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AN ENERGY-DISPERSIVE X-RAY FLUORESCENCE ANALYSIS OF MAJOR, MINOR, AND TRACE ELEMENTS OF SOIL SAMPLES FROM RIO VERDE, OAXACA, WEST MEXICO

by

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Report Prepared for

Dr. Charles Frederick
Dublin, Texas

11 December 2017

INTRODUCTION

The analysis here of 62 powdered soil samples indicates considerable variability based on the EDXRF analysis. I leave the interpretive details to you.

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

All podered samples are analyzed whole. 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; Shackley 2011).

All analyses for this study were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer, located in the Archaeological XRF Laboratory, Albuquerque, New Mexico the mirror lab of the NSF sponsored Geoarchaeological XRF Laboratory at the University of California, Berkeley. It is equipped with a thermoelectrically Peltier cooled solid-state Si(Li) X-ray detector, with a 50 kV, 50 W, ultra-high-flux end window bremsstrahlung, Rh target X-ray tube and a 76 µm (3 mil) beryllium (Be) window (air cooled), that runs on a power supply operating 4-50 kV/0.02-1.0 mA at 0.02 increments. The spectrometer is equipped with a 200 l min^{-1} Edwards vacuum pump, allowing for the analysis of lower-atomic-weight elements between sodium (Na) and titanium (Ti). Data acquisition is accomplished with a pulse processor and an analogue-to-digital converter. Elemental composition is identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities and net peak intensities above background.

Trace Elements

The analysis for mid Zb condition elements Ni-Nb, Pb, Th, the x-ray tube is operated at 30 kV, using a 0.05 mm (medium) Pd primary beam filter in an air path at 100 seconds livetime to generate x-ray intensity Ka-line data for elements titanium (Ti), manganese (Mn), iron (as $Fe_2O_3^T$), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). Not all these elements are reported since their values in many volcanic rocks are very low. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter 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). Line fitting is linear (XML) for all elements but Fe where a derivative fitting is used to improve the fit for iron and thus for all the other elements. When barium (Ba) is analyzed in the High Zb condition, the Rh tube is operated at 50 kV and up to 1.0 mA, ratioed to the bremsstrahlung region (see Davis 2011; Shackley 2011). Further details concerning the petrological choice of these elements in Southwest volcanics is available in Shackley (1988, 1995, 2005; also Mahood and Stimac 1991; and Hughes and Smith 1993). Nineteen specific pressed powder standards are used for the best fit regression calibration for elements Ti-Nb, Pb, Th, and Ba, include G-2 (granite), AGV-2 (andesite), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (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), NOD-A-1 and NOD-P-1 (manganese) all US Geological Survey standards, NIST-278 (obsidian), U.S. National Institute of Standards and Technology, BE-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France, and JR-1 and JR-2 (obsidian) from the Geological Survey of Japan (Govindaraju 1994).

Major Oxides

The powdered samples were analyzed in partly sealed sample cups with a 6 μm thin film base. Analysis of the major oxides of Na, Mg, Al, Si, P, Cl K, Ca, Ti, V, Cr, Mn and Fe is performed under the multiple conditions elucidated below under vacuum. This fundamental parameter analysis (theoretical with standards), while not as accurate as destructive analyses (pressed powder and fusion disks) is usually within a few percent of actual, based on the analysis of the G-2 granite standard (see also Shackley 2011). The fundamental parameters (theoretical) method is run under conditions commensurate with the elements of interest and calibrated with 11 USGS standards (RGM-1, rhyolite; AGV-2, andesite; BHVO-1, hawaiite; BIR-1, basalt; G-2, granite; GSP-2 granodiorite; BCR-1, basalt; W-2, diabase; QLO-1, quartz latite; STM-1, syenite), and one Japanese Geological Survey rhyolite standard (JR-1). See Lundblad et al. (2011) for another set of conditions and methods for oxide analyses of hawaiite basalt.

P_2O_5 is generally very low to undetectable in volcanic rocks, so in this analysis P_2O_5 was acquired from NOD-A1 a USGS benthic manganese sample with a recommended value of 1.4 wt.% P_2O_5 within the detection limits of the Quant'X EDXRF instrument. Analysis by the Quant'X yielded a value of 0.743 wt.%, yielding a normalized correction value of x=1.8843. The trace element value for the P oxide is acquired by a multiplier of 4364. Those values are presented in Table 1.

CONDITIONS OF FUNDAMENTAL PARAMETER ANALYSIS[1]

Low Za (Na, Mg, Al, Si, P)

Voltage	6 kV	Current	Auto[2]
Livetime	100 seconds	Counts Limit	0
Filter	No Filter	Atmosphere	Vacuum
Maximum Energy	10 keV	Count Rate	Low

Mid Zb (K, Ca, Ti, V, Cr, Mn, Fe)

Voltage	32 kV	Current	Auto
Livetime	100 seconds	Counts Limit	0
Filter	Pd (0.06 mm)	Atmosphere	Vacuum
Maximum Energy	40 keV	Count Rate	Medium

High Zb (Sn, Sb, Ba, Ag, Cd)

Voltage	50 kV	Current	Auto
Livetime	100 seconds	Counts Limit	0
Filter	Cu (0.559 mm)	Atmosphere	Vacuum
Maximum Energy	40 keV	Count Rate	High

Low Zb (S, Cl, K, Ca)

Voltage	8 kV	Current	Auto
Livetime	100 seconds	Counts Limit	0
Filter	Cellulose (0.06 mm)	Atmosphere	Vacuum
Maximum Energy	10 keV	Count Rate	Low

[1] Multiple conditions designed to ameliorate peak overlap identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities and net peak intensities above background.

[2] Current is set automatically based on the mass absorption coefficient.

The data from the WinTrace software were translated directly into Excel for Windows software for statistical manipulation as required. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. G-2 a USGS Rhode Island granite standard was analyzed during each sample run to check machine calibration (Table 1). The recommended values for G-2 are also presented in Table 1.

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Table 1. Elemental concentrations for the geological specimens, and USGS G-2 granite standard. Measurements in percent by weight or parts per million (ppm) as noted. P_2O_5 normalized by USGS NOD-A1 oceanic manganese standard results for P_2O_5.

Sample	Na2O	MgO	Al2O3	SiO2	P2O5	P2O5 (normalized)	P	K2O	CaO	TiO2	V2O5	Cr2O3	MnO	Fe2O3	Σ*
	%	%	%	%	%	%	ppm	%	%	%	%	%	%	%	
CL1	2.14	0.59	5.20	44.51	0.96	1.80	7869	3.98	31.72	2.04	0.13	0.02	0.12	7.97	99.25
CL2	3.07	0.44	1.43	9.71	1.97	3.71	16183	3.14	61.02	2.91	0.03	0.05	0.17	14.60	98.51
CL3	4.09	0.86	5.31	44.93	1.05	1.98	8634	3.92	30.00	1.46	0.06	0.04	0.12	7.69	99.47
CL4	2.44	0.50	4.11	34.12	1.49	2.81	12261	3.35	43.53	1.67	0.08	0.01	0.13	7.92	99.25
CL5	4.49	0.99	6.44	58.02	0.49	0.92	4021	4.72	16.70	1.57	0.07	0.02	0.11	6.10	99.64
CL6	3.12	0.75	5.38	46.32	0.91	1.71	7442	3.70	29.38	1.86	0.09	0.03	0.13	7.92	99.50
CL7	3.17	1.04	5.13	47.94	0.78	1.47	6422	4.46	23.48	1.95	0.05	0.01	0.17	7.78	95.90
RV1	1.69	0.88	8.10	41.46	1.34	2.52	11002	4.79	17.21	3.90	0.18	0.02	0.31	19.35	99.04
RV2	2.66	1.13	9.11	46.36	1.08	2.04	8914	4.65	16.42	2.93	0.09	0.04	0.22	14.77	99.37
RV3	2.96	0.99	9.32	44.06	0.96	1.82	7927	4.47	14.39	3.40	0.15	0.02	0.29	18.47	99.32
RV4	3.14	0.77	9.67	40.42	0.80	1.51	6587	4.87	17.46	2.47	0.14	0.04	0.29	19.46	99.39
RV5	2.42	0.72	9.21	37.74	1.09	2.05	8938	4.94	19.45	2.42	0.13	0.05	0.31	20.92	99.26
RV6	2.96	1.29	9.71	38.68	0.82	1.55	6776	4.62	17.85	2.65	0.10	0.04	0.30	20.51	99.43
RV7	2.89	0.99	9.28	37.74	0.89	1.68	7343	4.59	19.68	2.64	0.13	0.04	0.31	20.31	99.36
RV8	2.99	1.06	9.95	40.86	0.78	1.46	6381	4.85	16.40	2.52	0.15	0.04	0.28	19.65	99.37
RV9	3.18	0.97	9.87	41.25	0.96	1.81	7886	4.75	16.48	2.52	0.13	0.02	0.33	19.07	99.39
RV10	4.65	1.39	9.67	40.63	1.18	2.22	9679	4.75	14.64	2.52	0.13	0.05	0.30	19.64	99.42
RV11	2.92	1.13	10.41	41.90	0.72	1.35	5912	5.05	15.08	2.47	0.12	0.03	0.32	19.40	99.43
RV12	2.53	0.87	9.65	43.03	1.18	2.22	9687	4.88	15.63	2.26	0.08	0.05	0.32	19.05	99.43
RV13	2.70	1.05	9.78	40.24	0.75	1.41	6134	4.92	16.35	2.42	0.13	0.03	0.34	20.71	99.28
RV14	2.18	0.57	10.96	32.18	0.99	1.87	8157	5.17	10.82	3.21	0.11	0.02	0.26	31.58	97.93
RV15	3.19	0.93	15.29	43.34	0.41	0.78	3396	4.91	5.98	2.52	0.17	0.00	0.22	22.28	99.07
RV16	2.91	1.35	9.51	39.48	0.95	1.80	7837	4.86	17.09	2.56	0.13	0.06	0.32	20.16	99.26
RV17	2.64	1.25	9.63	40.31	0.72	1.35	5904	4.95	16.71	2.46	0.12	0.07	0.32	20.23	99.26
RV18	3.26	1.33	8.82	36.20	0.97	1.82	7944	4.41	22.08	2.43	0.15	0.06	0.31	19.42	99.28
RV19	3.18	1.35	9.93	40.13	0.93	1.75	7631	4.65	16.98	2.27	0.15	0.03	0.29	19.64	99.38
RV20	4.03	1.40	9.76	39.09	0.84	1.59	6940	4.71	16.66	2.33	0.09	0.03	0.30	20.30	99.45
RV21	2.38	1.05	9.46	39.03	0.80	1.50	6546	4.84	17.55	2.28	0.16	0.04	0.31	21.56	99.30
RV22	2.88	0.96	9.90	40.36	0.92	1.73	7549	4.70	16.72	2.37	0.14	0.03	0.31	20.22	99.37
RV23	2.71	1.21	10.00	39.91	0.76	1.42	6208	4.67	17.46	2.41	0.11	0.05	0.26	19.85	99.29
RV24	2.93	1.43	9.87	39.18	0.90	1.69	7393	4.82	17.77	2.32	0.12	0.05	0.30	19.79	99.35
RV25	2.97	1.08	9.93	40.77	0.60	1.13	4942	4.59	17.06	2.33	0.10	0.05	0.30	19.76	99.43
RV26	2.42	1.06	9.13	39.20	0.93	1.76	7672	4.70	18.40	2.76	0.12	0.03	0.31	20.37	99.32
RV27	2.97	0.85	9.34	41.19	0.88	1.65	7195	4.85	16.98	2.53	0.10	0.05	0.29	19.43	99.36
RV28	2.76	1.11	9.74	40.51	0.84	1.58	6907	4.83	16.81	2.11	0.16	0.02	0.32	20.22	99.27

RV29	2.77	1.21	9.77	38.89	0.83	1.55	6784	4.68	17.28	2.22	0.17	0.05	0.37	21.33	99.39
Sample	Na2O	MgO	Al2O3	SiO2	P2O5	P2O5 (normalized)	P	K2O	CaO	TiO2	V2O5	Cr2O3	MnO	Fe2O3	Σ*
RV30	2.66	1.23	9.66	39.67	0.80	1.51	6587	4.73	17.85	2.41	0.13	0.00	0.30	20.06	99.36
RV31	3.02	1.08	9.23	40.39	0.78	1.47	6406	4.57	17.13	2.43	0.17	0.06	0.31	20.27	99.26
RV32	3.62	1.14	9.07	38.61	0.88	1.66	7236	4.40	18.23	2.51	0.08	0.06	0.29	20.61	99.39
RV33	2.80	1.05	8.99	38.45	0.90	1.69	7384	4.48	18.96	2.60	0.16	0.02	0.31	20.78	99.35
RV34	2.53	0.97	9.21	36.76	1.06	2.00	8749	4.73	18.92	2.77	0.12	0.05	0.31	22.03	99.33
RV35	2.83	0.82	8.60	34.31	1.02	1.93	8412	4.25	24.37	2.35	0.13	0.04	0.27	20.55	99.41
RV36	3.00	1.04	9.60	38.03	0.79	1.50	6529	4.68	18.24	2.66	0.12	0.05	0.31	20.83	99.24
RV37	3.39	1.07	9.04	31.49	0.93	1.74	7615	4.42	21.98	2.55	0.13	0.05	0.38	24.16	99.44
RV38	3.23	0.88	9.69	35.54	0.74	1.40	6093	4.66	17.68	2.50	0.17	0.04	0.37	23.96	99.29
RV39	2.61	0.97	9.14	31.60	0.93	1.75	7647	4.37	22.05	2.53	0.18	0.04	0.40	24.79	99.41
RV40	3.13	0.84	9.64	35.77	0.67	1.26	5501	4.76	18.68	2.56	0.15	0.05	0.36	22.92	99.36
RV41	3.15	1.25	9.92	39.96	0.74	1.39	6069	4.82	16.14	2.43	0.16	0.04	0.30	20.56	99.32
RV42	2.84	1.11	9.71	39.65	0.79	1.50	6529	4.80	17.09	2.52	0.10	0.04	0.29	20.45	99.29
RV43	3.03	1.23	9.87	39.83	0.68	1.28	5583	4.72	16.87	2.50	0.09	0.04	0.30	20.36	99.44
RV44	2.60	1.15	10.04	40.34	0.60	1.12	4893	4.78	14.92	2.50	0.15	0.03	0.36	21.88	99.19
RV45	2.45	0.89	9.72	39.54	0.78	1.47	6406	4.71	17.80	2.47	0.21	0.05	0.33	20.63	99.35
RV46	3.27	1.19	10.04	39.03	0.83	1.57	6858	4.59	16.64	2.54	0.08	0.05	0.31	20.95	99.44
RV47	2.83	0.81	8.98	40.07	1.12	2.11	9218	4.79	19.32	2.52	0.10	0.02	0.26	18.70	99.42
RV48	2.96	1.46	10.11	42.47	0.81	1.52	6620	4.99	12.57	2.86	0.14	0.01	0.31	20.66	99.20
RV49	1.92	0.49	8.05	43.55	0.94	1.77	7721	5.12	17.09	2.78	0.21	0.04	0.26	18.87	99.11
RV50	2.71	0.92	9.62	40.36	0.78	1.48	6439	4.83	17.31	2.41	0.12	0.04	0.32	19.95	99.24
RV32	3.62	1.14	9.07	38.61	0.88	1.66	7236	4.40	18.23	2.51	0.08	0.06	0.29	20.61	99.39
RV33	2.80	1.05	8.99	38.45	0.90	1.69	7384	4.48	18.96	2.60	0.16	0.02	0.31	20.78	99.35
RV34	2.53	0.97	9.21	36.76	1.06	2.00	8749	4.73	18.92	2.77	0.12	0.05	0.31	22.03	99.33
RV35	2.83	0.82	8.60	34.31	1.02	1.93	8412	4.25	24.37	2.35	0.13	0.04	0.27	20.55	99.41
RV36	3.00	1.04	9.60	38.03	0.79	1.50	6529	4.68	18.24	2.66	0.12	0.05	0.31	20.83	99.24
RV37	3.39	1.07	9.04	31.49	0.93	1.74	7615	4.42	21.98	2.55	0.13	0.05	0.38	24.16	99.44
RV38	3.23	0.88	9.69	35.54	0.74	1.40	6093	4.66	17.68	2.50	0.17	0.04	0.37	23.96	99.29
RV39	2.61	0.97	9.14	31.60	0.93	1.75	7647	4.37	22.05	2.53	0.18	0.04	0.40	24.79	99.41
RV40	3.13	0.84	9.64	35.77	0.67	1.26	5501	4.76	18.68	2.56	0.15	0.05	0.36	22.92	99.36
RV41	3.15	1.25	9.92	39.96	0.74	1.39	6069	4.82	16.14	2.43	0.16	0.04	0.30	20.56	99.32
RV42	2.84	1.11	9.71	39.65	0.79	1.50	6529	4.80	17.09	2.52	0.10	0.04	0.29	20.45	99.29
RV43	3.03	1.23	9.87	39.83	0.68	1.28	5583	4.72	16.87	2.50	0.09	0.04	0.30	20.36	99.44
RV44	2.60	1.15	10.04	40.34	0.60	1.12	4893	4.78	14.92	2.50	0.15	0.03	0.36	21.88	99.19
RV45	2.45	0.89	9.72	39.54	0.78	1.47	6406	4.71	17.80	2.47	0.21	0.05	0.33	20.63	99.35
RV46	3.27	1.19	10.04	39.03	0.83	1.57	6858	4.59	16.64	2.54	0.08	0.05	0.31	20.95	99.44
RV47	2.83	0.81	8.98	40.07	1.12	2.11	9218	4.79	19.32	2.52	0.10	0.02	0.26	18.70	99.42
RV48	2.96	1.46	10.11	42.47	0.81	1.52	6620	4.99	12.57	2.86	0.14	0.01	0.31	20.66	99.20

RV49	1.92	0.49	8.05	43.55	0.94	1.77	7721	5.12	17.09	2.78	0.21	0.04	0.26	18.87	99.11
RV50	2.71	0.92	9.62	40.36	0.78	1.48	6439	4.83	17.31	2.41	0.12	0.04	0.32	19.95	99.24
Sample	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	P_2O_5 (normalized)	P	K_2O	CaO	TiO_2	V_2O_5	Cr_2O_3	MnO	Fe_2O_3	Σ*
RV51	2.798	0.754	8.955	38.175	1.073	2.02	8823	5.304	17.772	2.32	0.177	0.042	0.382	21.652	100
RV52	3.037	1.138	9.278	37.391	0.889	1.68	7310	4.76	19.279	2.26	0.126	0.059	0.303	21.012	99.532
RV53	1.787	0.701	8.946	36.526	1	1.88	8223	4.997	17.57	2.558	0.193	0.042	0.366	24.503	99.189
RV54	3.111	0.99	9.313	39.115	0.737	1.39	6060	4.903	17.805	2.577	0.136	0.058	0.305	20.422	99.472
RV55	3.512	1.243	9.629	38.67	0.71	1.34	5838	4.893	17.17	2.357	0.128	0.033	0.333	20.76	99.438
RV56	2.715	0.927	9.322	41.14	1.014	1.91	8338	4.78	16.349	2.752	0.182	0.03	0.35	19.797	99.358
RV57	3.647	1.101	8.486	42.626	1.14	2.15	9374	4.707	16.961	2.58	0.156	0.025	0.308	17.625	99.362
RV58	3.289	1.069	9.112	47.587	0.867	1.63	7129	4.703	14.383	3.106	0.123	0.034	0.216	14.921	99.41
RV59	2.956	0.948	8.992	46.182	0.711	1.34	5847	4.753	15.397	2.691	0.109	0.032	0.235	16.433	99.439
RV60	3.184	1.15	9.517	45.679	0.851	1.60	6998	4.687	15.185	2.635	0.12	0.031	0.224	16.218	99.481
RV61	3.356	0.961	8.724	47.038	0.821	1.55	6751	4.612	14.533	2.807	0.158	0.022	0.275	16.085	99.392
RV51	2.798	0.754	8.955	38.175	1.073	2.02	8823	5.304	17.772	2.32	0.177	0.042	0.382	21.652	100
G-2	3.93	0.52	15.00	70.18	0	0	0	4.76	2.15	0.48	0.02	0.00	0.03	2.60	99.65
G-2	3.96	0.62	14.92	70.21	0	0	0	4.78	2.13	0.40	0.03	0.00	0.03	2.59	99.65
G-2	3.93	0.52	15.00	70.18	0	0	0	4.76	2.15	0.48	0.02	0.00	0.03	2.60	99.64
G-2 USGS	4.08	0.75	15.39	69.14	0.14		611	4.48	1.96	0.48	nr+	nr	0.03	2.66	99.11

	Ni ppm	Cu ppm	Zn ppm	Ga ppm	Rb ppm	Sr ppm	Y ppm	Zr ppm	Nb ppm	Ba ppm	Pb ppm	Th ppm
CL1	19	12	41	12	63	152	17	256	8	1030	12	8
CL2	17	17	101	9	35	130	15	224	7	671	10	15
CL3	17	12	52	11	60	138	16	229	9	1288	19	7
CL4	17	18	55	15	56	257	19	305	9	1228	14	11
CL5	18	11	85	14	77	131	16	214	3	691	15	5
CL6	20	14	87	12	61	176	17	363	6	562	13	10
CL7	17	10	50	12	59	129	15	202	12	570	15	6
RV1	25	23	122	18	72	340	30	358	5	704	19	13
RV2	22	22	89	19	69	332	26	220	17	803	15	14
RV3	27	35	125	20	85	317	30	265	10	732	25	9
RV4	27	34	148	23	92	284	36	246	13	908	31	6
RV5	30	43	134	19	91	283	23	163	9	823	30	9
RV6	30	45	185	22	100	293	32	224	14	845	36	4
RV7	28	34	155	22	95	284	26	212	14	745	26	4
RV8	27	36	140	22	98	296	30	220	7	767	31	4
RV9	30	41	177	24	93	302	29	235	10	839	27	4
RV10	29	55	243	25	103	304	28	225	14	690	30	4

RV11	30	41	173	24	102	278	32	255	10	757	34	4
RV12	28	47	175	21	103	320	28	238	13	808	27	5
RV13	25	37	144	19	95	275	29	223	14	844	30	4
RV14	19	16	126	20	55	323	15	185	8	1026	14	13
	Ni	Cu	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
RV15	18	13	132	24	73	446	18	219	7	1116	11	4
RV16	21	26	118	20	86	267	25	193	6	784	24	10
RV17	24	32	118	20	93	267	28	198	9	799	25	4
RV18	27	29	127	19	92	293	28	187	11	842	25	6
RV19	28	45	159	24	102	282	30	203	15	714	40	9
RV20	27	43	204	24	103	271	37	202	10	721	34	9
RV21	34	44	167	23	107	290	33	227	12	754	34	4
RV22	28	42	154	21	101	285	34	213	7	785	31	4
RV23	30	36	123	20	85	255	31	197	13	886	27	4
RV24	26	37	138	19	95	271	35	201	8	896	29	12
RV25	31	44	157	21	100	272	29	220	19	883	33	16
RV26	31	36	176	22	102	331	31	220	15	875	34	10
RV27	27	34	148	22	100	311	27	231	16	855	25	16
RV28	27	35	121	19	92	273	27	206	16	809	30	7
RV29	31	52	196	25	110	287	34	201	10	788	42	9
RV30	28	32	134	23	100	295	27	204	11	830	34	12
RV31	26	39	133	22	100	330	24	217	15	902	26	9
RV32	28	43	163	23	102	353	29	201	7	867	29	4
RV33	27	39	161	25	104	359	32	218	16	814	25	13
RV34	27	41	140	22	97	273	30	171	13	785	26	11
RV35	24	45	140	20	90	237	25	199	8	672	28	4
RV36	22	27	116	18	86	255	27	189	16	806	21	4
RV37	29	62	172	25	122	221	26	150	9	652	34	6
RV38	29	46	159	24	111	247	27	197	13	797	30	13
RV39	28	48	194	28	114	211	31	147	16	774	38	6
RV40	28	49	160	19	111	235	33	183	11	785	36	17
RV41	28	47	158	23	101	279	33	248	10	845	35	4
RV42	27	33	126	19	88	260	29	228	10	803	30	11
RV43	27	42	164	22	101	283	34	253	12	736	34	7
RV44	26	44	120	20	98	271	30	247	18	936	29	11
RV45	25	47	181	25	111	282	29	246	9	720	30	4
RV46	28	40	168	21	108	278	33	210	9	775	34	4
RV47	25	32	140	21	95	306	24	192	9	756	24	15
RV48	19	25	137	20	81	384	23	205	9	993	16	4
RV49	21	27	103	18	78	314	23	198	10	864	19	4
RV50	25	32	126	19	79	254	30	236	14	829	25	4

RV51	26	47	145	21	98	309	28	192	7	788	25	9
RV52	28	56	192	20	97	245	32	209	13	694	32	13
RV53	25	30	126	21	87	259	31	217	10	859	26	4
RV54	29	35	149	19	97	282	25	229	14	844	29	9
	Ni	Cu	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
RV55	25	41	141	20	92	284	33	209	13	903	28	12
RV56	23	26	112	22	88	285	32	244	15	844	22	10
RV57	24	24	104	19	79	326	25	287	11	859	21	8
RV58	20	14	86	17	75	335	19	216	2	840	19	11
RV59	24	23	109	17	75	340	26	195	12	877	15	4
RV60	23	17	113	21	82	357	19	205	7	765	22	6
RV61	20	20	85	17	71	332	21	191	10	952	17	9
G-2	15	8	89	22	163	458	14	280	16	1827	23	32
G-2	17	13	93	22	167	459	12	286	15	1961	21	28
G-2	15	14	91	20	170	470	11	288	15	1972	23	26
G-2 USGS	nr	11	86	23	170	478	11	309	12	1880	30	25

* sum does not include trace elements, and includes slight rounding errors; + nr = not reported