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**AN ENERGY DISPERSIVE X-RAY FLUORESCENCE
(EDXRF) ANALYSIS OF OBSIDIAN ARTIFACTS FROM THREE
SITES IN THE ROOSEVELT COMMUNITY DEVELOPMENT STUDY,
LOWER TONTO BASIN, ARIZONA**

by

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Report Prepared for

Mark Elson

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INTRODUCTION

The following report documents the EDXRF analysis of 15 obsidian artifacts recovered from four sites in the Roosevelt Community Development Study, Lower Tonto Basin, Arizona. The artifacts were produced from obsidian procured from two known and one unknown source, mainly from the Superior (Picketpost Mountain) source to the south, and Partridge Creek on the Coconino Plateau in northern Arizona. The absence of source material from the mid-Tertiary rhyolites in the Sonoran Desert common in Sedentary and Classic period contexts in the Gila Salt basins may have some significance, and parallels results from four sites in the generally contemporaneous Livingston Management Group of the Roosevelt Platform Mound Study (Shackley 1992a).

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 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 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), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Weight percent iron ($\text{Fe}=\text{Fe}_2\text{O}_3^T$) can be derived by multiplying ppm estimates by 1.4297. 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 Southwest obsidians is available in Shackley (1988, 1990, 1992; also Mahood and Stimac 1991).

The data from the Tracor software were translated directly into Quattro Pro for Windows software for manipulation and on into SPSSPC+ 3.0 for statistical analyses. 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. Table 2 exhibits the trace element concentrations for the 17 samples by site. Figures 1 through 3 exhibit bivariate plots of four of the measured elements for the site data. Table 3, and Figure 4 exhibit the project level data, and Table 4 is a crosstabulation of site by glass source.

DISCUSSION

This is the one of the first systematic analyses of archaeological obsidian from the Tonto Basin. Indeed, in the northern portion of central Arizona and northern Arizona

proper, very little effort has been expended toward the geochemical analysis of archaeological obsidian (Lesko 1989; Shackley 1986, 1991, 1992a).

While the sample size here is relatively small, a number of inferences can be derived. The assemblage is dominated by obsidian from the Picketpost Mountain glass source near Superior, Arizona, approximately 30 km south (60%; Table 3 and Figure 4). This is the nearest source and appears to be a resource within Salado "territory" at least during the Gila Butte Phase (Peterson et al. 1992). The remainder of the assemblage is derived from obsidian procured from the Partridge Creek source on the Coconino Plateau (33.3%) in the Mount Floyd Volcanic Field approximately 220 km northwest (Lesko 1989; Shackley 1988, 1990). The ratio of Coconino Plateau obsidian to Superior is essentially the inverse of that from an analyzed sample ($n=27$) from Shoofly Ruin near Payson (Shackley 1986). What may be most significant here is the lack of obsidian from the Sonoran Desert sources so common in Sedentary and Classic period contexts in the Salt-Gila Basin (Peterson et al. 1992). While proximity to sources can be argued as one reason for this distribution, it is only about 170 km to both Vulture and the Saucedo Mountains sources, two glass sources very common in contemporary sites in the Salt-Gila Basin. Based on this limited sample, it is tempting to infer that little interaction occurred with groups in these regions, at least for the procurement of obsidian, particularly since Superior obsidian is definitely equal to the other two sources in nodule size, density, and flakeability. This was essentially the same pattern seen the Livingston Group sites, although Government Mountain from the San Francisco Volcanic Field was also present (Shackley 1992a).

No match with known Arizona, New Mexico, Utah, Nevada, California, Chihuahua, or Sonoran sources for the sample 6267-3 from AZ V:5:90 was found (Baugh and Nelson 1987; Nelson 1984; Shackley 1988, 1990, 1991, 1992b). It is possible that the material this projectile point was produced from is a chemical outlier of some known

source, but this is probably not the case. This particular chemical signature has not occurred in any other archaeological contexts known to me.

It appears thus far that the directional opposition in obsidian procurement (Coconino Plateau versus Superior) is quite typical of sites in the Tonto Basin, and is most influenced by proximity to sources and availability. Further analyses will clarify this probability.

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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. Element-to-Oxide conversions can be found in Glascock (1991).

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	232.86 $\pm$ 15	13813 $\pm$ 59	149.58 $\pm$ 4.05	108.03 $\pm$ 3	22.7 $\pm$.86	226.8 $\pm$ 2	10 $\pm$.28
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. Trace element concentrations for obsidian artifacts from the Roosevelt Community Development Study sites. All measurements in parts per million (ppm).

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
AZ:V:5:1									
4148	586.6	386.4	9749.4	242.5	14.5	38.6	108.7	26.6	Partridge Cr
AZ:V:5:1									
911-2	636.1	487.5	6865.3	119.3	14.5	27.3	96.1	30.0	Superior
685-2	539.7	409.6	10605.5	276.5	18.3	38.8	123.8	27.9	Partridge Cr
911-9	679.3	476.5	7099.5	124.6	15.3	24.6	93.9	30.3	Superior
135-2	557.2	438.7	6126.5	103.2	12.4	23.6	83.9	31.3	Superior*
136-4	832.9	562.2	7655.2	129.7	16.0	25.0	90.8	33.5	Superior
AZ:V:5:90									
6496-2	567.8	454.4	6877.3	112.9	14.2	27.4	90.5	28.6	Superior
6478-2	471.1	445.3	8454.4	221.4	24.9	30.6	81.4	30.8	Partridge Cr
6356-2	333.6	380.7	7695.2	194.4	18.2	30.4	74.9	30.6	Partridge Cr
6251-2	569.2	414.2	6440.3	124.8	18.3	27.5	87.4	28.9	Superior
6053-3	566.2	421.9	6803.6	113.9	13.8	24.4	86.0	27.4	Superior
6586-2	386.0	313.0	7512.7	192.1	19.3	29.7	70.3	21.8	Partridge Cr
6537-3	730.3	468.4	7234.5	113.3	16.9	25.9	88.4	33.2	Superior
6004	640.2	488.9	6700.6	116.5	14.7	23.5	87.6	30.1	Superior
6267-3	555.9	365.6	9755.1	160.2	8.0	38.6	166.0	55.8	Unknown

* irregular surface or very small sample

Figure 1. Rb versus Sr concentration plot of archaeological obsidian (P=Partridge Creek; S=Superior; U=unknown).

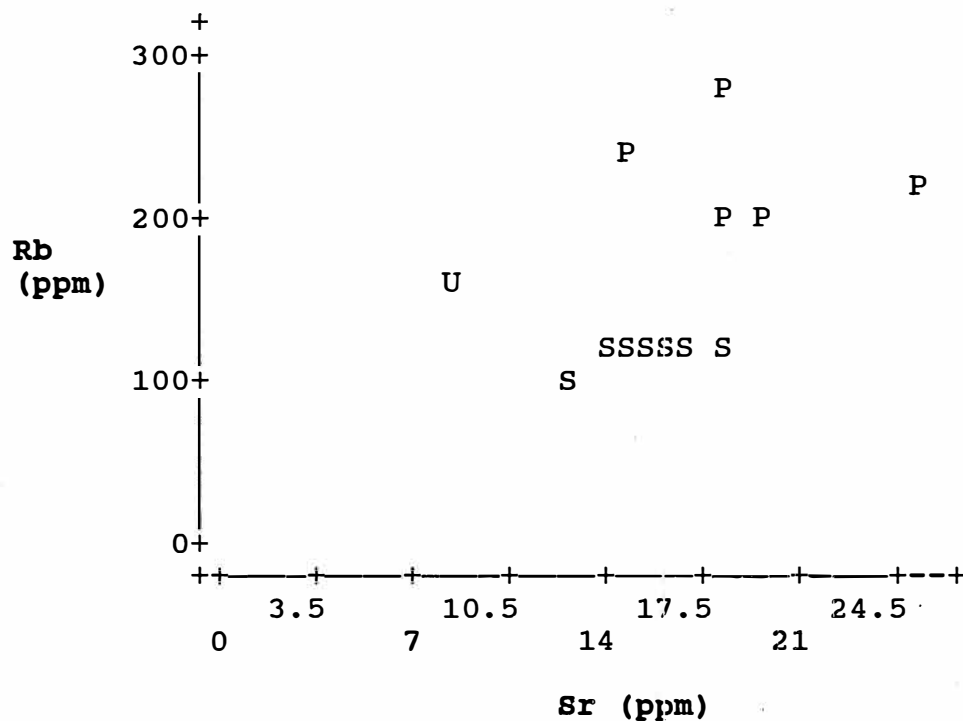


Figure 2. Rb versus Zr concentration plot of archaeological obsidian (P=Partridge Creek; S=Superior; U=unknown).

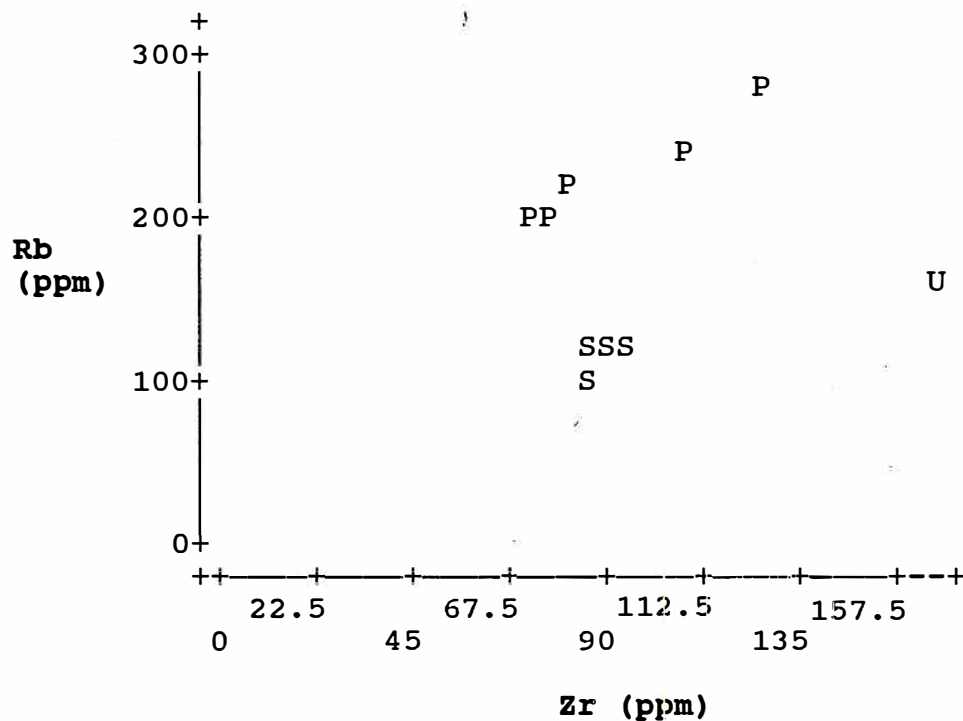


Figure 3. Rb versus Nb concentration plot of archaeological obsidian (P=Partridge Creek; S=Superior; U=unknown).

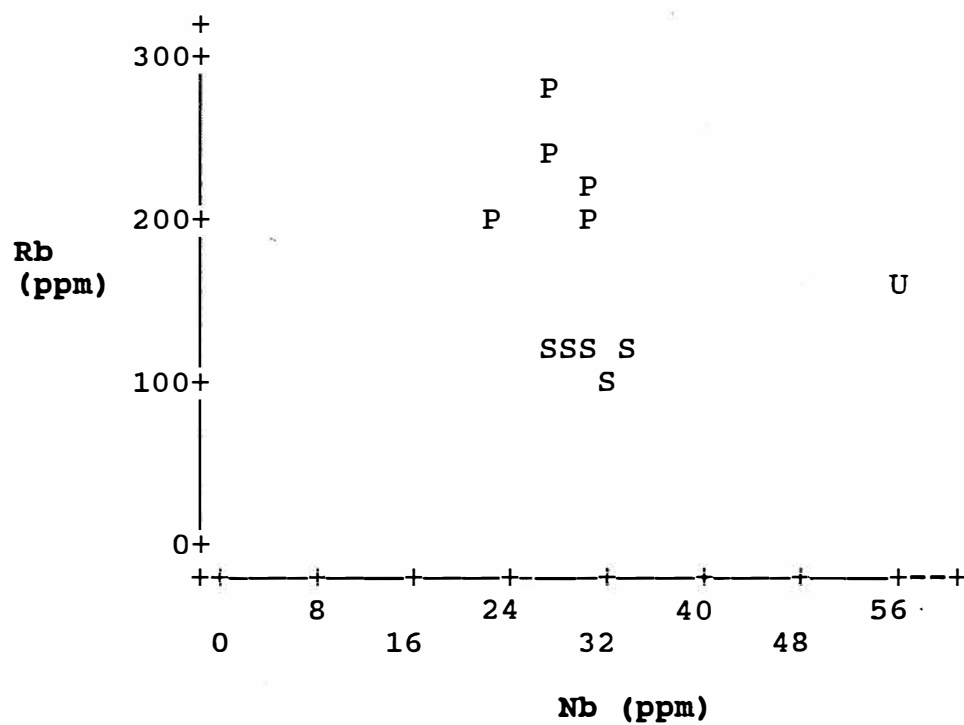


Table 3. Frequency distribution of archaeological obsidian source provenience.

Source	Value	Frequency
Unknown	1	6.7
Partridge Cr	5	33.3
Superior	9	60.0
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TOTAL	15	100.0

Figure 4. Frequency histogram of the distribution of archaeological obsidian.

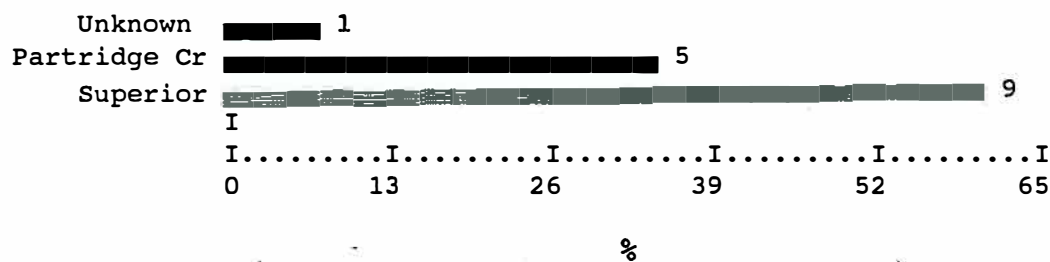
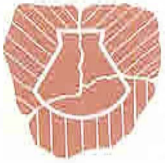


Table 4. Crosstabulation of source provenience by site.

SITE-> SOURCE	Count				Row Total
	Row Pct Col Pct	V:5:1	V:5:4	V:5:90	
Partridge Cr	1 20.0 100.0	1 20.0 20.0	3 60.0 33.3	5 33.3	5 33.3
Superior		4 44.4 80.0	5 55.6 55.6	9 60.0	9 60.0
Unknown			1 100.0 11.1	1 6.7	1 6.7
Column Total		1 6.7	5 33.3	9 60.0	15 100.0



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William H. Doelle, Ph.D.
President

24 March 1993

Dear Steve:

Enclosed are 15 obsidian samples from various sites on the Roosevelt Community Development Study situated in the Lower Tonto Basin of central Arizona. As we discussed on the phone (and as I mentioned in a note I sent with the argillite chapter) none of these are from the Early Ceramic Horizon at AZ V:5:104 -- no obsidian was recovered from that component. The obsidian we are sending are from our three largest sites, Griffin (n=9), a 100 room pueblo, Meddler (n=5), a moderately sized platform mound, and Pyramid (n=1), a small platform mound. All of these sites date to the late Roosevelt/early Gila phases (as Gila is currently defined, I'd probably start it later, around the time these sites are abandoned and larger scale aggregation is occurring) between A.D. 1250 and around 1320 or 1330. We only recovered obsidian from one other site, a small compound also dating to the Roosevelt phase, which we only tested.

Mike Lindeman, who is doing the lithic analysis and selected the samples, believes that 5 of the pieces are from an unknown source (i.e. he doesn't know it) and the other 10 are from Superior source.

So if my notes of our phone conversation are correct, you will run these for \$20.00 a sample, or a total of \$300.

Please sign and date the enclosed artifact release form and return it to us. If you have any questions please call.

Sincerely,

Mark Elson
Project Director
Roosevelt Community Development Study

P.S. -- Any comments on the argillite chapter? We are still working at it, and now have collected about 200 samples from the Tucson Mountain Recreation Redbed source which we only

had 3 samples from before. Still have a couple more potential source areas to check out and sample, however, up by the Mogollon Rim. I am starting to veer off more now into an analysis of argillite as a red ceramic slip, which I am convinced it is being used for, particularly in the Classic period when red slip sources become highly desirable, but am still searching for an appropriate method. XRD is not sensitive enough because the key minerals (diaspore, pyrrophyllite, etc.) dissipate between 500 and 700 C firing temperature. Because all red argillites contain hematite, it is therefore impossible to separate the argillite from hematite through XRD without these key minerals. It worked great in my experimental runs because I fired outdoors (uncontrolled) with low temperature and the argillite slips were readily distinguishable because they contained pyrrophyllite and hematite does not. Maybe XRF or SEM? Any ideas for slip analysis?