DOE/NV/10872--T193

FINGERPRINTING OF GROUND WATER
BY ICP-MS

PROGRESS REPORT
JANUARY 1, 1995 TO MARCH 31, 1995

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No. DE-FC 08-90NV10872

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SAMPLE ANALYSIS

The samples were collected from Death Valley and Ash Meadows springs in November 1994 have not been completely analyzed due to ICP-MS problems. As soon as the instrument is operating again, analyses will continue. The estimated completion time is now June, 1995.

DATA REDUCTION

Data verification was completed for Ash Meadows samplings one through five. The results are enclosed with this report.

The verification of data from the Ash Meadows six week study, Lincoln County springs and several wells, including J-13 is in progress and should be completed by June, 1995.

CHEMICAL ANALYSIS OF WATER
FROM
ASH MEADOWS SPRINGS

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SUMMARY

This report contains the results of the chemical analysis of water from springs in Ash Meadows National Wildlife Refuge, Nevada. Each spring was sampled two to five times between July, 1992 and March, 1994. Samples were collected and analyzed by the Harry Reid Center for Environmental Studies (HRC) Environmental/Analytical Laboratory, at the University of Nevada, Las Vegas. The coordinates and dates of sampling are included.

The chemical analyses performed on these spring waters included major cations and anions and trace elements. The analyses for the major anions were performed by atomic absorption (AA) spectrophotometry, the anions by ion chromatography (IC) and the trace elements by inductively coupled plasma - mass spectrometry (ICP-MS). The standard operating procedures (SOP) used for each method are included.

The concentrations of the analytes range from the part per million (ppm) levels for the major cations and anions to the sub part per trillion (ppt) levels for a number of the trace elements. Approximately nine orders of magnitude are covered from the highest to the lowest concentrations.

The formation of molecular species in the ICP-MS plasma produces false positives for a number of elements. None of the elements reported here, that the HRC is aware of, are subject to these isobaric interferences, with the exception of europium (Eu). Europium values are reported for samplings four and five where the HRC used an extraction procedure that extracted Eu but not barium (Ba), whose oxides cause the interference. In order to overcome matrix effects in the samples from high concentrations of cations and other elements, the method of standard additions was instituted for the analysis of samplings four and five as an alternative to external standardization.

It is believed that these data, and those for the Death Valley Spring reported in January, 1995 are the first efforts at such a comprehensive trace element analysis of ground waters. HRC has had to develop, test, and refine sampling and analysis procedures throughout the course of this study. A great deal of effort has gone into ensuring that even with the variations in methods and procedures, the data quality from any one sampling is comparable to the others.

There are variations in the measurements. These can be attributed to environmental influences (e.g., precipitation, seasonal changes, human disturbances, and others) causing fluctuations in concentrations or due to changes in the sampling and analysis methods. Some variations also arise from lack of precision in the instrument. This is especially true when measurements are made near the detection limits of the instrument. It is important therefore, when looking at the data variation, to observe how close the measurements are to the detection limits.

Questions concerning these data should be addressed to:

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Vernon Hodge, Environmental/Analytical Chemist, UNLV/Chemistry
Amy Smiecinski, Quality Assurance Officer, UNLV/HRC

702-895-3742
702-895-3845
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Ash Meadows Sampling Site Names and Locations

Spring Name	Latitude	Longitude
Big Spring	36 22.41 N	116 16.48 W
Bradford	36 24.07 N	116 18.18 W
Cold Spring	36 27.65 N	116 20.74 W
Crystal Pool	36 25.20 N	116 19.37 W
Fairbanks	36 29.45 N	116 20.49 W
Five	36 27.52 N	116 19.13 W
Forest	36 23.94 N	116 17.01 W
Indian	36 25.57 N	116 18.58 W
Jack Rabbit	36 23.39 N	116 16.71 W
King's Pool	36 24.09 N	116 16.42 W
Longstreet	36 28.05 N	116 19.58 W
Marsh	36 25.74 N	116 18.58 W
Point of Rocks - NE (formerly Point of Rocks #1)	36 24.12 N	116 16.28 W
Point of Rocks - NW (formerly Point of Rocks #2)	36 24.15 N	116 16.37 W
Rogers	36 28.86 N	116 19.69 W
School	36 25.68 N	116 18.25 W
Scruggs	36 26.05 N	116 18.61 W
Tubbs	36 23.96 N	116 18.08 W

Ash Meadows- Big Spring									
		Sample #1	Sample #2	Sample #3		Sample #4		Sample #5	
		July 1992	Jan. 1993	May 1993		Oct. 1993		Mar. 1994	
		Mean	Mean	Mean		Mean		Mean	Detection
		S.D.	S.D.	S.D.		S.D.		S.D.	Limit
ANIONS									
Bromide	PPM	0.22	0.21	0.23		0.32		0.18	0.03
		0.01	0.01	0.01		0.01		0.01	
Chloride	PPM	23.2	25.3	24.7		24.9		23.6	0.08
		0.3	0.4	0.3		0.1		0.1	
Fluoride	PPM	1.51	1.32	1.30		1.24		1.29	0.03
		0.04	0.04	0.03		0.02		0.02	
Nitrate	PPM	2.11	1.31	0.81		0.58		0.61	0.02
		0.01	0.01	0.01		0.01		0.01	
Sulfate	PPM	94.8	110.8	107.8		107.2		100.1	0.03
		0.4	0.6	0.2		0.3		0.1	
MAJOR METALS									
Ca	PPM	NM	49.0	43.5		44.6		44.6	0.06
			0.4	0.5		0.3		0.2	
Mg	PPM	NM	20.4	18.2		19.4		19.3	0.3
			0.3	0.2		0.1		0.2	
K	PPM	NM	9.4	8.7		9.2		8.7	0.05
			0.1	0.3		0.1		0.1	
Na	PPM	NM	105	103		101		100	1.5
			1	2		2		1	
TRACE METALS									
Li 7	PPB	109	120	168		111		98	0.01
		4	5	4		2		2	
Al 27	PPB	NM	NM	NM		0.54		0.53	0.02
						0.03		0.02	
Ti 47	PPB	4.9	1.54	0.57		0.82		0.56	0.01
		0.6	0.04	0.02		0.05		0.05	
V 51	PPB	1.22	1.7	1.39		1.51		1.56	0.003
		0.04	0.1	0.03		0.05		0.04	
Cr 52	PPB	1.9	1.6	0.52		0.92		4.5	0.02
		0.1	0.1	0.05		0.02		0.2	
Mn 55	PPB	0.053	0.07	0.070		0.05		0.24	0.01
		0.007	0.03	0.007		0.01		0.01	
Ni 60	PPB	9.0	0.36	0.29		0.55		0.80	0.01
		0.3	0.01	0.02		0.05		0.03	
Cu 63	PPB	NM	NM	NM		1.43		2.78	0.07
						0.03		0.06	

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDS

Ash Meadows- Big Spring (cont':pg.2)									
		Sample #1	Sample #2	Sample #3		Sample #4		Sample #5	
		Mean	Mean	Mean		Mean		Mean	Detection
		S.D.	S.D.	S.D.		S.D.		S.D.	Limit
Zn 66	PPB	NM	NM	NM		0.49		1.19	0.01
						0.03		0.01	
Ge 73	PPB	0.77	0.71	0.52		0.53		0.60	0.001
		0.05	0.04	0.02		0.03		0.02	
As 75	PPB	31	34	95		30.4		25.2	0.01
		2	1	11		0.7		0.3	
Se 77	PPB	3.6	16	1.1		0.49		0.4	0.1
		0.3	3	0.2		0.07		0.2	
Rb 85	PPB	17.9	19.4	20.7		17.8		14.2	0.001
		0.1	0.8	0.4		0.6		0.2	
Sr 86	PPB	1090	1210	1411		1010		860	0.4
		20	20	21		10		8	
Mo 95	PPB	6.8	9.1	7.2		6.6		7.1	0.03
		0.2	0.2	0.2		0.1		0.5	
Sn 117	PPB	0.35	0.36	0.026		0.24		0.037	0.004
		0.07	0.01	0.003		0.02		0.003	
Sb 121	PPB	0.26	0.22	0.20		0.28		0.29	0.01
		0.02	0.01	0.01		0.01		0.02	
Cs 133	PPB	4.83	4.2	3.66		3.6		3.53	0.001
		0.05	0.2	0.04		0.1		0.07	
Ba 135	PPB	49	60	49		34		40	0.002
		3	2	2		1		3	
W 182	PPB	0.27	0.31	0.390		0.24		0.26	0.02
		0.01	0.02	0.004		0.01		0.02	
Tl 205	PPB	0.25	0.24	0.160		0.19		0.17	0.002
		0.01	0.02	0.004		0.01		0.01	
U 238	PPB	3.28	3.21	2.41		2.47		2.54	0.0002
		0.05	0.08	0.02		0.09		0.08	
Be 9	PPT	ND	ND	ND		ND		ND	20
Co 59	PPT	339 (A)	16	16		28		16	1
		9	6	1		3		4	
Ga 71	PPT	8	20	7		11		2	0.8
		1	10	1		1		1	
Zr 90	PPT	ND	1450	83		62		42	0.6
			40	2		4		3	
Nb 93	PPT	ND	ND	14		13		12	4
				1		3		4	

Ash Meadows- Big Spring (cont':pg.3)									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		Mean	Mean	Mean	Mean		Mean		Detection
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
Ru 99	PPT	ND	ND	ND	ND		ND		1.5
Rh 103	PPT	115	16	12	12		25		2
		8	2	1	2		3		
Ag 107	PPT	ND	ND	ND	ND		ND		3.0
Cd 114	PPT	15	39	36	ND		ND		5
		2	6	6					
In 115	PPT	NM	1.1	ND	4		ND		0.4
			0.5		1				
Te 125	PPT	110	50	19	18		6		9
		20	10	4	4		3		
Hf 177	PPT	3	55	6	ND		ND		3
		1	3	2					
Ta 181	PPT	ND	4	14	10.8		ND		0.03
			1	1	0.2				
Re 187	PPT	7.0	7.7	6.3	6.8		6		0.12
		0.3	0.7	0.3	0.9		2		
Ir 193	PPT	ND	ND	ND	ND		ND		0.6
Pt 195	PPT	ND	ND	6	ND		ND		0.3
				1					
Au 197	PPT	ND	ND	52	ND		ND		3
				8					
Pb 208	PPT	50	ND	24	ND		51		8
		20		3			4		
Bi 209	PPT	ND	ND	ND	ND		13		2
							3		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Big Spring (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			Detection
		Mean	Mean	Mean	Mean			Mean			Limit
		S.D.	S.D.	S.D.	S.D.			S.D.			
		D	P	P	P	D	E	P	D	E	P & E, D
Y 89	PPT	10.6	14.3	8	5.98	10.19	4.07	11.11	6.1	5.73	0.2, 1
		0.6	0.4	2	0.10	0.96	0.10	0.19	0.3	0.08	
La 139	PPT	3.8	18.9	40	0.24	2.57	3.18	4.42	2.90	0.41	0.08, 1
		0.3	0.5	8	0.09	0.30	0.07	0.07	0.30	0.03	
Ce 140	PPT	9.4	4.1	11	1.00	4.71	0.63	2.19	1.7	ND	0.06, 0
		0.3	0.4	2	0.07	0.29	0.10	0.05	0.3		
Pr 141	PPT	ND	0.6	1.4	0.04	ND	0.10	0.38	ND	0.07	0.01, 0
			0.1	0.3	0.03		0.02	0.02		0.01	
Nd 143	PPT	ND	3.3	5	1.1	ND	0.46	1.46	ND	0.47	0.08, 5
			0.8	1	0.2		0.06	0.09		0.03	
Sm 147	PPT	ND	0.9	0.8	1.89	6	3.8	5.2	3.7	5.0	0.1, 1
			0.3	0.2	0.09	1	0.3	0.1	0.5	0.1	
Eu 153	PPT	NM	NM	NM	NM	NM	0.10	NM	NM	0.09	0.06, 0
							0.02			0.02	
Gd 158	PPT	ND	0.8	0.9	0.30	ND	0.31	0.49	ND	0.43	0.1, 3
			0.4	0.1	0.03		0.05	0.03		0.04	
Tb 159	PPT	ND	ND	0.33	0.01	NM	0.06	0.06	ND	0.12	0.01, 0
				0.06	0.02		0.01	0.01		0.01	
Dy 163	PPT	ND	1.0	1.0	0.36	ND	0.37	0.36	ND	0.64	0.05,
			0.5	0.2	0.06		0.04	0.06		0.04	
Ho 165	PPT	ND	0.14	0.44	0.06	ND	0.09	0.09	ND	0.15	0.01, 0
			0.07	0.02	0.01		0.01	0.01		0.01	
Er 166	PPT	ND	0.5	0.8	0.30	ND	0.32	0.28	ND	0.44	0.05,
			0.3	0.2	0.04		0.06	0.03		0.02	
Tm 169	PPT	ND	0.06	0.38	ND	ND	0.03	0.026	ND	0.05	0.01, 0
			0.09	0.07			0.01	0.003		0.01	
Yb 173	PPT	ND	0.70	0.74	0.17	ND	ND	0.10	ND	0.16	0.1,
			0.10	0.20	0.03			0.03		0.03	
Lu 175	PPT	ND	ND	0.36	ND	NM	ND	0.014	ND	ND	0.01, 0
				0.08				0.003			
Th 232	PPT	ND	ND	1.0	ND	ND	ND	0.71	ND	0.09	0.05, 0
				0.2				0.06		0.02	
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Bradford									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		July 1992	Jan. 1993	May 1993	Oct. 1993		Mar. 1994		
		Mean	Mean	Mean	Mean		Mean		Detection
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
ANIONS									
Bromide	PPM	0.29	0.26	0.27	0.22		0.19		0.03
		0.01	0.01	0.01	0.01		0.01		
Chloride	PPM	26.4	36.7	36.4	37.7		33.0		0.08
		0.4	0.6	0.2	0.1		0.5		
Fluoride	PPM	1.79	1.61	1.68	1.89		1.72		0.03
		0.02	0.02	0.01	0.07		0.01		
Nitrate	PPM	1.91	0.78	0.57	0.33		0.29		0.02
		0.01	0.01	0.01	0.01		0.01		
Sulfate	PPM	118	141	152	138		143		0.03
		1	1	1	1		1		
MAJOR METALS									
Ca	PPM	NM	60.5	55.1	32.0		56.3		0.06
			0.6	0.3	0.3		0.1		
Mg	PPM	NM	29.2	27.8	28.8		28.9		0.3
			0.4	0.2	0.4		0.1		
K	PPM	NM	10.7	10.5	11.0		10.5		0.05
			0.2	0.1	0.1		0.1		
Na	PPM	NM	114	112	104		112		1.5
			1	4	3		1		
TRACE METALS									
Li 7	PPB	107	134	185	94		96		0.009
		7	9	6	2		1		
Al 27	PPB	NM	NM	NM	0.38		0.31		0.02
					0.03		0.01		
Ti 47	PPB	5.9	1.42	0.88	0.80		0.62		0.009
		0.6	0.04	0.06	0.05		0.03		
V 51	PPB	1.99	1.80	2.17	2.38		2.16		0.003
		0.03	0.04	0.06	0.09		0.03		
Cr 52	PPB	1.8	0.20	0.48	4.7		5.3		0.02
		0.2	0.01	0.04	0.8		0.1		
Mn 55	PPB	0.10	0.34	0.43	0.048		0.195		0.005
		0.03	0.01	0.01	0.004		0.004		
Ni 60	PPB	4.4	0.2	0.56	1.37		1.42		0.01
		0.2	0.03	0.05	0.09		0.08		
Cu 63	PPB	NM	NM	NM	4.3		2.93		0.07
					0.2		0.05		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEE

Ash Meadows- Bradford (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Zn 66	PPB	NM	NM	NM	0.56			0.59	0.01
					0.03			0.02	
Ge 73	PPB	0.55	0.46	0.33	0.38			0.39	0.0009
		0.06	0.02	0.01	0.03			0.02	
As 75	PPB	21	20	36	20			19.3	0.009
		2	1	5	1			0.9	
Se 77	PPB	1.7	0.4	1.0	0.44			0.43	0.10
		0.3	0.1	0.2	0.08			0.04	
Rb 85	PPB	18.4	20	22.3	17			17.4	0.001
		0.1	1	0.6	1			0.3	
Sr 86	PPB	1290	1520	1935	1180			1106	0.40
		20	50	30	10			20	
Mo 95	PPB	13.3	18	2.8	11.9			14.3	0.025
		0.2	0.6	0.1	0.4			0.2	
Sn 117	PPB	ND	ND	2.24	0.122			0.038	0.004
				0.04	0.007			0.003	
Sb 121	PPB	0.25	0.137	0.163	0.234			0.260	0.005
		0.02	0.008	0.004	0.006			0.005	
Cs 133	PPB	4.2	3.34	3.6	4.6			3.34	0.0005
		0.1	0.06	0.1	0.2			0.04	
Ba 135	PPB	47	45	49	34			41.0	0.002
		3	1	2	1			0.5	
W 182	PPB	0.77	0.29	0.06	0.26			0.27	0.018
		0.02	0.02	0.01	0.01			0.01	
Tl 205	PPB	0.343	0.32	0.250	0.31			0.201	0.002
		0.005	0.03	0.003	0.02			0.001	
U 238	PPB	8.3	6.7	6.8	8.0			5.7	0.0002
		0.1	0.2	0.1	0.3			0.1	
Be 9	PPT	ND	ND	ND	ND			ND	20
Co 59	PPT	172	27	32	46			74	1
		7	2	2	1			2	
Ga 71	PPT	2.2	2	1.7	ND			ND	0.8
		0.8	1	0.4					
Zr 90	PPT	ND	440	51	69			10	0.6
			20	2	5			3	
Nb 93	PPT	ND	ND	10	21			17	4
				0.5	2			4	

Ash Meadows- Bradford (cont':pg.3)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Ru 99	PPT	ND	ND	ND	ND			ND	1.5
Rh 103	PPT	200	18	29.8	28			26	2
		30	1	2	3			1	
Ag 107	PPT	ND	ND	ND	98			44	3
					30			1	
Cd 114	PPT	ND	42	25	68			63	5
			7	3	9			2	
In 115	PPT	NM	ND	ND	ND			5.7	0.4
								0.3	
Te 125	PPT	480	ND	22	ND			ND	9
		20		5					
Hf 177	PPT	ND	49	ND	ND			ND	3
			2						
Ta 181	PPT	ND	9	7	30			24	0.03
			3	1	3			4	
Re 187	PPT	13	12	13	13			13	0.12
		1	1	1	1			1	
Ir 193	PPT	ND	ND	ND	ND			ND	0.6
Pt 195	PPT	ND	ND	4	ND			ND	0.3
				1					
Au 197	PPT	ND	18	15	ND			ND	3
			6	2					
Pb 208	PPT	90	ND	85	ND			ND	8
		20		2					
Bi 209	PPT	5	12	ND	ND			ND	2
		2	2						

Ash Meadows- Bradford (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			Detection
		Mean	Mean	Mean	Mean			Mean			Limit
		S.D.	S.D.	S.D.	S.D.			S.D.			
		D	P	P	P	D	E	P	D	E	P & E, D
Y 89	PPT	13.8	13.2	7.4	0.91	9.2	3.6	10.6	8.4	5.9	0.2, 1
		0.8	0.7	1.6	0.08	0.8	0.1	0.4	0.6	0.1	
La 139	PPT	3.8	4.9	40	NM	3.3	1.81	2.21	2.4	0.35	0.08, 1
		0.3	0.4	8.3		0.3	0.06	0.07	0.3	0.06	
Ce 140	PPT	3.6	3.3	6.4	NM	2.6	0.90	0.55	1.3	1.16	0.06, 0.8
		0.3	0.3	1.4		0.3	0.09	0.06	0.3	0.07	
Pr 141	PPT	ND	0.6	0.9	NM	ND	0.23	0.25	ND	0.24	0.01, 0.6
			0.1	0.2			0.01	0.03		0.02	
Nd 143	PPT	ND	2.9	3.5	NM	ND	1.3	1.0	ND	0.99	0.08, 5
			0.7	0.8			0.1	0.2		0.07	
Sm 147	PPT	ND	0.7	0.7	NM	3.5	2.61	1.16	1.6	1.94	0.1, 1
			0.4	0.1		0.7	0.07	0.07	0.6	0.07	
Eu 153	PPT	NM	NM	NM	NM	NM	0.35	NM	NM	0.10	0.06, 0.6
							0.02			0.02	
Gd 158	PPT	ND	0.7	0.8	NM	ND	0.34	0.37	ND	0.57	0.1, 3
			0.2	0.1			0.08	0.05		0.06	
Tb 159	PPT	ND	0.12	0.13	NM	NM	2.23	0.030	ND	0.09	0.01, 0.7
			0.07	0.02			0.09	0.005		0.01	
Dy 163	PPT	ND	0.6	0.8	NM	ND	0.42	0.34	ND	0.66	0.05, 4
			0.2	0.2			0.05	0.06		0.05	
Ho 165	PPT	ND	0.14	0.18	NM	ND	0.34	0.078	ND	0.145	0.01, 0.8
			0.06	0.03			0.02	0.006		0.008	
Er 166	PPT	ND	0.5	0.5	NM	ND	0.34	0.24	ND	0.47	0.05, 2
			0.2	0.1			0.07	0.02		0.02	
Tm 169	PPT	ND	ND	0.08	NM	ND	0.07	0.02	ND	0.075	0.01, 0.5
				0.02			0.01	0.01		0.005	
Yb 173	PPT	ND	0.5	0.6	NM	ND	0.41	0.21	ND	0.32	0.1, 2
			0.2	0.1			0.07	0.05		0.03	
Lu 175	PPT	ND	0.09	0.09	NM	67 (A)	0.04	0.02	ND	0.041	0.01, 0.8
			0.07	0.02		5	0.01	0.01		0.005	
Th 232	PPT	ND	ND	0.57	NM	2.2	0.1	0.5	ND	0.17	0.05, 0.8
				0.2		1.0	0.2	0.1		0.05	
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Cold Spring									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		July 1992	Jan. 1993	May 1993	Oct. 1993		Mar. 1994		
		Mean	Mean	Mean	Mean		Mean		Detection
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
ANIONS									
Bromide	PPM	0.33	0.31	0.36	0.94		0.34		0.03
		0.03	0.01	0.01	0.03		0.04		
Chloride	PPM	53	32.6	61	61		60.1		0.08
		1	0.1	1	1		0.5		
Fluoride	PPM	1.95	1.63	1.97	2.22		1.72		0.03
		0.06	0.05	0.06	0.03		0.01		
Nitrate	PPM	1.45	0.48	0.65	0.74		0.39		0.02
		0.01	0.01	0.01	0.01		0.01		
Sulfate	PPM	276	318.0	323.3	315.4		294.8		0.03
		3	0.2	0.5	0.7		0.1		
MAJOR METALS									
Ca	PPM	NM	77.4	74.1	74.6		76.1		0.06
			0.2	0.5	0.6		0.2		
Mg	PPM	NM	40.1	36.8	36.9		37.5		0.3
			0.3	0.3	0.6		0.1		
K	PPM	NM	13.8	12.9	13.6		18.6		0.05
			0.2	0.2	0.2		0.1		
Na	PPM	NM	204	196	193		198		1.5
			6	4	2		1		
TRACE METALS									
Li 7	PPB	132	172	167	143		167		0.009
		4	6	5	1		4		
Al 27	PPB	NM	NM	NM	0.28		0.31		0.02
					0.01		0.01		
Ti 47	PPB	2.1	1.7	0.09	0.9		0.70		0.009
		0.1	0.1	0.03	0.6		0.02		
V 51	PPB	1.94	1.7	1.70	1.43		1.37		0.003
		0.04	0.1	0.08	0.02		0.07		
Cr 52	PPB	1.7	0.26	2.7	0.09		4.9		0.02
		0.4	0.01	0.2	0.01		0.3		
Mn 55	PPB	0.695	0.028	0.110	0.032		0.017		0.005
		0.008	0.004	0.005	0.004		0.003		
Ni 60	PPB	9.6	0.39	1.21	0.66		0.78		0.01
		0.2	0.01	0.08	0.02		0.03		
Cu 63	PPB	NM	NM	NM	2.85		4.0		0.07
					0.05		0.2		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Cold Spring (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		Mean	Mean	Mean	Mean		Mean		Detection
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
Zn 66	PPB	NM	NM	NM	1.10		1.3		0.01
					0.06		0.3		
Ge 73	PPB	0.94	0.57	0.36	0.4		0.45		0.0009
		0.07	0.03	0.01	0.3		0.02		
As 75	PPB	17	18.2	24	15.6		17.7		0.009
		1	0.6	2	0.2		0.5		
Se 77	PPB	12.6	1.1	2.80	0.8		0.84		0.10
		0.4	0.1	0.05	0.1		0.08		
Rb 85	PPB	19.2	19.9	23.9	19.6		19.9		0.001
		0.2	0.6	0.7	0.2		0.7		
Sr 86	PPB	1530	1910	1640	1456		2168		0.4
		20	70	30	20		70		
Mo 95	PPB	27	30	23.6	21		22.5		0.025
		1	1	0.6	14		0.6		
Sn 117	PPB	ND	0.28	0.022	0.16		0.063		0.004
			0.02	0.004	0.07		0.004		
Sb 121	PPB	0.187	0.144	0.201	0.34		0.247		0.005
		0.004	0.008	0.003	0.01		0.005		
Cs 133	PPB	5.62	3.9	4.4	3.82		4.0		0.0005
		0.04	0.2	0.2	0.04		0.3		
Ba 135	PPB	23.2	16.7	16.4	15.9		18.2		0.002
		0.7	0.8	0.4	0.8		0.5		
W 182	PPB	0.17	0.23	0.25	ND		0.20		0.018
		0.01	0.01	0.01			0.01		
Ti 205	PPB	0.80	0.69	0.36	0.40		0.41		0.002
		0.02	0.01	0.01	0.01		0.03		
U 238	PPB	10.5	7.7	6.25	6.1		7.9		0.0002
		0.2	0.1	0.07	0.1		0.5		
Be 9	PPT	41	ND	ND	ND		ND		20
		18							
Co 59	PPT	227	37	72	55		34		1
		5	3	2	3		3		
Ga 71	PPT	3.7	3	2.8	ND		ND		0.8
		0.9	1	1					
Zr 90	PPT	ND	260	52	ND		ND		0.6
			10	3					
Nb 93	PPT	ND	ND	6.8	ND		ND		4
				0.6					

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Cold Spring (cont':pg.3)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Ru 99	PPT	2.4	3.2	ND	ND			ND	1.5
		0.7	0.7						
Rh 103	PPT	100	24	34	39			28	2
		3	1	2	3			3	
Ag 107	PPT	ND	ND	ND	ND			ND	3
Cd 114	PPT	330	70	77	ND			ND	5
		10	4	4					
In 115	PPT	NM	ND	ND	ND			ND	0.4
Te 125	PPT	1050A	ND	46	ND			ND	9
		60		6					
Hf 177	PPT	25	20	ND	ND			ND	3
		4	2						
Ta 181	PPT	ND	1.3	7	13			15	0.03
			0.6	1	10			4	
Re 187	PPT	26	30	23	22			26	0.12
		1	2	2	16			2	
Ir 193	PPT	ND	ND	ND	ND			ND	0.6
Pt 195	PPT	ND	ND	ND	ND			ND	0.3
Au 197	PPT	ND	ND	20	ND			ND	3
				2					
Pb 208	PPT	170	ND	ND	ND			ND	8
		60							
Bi 209	PPT	9	33	ND	ND			20	2
		1	5					6	

Ash Meadows- Cold Spring (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			Detection
		Mean	Mean	Mean	Mean			Mean			Limit
		S.D.	S.D.	S.D.	S.D.			S.D.			
		D	P	P	P	D	E	P	D	E	P & E, D
Y 89	PPT	16.1	12.2	7	6.4	10.6	5.05	10.19	7.4	7.9	0.2, 1
		0.9	0.6	1	0.2	1.0	0.07	0.07	0.3	0.2	
La 139	PPT	5.3	3.1	30	1.5	3.2	3.94	3.1	3.7	3.14	0.08, 1
		0.4	0.4	5.4	0.1	0.6	0.09	0.1	0.3	0.03	
Ce 140	PPT	7.7	2.1	3.7	0.89	6.9	2.2	1.79	2.8	4.7	0.06, 0.8
		0.3	0.2	0.7	0.09	0.7	0.1	0.07	0.2	0.1	
Pr 141	PPT	1.1	0.7	0.8	0.20	ND	0.45	0.51	ND	0.61	0.01, 0.6
		0.2	0.1	0.2	0.03		0.01	0.02		0.01	
Nd 143	PPT	ND	3.0	3.1	1.70	ND	2.18	2.0	ND	2.3	0.08, 5
			0.5	0.7	0.09		0.08	0.1		0.2	
Sm 147	PPT	ND	0.8	0.7	2.4	5.1	3.5	1.01	ND	1.37	0.1, 1
			0.2	0.2	0.1	0.4	0.2	0.05		0.05	
Eu 153	PPT	NM	NM	NM	NM	NM	0.12	NM	NM	0.19	0.06, 0.6
							0.03			0.02	
Gd 158	PPT	ND	0.6	0.8	0.46	5	0.53	0.62	ND	0.90	0.1, 3
			0.2	0.2	0.03	1	0.04	0.04		0.04	
Tb 159	PPT	ND	ND	0.12	0.04	NM	0.08	0.07	ND	0.131	0.01, 0.7
				0.02	0.01		0.01	0.01		0.003	
Dy 163	PPT	ND	0.6	0.7	0.47	ND	0.59	0.50	ND	0.87	0.05, 4
			0.1	0.1	0.04		0.06	0.05		0.04	
Ho 165	PPT	ND	ND	0.17	0.10	1.0	0.12	0.09	ND	0.20	0.01, 0.8
				0.03	0.02	0.3	0.01	0.01		0.01	
Er 166	PPT	ND	0.4	0.56	0.34	ND	0.41	0.34	ND	0.566	0.05, 2
			0.1	0.09	0.06		0.02	0.03		0.017	
Tm 169	PPT	ND	ND	0.08	0.02	ND	0.07	0.057	ND	0.083	0.01, 0.5
				0.02	0.01		0.02	0.003		0.003	
Yb 173	PPT	ND	0.6	0.5	0.34	ND	0.31	0.36	ND	0.54	0.1, 2
			0.3	0.1	0.06		0.04	0.05		0.03	
Lu 175	PPT	ND	0.11	0.08	0.02	68(A)	ND	0.049	ND	0.075	0.01, 0.8
			0.08	0.02	0.01	7		0.010		0.003	
Th 232	PPT	ND	ND	0.2	2.0	1.9	ND	0.37	ND	0.08	0.05, 0.8
				0.1	0.4	0.9		0.10		0.02	
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

Ash Meadows- Crystal Pool									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		July 1992	Jan. 1993	May 1993	Oct. 1993		Mar. 1994		
		Mean	Mean	Mean	Mean		Mean		Detection
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
ANIONS									
Bromide	PPM	ND	0.21	0.24	0.26		0.18		0.03
			0.01	0.01	0.01		0.01		
Chloride	PPM	19.8	24.9	24.8	24.9		23.0		0.08
		0.3	0.2	0.1	0.2		0.1		
Fluoride	PPM	1.64	1.57	1.46	1.74		1.66		0.03
		0.01	0.04	0.02	0.01		0.01		
Nitrate	PPM	1.47	1.08	0.66	0.53		0.36		0.02
		0.02	0.01	0.01	0.01		0.01		
Sulfate	PPM	72.8	94.1	92.9	90.3		90.1		0.03
		0.3	0.5	0.1	0.1		0.1		
MAJOR METALS									
Ca	PPM	NM	52.7	46.2	48.3		48.7		0.06
			0.2	0.3	0.3		0.1		
Mg	PPM	NM	40.1	20.4	20.8		22.1		0.3
			0.3	0.3	0.1		0.1		
K	PPM	NM	9.6	9.0	9.30		9.23		0.05
			0.1	0.2	0.08		0.03		
Na	PPM	NM	84	85	79		81		1.5
			3	1	1		1		
TRACE METALS									
Li 7	PPB	86	79	103	78		88		0.009
		3	1	4	4		2		
Al 27	PPB	NM	NM	NM	0.27		0.18		0.02
					0.01		0.01		
Ti 47	PPB	1.2	1.33	0.60	0.70		0.56		0.009
		0.2	0.03	0.02	0.03		0.04		
V 51	PPB	1.34	1.39	1.62	1.27		1.30		0.003
		0.05	0.03	0.05	0.03		0.02		
Cr 52	PPB	2.79	0.28	0.81	0.73		5.8		0.02
		0.09	0.01	0.05	0.02		0.2		
Mn 55	PPB	0.128	0.04	0.164	0.306		0.193		0.005
		0.004	0.01	0.006	0.005		0.006		
Ni 60	PPB	4.8	0.16	0.64	0.92		1.0		0.01
		0.1	0.02	0.04	0.04		0.1		
Cu 63	PPB	NM	NM	NM	1.63		2.22		0.07
					0.02		0.07		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEE

Ash Meadows- Crystal Pool (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Zn 66	PPB	NM	NM	NM	0.53			1.61	0.01
					0.03			0.05	
Ge 73	PPB	0.94	0.48	0.38	0.39			0.42	0.0009
		0.07	0.03	0.02	0.04			0.02	
As 75	PPB	15.6	14.7	49	18.8			20.9	0.009
		1.2	0.4	3	0.3			0.6	
Se 77	PPB	5.0	3.7	1.7	0.47			0.33	0.10
		0.4	0.2	0.3	0.09			0.03	
Rb 85	PPB	14.8	13	19.0	16.3			19.8	0.001
		0.2	0.4	0.4	0.2			0.2	
Sr 86	PPB	966	990	1040	894			948	0.40
		11	30	16	4			17	
Mo 95	PPB	8.0	9.1	7.5	7.0			7.85	0.025
		0.3	0.3	0.3	0.2			0.03	
Sn 117	PPB	ND	ND	0.21	0.18			0.046	0.004
				0.01	0.01			0.006	
Sb 121	PPB	0.224	0.19	0.235	0.76			0.28	0.005
		0.007	0.01	0.006	0.03			0.01	
Cs 133	PPB	4.24	2.79	3.46	3.32			3.42	0.0005
		0.14	0.04	0.04	0.02			0.04	
Ba 135	PPB	73	70	67	55			67	0.002
		2	1	2	1			1	
W 182	PPB	0.31	0.36	0.205	0.290			0.224	0.018
		0.02	0.007	0.007	0.009			0.006	
Ti 205	PPB	0.39	0.31	0.20	0.232			0.146	0.002
		0.01	0.01	0.01	0.008			0.005	
U 238	PPB	3.8	2.67	2.56	2.45			2.9	0.0002
		0.1	0.05	0.05	0.04			0.1	
Be 9	PPT	ND	30	50	ND			ND	20
			10	10					
Co 59	PPT	154	22	36	41			44	1
		6	1	2	1			1	
Ga 71	PPT	12	10	13	ND			ND	0.8
		1	2	1					
Zr 90	PPT	ND	58	37	63			16	0.6
			6	2	5			4	
Nb 93	PPT	ND	ND	7	ND			ND	4
				1					

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Crystal Pool (cont':pg.3)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Ru 99	PPT	ND	ND	ND	ND			ND	1.5
Rh 103	PPT	NM	14 1	18 2	ND			ND	2
Ag 107	PPT	ND	ND	ND	ND			ND	3
Cd 114	PPT	145 7	25 5	18 4	ND			ND	5
In 115	PPT	NM	ND	ND	ND			ND	0.4
Te 125	PPT	510 30	ND	ND	ND			ND	9
Hf 177	PPT	20 2	5 1	ND	ND			ND	3
Ta 181	PPT	ND	ND 0.4	6.6 0.6	9 3			7 3	0.03
Re 187	PPT	7.8 0.5	8.9 0.6	7.7 0.7	7.7 0.7			9 1	0.12
Ir 193	PPT	ND	ND	ND	ND			ND	0.6
Pt 195	PPT	ND	ND	ND	ND			ND	0.3
Au 197	PPT	ND	ND	44 2	ND			ND	3
Pb 208	PPT	ND	ND	51 4	ND			ND	8
Bi 209	PPT	ND	ND	ND	ND			ND	2

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Crystal Pool (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			Detection
		Mean	Mean	Mean	Mean			Mean			Limit
		S.D.	S.D.	S.D.	S.D.			S.D.			
		D	P	P	P	D	E	P	D	E	P & E, D
Y 89	PPT	31	10.0	5.6	3.7	8.2	2.4	8.7	6.8	3.83	0.2, 1
		4	0.6	1.2	0.2	0.8	0.1	0.2	0.3	0.06	
La 139	PPT	9	3.8	32.2	22.4	2.8	0.70	3.7	2.2	ND	0.08, 1
		1	0.1	6.7	0.3	0.3	0.08	0.1	0.3		
Ce 140	PPT	8	2.2	3.4	0.8	2.7	0.7	1.85	2.8	ND	0.06, 0.8
		1	0.2	0.7	0.1	0.3	0.1	0.06	0.3		
Pr 141	PPT	1.3	0.65	0.7	0.11	ND	0.34	0.414	ND	0.08	0.01, 0.6
		0.2	0.09	0.1	0.03		0.01	0.009		0.01	
Nd 143	PPT	10	2.8	2.8	1.2	ND	1.6	1.67	ND	0.4	0.08, 5
		2	0.6	0.5	0.1		0.2	0.08		0.1	
Sm 147	PPT	2.3	ND	0.7	9.3	5	4.9	1.60	ND	1.03	0.1, 1
		0.4		0.2	0.3	1	0.4	0.07		0.04	
Eu 153	PPT	NM	NM	NM	NM	NM	0.22	NM	NM	0.08	0.06, 0.
							0.06			0.02	
Gd 158	PPT	7	0.6	0.6	0.24	ND	0.41	0.48	ND	0.39	0.1, 3
		1	0.3	0.1	0.05		0.07	0.03		0.03	
Tb 159	PPT	ND	ND	0.10	ND	ND	0.09	0.051	ND	0.064	0.01, 0.
				0.02			0.02	0.008		0.007	
Dy 153	PPT	ND	0.6	0.6	0.21	ND	0.5	0.31	ND	0.45	0.05, 4
			0.3	0.1	0.05		0.1	0.05		0.06	
Ho 165	PPT	ND	ND	0.13	ND	ND	0.10	0.082	ND	0.106	0.01, 0.
				0.03			0.01	0.009		0.007	
Er 166	PPT	ND	0.3	0.41	0.08	ND	0.29	0.23	ND	0.32	0.05, 2
			0.1	0.09	0.03		0.05	0.03		0.06	
Tm 169	PPT	ND	ND	0.06	ND	ND	0.05	0.030	ND	0.038	0.01, 0.
				0.01			0.02	0.004		0.006	
Yb 173	PPT	ND	0.5	0.4	ND	ND	0.27	0.16	ND	0.25	0.1, 2
			0.2	0.1			0.09	0.06		0.03	
Lu 175	PPT	ND	ND	0.06	ND	ND	0.04	0.026	ND	0.034	0.01, 0
				0.01			0.01	0.006		0.004	
Th 232	PPT	ND	ND	0.4	ND	ND	0.3	0.51	ND	ND	0.05, 0.
				0.1			0.2	0.05			
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEPT

Ash Meadows- Fairbanks									
		Sample #1	Sample #2	Sample #3	Sample #4	Sample #5			
		July 1992	Jan. 1993	May 1993	Oct. 1993	Mar. 1994			
		Mean	Mean	Mean	Mean	Mean		Detection	
		S.D.	S.D.	S.D.	S.D.	S.D.		Limit	
ANIONS									
Bromide	PPM	0.20	0.16	0.21	0.16	0.15		0.03	
		0.01	0.01	0.01	0.01	0.01			
Chloride	PPM	20.3	20.2	20.5	21.7	20.0		0.08	
		0.4	0.1	0.3	0.1	0.3			
Fluoride	PPM	1.71	1.42	1.46	1.75	1.6		0.03	
		0.01	0.04	0.01	0.05	0.2			
Nitrate	PPM	1.78	0.26	0.39	0.14	0.14		0.02	
		0.01	0.03	0.01	0.01	0.01			
Sulfate	PPM	70.2	76.6	80.1	82.2	79.7		0.03	
		0.1	0.3	0.1	0.2	0.2			
MAJOR METALS									
Ca	PPM	NM	53.3	43.8	48.14	48.7		0.06	
			0.2	0.4	0.01	0.1			
Mg	PPM	NM	22.5	20.1	20.5	21.3		0.3	
			0.1	0.1	0.3	0.3			
K	PPM	NM	8.1	7.8	8.0	7.9		0.05	
			0.1	0.2	0.1	0.1			
Na	PPM	NM	75	75	74	73		1.5	
			1	1	2	1			
TRACE METALS									
Li 7	PPB	81	76	87	73	78		0.009	
		8	2	3	3	3			
Al 27	PPB	NM	NM	NM	0.8	0.35		0.02	
					0.1	0.01			
Ti 47	PPB	3.4	1.38	0.79	0.61	0.45		0.009	
		0.7	0.04	0.04	0.07	0.05			
V 51	PPB	0.67	1.17	0.81	1.60	0.79		0.003	
		0.02	0.02	0.03	0.09	0.01			
Cr 52	PPB	2.6	0.23	1.57	0.47	0.27		0.02	
		0.1	0.01	0.09	0.04	0.01			
Mn 55	PPB	0.139	0.118	0.16	0.066	0.061		0.005	
		0.005	0.003	0.01	0.003	0.002			
Ni 60	PPB	12.5	0.43	0.53	0.22	0.50		0.01	
		1.7	0.03	0.04	0.02	0.01			
Cu 63	PPB	NM	NM	NM	1.32	1.34		0.07	
					0.03	0.05			

Ash Meadows- Fairbanks (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		Detection
		Mean	Mean	Mean	Mean		Mean		Limit
		S.D.	S.D.	S.D.	S.D.		S.D.		
Zn 66	PPB	NM	NM	NM	0.8		0.80		0.01
					0.2		0.03		
Ge 73	PPB	0.51	0.43	0.34	0.35		0.40		0.0009
		0.02	0.05	0.01	0.03		0.02		
As 75	PPB	10.6	15.6	14	11.0		10.6		0.009
		1.5	0.04	2	0.3		0.1		
Se 77	PPB	2.2	1.6	0.91	0.19		0.33		0.10
		0.3	0.3	0.07	0.06		0.03		
Rb 85	PPB	15.0	16.8	14.4	18.6		14.6		0.001
		0.4	0.7	0.3	0.2		0.2		
Sr 86	PPB	910	1100	900	750		910		0.40
		20	40	10	10		20		
Mo 95	PPB	6.9	9.2	7.4	6.92		6.57		0.025
		0.1	0.3	0.3	0.09		0.03		
Sn 117	PPB	0.07	0.068	0.072	0.07		0.05		0.004
		0.03	0.005	0.003	0.02		0.01		
Sb 121	PPB	0.130	0.123	0.117	0.165		0.171		0.005
		0.007	0.006	0.003	0.004		0.008		
Cs 133	PPB	3.5	3.68	3.1	3.30		3.16		0.0005
		0.2	0.09	0.1	0.07		0.02		
Ba 135	PPB	61	65	56	52		56		0.002
		4	2	2	1		1		
W 182	PPB	0.22	0.26	0.30	0.22		0.21		0.018
		0.02	0.02	0.01	0.02		0.01		
Tl 205	PPB	0.302	0.40	0.169	0.26		0.223		0.002
		0.006	0.02	0.006	0.01		0.004		
U 238	PPB	2.3	2.78	1.81	2.51		2.2		0.0002
		0.2	0.06	0.05	0.07		0.1		
Be 9	PPT	ND	ND	ND	ND		ND		20
Co 59	PPT	300	36	30	ND		16		1
		10	3	2			1		
Ga 71	PPT	6	9	7	ND		11		0.8
		2	2	2			2		
Zr 90	PPT	ND	72	62	61		ND		0.6
			4	2	10				
Nb 93	PPT	ND	ND	7.8	ND		ND		4
				0.4					

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Fairbanks (cont':pg.3)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	Detection
		Mean	Mean	Mean	Mean			Mean	Limit
		S.D.	S.D.	S.D.	S.D.			S.D.	
Ru 99	PPT	ND	ND	ND	ND			ND	1.5
Rh 103	PPT	130	14	14	5.6			13	2
		10	2	1	0.7			3	
Ag 107	PPT	ND	190	ND	ND			ND	3
			10						
Cd 114	PPT	40	34	ND	ND			ND	5
		10	4						
In 115	PPT	NM	ND	ND	35			6	0.4
					1			1	
Te 125	PPT	182	20	ND	ND			ND	9
		9	10						
Hf 177	PPT	ND	8	ND	ND			ND	3
			2						
Ta 181	PPT	ND	1.4	7.9	10			6	0.03
			0.7	0.9	4			2	
Re 187	PPT	7.1	7.6	6.2	5			7	0.12
		0.5	0.5	0.2	1			1	
Ir 193	PPT	ND	ND	ND	ND			ND	0.6
Pt 195	PPT	ND	ND	10	ND			ND	0.3
				1					
Au 197	PPT	ND	ND	18	ND			ND	3
				3					
Pb 208	PPT	150	66	ND	15			12	8
		20	4		3			3	
Bi 209	PPT	ND	21	ND	26			21	2
			1		1			1	

Ash Meadows- Fairbanks (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			Detection
		Mean	Mean	Mean	Mean			Mean			Limit
		S.D.	S.D.	S.D.	S.D.			S.D.			
		D	P	P	P	D	E	P	D	E	P & E, D
Y 89	PPT	7.6	13.9	8	6.4	12	3.8	7.37	5.6	6.64	0.2, 1
		0.4	0.4	2	0.1	1	0.2	0.07	0.5	0.07	
La 139	PPT	3.0	5.5	40.1	1.40	4	4.52	2.18	6.6	4.34	0.08, 1
		0.4	0.4	9	0.09	1	0.05	0.08	0.5	0.08	
Ce 140	PPT	3.8	4.1	7	0.3	2.2	7.8	1.35	ND	3.96	0.06, 0.8
		0.3	0.3	1.5	0.1	0.8	0.2	0.03		0.06	
Pr 141	PPT	0.6	1.0	1.2	0.18	ND	1.04	0.353	ND	0.70	0.01, 0.6
		0.2	0.1	0.3	0.03		0.04	0.008		0.01	
Nd 143	PPT	ND	4.3	4	1.5	ND	3.0	1.4	ND	2.83	0.08, 5
			0.7	1	0.2		0.2	0.1		0.08	
Sm 147	PPT	ND	1.0	1	1.1	ND	0.9	1.18	2.9	1.86	0.1, 1
			0.4	0.2	0.1		0.1	0.03	0.8	0.05	
Eu 153	PPT	NM	NM	NM	NM	NM	0.14	NM	NM	0.18	0.06, 0.6
							0.06			0.03	
Gd 158	PPT	ND	0.8	1.0	0.4	4	0.4	0.41	ND	0.95	0.1, 3
			0.4	0.2	0.1	1	0.1	0.04		0.08	
Tb 159	PPT	ND	0.10	0.16	ND	ND	0.08	0.044	ND	0.134	0.01, 0.7
			0.07	0.02			0.01	0.003		0.009	
Dy 163	PPT	ND	0.9	0.9	0.5	ND	0.41	0.27	ND	0.81	0.05, 4
			0.1	0.2	0.1		0.05	0.05		0.05	
Ho 165	PPT	ND	0.13	0.19	0.05	ND	0.09	0.048	ND	0.17	0.01, 0.8
			0.05	0.05	0.01		0.01	0.004		0.01	
Er 166	PPT	ND	0.5	0.5	0.24	ND	0.29	0.18	ND	0.52	0.05, 2
			0.2	0.2	0.06		0.03	0.02		0.02	
Tm 169	PPT	ND	ND	0.08	ND	ND	ND	0.022	ND	0.073	0.01, 0.5
				0.02				0.003		0.003	
Yb 173	PPT	ND	0.5	0.5	0.22	ND	0.16	0.14	ND	0.47	0.1, 2
			0.1	0.1	0.06		0.06	0.03		0.03	
Lu 175	PPT	ND	ND	0.08	ND	ND	ND	0.023	ND	0.069	0.01, 0.8
				0.02				0.003		0.003	
Th 232	PPT	ND	ND	0.5	1.8	ND	ND	0.24	ND	0.41	0.05, 0.8
				0.1	0.3			0.09		0.02	
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

Ash Meadows- Jackrabbit									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		July 1992	Jan. 1993	May 1993	Oct. 1993		Mar. 1994		
		Mean	Mean	Mean	Mean		Mean		Detection
		S.D.	S.D.	S.D.	S.D.		S.D.		Limits
ANIONS									
Bromide	PPM	0.24	0.21	0.23	0.25		0.16		0.03
		0.01	0.01	0.02	0.01		0.01		
Chloride	PPM	23.3	25.1	25.4	24.2		23.4		0.08
		0.2	0.5	0.4	0.2		0.1		
Fluoride	PPM	1.63	1.57	1.50	1.34		1.38		0.03
		0.01	0.04	0.05	0.01		0.01		
Nitrate	PPM	2.66	1.45	1.14	0.94		0.88		0.02
		0.02	0.03	0.01	0.01		0.01		
Sulfate	PPM	112	116	115	102		97		0.03
		1	1	1	1		1		
MAJOR METALS									
Ca	PPM	NM	52.3	46.9	47.1		48		0.06
			0.4	0.4	0.1		1		
Mg	PPM	NM	24.2	21.4	22.2		23.2		0.3
			0.2	0.2	0.2		0.3		
K	PPM	NM	9.1	8.0	8.5		8.4		0.05
			0.2	0.1	0.1		0.1		
Na	PPM	NM	91	88	84		89		1.5
			3	4	1		1		
TRACE METALS									
Li 7	PPB	89.6	85	109	78		83		0.009
		7.5	4	4	4		2		
Al 27	PPB	NM	NM	NM	0.6		0.55		0.02
					0.1		0.01		
Ti 47	PPB	3.9	1.5	0.47	0.38		0.48		0.009
		0.5	0.05	0.01	0.04		0.04		
V 51	PPB	1.47	2.3	1.46	1.83		1.60		0.003
		0.04	0.1	0.03	0.07		0.03		
Cr 52	PPB	1.50	0.38	0.76	0.88		3.74		0.02
		0.06	0.02	0.07	0.05		0.06		
Mn 55	PPB	0.007	0.07	0.037	0.046		0.035		0.005
		0.003	0.004	0.006	0.005		0.003		
Ni 60	PPB	15.3	0.43	0.31	0.15		0.90		0.01
		0.9	0.05	0.05	0.02		0.02		
Cu 63	PPB	NM	NM	NM	1.24		1.84		0.07
					0.05		0.07		

Ash Meadows- Jackrabbit (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detector
		S.D.	S.D.	S.D.	S.D.			S.D.	Limits
Zn 66	PPB	NM	NM	NM	0.7			0.92	0.01
					0.1			0.04	
Ge 73	PPB	0.54	0.49	0.36	0.41			0.42	0.0009
		0.04	0.01	0.03	0.04			0.01	
As 75	PPB	21	29.4	54	32			24	0.009
		2	0.7	6	1			1	
Se 77	PPB	3.2	0.9	1.0	0.39			0.59	0.10
		0.3	0.2	0.1	0.06			0.03	
Rb 85	PPB	15.8	18.2	18.6	19			17.5	0.001
		0.5	0.6	0.5	1			0.3	
Sr 86	PPB	1070	1210	1140	880			980	0.40
		30	20	20	10			20	
Mo 95	PPB	11.4	15.5	11	9.58			10.5	0.025
		0.2	0.5	1	0.01			0.6	
Sn 117	PPB	ND	0.21	0.030	0.113			0.028	0.004
			0.02	0.006	0.007			0.006	
Sb 121	PPB	0.22	0.193	0.16	0.386			0.175	0.005
		0.02	0.003	0.01	0.005			0.007	
Cs 133	PPB	2.7	3.81	3.50	3.3			3.4	0.0005
		0.2	0.08	0.08	0.2			0.1	
Ba 135	PPB	48	56	53	48.8			54.2	0.002
		5	2	1	3			0.6	
W 182	PPB	0.284	0.30	0.44	0.252			0.26	0.018
		0.009	0.01	0.03	0.007			0.02	
Tl 205	PPB	0.272	0.40	0.20	0.20			0.20	0.002
		0.004	0.01	0.01	0.02			0.02	
U 238	PPB	3.3	4.5	3.6	3.0			3.4	0.0002
		0.3	0.2	0.1	0.2			0.1	
Be 9	PPT	ND	ND	ND	ND			ND	20
Co 59	PPT	232	39	16	15			66	1
		6	3	3	5			2	
Ga 71	PPT	6	8	4	ND			8	0.8
		1	2	1				2	
Zr 90	PPT	ND	450	118	52			11	0.6
			10	5				5	
Nb 93	PPT	20	ND	18	10			10	4
		2		4	5			5	

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Jackrabbit (cont':pg.3)										
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5		
		Mean	Mean	Mean	Mean			Mean		Detection
		S.D.	S.D.	S.D.	S.D.			S.D.		Limits
Ru 99	PPT	ND	ND	ND	ND			ND		1.5
Rh 103	PPT	130	16	10.2	9			18		2
		10	1	0.9	1			2		
Ag 107	PPT	ND	180	ND	11			73		3
			10		4			4		
Cd 114	PPT	41	46	19	43			113		5
		9	5	4	4			3		
In 115	PPT	NM	ND	ND	24			60		0.4
					1			1		
Te 125	PPT	160	30	20	12			ND		9
		20	10	6	5					
Hf 177	PPT	ND	23	15	ND			ND		3
			2	3						
Ta 181	PPT	ND	2.3	20	7			15		0.03
			0.5	1	2			5		
Re 187	PPT	11	10	10	9			11		0.12
		1	1	1	1			3		
Ir 193	PPT	ND	ND	ND	ND			ND		0.6
Pt 195	PPT	ND	ND	4	ND			ND		0.3
				2						
Au 197	PPT	ND	ND	77	ND			ND		3
				6						
Pb 208	PPT	ND	240	21	ND			ND		8
			20	4						
Bi 209	PPT	4	34	ND	ND			ND		2
		2	2							

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEE

Ash Meadows- Jackrabbit (cont':pg.4)												
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5				Detection Limits
		Mean	Mean	Mean	Mean			Mean				
		S.D.	S.D.	S.D.	S.D.			S.D.				
		D	P	P	P	D	E	P	D	E	P & E, D	
Y 89	PPT	21	12.5	7.6	2.6	6	1.6	9.2	7.2	4.3	0.2, 1	
		1	0.3	2	0.2	1	0.3	0.3	0.3	0.1		
La 139	PPT	3.7	4.9	74 (A)	ND	2.8	1.39	2.65	1.7	4.99	0.08, 1	
		0.6	0.2	14		0.4	0.07	0.08	0.3	0.08		
Ce 140	PPT	5	4.7	9	0.2	3.2	0.7	1.84	3.1	6.2	0.06, 0	
		2	0.3	1.6	0.1	0.3	0.1	0.07	0.8	0.1		
Pr 141	PPT	ND	1.2	1.2	ND	ND	0.14	0.28	ND	0.94	0.01, 0	
			0.2	0.2			0.02	0.02		0.03		
Nd 143	PPT	ND	5.9	5.1	1.1	ND	0.6	0.96	ND	3.4	0.08, 5	
			0.9	0.8	0.2		0.1	0.09		0.3		
Sm 147	PPT	1.3	1.1	1.0	4.2	19	11.9	0.30	ND	0.70	0.1, 1	
		0.3	0.4	0.2	0.2	1	0.2	0.03		0.04		
Eu 153	PPT	NM	NM	NM	NM	NM	0.09	NM	NM	0.12	0.06, 0	
							0.02			0.02		
Gd 158	PPT	5	1.0	0.9	0.2	ND	0.2	0.32	ND	0.83	0.1, 3	
		1	0.3	0.2	0.1		0.1	0.03		0.04		
Tb 159	PPT	ND	0.16	0.15	3.3	ND	0.10	0.020	ND	0.116	0.01, 0	
			0.08	0.02	0.1		0.01	0.005		0.009		
Dy 163	PPT	ND	1.0	0.8	0.19	ND	0.21	0.19	ND	0.61	0.05, 1	
			0.4	0.1	0.05		0.05	0.02		0.05		
Ho 165	PPT	ND	0.12	0.19	0.39	ND	0.04	0.05	ND	0.136	0.01, 0	
			0.05	0.02	0.02		0.02	0.01		0.003		
Er 166	PPT	ND	0.4	0.5	0.09	ND	0.13	0.17	ND	0.37	0.05, 1	
			0.2	0.1	0.02		0.02	0.03		0.01		
Tm 169	PPT	ND	ND	0.08	ND	ND	ND	0.020	ND	0.057	0.01, 0	
				0.02				0.003		0.003		
Yb 173	PPT	ND	0.63	0.64	0.38	ND	ND	0.14	ND	0.33	0.1, 2	
			0.08	0.20	0.03			0.03		0.06		
Lu 175	PPT	ND	0.03	0.10	0.02	ND	ND	0.028	ND	0.053	0.01, 0	
			0.07	0.02	0.01			0.006		0.003		
Th 232	PPT	ND	ND	0.4	ND	ND	ND	0.51	ND	0.43	0.05, 0	
				0.2				0.02		0.06		
P = PRECONCENTRATION BY ION EXCHANGE												
D = DIRECT ANALYSIS												
E = PRECONCENTRATION BY EXTRACTION COLUMN												

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- King's Pool									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		July 1992	Jan. 1993	May 1993	Oct. 1993			Mar. 1994	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
ANIONS									
Bromide	PPM	0.20	0.20	0.22	0.18			sample	0.03
		0.01	0.01	0.01	0.01			not collected	
Chloride	PPM	20.0	21.4	20.4	20.8				0.08
		0.1	0.2	0.2	0.1				
Fluoride	PPM	1.67	1.46	1.33	1.26				0.03
		0.02	0.03	0.02	0.01				
Nitrate	PPM	2.13	1.33	0.83	0.65				0.02
		0.01	0.04	0.03	0.01				
Sulfate	PPM	67.9	83.9	78.2	78.4				0.03
		0.6	0.3	0.2	0.2				
MAJOR METALS									
Ca	PPM	NM	52.5	46.6	48.1				0.06
			0.4	0.3	0.1				
Mg	PPM	NM	22.2	20.4	20.9				0.3
			0.1	0.1	0.2				
K	PPM	NM	7.8	7.5	7.8				0.05
			0.1	0.2	0.1				
Na	PPM	NM	76	71	69				1.5
			1	2	1				
TRACE METALS									
Li 7	PPB	78	106	99	86				0.009
		5	5	4	2				
Al 27	PPB	NM	NM	NM	0.58				0.02
					0.01				
Ti 47	PPB	3.9	1.47	0.62	0.69				0.009
		0.5	0.08	0.06	0.04				
V 51	PPB	1.31	1.97	1.39	1.44				0.003
		0.03	0.06	0.03	0.02				
Cr 52	PPB	2.2	0.32	0.78	0.34				0.02
		0.1	0.01	0.05	0.01				
Mn 55	PPB	0.087	0.146	0.110	0.135				0.005
		0.004	0.003	0.006	0.005				
Ni 60	PPB	13.10	0.47	0.38	0.39				0.01
		0.03	0.03	0.05	0.01				
Cu 63	PPB	NM	NM	NM	1.16				0.07
					0.02				

Ash Meadows- King's Pool (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Zn 66	PPB	NM	NM	NM	1.51			sample	0.01
					0.02			not collected	
Ge 73	PPB	0.52	0.43	0.34	0.36				0.0009
		0.06	0.02	0.02	0.03				
As 75	PPB	15	19.9	21	16.8				0.009
		2	0.4	3	0.5				
Se 77	PPB	2.0	0.5	0.94	0.54				0.10
		0.3	0.2	0.07	0.08				
Rb 85	PPB	14.8	16.3	15.6	15.6				0.001
		0.4	0.9	0.3	0.3				
Sr 86	PPB	930	1110	930	770				0.4
		30	30	10	20				
Mo 95	PPB	6.2	8.2	6.2	6.1				0.025
		0.1	0.1	0.4	0.2				
Sn 117	PPB	0.17	0.05	0.117	0.14				0.004
		0.06	0.01	0.005	0.01				
Sb 121	PPB	0.22	0.166	0.158	0.347				0.005
		0.02	0.005	0.006	0.008				
Cs 133	PPB	3.83	3.5	3.2	3.25				0.0005
		0.04	0.1	0.1	0.02				
Ba 135	PPB	77	82	75	66				0.002
		3	5	2	1				
W 182	PPB	0.27	0.27	0.343	0.226				0.018
		0.06	0.02	0.008	0.009				
Tl 205	PPB	0.208	0.33	0.14	0.165				0.002
		0.005	0.02	0.01	0.002				
U 238	PPB	2.6	3.45	2.75	2.95				0.0002
		0.3	0.07	0.06	0.03				
Be 9	PPT	ND	ND	ND	ND				20
Co 59	PPT	193	38	20	20				1
		6	5	2	2				
Ga 71	PPT	6.8	8	6	5				0.8
		0.8	2	2	2				
Zr 90	PPT	ND	67	120	73				0.6
			5	2	1				
Nb 93	PPT	ND	ND	9	4				4
				1	2				

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- King's Pool (cont':pg.3)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Ru 99	PPT	ND	ND	ND	ND			sample not collected	1.5
Rh 103	PPT	180 20	14 1	9 1	15 1				2
Ag 107	PPT	ND	110 10	ND	ND				3
Cd 114	PPT	ND	70 10	ND	ND				5
In 115	PPT	NM	ND	ND	ND				0.4
Te 125	PPT	250 30	ND	ND	ND				9
Hf 177	PPT	ND	6 1	ND	ND				3
Ta 181	PPT	ND	ND	11 2	ND				0.03
Re 187	PPT	8.4 0.4	8.2 0.9	6.9 0.9	8 1				0.12
Ir 193	PPT	ND	ND	ND	ND				0.6
Pt 195	PPT	ND	ND	ND	18 3				0.3
Au 197	PPT	ND	ND	31 7	ND				3
Pb 208	PPT	2150 130	200 20	ND	27 3				8
Bi 209	PPT	65 4	14 1	ND	ND				2

Ash Meadows- King's Pool (cont':pg.4)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	Detection
		Mean	Mean	Mean	Mean			Mean	Limit
		S.D.	S.D.	S.D.	S.D.			S.D.	
		D	P	P	P	D	E		P & E, D
Y 89	PPT	10.8	9.3	3.0	5.5	8	1.0	sample	0.2, 1
		0.7	0.6	0.6	0.2	1	0.2	not collected	
La 139	PPT	5.9	2.7	33	2.8	5	3.72		0.08, 1
		0.3	0.1	6.7	0.2	1	0.08		
Ce 140	PPT	15.2	2.6	2.8	2.5	8.4	0.4		0.06, 0.8
		0.7	0.3	0.53	0.1	1.0	0.1		
Pr 141	PPT	1.1	0.24	0.32	0.14	ND	0.09		0.01, 0.6
		0.2	0.06	0.06	0.03		0.01		
Nd 143	PPT	ND	1.6	1.2	1.38	ND	0.3		0.08, 5
			0.5	0.2	0.11		0.1		
Sm 147	PPT	ND	0.6	0.36	10.3	14	1.7		0.1, 1
			0.4	0.07	0.2	3	0.1		
Eu 153	PPT	NM	NM	NM	NM	NM	0.14		0.06, 0.6
							0.06		
Gd 158	PPT	ND	0.59	0.23	0.3	5.9	ND		0.1, 3
			0.09	0.04	0.1	0.9			
Tb 159	PPT	ND	ND	0.041	ND	ND	0.31		0.01, 0.7
				0.006			0.02		
Dy 163	PPT	ND	0.32	0.18	0.32	ND	0.12		0.05, 4
			0.07	0.04	0.07		0.05		
Ho 165	PPT	ND	ND	0.039	0.05	ND	0.05		0.01, 0.8
				0.006	0.01		0.01		
Er 166	PPT	ND	ND	0.11	0.20	ND	0.08		0.05, 2
				0.04	0.03		0.01		
Tm 169	PPT	ND	ND	0.02	ND	ND	0.03		0.01, 0.5
				0.01			0.01		
Yb 173	PPT	ND	0.25	0.15	0.26	ND	0.07		0.1, 2
			0.04	0.03	0.04		0.05		
Lu 175	PPT	ND	ND	0.033	ND	ND	ND		0.01, 0.8
				0.005					
Th 232	PPT	1.7	ND	0.9	ND	ND	ND		0.05, 0.8
		0.2		0.2					
P = PRECONCENTRATION BY ION EXCHANGE									
D = DIRECT ANALYSIS									
E = PRECONCENTRATION BY EXTRACTION COLUMN									

Ash Meadows- Longstreet									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		July 1992	Jan. 1993	May 1993	Oct. 1993		Mar. 1994		
		Mean	Mean	Mean	Mean		Mean		Detectio
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
ANIONS									
Bromide	PPM	ND	0.15	0.21	0.56		0.15		0.03
			0.01	0.01	0.01		0.01		
Chloride	PPM	18.5	20.2	21.5	22.7		17.4		0.08
		0.3	0.2	0.2	0.1		0.2		
Fluoride	PPM	1.55	1.30	1.33	1.60		1.42		0.03
		0.01	0.01	0.02	0.01		0.04		
Nitrate	PPM	1.50	0.59	0.71	0.58		0.47		0.02
		0.01	0.02	0.01	0.01		0.01		
Sulfate	PPM	67.6	75.5	79.5	84.5		88.0		0.03
		0.3	0.2	0.2	0.3		0.1		
MAJOR METALS									
Ca	PPM	NM	49.9	46.1	47.61		48.6		0.06
			0.7	0.8	0.02		0.1		
Mg	PPM	NM	21.4	19.9	20.7		21.5		0.3
			0.4	0.1	0.1		0.1		
K	PPM	NM	8.10	7.7	7.9		7.8		0.05
			0.02	0.1	0.1		0.1		
Na	PPM	NM	77	81	73		74		1.5
			2	4	1		1		
TRACE METALS									
Li 7	PPB	80	73	83	68		88.2		0.00
		2	2	2	2		0.1		
Al 27	PPB	NM	NM	NM	0.44		0.36		0.02
					0.01		0.01		
Ti 47	PPB	0.6	1.43	0.60	0.70		0.61		0.00
		0.1	0.04	0.05	0.06		0.03		
V 51	PPB	1.56	1.75	1.04	1.28		1.31		0.00
		0.03	0.04	0.01	0.01		0.02		
Cr 52	PPB	3.0	0.33	1.21	1.86		3.6		0.02
		0.1	0.01	0.06	0.04		0.1		
Mn 55	PPB	0.480	0.098	0.042	0.90		0.061		0.00
		0.007	0.004	0.004	0.01		0.002		
Ni 60	PPB	2.8	0.40	0.26	2.4		0.89		0.0
		0.1	0.03	0.02	0.1		0.01		
Cu 63	PPB	NM	NM	NM	1.92		1.64		0.0
					0.09		0.02		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Longstreet (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Zn 66	PPB	NM	NM	NM	0.68			1.02	0.01
					0.03			0.05	
Ge 73	PPB	0.87	0.47	0.35	0.38			0.39	0.0009
		0.05	0.03	0.02	0.03			0.01	
As 75	PPB	15	21.8	19	15.8			15.2	0.009
		1	0.6	2	0.3			0.7	
Se 77	PPB	3.6	0.4	0.6	0.5			0.5	0.1
		0.4	0.1	0.1	0.1			0.1	
Rb 85	PPB	13.1	15.7	13.9	14.4			16.7	0.001
		0.1	0.3	0.6	0.3			0.3	
Sr 86	PPB	890	1110	810	788			970	0.4
		10	30	20	4			30	
Mo 95	PPB	7.6	8.5	6.4	6.5			6.26	0.025
		0.3	0.3	0.4	0.4			0.05	
Sn 117	PPB	ND	0.38	0.048	0.125			0.041	0.004
			0.01	0.002	0.007			0.003	
Sb 121	PPB	0.218	0.238	0.212	0.34			0.327	0.005
		0.005	0.008	0.004	0.02			0.005	
Cs 133	PPB	4.25	3.6	2.67	3.32			3.50	0.0005
		0.06	0.2	0.02	0.05			0.03	
Ba 135	PPB	68	61	49	46			57	0.002
		2	1	2	1			1	
W 182	PPB	0.22	0.193	0.27	0.206			0.214	0.018
		0.01	0.006	0.01	0.008			0.006	
Tl 205	PPB	0.39	0.40	0.192	0.249			0.299	0.002
		0.01	0.02	0.003	0.004			0.006	
U 238	PPB	4.10	3.3	2.46	2.77			2.74	0.0002
		0.05	0.1	0.05	0.04			0.09	
Be 9	PPT	ND	ND	ND	ND			ND	20
Co 59	PPT	94	37	13	67			91	1
		2	2	1	2			9	
Ga 71	PPT	6.5	7	4.7	ND			ND	0.8
		0.8	2	0.7					
Zr 90	PPT	ND	130	37	39			ND	0.6
			30	1	2				
Nb 93	PPT	ND	9	ND	ND			ND	4
			2						

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Longstreet (cont':pg.3)										
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5		
		Mean	Mean	Mean	Mean			Mean		Detection
		S.D.	S.D.	S.D.	S.D.			S.D.		Limit
Ru 99	PPT	ND	ND	ND	ND			ND		1.5
Rh 103	PPT	60	14	16	16			27		2
		2	1	1	2			2		
Ag 107	PPT	ND	54	ND	ND			ND		3
			3							
Cd 114	PPT	134	50	10	7			43		5
		5	10	3	2			2		
In 115	PPT	NM	1.5	ND	ND			ND		0.4
			0.3							
Te 125	PPT	460	90	ND	ND			ND		9
		20	20							
Hf 177	PPT	20	60	ND	ND			ND		3
		3	30							
Ta 181	PPT	230	6	6	ND			7		0.03
		20	1	1				2		
Re 187	PPT	7.9	9.4	7.6	7			8		0.12
		0.5	0.7	0.2	1			1		
Ir 193	PPT	ND	ND	ND	ND			ND		0.6
Pt 195	PPT	ND	ND	1.0	ND			ND		0.3
				0.9						
Au 197	PPT	ND	13	14	ND			ND		3
			2	3						
Pb 208	PPT	100	240	32	18			40		8
		40	20	2	7			8		
Bi 209	PPT	ND	90	ND	ND			ND		2
			10							

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Longstreet (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			Detection
		Mean	Mean	Mean	Mean			Mean			Limit
		S.D.	S.D.	S.D.	S.D.			S.D.			
		D	P	P	P	D	E	P	D	E	P & E
Y 89	PPT	7.7	9	5.2	2.8	6	1.8	1.8	5.8	1.72	0.2, 1
		0.6	0.5	0.9	0.2	1	0.2	0.2	0.3	0.07	
La 139	PPT	3.5	3.2	33	ND	2	2.6	4.0	6.0	ND	0.08, 1
		0.3	0.2	5		1	0.1	0.1	0.4		
Ce 140	PPT	6.3	2.8	6.0	1.20	3.4	0.9	0.58	2.2	ND	0.06, 0
		0.4	0.3	0.8	0.08	0.8	0.1	0.06	0.3		
Pr 141	PPT	0.7	0.4	0.8	ND	ND	0.20	0.11	ND	ND	0.01, 0
		0.2	0.1	0.1			0.02	0.01			
Nd 143	PPT	ND	1.9	3.4	0.8	ND	0.81	0.43	ND	ND	0.08, 1
			0.6	0.4	0.1		0.09	0.08			
Sm 147	PPT	ND	0.7	0.7	1.8	ND	0.9	6.4	13.9	15.27	0.1, 1
			0.2	0.2	0.4		0.1	0.2	0.6	0.09	
Eu 153	PPT	NM	NM	NM	NM	NM	ND	NM	NM	ND	0.06, 0
Gd 158	PPT	ND	0.44	0.71	ND	5	0.2	0.14	ND	0.20	0.1, 3
			0.09	0.06		1	0.1	0.03		0.03	
Tb 159	PPT	ND	ND	0.13	ND	ND	0.02	ND	ND	0.042	0.01, 0
				0.02			0.01			0.003	
Dy 163	PPT	ND	0.4	0.60	0.14	ND	0.15	0.08	ND	0.26	0.05, 1
			0.2	0.09	0.05		0.05	0.02		0.05	
Ho 165	PPT	ND	ND	0.16	ND	ND	0.04	0.138	ND	0.06	0.01, 0
				0.02			0.01	0.005		0.01	
Er 166	PPT	ND	ND	0.45	0.13	ND	0.12	ND	ND	0.15	0.05, 1
				0.04	0.02		0.02			0.02	
Tm 169	PPT	ND	ND	0.10	ND	ND	ND	ND	ND	0.02	0.01, 0
				0.01						0.01	
Yb 173	PPT	ND	ND	0.46	0.11	ND	ND	ND	ND	ND	0.1, 1
				0.06	0.04						
Lu 175	PPT	ND	ND	0.12	ND	ND	ND	ND	ND	ND	0.01, 1
				0.02							
Th 232	PPT	ND	ND	1.6	ND	ND	ND	0.30	ND	ND	0.05, 0
				0.3				0.07			
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Point of Rocks NE									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		Detection
		July 1992	Jan. 1993	May 1993	Oct. 1993		Mar. 1994		Limit
		Mean	Mean	Mean	Mean		Mean		
		S.D.	S.D.	S.D.	S.D.		S.D.		
ANIONS									
Bromide	PPM	sample	0.14	0.21	0.18		0.13		0.03
		not collected	0.01	0.01	0.01		0.01		
Chloride	PPM		19.4	20.5	20.5		19.5		0.08
			0.1	0.1	0.2		0.1		
Fluoride	PPM		1.28	1.30	1.26		1.26		0.03
			0.02	0.06	0.02		0.01		
Nitrate	PPM		0.36	0.87	0.65		0.47		0.02
			0.01	0.04	0.01		0.01		
Sulfate	PPM		75.2	77.8	78.2		77.0		0.03
			0.1	0.3	0.1		0.2		
MAJOR METALS									
Ca	PPM		59.9	47.2	49.0		49.0		0.06
			0.2	0.3	0.3		0.3		
Mg	PPM		22.7	20.3	20.9		21.6		0.3
			0.2	0.1	0.3		0.2		
K	PPM		7.6	7.6	7.9		7.7		0.05
			0.1	0.1	0.1		0.1		
Na	PPM		74	70	69.5		70.6		1.5
			1	1	0.8		0.8		
TRACE METALS									
Li 7	PPB		76	97	73		68		0.009
			3	4	1		3		
Al 27	PPB		NM	NM	0.8		0.54		0.02
					0.1		0.02		
Ti 47	PPB		1.21	0.58	0.71		0.40		0.009
			0.06	0.06	0.05		0.01		
V 51	PPB		1.27	1.31	1.41		1.40		0.003
			0.04	0.02	0.02		0.02		
Cr 52	PPB		0.299	0.41	0.49		3.70		0.02
			0.003	0.05	0.04		0.02		
Mn 55	PPB		ND	0.025	0.021		ND		0.005
				0.005	0.007				
Ni 60	PPB		0.17	0.37	0.23		1.12		0.01
			0.03	0.03	0.01		0.01		
Cu 63	PPB		NM	NM	0.93		1.68		0.07
					0.02		0.02		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDS

Ash Meadows- Point of Rocks NE (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detection
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Zn 66	PPB		NM	NM	0.52			1.21	0.01
					0.06			0.02	
Ge 73	PPB	sample	0.39	0.34	0.34			0.41	0.0009
		not collected	0.03	0.02	0.02			0.1	
As 75	PPB		13.4	41	14.2			12.5	0.009
			0.08	5	0.3			0.2	
Se 77	PPB		1.9	1.2	0.6			0.51	0.10
			0.3	0.2	0.1			0.03	
Rb 85	PPB		11.9	15.9	9.0			12.0	0.001
			0.5	0.5	0.3			0.3	
Sr 86	PPB		1040	942	684			771	0.4
			20	10	10			9	
Mo 95	PPB		6.8	6.4	6.0			6.1	0.025
			0.2	0.2	0.1			0.1	
Sn 117	PPB		0.48	0.026	0.28			0.038	0.004
			0.02	0.004	0.03			0.005	
Sb 121	PPB		0.060	0.157	0.194			0.160	0.005
			0.008	0.007	0.004			0.005	
Cs 133	PPB		2.87	3.20	3.00			3.38	0.0005
			0.09	0.03	0.03			0.03	
Ba 135	PPB		66	72	64			64	0.002
			3	2	1			1	
W 182	PPB		0.07	0.36	0.22			0.23	0.018
			0.02	0.01	0.01			0.01	
Tl 205	PPB		0.27	0.140	0.158			0.166	0.002
			0.01	0.003	0.006			0.002	
U 238	PPB		2.89	2.71	2.86			2.84	0.0002
			0.07	0.02	0.06			0.05	
Be 9	PPT		ND	ND	ND			ND	20
Co 59	PPT		33	18	40			48	1
			3	2	2			4	
Ga 71	PPT		6	5	4			12	0.8
			2	1	1			1	
Zr 90	PPT		48	86	52			11	0.6
			5	4	3			3	
Nb 93	PPT		ND	13	4			10	4
				4	1			3	

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Point of Rocks NE (cont':pg.3)										
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5		
		Mean	Mean	Mean	Mean			Mean		Detectio
		S.D.	S.D.	S.D.	S.D.			S.D.		Limit
Ru 99	PPT	sample	ND	ND	ND			ND		1.5
		not collected								
Rh 103	PPT		13	NM	8			16		2
			1		1			2		
Ag 107	PPT		ND	ND	20			16		3
					6			3		
Cd 114	PPT		17	11	17			23		5
			3	3	3			2		
In 115	PPT		ND	ND	12			7		0.4
					3			2		
Te 125	PPT		ND	ND	ND			ND		9
Hf 177	PPT		ND	ND	ND			ND		3
Ta 181	PPT		ND	13	10			14		0.03
				1	3			3		
Re 187	PPT		8.2	6.7	7			7.2		0.12
			0.4	0.9	1			0.4		
Ir 193	PPT		ND	ND	ND			ND		0.6
Pt 195	PPT		ND	5	11			ND		0.3
				1	3					
Au 197	PPT		ND	43	ND			ND		3
				5						
Pb 208	PPT		ND	ND	ND			ND		8
Bi 209	PPT		ND	ND	ND			ND		2

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Point of Rocks NE (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			Detection
		Mean	Mean	Mean	Mean			Mean			Limit
		S.D.	S.D.	S.D.	S.D.			S.D.			
			P	P	P	D	E	P	D	E	P & E, D
Y 89	PPT	sample	6.9	2.4	3.0	7	1.2	8.2	2.9	1.26	0.2, 1
		not collected	0.4	0.5	0.2	1	0.2	0.2	0.5	0.02	
La 139	PPT		2.4	35(A)	0.9	4	3.1	2.3	2.5	1.14	0.08, 1
			0.2	8	0.1	1	0.1	0.1	0.3	0.08	
Ce 140	PPT		2.2	2.5	2.14	3.9	1.3	1.22	ND	2.5	0.06, 0
			0.3	0.5	0.06	0.8	0.1	0.06		0.1	
Pr 141	PPT		0.2	0.29	0.07	ND	0.18	0.07	ND	0.29	0.01, 0
			0.1	0.07	0.04		0.02	0.04		0.01	
Nd 143	PPT		1.2	1.1	1.1	ND	0.71	0.3	ND	1.02	0.08, 1
			0.6	0.3	0.1		0.08	0.1		0.09	
Sm 147	PPT		0.6	0.32	2.5	2	1.3	0.29	ND	0.22	0.1, 1
			0.3	0.07	0.1	1	0.2	0.06		0.04	
Eu 153	PPT		NM	NM	NM	NM	0.10	NM	NM	ND	0.06, 0
							0.06				
Gd 158	PPT		0.2	0.24	0.2	ND	ND	ND	ND	ND	0.1, 3
			0.1	0.04	0.1						
Tb 159	PPT		ND	0.035	ND	ND	0.03	ND	ND	0.035	0.01, 0
				0.009			0.01			0.005	
Dy 163	PPT		0.2	0.17	0.13	ND	0.15	ND	ND	0.20	0.05,
			0.1	0.05	0.05		0.05			0.03	
Ho 165	PPT		ND	0.04	ND	ND	0.02	ND	ND	0.038	0.01, 0
				0.01			0.01			0.003	
Er 166	PPT		ND	0.09	0.11	ND	0.11	ND	ND	0.11	0.05,
				0.02	0.03		0.03			0.02	
Tm 169	PPT		ND	ND	ND	ND	ND	ND	ND	0.019	0.01, 0
										0.003	
Yb 173	PPT		ND	ND	0.15	ND	ND	ND	ND	ND	0.1, 1
					0.05						
Lu 175	PPT		ND	0.018	ND	ND	ND	ND	ND	ND	0.01, 0
				0.005							
Th 232	PPT			0.2	ND	ND	ND	0.6	ND	0.39	0.05, 0
				0.1				0.2		0.09	
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Point of Rocks NW									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		July 1992	Jan. 1993	May 1993	Oct. 1993			Mar. 1994	
		Mean	Mean	Mean	Mean			Mean	Detectio
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
ANIONS									
Bromide	PPM	sample	0.14	0.21	0.14			0.16	0.03
		not collected	0.01	0.01	0.01			0.01	
Chloride	PPM		18.7	20.6	20.8			19.8	0.08
			0.2	0.1	0.2			0.1	
Fluoride	PPM		1.20	1.33	1.31			1.29	0.03
			0.01	0.01	0.02			0.02	
Nitrate	PPM		0.79	0.82	0.65			0.75	0.02
			0.01	0.01	0.01			0.01	
Sulfate	PPM		69.6	77.8	78.3			77.0	0.03
			0.2	0.2	0.1			0.1	
MAJOR METALS									
Ca	PPM		59.3	47.7	48.0			50.9	0.06
			0.4	0.7	0.3			0.2	
Mg	PPM		21.5	20.1	21.3			21.7	0.3
			0.5	0.1	0.2			0.1	
K	PPM		7.5	7.6	7.9			7.7	0.05
			0.1	0.1	0.1			0.1	
Na	PPM		73	70	71			72	1.5
			2	2	1			1	
TRACE METALS									
Li 7	PPB		74	101	73			82	0.00
			2	2	1			2	
Al 27	PPB		NM	NM	0.7			0.76	0.02
					0.1			0.04	
Ti 47	PPB		1.45	0.61	0.70			0.67	0.00
			0.07	0.05	0.03			0.07	
V 51	PPB		1.44	1.65	1.68			1.71	0.00
			0.06	0.02	0.01			0.03	
Cr 52	PPB		0.28	0.52	ND			5.7	0.02
			0.02	0.05				0.2	
Mn 55	PPB		ND	0.087	0.021			0.048	0.00
				0.005	0.003			0.002	
Ni 60	PPB		0.19	0.44	0.17			1.25	0.01
			0.01	0.03	0.01			0.01	
Cu 63	PPB		NM	NM	0.89			1.69	0.01
					0.02			0.05	

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Point of Rocks NW (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		Mean	Mean	Mean	Mean		Mean		Detectio
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
Zn 66	PPB	sample	NM	NM	0.55		2.97		0.01
		not collected			0.04		0.05		
Ge 73	PPB		0.37	0.32	0.35		0.38		0.0009
			0.03	0.02	0.02		0.02		
As 75	PPB		11.8	20	13		15.2		0.009
			0.3	2	1		0.8		
Se 77	PPB		2.0	1.27	0.60		0.64		0.10
			0.2	0.09	0.04		0.02		
Rb 85	PPB		11.7	15.9	10.7		13		0.001
			0.5	0.6	0.3		0.2		
Sr 86	PPB		1040	930	758		928		0.4
			40	20	20		6		
Mo 95	PPB		7.2	6.3	6.2		6.0		0.025
			0.2	0.2	0.1		0.2		
Sn 117	PPB		0.017	0.032	0.36		0.053		0.004
			0.007	0.005	0.02		0.003		
Sb 121	PPB		0.102	0.198	0.203		0.17		0.005
			0.009	0.005	0.009		0.09		
Cs 133	PPB		2.9	3.35	3.12		3.3		0.000
			0.1	0.07	0.05		0.1		
Ba 135	PPB		73	82	75.3		81		0.000
			2	3	0.7		1		
W 182	PPB		0.19	0.337	0.25		0.232		0.010
			0.02	0.007	0.01		0.008		
Tl 205	PPB		0.27	0.142	0.145		0.221		0.000
			0.02	0.003	0.006		0.002		
U 238	PPB		2.91	2.71	2.63		2.9		0.000
			0.05	0.03	0.08		0.1		
Be 9	PPT		ND	ND	ND		ND		20
Co 59	PPT		25	26	179		100		1
			3	2	6		1		
Ga 71	PPT		6	8	6		9		0.8
			1	1	1		1		
Zr 90	PPT		71	95	71		9		0.6
			6	2	6		2		
Nb 93	PPT		ND	8	12		6		4
				1	5		2		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Point of Rocks NW (cont':pg.3)										
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5			
		Mean	Mean	Mean	Mean		Mean			Detectio
		S.D.	S.D.	S.D.	S.D.		S.D.			Limit
Ru 99	PPT	sample not collected	ND	ND	ND		ND			1.5
Rh 103	PPT		18	NM	32		29			2
			2		2		3			
Ag 107	PPT		ND	ND	41		87			3
					1		9			
Cd 114	PPT		21	11	17		78			5
			6	3	4		2			
In 115	PPT		ND	ND	12		1.1			0.4
					1		0.3			
Te 125	PPT		ND	14	ND		ND			9
				5						
Hf 177	PPT		4	ND	ND		ND			3
			2							
Ta 181	PPT		ND	10	11		9			0.03
				1	2		3			
Re 187	PPT		7	7.1	8		9			0.12
			1	0.4	1		1			
Ir 193	PPT		ND	ND	ND		ND			0.6
Pt 195	PPT		ND	3	7		ND			0.3
				1	3					
Au 197	PPT		ND	24	ND		ND			3
				4						
Pb 208	PPT		ND	ND	ND		47			8
							3			
Bi 209	PPT		ND	ND	ND		ND			2

Ash Meadows- Point of Rocks NW (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			Detect
		Mean	Mean	Mean	Mean			Mean			Limit
		S.D.	S.D.	S.D.	S.D.			S.D.			
			P	P	P	D	E	P	D	E	
Y 89	PPT	sample	7.4	3.2	1.5	4.6	0.66	4.9	3.1	0.46	0.2.
		not collected	0.5	0.2	0.1	0.5	0.07	0.2	0.3	0.07	
La 139	PPT		2.27	37.03(A)	ND	2.4	0.57	10.5	5.4	ND	0.08.
			0.08	0.03		0.3	0.04	0.1	0.3		
Ce 140	PPT		2.8	ND	0.4	2.1	2.2	2.07	ND	ND	0.06.
			0.2		0.1	0.3	0.1	0.05			
Pr 141	PPT		0.23	ND	ND	ND	0.28	0.20	ND	ND	0.01.
			0.07				0.03	0.02			
Nd 143	PPT		1.2	1.3	0.4	ND	2.4	0.64	ND	ND	0.08.
			0.5	0.4	0.1		0.3	0.09			
Sm 147	PPT		ND	ND	1.10	ND	0.45	0.28	ND	ND	0.1.
					0.06		0.04	0.04			
Eu 153	PPT		NM	NM	NM	NM	1.86	NM	NM	ND	0.06.
							0.07				
Gd 158	PPT		ND	0.23	ND	ND	0.25	0.16	ND	ND	0.1.
				0.06			0.04	0.03			
Tb 159	PPT		ND	ND	ND	ND	16.7 (A)	ND	ND	0.071	0.01.
							0.3			0.008	
Dy 163	PPT		0.2	0.20	ND	ND	0.29	0.07	ND	0.12	0.05.
			0.1	0.05			0.02	0.02		0.02	
Ho 165	PPT		0.08	ND	ND	ND	1.89	ND	ND	0.074	0.01.
			0.01				0.03			0.006	
Er 166	PPT		0.11	0.11	ND	ND	0.23	ND	ND	0.09	0.05.
			0.06	0.02			0.04			0.02	
Tm 169	PPT		ND	ND	ND	ND	0.18	ND	ND	0.067	0.01.
							0.02			0.009	
Yb 173	PPT		0.19	ND	ND	ND	1.85	ND	ND	ND	0.1.
			0.06				0.09				
Lu 175	PPT		0.06	ND	ND	ND	0.24	ND	ND	0.053	0.01.
			0.03				0.03			0.005	
Th 232	PPT		ND	0.20	ND	ND	ND	0.68	ND	ND	0.05.
				0.02				0.06			
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

Ash Meadows- Rogers									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		July 1992	Jan. 1993	May 1993	Oct. 1993		Mar. 1994		
		Mean	Mean	Mean	Mean		Mean		Detectic
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
ANIONS									
Bromide	PPM	sample	0.15	0.21	0.19		0.17		0.03
		not collected	0.01	0.01	0.01		0.01		
Chloride	PPM		20.7	20.6	21.4		16.7		0.08
			0.1	0.1	0.2		0.1		
Fluoride	PPM		1.35	1.38	1.61		1.50		0.03
			0.01	0.03	0.04		0.08		
Nitrate	PPM		0.15	0.60	0.40		0.31		0.02
			0.02	0.01	0.02		0.02		
Sulfate	PPM		77.1	78.9	80.9		86.8		0.03
			0.1	0.1	0.2		0.1		
MAJOR METALS									
Ca	PPM		61.4	44.4	47.6		48.5		0.06
			0.4	0.3	0.5		0.1		
Mg	PPM		22.5	19.9	20.4		21.5		0.3
			0.2	0.2	0.2		0.2		
K	PPM		7.8	7.4	8.0		7.8		0.05
			0.1	0.1	0.1		0.1		
Na	PPM		74	76	72		72		1.5
			1	3	1		1		
TRACE METALS									
Li 7	PPB		85	99	87		73		0.009
			4	4	2		2		
Al 27	PPB		NM	NM	0.359		0.380		0.02
					0.008		0.007		
Ti 47	PPB		2.0	0.05	0.72		0.62		0.009
			0.3	0.90	0.04		0.08		
V 51	PPB		1.31	1.20	0.97		1.08		0.009
			0.04	0.02	0.01		0.01		
Cr 52	PPB		0.22	0.90	0.744		4.71		0.02
			0.01	0.05	0.008		0.04		
Mn 55	PPB		0.063	0.060	ND		ND		0.009
			0.006	0.005					
Ni 60	PPB		0.44	0.58	0.77		1.01		0.009
			0.04	0.03	0.02		0.04		
Cu 63	PPB		NM	NM	1.32		1.68		0.009
					0.02		0.04		

Ash Meadows- Rogers (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5	
		Mean	Mean	Mean	Mean			Mean	Detectio
		S.D.	S.D.	S.D.	S.D.			S.D.	Limit
Zn 66	PPB	sample not collected	NM	NM	0.49 0.02			0.89 0.04	0.01
Ge 73	PPB		0.45 0.02	0.391 0.009	0.39 0.03			0.297 0.007	0.0009
As 75	PPB		21 2	24 2	16.5 0.1			20.4 0.4	0.009
Se 77	PPB		14 2	1.3 0.2	0.37 0.07			0.42 0.05	0.1
Rb 85	PPB		15.6 0.6	16.2 0.3	14.8 0.1			17.1 0.7	0.001
Sr 86	PPB		1080 30	940 20	835 5			980 20	0.4
Mo 95	PPB		9.1 0.3	7.1 0.3	6.57 0.09			6.3 0.2	0.025
Sn 117	PPB		0.084 0.005	0.040 0.004	0.13 0.01			0.033 0.007	0.004
Sb 121	PPB		0.29 0.01	0.309 0.006	0.365 0.006			0.45 0.01	0.005
Cs 133	PPB		3.9 0.2	3.68 0.06	3.37 0.03			3.68 0.08	0.000
Ba 135	PPB		70 3	60.5 0.8	45.9 0.6			63.4 0.6	0.002
W 182	PPB		0.19 0.01	0.245 0.006	0.162 0.009			0.164 0.006	0.011
Tl 205	PPB		0.64 0.03	0.34 0.01	0.42 0.01			0.463 0.009	0.001
U 238	PPB		3.5 0.1	2.50 0.02	2.70 0.03			2.61 0.07	0.000
Be 9	PPT		ND	ND	ND			ND	20
Co 59	PPT		40 2	34 2	30 2			81 1	1
Ga 71	PPT		10 3	8 2	3 1			1.0 0.4	0.8
Zr 90	PPT		122 6	41 1	64 6			13 3	0.6
Nb 93	PPT		ND	7 1	ND			ND	4

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Rogers (cont':pg.3)									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		Mean	Mean	Mean	Mean		Mean		Detectic
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
Ru 99	PPT	sample not collected	ND	ND	ND		ND		1.5
Rh 103	PPT		NM	16 1	16 1		26 2		2
Ag 107	PPT		106 (A) 10	ND	ND		ND		3
Cd 114	PPT		42 9	6 3	ND		35 2		5
In 115	PPT		ND	ND	7 1		76 (A) 1		0.4
Te 125	PPT		39 6	ND	ND		ND		9
Hf 177	PPT		ND	ND	ND		ND		3
Ta 181	PPT		2.3 0.3	7.7 0.7	18 1		7 2		0.03
Re 187	PPT		8 1	7.2 0.5	7 2		8 1		0.12
Ir 193	PPT		ND	ND	ND		ND		0.6
Pt 195	PPT		1.3 0.6	2 1	3 1		ND		0.3
Au 197	PPT		ND	18 4	ND		ND		3
Pb 208	PPT		80 20	63 5	12 2		37 8		8
Bi 209	PPT		10 5	ND	39 2		40 1		2

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Rogers (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			
		Mean	Mean	Mean	Mean			Mean			Detection
		S.D.	S.D.	S.D.	S.D.			S.D.			Limit
			P	P	P	D	E	P	D	E	
Y 89	PPT	sample	20	14.0	4.8	8.4	3.5	6.1	7.9	5.27	0.2, 1
		not collected	1	0.1	0.1	0.8	0.1	0.2	0.8	0.07	
La 139	PPT		16	37.00	3.02	3.4	6.57	11.9	4.6	ND	0.08, 1
			1	0.03	0.09	0.3	0.05	0.1	0.3		
Ce 140	PPT		21	ND	0.56	1.8	1.8	5.83	2.3	ND	0.06, 0
			1		0.08	0.3	0.1	0.08	0.3		
Pr 141	PPT		2.8	1.1	0.30	ND	0.33	1.40	0.9	0.08	0.01, 0
			0.2	0.8	0.03		0.01	0.03	0.2	0.01	
Nd 143	PPT		11	5	2.16	ND	1.1	4.67	ND	0.39	0.08, 1
			2	1	0.07		0.1	0.09		0.04	
Sm 147	PPT		1.9	1.1	1.5	ND	1.4	3.5	3.7	2.61	0.1, 1
			0.7	0.9	0.1		0.1	0.1	0.7	0.04	
Eu 153	PPT		35	9.0	NM	NM	0.16	NM	NM	0.16	0.06, 0
			2	0.3			0.02			0.02	
Gd 158	PPT		2.4	1.2	0.37	4	0.45	0.98	ND	0.67	0.1, 3
			0.4	0.2	0.08	1	0.06	0.04		0.03	
Tb 159	PPT		0.33	ND	ND	ND	0.08	0.112	ND	0.1052	0.01, 0
			0.09				0.01	0.008		0.0074	
Dy 163	PPT		2.0	1.4	0.46	ND	0.42	0.61	ND	0.69	0.05, 1
			0.3	0.2	0.04		0.03	0.05		0.05	
Ho 165	PPT		0.29	ND	0.08	ND	0.10	0.12	ND	0.15	0.01, 0
			0.08		0.03		0.01	0.01		0.01	
Er 166	PPT		1.2	1.3	0.20	ND	0.29	0.36	ND	0.43	0.05, 1
			0.3	0.1	0.02		0.03	0.03		0.02	
Tm 169	PPT		0.15	ND	ND	ND	0.032	0.04	ND	0.057	0.01, 0
			0.07				0.005	0.01		0.003	
Yb 173	PPT		1.3	1.8	0.14	ND	ND	0.16	ND	0.22	0.1, 1
			0.2	0.3	0.03			0.02		0.02	
Lu 175	PPT		0.19	ND	ND	ND	ND	0.019	ND	0.021	0.01, 0
			0.06					0.003		0.004	
Th 232	PPT		1.8	ND	ND	ND	0.5	0.6	ND	ND	0.05, 0
			0.6				0.2	0.1			
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Scruggs									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		July 1992	Jan. 1993	May 1993	Oct. 1993		Mar. 1994		
		Mean	Mean	Mean	Mean		Mean		Detection
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
ANIONS									
Bromide	PPM	ND	0.15	sample	0.28		0.14		0.03
			0.01	not collected	0.01		0.01		
Chloride	PPM	19.1	19.5		21.6		19.4		0.08
		0.5	0.2		0.2		0.1		
Fluoride	PPM	1.59	1.32		1.66		1.52		0.03
		0.02	0.03		0.05		0.02		
Nitrate	PPM	1.51	0.50		0.50		0.45		0.02
		0.02	0.02		0.01		0.01		
Sulfate	PPM	69.6	72.9		79.4		75.8		0.03
		0.2	0.3		0.1		0.2		
MAJOR METALS									
Ca	PPM	NM	51.9		47.3		48.6		0.06
			0.4		0.3		0.3		
Mg	PPM	NM	21.7		20.2		20.3		0.3
			0.1		0.1		0.2		
K	PPM	NM	8.8		8.8		8.4		0.05
			0.2		0.2		0.1		
Na	PPM	NM	75		72		71		1.5
			3		1		1		
TRACE METALS									
Li 7	PPB	81	68		72		75		0.009
		2	2		2		1		
Al 27	PPB	NM	NM		2.89		0.36		0.02
					0.08		0.01		
Ti 47	PPB	1.0	1.6		0.88		0.61		0.009
		0.2	0.2		0.06		0.02		
V 51	PPB	1.38	1.09		1.20		1.13		0.003
		0.02	0.02		0.02		0.03		
Cr 52	PPB	2.8	0.35		1.03		0.11		0.02
		0.1	0.02		0.01		0.05		
Mn 55	PPB	0.242	0.05		0.234		0.10		0.005
		0.006	0.01		0.008		0.01		
Ni 60	PPB	4.0	0.13		1.58		0.42		0.01
		0.2	0.02		0.09		0.01		
Cu 63	PPB	NM	NM		1.60		1.21		0.07
					0.02		0.03		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCEEDED

Ash Meadows- Scruggs (cont':pg.2)									
		Sample #1	Sample #2	Sample #3	Sample #4		Sample #5		
		Mean	Mean	Mean	Mean		Mean		Detection
		S.D.	S.D.	S.D.	S.D.		S.D.		Limit
Zn 66	PPB	NM	NM	sample	0.36		0.53		0.01
				not collected	0.03		0.02		
Ge 73	PPB	0.88	0.49		0.39		0.41		0.0009
		0.08	0.04		0.01		0.02		
As 75	PPB	14	11.8		15.8		18.6		0.009
		1	0.3		0.3		0.9		
Se 77	PPB	4.3	2.4		0.40		0.36		0.10
		0.5	0.2		0.05		0.03		
Rb 85	PPB	13.7	10.8		14.7		14.4		0.001
		0.1	0.3		0.2		0.1		
Sr 86	PPB	896	1040		867		942		0.4
		9	10		9		7		
Mo 95	PPB	7.2	8.1		6.63		6.2		0.025
		0.3	0.2		0.05		0.3		
Sn 117	PPB	ND	0.17		0.072		0.033		0.004
			0.01		0.009		0.005		
Sb 121	PPB	0.203	0.238		0.57		0.22		0.005
		0.006	0.007		0.01		0.01		
Cs 133	PPB	4.58	2.63		3.27		3.34		0.0005
		0.04	0.02		0.03		0.09		
Ba 135	PPB	84	61		66		77		0.002
		2	1		1		1		
W 182	PPB	0.30	0.38		0.28		0.30		0.018
		0.02	0.02		0.01		0.02		
Tl 205	PPB	0.287	0.23		0.173		0.184		0.002
		0.008	0.01		0.003		0.007		
U 238	PPB	3.5	2.27		2.60		2.7		0.0002
		0.1	0.06		0.06		0.1		
Be 9	PPT	ND	ND		ND		117		20
							9		
Co 59	PPT	129	18		54		18		1
		5	2		5		6		
Ga 71	PPT	13	5		4		1.6		0.8
		1	2		1		0.3		
Zr 90	PPT	ND	420 (A)		51		38		0.6
			10		4		4		
Nb 93	PPT	ND	92		11		6		4
			3		6		4		

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Ash Meadows- Scruggs (cont':pg.3)										
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5		
		Mean	Mean	Mean	Mean			Mean		Detection
		S.D.	S.D.	S.D.	S.D.			S.D.		Limit
Ru 99	PPT	ND	ND	sample	ND			ND		1.5
				not collected						
Rh 103	PPT	67	NM		27			20		2
		2			1			2		
Ag 107	PPT	ND	ND		ND			ND		3
Cd 114	PPT	139	ND		11			7		5
		4			4			2		
In 115	PPT	NM	2.2		4			ND		0.4
			0.7		1					
Te 125	PPT	460	60		ND			ND		9
		30	10							
Hf 177	PPT	14	22		ND			ND		3
		1	3							
Ta 181	PPT	ND	53		12			8		0.03
			2		3			4		
Re 187	PPT	7.1	8.5		6.5			7.2		0.12
		0.5	0.7		0.8			0.8		
Ir 193	PPT	ND	ND		ND			ND		0.6
Pt 195	PPT	ND	ND		3			ND		0.3
					1					
Au 197	PPT	ND	ND		ND			ND		3
Pb 208	PPT	120	ND		ND			34		8
		40						7		
Bi 209	PPT	4	9		ND			ND		2
		2	3							

Ash Meadows- Scruggs (cont':pg.4)											
		Sample #1	Sample #2	Sample #3	Sample #4			Sample #5			
		Mean	Mean	Mean	Mean			Mean			Detection
		S.D.	S.D.	S.D.	S.D.			S.D.			Limit
		D	P		P	D	E	P	D	E	
Y 89	PPT	10.4	7.1	sample	2.50	6.4	1.15	4.0	3.7	1.56	0.2, 1
		0.6	0.3	not collected	0.08	0.3	0.07	0.1	0.3	0.07	
La 139	PPT	5.7	2.6		135.7(A)	3.1	2.3	5.81	2.6	0.89	0.08, 1
		0.4	0.1		0.5	0.8	0.1	0.07	0.4	0.06	
Ce 140	PPT	7.0	1.7		2.03	6.1	0.7	0.95	ND	ND	0.06, 0.8
		0.4	0.2		0.06	0.9	0.1	0.05			
Pr 141	PPT	0.9	0.30		0.04	ND	0.16	0.160	ND	0.092	0.01, 0.6
		0.2	0.04		0.03		0.01	0.008		0.009	
Nd 143	PPT	ND	1.3		1.2	ND	0.74	0.57	ND	0.50	0.08, 5
			0.5		0.1		0.08	0.07		0.03	
Sm 147	PPT	ND	0.4		8.4	9	3.0	0.87	ND	0.98	0.1, 1
			0.2		0.4	1	0.1	0.04		0.04	
Eu 153	PPT	NM	13.6		NM	NM	0.13	NM	NM	ND	0.06, 0.6
			0.9				0.02				
Gd 158	PPT	ND	0.4		0.23	6	0.14	0.17	ND	0.18	0.1, 3
			0.1		0.05	1	0.04	0.03		0.03	
Tb 159	PPT	ND	ND		ND	ND	0.03	ND	ND	0.035	0.01, 0.7
							0.01			0.003	
Dy 163	PPT	ND	0.3		0.08	ND	0.14	0.10	ND	0.20	0.05, 4
			0.1		0.03		0.04	0.02		0.03	
Ho 165	PPT	ND	ND		ND	ND	0.02	0.016	ND	0.047	0.01, 0.8
							0.01	0.005		0.005	
Er 166	PPT	ND	ND		ND	ND	0.10	0.07	ND	0.15	0.05, 2
							0.02	0.02		0.02	
Tm 169	PPT	ND	ND		ND	ND	ND	ND	ND	0.023	0.01, 0.5
										0.003	
Yb 173	PPT	ND	ND		ND	ND	ND	ND	ND	0.15	0.1, 2
										0.03	
Lu 175	PPT	ND	ND		ND	ND	ND	0.015	ND	0.021	0.01, 0.8
								0.005		0.003	
Th 232	PPT				ND	ND	ND	0.45	ND	0.09	0.05, 0.8
								0.03		0.02	
P = PRECONCENTRATION BY ION EXCHANGE											
D = DIRECT ANALYSIS											
E = PRECONCENTRATION BY EXTRACTION COLUMN											

ND = NOT DETERMINED NM = NOT MEASURED A = ANOMALOUS VALUE H = HOLDING TIME EXCE

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
SAMPLING PROTOCOL INORGANICS

Purpose: To collect a representative water sample which is free from contamination.

1. Approvals

Principal Investigator

Quality Assurance Staff

Approval Date

Approval Date

2. Sample containers.

- 2.1 Samples to be analyzed for inorganic constituents will be collected in acid cleaned polyethylene bottles.
- 2.2 Samples for trace element/cation analysis will be collected in two 1-L bottles at each site.
- 2.3 Samples for anion analysis will be collected in one 125-mL bottle.
- 2.4 An additional 125-mL sample will be collected for field measurements (Total dissolved solids, conductivity, temperature, pH, and alkalinity).
- 2.5 Sample containers will be handled at all times with clean polyethylene gloves to prevent contamination of the containers.

3. Sample container preparation.

3.1 New 1-L polyethylene bottles.

- 3.1.1 Wash with tap water and detergent.
- 3.1.2 Rinse thoroughly with tap water.
- 3.1.3 Rinse three times with Nanopure water.
- 3.1.4 Soak in 10-20% reagent-grade nitric acid for one week.
- 3.1.5 Rinse three times with Nanopure water.
- 3.1.6 Soak in 10-20% trace-metal grade nitric acid for one week.
- 3.1.7 Rinse twice with Nanopure water, then rinse a final time with distilled Nanopure water.
- 3.1.8 Air dry bottles, seal, bag in sealable plastic bags.

3.2 Used 1-L polyethylene bottles.

- 3.2.1 Dispose of old sample.
- 3.2.2 Rinse three times with Nanopure water.
- 3.2.3 Continue to prepare as in sections 2.1.4 to 2.1.8 above.

- 3.3 All other new polyethylene bottles.
 - 3.3.1 Prepare as in sections 3.1.1 to 3.1.5.
 - 3.3.2 Then dry as in 3.1.8 above.
- 3.4 All other used polyethylene bottles.
 - 3.4.1 Prepare as in 3.2.1 and 3.2.2 above.
 - 3.4.2 Soak in 10-20% reagent-grade nitric acid for at least three days.
 - 3.4.3 Rinse three times with Nanopure water.
 - 3.4.4 Air dry bottles, seal, bag in sealable plastic bags.
- 4. Record Keeping.
 - 4.1 All records regarding sample collection will be kept in the Field Sampling Log Book or on the HRC Field Sampling Data Form and are entered into the sample tracking database.
 - 4.2 Information to be recorded will include, but not be limited to:
 - 4.2.1 Date and time of sample collection.
 - 4.2.2 Location name.
 - 4.2.3 The sample number.
 - 4.2.4 Sample type and purpose.
 - 4.2.5 Samplers initials.
 - 4.2.6 When possible: location and altitude as read by Global Positioning System (GPS), including the GPS error.
 - 4.2.7 Any problems or observations are recorded on the sampling form.
 - 4.3 Measurements to be taken and recorded in the field.
 - 4.3.1 Total dissolved solids (TDS).
 - 4.3.2 Conductivity.
 - 4.3.3 Temperature.
 - 4.3.4 pH.
 - 4.3.5 Alkalinity.
- 5. Sample Collection.
 - 5.1 Information regarding the sample collection will be recorded in the HRC Field Sampling Data Form.
 - 5.2 Always wear polyethylene gloves when handling bottles or sample collection tubing. While wearing gloves, don't touch anything but clean bottles or tubing. If you touch anything other than these items, put on clean gloves.
 - 5.3 Samples will be collected directly into the sample bottle from the source using a peristaltic pump system.
 - 5.3.1 Teflon tubing will be used except in the pump head, where Tygon tubing will be used.
 - 5.3.2 The teflon tubing will be cleaned in the same manner as the bottles.
 - 5.3.3 The tygon tubing will be cleaned in a manner similar to the teflon tubing, except new and used tubing will be soaked for only 30 minutes to prevent damage to the tubing.
 - 5.3.4 A 0.45 micron in-line filter will be used to filter all samples.

- 5.3.5 The sample tube inlet and outlet will be covered with plastic during transport of the system and when the system is not in use to prevent contamination.
- 5.3.6 If the tubing openings become dirty (touched the dirt or mud, etc.), rinse well with dilute acid, then with Nanopure water before using.
- 5.3.7 If the sample site can not be reached with the pump system, the sample will be collected directly into a clean 1-liter bottle. The sample will then be filtered through the pump system described above as soon as possible after collection.
- 5.4 The sample should be collected as close to the source of a spring as possible, or nearest the center of a well or pool. The end of the sample collection tubing should be approximately 1 ft below the surface, when possible, to prevent surface contamination.
- 5.5 To prevent contamination, sample containers will be open for the shortest time possible to allow sample collection.
- 5.6 Do not touch the inside of bottles, caps or tubes. Hold the bottle cap with the inside facing down to prevent contamination of the inside of the cap.
- 5.7 Do not place the sample collection tube inside of the bottle. Allow the sample water to flow into the bottle from above.
- 5.8 Approximately one liter of sample will be pumped through the system prior to actual sample collection.
- 5.9 Sample bottles will be rinsed three times with a small amount of filtered sample. After rinsing, fill the bottle with the filtered sample and seal tightly.
- 5.10 If the wind is blowing while collecting the sample, try to block the wind to prevent dust from blowing into the bottle.
- 5.11 Filters will be changed daily, or as needed due to clogging.
- 6. Sample preservation.
 - 6.1 At the time of collection, all samples for trace element/cation analysis will be acidified to $< \text{pH } 2$ with nitric acid (10 ml of concentrated nitric acid to 1 L of sample). The amount of acid added will be recorded on the HRC Field Sampling Data Form.
 - 6.2 Samples collected for anion analysis will not be acidified. These samples will be placed in sealable plastic bags and stored on ice in an insulated container.
 - 6.3 After acidification, sample containers will be closed tightly, placed back in the sealable plastic bags, then placed on ice in an insulated container.
 - 6.4 Samples will be returned to the lab as soon as possible, but no later than the following day.
 - 6.5 Samples will be stored in the lab in a cold storage room at 4°C .
- 7. Quality Control.
 - 7.1 A lab blank consisting of unfiltered, distilled Nanopure water will be collected for each sample type. These samples will remain in the lab, stored at 4°C .
 - 7.1 Nanopure water from the lab will be brought to the field, filtered, and subsequently treated as a sample.
 - 7.1.1 One blank for trace element/cation analysis (two 1-L) and one blank for anion analysis (125-ml) per day, per sampling team, will be prepared.

- 7.1.2 If the blank is being collected for trace element/cation analysis, it should be acidified as in 7.1 above.
- 7.1.3 All further treatment, storage, and analysis will be the same as that for all samples collected at the same time.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
Ion Chromatography System

1. Approvals:

Principal Investigator

Quality Assurance Staff

Approval Date

Approval Date

2. Instrumentation:

- 2.1 Dionex Ion Chromatograph System consisting of:
Advanced Gradient Pump, Model# AGP-1
Eluant Degas Module, Model# EDM-2
Liquid Chromatography Module, Model# LCM-3
Conductivity Detector, Model# CDM-2
Advanced Computer Interface, Model# ACI-1
Automated Sampler, Model# ASM-3
Dionex AI-450 Chromatography Automation Software, Version 3.1 (or
equivalent)
Anion AS4A-Ionpac Chromatography Column
Anion AG4A Guard Column
Micromembrane Suppressor, Model# AMMS-II

3. Analytical Method:

- 3.1 Test Method, *The Determination of Inorganic Anions in Water by Ion Chromatography-Method 300.0*, Revised August 1991.

4. Sample Preparation:

- 4.1 All samples will be logged in to the sampling notebook upon collection, and any applicable environmental factors and on site measurements will be noted, along with site location, time, and date of sample collection.
- 4.2 Samples will be filtered through a 0.45um filter, and stored in low-density polyethylene (LDPE) sample jars. A minimum of 50 ml of water will be collected at each site for anion analysis.
- 4.3 Samples will be transported from the sampling site to the laboratory in ice chests. Blue ice will be used as the primary coolant in these chests.
- 4.4 Samples will be stored at the laboratory in a cold room (currently located in room 165), at approximately 4°C until analysis.
- 4.5 All analyses will be performed as soon as possible following sample collection.
- 4.6 Spiking is performed on all U.S. EPA certification samples and annually on samples representing each sampling site.

5. Instrument Start-up:

- 5.1 Instrument start-up will be performed according to the instructions listed in the manufacturer's operation manuals. These manuals are available for each separate module of the system, and each instrument operator will have read through all applicable manuals for the current system before starting any part of the system, to avoid problems with those modules functioning as a group, or controlled by the computer interface. The appropriate manuals and sections are listed below:
 - Advanced Gradient Pump, Model# AGP-1, Sections 1.4 - 3.4
 - Eluant Degas Module, Model# EDM-2, Complete instructions
 - Liquid Chromatography Module, Model# LCM-3, Sections 3 and 4
 - Conductivity Detector, Model# CDM-2, Sections 2, 4, and 5
 - Advanced Computer Interface, Model# ACI-1, Sections 2 and 3.4 o f
 - Autoregen Manual, and section 4 of the EX Series Pump manual
 - Automated Sampler, Model# ASM-3, Sections 2, 4, and 5
 - Dionex AI-450 Chromatography Automation Software, Version 3.1 (or equivalent), User's Guide
 - Anion AS4A-Ionpac Chromatography Column, Sections 3 - 6
 - Anion AG4A Guard Column
 - Micromembrane Suppressor, Model# AMMS-II, sections 1, 2, and 3
 - Anion Autoregen Cartridge Accessory, section 2.0

NOTE: All sections of the above listed manuals pertaining to installation, operation, service/maintenance, and troubleshooting will be read and understood to the fullest possible degree by all analysts using the instrument.

6. Instrument Log Book:

- 6.1 An instrument logbook entitled, Ion Chromatography, will be kept to record all pertinent information including (but not limited to): analyst ID, date, conductivity, type of analyses run, calibration concentration ranges, instrument maintenance, and standard preparation.
- 6.2 This logbook will be kept in accordance with standard laboratory notebook/logbook guidelines and procedures laid out in the HRC Notebook SOP.

7. Calibration:

- 7.1 Calibration standards preparation, curve range evaluation and etc. will be performed according to EPA Method 300.0 with the following exceptions:
 - 7.1.1 A 50 ul loop will be used for sample analysis, instead of the 0.1 to 1.0 ml loop recommended by the method.
 - 7.1.2 A four or more-point calibration, including the zero-point blank, is performed prior to each sample analysis.
 - 7.1.3 A reagent blank will be analyzed before the calibration standards to be used for blank correction of any aliquots that have been prepared or diluted using the same water comprising the reagent blank.
 - 7.1.4 Field blank subtraction will be performed for any sample for which the field blank contamination is greater than or equal to 1% of the sample. Field blank subtraction should not be performed on samples that are diluted.
 - 7.1.5 Because environmental samples will be analyzed, accurate prediction of analyte concentrations is difficult to do. All samples which fall above the concentration curve range will be diluted and re-run, or will be re-run under a higher concentration calibration curve.
 - 7.1.6 Each chromatogram peak will be viewed and if necessary, manually integrated.
 - 7.1.7 A separate calibration curve for each anion of interest will be prepared by plotting peak area against concentration values.
 - 7.1.8 The calibration curve will be verified using a NIST-traceable quality control sample.
 - 7.1.9 Correlation coefficients for calibration curves will be equal to or greater than 0.95, or new calibration standards will be prepared and re-run until this value is met or exceeded.

8. Quality Control:

- 8.1 The following QC guidelines set forth in EPA Method 300.0 (Section 10) will be used:
 - 8.1.1 A blank, consisting of reagent water, will be analyzed prior to calibration standards. A reagent blank will also be analyzed prior to the analysis of each

sample. Corrective action will take place if reagent interferences are not under control. The responses and acceptance limits for the reagent blank are listed in the QC check list.

- 8.1.2 A quality control sample prepared by an independent source (currently Dionex) will be analyzed immediately following instrument calibration. This standard will be NIST traceable, and will be compared to standards made up in-house to verify the accuracy of the in-house standard solutions. The true values, measured values and the %difference will be recorded on the QC check list. If the % difference is greater than 10% corrective action will take place.
- 8.1.3 Triplicate measurements will be taken for each sample. The average values, standard deviations and percent relative standard deviations (%RSD) will be reported. If a %RSD is above 10%, the samples will be re-run to obtain a standard deviation within the limits.
- 8.1.4 A mid range calibration check standard will be analyzed for every 20 samples. The percent difference, between the mid range concentration and that measured for the check standard, will be calculated and documented on the QC check list. The %difference must be less than 10% or corrective action will take place.
- 8.1.5 Control charts will be prepared using the quality control sample. The upper and lower control limits will be the actual concentration $\pm 10\%$. If the measured concentration falls out of the limits, the standards will be rerun or new standards prepared.
- 8.1.6 A minimum of 10% of all samples will be run in duplicate. The duplicates must agree within 10%.
- 8.1.7 Method detection limits will be performed (as in 13.1 of 300.0) each 6 months or whenever there is a significant change in the system that would effect response, such as a column change.
- 8.1.8 Instrument detection limits will be determined and reported for each set of samples.
- 8.1.9 The Laboratory Fortified Matrix procedure (LFM, described in 3.8 of 300.0) is intended to detect matrix effects and interferences (see also 4.1 of 300.0). LFM will be performed for each U.S.EPA performance sample analyzed for certification. LFM will also be performed for each initial field site/matrix and biannually if no interference or matrix effect is observed or sooner if a significant change in the site/matrix chemistry is observed. If an interference or matrix effect is inherent in the site/matrix then the LFM procedure will be used on all field samples from that site/matrix.

9. Record Keeping:

- 9.1 An instrument logbook entitled, Ion Chromatography, will be kept to record all

pertinent information including (but not limited to): analyst ID, analyses run, calibration concentration ranges, instrument maintenance, and standard preparation.

- 9.2 A QC check list will be prepared with every analysis. These check lists will be placed in a notebook entitled, Ion Chromatograph, Quality Control Check List.
- 9.3 Hard copies of all analyses will be stored in the analysts' files referenced by site name, and sample date until data are transferred to the HRC Chemistry Division Data Management System.

10. Retention Time Analysis:

- 10.1 Chromatographic analysis will be accomplished using the Dionex AI-450 Chromatography Automation Software, Version 3.1 (or equivalent).
- 10.2 Retention time windows will be calculated using guidelines set out in EPA Method 300.0 (Section 11.4), and the experience of the analyst.

11. Calculations and Data Manipulations:

- 11.1 All mean values, and %RSD values calculated for the anion analyses will be performed using a standard spreadsheet program such as Lotus 1-2-3 or QuattroPro.
- 11.2 All other calculations and data manipulations will be performed using the Dionex AI-450 Chromatography Automation Software, Version 3.1 (or equivalent).

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
FLAME ATOMIC ABSORPTION SPECTROMETRY

1. Approvals

Principal Investigator

Quality Assurance Staff

Approval Date

Approval Date

2. Instrumentation.

- 2.1 Varian Atomic Absorption Spectrometer.
Model AA-20. Serial # 9061386.

3. Sample Storage and Handling

Sample containers are stored in plastic ziploc bags at 4°C and are handled at all times with gloved hands.

4. Analytical Methods.

- 4.1 Atomic absorption direct aspiration method, EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983.
4.2 Supplemental EPA methods, element specific.
4.3 The Varian publication *Flame Atomic Absorption Spectrometry Analytical Methods* (publication #85-100009-00, 1989) will provide additional guidance, especially when developing a method for an element not previously analyzed.

5. Instrument start-up and operation will be conducted as per the manufacturer's specifications (SpectrAA-10/20 Operation Manual, Varian publication #85-100625-00, 1986).

6. Instrument Log Book.

- 6.1 An instrument log book will be kept following the HRC Scientific Notebook SOP.
6.2 Parameters to be included in the log book are:
6.2.1 Analyst ID.
6.2.2 Project name and/or sample ID.
6.2.3 Date.
6.2.4 Element to be analyzed.
6.2.5 Wavelength.
6.2.6 Photomultiplier Volts.
6.2.7 Lamp ID number.
6.2.8 The number and type of samples run.
6.2.9 Calibration response.

6.2.10 Problems and corrective action taken.

7. Calibration.

- 7.1 Calibration, following EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983, will be completed each day that samples are analyzed.
- 7.2 Standards will be prepared from the appropriate reference standards. The method of preparation and source of the standards, including lot numbers, will be recorded in the analyst's notebook.
- 7.3 At least 4 standards and a blank will be prepared for the calibration curve.
- 7.4 The calibration slope and correlation coefficient will be recorded in the instrument log book.
 - 7.4.1 Correlation coefficients must have an r value of 0.995 or greater ($r^2 = 0.990$) to be acceptable. Preferably, the r value will be 0.998 or greater ($r^2 = 0.996$). If r is less than 0.995, corrective action will be taken as specified in 4.1 above.
 - 7.4.2 Only the linear portion of the calibration curve will be used for sample analysis.

8. Quality Assurance.

- 8.1 Quality assurance will be conducted as in EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983.
- 8.2 An unknown performance sample, either an EPA performance sample or a USGS Standard Reference Water Sample, will be analyzed annually. The results must be within the control limit established by the agency from which the sample was obtained. If the results are not in the acceptable range, corrective action should be taken, and a follow-up performance sample should be analyzed.
- 8.3 A QC standard from another laboratory will be analyzed immediately following the instrument calibration. The determined value must be within 10% of the certified value. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.1.
- 8.4 Triplicate measurements will be taken for each sample.
 - 8.4.1 The average value and the standard deviation will be reported.
 - 8.4.2 The relative standard deviation (RSD), the standard deviation divided by the average value and expressed as a percent, should be below 10%, preferably below 5%. If the standard deviation is greater than 10%, the samples will be re-run to obtain a standard deviation within the acceptable range.
- 8.5 For every 20 samples, the calibration blank, a mid-range standard, and a QC standard will be run as samples. These values must be within 10% of the value determined during the initial calibration. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.1.
- 8.6 One replicate preparation and analysis will be completed for each 20 samples.
- 8.7 A reagent blank and method blank will be run with each analysis.
- 8.8 Detection limits will be determined for each group of samples analyzed by multiplying by three the standard deviation of the method blank analyzed with the samples. These values will be reported with the analytical results for the corresponding samples.
- 8.9 To determine if matrix effects are present in a sample, a laboratory fortified sample must be run for all new samples. The percent recovery of a fortified sample must be within 20% of the expected concentration. If the percent recovery is not within the required limits, the method of standard additions must be applied (section 4.1 above). For samples previously analyzed and

shown to be free of matrix effects, fortified samples will be run at a frequency of 10% or one for each sample set, whichever is greater.

9. Record keeping.

- 9.1 An analyst's notebook will be kept as specified in the HRC Scientific Notebook SOP. All information relating to sample identification, preparation, and analysis will be kept in the analyst's notebook. Data to be recorded in the notebook includes, but is not limited to: method number, element to be analyzed, wavelength, QC standard value, weights and concentration used in preparing standards and samples, type and source of reagents used, and any corrective action taken.
- 9.2 Any data originating from instrument or computer printouts will be kept in the analyst's file named by project and/or sample set, and the location will be referenced in the analyst's notebook.

10. Calculations and data manipulations.

- 10.1 The concentration values provided directly by the Varian SpectrAA 10/20 will not be the reported values used. The software program which this instrument uses calculates a curve fit for the calibration standards, not a linear regression. This could result in the use of non-linear portions of the calibration curve. Instead, the following method of calculating the concentration for the absorbance readings will be used:
- 10.1.2 Prepare the calibration curve by plotting the absorbance against the concentration.
- 10.1.3 Using the Quattro Pro mathematics calculations, calculate the least squares linear regression for the calibration standards.
- 10.1.4 If the r value meets the specifications in 7.4.1, use the slope of this line to convert the sample absorbance values to concentration using the following equation: $\text{absorbance/slope} = \text{concentration}$. Take corrective action as specified in 7.4.1, if the r value is not in the acceptable range.
- 10.1.5 Apply any sample dilution factors to the concentration obtained in 10.1.4.
- 10.1.6 Print out the calculations and file with the original instrument readings.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
INDUCTIVELY COUPLED PLASMA - MASS SPECTROMETRY

1. Approvals

Principal Investigator

Quality Assurance Staff

Approval Date

Approval Date

2. Instrumentation.

- 2.1 Perkin-Elmer inductively coupled plasma mass spectrometer, Model Elan 5000. Serial #114920888.
- 2.2 Instrument Software: SCO XENIX 386 Operating System. Release 2.3.2 and Elan software.

3. Samples are stored in plastic ziploc bags at 4°C and are handled at all times with gloved hands.

4. Analytical Methods.

- 4.1 EPA method 200.8, *Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry*
- 4.2 The Perkin-Elmer manuals, *Users Manual, Elan 5000 Inductively Coupled Plasma-Mass Spectrometry* (#0993-8429) and *Reference Manual, Elan 5000 Inductively Coupled Plasma-Mass Spectrometry* (#0993-8467), will provide additional guidance.

5. Instrument start-up and operation will be conducted as per the manufacturer's specifications (see manuals listed in 4.2 above).

- 5.1 The tuning solution will be obtained directly from Perkin-Elmer. This solution contains 10ppb of each of the following elements: Mg, Cu, Cd, Pb, Sc, Rh, Tl, Ce, Tb, Ba, Ge.
- 5.2 Intensity and oxide checks will be conducted with the tuning solution (4.1) per the instrument manufacturer's instructions (4.2).
- 5.3 To demonstrate instrument stability, at least 70 replicates of the tuning solution should result in relative standard deviations (RSD's) of less than 10%. If the RSD's are greater than 10%, corrective action should be taken as specified in the manuals listed in 4.2.

*Revisions are indicated by vertical lines in the right margin.

- 5.4 The oxide ratios will not exceed the following: CeO/Ce less than 3%, BaO/Ba less than 2%, and Ba++/Ba less than 3%. If these values are exceeded, take corrective action as specified in the manuals listed in 4.2.
6. Instrument Log Book.
- 6.1 An instrument log book or file will be kept following the HRC Scientific Notebook SOP.
- 6.2 Parameters to be included in the log book are:
- 6.2.1 Analyst ID.
 - 6.2.2 Project and/or sample ID.
 - 6.2.3 Date.
 - 6.2.4 Elements to be analyzed. A parameter file will be generated and saved.
 - 6.2.5 The number and type of samples run.
 - 6.2.6 Nebulizer flow rate.
 - 6.2.7 Sensitivity for Mg, Pb and Rh.
 - 6.2.8 Oxide ratios for CeO/Ce, BaO/Ba and Ba++/Ba.
 - 6.2.9 Problems and corrective actions.
7. Calibration and Standardization.
- 7.1 Calibration, following the EPA method listed in 4.1 above, will be completed each day that samples are analyzed.
- 7.2 Standards will be prepared from the appropriate reference standards. The method of preparation and source, including lot numbers, of the standards will be recorded in the analyst's notebook. Standards may vary from those specified in the EPA method so that additional elements may be analyzed.
- 7.3 At least 4 standards and a blank will be prepared for the calibration curve.
- 7.4 The calibration slope and correlation coefficient will be recorded in the instrument log book or file.
- 7.4.1 Correlation coefficients must have an r value of 0.995 or greater ($r^2 = 0.990$) to be acceptable. Preferably, the r value will be 0.998 or greater ($r^2 = 0.996$). If r is less than 0.995, corrective will be taken as specified in the methods referenced in 4.1 and 4.2 above.
- 7.5 Internal standardization will be used unless standard addition procedures are used when appropriate to correct for instrumental drift and physical interferences. If employed in the analysis, internal standard(s) will be prepared based on the nature and analyte concentrations of the samples. They will be spiked into all blanks, standards, and sample solutions at identical levels. The level of the spikes is important for achieving a range of intensity rather than a specific concentration. For this reason the expiration dates of the primary internal standards are not monitored.
8. Quality Assurance.
- 8.1 Quality assurance will be conducted as in the EPA method in 4.1 above.
- 8.2 The method detection limits will be determined to insure that the analysis is carried out as specified in the EPA method listed in section 4.1.

- 8.3 An unknown performance sample, either an EPA performance sample or a USGS Standard Reference Water Sample, will be analyzed annually. The results must be within the control limit established by the agency from which the sample was obtained. If the results are not in the acceptable range, corrective action should be taken, and a follow-up performance sample should be analyzed.
- 8.4 An NIST QC reference material or one from another laboratory will be analyzed immediately following the instrument calibration. The determined value must be within 10% of the certified value. If the sample is in the ppb range. Samples with concentrations in the ppt range should be within $\pm 20\%$ of the certified value. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.1 above.
- 8.5 Five replicate measurements of all samples will be made.
- 8.5.1 The average value and the standard deviation will be reported.
- 8.5.2 The relative standard deviation (RSD), the standard deviation divided by the average value and expressed as a percent, should be below 10%, preferably below 5% for ppb concentrations and 20% for ppt concentrations. If the standard deviation is greater than 10% for ppb or 20% for ppt, the samples will be re-run to obtain a standard deviation within the acceptable range.
- 8.6 For every 10 to 20 samples, the calibration blank, a mid-range standard, and a QC standard will be run as samples. These values must be within 10% of the value determined during the initial calibration. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.1.
- 8.7 A reagent blank and method blank will be run with each analysis.
- 8.8 Instrument detection limits will be determined whenever a significant change in the instrumental response is observed using a blank solution and a approximately 1 ppb solution. The detection limit will be calculated using the following formula from the Perkin Elmer manual:

$$DL \text{ (ppt)} = \frac{3 \times SD_{\text{blank}} \text{ (counts sec}^{-1}\text{)}}{I_{1\text{ppb}} \text{ (counts sec}^{-1}\text{)}} \cdot 10^3 \text{ ppt}$$

where

- DL = detection limit of the analyte (in ppt)
 SD_{blank} = Standard deviation of blank (counts sec⁻¹)
 $I_{1\text{ppb}}$ = Intensity of the analyte in 1-ppb solution in counts sec⁻¹

These values will be reported with the analytical results for the corresponding samples.

- 8.9 If matrix effects are suspected by observing the internal standard response as required in 8.10, to be present in a sample, the method of standard additions will be used.

- 8.10 The absolute response of the internal standard should not deviate more than 60-125% of the original response in the calibration blank. If deviations greater than this are observed, corrective action as specified in the EPA method listed in 4.1 will be taken.
9. Record keeping.
- 9.1 An analyst's notebook, files, and other records will be kept as specified in the HRC Scientific Notebook SOP. All information relating to sample identification, preparation and analysis will be kept in the analyst's notebook or records. Data to be recorded in the notebook includes, but it not limited to: method number, elements to be analyzed, calibration response, QC standard value and the percent deviation from the true value, weights and concentrations used in preparing standards and samples, type and source of reagents used, and any corrective action taken.
- 9.2 Any data originating from instrument or computer printouts will be kept in the analyst's file, named by project and/or sample set, and the location will be referenced in the analyst's notebook.
10. Calculations and data manipulations.
- 10.1 The concentration values provided directly by the Perkin-Elmer Elan 5000 will be the reported values used. The software program which this instrument uses applies element correction equations to the data.
- 10.2 Apply any dilution factors to the concentrations obtained in 10.1.
- 10.3 Copies of the final calculations are stored in the analyst's files and referenced in the analyst's notebook. Computer files which are a necessary part of the ICP-MS system are also referenced in the notebook. The files for a particular analysis will be kept on 3½-inch disks (UNIX and DOS) and will be retrieved as necessary.

Harry Reid Center for Environmental Studies
Standard Operating Procedure
for
LANTHANIDE CONCENTRATION PROCEDURE

1. Approvals:

Principal Investigator

Quality Assurance Staff

Approval Date

Approval Date

Objective of Method:

The Lanthanides are present in spring water at less than one part per trillion (ppt). This concentration is at or below the detection limit of the ICP-MS. The Lanthanides are concentrated on a cation exchange column. The concentrated Lanthanides are then eluted with a small volume of 8 Molar nitric acid. This column ion exchange procedure can concentrate the Lanthanides fifty to one hundred times, depending on the sample volume passed through the column and the final volume of the sample after extraction. The column does not retain most other ions, which normally clog the skimmers of the ICP-MS.

Preparation of The Ion Exchange Column:

Reagents:

- * Ultrapure Nitric acid concentrated purchased from Seastar Industries; Seattle, WA
- * Deionized and distilled water
- * AG* 50W-X8 Cation exchange resin; purchased from Bio-Rad laboratories; Richmond, CA
- * 8 Molar Nitric acid; prepared from equal volumes of Seastar nitric acid and distilled deionized water
- * 1 % Nitric acid solution prepared from ultrapure acid and deionized distilled water.

Equipment:

- * Top loading balance capable of weighing one thousand grams to one tenth of a gram

- * One liter polyethylene bottles and caps
- * Hot plate heater, large
- * Vacuum pump
- * Poly-Prep columns; purchased from Bio-Rad laboratories, Richland, WA: catalogue # 731-1550
- * Teflon wool; purchased from Alltech Associates, Deerfield, IL
- * Teflon beakers, 50 ml

Procedure:

1. Clean the cation exchange resin by soaking in 8 Molar nitric acid overnight.
2. Decant the fines and floating ion exchange beads, after swirling the slurry.
3. Pack each poly-prep column with 5 ml of cleaned cation exchange resin slurry. Placing the columns in a vacuum filter device will aid the packing procedure.
4. Plug each column with teflon wool to hold the packing securely in place.
5. Clean and condition each column by first passing 100 ml of 8 Molar nitric acid then 20 ml of 1 % nitric acid solution through the column.

Method For Concentrating The Lanthanides:

1. Weigh 500g of sample into a tared 1 liter polyethylene bottle.
2. Pass the sample through a packed ion exchange column. The flow rate should be about 1 ml/minute for optimum mass transfer of ions.
3. Elute the column with 50 ml of 8 Molar nitric acid and collect the eluent in a 50 ml teflon beaker.
4. Take the eluent to less than one ml on a hot plate under a hood. A setting of 2 on the hot plate is optimum.
5. Bring the concentrate to 10 or 20 ml using 1 % nitric acid.
6. Analyze the sample for the lanthanides using the ICP-MS procedure.

Calculation of The Dilution Factor (DF):

$$DF = \frac{\text{Weight of the original water sample}}{\text{Weight of the final volume to be analyzed}}$$

Harry Reid Center for Environmental Studies
Standard Operating Procedure (SOP)
for
EUROPIUM CONCENTRATION PROCEDURE

1. Approvals:

Principal Investigator

Quality Assurance Staff

Approval Date

Approval Date

Objective of Method:

Europium is present in spring water at less than one part per trillion (ppt). This concentration is at or below the detection limit of the ICP-MS. In addition to the low concentration, the presence of barium, which forms barium oxide in the plasma, is measured at the same masses as europium. This interference cannot be corrected by the use of correction factors. This method eliminates both problems. Europium is concentrated on the column while barium is not retained by the column. The concentrated europium is then eluted with a small volume of 8 Molar nitric acid. This column extraction procedure can concentrate the europium fifty to one hundred times depending on the sample volume passed through the column and the final volume of the sample after extraction.

Preparation of The extraction Column:

Reagents:

- * Bis(2-ethylhexyl) hydrogen phosphate (1) purchased from Pfaltz and Bauer
- * 2-ethylhexyl dihydrogen phosphate (2) Waterbury, CT
- * Ultrapure Nitric acid concentrated purchased from Seastar Industries; Seattle, WA
- * Heptane reagent grade
- * Deionized and distilled water
- * Bio-Beads SM-2 Adsorbent; purchased from Bio-Rad laboratories; Richmond, CA
- * 8 Molar Nitric acid; prepared from equal volumes of Seastar nitric acid and distilled

deionized water

- * 1% Nitric acid solution prepared from ultrapure acid and deionized distilled water.

Equipment:

- * Top loading balance capable of weighing one thousand grams to one tenth of a gram
- * One liter polyethylene bottles and caps
- * Teflon bottles, 125 ml
- * Polyethylene beakers, 50 ml
- * Polyethylene stirring rods
- * Hot plate heater, large
- * Vacuum pump
- * Poly-Prep columns; purchased from Bio-Rad laboratories, Richland, WA: catalogue # 731-1550
- * Teflon wool; purchased from Alltech Associates, Deerfield, IL
- * Teflon beakers, 50 ml

Procedure:

1. Weigh approximately 6.5 g of (1) from the reagent list and 3.5g of (2) into a tared Teflon bottle.
2. Add heptane till the final weight is 100 g approximately.
3. Cap the bottle and shake till solution is homogeneous
4. Weigh 5g of Bio-Beads into a polyethylene beaker then add 15g of the heptane solution and mix with a polyethylene stir rod till the beads are thoroughly coated
5. Place the beaker on a hot plate in a hood. The hot plate setting should be low or 1. Stir every fifteen minutes to distribute the reagent uniformly.
6. When the beads are dry, no solvent odor, add 20 to 40 ml of 8 Molar nitric acid to hydrate the beads.
7. Pack the slurried contents of the beaker equally into two poly-prep column. Placing the columns in a vacuum filter device will aid the packing procedure.
8. Plug each column with teflon wool to hold the packing securely in place.
9. Clean and condition each column by first passing 100 ml of 8 Molar nitric acid then 20 ml of 1% nitric acid solution through the column.

Method for Concentrating Europium:

1. Weigh 500 g of sample into a tared 1 liter polyethylene bottle.
2. Pass the sample through a packed poly-prep column.

3. Elute the column with 50 ml of 8 Molar nitric acid and collect the eluent in a 50 ml Teflon beaker.
4. Take the eluent to one ml on a hot plate under a hood. A setting of 2 on the hot plate is optimum.
5. Bring the concentrate to 10 or 20 ml using 1 % nitric acid.
6. Analyze the sample for europium using the ICP-MS procedure.

Calculation of The Dilution Factor (DF):

$$DF = \frac{\text{Weight of the original water sample}}{\text{Weight of the final volume to be analyzed}}$$

Harry Reid Center for Environmental Studies
Standard Operating Procedure (SOP)
for
METHOD OF STANDARD ADDITIONS

1. Approvals:

Principal Investigator

Quality Assurance Staff

Approval Date

Approval Date

Objective of Method:

Reference: "Methods of Chemical Analysis of Water and Wastes." U.S. EPA, EMSL, Cincinnati, OH 45268, March, 1983; EPA-600/4-79-020. This procedure is used to correct sample concentrations for sample matrix effects. The calibration curves and sample concentrations are determined in the sample matrix. The assumption is that whatever components of the sample matrix interacts with the element being measured will also exactly interact with the standards which are added to the sample, to give the calibration curve. The concentrations of standards added are 50%, 100% and 150% of the estimated sample concentration. The concentration of each element in the sample is determined by extrapolation of the linear calibration curve to the abscissa and reading the point of intersection of the abscissa with the calibration line.

Reagents:

- * Perkin -Elmer Multi Element Atomic Spectroscopy Standards; The concentration of each element is 10ug/ml (10ppm)
- * Sample size minimum 60 ml
- * 1% nitric acid; prepared from Seastar acid and distilled water
- * Internal standards: Tb approximately 2ppm and Cs approximately 2ppm and Pt at 9ppm may also be used; prepared from pure reagent solutions diluted with 1% nitric acid.

Equipment:

- * Analytical Balance
- * Disposable scintillation bottles with cone closures: 20 ml available from Baxter Labs
- * Teflon Bottles: 125 ml
- * Pipets Automatic and adjustable such as the Gilson Pipetman :100 ul and 1000 ul
- * Perkin-Elmer ICP/MS Elan or equivalent instrument

Standards Preparation:

1. Dilute by weight the multi-element standard using the 1 % nitric acid and the 125-ml teflon bottle.
2. The standard concentrations, for spring waters, is in the range of 1 to 10 parts per billion (ppb). If this concentration is chosen correctly then 50, 100, and 150 ul added to 20 ml of sample will approximately equal 50%, 100% and 150% of the estimated concentration of the analyte in the sample. If the sample contains many elements which vary widely in concentration then the sample should be diluted and an additional standard addition analysis should be performed on those analytes of higher concentration.

Sample Preparation:

1. Weigh four aliquots of the sample into the tared disposable scintillation vials. 20 g $\pm$ 0.1 g is used for the spring water analysis.
2. Add 50 ul of internal standard to each of the four aliquots of sample.
3. One of the following volumes of diluted standard is added to one of the four aliquots of previously weighed samples: 0, 50, 100, 150 ul.

Sample Analysis:

1. Use the standard addition program of the Elan software.
2. Run the three spiked samples first in order of increasing concentration.
3. Then run the sample (0 addition of standard).
4. The instrument will draw the calibration curve and determine the concentration of each element analyzed for in the sample.