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**AN ENERGY DISPERSIVE X-RAY FLUORESCENCE (EDXRF)
ANALYSIS OF OBSIDIAN ARTIFACTS FROM CA-SDI-10,158
NORTHERN SAN DIEGO COUNTY, CALIFORNIA**

by

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San Diego, California

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INTRODUCTION

The following report documents the EDXRF analysis of 17 obsidian artifacts from CA-SDI-10,158 in northern San Diego County, California. The vast majority of the artifacts (n=15) were most likely derived from the Obsidian Butte source in Imperial County, California, one was derived from one of the domes in the Coso Volcanic Field, and one was derived from the San Felipe source in northern Baja California. One sample was actually crystalline quartz.

ANALYSIS AND INSTRUMENTATION

All samples were analyzed whole, and were washed in distilled water before analysis. 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 Department of Geology and Geophysics, University of California, Berkeley, using a Spectrace™ 400 (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, 0.20 mA, using a .127 mm Rh primary beam filter in a vacuum path at 250 seconds livetime to generate x-ray intensity $K\alpha$ -line data for elements titanium (Ti), manganese (Mn), iron (as Fe^T), zinc (Zn), rubidium (Rb), strontium

(Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Weight percent iron ($\text{Fe}=\text{Fe}_2\text{O}_3^{\text{T}}$) can be derived by multiplying ppm estimates by 0.00014297. 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 US. Bureau of Standards, the US. Geological Survey, Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1989). Further detail concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1990, 1994, 1995; 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 and SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLM-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 1989). In addition to the reported values here, Ni, Cu, Pb, Ga, and Th were measured, but these are rarely useful in discriminating glass sources and are not reported. These data are available on disk by request.

The data from the Tracor software were translated directly into Quattro Pro 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. Table 1 shows a comparison between values recommended for two international obsidian and rhyolite rock standards, RGM-1, and NBS-278. One of these standards is analyzed during each sample run to check machine

calibration. The results shown in Table 1 indicate that the machine accuracy is quite high for the mid-Z incompatibles, 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. Table 2 exhibits the trace element concentrations for the source samples.

DISCUSSION

The analyzed obsidian assemblage was relatively diverse for a southern California late prehistoric site. The dominance of Obsidian Butte material in the site is quite expectable given its relative proximity (Hughes and True 1985). The presence of Coso in late contexts is somewhat of an anomaly and could indicate the presence of an Archaic component, and/or recycling of early obsidian by late occupants (Hughes and True 1985; Shackley 1990). The specimen produced from obsidian derived from San Felipe in Baja California is a relatively northern occurrence, and certainly signals contact and interaction with the Tipai or Paipai that may have controlled the source (see Shackley 1981). San Felipe obsidian is generally a better medium for tool production (aphyric) than Obsidian Butte except that it occurs in smaller nodule (marekanite) sizes than is available at Obsidian Butte (Bouey 1984; Douglas 1981; Hughes 1986).

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Table 1. X-ray fluorescence concentrations for selected trace elements of two international rock standards. \pm values represent first standard deviation computations for the group of measurements. All values are in parts per million (ppm) as reported in Govindaraju (1989) and this study. RGM-1 is a U.S. Geological Survey rhyolite (obsidian) rock standard, and NBS-278 is a National Bureau of Standards obsidian standard.

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb
RGM-1 (Govindaraju 1989)	1600	279	12998	149	108	25	219	8.9
RGM-1 (this study)	1513.24 \pm 46 226.8 \pm 2	232.86 \pm 15	13813 \pm 59		149.58 \pm 4.05	108.03 \pm 3	22.7 \pm .86	
NBS-278 (Govindaraju 1989)	1468	402	14256	127.5	63.5	41	295	n.r. ¹
NBS-278 (this study)	1405 \pm 93	365 \pm 8	15399 \pm 394	130 \pm 2	68 \pm 2	43 \pm 1.7	290 \pm 4	18 \pm 2
¹ n.r = no report								

Table 2. X-ray fluorescence concentrations for archeological samples from the archaeological specimens from SDI-10,158. All values are in parts per million (ppm).

SAMPLE	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb
Source									
650	1216.27364.9218661.62	91.70	146.86	23.96	120.18	318.47	27.34	Obs. Butte	
661	2029.98180.0414163.13	160.16	108.88	14.19	85.27	184.17	23.81	Obs. Butte?	
674	2025.17301.8814884.61	118.67	85.47	35.47	66.56	224.21	14.37	Obs. Butte?	
776	1696.05285.6015299.91	115.43	110.49	29.07	83.62	252.78	28.79	Obs. Butte	
620	973.73263.2410741.63	77.06	200.64	17.22	41.39	146.64	32.23	Coso	
578	1701.96388.8717702.25	116.41	124.54	32.20	88.32	267.87	17.14	Obs. Butte	
528	1675.02245.4712727.08	60.12	102.45	19.13	78.43	220.53	8.68	Obs. Butte	
507	2159.73254.5413562.30	141.93	75.24	21.92	64.45	162.39	9.10	Obs. Butte?	
479	1970.90267.5513952.59	63.00	105.37	22.09	81.87	221.69	11.43	Obs. Butte	
264	1315.82158.45 8724.97	84.86	126.23	30.30	24.91	80.52	1.99	San Felipe, B.C.	
460-1	1798.30413.8517266.70	120.50	116.91	34.22	98.63	281.85	25.43	Obs. Butte	
460-2	1839.54350.3017250.73	156.81	112.01	23.64	86.06	262.02	13.05	Obs. Butte	
349	1991.46332.6816793.84	147.11	116.97	25.45	84.93	267.47	23.57	Obs. Butte	
176	660.99 88.31 5862.53	23.73	0.00	25.24	9.49	8.81	0.00	quartz	
370	1781.06270.6113777.92	104.05	95.97	23.93	77.43	218.49	11.74	Obs. Butte?	
429	2033.61240.4312838.82	67.05	88.25	16.60	61.43	190.00	6.78	Obs. Butte?	
395-1	1298.71348.0417763.31	85.52	140.55	35.59	112.24	336.05	24.77	Obs. Butte	
395-2	1474.56408.6719507.01	88.98	141.65	33.01	113.35	351.51	27.37	Obs. Butte	

?=These samples were too small for confident assignment although the proportions of the elemental variability appears to be most similar to Obsidian Butte source standards. Many of the artifacts were theoretically too small for confident assignment (Jackson and Hampel 1992).

Figure 1. Rb, Sr, Zr 3-D plot of archaeological data. ?=small sample sizes