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SECONDARY DEPOSIT OBSIDIAN ALONG SAN ANTONIO CREEK, VALLES CALDERA NATIONAL PRESERVE, NORTHERN NEW MEXICO

by

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Report Prepared for

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INTRODUCTION

The analysis here of 37 secondary geological samples recovered from one 5X5 meter sample unit along San Antonio Creek on 13 June 2006, indicates that all the samples were originally derived from the Cerro del Medio dome complex in the caldera. The relatively high elemental variability in the sample is due both to small nodule sizes, and apparent elemental variability within the Cerro del Medio complex proper.

FIELD AND LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

On 13 June 2006, as part of the University of California, Berkeley's Archaeological Petrology Field school, 42 geological obsidian samples were collected from a 5X5 meter collection unit in recent alluvium along San Antonio Creek in the caldera proper. The northwest corner was located at UTM 13S 0353966/3980625, based on corrected Trimble GPS data. The nodules varied in size from 2 mm to 41 mm. For this analysis, only those 37 samples over 10 mm in smallest diameter were analyzed by EDXRF (see Davis et al. 1998).

This assemblage was analyzed on a Spectrace/Thermo *QuanX* energy-dispersive x-ray spectrometer at the Archaeological XRF Laboratory, Department of Earth and Planetary Sciences at the University of California, Berkeley. All samples were analyzed whole with little or no formal preparation. 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 spectrometer is equipped with an electronically cooled Cu x-ray target with a 125 micron Be window, an x-ray generator that operates from 4-50 kV/0.02-2.0 mA at 0.02

increments, using an IBM PC based microprocessor and WinTrace™ reduction software. The x-ray tube is operated at 30 kV, 0.14 mA, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 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). 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 National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1992, 1995, 2005; also Mahood and Stimac 1990; 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, SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLO-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, and JR-1 and JR-2 obsidian standards from the Japan Geological Survey (Govindaraju 1994). In addition to the reported values here, Ni, Cu, Th, and Ga were measured, but these are rarely useful in discriminating glass sources and are not reported here.

The data from both systems were translated directly into Excel™ 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. An analysis of RGM-1 analyzed during each run is included in Table 1. Source nomenclature follows Shackley (2005). Further information on the laboratory

instrumentation can be found at: <http://www.swxrflab.net/>. Trace element data exhibited in Table 1 are reported in parts per million (ppm), a quantitative measure by weight (see also Figure 1).

DISCUSSION

Immediately apparent in the data tables (Tables 1 and 2) as well as the bivariate plot of Rb and Nb, that the level of variability within the Cerro del Medio rhyolite is potentially relatively great. It is true that the level of variability is greater in the secondary samples collected along San Antonio Creek, that variability is not necessarily all due to smaller sample sizes and the limitations of x-ray fluorescence analysis (Davis et al. 1998; see Figure 1 here). It seems perfectly possible that at least some of this variability is due to the inherent variability within the Cerro del Medio dome complex itself (see Hildreth 1981; Shackley 2005). However great that variability is, it does not overlap the elemental signatures of any of the other sources of archaeological obsidian in the Jemez Mountains – Bear Springs Peak, Cerro Toledo Rhyolite, or El Rechuelos.

We are currently engaged in a longer term analysis of major, minor, and trace element analyses of samples collected from various locations on Cerro del Medio during the summer of 2004 using both EDXRF and WXRf here at Berkeley. This may indicate a higher level of variability within the Cerro del Medio dome complex than previously reported (Baugh and Nelson 1987; Glascock et al. 1999; Shackley 2005).

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Table 1. Elemental concentrations and source assignments for the geological samples collected at San Antonio Creek. All measurements in parts per million (ppm).

Sample	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb
A-1	1152	474	10362	62	176	13	34	154	54
A-10	1060	422	9102	54	138	12	42	145	49
A-11	1042	394	7850	55	135	12	41	140	53
A-12	875	396	8317	57	143	13	36	140	58
A-13	1101	441	9508	54	149	16	45	165	54
A-14	1000	418	8331	53	131	12	37	149	55
A-15	1000	446	9640	68	153	8	38	158	48
A-16	975	368	8268	57	143	13	47	158	54
A-17	1070	418	9042	61	157	14	37	160	59
A-18	1123	369	8036	54	132	16	36	146	55
A-19	1145	435	9770	61	168	18	46	168	60
A-2	886	378	6832	47	117	16	33	147	53
A-3	1012	402	9165	65	193	12	39	155	53
A-4	1131	466	11072	62	158	12	32	166	62
A-5	1086	368	9148	54	150	12	42	159	55
A-6	940	387	7690	62	146	13	43	158	56
A-7	1162	354	7021	51	109	18	43	124	45
A-8	1004	403	8432	53	172	12	39	144	47
A-9	1186	476	11069	66	174	7	46	165	51
B-1	966	393	8033	54	190	6	44	146	57
B-10	1228	418	9116	57	164	7	40	153	52
B-11	1038	419	9309	56	193	16	37	156	47
B-12	1004	337	8469	54	142	12	42	140	55
B-13	1138	413	8933	61	195	10	34	166	65
B-14	1003	401	8213	56	159	9	41	149	45
B-15	1058	436	8105	50	143	13	33	150	58
B-16	1189	516	8878	56	142	15	43	176	50
B-17	1074	396	8735	61	142	6	45	151	57
B-18	1006	363	9084	56	149	14	41	166	57
B-2	1054	424	8509	56	176	7	45	157	53
B-3	992	412	8987	71	138	12	41	152	53
B-4	879	402	8909	63	144	8	38	148	51
B-5	1095	474	7893	54	131	6	36	168	50
B-6	1021	359	8111	52	151	10	43	158	48
B-7	1138	305	7717	46	181	7	32	127	42
B-8	1121	391	7881	51	168	14	34	142	54
B-9	956	414	8334	57	153	9	35	162	55
RGM1-S3	1482	320	13146	35	147	110	22	218	9
RGM1-S3	1601	303	13158	37	149	104	21	219	13

Table 2. Mean and central tendency data for the San Antonio Creek samples from Table 1. All measurements in parts per million (ppm).

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Ti	37	875	1228	1052	88	7798
Mn	37	305	516	408	42	1763
Fe	37	6832	11072	8699	931	866773
Zn	37	46	71	57	6	31
Rb	37	109	195	154	21	441
Sr	37	6	18	12	3	11
Y	37	32	47	39	4	19
Zr	37	124	176	153	11	128
Valid N (listwise)	37					

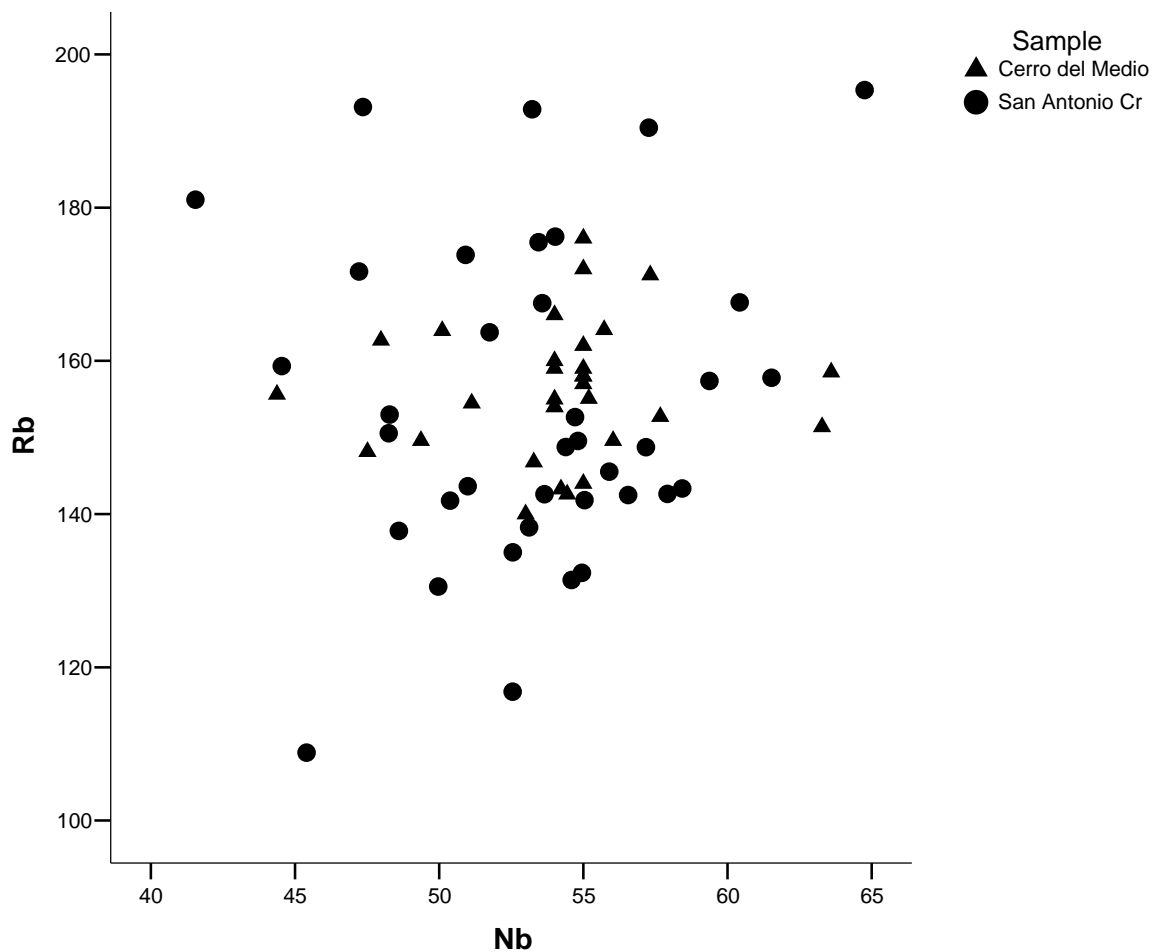


Figure 1. Rb versus Nb, plot of the elemental concentrations for the San Antonio Creek secondary samples and Cerro del Medio primary source standards as reported in Shackley (2005).