DOE/NV/10872--T203

FINGERPRINTING OF GROUND WATER BY ICP-MS

PROGRESS REPORT
APRIL 1, 1995 TO JUNE 30, 1995

DISCLAIMER

DOE Cooperative Agreement
No. DE-FC 08-90NV10872

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SAMPLE ANALYSIS

The ICP-MS was down for almost 6 weeks during this quarter. This greatly reduced the number of samples processed through the laboratory.

Ash Meadows 6 and Death Valley 6 were analyzed and are now undergoing review. The fourth sampling of the Pahranagat springs were also analyzed and the review should be completed during the next quarter.

DATA REDUCTION

Data for the Ash Meadows six week study, eight wells south and west of the NTS, J-12, J-13 and Tippipah, Topopah and Cane springs have been verified and are included in this report. The three NTS springs, Tippipah, Topopah and Cane, are being studied under a grant from the NTS, but the data are also included here because of the proximity to the Yucca Mountain Site. Latitude and longitude for each well and the three NTS springs are shown on table one.

What we have termed the six week study was conducted between 29 March, 1993 and 30 April, 1993 to evaluate short term variability in water chemistry and variability in our sampling and analysis methods. Fairbanks spring was sampled six times and Bradford spring was sampled five times. Both springs are located in Ash Meadows National Wildlife Refuge, Nevada.

DATA ANALYSIS

Three journal articles have been accepted for publication. "*The solubility control of rare earth elements in natural terrestrial waters and the significance of PO_4^{3-} and CO_3^{2-} in limiting dissolved rare earth concentrations: A review of recent information*" will be published in the journal of Aquatic Geochemistry, Volume 1, Number 2.

"*Multivariate statistical analysis of arsenic and selenium concentrations on groundwaters from south-central Nevada and Death Valley, California*" will be published in the Journal of Hydrology.

"*Speciation of the rare earth element neodymium in groundwaters of the Nevada Test Site and Yucca Mountain and implications for actinide solubility*" will be published in Applied Geochemistry. Copies of the papers are included in this report.

3 preprints removed for separate processing pa 8/22/95

TABLE 1.

Name	Alternate Names	Date Sampled	Latitude (N)	Longitude (W)
Wells				
Coffer Ranch		9/19/94	NA	NA
Windmill		9/19/94	37 00.25	116 33.42
Airport	Jackass Aero Park or AD-2	5/23/94	36 38.40	116 24.59
Army Well	MV-1	6/23/94	36 35.49	116 02.28
Cind-R-Lite		5/23/94	NA	NA
Lathrop Wells	NDOT Rest Stop or AD-2a	5/23/94	36 38.35	116 23.40
Saga	VH-2 or CF-2a	6/23/94	36 48.21	116 34.37
Gexa #3	CF-1a	6/23/94	36 54.45	116 38.39
J-12		3/3/94	36 45.54	116 23.24
J-13		3/3/94	36 48.32	116 23.75
Springs				
Tippipah Spring		12/8/94	NA	NA
Cane Spring		12/8/94	36 47.64	116 05.96
Topopah Spring		12/8/94	36 56.27	116 16.18

WELLS

		SAGA	ARMY	GEXA #3	AIRPORT	CIND-R-LITE	LATHROP	C-RANCH	WINDMILL	DL
		6/23/94	6/23/94	6/23/94	5/23/94	5/23/94	5/23/94	9/19/94	9/19/94	
		Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	
		S.D	S.D	S.D	S.D.	S.D	S.D	S.D	S.D	
ANIONS										
Bromide	PPM	0.111	0.157	0.555	0.049	0.046	0.098	0.31	0.07	0.01
		0.002	0.008	0.1	0.009	0.004	0.004	0.01	0	
Chloride	PPM	13.114	17.875	152	6.22	8.729	11.893	65.84	7.6	0.002
		0.009	0.006	1	0.001	0.049	0.006	0.77	0.18	
Fluride	PPM	0.913	0.922	ND	1.723	2.324	1.636	3.32	3.73	0.006
		0.001	0.008		0.001	0.001	0.001	0.03	0.06	
Nitrate	PPM	1.691	1.448	0.097	6.033	4.64	8.721	0.93	1.59	0.01
		0.002	0.003	0.001	0.014	0.01	0.02	0.03	0.02	
Sulfate	PPM	143.6	52.478	413.4	42.564	43.081	106.204	109.95	30.35	0.02
			0.268	1.3	0.129	0.101	0.128	0.34	0.11	
MAJOR METALS										
Ca	PPM	92.7	47	114.4	5.8	13.3	17.4	21.8	18.3	0.046
		0.4	0.3	0.4	0	0	0.4	0.9	0.2	
Mg	PPM	34.7	21.6	84.8	0.185	6.7	0.911	1.52	0.19	0.009
		0.3	0.2	0.9	0.002	0.3	0.005	0.03	0.01	
K	PPM	7.76	5.41	3.55	1.45	3.9	1.45	9.54	0.91	0.077
		0.1	0.04	0.05	0.04	0.2	0.04	0.13	0.01	
Na	PPM	75.5	42	73.7	68	73	68	176	73	1.7
		0.8	2	0.8	3	2	3	2	2	
TRACE METALS										
Li 7	PPB	92.4	44	72	73	64.9	80	166	111	0.04
		0.1	1	1	2	0.7	3	4	3	
Al 27	PPB	0.43	0.7	0.33	2.22	1.08	0.62	NM	NM	0.04
		0.06	0.03	0.04	0.07	0.04	0.03			
Ti 47	PPB	0.543	0.53	0.73	0.72	0.93	0.72	1.08	0.63	0.02
		0.009	0.03	0.01	0.04	0.03	0.06	74	27	
V 51	PPB	1.51	1.57	0.069	10.15	4.79	9.83	2.67	0.99	0.003
		0.03	0.02	0.006	0.09	0.06	0.02	0.03	0.03	
Cr 52	PPB	3.2	3.38	2.4	5.6	1.4	7.7	0.8	0.26	0.02
		0.2	0.06	0.2	0.2	0.2	0.1	0.01	0.01	
Mn 55	PPB	0.82	0.165	47.3	0.36	0.187	0.216	0.341	11.8	0.01
		0.02	0.004	0.5	0.007	0.008	0.008	0.003	0.3	
Ni 60	PPB	0.56	0.98	1.38	ND	0.11	0.11	0.105	0.6	0.03
		0.05	0.02	0.07		0.02	0.03	0.005	0.02	
Cu 63	PPB	1.85	1.97	1.50	1.31	1.47	1.97	0.9	2.92	0.012
		0.08	0.05	0.07	0.07	0.04	0.06	0.03	0.03	

A=ANOMALAOUS VALUE ND= NOT DETECTED NM=NOT MEASURED

WELLS PAGE 2

		SAGA	ARMY	GEXA #3	AIRPORT	CIND-R-LITE	LATHROP	C-RANCH	WINDMILL	DL
		Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	
		S.D	S.D	S.D	S.D.	S.D	S.D	S.D	S.D	
Zn 66	PPB	4.2	2.01	629	10.6	69	62.4	7.07	41.25	0.03
		0.2	0.09	2	0.6	1	0.6	0.08	0.61	
Ge 73	PPB	0.548	0.3	0.23	0.92	0.82	1.08	1.55	0.775	0.007
		0.009	0.03	0.01	0.02	0.06	0.03	50	13	
As 75	PPB	8.72	9.6	3.01	23.2	19.7	22.2	6.36	7.82	0.007
		0.08	0.2	0.09	0.2	0.4	0.3	0.19	0.09	
Se 77	PPB	1.56	1.31	0.61	2.7	1.05	2.5	0.57	0.4	0.03
		0.07	0.07	0.06	0.1	0.08	0.2	0.07	0.1	
Rb 85	PPB	26.7	8.8	5	5.73	12.7	11	18.1	4.7	0.003
		0.4	0.1	0.2	0.08	0.6	0.2	0.7	0.1	
Sr 86	PPB	610	740	4210	24.1	105	101	163	183	0.01
		10	20	20	0.5	5	2	4	8	
Mo 95	PPB	5.32	5.6	3.6	1.99	5.5	6.6	12.22	11.23	0.007
		0.08	0.3	0.2	0.02	0.1	0.2	0.58	0.22	
Sn 117	PPB	0.039	0.044	0.041	0.027	0.034	0.033	0.023	0.034	0.006
		0.004	0.007	0.007	0.002	0.005	0.006	0.007	0.013	
Sb 121	PPB	0.278	0.191	0.022	0.295	0.41	0.5	0.192	0.227	0.002
		0.004	0.008	0.002	0.006	0.02	0.02	0.005	0.015	
Cs 133	PPB	3.3	1.79	1.6	1.35	1.52	1.41	0.0616	3.99	0.0005
		0.1	0.03	0.1	0.05	0.04	0.01	0.0009	0.08	
Ba 135	PPB	50	80	39.7	1.74	1.34	8.8	9.8	1.82	0.024
		1	2	0.8	0.04	0.04	0.2	0.1	0.04	
W 182	PPB	0.118	0.17	0.005	1.81	1.9	1.32	0.755	1.464	0.001
		0.004	0.01	0.002	0.02	0.1	0.05	0.02	0.07	
Tl 205	PPB	0.385	0.096	0.051	0.031	0.03	0.049	0.074	0.046	0.008
		0.009	0.004	0.001	0.003	0.001	0.002	0.004	0.005	
U 238	PPB	6.1	2.34	0.023	0.6	2.54	2.34	15.4	5.08	0.005
		0.2	0.06	0.003	0.02	0.07	0.08	0.2	0.16	
Be 9	PPT	140	210	190	150	200	120	ND	ND	20
		40	30	60	30	60	40			
Co 59	PPT	19	28	75	23	27	12	30	130	1
		5	1	4	3	2	3	2	2	
Ga 71	PPT	ND	10	13	39	48	4	2.7	18	0.8
			4	3	2	2	2	0.9	1	
Zr 90	PPT	17	17	ND	62	14	ND	28	17	0.6
		2	3		4	4		2	2	
Nb 93	PPT	9	19	10	13	20	ND	1.6	2.4	4
		3	3	3	2	4		0.2	0.5	

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WELLS PAGE 3

		SAGA	ARMY	GEXA #3	AIRPORT	CIND-R-LITE	LATHROP	C-RANCH	WINDMILL	DL
		Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	
		S.D	S.D	S.D	S.D.	S.D	S.D	S.D	S.D	
Ru 99	PPT	ND	8	ND	ND	ND	ND	3.3	2.2	1.5
			2					0.5	0.5	
Rh 103	PPT	ND	ND	ND	ND	ND	ND	1.8	2.7	2
								0.2	0.6	
Ag 107	PPT	ND	ND	ND	ND	ND	ND	ND	9	3
									3	
Cd 114	PPT	30	ND	23	ND	12	10	16.6	47	5
		8		4		4	2	0.6	6	
In 115	PPT	ND	6	7	14	20	ND	0.2	ND	0.4
			1	2	3	2		0.1		
Te 125	PPT	15	50	ND	19	ND	13	ND	ND	9
		2	10		4		6			
Hf 177	PPT	ND	ND	ND	6	ND	18	ND	ND	3
					3		3			
Ta 181	PPT	ND	28	ND	12	25	25	5	6	0.03
			3		3	3	4	1	1	
Re 187	PPT	25	24	ND	25	16	31	7	7.2	0.12
		2	4		2	4	2	0.3	0.6	
Ir 193	PPT	ND	29	ND	12	8	14	1	1.2	0.6
			2		2	2	2	0.1	0.2	
Pt 195	PPT	ND	25	ND	11	ND	ND	1.7	1.1	0.3
			2		2			0.3	0.1	
Au 197	PPT	ND	ND	ND	ND	ND	ND	11	5	3
								2	2	
Pb 208	PPT	100	897	20	69	697	165	13	418	8
		10	9	5	4	9	9	1	3	
Bi 209	PPT	ND	ND	26	ND	ND	ND	6.7	0.8	2
				5				0.3	0.3	

A=ANOMALAOUS VALUE ND= NOT DETECTED NM=NOT MEASURED

WELLS PAGE 4

		SAGA	ARMY	GEXA #3	AIRPORT	CIND-R-LITE	LATHROP	C-RANCH	WINDMILL	DL
		Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	
		S.D	S.D	S.D	S.D.	S.D	S.D	S.D	S.D	
Y 89	PPT	21.7	3.2	10	1.52	6.4	4.7	5.5	2.3	1
		0.7	0.2	1	0.07	0.2	0.1	0.5	0.4	
La 139	PPT	5.9	1.2	0.6	1.7	0.78	2.2	1.57	0.8	1
		0.3	0.1	0.1	0.2	0.06	0.1	0.25	0.3	
Ce 140	PPT	14	ND	ND	0.7	ND	ND	10	0.8	0.8
		2			0.3			1	0.2	
Pr 141	PPT	1.73	0.309	0.189	0.2	0.63	0.35	0.35	0.14	0.6
		0.03	0.009	0.003	0.03	0.01	0.02	0.06	0.02	
Nd 146	PPT	6	1.31	0.69	0.758	1.77	1.26	1.65	0.68	5
		0.05	0.09	0.03	0.007	0.09	0.07	0.24	0.11	
Sm 147	PPT	1.94	4.7	0.43	0.17	0.141	0.28	0.32	ND	1
		0.04	0.2	0.03	0.03	0.004	0.01	0.09		
Eu 153	PPT	0.2	0.07	0.05	0.057	0.082	0.1	0.03	NM	0.6
		0.03	0.02	0.003	0.003	0.009	0.03	0.02		
Gd 158	PPT	1.4	0.28	0.121	0.16	0.24	0.3	0.46	0.14	3
		0.03	0.03	0.009	0.03	0.01	0.01	0.09	0.05	
Tb 159	PPT	0.22	0.051	0.026	0.02	0.039	0.046	0.06	0.02	0.7
		0.004	0.007	0.006	0.01	0.006	0.006	0.02	0.01	
Dy 163	PPT	1.54	0.24	0.09	0.13	0.29	0.32	0.3	ND	4
		0.06	0.03	0.02	0.02	0.01	0.03	0.1		
Ho 165	PPT	0.4	0.065	0.033	0.032	0.084	0.1	0.1	ND	0.8
		0.02	0.006	0.006	0.003	0.004	0.01	0.02		
Er 166	PPT	1.39	0.2	0.11	0.1	0.29	0.33	0.37	0.17	2
		0.06	0.02	0.03	0.02	0.009	0.03	0.04	0.04	
Tm 169	PPT	0.21	0.031	0.015	ND	0.035	0.042	0.06	ND	0.5
		0.02	0.002	0.005		0.002	0.005	0.01		
Yb 174	PPT	1.36	0.14	0.12	0.07	0.22	0.265	0.4	0.15	2
		0.03	0.02	0.02	0.02	0.02	0.008	0.1	0.05	
Lu 175	PPT	0.22	0.029	0.022	0.015	0.031	0.04	0.06	0.018	0.8
		0.01	0.002	0.008	0.005	0.004	0.01	0.02	0.008	
Th 232	PPT	0.7	0.4	0.5	0.7	0.5	1.0	0.21	0.14	0.8
		0.1	0.1	0.2	0.2	0.1	0.2	0.04	0.03	

A=ANOMALAOUS VALUE ND= NOT DETECTED NM=NOT MEASURED

J-12 and J-13 WELLS

		J-12 Sample#1	J-13 Sample #2	J-13 Sample #3	Detection
		March 1994	March 1993	March 1994	Limit
		Mean	Mean	Mean	
		SD	SD	SD	
ANIONS					
Bromide	PPM	0.08	0.85	0.135	0.05
		0.007	0.02	0.005	
Chloride	PPM	6.9	7.48	6.52	0.08
		0.18	0.14	0.03	
Fluoride	PPM	1.67	2.12	2.045	0.03
		0.03	0.10	0.003	
Nitrate	PPM	8.47	8.84	8.89	0.004
		0.01	0.09	0.03	
Sulfate	PPM	22.32	18.07	18.09	0.03
		0.002	0.07	0.03	
MAJOR ELEMENTS					
Ca	PPM	14.8	12.3	12.81	0.06
		0.2	0.1	0.03	
Mg	PPM	2.09	1.6	1.69	0.3
		0.03	0.1	0.03	
K	PPM	4.78	4.58	4.60	0.05
		0.03	0.06	0.06	
Na	PPM	41.8	44.9	44.4	1.5
		0.4	0.5	0.5	
TRACE ELEMENTS					
Li 7	ppb	39.2	41.6	39.2	0.009
		0.9	0.6	0.6	
Al 27	ppb	0.43	NM	0.75	0.02
		0.01		0.03	
Ti 47	ppb	0.86	1.35	0.74	0.009
		0.02	0.06	0.04	
V 51	ppb	5.39	11.4	9.4	.003
		0.05	0.4	0.2	
Cr 52	ppb	1.00	2.25	1.41	0.02
		0.01	0.03	0.05	
Mn 55	ppb	0.104	3.5	2.96	0.005
		0.001	0.1	0.05	
Ni 60	ppb	0.32	0.36	0.46	0.01
		0.01	0.02	0.02	
Cu 63	ppb	1.130	NM	1.52	0.07
		0.002		0.04	

J-12 and J-13 WELLS PAGE 2

		J-12 Sample#1	J-13 Sample #2	J-13 Sample #3	Detectio
		Mean	Mean	Mean	Limit
		SD	SD	SD	
Zn 66	ppb	0.668	NM	0.61	0.01
		0.008		0.01	
Ge 73	ppb	0.36	0.40	0.350	0.0009
		0.02	0.01	0.003	
As 75	ppb	10.2	17.3	12.2	0.009
		0.3	0.7	0.1	
Se 77	ppb	0.69	1.6	0.7	0.10
		0.07	0.2	0.1	
Rb 85	ppb	13.7	12.7	9.93	0.001
		0.2	0.7	0.08	
Sr 86	ppb	44.5	55	39.2	0.4
		0.6	2	0.7	
Mo 95	ppb	7.4	8.2	7.87	0.025
		0.1	0.4	0.03	
Sn 117	ppb	ND	0.23	0.012	0.004
			0.02	0.004	
Sb 121	ppb	0.219	0.516	0.509	0.005
		0.004	0.008	0.002	
Cs 133	ppb	0.82	1.94	1.61	0.0005
		0.02	0.09	0.03	
Ba 135	ppb	1.81	1.6	1.19	0.002
		0.03	0.2	0.02	
W 182	ppb	0.493	1.18	1.02	0.018
		0.009	0.07	0.03	
Tl 205	ppb	ND	0.059	0.074	0.002
			0.009	0.002	
U 238	ppb	0.58	0.62	0.51	0.0002
		0.02	0.01	0.01	
Be 9	ppt	ND	136	ND	20
			69		
Co 59	ppt	ND	20	ND	1
			4		
Ga 71	ppt	ND	11	ND	0.8
			3		
Zr 90	ppt	16	43	28	0.6
		3	16	4	
Nb 93	ppt	ND	7	30	4
			1	4	

J-12 and J-13 WELLS PAGE 3					
		J-12 Sample#1	J-13 Sample #2	J-13 Sample #3	Detectio
		Mean	Mean	Mean	Limit
		SD	SD	SD	
					1.5
Ru 99	ppt	ND	4.4	4.3	
			0.8	0.3	2
Rh 103	ppt	15.1	2.3	20.0	
		0.5	0.3	0.4	3
Ag 107	ppt	ND	3	ND	
			1		5
Cd 114	ppt	ND	13	ND	
			5		0.4
In 115	ppt	ND	0.3	4	
			0.6	1	9
Te 125	ppt	ND	87	ND	
			17		3
Hf 177	ppt	ND	35	ND	
			14		0.03
Ta 181	ppt	6	6	17	
		3	1	3	0.12
Re 187	ppt	2.6	2.3	11.4	
		0.2	0.5	0.5	0.6
Ir 193	ppt	ND	0.9	7.3	
			0.2	0.6	0.3
Pt 195	ppt	ND	5	ND	
			2		3
Au 197	ppt	ND	33	ND	
			4		8
Pb 208	ppt	100	287	289	
		5	14	8	2
Bi 209	ppt	ND	3	47.7	
			2	0.5	

J-12 and J-13 WELLS PAGE 4

		J-12 Sample#1	J-13 Sample #2	J-13 Sample #3	Detectio
		Mean	Mean	Mean	Limit
		SD	SD	SD	
Y 89	ppt	1.98	1.2	0.82	1
		0.07	0.4	0.04	
La 139	ppt	2.9	2.3	2.2	1
		0.1	0.2	0.2	
Ce 140	ppt	2.4	2.7	1.44	0.8
		0.6	0.5	0.08	
Pr 141	ppt	0.149	0.3	0.135	0.6
		0.006	0.1	0.008	
Nd 143	ppt	0.61	2.5	0.5	5
		0.06	0.4	0.2	
Sm 147	ppt	6.77	16	7.34	1
		0.04	1	0.05	
Eu 153	ppt	ND	0.3	ND	0.6
			0.3		
Gd 158	ppt	0.20	0.4	0.23	3
		0.04	0.2	0.01	
Tb 159	ppt	ND	0.07	ND	0.7
			0.07		
Dy 163	ppt	0.23	0.7	0.171	4
		0.03	0.3	0.005	
Ho 165	ppt	0.047	0.13	0.03	0.8
		0.007	0.10	0.01	
Er 166	ppt	0.108	0.3	0.068	2
		0.009	0.1	0.007	
Tm 169	ppt	ND	0.10	ND	0.5
			0.06		
Yb 173	ppt	ND	0.6	0.05	2
			0.5	0.02	
Lu 175	ppt	ND	0.07	ND	0.8
			0.03		
Th 232	ppt	0.37	0.7	ND	0.8
		0.09	0.4		

Ash Meadows Six Week Study - Fairbanks Spring

		Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6			
		3/29/93	4/2/93	4/10/93	4/16/93	4/23/93	4/30/93	Average	SD of	
		Mean	Mean	Mean	Mean	Mean	Mean	mean	means	Detection
		S.D.	S.D.	S.D.	S.D.	S.D.	S.D.			Limit
ANIONS										
Bromide	PPM	0.14	0.18	0.26	0.15	0.13	0.21	0.18	0.05	0.03
		0.01	0.01	0.01	0.01	0.01	0.01			
Chloride	PPM	20.8	20.8	21.7	21.3	20.9	21.0	21.08	0.32	0.08
		0.2	0.2	0.2	0.1	0.3	0.1			
Fluoride	PPM	1.49	1.51	1.48	1.59	1.46	1.54	1.51	0.04	0.03
		0.01	0.02	0.02	0.01	0.01	0.02			
Nitrate	PPM	0.79(H)	0.83(H)	0.43 (H)	0.26(H)	0.28(H)	0.51(H)	0.52	0.22	0.02
		0.09	0.01	0.01	0.01	0.01	0.01			
Sulfate	PPM	79.0	78.4	79.1	78.3	78.2	81.2	79.03	1.03	0.03
		0.1	0.5	0.1	0.1	0.1	0.2			
MAJOR METALS										
Ca	PPM	48.20	47.70	50.0	49.6	49.7	49	49.03	0.83	0.06
		0.02	0.02	0.7	0.02	0.7	1			
Mg	PPM	21	20.5	21.0	20.9	21.1	21.0	20.92	0.20	0.3
		1	0.6	0.4	0.4	0.4	0.2			
K	PPM	7.77	7.75	7.83	7.81	7.75	7.72	7.77	0.04	0.05
		0.09	0.09	0.09	0.07	0.09	0.03			
Na	PPM	70.1	69	69	70.6	69	72	69.95	1.11	1.5
		0.5	2	2	0.9	3	2			
TRACE METALS - NOT BLANK SUBTRACTED										
Li 7	**PPB**	121	109	119	123	121	116	118.17	4.63	0.009
		5	9	5	12	12	9			
Al 27	PPB	NM	NM	NM	NM	NM	NM			0.02
Ti 47	PPB	2.2	2.1	2.0	1.22	1.19	0.80	1.59	0.54	0.009
		0.1	0.2	0.2	0.09	0.07	0.07			
V 51	PPB	0.92	0.85	0.78	1.06	1.13	1.11	0.98	0.13	0.003
		0.02	0.01	0.01	0.04	0.04	0.02			
Cr 52	PPB	4.35	1.1	3.18	1.10	1.39	3.94	2.51	1.36	0.02
		0.04	0.1	0.09	0.04	0.06	0.07			
Mn 55	PPB	0.50	0.31	0.23	0.30	0.26	0.28	0.31	0.09	0.005
		0.01	0.01	0.01	0.01	0.01	0.01			
Ni 60	PPB	0.99	0.69	0.44	0.14	0.16	0.36	0.46	0.30	0.01
		0.06	0.05	0.02	0.02	0.02	0.03			
Cu 63	PPB	NM	NM	NM	NM	NM	NM			0.07

Ash Meadows Six Week Study - Fairbanks (pg.2)

		Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Average	SD of	
		Mean	Mean	Mean	Mean	Mean	Mean	mean	means	Detection
		S.D.	S.D.	S.D.	S.D.	S.D.	S.D.			Limit
Zn 66	PPB	NM	NM	NM	NM	NM	NM			0.01
Ge 73	PPB	1.0	0.9	0.91	0.54	0.55	0.42	0.72	0.22	0.0009
		0.1	0.2	0.08	0.05	0.05	0.03			
As 75	PPB	18	15	17	16	16	14	16.00	1.29	0.009
		2	1	2	2	2	2			
Se 77	PPB	1.0	1.15	0.9	1.4	2.1	1.2	1.29	0.39	0.10
		0.1	0.04	0.1	0.2	0.1	0.1			
Rb 85	PPB	18.3	18.2	18.9	19.8	19.3	17.9	18.73	0.66	0.001
		0.9	0.8	1.0	0.9	1.8	1.2			
Sr 86	PPB	1110	1060	1120	1130	1120	1160	1116.67	29.81	0.40
		20	30	30	30	10	40			
Mo 95	PPB	8	12	9	11	(ND)	12	10.40	1.80	0.025
		2	2	3	2		2			
Sn 117	PPB	0.42	0.35	0.25	0.17	0.28	0.186	0.28	0.09	0.004
		0.03	0.02	0.04	0.02	0.02	0.005			
Sb 121	PPB	0.23	0.56	0.25	0.30	0.24	0.24	0.30	0.12	0.005
		0.02	0.03	0.02	0.02	0.02	0.01			
Cs 133	PPB	3.8	3.5	3.40	3.7	3.51	4.4	3.72	0.33	0.0005
		0.1	0.1	0.05	0.1	0.03	0.2			
Ba 135	PPB	72	73	72	75	76	67	72.50	2.87	0.002
		5	3	6	7	7	5			
W 182	PPB	0.89	0.74	0.83	0.38	0.19	0.29	0.55	0.28	0.018
		0.04	0.04	0.05	0.02	0.02	0.02			
Tl 205	PPB	0.32	0.30	0.28	0.31	0.29	0.36	0.31	0.03	0.002
		0.02	0.01	0.01	0.02	0.01	0.02			
U 238	PPB	2.80	2.46	2.32	2.69	2.48	3.08	2.64	0.25	0.0002
		0.09	0.07	0.06	0.04	0.07	0.13			
Be 9	**PPT**	90	90	70	150	140	160	116.67	34.48	20
		20	10	20	30	50	60			
Sc 45	PPT	NM	NM	NM	NM	NM	NM			0.1
Co 59	PPT	81	97	48	24	26	37	52.17	27.59	1
		3	3	2	3	6	6			
Ga 71	PPT	13	7	6	(ND)	5	7	7.60	3.10	0.8
		1	2	1		3	4			
Zr 90	PPT	170(A)	17	392 (A)	83	59	23	45.50	31.10	0.6
		5	5	17	3	10	2			
Nb 93	PPT	2	(ND)	4	153 (A)	2	3	2.75	0.96	4
		1		1	5	1	1			

Ash Meadows Six Week Study - Fairbanks (pg.3)

		Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Average	SD of	
		Mean	Mean	Mean	Mean	Mean	Mean	mean	means	Detection
		S.D.	S.D.	S.D.	S.D.	S.D.	S.D.			Limit
Ru 99	PPT	9	10	8	9	11	5	8.67	1.89	1.5
		3	5	3	4	4	1			
Rh 103	PPT	27	29	27	11	12	7	18.83	8.99	2
		5	4	2	1	3	1			
Ag 107	PPT	5	4	11	8	ND	7	7.00	2.70	3
		1	1	2	2		3			
Cd 114	PPT	16	16	14	11	ND	11	13.60	2.50	5
		3	3	2	4		5			
In 115	PPT	0.5	(ND)	0.6	ND	ND	1	0.70	0.26	0.4
		0.1		0.2			1			
Te 125	PPT	98	135	113	137	146	87	119.33	21.64	9
		3	3	3	39	32	10			
Hf 177	PPT	18	9	40	10	10	10	16.17	11.08	3
		7	3	7	3	3	1			
Ta 181	PPT	4.1	3.2	5.0	51 (A)	2	4	3.66	1.13	0.03
		0.6	0.8	0.9	4	1	1			
Re 187	PPT	17	15	14	12	11	6	12.50	3.50	0.12
		2	3	2	2	2	1			
Ir 193	PPT	(ND)	(ND)	(ND)	2	(ND)	0.6			0.6
					1		0.2			
Pt 195	PPT	(ND)	14	8	9	9	6	9.20	2.95	0.3
			3	1	3	3	3			
Au 197	PPT	6	5	13	16	10	25	12.50	6.75	3
		2	2	5	4	5	2			
Pb 208	PPT	106 (A)	15	39	40	450 (A)	21	28.75	12.66	8
		5	2	2	5	10	4			
Bi 209	PPT	3	2	5	4	2	5	3.50	1.26	2
		1	1	1	1	1	3			

Ash Meadows Six Week Study - Fairbanks (pg.4)

		Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Average	SD of	
		Mean	Mean	Mean	Mean	Mean	Mean	mean	means	Detection
		S.D.	S.D.	S.D.	S.D.	S.D.	S.D.			Limit
Y 89	PPT	8	10	9	8	8	6	8.17	1.21	1
		2	3	2	2	2	1			
La 139	PPT	21.1(A)	6	113(A)	3	2.4	3	3.60	1.60	1
		1	1	5	1	0.5	1			
Ce 140	PPT	2.1	11	12	1.3	0.8	0.8	4.67	4.86	0.8
		0.3	2	1	0.5	0.3	0.3			
Pr 141	PPT	0.9	(ND)	0.9	0.9	1.1	0.5	0.86	0.22	0.6
		0.3		0.4	0.3	0.4	0.2			
Nd 143	PPT	(ND)	6	(ND)	(ND)	(ND)	(ND)			5
			3							
Sm 147	PPT	2	(ND)	5	4	6	4	4.20	1.50	1
		1		2	2	2	1			
Eu 153	PPT	I	I	I	I	I	I			0.6
Gd 158	PPT	2	2	(ND)	2	2	(ND)	2.00	0.00	3
		1	1		1	1				
Tb 159	PPT	(ND)	(ND)	(ND)	(ND)	(ND)	(ND)			0.7
Dy 163	PPT	(ND)	(ND)	(ND)	(ND)	(ND)	(ND)			4
Ho 165	PPT	0.7	(ND)	(ND)	(ND)	0.6	(ND)			0.8
		0.2				0.3				
Er 166	PPT	2.1	(ND)	1.4	1.4	2	(ND)	1.72	0.38	2
		0.9		0.7	0.7	1				
Tm 169	PPT	0.4	0.4	(ND)	0.6	(ND)	(ND)	0.47	0.12	0.5
		0.2	0.2		0.3					
Yb 173	PPT	4	2	1.5	4	(ND)	(ND)	2.88	1.31	2
		2	1	0.7	2					
Lu 175	PPT	(ND)	(ND)	(ND)	0.6	(ND)	(ND)			0.8
					0.3					
Th 232	PPT	2	1.4	2	1.5	0.7	3	1.77	0.70	0.8
		1	0.5	1	0.6	0.3	1			

Ash Meadows Six Week Study - Bradford Spring

		Sample #1	Sample #2	Sample #3	Sample #4	Sample #5			
		4/2/93	4/10/93	4/16/93	4/23/93	4/30/93	Average	SD of	
		Mean	Mean	Mean	Mean	Mean	mean	means	Detection
		S.D.	S.D.	S.D.	S.D.	S.D.			Limit
ANIONS									
Bromide	PPM	0.25	0.33	0.22	0.21	0.25	0.25	0.04	0.03
		0.02	0.01	0.01	0.01	0.01			
Chloride	PPM	40.5	40.7	40.1	38.4	38.7	39.68	0.95	0.08
		0.3	0.2	0.3	0.1	0.1			
Fluoride	PPM	1.65	1.61	1.76	1.57	1.64	1.65	0.06	0.03
		0.05	0.05	0.03	0.04	0.01			
Nitrate	PPM	1.04 (H)	0.62 (H)	0.50 (H)	0.48 (H)	0.70 (H)	0.67	0.2	0.02
		0.01	0.01	0.01	0.02	0.01			
Sulfate	PPM	165.2	166.9	160.9	159.6	161.3	162.78	2.78	0.03
		0.2	0.1	0.4	0.3	0.2			
MAJOR METALS									
Ca	PPM	62.2	62	62	61.1	61.5	61.76	0.40	0.06
		0.7	1	1	0.7	0.7			
Mg	PPM	30.5	30	30.3	30.1	29.0	29.98	0.52	0.3
		0.7	1	0.6	0.7	0.6			
K	PPM	11.1	11.0	11.03	10.87	10.87	10.97	0.09	0.05
		0.1	0.1	0.05	0.05	0.05			
Na	PPM	119	115	116	113	115	115.60	1.96	1.5
		2	3	6	1	1			
TRACE METALS - NOT BLANK SUBTRACTED									
Li 7	**PPB**	143	158	160	156	145	152.40	7.00	0.009
		6	10	6	8	6			
Al 27	PPB	NM	NM	NM	NM	NM			0.02
Ti 47	PPB	2.77	2.6	1.4	1.5	0.95	1.84	0.71	0.009
		0.06	0.3	0.1	0.1	0.02			
V 51	PPB	2.00	1.92	2.71	2.63	2.9	2.43	0.40	0.003
		0.04	0.02	0.08	0.07	0.1			
Cr 52	PPB	5.1	3.43	2.64	1.79	3.1	3.21	1.09	0.02
		0.1	0.08	0.09	0.07	0.1			
Mn 55	PPB	0.40	0.44	0.58	0.52	0.53	0.49	0.06	0.005
		0.02	0.01	0.02	0.02	0.02			
Ni 60	PPB	0.18	0.60	0.28	0.26	0.56	0.38	0.17	0.01
		0.10	0.02	0.02	0.03	0.05			
Cu 63	PPB	NM	NM	NM	NM	NM			0.07

	Ash Meadows Six Week Study - Bradford (pg.2)								
		Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Average	SD of	
		Mean	Mean	Mean	Mean	Mean	mean	means	Detection
		S.D.	S.D.	S.D.	S.D.	S.D.			Limit
Zn 66	PPB	NM	NM	NM	NM	NM			0.01
Ge 73	PPB	0.99	0.88	0.66	0.62	0.42	0.71	0.20	0.0009
		0.08	0.07	0.04	0.05	0.03			
As 75	PPB	24	27.8	33	29	24	27.56	3.38	0.009
		3	0.8	2	4	2			
Se 77	PPB	1.7	1.33	1.04	2.07	2.20	1.67	0.44	0.10
		0.1	0.07	0.07	0.27	0.06			
Rb 85	PPB	19.7	23	24	23	20.4	22.02	1.66	0.001
		0.9	2	1	1	0.7			
Sr 86	PPB	1520	1760	1800	1770	1580	1686.00	113.42	0.40
		40	50	60	50	50			
Mo 95	PPB	18	14	20	18	17	17.40	1.96	0.025
		2	1	3	2	1			
Sn 117	PPB	0.50	0.36	0.13	0.12	0.20	0.26	0.15	0.004
		0.04	0.03	0.02	0.02	0.01			
Sb 121	PPB	0.84	0.49	0.45	0.60	0.23	0.52	0.20	0.005
		0.05	0.01	0.02	0.03	0.01			
Cs 133	PPB	3.37	3.47	4.3	4.0	4.7	3.97	0.50	0.0005
		0.02	0.04	0.1	0.1	0.2			
Ba 135	PPB	51	60	60	61	55	57.40	3.83	0.002
		2	7	3	4	5			
W 182	PPB	1.23	1.09	0.52	0.51	0.32	0.73	0.36	0.018
		0.04	0.10	0.03	0.03	0.01			
Tl 205	PPB	0.29	0.29	0.38	0.34	0.39	0.34	0.04	0.002
		0.01	0.01	0.03	0.02	0.01			
U 238	PPB	7.2	7.2	9.6	8.4	9.6	8.40	1.07	0.0002
		0.2	0.1	0.2	0.3	0.2			
Be 9	**PPT**	70	90	170	150	180	132.00	44.00	20
		20	30	50	50	70			
Sc 45	PPT	NM	NM	NM	NM	NM			0.1
Co 59	PPT	70	67	42	38	56	54.60	12.86	1
		4	2	8	5	4			
Ga 71	PPT	6	4	7	ND	5	5.50	1.30	0.8
		1	2	3		3			
Zr 90	PPT	67	480 (A)	59	46.5	24	49.12	18.75	0.6
		8	40	10	0.2	1			
Nb 93	PPT	4	4	3	3	7	4.20	1.47	4
		2	2	1	1	1			

Ash Meadows Six Week Study - Bradford (pg.3)

		Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Average	SD of	
		Mean	Mean	Mean	Mean	Mean	mean	means	Detection
		S.D.	S.D.	S.D.	S.D.	S.D.			Limit
Ru 99	PPT	14	10	9	9	6	7.50	4.45	1.5
		4	5	3	4	1			
Rh 103	PPT	54	48	18	16	14	30.00	17.30	2
		3	8	2	2	1			
Ag 107	PPT	12	9	17	8	6	10.40	3.83	3
		2	2	2	3	2			
Cd 114	PPT	27	28	20	17	29	24.20	4.79	5
		6	6	8	6	5			
In 115	PPT	(ND)	ND	ND	1.7	(ND)			0.4
					0.6				
Te 125	PPT	(ND)	135	190	181	102	152.00	41.00	9
			3	60	3	12			
Hf 177	PPT	(ND)	32	30	8	14	21.00	12.00	3
			4	10	2	2			
Ta 181	PPT	3	5	3	2.0	17	6.00	5.59	0.03
		1	2	1	0.2	1			
Re 187	PPT	33	35	22	21	13	24.80	8.16	0.12
		2	4	3	4	1			
Ir 193	PPT	(ND)	2	2	2	0.6	1.65	0.70	0.6
			1	1	1	0.3			
Pt 195	PPT	10	8	8	8	6	8.00	1.26	0.3
		2	1	2	2	1			
Au 197	PPT	7	9	40 (A)	17	68 (A)	11.00	5.00	3
		3	3	10	1	5			
Pb 208	PPT	45	43	31	24	15	31.60	11.34	8
		4	2	5	3	4			
Bi 209	PPT	3	5	21	8	7	8.80	6.34	2
		1	1	3	1	1			

Ash Meadows Six Week Study - Bradford (pg.4)

Direct Measurements		Sample #1 Mean S.D.	Sample #2 Mean S.D.	Sample #3 Mean S.D.	Sample #4 Mean S.D.	Sample #5 Mean S.D.	Average mean	SD of means	Detection Limit
Y 89	PPT	10	11	10	10	9	10.00	0.63	1
		1	1	2	2	1			
La 139	PPT	5	3	4	3	3.3	3.66	0.76	1
		2	1	1	1	0.3			
Ce 140	PPT	4	1.4	2	(ND)	4	2.85	1.35	0.8
		1	0.4	1		1			
Pr 141	PPT	(ND)	(ND)	0.8	0.9	0.6	0.77	0.15	0.6
				0.2	0.4	0.2			
Nd 143	PPT	6	4	6	5	4	5.00	0.89	5
		2	1	3	2	2			
Sm 147	PPT	(ND)	(ND)	6	8	(ND)			1
				3	2				
Eu 153	PPT	5	4	4	5	4.8	4.56	0.46	0.6
		1	1	1	1	0.3			
Gd 158	PPT	(ND)	2	2	2	(ND)	2.00	0.00	3
			1	1	1				
Tb 159	PPT	0.5	0.5	0.4	0.4	(ND)	0.45	0.06	0.7
		0.2	0.2	0.2	0.2				
Dy 163	PPT	(ND)	(ND)	2	(ND)	(ND)			4
				1					
Ho 165	PPT	(ND)	(ND)	(ND)	(ND)	(ND)			0.8
Er 166	PPT	2	(ND)	2	(ND)	(ND)			2
		1		1					
Tm 169	PPT	(ND)	(ND)	(ND)	0.4	(ND)			0.5
					0.2				
Yb 173	PPT	(ND)	(ND)	(ND)	(ND)	(ND)			2
Lu 175	PPT	(ND)	(ND)	(ND)	(ND)	(ND)			0.8
Th 232	PPT	1.8	1.3	4.0	1.0	0.8	1.78	1.16	0.8
		0.5	0.3	2	0.4	0.3			

NEVADA TEST SITE SPRINGS

		Tippipah Dec 1994 Mean S.D.	Cane Dec 1994 Mean S.D.	Topopah Dec 1994 Mean S.D.	Detection Limit
ANIONS					
Bromide	PPM	0.07	0.15	ND	0.01
		0.002	0.01		
Chloride	PPM	7.48	20	3.23	0.002
		0.08	0.82	0.03	
Fluoride	PPM	0.15	0.52	0.09	0.006
		0.01	0.01	0.003	
Nitrate	PPM	5.9	15.4	2.48	0.01
		0.08	0.16	0.01	
Sulfate	PPM	15.5	27.1	8.8	0.02
		0.04	0.69	0.02	
MAJOR METALS					
Ca	PPM	5.5	36.1	8.9	0.62
		0.2	0.3	0.1	
Mg	PPM	0.35	9.45	1.8	0.15
		0.01	0.05	0.1	
K	PPM	2.66	5.9	5.62	0.037
		0.08	0.1	0.03	
Na	PPM	42.5	42.1	13.9	1.1
		0.2	0.1	0.3	
TRACE METALS					
"Li 7"	PPB	11.77	27.40	4.55	0.021
		0.07	7.00	0.06	
"Al 27"	PPB	348	0.9	101	0.025
		2	0.07	2	
"Ti 47"	PPB	4.1	1.27	1.94	0.018
		0.2	0.04	0.02	
"V 51"	PPB	1.4	9.5	1.34	0.004
		0.01	0.1	0.04	
"Cr 52"	PPB	0.087	0.802	0.086	0.009
		0.004	0.002	0.006	
"Mn 55"	PPB	1.39	1.12	5.2	0.008
		0.04	0.02	0.1	
"Ni 60"	PPB	0.087	0.106	0.2	0.012
		0.004	0.002	0.01	
"Cu 63"	PPB	0.65	320	0.54	0.013
		0.01	0.004	0.01	

A = ANOMALOUS VALUE ND = NOT DETECTED

	NEVADA TEST SITE SPRINGS PAGE 2						
		Tippipah		Cane		Topopah	
		Mean		Mean		Mean	Detection
		S.D.		S.D.		S.D.	Limit
"Zn 66"	PPB	1.15		9.9		7.32	0.021
		0.03		0.3		0.08	
"Ge 73"	PPB	0.041		0.2		0.034	0.022
		0.006		0.02		0.005	
"As 75"	PPB	2.04		7.2		1.64	0.01
		0.03		0.2		0.04	
"Se 77"	PPB	0.56		2.2		0.17	0.13
		0.05		0.1		0.06	
"Rb 85"	PPB	7.07		9.7		10	0.0022
		0.02		0.2		0.2	
"Sr 86"	PPB	6.24		108		6.9	0.018
		0.09		2		0.3	
"Mo 95"	PPB	0.7		4.23		0.387	0.009
		0.02		0.03		0.004	
"Sn 117"	PPB	ND		ND		ND	0.013
"Sb 121"	PPB	1.94		0.07		0.269	0.0015
		0.06		0.001		0.0069	
"Cs 133"	PPB	0.13		0.079		0.7	0.004
		0.002		0.0009		0.01	
"Ba 135"	PPB	0.34		18.6		0.258	0.02
		0.02		0.1		0.007	
"W 182"	PPB	0.0119		0.28		0.024	0.0042
		0.0007		0.01		0.0014	
"Tl 205"	PPB	0.0429		0.0597		0.053	0.004
		0.0006		0.0007		0.005	
"U 238"	PPB	0.524		1.726		0.076	0.004
		0.015		0.042		0.001	
"Be 9"	PPT	67.75		ND		65.47	25
		14.6				12.46	
"Co 59"	PPT	28		42		45	8
		2		2		3	
"Ga 71"	PPT	76		ND		93	9
		2				4	
"Zr 90"	PPT	290		ND		261	8
		20				7	
"Nb 93"	PPT	41		13		28	1.5
		3		6		3	

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NEVADA TEST SITE SPRINGS PAGE 3

		Tippipah		Cane	Topopah		
		Mean		Mean	Mean		Detection
		S.D.		S.D.	S.D.		Limit
"Ru 99"	PPT	ND		2.4	ND		1.8
				0.8			
"Rh 103"	PPT	ND		ND	ND		4
"Ag 107"	PPT	ND		ND	ND		21
"Cd 114"	PPT	ND		ND	23		8
					3		
"In 115"	PPT	ND		ND	ND		3
"Te 125"	PPT	ND		ND	ND		14
"Hf 177"	PPT	ND		ND	ND		18
"Ta 181"	PPT	17		ND	20		2.1
		1			2		
"Re 187"	PPT	11		21	17		2.2
		1		2	1		
"Ir 193"	PPT	ND		3.2	ND		2.8
				0.7			
"Pt 195"	PPT	ND		ND	ND		6
"Au 197"	PPT	ND		30	ND		24
				10			
"Pb 208"	PPT	101		15	183		8
		1		2	2		
"Bi 209"	PPT	ND		ND	ND		6

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NEVADA TEST SITE SPRINGS PAGE 4

		Tippipah		Cane		Topopah		
		Mean		Mean		Mean		Detection
		S.D.		S.D.		S.D.		Limit
"Y 89"	PPT	146		97		205		1.2
		7		2		8		
"La 139"	PPT	320		19.6		136		1.4
		20		0.9		4		
"Ce 140"	PPT	720		22.1		450		1.9
		40		0.2		20		
"Pr 141"	PPT	68		5.5		32.6		1
		5		0.4		0.1		
"Nd 143"	PPT	240		22		125		2.4
		20		2.1		5		
"Sm 147"	PPT	69		5.4		25		1.9
		5		0.8		3		
"Eu 151"	PPT	3.5		3		2.4		1.7
		0.7		0.4		0.3		
"Gd 158"	PPT	42		8.4		31		1.4
		1		1.3		2		
"Tb 159"	PPT	6.3		2.3		5.1		1.4
		0.6		0.1		0.1		
"Dy 163"	PPT	29		11		30		2.4
		2		2		2		
"Ho 165"	PPT	5.5		2.8		6.6		0.9
		0.8		0.3		0.3		
"Er 166"	PPT	15.1		7.7		19		1.5
		0.6		0.2		2		
"Tm 169"	PPT	1.9		1.1		3.2		1.1
		0.2		0.2		0.1		
"Yb 173"	PPT	15		8.8		21		1
		2		0.6		2		
"Lu 175"	PPT	1.9		ND		3.6		1.4
		0.1				0.3		
"Th 232"	PPT	63		1.2		14.3		15.4
		2		0.2		0.8		1.1

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