mtn
NA 20695								
44	31.347	16.663	102.535	73.232	21.426	91.532	53.388	Govt Mtn
45	79.036	54.393	411.304	3.541	93.811	183.738	266.173	RS Hill/Sitgreaves
46	25.534	23.428	82.817	181.2	18.403	140.849	22.141	Presley Wash
47	23.041	8.535	58.072	934.509	32.48	403.208	53.485	basalt?
NA 20696								
48	27.187	9.263	70.957	155.59	32.636	238.542	47.35	O'Leary Peak
NA 20700								
49	32.727	17.52	109.152	81.836	21.089	89.542	51.711	Govt Mtn
50	31.321	14.66	110.631	79.923	21.283	96.536	53.945	Govt Mtn
51	33.589	17.77	109.594	78.179	22.463	87.447	52.721	Govt Mtn
52	33.883	13.414	110.949	76.409	21.132	91.041	51.917	Govt Mtn
53	89.293	52.049	424.649	4.599	93.299	190.143	258.753	RS Hill/Sitgreaves
54	40.369	31.118	240.274	2.978	38.544	101.462	53.396	Partridge Cr
55	88.914	63.121	403.028	3.533	84.19	174.099	255.466	RS Hill/Sitgreaves
56	23.446	18.888	85.304	184.308	15.168	139.057	18.241	Presley Wash
57	33.839	26.627	120.932	109.75	19.086	105.186	29.452	Black Tank
58	35.707	9.212	112.461	78.399	19.411	97.108	58.059	Govt Mtn

Table 3. Frequency distribution of obsidian source provenience.

Source	Frequency	Percent
Partridge Creek	27	46.6
Presley Wash	10	17.2
Government Mtn	8	13.8
RS Hill/Sitg.	8	13.8
Black Tank	3	5.2
O'Leary Peak	1	1.7
basalt?	1	1.7
TOTAL	58	100.0

Figure 1. Frequency and proportional histogram of obsidian source provenience.