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AN ENERGY DISPERSIVE X-RAY FLUORESCENCE
(EDXRF) ANALYSIS OF OBSIDIAN ARTIFACTS FROM SDi-4759
NEAR JAMACHA, SAN DIEGO COUNTY, CALIFORNIA

by

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INTRODUCTION

The following is a report of a x-ray fluorescence analysis of 2 obsidian artifacts recovered from CA-SDi-4759 near Jamacha, San Diego County, California. Similar to other sites in the valley the assemblage is a mix of material from various centers in the Coso Volcanic Field in the southeastern Sierra Nevada, and Obsidian Butte in the Salton Trough, Imperial County, California (Shackley 1991a).

ANALYSIS AND INSTRUMENTATION

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 an air path at 250 seconds livetime to generate x-ray intensity data for elements titanium (Ti), manganese (Mn), iron (as FeOT), 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 southern California and Southwestern obsidians is available in Hughes (1986, 1988) and 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 2 samples. Source standard data for the Coso glass can be found in Hughes (1988) and Obsidian Butte in Hughes (1986).
DISCUSSION

As noted earlier, one of the artifacts (142) is derived from the Coso Volcanic Field approximately 420 linear kilometers north and one (202) from Obsidian Butte only approximately 130 linear kilometers east (Table 2).

Recently, Hughes (1988) suggested that there were at least four geochemically distinguishable source groups of artifact quality obsidian in the Coso Volcanic Field. These include Joshua Ridge, West Sugarloaf Mountain, Sugarloaf Mountain proper, and West Cactus Peak. The geochemical signature of these four, however, is quite close indicating the common magmatic origin of these centers. Furthermore, Bouey’s (1991) recent analysis of the same data suggests that there is too much overlap of the chemical signatures to indicate more than one chemical group at Coso. It does appear that the West Sugarloaf material is generally superior for tool production than the other source areas, and so probably contributes more to most archaeological assemblages. For this study, the argument is not relevant since a transport distance of over 400 km is of sufficient import in and of itself.

Probably more meaningful in this archaeological context is the presence of the more distant Coso glass rather than the relatively nearby Obsidian Butte. The superior quality of Coso glass is one possible factor in the dominance in the assemblage. It is generally aphyric, not exhibiting the sanidine and plagioclase phenocrysts so common in Obsidian Butte material. Recently, in an analysis of obsidian from a number of Archaic and Late Prehistoric sites in San Diego and Riverside Counties, Hughes and True (1985) noted that obsidian derived from the Coso source was much more common in the Archaic period than in the Late Prehistoric period. This may be due to a mix of factors such as higher residential mobility, and the lack of defended territories in the earlier period, as well as the apparent lack of occupation in the Obsidian Butte region (Colorado Desert) during the Late Archaic (Warren 1984; Wilke et al. 1986). Coso obsidian also occurred at SDi-295 in
northern San Diego County, in probable association with Archaic period remains (Shackley 1991b). Obsidian hydration analyses of these specimens may prove fruitful in this regard.
REFERENCES CITED

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Schamber, F.H.

Shackley, M. Steven


Warren, Claude N.  

Wilke, Philip J., Meg McDonald, and L.A. Payen (editors)  
1986 Excavations at Indian Hill Rockshelter, Anza-Borrego Desert State Park, California, 1984-1985. Archaeological Research Unit, University of California, Riverside, UCARU 772.
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>TiO₂</th>
<th>MnO</th>
<th>Rb</th>
<th>Sr</th>
<th>Y</th>
<th>Zr</th>
<th>Nb</th>
<th>Ba</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGM-1 (Govindaraju 1989)</td>
<td>2670</td>
<td>360</td>
<td>149</td>
<td>108</td>
<td>25</td>
<td>219</td>
<td>8.9</td>
<td>807</td>
</tr>
<tr>
<td>RGM-1 (this study)</td>
<td>2433.07±147.1</td>
<td>321.12±16.75</td>
<td>150±3.4</td>
<td>105±1.7</td>
<td>26±0.9</td>
<td>218±5</td>
<td>9.5±1.1</td>
<td>844±48.86</td>
</tr>
<tr>
<td>NBS-278 (Govindaraju 1989)</td>
<td>2450</td>
<td>520</td>
<td>127.5</td>
<td>63.5</td>
<td>41</td>
<td>295</td>
<td>n.r.</td>
<td>1140</td>
</tr>
<tr>
<td>NBS-278 (this study)</td>
<td>n.m.</td>
<td>n.m.</td>
<td>126±1.9</td>
<td>62±2.3</td>
<td>40±2.2</td>
<td>280±3.6</td>
<td>14±1.4</td>
<td>n.m.</td>
</tr>
</tbody>
</table>

1 n.r = no report; n.m. = not measured

Table 2. X-ray fluorescence concentrations for obsidian artifacts from SDi-4759. All values are in parts per million (ppm) except FeO% in weight percent.

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Ti</th>
<th>Mn</th>
<th>FeO%</th>
<th>Rb</th>
<th>Sr</th>
<th>Y</th>
<th>Zr</th>
<th>Nb</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>202</td>
<td>1715.72</td>
<td>256.91</td>
<td>1.334</td>
<td>95.648</td>
<td>27.125</td>
<td>73.876</td>
<td>222.991</td>
<td>14.302</td>
<td>Obsidian Butte</td>
</tr>
<tr>
<td>142</td>
<td>644.72</td>
<td>229.88</td>
<td>1.075</td>
<td>225.917</td>
<td>17.161</td>
<td>46.876</td>
<td>162.11</td>
<td>39.039</td>
<td>Coso</td>
</tr>
</tbody>
</table>

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