FINGERPRINTING OF GROUND WATER
BY ICP-MS

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PROGRESS REPORT
JULY 1, 1991, TO DECEMBER 31, 1991

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FINGERPRINTING OF GROUND WATER BY ICP-MS

JULY 1991 TO DECEMBER 1991

The purpose of this project is to investigate the use of minor constituents of ground water and vadose zone water, such as the rare earths and some lighter elements, to delineate ground water flow paths and recharge zones in the Yucca Mountain area. The major piece of equipment required to perform this task is an inductively coupled plasma-mass spectrometer (ICP-MS). This instrument has been purchased and should be delivered in February 1992. During this reporting period, three ICP-MS systems were evaluated and the Perkin-Elmer Elan 5000 was chosen. As part of the evaluation process, samples of J-13 water and tuff were prepared and analyzed by each of the competing companies. This gave us the opportunity to make initial observations as to the number of compounds and their concentrations present in the J-13 samples. Table 1 lists the results of the analysis of J-13 water. (The information listed in Table 1 was provided by the bidders for the ICP-MS, and we cannot make any statements regarding its quality or the manner in which it is presented. It is reproduced here only to show the potential value if this type of analysis.) Once the ICP-MS is operational, we will be collecting and analyzing waters from existing wells, springs, and seeps to determine which of these minor chemical constituents will be most helpful in establishing chemical signatures for the ground waters beneath Yucca Mountain.

The primary research effort for this project will be the materials dissolved in the water, but the materials suspended in the water may also be helpful in the characterization process. On this premise, we collected infrared scans on some of the particulate filtered from J-13 water and compared this to the tuffs that are being used for the tracer studies. We are purchasing a Fourier Transform Infrared Spectrophotometer (FT-IR) for another project, and, during the evaluation of the instruments, we decided to test the applicability of FT-IR to the particulates found in ground water.

Figures 1-3 represent IR scans of particulate from J-13 (A) and from the three types of tuff used in the tracer study (B). As expected, the spectra are similar, but there are some differences in the 800 to 1200 and the 2500 to 3500 cm^{-1} regions. Figures 4-7 are IR scans of particulate fractions collected from two different filter sizes. Some of the work was done here and some was sent to an instrument company's application laboratory, so it is difficult to provide a detailed analysis of the results. However, the results do indicate that the FT-IR has some potential for gross characterization of the particulates found in ground water. We will continue to investigate the value of FT-IR spectra for particulates in the "fingerprinting" process.

CONTINUING WORK

During the period of January to June 1992, we will start the chemical analysis of ground waters by ICP-MS and continue the FT-IR characterization of the particulates.

TABLE 1

RESULTS OF ANALYSES AND STATISTICAL COMPARISONS OF J-13 WATER, YUCCA MOUNTAIN.

Sample	J-13A*	J-13AA*	J-13B*	J-13BB*	J-13C	MEAN CONC.	STD. DEVIATION	DET. LIMITS
CONC.	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
NAME								
Aluminum	*****		*****		0	0.000	0.000	0.000
Antimony	0.337	0.57325	0.402	0.8309	0.55	0.499	0.000	0.000
Arsenic	8.535	11.99715	9.718	12.85375	15.15	11.651	0.000	0.000
Barium	1.018		1.087		1.03	1.045	0.000	0.000
Beryllium	0.034	0.0442	0.035	0.08125	0	0.035	0.000	0.000
Boron	181.814		187.807		146.5	165.307	0.285	0.854
Cadmium	0.059	-0.02195	0.021	-0.02095	0	0.007	4.579	13.738
Calcium	10866.327		11086.749		12910	12910.000	0.000	0.000
Cerium	0.005	0.0026	0.008	0.00435	0	0.004	0.020	0.060
Cesium	1.231		1.279		1.19	1.233	0.000	0.000
Chromium	1.728	1.8844	1.788	1.9265	0.87	1.635	0.030	0.061
Cobalt	*****		*****		0.02	0.020	0.000	0.000
Copper	1.229	0.99755	1.551	1.2213	0.85	1.130	0.003	0.008
Dysprosium 162	*****	-0.00355	0.007	0.0059	0	0.002	0.628	1.883
Dysprosium 163	0.012	0.00385	0.009	0.00645		0.008	0.779	2.338
Erbium 166	*****	0.0045	*****	0.0058	0	0.003	0.000	0.000
Erbium 167	0.002		0.008			0.004	0.489	1.498
Europium 151	0.004	-0.0001	0.001	0	0	0.001	0.004	0.012
Europium 153	0.01		*****			0.010	0.000	0.000
Gadolinium 157	0.008	-0.00755	0.037	0.01115	0	0.009	0.003	0.008
Gadolinium 158	*****		*****			*****	*****	0.000
Gadolinium 160	*****		*****			*****	*****	0.000
Gallium	0.058		0.087		0	0.041	0.000	0.000
Germanium	0.243		0.24		0.38	0.281	0.008	0.023
Gold	0.004		*****		0	0.002	0.000	0.000
Hafnium	*****		*****		0	0.000	0.000	0.000
Holmium	0	-0.0029	*****	-0.0043	0	-0.002	0.031	0.083
Iridium	*****		*****		0	0.000	0.000	0.000
Iron	16.428		19.293		0	11.907	0.000	0.000
Lanthanum	*****	0.0007	*****	-0.0045	0	-0.001	0.000	0.000
Lead	0.803		1.016		0.05	0.823	0.002	0.005
Lutetium	0.001	0.00055	*****	0	0	0.000	0.000	0.000
Magnesium	1911.231		1987.502		1706	1706.000	0.000	0.000
Manganese	1.001		0.98		0.03	0.870	0.002	0.007
Mercury	0.05		0.048		0	0.032	0.000	0.000
Molybdenum	3.588		3.878		6.95	4.738	0.000	0.001
Neodymium 143	*****	-0.00015	*****	0.01375	0	0.005	919.488	2758.403
Neodymium 146	0		0.028			0.014	0.000	0.000
Nickel	1.571	1.8014	1.738	1.90845	1.24	1.651	0.024	0.071
Niobium	*****		*****		0.14	0.140	0.000	0.000
Osmium	0.01		*****		0	0.005	0.007	0.021
Palladium	*****		0.005		0	0.003	0.000	0.000
Phosphorus	*****		*****		5.21	5.210	0.000	0.000
Platinum	*****		*****		0	0.000	0.000	0.000
Praseodymium	*****	0.0005	*****	-0.0039	0	-0.001	0.005	0.014
Rhenium	0.009		0.008		0	0.006	0.000	0.000
Rhodium	0.016		0.024		0.55	0.197	0.000	0.000
Rubidium	5.357		5.814		9.65	6.940	0.000	0.000
Ruthenium	0.018		0.01		0	0.009	0.002	0.008
Samarium 149	*****	-0.00595	0.022	0.0068	0	0.008	0.004	0.013
Samarium 152	*****		0.008			0.008	0.000	0.000
Silver	*****		*****		0	0.000	0.000	0.000
Strontium	21.627		23.395		41.78	28.927	0.000	0.000
Tantalum	0.004		0.008		0	0.003	0.008	0.018
Tellurium	0.019		*****		0	0.010	0.000	0.000
Terbium	*****	-0.00185	0.001	0.00025	0	-0.000	0.000	0.000
Thallium	0.21		0.044		0	0.085	0.000	0.000
Thorium	0.001	0.0008	0.008	0.0021	0	0.002	0.003	0.008
Thulium	*****	0.0008	0.008	0.0025	0	0.002	0.008	0.025
Tin	*****		*****		0.04	0.040	0.000	0.000
Titanium	9.582		10.447		13.04	11.026	0.000	0.000
Tungsten	1.515		1.609		0.74	1.288	0.001	0.003
Uranium	0.585		0.59		0.98	0.718	0.001	0.003
Vanadium	6.79		6.969		3.01	7.590	0.000	0.000
Ytterbium 172	*****	-0.004	*****	0.00145	0	-0.002	4.738	14.208
Ytterbium 174	*****		*****			*****	*****	0.000
Yttrium	0		0.001		0	0.000	0.000	0.000
Zinc	1.68	1.8218	2.478	2.2847	1.59	1.971	0.371	10.112
Zirconium	0.026		0.004		0	0.010	0.002	0.005

* A, AA and B, BB are duplicate samples.

***** Data not available, not gathered, or indeterminate.

PERKIN ELMER

Figure 1 A. Suspended Particles from J-13 well on 0.45 μ filters.
B. Light tuff on KBr window.

PERKIN ELMER

100.14
2T

Figure 2. A. Suspended Particles from J-13 well on 0.45 μ filters.
B. Medium tuff on KBr window.

PERKIN ELMER

Figure 3. A. Suspended Particles from J-13 well on 0.45 μ filters.
B. Dark tuff on KBr window.

BioRad FT-IR

Figure 4. Primary material from 0.4 μ filter.

BioRad FT-IR

Absonce

Figure 5. Primary material from 0.2 μ filter.

BioRad FT-IR

0.4

0.3

0.2

0.1

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

1000

1500

2000

2500

3000

3500

4000

Wavenumbers

Figure 6. Clear silicate particle from 0.4 μ filter.

BioRad FT-IR

Figure 7. Orange fragment from 0.2 μ filter.

END

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