AN ENERGY DISPERSIVE X-RAY FLUORESCENCE (EDXRF) ANALYSIS OF OBSIDIAN ARTIFACTS FROM AZ P:60:31, APACHE COUNTY ARIZONA

by

M. Steven Shackley
Phoebe Hearst Museum of Anthropology
University of California, Berkeley

for

Laura Leach-Palm
Cultural Resource Enterprise
Pueblo of Zuni
Zuni, New Mexico

2 September 1993
INTRODUCTION

The following report documents the XRF analysis of 12 obsidian artifacts recovered from AZ P:60:31 in Apache County, Arizona. The obsidian in this sample was procured from three of the nearest glass sources, Grant's Ridge (n=8), Red Hill (n=2), and one of the Mule Creek chemical groups (n=2), all in western New Mexico.

ANALYSIS AND INSTRUMENTATION

The 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, 0.20 mA, using a 0.127 mm Rh primary beam filter in a vacuum path at 250 seconds livetime to generate x-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (as FeT), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Weight percent iron (Fe=Fe2O3T) 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 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 details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1990, 1992; also Mahood and Stimac 1990).

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 archaeological samples. Figures 1 through 4 exhibit bivariate plots of six of the measured elements for the site data. Source assignments were made by comparison to source standard data in Baugh and Nelson (1987); Newman and Nielsen (1985), as well as Shackley (1988, 1990, 1992).

**DISCUSSION**

While the source provenience of the obsidian artifacts from this site is what would be expected, some discussion is in order. The two projectile points included in the sample were the only specimens produced from glass derived from the Red Hill source in west-central New Mexico. This source produced a very vitreous, aphyric glass that is an excellent medium for tool production, often better than Mule Creek or Grant's Ridge (Shackley 1990). This may explain the apparent pattern of procurement.
REFERENCES CITEd

Baugh, Timothy G., and Fred W. Nelson, Jr.

Govindaraju, K.

Hampel, Joachim H.

Mahood, Gail A., and James A. Stimac

McCarthy, J.J., and F.H. Schamber

Newman, Jay R., and Roger L. Nielson

Schamber, F.H.

Shackley, M. Steven


Table 1. X-ray fluorescence concentrations for selected trace elements of two international rock standards. ± 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.

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Ti</th>
<th>Mn</th>
<th>Fe</th>
<th>Rb</th>
<th>Sr</th>
<th>Y</th>
<th>Zr</th>
<th>Nb</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGM-1 (Govindaraju 1989)</td>
<td>1600</td>
<td>279</td>
<td>12998</td>
<td>149</td>
<td>108</td>
<td>25</td>
<td>219</td>
<td>8.9</td>
</tr>
<tr>
<td>RGM-1 (this study)</td>
<td>1513.24±46</td>
<td>232.86±15</td>
<td>13813±59</td>
<td>149.58±4.05</td>
<td>108.03±3</td>
<td>22.7±.86</td>
<td>226.8±2</td>
<td>10±.28</td>
</tr>
<tr>
<td>NBS-278 (Govindaraju 1989)</td>
<td>1468</td>
<td>402</td>
<td>14256</td>
<td>127.5</td>
<td>63.5</td>
<td>41</td>
<td>295</td>
<td>n.r.1</td>
</tr>
<tr>
<td>NBS-278 (this study)</td>
<td>1405±93</td>
<td>365±8</td>
<td>15399±394</td>
<td>130±2</td>
<td>68±2</td>
<td>43±1.7</td>
<td>290±4</td>
<td>18±2</td>
</tr>
</tbody>
</table>

1 n.r = no report
Table 2. X-ray fluorescence concentrations for archeological samples from AZ P:60:31. All values are in parts per million (ppm).

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Ti</th>
<th>Mn</th>
<th>Fe</th>
<th>Rb</th>
<th>Sr</th>
<th>Y</th>
<th>Zr</th>
<th>Nb</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>142-3</td>
<td>324.82</td>
<td>564.11</td>
<td>8776.14</td>
<td>487.83</td>
<td>7.88</td>
<td>85.18</td>
<td>131.98</td>
<td>217.98</td>
<td>Grant's Ridge</td>
</tr>
<tr>
<td>283-3</td>
<td>574.42</td>
<td>333.85</td>
<td>8915.24</td>
<td>227.74</td>
<td>19.06</td>
<td>38.98</td>
<td>107.90</td>
<td>23.37</td>
<td>Mule Cr B</td>
</tr>
<tr>
<td>283-4</td>
<td>786.07</td>
<td>412.37</td>
<td>10506.59</td>
<td>232.96</td>
<td>14.81</td>
<td>41.84</td>
<td>105.86</td>
<td>22.28</td>
<td>Mule Cr B</td>
</tr>
<tr>
<td>1058-7</td>
<td>826.46</td>
<td>673.56</td>
<td>7718.11</td>
<td>402.98</td>
<td>5.48</td>
<td>47.87</td>
<td>80.76</td>
<td>127.27</td>
<td>Grant's Ridge*</td>
</tr>
<tr>
<td>1069-4</td>
<td>450.45</td>
<td>582.47</td>
<td>9189.17</td>
<td>460.71</td>
<td>4.17</td>
<td>75.59</td>
<td>122.99</td>
<td>200.31</td>
<td>Grant's Ridge</td>
</tr>
<tr>
<td>1303-3</td>
<td>517.59</td>
<td>500.43</td>
<td>7670.33</td>
<td>389.91</td>
<td>7.88</td>
<td>62.07</td>
<td>101.72</td>
<td>147.80</td>
<td>Grant's Ridge</td>
</tr>
<tr>
<td>1460-5</td>
<td>305.48</td>
<td>579.21</td>
<td>9265.65</td>
<td>500.86</td>
<td>9.95</td>
<td>85.27</td>
<td>131.11</td>
<td>211.41</td>
<td>Grant's Ridge</td>
</tr>
<tr>
<td>1484-3</td>
<td>267.44</td>
<td>625.39</td>
<td>9351.30</td>
<td>538.13</td>
<td>7.35</td>
<td>84.00</td>
<td>135.76</td>
<td>225.14</td>
<td>Grant's Ridge</td>
</tr>
<tr>
<td>2221-4</td>
<td>317.34</td>
<td>675.31</td>
<td>7544.61</td>
<td>184.03</td>
<td>15.63</td>
<td>37.01</td>
<td>68.80</td>
<td>43.22</td>
<td>Red Hill</td>
</tr>
<tr>
<td>2494-18</td>
<td>270.26</td>
<td>578.66</td>
<td>8752.39</td>
<td>527.59</td>
<td>6.13</td>
<td>84.76</td>
<td>129.44</td>
<td>227.69</td>
<td>Grant's Ridge</td>
</tr>
<tr>
<td>5001-1</td>
<td>524.01</td>
<td>415.83</td>
<td>6071.22</td>
<td>130.37</td>
<td>4.03</td>
<td>25.79</td>
<td>56.40</td>
<td>35.90</td>
<td>Red Hill</td>
</tr>
<tr>
<td>5015-1</td>
<td>432.64</td>
<td>630.89</td>
<td>9141.04</td>
<td>476.85</td>
<td>4.24</td>
<td>79.01</td>
<td>119.08</td>
<td>177.85</td>
<td>Grant's Ridge</td>
</tr>
</tbody>
</table>

Figure 1. Fe versus Ti concentration plot of archaeological specimens (G=Grant's Ridge; M=Mule Creek; R=Red Hill).
Figure 2. Rb versus Zr concentration plot of archaeological specimens (G=Grant's Ridge; M=Mule Creek; R=Red Hill).

Figure 3. Rb versus Nb concentration plot of archaeological specimens (G=Grant's Ridge; M=Mule Creek; R=Red Hill).
Figure 4. Y versus Nb concentration plot of archaeological specimens (G=Grant's Ridge; M=Mule Creek; R=Red Hill).
AZ-P-60-31

The site is located south of Navajo, AZ, Apache Co., in the Puerco River drainage. It is situated on a ridge that runs southeast from the Puerco River flood plain to several miles beyond the right-of-way of N-2015 to which this project was limited.

The area of the site within the right-of-way contains a Basketmaker III occupation of 19 structures, midden and about 100 extramural features.

Dates from archaeomagnetic sample taken from a collared hearth on the floor of structure 2 (SU 20-2) are:

visual dates  AD 680-775
             840-975

stat. dates   660-800
             825-1020
             1490-1660

Ceramics from testing indicates that the major occupation was Basketmaker III, AD 500-700.

Calibrated C-14 dates range from AD 539 - 1437, but cluster around the mid- to late 600s, with a possible, slightly later component as well.
8/18/93

Obsidian pieces from AZ-P-60-31
Task Order 1991-6
ZAP\ZCRE project #040-91
Account #500.340

FS # 142-3 - from a trench
FS # 283-3 - from the uppermost level of fill within a pitstructure
FS # 283-4 - same
FS #1058-7 - from a horizontal sandstone slab feature
FS #1069-4 - from extramural fill
FS #1303-3 - from fill within a pitstructure, well above the floor
FS #1460-5 - from extramural fill - possible activity area
FS #1484-3 - from extramural fill - possible activity area
FS #2221-4 - from midden
FS #2494-18 - from a cache in a pitstructure floor
FS #5001-1 - from midden
FS #5015-1 - from extramural surface