CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
3550 N. Central Ave, 2nd floor
Phoenix, AZ, 85012
602-771-1601
http://www.azgs.az.gov
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THE UNIVERSITY OF ARIZONA

ARIZONA BUREAU OF MINES
GEOLOGICAL SURVEY BRANCH
845 NORTH PARK AVENUE
TUCSON, ARIZONA 85719

TEL. (602) 884-2733

February 2, 1977

Chris Hill
Minerals Exploration
PO Box 2246
Wickenburg, Arizona 85358

Dear Mr. Hill:

Not long ago I visited with you and collected a sample of basalt for dating purposes. At that time I told you that I would keep you posted on our dating efforts. The sample has been accepted by the dating people and they say that it will take about a month to turn out a number. Sometime they are overly optimistic, but rest assured that as soon as I get any data I will forward it to you.

I thank you for the visit in the hills and hope that all goes well with you and your efforts.

Sincerely,

H. Wesley Peirce

H. Wesley Peirce
Geologist

HWP:jg

100984

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION

24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617)-876-3691

POTASSIUM–ARGON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. B-3880 — Date Received: 31 May 1977

Your Reference: P.O. 8487 — Date Reported: 6 June 1977

Submitted by: Bendix Field Engineering Corp.
P.O. Box 1569
Grand Junction, Colorado 81501

Sample Description & Locality: Biotite granite, sample #23703.

Material Analyzed: Biotite concentrate, -40/+100 mesh. Estimated Composition: Biotite, 99%; Iron oxides and others, 1%.

Ar^{40*}/K^{40} = .009438 — AGE = 155 ± 6 M.Y.

Argon Analyses:

Ar^{40*}, ppm.	Ar^{40*}/ Total Ar^{40}	Ave. Ar^{40*}, ppm.
.08514	.667	.08524
.08534	.796	

Potassium Analyses:

% K	Ave. %K	K^{40}, ppm
7.430	7.403	9.031
7.376		

Constants Used:

$\lambda_\beta = 4.72 \times 10^{-10}$/ year

$\lambda_e = 0.585 \times 10^{-10}$/ year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$AGE = \frac{1}{\lambda_e + \lambda_\beta} \ln\left[\frac{\lambda_\beta + \lambda_e}{\lambda_e} \times \frac{Ar^{40*}}{K^{40}} + 1\right]$$

Note: Ar^{40*} refers to radiogenic Ar^{40}.
M.Y. refers to millions of years.

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION
24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617)-876-3691

100984

POTASSIUM–ARGON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. B-3881 — Date Received: 31 May 1977

Your Reference: P.O. 8487 — Date Reported: 6 June 1977

Submitted by: Bendix Field Engineering Corp.
P.O. Box 1569
Grand Junction, Colorado 81501

Sample Description & Locality: Biotite granite, sample #23704.

Material Analyzed: Biotite concentrate, -40/+100 mesh. Estimated Composition: Biotite, 99%; Iron oxides and others, 1%.

Ar^{40*}/K^{40} = .009764 — AGE = 160 ± 6 M.Y.

Argon Analyses:

Ar^{40*}, ppm.	Ar^{40*}/ Total Ar^{40}	Ave. Ar^{40*}, ppm.
.08887	.719	.08833
.08778	.753	

Potassium Analyses:

% K	Ave. %K	K^{40}, ppm
7.389	7.415	9.046
7.441		

Constants Used:

$\lambda_\beta = 4.72 \times 10^{-10}$/ year

$\lambda_e = 0.585 \times 10^{-10}$/ year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$AGE = \frac{1}{\lambda_e + \lambda_\beta} \ln\left[\frac{\lambda_\beta + \lambda_e}{\lambda_e} \times \frac{Ar^{40*}}{K^{40}} + 1\right]$$

Note: Ar^{40*} refers to radiogenic Ar^{40}.
M.Y. refers to millions of years.

SPECOMP SERVICES, INC.
WILLIAM A. BOWES and ASSOCIATES
P.O. Box 160 ⊙ Steamboat Springs, Colorado 80477 ⊙ 303-879-0286

SEMIQUANTITATIVE SPECTROGRAPHIC ANALYSIS

INSTRUMENT: WADSWORTH MOUNTED, JARRELL-ASH, 1.5 METER, DC ARC EMISSION SPECTROGRAPH
Fe, Mg, Ca, Ti, Na, K, Si, Al & P reported in %, all other elements reported in PPM

FILM NO 264-17
DATE 5-25-77

Reg No 100984

Plate No.	Office No.	Field No.	Au	Ag	Cu	Pb	Zn	Mo	Fe	W	Ni	Co	Cr	Cd	As	Sb	Mn	V	Bi	Sn	Zr	B	Ba	Be	La	Nb	Sc	Sr	Y	Ca	Mg	Ti	Na	K	Si	Al	P
100984 4	60251	MAF-802 23763	N	N	10	70	N	N	3.	N	20	N	20	N	N	N	500	30	N	N	100	N	1500	20	100	50	10	300	70	2.	1.	.2	4.	)	(	)	(
5	60252	23704 MAF-803	N	N	7	70	N	N	2.	N	15	N	20	N	N	N	500	30	N	N	200	N	1500	20	100	L	10	300	70	3.	1.	.2	4.	)	(	)	(
Lower Detection Limit			10	0.5	5	10	200	5	0.05%	50	5	10	20	20	200	100	10	10	10	10	10	10	10	2	20	10	5	100	10	0.05	0.02%	.001%	0.2%	0.5%	1%	0.5%	.1%

N - Not detected L - Detected, but below limit of determination G - Greater than value shown

REMARKS 31 cl. pulp sat.

JOB NO: 1840 Final Reading

KEYPUNCH CODE

ROCKY MOUNTAIN GEOCHEMICAL CORP.
2561 EAST FORT LOWELL ROAD · TUCSON, ARIZONA 85716 · PHONE: (602) 795-9780
TUCSON OFFICE

Certificate of Analysis

RMGC Numbers:
Local Job No.: 77-44-12T
Foreign Job No.:
Invoice No.: T 6946

Date: May 20, 1977

Client: Minerals Exploration
1846 W. Grant
Tucson, Arizona 85705

Client Order No.:

Report On: 131 samples

Submitted by: B. McNeil

Date Received: May 6, 1977

Analysis: Copper, molybdenum, manganese, cobalt, vanadium, lithium

Analytical Methods: Determined by atomic absorption.

Remarks: Uranium results to follow from SLC.

cc: Enc.
RMGC: SLC
file
PDW/sl

Anderson McNair

All values are reported in parts per million unless specified otherwise. A minus sign (—) is to be read "less than" and a plus sign (+) "greater than." Values in parenthesis are estimates. This analytical report is the confidential property of the above mentioned client and for the protection of this client and ourselves we reserve the right to forbid publication or reproduction of this report or any part thereof without written permission.

ND = None Detected 1 ppm = 0.0001% 1 Troy oz./ton = 34.286 ppm 1 ppm = 0.0292 Troy oz./ton

Client Min. Expl. Date May 20, 1977 RMGC Job No. 77-44-12T

Sample No.	ppm Cu	ppm Mo	ppm Mn	ppm Co	% V205	ppm Li
AN341-100	70	-1	760	80	.011	111
105	35	-1	720	80	.012	133
110	50	-1	770	90	.018	179
115	35	-1	710	85	.014	158
120	20	-1	700	70	.010	218
125	50	-1	920	90	.014	305
130	10	-1	880	80	.012	321
135	25	-1	800	70	.012	326
140	20	-1	810	75	.013	375
145	20	-1	0.10%	60	.011	226
150	10	-1	720	65	.010	448
155	15	1	750	60	.011	400
160	10	1	410	50	.004	177
165	5	2	540	50	.008	230
170	15	-1	430	45	.032	341
175	10	1	390	40	.022	410
180	10	-1	470	40	.018	402
185	20	-1	420	50	.018	239
190	10	-1	870	35	.009	130
195	10	-1	700	50	.010	124
200	40	-1	420	60	.034	251
205	25	-1	720	75	.006	132
210	20	1	450	50	.038	697
215	15	1	685	40	.018	273
220	10	-1	730	40	.018	416

Client Min. Expl. Date May 20, 1977 RMGC Job No. 77-44-12T

Sample No.	ppm Cu	ppm Mo	ppm Mn	ppm Co	% V205	ppm Li
AM341-225	10	1	530	55	.005	301
230	10	-1	560	40	.004	161
235	10	-1	595	40	.008	282
240	5	-1	310	25	.062	180
255	30	-1	670	40	.122	634
260	15	-1	510	45	.060	434
265	10	-1	320	40	.065	348
270	10	-1	330	35	.075	244
275	10	7	200	30	.082	159
280	10	2	870	35	.031	455
290	25	1	400	45	.051	124
305	20	10	600	50	.021	120
310	20	16	885	40	.046	94
315	15	11	760	65	.012	180
320	25	16	570	50	.041	169
325	20	3	320	50	.032	307
330	20	2	340	60	.040	272
335	15	2	310	40	.041	165
340	15	13	300	50	.056	122
345	15	1	380	70	.025	91
350	25	-1	440	80	.018	105
355	25	1	470	75	.017	121
375	25	4	420	75	.028	94
380	35	1	425	75	.038	96
385	55	2	380	80	.040	113

Client Min. Expl. Date May 20, 1977 RMGC Job No. 77-44-12T

Sample No.	ppm Cu	ppm Mo	ppm Mn	ppm Co	% V205	ppm Li
AM341-390	50	4	420	90	.038	114
395	45	1	410	80	.034	121
400	35	1	410	80	.034	119
405	30	-1	455	95	.012	378
410	20	-1	450	90	.014	385
AM514-325	25	-1	580	75	.015	278
330	20	-1	630	80	.014	310
335	30	-1	790	80	.018	401
340	20	-1	650	70	.014	325
345	15	-1	730	55	.010	539
350	20	-1	670	60	.012	520
355	20	-1	660	65	.012	463
360	30	1	705	70	.011	404
365	20	-1	680	70	.012	268
370	20	-1	670	70	.012	246
375	20	-1	640	70	.011	244
380	20	-1	680	65	.013	248
385	20	1	640	60	.010	244
390	15	1	645	60	.010	246
395	20	-1	830	75	.009	287
400	25	-1	765	75	.009	236
405	25	-1	690	80	.011	238
410	20	-1	620	60	.011	181
415	20	-1	630	75	.010	141
420	15	-1	570	70	.014	132

Client Min. Expl. Date May 20, 1977 RMGC Job No. 77-44-12T

Sample No.	ppm Cu	ppm Mo	ppm Mn	ppm Co	% V205	ppm Li
AM514-425	25	-1	680	80	.012	197
430	25	1	655	80	.010	184
435	45	1	590	75	.014	215
440	40	1	0.15%	80	.010	172
445	50	7	0.17%	90	.016	139
450	40	2	0.30%	90	.017	216
455	30	1	0.12%	80	.014	184
460	30	2	890	85	.012	196
465	30	-1	695	65	.013	233
470	25	-1	630	55	.014	235
475	30	1	790	70	.015	301
480	20	-1	840	70	.013	278
485	20	-1	900	70	.012	200
490	20	1	895	75	.013	222
495	20	1	685	75	.011	166
500	25	-1	905	75	.012	159
505	25	-1	750	70	.010	216
510	20	-1	840	75	.010	167
515	20	1	930	70	.008	135
520	20	-1	925	65	.010	102
525	10	-1	600	55	.006	48
530	20	2	800	70	.016	144
535	20	-1	810	75	.011	181
540	20	-1	0.13%	75	.007	141
545	25	-1	830	70	.007	142

Client Min. Expl. Date May 20, 1977 RMGC Job No. 77-44-12T

Sample No.	ppm Cu	ppm Mo	ppm Mn	ppm Co	% V205	ppm Li
AM514-550	20	-1	490	70	.005	95
555	5	1	285	55	-.001	29
560	5	1	410	80	.004	62
565	40	1	740	70	.012	171
570	25	-1	570	65	.008	99
575	25	-1	540	65	.005	99
580	20	-1	860	60	.006	94
585	20	1	710	60	.005	133
590	10	1	390	70	.004	63
595	10	-1	360	60	.004	60
600	10	-1	350	70	-.001	51
605	20	-1	930	75	.007	133
610	25	-1	0.20%	75	.006	158
615	20	1	0.28%	75	.005	218
620	25	2	0.37%	70	.004	209
625	25	-1	0.13%	70	.006	179
630	25	-1	0.12%	70	.009	201
635	35	-1	880	65	.011	146
640	35	3	0.10%	90	.011	169
645	45	9	0.15%	95	.014	187
650	40	9	0.18%	105	.018	177
655	25	1	720	85	.012	163
660	25	-1	620	80	.019	303
665	20	-1	940	70	.017	346
670	20	-1	930	75	.018	352

Client Min. Mpl. Date May 20, 1977 RMGC Job No. 77-44-12T

Sample No.	ppm Cu	ppm Mo	ppm Mn	ppm Co	% V205	ppm Li
AM514-675	20	1	0.11%	75	.012	221
680	20	1	870	75	.009	195
685	10	-1	0.10%	60	.008	133
690	15	1	995	70	.004	176
695	15	2	660	70	.008	167
700	20	2	780	65	.010	171

By Parry D. Willard

Parry D. Willard

ROCKY MOUNTAIN GEOCHEMICAL CORP.
1323 W. 7900 SOUTH • WEST JORDAN, UTAH 84084 • PHONE: (801) 255-3558
WEST JORDAN OFFICE

Certificate of Analysis

RMGC Numbers:
Local Job No.: 77-47-09-SI
Foreign Job No.: 77-43-15T
Invoice No.: M 90683

Date: June 1, 1977

Client: Minerals Exploration
1846 West Grant Road, #102
Tucson, Arizona 85705

Client Order No.: none

Report On: 159 Samples

Submitted by: R. McNeil

Date Received: 5/20/77

Analysis: U_3O_8

Analytical Methods: Determined fluorometrically.

Remarks:

cc: enc.
file (2)
report: RMGC - Tucson
LRR/lw

All values are reported in parts per million unless specified otherwise. A minus sign (—) is to be read "less than" and a plus sign (+) "greater than." Values in parenthesis are estimates. This analytical report is the confidential property of the above mentioned client and for the protection of this client and ourselves we reserve the right to forbid publication or reproduction of this report or any part thereof without written permission.

ND = None Detected 1 ppm = 0.0001% 1 Troy oz./ton = 34.286 ppm 1 ppm = 0.0292 Troy oz./ton

Client Minerals Exploration Date 6/1/77 RMGC Job No. 77-47-09-SL

Sample No.	ppm U_3O_8	Sample No.	ppm U_3O_8
AM 505 5	2	AM 505 130	2
10	2	140	2
15	2	145	-2
20	2	150	2
25	-2	155	2
30	2	160	2
35	-2	165	2
40	2	170	2
45	-2	175	2
50	2	180	2
55	2	185	2
60	-2	190	-2
65	-2	195	-2
70	2	200	-2
75	2	205	-2
80	2	210	-2
85	2	215	2
90	2	220	2
95	2	225	-2
100	2	230	-2
105	2	235	-2
110	2	240	2
115	2	245	2
120	2	250	2
AM 505 125	-2	AM 505 255	2

Client Minerals Exploration Date 6/1/77 RMGC Job No. 77-47-09-SL

Sample No.	ppm U_3O_8	Sample No.	ppm U_3O_8
AM 505 260	2	AM 505 385	4
265	3	390	4
270	2	395	4
275	3	400	4
280	3	405	3
285	3	410	2
290	3	415	3
295	3	420	3
300	3	425	3
305	3	430	2
310	2	435	3
315	2	440	3
320	3	445	3
325	3	450	2
330	3	455	2
335	2	460	-2
340	2	465	-2
345	3	470	2
350	3	475	2
355	2	480	2
360	3	485	2
365	3	490	-2
370	3	495	2
375	3	500	4
AM 505 380	4	AM 505 505	3

Client Minerals Exploration Date 6/1/77 RMGC Job No. 77-47-09-SL

Sample No.	ppm U_3O_8	Sample No.	ppm U_3O_8
AM 505 510	-2	AM 505 635	17
515	2	640	34
520	3	645	30
525	4	650	37
530	4	655	33
535	3	660	28
540	3	665	15
545	-2	670	12
550	-2	675	11
555	-2	680	5
560	4	685	6
565	4	690	7
570	7	695	5
575	7	700	5
580	7	705	5
585	5	710	6
590	5	715	8
595	5	720	5
600	5	725	4
605	4	730	4
610	5	735	4
615	8	740	4
620	9	745	5
625	10	750	4
AM 505 630	8	AM 505 755	3

Client Minerals Exploration Date 6/1/77 RMGC Job No. 77-47-09-SL

Sample No.	ppm U_3O_8
AM 505 760	3
765	4
770	3
775	3
780	3
785	2
790	2
795	2
AM 505 800	2

By Lawrence R. Reid
Lawrence R. Reid

ROCKY MOUNTAIN GEOCHEMICAL CORP.
SALT LAKE CITY, UTAH • RENO, NEVADA • TUCSON, ARIZONA

ROCKY MOUNTAIN GEOCHEMICAL CORP.
2561 EAST FORT LOWELL ROAD · TUCSON, ARIZONA 85716 · PHONE: (602) 795-9780
TUCSON OFFICE

Certificate of Analysis

RMGC Numbers: 77-43-15TP
Local Job No.:
Foreign Job No.:
Invoice No.: T 6932

Date: May 18, 1977

Client: Minerals Exploration
1846 W. Grant Rd.
Tucson, Arizona 85705

Client Order No.:

Report On: 160 of 590 samples

Submitted by: R. McNeil

Date Received: April 21, 1977

Analysis: Copper, molybdenum, cobalt, vanadium, manganese, lithium

Analytical Methods: Determined by atomic absorption.

Remarks: Uranium results to follow from SLC.

cc: Enc.
RMGC: SLC
file
PDW/sl

Anderson Mine

All values are reported in parts per million unless specified otherwise. A minus sign (—) is to be read "less than" and a plus sign (+) "greater than." Values in parenthesis are estimates. This analytical report is the confidential property of the above mentioned client and for the protection of this client and ourselves we reserve the right to forbid publication or reproduction of this report or any part thereof without written permission.

ND = None Detected 1 ppm = 0.0001% 1 Troy oz./ton = 34.286 ppm 1 ppm = 0.0292 Troy oz./ton

Client Min. Expl Date May 18, 1977 RMGC Job No. 77-43-15T

Sample No.	ppm Cu	ppm Mo	ppm Co	% V205	ppm Mn	ppm Li
AM505-5	25	-1	90	.006	450	17
10	20	1	60	.007	500	23
15	20	1	95	.004	470	27
20	20	-1	70	.005	555	25
25	20	-1	70	.006	580	42
30	20	-1	70	.008	550	30
35	15	-1	80	.007	455	28
40	20	-1	65	.008	460	32
45	20	1	70	.005	510	32
50	25	1	65	.002	510	33
55	45	-1	120	.022	0.13%	33
60	20	-1	120	.006	510	39
65	30	-1	75	.009	430	31
70	25	-1	100	.010	525	40
75	25	-1	90	.012	520	41
80	20	-1	105	.012	520	36
85	20	-1	80	.014	520	39
90	20	-1	105	.013	535	41
95	55	-1	110	.013	500	42
100	20	-1	110	.012	500	37
105	20	-1	130	.011	480	35
110	25	-1	90	.012	480	34
115	35	-1	110	.016	595	36
120	30	-1	125	.014	545	35
125	20	-1	135	.012	535	32

Client Minerals Exploration Date May 18, 1977 RMGC Job No. 77-43-15T

Sample No.	ppm Cu	ppm Mo	ppm Co	% V205	ppm Mn	ppm Li
AM505 130	20	-1	120	.014	480	34
135	25	-1	115	.018	540	35
140	45	-1	110	.017	540	36
145	25	1	110	.012	470	34
150	25	-1	105	.012	500	41
155	20	6	100	.012	505	46
160	20	-1	105	.014	430	39
165	20	-1	110	.012	520	42
170	25	-1	90	.012	470	36
175	20	-1	105	.012	440	39
180	20	-1	120	.014	530	53
185	15	-1	120	.010	510	35
190	15	-1	100	.004	295	24
195	15	-1	115	.002	285	25
200	10	-1	110	.002	280	18
205	10	1	75	.004	340	34
210	10	1	60	.004	300	24
215	10	-1	70	.002	270	26
220	5	1	50	.002	215	32
225	5	-1	50	.003	220	31
230	5	1	70	-.001	200	35
235	5	1	70	-.001	240	37
240	10	-1	50	.002	280	87
245	10	-1	50	.002	255	117
250	5	-1	50	-.001	290	108

Client Min. Expl. Date May 18, 1977 RMGC Job No. 77-43-15T

Sample No.	ppm Cu	ppm Mo	ppm Co	% V205	ppm Mn	ppm Li
AM505-255	10	-1	55	.003	280	100
260	10	-1	40	.002	400	144
265	15	-1	55	.002	440	153
270	10	-1	60	.003	405	114
275	15	-1	50	.003	385	123
280	15	-1	60	.002	370	112
285	15	-1	55	.002	370	91
290	15	-1	60	.007	425	144
295	15	-1	90	.002	480	141
300	20	-1	80	.003	505	160
305	20	-1	60	.010	570	175
310	20	-1	85	.011	510	231
315	20	-1	75	.008	580	205
320	15	-1	70	.007	475	179
325	15	-1	90	.007	480	186
330	20	-1	60	.008	500	202
335	20	-1	85	.008	540	197
340	20	-1	80	.011	570	215
345	20	-1	100	.008	560	200
350	35	-1	90	.012	670	304
355	25	-1	85	.014	660	211
360	20	-1	60	.012	625	200
365	35	-1	95	.012	620	252
370	30	-1	100	.007	700	235
375	25	-1	85	.008	630	240

Client Min. Expl. Date May 18, 1977 RMGC Job No. 77-43-15T

Sample No.	ppm Cu	ppm Mo	ppm Co	% V205	ppm Mn	ppm Li
AM505 380	25	-1	110	.014	635	256
385	30	-1	85	.012	610	266
390	30	-1	100	.014	675	255
395	30	1	80	.014	780	230
400	30	-1	90	.012	945	182
405	20	1	70	.007	455	124
410	20	-1	70	.005	400	124
415	15	-1	75	.006	400	92
420	20	1	90	.008	490	130
425	20	1	90	.009	455	120
430	20	1	70	.008	435	117
435	15	1	90	.008	465	96
440	30	1	80	.013	600	198
445	25	1	90	.012	595	165
450	20	-1	125	.011	680	213
455	15	-1	95	.012	595	164
460	15	-1	80	.008	560	175
465	20	-1	90	.010	470	112
470	15	-1	100	.009	395	83
475	20	1	105	.013	505	114
480	30	1	100	.012	640	262
485	15	-1	95	.015	550	174
490	15	-1	100	.012	395	56
495	15	1	105	.014	550	145
500	20	-1	100	.013	860	216

Client Min. Expl. Date May 18, 1977 RMGC Job No. 77-43-15T

Sample No.	ppm Cu	ppm Mo	ppm Co	% V205	ppm Mn	ppm Li
AM505-505	20	-1	70	.011	740	204
510	10	-1	60	.009	390	75
515	10	-1	70	.009	499	72
520	25	-1	50	.010	640	423
525	20	-1	85	.011	630	377
530	20	-1	50	.009	640	339
535	20	-1	70	.010	570	250
540	20	-1	70	.009	590	271
545	10	1	60	.007	355	75
550	40	1	160	.018	0.10%	265
555	25	-1	60	.012	730	248
560	25	-1	70	.012	810	236
565	25	-1	60	.020	635	283
570	25	-1	60	.022	630	249
575	25	-1	55	.017	735	252
580	20	-1	70	.014	640	208
585	25	-1	80	.012	630	192
590	20	-1	70	.012	805	179
595	20	-1	60	.011	790	139
600	20	-1	40	.010	770	159
605	20	-1	70	.009	810	160
610	15	-1	85	.009	800	159
615	15	-1	85	.010	790	181
620	20	-1	80	.009	960	232
625	20	-1	70	.010	0.11%	185

Client Min. Expl. Date May 18, 1977 RMGC Job No. 77-43-15T

Sample No.	ppm Cu	ppm Mo	ppm Co	% V205	ppm Mn	ppm Li
AM505-630	20	-1	90	.010	0.15%	185
635	20	-1	75	.015	620	184
640	25	-1	80	.016	650	184
645	25	-1	70	.018	625	204
650	20	-1	60	.016	770	188
655	20	-1	70	.016	860	171
660	20	-1	55	.014	0.12%	164
665	20	-1	70	.012	0.12%	153
670	20	-1	65	.012	0.11%	158
675	20	-1	55	.011	920	135
680	20	-1	60	.010	930	128
685	40	-1	80	.010	830	136
690	25	-1	50	.011	955	167
695	20	-1	55	.011	750	116
700	25	-1	70	.011	750	121
705	50	-1	80	.013	970	144
710	25	-1	60	.013	880	149
715	25	-1	45	.013	900	133
720	20	-1	60	.012	795	122
725	20	-1	50	.011	680	136
730	20	-1	75	.012	750	129
735	35	-1	60	.010	770	119
740	20	-1	45	.010	700	135
745	25	-1	50	.012	935	167
750	25	-1	40	.011	950	144

Client Minerals Exploration Date May 18, 1977 RMGC Job No. 77-43-15T

Sample No.	ppm Cu	ppm Mo	ppm Co	% V205	ppm Mn	ppm Li
AM505-755	15	-1	50	.010	720	93
760	15	-1	60	.010	730	103
765	20	-1	70	.011	750	121
770	15	-1	65	.010	930	91
775	35	-1	90	.012	0.13%	88
780	30	-1	90	.024	0.14%	90
785	30	-1	70	.018	0.12%	86
790	35	-1	80	.020	0.12%	89
795	55	-1	140	.022	0.14%	80
800	55	1	130	.029	0.15%	73

By Parry D. Willard

Parry D. Willard

100984

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION

24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617)-876-3691

POTASSIUM–ARGON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. B-3880 — Date Received: 31 May 1977

Your Reference: P.O. 8487 — Date Reported: 6 June 1977

Submitted by: Bendix Field Engineering Corp.
P.O. Box 1569
Grand Junction, Colorado 81501

Sample Description & Locality: Biotite granite, sample #23703.

Material Analyzed: Biotite concentrate, -40/+100 mesh. Estimated Composition: Biotite, 99%; Iron oxides and others, 1%.

Ar^{40*}/K^{40} = .009438 — AGE = 155 ± 6 M.Y.

Argon Analyses:

Ar^{40*}, ppm.	Ar^{40*}/ Total Ar^{40}	Ave. Ar^{40*}, ppm.
.08514	.667	.08524
.08534	.796	

Potassium Analyses:

% K	Ave. %K	K^{40}, ppm
7.430	7.403	9.031
7.376		

Constants Used:

$\lambda_\beta = 4.72 \times 10^{-10}$/ year

$\lambda_e = 0.585 \times 10^{-10}$/ year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$AGE = \frac{1}{\lambda_e + \lambda_\beta} \ln\left[\frac{\lambda_\beta + \lambda_e}{\lambda_e} \times \frac{Ar^{40*}}{K^{40}} + 1\right]$$

Note: Ar^{40*} refers to radiogenic Ar^{40}.
M.Y. refers to millions of years.

KRUEGER-ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION
24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617)-876-3691

100984

POTASSIUM-ARGON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. B-3881 — Date Received: 31 May 1977

Your Reference: P.O. 8487 — Date Reported: 6 June 1977

Submitted by: Bendix Field Engineering Corp.
P.O. Box 1569
Grand Junction, Colorado 81501

Sample Description & Locality: Biotite granite, sample #23704.

Material Analyzed: Biotite concentrate, -40/+100 mesh. Estimated Composition: Biotite, 99%; Iron oxides and others, 1%.

Ar^{40*}/K^{40} = .009764 — AGE = 160 ± 6 M.Y.

Argon Analyses:

Ar^{40*}, ppm.	Ar^{40*}/ Total Ar^{40}	Ave. Ar^{40*}, ppm.
.08887	.719	.08833
.08778	.753	

Potassium Analyses:

% K	Ave. %K	K^{40}, ppm
7.389	7.415	9.046
7.441		

Constants Used:

$\lambda_\beta = 4.72 \times 10^{-10}$/ year

$\lambda_e = 0.585 \times 10^{-10}$/ year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$AGE = \frac{1}{\lambda_e + \lambda_\beta} \ln\left[\frac{\lambda_\beta + \lambda_e}{\lambda_e} \times \frac{Ar^{40*}}{K^{40}} + 1\right]$$

Note: Ar^{40*} refers to radiogenic Ar^{40}.
M.Y. refers to millions of years.

WEST JORDAN OFFICE

ROCKY MOUNTAIN GEOCHEMICAL CORP.

1323 W. 7900 SOUTH • WEST JORDAN, UTAH 84084 • PHONE: (801) 255-3558

Certificate of Analysis

RMGC Numbers:
Local Job No.: 77-47-27-SL
Foreign Job No.: 77-44-12T
Invoice No.: M 90731

Date: June 9, 1977

Client: Minerals Exploration
1846 West Grant Road, #102
Tucson, Arizona 85705

Client Order No.: none

Report On: 131 Samples

Submitted by: R. McNeil

Date Received: 5/24/77

Analysis: U_3O_8

Analytical Methods: Determined fluorometrically.

Remarks:

cc: enc.
file (2)
report: RMGC - Tucson
LRR/lw

All values are reported in parts per million unless specified otherwise. A minus sign (—) is to be read "less than" and a plus sign (+) "greater than." Values in parenthesis are estimates. This analytical report is the confidential property of the above mentioned client and for the protection of this client and ourselves we reserve the right to forbid publication or reproduction of this report or any part thereof without written permission.

ND = None Detected 1 ppm = 0.0001% 1 Troy oz./ton = 34.286 ppm 1 ppm = 0.0292 Troy oz./ton

Minerals Exploration Date 6/9/77 RMGC Job No. 77-47-27-SL

Sample No.	ppm U_3O_8
AM-341- 100	3
105	4
110	5
115	3
120	2
125	4
130	4
135	5
140	12
145	3
150	5
155	5
160	4
165	6
170	8
175	10
180	9
185	11
190	11
195	13
200	26
205	3
210	471
215	127
AM-341- 220	30

Sample No.	ppm U_3O_8
AM-341- 225	16
230	16
235	14
240	16
255	17
260	12
265	34
270	980
275	356
280	93
290	26
305	260
310	578
315	146
320	172
325	44
330	31
335	35
340	61
345	11
350	16
355	15
375	11
380	16
AM-341- 385	173

Minerals Exploration Date 6/9/77 RMGC Job No. 77-47-27-SL

Sample No.	ppm U_3O_8
AM-341- 390	74
395	55
400	25
405	5
AM-341- 410	10
AM-514- 325	3
330	5
335	5
340	3
345	4
350	4
355	4
360	4
365	3
370	4
375	4
380	7
385	4
390	4
395	3
400	4
405	4
410	4
415	9
AM-514- 420	8

Sample No.	ppm U_3O_8
AM-514- 425	13
430	13
435	21
440	21
445	22
450	17
455	16
460	21
465	42
470	46
475	36
480	34
485	15
490	20
495	17
500	14
505	14
510	14
515	10
520	10
525	3
530	11
535	11
540	3
AM-514- 545	7

Minerals Exploration Date 6/9/77 RMGC Job No. 77-47-27-SL

Sample No.	ppm U_3O_8	Sample No.	ppm U_3O_8
AM-514- 550	6	AM-514- 630	9
555	3	635	19
560	5	640	18
565	9	645	26
570	8	650	25
575	7	655	13
580	7	660	28
585	11	665	21
590	4	670	19
595	2	675	14
600	2	680	10
605	16	685	11
610	15	690	17
615	18	695	18
620	20	AM-514-700	20
AM-514- 625	11		

By Lawrence R. Reid
Lawrence R. Reid

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Mr. Bob Lucht
Minerals Exploration Company
P. O. Box 50324
Tucson, Arizona 85703

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-1	A.M.-213	140	0.034	0.05	0.038	-0.032	0.032	0
-2	A.M.-213	145	0.011	0.02	0.013	0.009	0.010	10
-3	A.M.-213	150	0.004	<0.01	0.006	0.006	0.006	0
-4	A.M.-213	155	0.003	<0.01	0.003	0.002	0.005	60
-5	A.M.-215	70	0.001	<0.01	0.002	0.002	0.002	0
-6	A.M.-215	75	0.001	0.01	0.004	0.001	0.004	75
-7	A.M.-215	80	0.018	0.02	0.017	0.017	0.017	0
-8	A.M.-215	85	0.003	0.01	0.004	0.004	0.005	20
-9	A.M.-216	5	0.020	0.03	0.023	0.022	0.022	0
-10	A.M.-216	10	0.019	0.02	0.019	0.019	0.019	0
-11	A.M.-223	80	0.013	0.01	0.012	0.011	0.012	8
-12	A.M.-223	85	0.026	0.03	0.030	0.029	0.029	0
-13	A.M.-223	90	0.028	0.03	0.027	0.023	0.023	0
-14	A.M.-223	95	0.014	0.01	0.015	0.017	0.017	0
-15	A.M.-223	100	0.020	0.03	0.024	0.023	0.023	0
-16	A.M.-223	105	0.005	0.01	0.009	0.007	0.007	0
-17	A.M.-229	65	0.016	0.03	0.020	0.016	0.016	0

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
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Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-18	A.M.-229	70	0.011	0.01	0.012	0.011	0.011	0
-19	A.M.-229	75	0.004	<0.01	0.006	0.007	0.007	0
-20	A.M.-229	120	0.002	<0.01	<0.002	0.002	0.003	33
-21	A.M.-229	125	0.009	0.01	0.011	0.011	0.011	0
-22	A.M.-229	140	0.003	<0.01	0.005	0.005	0.005	0
-23	A.M.-229	145	0.014	0.01	0.013	0.016	0.016	0
-24	A.M.-229	150	0.016	0.01	0.018	0.021	0.021	0
-25	A.M.-229	155	0.006	<0.01	0.007	0.008	0.008	0
-26	A.M.-230	110	0.002	<0.01	0.004	0.004	0.005	20
-27	A.M.-230	115	0.003	<0.01	0.003	0.004	0.004	0
-28	A.M.-230	120	0.028	0.03	0.029	0.029	0.029	0
-29	A.M.-230	185	0.005	<0.01	0.002	0.008	0.008	0
-30	A.M.-230	190	0.004	<0.01	0.004	0.005	0.005	0
-31	A.M.-230	195	0.018	0.02	0.024	0.025	0.025	0
-32	A.M.-230	200	0.015	0.01	0.017	0.019	0.019	0
-33	A.M.-231	95	0.002	<0.01	0.002	0.006	0.006	0
-34	A.M.-231	100	0.002	0.01	0.005	0.003	0.004	25

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

HAZEN RESEARCH, INC.
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Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-35	A.M.-232	210	0.001	<0.01	0.002	0.002	0.002	0
-36	A.M.-232	215	0.003	<0.01	0.004	0.006	0.006	0
-37	A.M.-232	220	0.017	0.01	0.018	0.020	0.020	0
-38	A.M.-232	225	0.003	<0.01	0.003	0.005	0.005	0
-39	A.M.-233	270	0.002	<0.01	0.003	0.003	0.003	0
-40	A.M.-233	275	0.016	0.02	0.021	0.022	0.022	0
-41	A.M.-233	280	0.007	INSUFFICIENT SAMPLE FOR ANALYSIS				
-42	A.M.-234	430	0.002	<0.01	0.003	0.004	0.005	20
-43	A.M.-234	435	0.002	<0.01	0.003	0.002	0.005	60
-44	A.M.-234	440	0.002	0.01	0.005	0.004	0.004	0
-45	A.M.-238	55	0.008	<0.01	0.006	0.009	0.010	10
-46	A.M.-238	60	0.022	0.05	0.040	0.037	0.037	0
-47	A.M.-244	80	0.008	0.01	0.010	0.009	0.009	0
-48	A.M.-244	85	0.002	<0.01	0.003	0.003	0.004	25
-49	A.M.-245	210	0.003	0.01	0.006	0.005	0.005	0
-50	A.M.-245	215	0.007	0.01	0.009	0.010	0.010	0
-51	A.M.-245	220	0.006	<0.01	0.005	0.008	0.010	20

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Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-52	A.M.-224	10	0.009	0.01	0.010	0.012	0.012	0
-53	A.M.-224	15	0.013	0.02	0.020	0.019	0.019	0
-54	A.M.-224	20	0.005	<0.01	0.005	0.006	0.008	25
-55	A.M.-224	75	0.002	<0.01	0.005	0.005	0.005	0
-56	A.M.-224	80	0.010	0.01	0.012	0.012	0.012	0
-57	A.M.-224	85	0.034	0.03	0.034	0.034	0.034	0
-58	A.M.-224	90	0.017	0.01	0.017	0.020	0.020	0
-59	A.M.-224	95	0.009	<0.01	0.008	0.011	0.011	0
-60	A.M.-224	100	0.014	0.01	0.014	0.016	0.016	0
-61	A.M.-249	40	0.003	<0.01	0.003	0.004	0.004	0
-62	A.M.-249	45	0.053	0.05	0.045	0.041	0.041	0
-63	A.M.-249	50	0.004	0.01	0.009	0.010	0.010	0
-64	A.M.-252	5	0.039	0.04	0.032	0.028	0.028	0
-65	A.M.-252	55	0.012	0.01	0.012	0.011	0.013	15
-66	A.M.-252	60	0.025	0.03	0.031	0.034	0.034	0
-67	A.M.-252	65	0.022	0.02	0.025	0.024	0.024	0
-68	A.M.-252	70	0.027	0.02	0.023	0.028	0.030	7

HAZEN RESEARCH, INC.

4601 INDIANA STREET
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TELEPHONE 303/279-4501

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-69	A.M.-252	75	0.021	0.02	0.025	0.025	0.025	0
-70	A.M.-253	20	0.058	0.06	0.052	0.046	0.046	0
-71	A.M.-253	25	0.003	<0.01	<0.002	0.006	0.006	0
-72	A.M.-254	120	0.004	<0.01	0.003	0.005	0.007	29
-73	A.M.-254	125	0.005	<0.01	0.006	0.008	0.008	0
-74	A.M.-254	130	0.003	<0.01	0.005	0.006	0.006	0
-75	A.M.-258	20	0.012	0.01	0.011	0.012	0.012	0
-76	A.M.-258	25	0.034	0.04	0.029	0.024	0.024	0
-77	A.M.-258	75	0.003	<0.01	<0.002	0.003	0.005	40
-78	A.M.-258	80	0.005	<0.01	0.003	0.006	0.006	0
-79	A.M.-278	60	0.002	<0.01	0.004	0.007	0.008	13
-80	A.M.-278	65	0.012	0.01	0.013	0.013	0.013	0
-81	A.M.-278	70	0.018	0.03	0.024	0.023	0.024	4
-82	A.M.-278	75	0.028	0.03	0.034	0.034	0.034	0
-83	A.M.-278	80	0.006	0.02	0.015	0.014	0.014	0
-84	A.M.-278	95	0.003	<0.01	0.004	0.004	0.007	43
-85	A.M.-278	100	0.003	<0.01	<0.002	0.002	0.006	67

HAZEN RESEARCH, INC.

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GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-86	A.M.-280	45	0.008	0.01	0.013	0.012	0.012	0
-87	A.M.-280	50	0.027	0.03	0.032	0.031	0.031	0
-88	A.M.-280	55	0.015	0.02	0.019	0.016	0.016	0
-89	A.M.-282	135	0.001	<0.01	<0.002	0.004	0.004	0
-90	A.M.-282	140	0.005	INSUFFICIENT SAMPLE FOR ANALYSIS				
-91	A.M.-282	141	0.015	0.02	0.017	0.016	0.016	0
-92	A.M.-287	135	0.005	<0.01	0.006	0.006	0.006	0
-93	A.M.-287	140	0.008	0.01	0.008	0.007	0.007	0
-94	A.M.-287	145	0.013	0.01	0.011	0.012	0.013	8
-95	A.M.-287	175	0.011	0.02	0.014	0.012	0.012	0
-96	A.M.-287	180	0.020	0.02	0.023	0.024	0.024	0
-97	A.M.-289	80	0.005	0.01	0.009	0.006	0.007	14
-98	A.M.-289	85	0.003	<0.01	0.005	0.006	0.006	0
-99	A.M.-289	90	0.036	0.05	0.040	0.038	0.038	0
-100	A.M.-289	135	0.002	<0.01	<0.002	0.004	0.004	0
-101	A.M.-289	140	0.002	<0.01	0.003	0.004	0.007	43
-102	A.M.-289	145	0.020	0.03	0.024	0.022	0.022	0

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-103	A.M.-289	150	0.027	0.03	0.029	0.027	0.027	0
-104	A.M.-289	160	0.023	0.03	0.024	0.022	0.022	0
-105	A.M.-289	165	0.005	0.01	0.011	0.009	0.009	0
-106	A.M.-289	170	0.010	<0.01	0.003	0.003	0.013	77
-107	A.M.-294	55	0.002	<0.01	0.012	0.014	0.014	0
-108	A.M.-294	60	0.010	<0.01	0.003	0.004	0.005	20
-109	A.M.-294	65	0.040	0.04	0.040	0.039	0.039	0
-110	A.M.-294	70	0.049	0.05	0.049	0.050	0.050	0
-111	A.M.-294	90	0.004	<0.01	0.005	0.004	0.007	43
-112	A.M.-294	95	0.003	<0.01	0.004	0.003	0.004	25
-113	A.M.-294	100	0.012	<0.01	0.010	0.011	0.011	0
-114	A.M.-323	140	0.005	INSUFFICIENT SAMPLE FOR ANALYSIS				
-115	A.M.-323	145	0.116	0.12	0.078	0.049	0.049	0
-116	A.M.-323	150	0.114	0.12	0.109	0.102	0.102	0
-117	A.M.-323	155	0.053	0.06	0.044	0.032	0.032	0
-118	A.M.-324	135	0.007	<0.01	0.009	0.008	0.009	11
-119	A.M.-324	140	0.011	INSUFFICIENT SAMPLE FOR ANALYSIS				

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-120	A.M.-324	145	0.012	0.01	0.012	0.012	0.012	0
-121	A.M.-324	150	0.015	0.01	0.014	0.014	0.014	0
-122	A.M.-324	155	0.062	0.07	0.056	0.050	0.050	0
-123	A.M.-325	110	0.004	<0.01	0.004	0.007	0.008	13
-124	A.M.-325	115	0.005	<0.01	0.006	0.007	0.008	13
-125	A.M.-325	120	0.028	0.03	0.028	0.028	0.028	0
-126	A.M.-325	135	0.004	INSUFFICIENT SAMPLE FOR ANALYSIS				
-127	A.M.-325	140	0.007	<0.01	0.007	0.008	0.011	27
-128	A.M.-325	145	0.031	0.04	0.031	0.028	0.028	0
-129	A.M.-330	145	0.006	<0.01	0.004	0.008	0.008	0
-130	A.M.-330	150	0.005	<0.01	0.002	0.007	0.008	13
-131	A.M.-330	155	0.007	<0.01	0.008	0.009	0.009	0
-132	A.M.-330	160	0.008	<0.01	0.010	0.011	0.011	0
-133	A.M.-330	165	0.012	0.01	0.014	0.015	0.015	0
-134	A.M.-331	140	0.003	<0.01	<0.002	0.004	0.004	0
-135	A.M.-331	145	0.013	<0.01	0.011	0.016	0.017	6
-136	A.M.-331	150	0.016	0.02	0.018	0.019	0.019	0

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Mr. Bob Lucht
Minerals Exploration Company

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 (Radiometric) β-γ	β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-137	A.M.-332	185	0.004	<0.01	0.004	0.005	0.005	0
-138	A.M.-332	190	0.020	0.01	0.021	0.028	0.028	0
-139	A.M.-332	195	0.193	0.23	0.200	0.181	0.181	0
-140	A.M.-332	200	0.038	0.05	0.040	0.036	0.036	0
-141	A.M.-333	170	0.002	INSUFFICIENT SAMPLE FOR ANALYSIS				
-142	A.M.-333	175	0.018	0.02	0.021	0.021	0.021	0
-143	A.M.-333	180	0.011	<0.01	0.010	0.011	0.012	8
-144	A.M.-333	205	0.004	<0.01	0.005	0.005	0.005	0
-145	A.M.-333	210	0.006	INSUFFICIENT SAMPLE FOR ANALYSIS				
-146	A.M.-333	215	0.039	0.04	0.035	0.029	0.029	0
-147	A.M.-336	210	0.002	<0.01	<0.002	0.003	0.004	25
-148	A.M.-336	215	0.023	0.03	0.022	0.019	0.019	0
-149	A.M.-336	220	0.141	0.16	0.149	0.144	0.144	0
-150	A.M.-336	245	0.006	<0.01	0.007	0.007	0.008	13
-151	A.M.-336	250	0.005	<0.01	0.005	0.006	0.007	14
-152	A.M.-336	255	0.026	0.03	0.025	0.025	0.025	0
-153	A.M.-337	420	<0.001	<0.01	0.002	0.002	0.003	33

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-154	A.M.-337	425	<0.001	<0.01	0.002	0.002	0.002	0
-155	A.M.-337	430	0.003	<0.01	0.002	0.004	0.005	20
-156	A.M.-337	435	0.001	<0.01	<0.002	0.002	0.003	33
-157	A.M.-338	335	<0.001	<0.01	<0.002	<0.002	<0.002	0
-158	A.M.-338	340	0.001	<0.01	0.002	0.002	0.002	0
-159	A.M.-338	345	0.008	<0.01	0.005	0.008	0.008	0
-160	A.M.-338	350	0.007	<0.01	0.008	0.008	0.009	11
-161	A.M.-338	355	0.031	0.04	0.035	0.034	0.034	0
-162	A.M.-338	360	0.029	0.03	0.031	0.031	0.031	0
-163	A.M.-338	365	0.018	0.02	0.021	0.022	0.022	0
-164	A.M.-339	260	0.006	0.01	0.007	0.005	0.006	17
-165	A.M.-339	265	0.017	0.02	0.022	0.024	0.024	0
-166	A.M.-339	270	0.008	<0.01	0.007	0.008	0.009	11
-167	A.M.-339	275	0.008	<0.01	0.007	0.010	0.011	9
-168	A.M.-340	245	0.004	<0.01	0.002	0.004	0.005	20
-169	A.M.-340	250	0.009	<0.01	0.007	0.010	0.010	0
-170	A.M.-340	255	0.015	0.02	0.016	0.013	0.014	7

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-171	A.M.-340	295	0.077	INSUFFICIENT SAMPLE FOR ANALYSIS				
-172	A.M.-340	300	0.039	0.05	0.065	0.076	0.076	0
-173	A.M.-340	305	0.020	0.02	0.023	0.025	0.025	0
-174	A.M.-340	310	0.054	0.07	0.058	0.047	0.047	0
-175	A.M.-340	315	0.025	0.03	0.024	0.022	0.022	0
-176	A.M.-341	185	0.002	INSUFFICIENT SAMPLE FOR ANALYSIS				
-177	A.M.-341	190	0.003	INSUFFICIENT SAMPLE FOR ANALYSIS				
-178	A.M.-341	195	0.004	INSUFFICIENT SAMPLE FOR ANALYSIS				
-179	A.M.-341	245	0.002	INSUFFICIENT SAMPLE FOR ANALYSIS				
-180	A.M.-341	250	0.001	<0.01	0.003	0.002	0.003	33
-181	A.M.-341	255	0.001	<0.01	<0.002	0.002	0.005	60
-182	A.M.-341	260	0.002	INSUFFICIENT SAMPLE FOR ANALYSIS				
-183	A.M.-341	285	0.018	INSUFFICIENT SAMPLE FOR ANALYSIS				
-184	A.M.-341	290	0.008	INSUFFICIENT SAMPLE FOR ANALYSIS				
-185	A.M.-341	295	0.004	INSUFFICIENT SAMPLE FOR ANALYSIS				
-186	A.M.-341	300	0.006	INSUFFICIENT SAMPLE FOR ANALYSIS				
-187	A.M.-341	360	0.003	INSUFFICIENT SAMPLE FOR ANALYSIS				
-188	A.M.-341	365	0.001	INSUFFICIENT SAMPLE FOR ANALYSIS				
-189	A.M.-341	370	0.001	INSUFFICIENT SAMPLE FOR ANALYSIS				
-190	A.M.-343	165	0.006	0.01	0.007	0.006	0.006	0

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Date: June 14, 1977
HRI Project: 4107
HRI Series: 11608
Samples received: 5/25/77

Mr. Bob Lucht
Minerals Exploration Company

REPORT OF ANALYSIS

HRI Sample Designation	Sponsor Designation		% U_3O_8 (fluo)	% U_3O_8 β-γ	(Radiometric) β-Eq.	γ-Eq.	Sealed %eU_3O_8	% Radon Loss
11608-191	A.M.-343	170	0.018	0.03	0.024	0.019	0.019	0
-192	A.M.-343	175	0.011	0.02	0.014	0.010	0.010	0
-193	A.M.-343	270	0.002	<0.01	0.002	0.002	0.003	33
-194	A.M.-343	275	0.002	<0.01	0.004	0.004	0.004	0
-195	A.M.-343	280	0.019	0.03	0.032	0.033	0.033	0
-196	A.M.-345	375	0.010	0.02	0.017	0.016	0.016	0
-197	A.M.-345	380	0.025	0.03	0.022	0.018	0.018	0
-198	A.M.-345	385	0.009	<0.01	0.006	0.007	0.007	0
-199	A.M.-345	390	0.006	0.02	0.010	0.007	0.008	13
-200	A.M.-345	420	0.007	0.02	0.010	0.006	0.006	0
-201	A.M.-345	425	0.018	0.02	0.022	0.021	0.021	0
-202	A.M.-345	430	0.018	0.02	0.019	0.017	0.017	0
-203	A.M.-345	435	0.010	0.01	0.009	0.010	0.010	0
-204	A.M.-345	440	0.011	0.01	0.011	0.009	0.010	10
-205	A.M.-345	445	0.004	0.01	0.005	0.004	0.004	0
-206	A.M.-345	455	0.004	<0.01	0.003	0.005	0.005	0
-207	A.M.-345	460	0.003	<0.01	0.002	0.004	0.004	0
-208	A.M.-345	465	0.006	0.01	0.006	0.006	0.006	0
-209	A.M.-346	350	0.003	0.01	0.006	0.004	0.004	0
-210	A.M.-346	355	0.005	0.01	0.006	0.007	0.007	0
-211	A.M.-346	360	0.034	0.05	0.037	0.032	0.032	0

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

REPORT OF ANALYSIS

Mr. Bob Lucht
Minerals Exploration
P. O. Box 50324
Tucson, Arizona 85703

Date: June 15, 1977

HRI Project No. 4107
HRI Series No. 11608
Samples Rec'd 5/25/77

Analysis No.	Sample Designation		% CO_2
11608-1	A.M.-213	140	10.4
-9	A.M.-216	5	8.17
-12	A.M.-223	85	26.7
-13	A.M.-223	90	20.7
-15	A.M.-223	100	22.2
-17	A.M.-229	65	2.92
-28	A.M.-230	120	1.68
-46	A.M.-238	60	1.43
-57	A.M.-224	85	14.3
-62	A.M.-249	45	0.47
-64	A.M.-252	5	1.43
-66	A.M.-252	60	20.0
-68	A.M.-252	70	20.7
-70	A.M.-253	20	0.83
-76	A.M.-258	25	0.72
-81	A.M.-278	70	2.57
-82	A.M.-278	75	15.9
-87	A.M.-280	50	15.0
-99	A.M.-289	90	8.24
-102	A.M.-289	145	5.14
-103	A.M.-289	150	4.87
-104	A.M.-289	160	7.22
-108	A.M.-294	60	3.75
-109	A.M.-294	65	2.06
-110	A.M.-294	70	18.6

Mr. Bob Lucht
Minerals Exploration

June 15, 1977
HRI Project No. 4107
HRI Series No. 11608
Page 2

Analysis No.	Sample Designation		% CO_2
11608-115	A.M.-323	145	6.61
-116	A.M.-323	150	9.64
-117	A.M.-323	155	17.5
-122	A.M.-324	155	12.5
-125	A.M.-325	120	8.07
-128	A.M.-325	145	13.7
-139	A.M.-332	195	14.0
-140	A.M.-332	200	16.6
-146	A.M.-333	215	10.8
-148	A.M.-336	215	5.28
-149	A.M.-336	220	1.69
-152	A.M.-336	255	8.53
-161	A.M.-338	355	7.93
-162	A.M.-338	360	14.6
-172	A.M.-340	300	1.26
-174	A.M.-340	310	3.57
-175	A.M.-340	315	3.12
-191	A.M.-343	170	1.64
-195	A.M.-343	280	1.28
-197	A.M.-345	380	0.65
-211	A.M.-346	360	9.34
-171	A.M.-340	295	0.99

By: John C. Jarvis
John C. Jarvis
Manager, Analytical Laboratory

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HOLE #	DEPTH	CHEMICAL GEOLOGICAL		MINERALS	HAZEN RESEARCH INC.		
		U_3O_8	eU_3O_8	β-γ**	U_3O_8	eU_3O_8	β-γ
AM 7C	96-97	<.001	.024	—		.011	.01
AM 7C	98-99	.016	.034	.01		.034	.03
AM 13C	123-124	.008	.023	—		.014	.01
AM 18C	296.1-297.1	.103	.147	—		.098	.14
AM 26C	637-638	.017	.057	—		.061	.01
AM 49C	631-633	.016	.054	—		.049	.02
AM 51C	400-401	.008	.036	.006		.024	.02
AM 51C	406-407	.011	.030	.024		.028	.03
AM 51C*	407-408	.152	.062	.162		.057	.15
AM 51C	408-409	.001	.036	.011		.031	.01
AM 51C	441-442	.063	.116	.061		.116	.12
AM 51C	445-446	.075	.096	.147		.055	.09
AM 51C	446-447	.111	.019	.041		.065	.09
AM 79C	41-42	.024	.011	.007		.009	.01
AM 113C	301-302	.030	.055	—		.053	.04
AM 119C	113.5-114	.044	.135	.028		.133	.05
AM 135C	385-386	.043	.065	.024		.047	.05
AM 135C	387-388	.025	.061	.030		.045	.04
AM 135C	458 459	.010	.054	.010		.025	.01
AM 135C	473-474	.273	.626	.190		.616	.32
AM 149C	392-393	.016	.045	.017		.035	.03

* CHEMICAL-GEOLOGICAL DID CHEMICAL TWICE: .057% + .152%
** MISSING VALUES DUE TO POOR QUALITY COPY.

POINTS OF POOR AGREEMENT BETWEEN OLD AND NEW DATA

union MINERALS EXPLORATION CO.

ANDERSON MINE PROJECT
YAVAPAI COUNTY, ARIZONA

QUALITY CONTROL – EQUILIBRIUM DATA

SCALE	DATE: 16 JUNE 77	APPROVED	REVISIONS
H:	DRAWN BY: LUCNT		
V:	CHECKED:		
	DESIGN:		FILE:

Bendix
Field Engineering Corporation
Grand Junction Operations

P.O. Box 1569
Grand Junction, CO. 81501
Tel (303) 242-8621

A Subsidiary of
The Bendix Corporation

July 25, 1977

Mr. Chris Hill
Minerals Exploration Company
Development Group
1846 West Grant, Suite 108
Tucson, AZ 85705

Dear Chris:

Things move slowly as you can see, but we did not forget you. The backlog at our labs and at outside ones these days is tremendous.

I am enclosing the reports. The two granites showed excellent correlation. I was surprised to find they were late Jurassic, but perhaps you suspected that.

Both Steve and I really enjoyed our visit to the property and your cooperation. Steve is swamped with an expanded workload being now responsible not only for the NURE airborne but also the hydrogeochemical program. He sends his regards, however.

Hope you and your wife are enjoying Tucson.

Sincerely,

Mary

Mary McNeil
Staff Geologist

Enclosures

100984

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION

24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617)-876-3691

POTASSIUM–ARGON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. B-3880 — Date Received: 31 May 1977

Your Reference: P.O. 8487 — Date Reported: 6 June 1977

Submitted by: Bendix Field Engineering Corp.
P.O. Box 1569
Grand Junction, Colorado 81501

Sample Description & Locality: Biotite granite, sample #23703.

Material Analyzed: Biotite concentrate, -40/+100 mesh. Estimated Composition: Biotite, 99%; Iron oxides and others, 1%.

Ar^{40*}/K^{40} = .009438 — AGE = 155 ± 6 M.Y.

Argon Analyses:

Ar^{40*}, ppm.	Ar^{40*}/ Total Ar^{40}	Ave. Ar^{40*}, ppm.
.08514	.667	.08524
.08534	.796	

Potassium Analyses:

% K	Ave. %K	K^{40}, ppm
7.430	7.403	9.031
7.376		

Constants Used:

$\lambda_\beta = 4.72 \times 10^{-10}$/ year

$\lambda_e = 0.585 \times 10^{-10}$/ year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$AGE = \frac{1}{\lambda_e + \lambda_\beta} \ln\left[\frac{\lambda_\beta + \lambda_e}{\lambda_e} \times \frac{Ar^{40*}}{K^{40}} + 1\right]$$

Note: Ar^{40*} refers to radiogenic Ar^{40}.
M.Y. refers to millions of years.

100984

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION

24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617)-876-3691

POTASSIUM–ARGON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. B-3881 — Date Received: 31 May 1977

Your Reference: P.O. 8487 — Date Reported: 6 June 1977

Submitted by: Bendix Field Engineering Corp.
P.O. Box 1569
Grand Junction, Colorado 81501

Sample Description & Locality: Biotite granite, sample #23704.

Material Analyzed: Biotite concentrate, -40/+100 mesh. Estimated Composition: Biotite, 99%; Iron oxides and others, 1%.

Ar^{40*}/K^{40} = .009764 — AGE = 160 ± 6 M.Y.

Argon Analyses:

Ar^{40*}, ppm.	Ar^{40*}/ Total Ar^{40}	Ave. Ar^{40*}, ppm.
.08887	.719	.08833
.08778	.753	

Potassium Analyses:

% K	Ave. %K	K^{40}, ppm
7.389	7.415	9.046
7.441		

Constants Used:

$\lambda_\beta = 4.72 \times 10^{-10}$/ year

$\lambda_e = 0.585 \times 10^{-10}$/ year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$AGE = \frac{1}{\lambda_e + \lambda_\beta} \ln\left[\frac{\lambda_\beta + \lambda_e}{\lambda_e} \times \frac{Ar^{40*}}{K^{40}} + 1\right]$$

Note: Ar^{40*} refers to radiogenic Ar^{40}.
M.Y. refers to millions of years.

SPECOMP
SERVICES, INC.
WILLIAM A. BOWES and ASSOCIATES
P.O. Box 160 ◎ Steamboat Springs,
Colorado 80477 ◎ 303-879-0286

SEMIQUANTITATIVE SPECTROGRAPHIC ANALYSIS

INSTRUMENT: WADSWORTH MOUNTED, JARRELL-ASH, 1.5 METER, DC ARC EMISSION SPECTROGRAPH
Fe, Mg, Ca, Ti, Na, K, Si, Al & P reported in %, all other elements reported in PPM

FILM NO 264-17
DATE 5-25-77

Reg No 100984

Plate No.	Office No.	Field No.	Au	Ag	Cu	Pb	Zn	Mo	Fe	W	Ni	Co	Cr	Cd	As	Sb	Mn	V	Bi	Sn	Zr	B	Ba	Be	La	Nb	Sc	Sr	Y	Ca	Mg	Ti	Na	K	Si	Al	P
4	60251	MAF-802 23763	N	N	10	70	N	N	3.	N	20	N	20	N	N	N	500	30	N	N	100	N	1500	20	100	50	10	300	70	2.	1.	.2	4.				
5	60252	23704	N	N	7	70	N	N	2.	N	15	N	20	N	N	N	500	30	N	N	200	N	1500	20	100	L	10	300	70	3.	1.	.2	4.				

MAF-803

Lower Detection Limit	10	0.5	5	10	200	5	0.05%	50	5	10	20	20	200	100	10	10	10	10	10	10	10	2	20	10	5	100	10	0.05	0.02%	.001%	0.2%	0.5%	1%	0.5%	.1%

N - Not detected L - Detected, but below limit of determination G - Greater than value shown

REMARKS 31 cl. pulp sat

JOB NO: 1840 Final
CUSTOMER: Bindly

KEYPUNCH CODE
ANALYST Shannon

A. H. ROSS & ASSOCIATES

J. ABRAMO
SEP 12 1977
Mgr. Met. Opr.

3-21

September 2, 1977

Mr. R. Mehle,
Morrison-Knudsen Company Inc.,
2 Morrison-Knudsen Plaza,
Boise, Idaho, 83729, U.S.A.

COPY

Re: Minerals Exploration Company

Dear Ray:

John Abramo has asked us to mail one of his copies of our report "Metallurgical Summary and Preliminary Design Data for the Anderson Uranium Deposit" directly to you and a copy is enclosed herewith.

We look forward to working with you on this interesting project.

Yours very truly

K.R. Coyne, P. Eng.

KRC:er

encl/1

cc: J.A. Abramo

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
1706 - 80 RICHMOND STREET WEST
TORONTO, ONTARIO M5H 2A4
CANADA

A. H. ROSS - PRINCIPAL
K. R. COYNE - PRINCIPAL ASSOCIATE (SENIOR)
N. GIBSON - PRINCIPAL ASSOCIATE

D. H. EBERTS - SENIOR ASSOCIATE
M. J. LAKE - SENIOR ASSOCIATE
D. F. LILLIE - SENIOR ASSOCIATE

W. V. BARKER
M. E. GRIMES
A. S. HAYDEN
J. L. HOPKINS
R. H. RICHARDS
R. C. SWIDER
E. W. S. WARD

CODE 416-366-1653
CABLE "ROSSONTO"
TELEX 06-22325 (ROSSONTO TOR.)

~~160.1~~ 3-21

J. ABRAMO
SEP 16 1977
Mgr. Met. Opr.

12th September, 1977

Mr. J. A. Abramo,
Minerals Exploration Company,
P. O. Box 50324,
Tucson, Arizona 85703
U.S.A.

Dear Sir,

Re: Anderson Mill Report

Please find enclosed six copies of corrected page 3-5 of our report "Metallurgical Summary and Preliminary Design Data for the Anderson Uranium Deposit". We would ask that you replace page 3-5 in your present copies of this report with the corrected page. We regret any inconvenience caused.

By copy of this letter, we have also sent corrected pages to Mr. Buchella and to Mr. Mehle.

Yours truly,

M. E. Grimes

M. E. Grimes, P.Eng.

MEG/va
enc.

c.c. Mr. F. H. Buchella Jr.
Mr. R. Mehle

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION		U_3O_8 %
***			
1-A	AM-336c	212.0-213.0	0.021
1-B		212.0-213.0	0.021
1-C		212.0-213.0	0.021
1-D		212.0-213.0	0.021
1-E		212.0-213.0	0.020
2-A		213.0-214.0	0.014
2-B		213.0-214.0	0.014
2-C		213.0-214.0	0.014
2-D		213.0-214.0	0.013
2-E		213.0-214.0	0.014
3-A		215.0-216.0	0.118
3-B		215.0-216.0	0.130
3-C		215.0-216.0	0.130
3-D		215.0-216.0	0.118
3-E		215.0-216.0	0.130
4-A		216.0-217.0	0.014
4-B		216.0-217.0	0.014
4-C		216.0-217.0	0.014
4-D		216.0-217.0	0.014
4-E		216.0-217.0	0.014
5-A		252.5-253.5	0.008
5-B		252.5-253.5	0.007
5-C		252.5-253.5	0.007
5-D		252.5-253.5	0.007
5-E		252.5-253.5	0.007
6-A		253.5-254.5	0.019
6-B		253.5-254.5	0.020
6-C		253.5-254.5	0.020
6-D		253.5-254.5	0.018
6-E		253.5-254.5	0.019
7-A		254.5-255.5	0.074
7-B		254.5-255.5	0.073
7-C		254.5-255.5	0.075
7-D		254.5-255.5	0.077
7-E	AM-336c	254.5-255.5	0.072

TO:
MINERALS EXPLORATION COMPANY
Development Group
P. O. Box 50324
Tucson, Arizona 85703
Attn.: Robert Lucht

REMARKS:
Single analysis

Page 1 of 3 pages
***Analysis on 5 replicate splits.

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
9/21/77	10/7/77	772187

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
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James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION		U_3O_8 %								
8-A	AM-~~366~~ 336c	255.5-256.5	0.029								
8-B		255.5-256.5	0.029								
8-C		255.5-256.5	0.029								
8-D		255.5-256.5	0.029								
8-E		255.5-256.5	0.029								
9-A		256.5-257.0	0.006								
9-B		256.5-257.0	0.006								
9-C		256.5-257.0	0.006								
9-D	336c	256.5-257.0	0.006								
9-E	AM-~~366~~c	256.5-257.0	0.006								
10-A	AM-323c	142.5-143.5	0.011								
10-B		142.5-143.5	0.012								
10-C		142.5-143.5	0.011								
10-D		142.5-143.5	0.011								
10-E	AM-323c	142.5-143.5	0.011								
10-1	[redacted]										
11-A	AM-323c	144.5-145.5	0.271								
11-B		144.5-145.5	0.260								
11-C		144.5-145.5	0.260	X							
11-D		144.5-145.5	0.260								
11-E		144.5-145.5	0.260								
12-A		145.5-146.5	0.028								
12-B		145.5-146.5	0.028								
12-C		145.5-146.5	0.028	X							
12-D		145.5-146.5	0.028								
12-E		145.5-146.5	0.029								
13-A		146.6-147.6	0.003								
13-B		146.6-147.6	0.002								
13-C		146.6-147.6	0.003	X							
13-D		146.6-147.6	0.003								
13-E		146.6-147.6	0.003								
14-A		147.6-148.6	0.004								
14-B		147.6-148.6	0.004								
14-C		147.6-148.6	0.004								
14-D	AM-323c	147.6-148.6	0.004								

TO:

REMARKS:

CERTIFIED BY:

(Please indicate if wet analysis is desired.)

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
9/21/77	10/7/77	772187

SKYLINE LABS, INC.
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James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION		U_3O_8 %	
***				
14-E	AM-323c	147.6-148.6	0.005	
15-A		148.6-149.6	0.021	
15-B		148.6-149.6	0.024	
15-C		148.6-149.6	0.022	X
15-D		148.6-149.6	0.021	
15-E		148.6-149.6	0.022	
16-A		149.6-150.2	0.189	
16-B		149.6-150.2	0.177	
16-C		149.6-150.2	0.189	
16-D		149.6-150.2	0.189	X
16-E		149.6-150.2	0.189	
17-A		150.8-151.8	0.027	
17-B		150.8-151.8	0.026	
17-C		150.8-151.8	0.026	
17-D		150.8-151.8	0.026	X
17-E		150.8-151.8	0.025	
18-A		151.8-152.8	0.009	
18-B		151.8-152.8	0.009	
18-C		151.8-152.8	0.009	
18-D		151.8-152.8	0.009	X
18-E		151.8-152.8	0.009	
19-A		152.8-153.8	0.013	
19-B		152.8-153.8	0.013	
19-C		152.8-153.8	0.013	
19-D		152.8-153.8	0.014	X
19-E		152.8-153.8	0.012	
20-A		153.8-154.8	0.013	
20-B		153.8-154.8	0.014	
20-C		153.8-154.8	0.014	
20-D		153.8-154.8	0.013	
20-E	AM-323c	153.8-154.8	0.013	
21	[redacted]			

TO:
MINERALS EXPLORATION COMPANY
Development Group
P. O. Box 50326
Tucson, Arizona 85703
Attn.: Robert Lucht

REMARKS:
Single analysis

Page 3 of 3 pages

***Analysis on 5 replicate splits.

CERTIFIED BY: William L. Lehmbeck

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK DATE SIGNED 10/7/77 Arizona U.S.A.

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
9/21/77	10/7/77	772187

OCT 24 1977

Memo
Union Oil Company of California

union 76

TO	NAME	DEPT. - LOCATION
	Mr. Bill Goth	Los Angeles, CA
SUBJECT	"Coal" at Anderson Mine	DATE

For some time there has been some concern here-abouts as to what to call the black stuff in the Anderson Mine cores - should it be referred to as "lignite" or "sub-bituminous". We picked some out for a proximate analysis and the results are attached. I suggest we call the black stuff "carbonaceous shale" I believe Twenhofel would go so far as to call it "bituminous shale".

EHE	
WRM	
REB	
FHB	
WHG	
WCG	
EHL	
GIL	
GEM	GEM
DMc	
JRMc	
HMR	
LER	
EAW	
FILE:	

FROM	SIGNED	DEPT. - LOCATION
	Bruce Robinson	Casper, Wyo.

CASPER, WYOMING • TYLER, TEXAS

COAL ANALYSIS RESULTS

PROXIMATE ANALYSIS

Samples from test holes at Anderson Mine, Yavapai County, Arizona

COMPANY: MINERAL EXPLORATION COMPANY
SAMPLE ID: AS SHOWN

FILE: RP-4-C-574
DATE: 19 OCT 77
ANALYSTS: APH/DJS

SW SE Sec. 10 T11N R10W

ID: AM-135C; 457.0-462.5

	AS RCVD	DRY
%MOIST	3.08	0.00
%ASH	88.71	91.53
%V.M.	5.97	6.16
%F.C.	2.24	2.31
TOTAL	100.00	100.00
BTU/LB	0	0
%SULFUR	0.60	0.62

NE NE Sec. 15 T11N R10W

ID: AM-26C; 603.0-606.3

	AS RCVD	DRY
%MOIST	3.25	0.00
%ASH	73.46	75.92
%V.M.	20.32	21.00
%F.C.	2.97	3.08
TOTAL	100.00	100.00
BTU/LB	1962	2028
%SULFUR	1.92	1.99

SW SW Sec. 10 T11N R10W

ID: AM-49C; 630.0-633.0

	AS RCVD	DRY
%MOIST	4.47	0.00
%ASH	68.29	71.49
%V.M.	15.72	16.46
%F.C.	11.52	12.05
TOTAL	100.00	100.00
BTU/LB	2943	3081
%SULFUR	2.25	2.36

Copy to Mineral Exploration

NOV 21 1977
Mgr. Met. Opr.
J. ABRAMO

These analyses, opinions or interpretations are based on observations and materials supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgment of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or

SKYLINE LABS, INC.
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William L. Lehmbeck
Arizona Registered Assayer No. 9425
James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 127-C	
118	40-41	0.0013
119	41-42	0.0018
120	42-43	0.0018
121	43-44	0.0013
122	Anderson 29	0.464*
123	44-45	0.0042
124	45-46	0.012
125	46-47	0.0010
126	47-48	0.0010
127	48-49	0.0013
128	49-50	0.0027

TO:
MINERALS EXPLORATION COMPANY
Development Group
P. O. Box 50324
Tucson, Arizona 85703
Attn.: Robert Lucht

REMARKS:
Single analysis
*Analysis by volumetric method
Project: Anderson Mine
Page 12 of 12 pages
(CO_2 to follow as Part II)

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/8/77	11/30/77	772570 - Part I

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
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CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 388-C	
109	372-373	0.0035
110	373-374	0.012
111	374-375	0.0013
112	345-346	0.0040
113	346-347	0.040
114	Anderson 30	0.033
115	347-348	0.0050
116	348-349	0.0040
117	344-345	0.0045

TO:

REMARKS:

CERTIFIED BY:

DATE REC'D: 11/8/77

DATE COMPL.: 11/30/77

JOB NUMBER: 772570 - Part I

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Hawley & Hawley, Assayers and Chemists Division
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CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 373-C	
99	368-369	0.038
100	369-370	0.012
101	370-371	0.095
102	371-372	0.0085
103	Anderson 26	0.017
104	372-373	0.142
105	373-374	0.019
106	378-379	0.014
107	379-380	0.034
108	380-381	0.0055

TO:

REMARKS:

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/8/77	11/30/77	772570 - Part I

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CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	338-C 1	
84	330-331	0.0020
85	331-332	0.047
86	332-333	0.026
87	337-338	0.0090
88	338-339	0.028
89	Anderson 23	0.051
90	339-340	0.047
91	345-346	0.062
92	346-347	0.033
93	347-348	0.165
94	348-349	0.155
95	349-350	0.210
96	352-353	0.071
97	353-354	0.059
98	354-355	0.042

TO:

REMARKS:

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/8/77	11/30/77	772570 - Part I

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James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 152-C 1	
81	127-128	0.010
82	128-129	0.044
83	129-130	0.0080

TO:

REMARKS:

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/8/77	11/30/77	772570 - Part I

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CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 384-C 1	
63	362-363	0.0040
64	363-364	0.468 *
	AM 384-C	
65	365-366	0.0085
66	Anderson 22	0.031
67	366-367	0.045
68	367-368	0.018
69	398-399	0.524 *
70	399-400	0.035
71	400-401	0.017
72	420-421	0.0018
73	421-422	0.0022
74	422-423	0.014
75	436-437	0.0055
76	437-438	0.029
77	Anderson 25	0.021
78	438-439	0.021
79	443-444	0.083
80	444-445	0.035

TO:

REMARKS:

*Analysis by volumetric method

CERTIFIED BY:

DATE REC'D: 11/8/77
DATE COMPL.: 11/30/77
JOB NUMBER: 772570 - Part I

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CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 325-C	
51	113-114	0.052
52	114-115	0.106
53	115-116	0.0040
54	136-137	0.0025
55	137-138	2.14 *
56	138-139	0.028
57	Anderson 21	0.456 *
58	139-140	0.538 *
59	140-141	0.770 *
60	146-147	0.012
61	147-148	0.028
62	148-149	0.013

TO:

REMARKS:

*Analysis by volumetric method

Page 6 of 12 pages

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/8/77	11/30/77	772570 - Part I

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CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 308-C	
31	69-70	0.0015
32	70-71	0.0020
33	72-73	0.010
34	73-74	0.037
35	74-75	0.025

TO:

REMARKS:

CERTIFIED BY:

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11/8/77	11/30/77	772570 - Part I

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CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 40-C	
27	68-69	0.0050
28	69-70	0.059
29	70-71	0.0085
30	71-72	0.0032

TO:

REMARKS:

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/8/77	11/30/77	772570 - Part I

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ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 28-C	
18	392-393	0.0070
19	393-394	0.023
20	394-395	0.011
21	396-397	0.010
22	397-398	0.034
23	398-399	0.013
24	Anderson 18	0.031
25	399-400	0.014
26	400-401	0.126 *

O:

REMARKS:

*Analysis by volumetric method

Page 3 of 12 pages

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
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(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 486-C	
11	511'9"-512'3"	0.512 *
12	512'3"-513	0.0032
13	513-514	0.0044
14	Anderson 17	0.016
15	514-515	0.0070
16	515-516	0.010
17	516-517	0.0085
36	510-511	0.059
37	Anderson 19	0.028
38	511-511'9"	0.0095
39	443-444	0.0026
40	444-445	0.021
41	445-446	0.122 *
42	446-447	0.071
43	447-448	0.014
44	494-495	0.019
45	495-496	0.083
46	496-497	0.0095
47	Anderson 20	0.112 *
48	501-502	0.050
49	502-503	0.028
50	503-504	0.011

TO:

REMARKS:

*Analysis by volumetric method

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/8/77	11/30/77	772570 - Part I

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427
William L. Lehmbeck
Arizona Registered Assayer No. 9425
James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 371-C	
1	406-407	0.0060
2	407-408	0.0045
3	408-409	0.118 *
4	409-410	0.021
5	411-412	0.020
6	Anderson 16	0.0080
7	412-413	0.077
8	413-414	0.053
9	414-415	0.059
10	415-416	0.0016

TO: MINERALS EXPLORATION COMPANY
Development Group
P. O. Box 50324
Tucson, Arizona 85703
Attn.: Robert Lucht

REMARKS:
Single analysis
*Analysis by volumetric method
Project: Anderson Mine
Page 1 of 12 pages

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/8/77	11/30/77	772570 - Part I

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
P.O. Box 50106 • 1700 West Grant Road
Tucson, Arizona 85703
(602) 622-4836

INVOICE

INVOICE NO.:
JOB NO.: 772570 - Part I
P.O. NO.:

SOLD TO: MINERALS EXPLORATION COMPANY
Development Group
P. O. Box 50324
Tucson, Arizona 85703

Attn.: Robert Lucht

DATE: November 30, 1977

TERMS: NET 30 DAYS

Analysis of 116 Drill Core and 12 Pulp Samples

128 Uranium (single) @ $3.00.	$ 384.00
116 Samples crushed and pulverized @ $1.25.	145.00
116 Samples dried @ $0.25	29.00
Total	$ 558.00

POSTING COPY

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427
William L. Lehmbeck
Arizona Registered Assayer No. 9425
James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 136-C	
53	299-300	0.018
54	300-301	0.066
55	301-302	0.035
56	302-303	0.0050
57	303-304	0.0016
58	335-336	0.0080
59	336-337	0.012
60	337-338	0.152 *
61	338-339	0.064
62	339-340	0.018
63	340-341	0.022
64	341-342	0.0075
65	342-343	0.040
66	343-344	0.054
67	352-353	0.026
68	353-354	0.302 *
69	354-355	0.040
70	355-356	0.046
71	356-357	0.059
72	347-348	0.172 *
73	358-359	0.158 *
74	359-360	0.013
75	360-361	0.0060
76	369-370	0.019
77	370-371	0.042
78	371-372	0.340 *
79	372-373	0.144 *
80	373-374	0.048
81	374-375	0.188 *
82	375-376	0.308 *
83	376-377	0.172 *
84	377-378	0.014

TO:
MINERALS EXPLORATION COMPANY
Development Group
P. O. Box 50324
Tucson, Arizona 85703
Attn.: Robert Lucht

REMARKS:
Single analysis
*Analysis by volumetric method
Project: Anderson Mine
Page 4 of 4 pages
(CO_2 analysis to follow as Part II).

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/15/77	11/30/77	772633 - Part I

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 443-C (continued)	
46	361-362	0.021
47	371-372	0.020
48	372-373	0.047
49	373-374	0.047
50	374-375	0.040
51	375-376	0.038
52	376-377	0.0075

TO:

REMARKS:

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/15/77	11/30/77	772633 - Part I

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 443-C	
13	275-276	0.040
14	276-277	0.010
15	277-278	0.024
16	278-279	0.0040
17	279-280	0.0060
18	280-281	0.0022
19	315-316	0.019
20	316-317	0.014
21	317-318	0.014
22	318-319	0.019
23	319-320	0.0060
24	320-321	0.029
25	321-322	0.388 *
26	322-323	0.018
27	323-324	0.033
28	328-329	0.019
29	329-330	0.033
30	330-331	0.025
31	333-334	0.021
32	334-335	0.027
33	335-336	0.021
34	338-339	0.014
35	339-340	0.019
36	340-341	0.021
37	341-342	0.066
38	342-343	0.202 *
39	343-344	0.047
40	344-345	0.029
41	345-346	0.0019
42	357-358	0.020
43	358-359	0.031
44	359-360	0.068
45	360-361	0.142 *

TO:

REMARKS:

*Analysis by volumetric method

Page 2 of 4 pages

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/15/77	11/30/77	772633 - Part I

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	U_3O_8 %
	AM 63-C	
1	191-192	0.0050
2	192-193	0.083
3	193-194	0.202 *
4	194-195	0.0080
5	195-196	0.038
6	196-197	0.026
7	197-198	0.0070
8	198-199	0.0038
9	219-220	0.0060
10	220-221	0.074
11	221-222	0.083
12	226-227	0.0030

TO:
MINERALS EXPLORATION COMPANY
Development Group
P. O. Box 50324
Tucson, Arizona 85703
Attn.: Robert Lucht

REMARKS:
Single analysis
*Analysis by volumetric method
Project: Anderson Mine

CERTIFIED BY:

Page 1 of 4 pages

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
11/15/77	11/30/77	772633 - Part I

Minerals Exploration Company
P.O. Box 50324
Mine Development Group
1846 W. Grant Road, Suite 108
Tucson, Arizona 85705
Telephone: (602) 884-8073

union 76
MINERALS

Head Office:
P.O. Box 54945
Los Angeles, California 90054
(213) 486-6929

December 27, 1977

Mr. Whitey Ferguson
Senior Analyst-Fuel Supply Department
Arizona Public Service Company
P.O. Box 21666
Phoenix, Arizona 85036

Dear Mr. Ferguson:

In regards to your request to run a geophysical survey across Union Oil's Anderson Mine Property near Wickenburg, I see no objection on our part to grant you access for the data verification checks in return for a copy of the results.

It is to be understood that all information derived from the study is to remain confidential unless so otherwise authorized in writing by Union Oil.

Union Oil accepts no responsibility for any liabilities incurred during the testing nor is any implication made that data gathered from the tests will be indicative of uranium deposits in general.

The costs incurred in the survey will be the total responsibility of APS.

If the above terms are agreeable, sign the original and return to me. The copy is for your records. Upon receipt of the signed agreement, I will contact you to arrange a meeting to discuss all details and procedures of the anticipated work.

Sincerely yours,

MINERALS EXPLORATION COMPANY

Gerald C. Dohm, Jr.
Manager, Mine Development

GCD/p

Agreed to:
Date:_____
By:_____
Title:_____

bc: Frank H. Buchella, Jr.
file

ANDERSON MINE SEISMIC SURVEY

The Development Group suggests the following parameters and requests that the collection of data address the following topics of interest during the seismic survey to be conducted at Anderson Mine. The suggested parameters are the outgrowth of geologic work completed by the Exploration Department and continuing work by the Development Group. The topics of interest are derived from two areas: 1) specific geologic and engineering problems that affect mine planning and development directly, and 2) problems of a general academic interest pertaining to the structural and stratigraphic relationships of the area.

We suggest that the seismic lines be run perpendicular to and parallel to the dominant northwest-southeast structural trend. We would definitely like one perpendicular-to-structure line to be extended across Section 16, T11N, R10W. All lines should cross the area of primary mineralization.

Any information applicable to the following topics of interest would have direct application to mine planning and development.

1. Structural Data
   - a. Faulting
     - 1) Attitudes
     - 2) Locations
     - 3) Units Affected
     - 4) Displacement
     - 5) Hinging
   - b. Dip
   - c. Displacement and fracturing of mineralized unit.
2. Stratigraphy
   - a. Mineralized zone and/or lithology
   - b. Unit contacts
   - c. Facies changes and pinchouts

d. Definable units within lacustrian unit.
e. Seismic velocities of units in backwall for slope stability data.

3. Hydrology

a. Water table
b. Confinement of water to fault blocks
c. Groundwater gradients
d. Presence and location of perched groundwater

4. Relationships of structure stratigraphy and hydrology in relation to slope stability.

5. Ripability of materials and units overlying the mineralized zone.

Information applicable to the following topics would be of academic interest:

1. Depth to granitic basement.

2. Location(s) of vents and/or intrusives within the basement complex.

3. Depth to the volcanics underlying the Anderson Mine lacustrian sediments.

4. The occurrence and distribution of units between the above volcanics and the granitic basement. (Artillery Peak formation, volcaniclastic unit, felsic to intermediate intrusive and extrusive unit, etc.)

5. General information on the basin shape and dimensions and any changes through time.

6. Thickening and thinning of units and direction of source.

7. Information applicable to regional structure (deformation, fault sets, direction of compressional or tensional forces, ages of events, etc.).

CZH/p

c: GCD, Glen Zinn

Union Oil Company of California

Union Research Center
P. O. Box 76, Brea, California 92621
Telephone (714) 528-7201

union 76

E&PE-78-42

January 25, 1978

Mr. W. G. Zinn
Tucson, Arizona

Dear Glen:

SEISMIC SURVEY
URANIUM; ARIZONA

Thank you for the opportunity to see the geological data and requirements for the Anderson Mine area. As I expressed in the meeting, there are a number of parameters we would be unable to provide from seismic surveys under the best of conditions, such as: top of the water table, lithology, minor facies changes, character of thin beds, ripability, etc. After viewing the area in the field and the location of the required information, it is my opinion that our energy sources are not capable of providing sufficient energy to yield coherent data. The principal reasons are the extreme variability of the surface from loose sands and conglomerates to volcanic pediments coupled with surface gradients of greater than 50% (120' in 200') every few hundred feet along the line. In order to stack high frequency energy which would be required for the thin-bedded nature of the section, the energy sources would have to be repeated every 10 feet along a straight line. With single large charges in shot holes there is little likelihood that usable high frequency data would be obtainable either. It is my opinion that a seismic survey would not provide the data that are necessary and would cost more than core holes, which can provide definitive information. I might suggest that gravity surveys could conceivably provide data for the lacustrine basin configuration and faults and an induced-potential or resistivity survey might detect the water table.

There is a reasonable possibility that in the relatively flat area south of the Santa Maria River canyon seismic surveys could be useful in detailing buried lacustrine basins. For reconnaissance surveys we might want to use

existing magnetic or gravimeter data first. Such a program might require extensive seismic lines and the potential ore zone could well be at depths that would require subsurface mining techniques.

Sincerely yours,

Walt

Walter R. Fillippone

WRF:ds

cc - D. J. Cant
R. B. Ellis, Tucson
O. G. Erich
C. Z. Hill, Tucson
J. Ljung, Tucson

3-29

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

REPORT OF ANALYSIS

Mr. John A. Abramo
Manager, Metallurgical Operations
Minerals Exploration Co.
P. O. Box 50324
Tucson, Arizona 85705

Date: May 3, 1978

HRI Project No. 4407
HRI Series No.

Analysis No.	Sample Designation	μCi/ml Ra^{228}	± Precision*
	Raffinate (1070-129-5)	2×10^{-8}	$\pm\ 3 \times 10^{-8}$

J. ABRAMO
MAY 5 1978
Mgr. Met. Opr.

By John C. Jarvis
John C. Jarvis
Manager, Analytical Laboratory

eah

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

cc: Sobeltrom
Salisbury
Larsone
Marshall

3-29

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO 80401
TELEPHONE 303/279-4501

REPORT OF ANALYSIS

Mr. John A. Abramo
Manager, Metallurgical Operations
Minerals Exploration Co.
P. O. Box 50324
Tucson, Arizona 85705

Date: May 3, 1978

HRI Project No. 4407
HRI Series No.

Analysis No.	Sample Designation	μCi/ml Ra^{228}	± Precision*
	Raffinate (1070-129-5)	2×10^{-8}	$\pm\ 3 \times 10^{-8}$

J. ABRAMO
MAY 5 1978
Mgr. Met. Opr.

By John C. Jarvis
John C. Jarvis
Manager, Analytical Laboratory

eah

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

cc: Sodestrom
Salisbury
Larson
Marshall

Called T. Bailey on 5/31/78 and gave info

3-37

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES

CONSULTING CHEMICAL & METALLURGICAL ENGINEERS

SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

J. ABRAMO
JUL 6 1978
Mgr. Met. Opr.

Minerals Exploration Company,
P. O. Box 50324,
Tucson, Arizona 85703
U.S.A.

Attn: Mr. J. A. Abramo

INVOICE No. 4788

DATE 30th June, 1978

TERMS Net 15 days

Account for June, 1978

Services Rendered: re Anderson Uranium Project; discussions, review of data and correspondence on process details.

A.H. Ross	0.3 days @ $500./day	$ 150.00	
M.E. Grimes	7.0 days @ $325./day	$2,275.00	$ 2,425.00
Long Distance Telephone and Telegraph			$ 19.52
Photostating and Duplicating			$ 159.08
Drafting Services by Leo Ratnik and Associates Ltd. for preparation of flowsheet; invoice No. 400-17 dated May 31, 1978			$ 464.47
Total Account (U.S. Funds)			$ 3,068.07

APPROVED: J. A. Abramo
VERIFIED: Alan J. Soderstrom
CHARGE:

RECEIVED JUN 5 1978

LEO RATNIK AND ASSOCIATES LTD.
CONSULTING ENGINEERS

MINING, MINERALS PROCESSING, AND INDUSTRIAL PLANTS
DESIGN AND ENGINEERING

L. RATNIK, P.ENG., C.E.
T. RATNIK, P.ENG.

2249 YONGE STREET - SUITE 203
TORONTO, ONTARIO M4S 2B1

TEL.: (416) 485-0363

File: 400
May 31, 1978

A.H. Ross & Associates
80 Richmond Street West
Toronto, Ontario
M5H 2A4

Attention: Mr. K.R. Coyne, P. Eng.

Subject: Minerals Exploration Company
Anderson Uranium Mill

INVOICE #400-17

Re: Drafting services for preparation of flowsheets under direction of Mr. M.E. Grimes as detailed below:

E. Hudson - May 2, 1978 - May 8, 1978

29.5 hours @ $15.00	$ 442.50
Blueprinting and reductions	$ 21.97
	$ 464.47

Approved for payment
[illegible] June 5/78

TR:EH

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

3-37

Minerals Exploration Company
P. O. Box 50324
Tucson, Arizona 85703, U.S.A.

Attention: Mr. J. A. Abramo

INVOICE No. 4850

DATE August 31, 1978

TERMS Net 15 days

Account for August, 1978-

J. ABRAMO
SEP 7 1978
Mgr. Met. Opr.

Services Rendered: Anderson Uranium Project

Minimum Monthly Fee	$1,000.00

Unused time will be accumulated and credited toward future visits or other assigned work.

Total Account (U.S. Funds) $1,000.00

3-37

A. H. ROSS & ASSOCIATES

CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
1706 - 80 RICHMOND STREET WEST
TORONTO, ONTARIO M5H 2A4
CANADA

A. H. ROSS - PRINCIPAL
K. R. COYNE - PRINCIPAL ASSOCIATE (SENIOR)
N. GIBSON - PRINCIPAL ASSOCIATE

D. H. EBERTS - SENIOR ASSOCIATE
M. J. LAKE - SENIOR ASSOCIATE
D. F. LILLIE - SENIOR ASSOCIATE
R. H. RICHARDS - SENIOR ASSOCIATE

W. V. BARKER
M. E. GRIMES
A. S. HAYDEN
R. C. SWIDER
E. W. S. WARD

CODE 416-366-1653
CABLE "ROSSONTO"
TELEX 06-22325 (ROSSONTO TOR.)

J. ABRAMO
OCT 26 1978
Mgr. Met. Opr.

October 23, 1978

Mr. J. A. Abramo
Minerals Exploration Company
P.O. Box 50324
Tucson, Arizona 85703
U.S.A.

Dear John:

Re: Consulting Services Agreements

Further to our telephone conversation of this date we enclose copies of the following letters:

December 10, 1975 letter from W. R. Moran to K. R. Coyne with enclosed December 2, 1975 contract for metallurgical services on the Red Desert Project.

November 11, 1977 letter from A. H. Ross to E. H. Eakland re revisions to fee structures for the Sweetwater and Anderson Projects.

Yours very truly,

K. R. Coyne, P. Eng.

KRC:mlh

Minerals Exploration Company
Dr. # 1

AHR KRC EWW MEG

November 11th, 1977

Minerals Exploration Company
P.O. Box 54945
Los Angeles, California 90054
U.S.A.

Attention: Mr. E. H. Eakland

Dear Sir:

Metallurgical Consulting Services for the
Sweetwater and Anderson Projects

Since 1975, our consulting services to Minerals Exploration Company have been provided under the terms of an employment contract dated December 2nd, 1975.

Since 1975, our costs for salaries and overhead expenses have increased appreciably as a result of the prevailing inflationary factors; and in general, schedules in the consulting field have risen substantially; Consequently we wish to give notice of the following changes in the "Fees' schedule; in all other respects, the terms of the agreement of December 2nd, 1975 shall remain unchanged.

Fees

A. H. Ross	$500 per day
K. R. Coyne	$400 per day
N. Gibson	$375 per day
Other staff engineers	$325 per engineer per day

The above fees include home office, stenographic and normal office expenses. They are based upon U.S. Funds.

The revised rates will become effective January 1st, 1978.

November 11th, 1977

In determining the proposed fee structure, we have endeavoured to give consideration to all relevant economic factors. We believe that the revised rates shown above are lower than the fees being charged by responsible consulting firms in North America for equivalent effort.

We wish to express our appreciation for the opportunity to be of service to the Minerals Exploration Company.

Yours sincerely,

A. H. Ross, P. Eng.

AHR:mlh

AFR N-1

MINERALS EXPLORATION COMPANY

P.O. BOX 54945
LOS ANGELES, CALIFORNIA 90054

December 10, 1975

W. R. MORAN
VICE PRESIDENT & GENERAL MANAGER

461 SO. BOYLSTON ST.
LOS ANGELES, CALIF. 90017
AREA CODE (213) 486-6934

Mr. K. R. Coyne
A. H. Ross & Associates
1706-80 Richmond Street West
Toronto, Ontario M5H 2A4
Canada

Re: Consulting Contract

Dear Ken:

I have your letter of December 2, enclosing your contract for consulting metallurgical services for the Red Desert project in Wyoming. Our lawyers have ok'd the contract as you have written it with the only additional stipulation being that we have a certificate from you indicating Union Oil Company of California and Minerals Exploration Company will be named as an additional insured under coverage as listed in the attached memo from Assistant Counsel Robert L. Humphrey, dated December 10, 1975. I presume this is a pretty standard requirement and there will be no problem in your giving us such a certificate. If so, please return same to me at your convenience.

All nine of the contractors we invited to bid on the feasibility study have accepted the invitation (unfortunately) and their bids are to be in this office by December 17. We will probably select the top three for further interviews sometime before the end of the year or early in 1976. We expect to actually award feasibility study bid by January 16, 1976. When we get the field narrowed down to three, we will undoubtedly contact you or Al for any thoughts you may have on the matter.

All of us are looking forward to working with you and Al.

Best regards,

Bill

WRM:mn
Enclosure

cc: W. C. Goth w/encl.
G. C. Dohm, Jr. w/encl.
R. L. Humphrey

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
1706-80 RICHMOND STREET WEST
TORONTO, ONTARIO M5H 2A4
CANADA

A. H. ROSS - PRINCIPAL
K. R. COYNE - PRINCIPAL ASSOCIATE (SENIOR)
J. M. HEMSTOCK - PRINCIPAL ASSOCIATE
D. F. LILLIE - SENIOR ASSOCIATE

D. H. EBERTS
M. J. LAKE
R. H. RICHARDS
R. C. SWIDER

CODE 416-366-1653
CABLE "ROSSONTO"

December 2, 1975

Minerals Exploration Company,
P.O. Box 54945,
Los Angeles, California
90054 - U.S.A.

Attn: Mr. W.R. Moran

Consulting Metallurgical Services
for the Red Desert Project

Dear Sir:

As requested during our recent telephone conversation, we are pleased to outline the terms and arrangements under which we will provide consulting metallurgical services on your Red Desert Uranium Project.

1. Scope of Activities

To the extent required and as requested by you, we will provide any or all of the following services. No work would be undertaken on your behalf without prior authorization or requests by you.

1.1 Process Development

We shall direct and co-ordinate the testwork activities on ore samples to develop the process. We shall assume responsibility for the interpretation and economic evaluation of the results, for the selection of a recommended flowsheet, and for the collection of the necessary engineering and equipment design data. The test results will be reviewed from the viewpoint of recovery, capital and operating costs, product quality, circuit and equipment alternatives, optimization of operating costs, etc.

1.2 Cost Estimates

As may be desirable, we can assist with the preparation of project evaluation studies including capital and operating costs, value of production, engineering and construction schedules.

2.....

1.3 Specifications and Design Data:

We shall prepare a process design criteria report. This document will be required by the firm that undertakes detailed engineering design of the commercial plant and includes flowsheets, material balances, process description, design criteria for the major equipment, materials of construction; analytical, sampling, instrumentation, utility and personnel requirements; and consumption of chemicals and supplies.

1.4 Detailed Engineering:

The detailed engineering design of the commercial facilities would be undertaken by a firm selected by you. As your representative, we shall review all general arrangement drawings, process prints, piping and instrumentation, detailed mechanical designs, equipment specifications and proposals, materials of construction, bidders' lists for equipment purchase, cost estimates, project schedules and progress reports prepared by the engineering firm. These reviews would be to ensure that the design will permit the plant to meet the processing objectives in terms of metal recoveries, production rates, estimated operating costs, etc.

1.5 Construction:

We will provide assistance as may be necessary during construction of the commercial plant. During the latter stage of construction, periodic visits will be made to the site to review and comment upon the adequacy of equipment installations.

1.6 Production Operations:

We shall assist your staff in bringing the plant into operation and in achieving maximum efficiency, and act in a consulting capacity to management on metallurgical matters pertaining to its operation.

1.7 General:

Generally and in addition to the above, our duties will be to act in an advisory capacity to you and your staff, and to report and consult with you as may be required.

To the extent that you may request from time to time, we shall assist on any other phases of your project.

3.....

2. Communications and Reports

Copies of pertinent prints, reports, correspondence and other relevant data will be supplied for our use.

Reports will be submitted as requested by you, copies of our correspondence will be supplied to you, and all important matters that arise in our efforts will be confirmed by letter.

3. Representatives of A.H. Ross & Associates

The detailed work on your project will be undertaken by one or more (if necessary) of our staff engineers. A.H. Ross and/or K.R. Coyne will supervise and direct the work of our firm.

4. Confidential Nature of Work and Patents

In connection with the work contemplated, A.H. Ross & Associates agree to keep confidential the information received from Minerals Exploration Company, together with the data developed by outside testing facilities and the staff of A.H. Ross & Associates.

Any and all patentable inventions, applications for patents and patents thereon relating to the subject matter of the project which may be made by A.H. Ross & Associates, during the time they are performing work on the project and as a result thereof, will become the property of Minerals Exploration Company.

5. Estimated Costs

Based on our experience with generally similar projects, we estimate that the cost of our services will be approximately as follows:

Supervision of testwork and preparation of design criteria (items 1.1 and 1.3 above)	$15,000 - $25,000 over a 4 month period
Activities during preparation of feasibility study and detailed engineering design phase (items 1.2 and 1.4 above)	$ 4,000 per month on an average, for 16 months
Assistance during the construction phase (item 1.5 above)	$ 1,500 per month on an average, for 12 months

4.....

6. Fees

Charges for our services shall be on the basis of a per diem fee for the actual time expended by our engineering staff on your behalf. The following schedule of fees is currently in effect:

A.H. Ross	$400. per day
K.R. Coyne	$325. per day
W.V. Barker	$300. per day
N. Gibson	$300. per day
Other Staff Engineers	$250. per day, per engineer.

The above fees include home office, stenographic and normal office expenses.

The minimum total monthly fee shall be $1,000.

7. Expenses

In addition to the above fees, we shall invoice at cost for any long distance telephone, telegraph, cable, travelling expenses, photostating and blueprint work, supplies and outside clerical and secretarial assistance that may be required.

8. Payment

All fees and expenses are based upon U.S. funds; our accounts will be payable in U.S. funds or the equivalent.

Invoices from A.H. Ross & Associates will be rendered at the end of each month; and will be due and payable within fifteen calendar days from date of invoice.

9. Effective Contract Date

This contract shall take effect on the date of acceptance or as designated by you.

10. Modification or Cancellation

This contract may be modified or cancelled at any time by either party giving to the other, written notice at least one month prior to the proposed date of cancellation or modification.

5.....

December 2, 1975

If these arrangements are satisfactory, we would appreciate your returning one signed copy of this letter.

Yours very truly

K.R. Coyne, P. Eng.

KRC:er

Accepted by: Minerals Exploration Company

Name: W.R. Moran

Title: Vice President and General Manager

Date: December 10, 1975

Property Damage: $100,000 each occurrence
$300,000 aggregate

Robert L. Humphrey
Assistant Counsel

RLH:ev

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

3-37

Minerals Exploration Company,
P.O. Box 50324,
Tucson, Arizona 85703,
U.S.A.

Attention: Mr. J.A. Abramo

INVOICE No. 4913

DATE October 31, 1978

TERMS Net 15 days

Account for October, 1978

Services Rendered: re. Anderson Uranium Project

Minimum monthly fee	$1,000.00
Unused time will be accumulated and credited toward future visits or other assigned work	
Long Distance Telephone and Telegraph	$ 3.00
Total Account for October	$1,003.00
Outstanding Account for September (Copy enclosed)	$1,000.00
Total Accounts Owing (U.S. Funds)	$2,003.00

J. ABRAMO
NOV 6 1978
Mgr. Met. Opr.

APPROVED: J.A. Abramo
VERIFIED:
CHARGE:

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

Minerals Exploration Company,
P.O. Box 50324,
Tucson, Arizona 85703,
U.S.A.

Attention: Mr. J.A. Abramo

INVOICE No. 4883

DATE September 30, 1978

TERMS Net 15 days

Account for September, 1978

Services Rendered: re. Anderson Uranium Project

Minimum Monthly Fee	$1,000.00
Unused time will be accumulated and credited toward future visits or other assigned work.	
Total Account for September	$1,000.00

COPY

3-37

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

J. ABRAMO
DEC 7 1978
Mgr. Met. Opr.

Minerals Exploration Company
Post Office Box 50324
Tucson, Arizona
85703, U.S.A.

Attention: Mr. J. A. Abramo

INVOICE No. 4941

DATE November 30, 1978

TERMS Net 15 days

Account for November, 1978

Services Rendered re Anderson Uranium Project

Minimum monthly fee	$1,000.00
Unused time will be accumulated and credited toward future visits or other assigned work.	
Long Distance Telephone and Telegraph	$ 33.58
Photostating and Duplicating	$ 1.92
Total Account (U.S. Funds)	$1,035.50

APPROVED: J. A. Abramo
VERIFIED: Jean J. Sudbrutzen
CHARGE:

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

CERTIFICATE OF ANALYSIS

Element	AM-730 30-35	AM-730 50-55	AM-730 60-65	AM-730 145-150
Copper	72	96	120	100
Zinc	9	63	63	85
Lead			84	50
Arsenic			9	
Iron	12000	11000	11000	14000
Nickel			11	30
Rubidium	110	120	120.	110
Barium	1900	1800	2100	1700
Strontium	620	680	760	500
Titanium	490	970	1300	970
Zirconium	290	320	300	330
Vanadium		76		
Uranium	30	30		
Manganese	220	330	260	260
Yttrium	22	22	33	

TO:
MINERALS EXPLORATION COMPANY
Development Group
P. O. Box 50324
Attn.: Robert Lucht
Tucson, Arizona 85703

REMARKS:
X-Ray spec (semi-quant)

CERTIFIED BY:

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
3/23/78	4/7/78	TDN 001

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

3-37

Minerals Exploration Company
Post Office Box 50324
Tucson, Arizona
85703, U.S.A.

Attention: Mr. J. A. Abramo

INVOICE No. 4970

DATE December 29, 1978

TERMS Net 15 days

J. ABRAMO
JAN 8 1979
Mgr. Met. Opr.

Account for December, 1978

Services Rendered re: Anderson Uranium Project

Minimum Monthly Fee	$1,000.00

Unused time will be accumulated and credited toward future visits or other assigned work.

Photostating and Duplicating	$ 1.06
Total Account for December	$1,001.06
Outstanding Account for November (copy enclosed)	$1,035.50
Total Accounts Owing (U.S. Funds)	$2,036.56

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

Minerals Exploration Company
Post Office Box 50324
Tucson, Arizona
85703, U.S.A.

Attention: Mr. J. A. Abramo

INVOICE No. 4941

DATE November 30, 1978

TERMS Net 15 days

Account for November, 1978

Services Rendered re Anderson Uranium Project

Minimum monthly fee	$1,000.00
Unused time will be accumulated and credited toward future visits or other assigned work.	
Long Distance Telephone and Telegraph	$ 33.58
Photostating and Duplicating	$ 1.92
Total Account (U.S. Funds)	$1,035.50

COPY

Minerals Exploration Company
Mine Development Group
1846 W. Grant Road, Suite 108
P.O. Box 50324
Tuscon, Arizona 85703
Telephone: (602) 884-8073

union 76
MINERALS

Head Office:
P.O. Box 54945
Los Angeles, California 90054
(213) 486-6929

February 1, 1979

Dr. James K. Otton, Geologist
UNITED STATES GEOLOGICAL SURVEY
Box 25046, Mail Stop 916
Office of Energy Resources
Denver, CO 80225

Dear Dr. Otton:

On January 5, 1979 you called our Tucson office requesting meteorological data from our Anderson Uranium Project. I have made a number of attempts to contact you at 303-234-3481 and have had no success. Therefore, I would appreciate it if you would call me back so I can get specific information as to what data you need.

Very truly yours,

MINERALS EXPLORATION COMPANY

Terrence L. Larson

Terrence L. Larson
Environmental Engineer

TLL/cll

Union Energy Mining Division

Union Oil Company of California
1846 W. Grant Road, Suite 105
Tucson, Arizona 85705
Telephone: (602) 884-8073

union 76

Head Office
P.O. Box 7600
Los Angeles, California 90051
(213) 486-6929

February 29, 1980

United States Department of the
Interior
Geological Survey
Denver Federal Center
Denver, Colorado 80225

Dear Mr. Otton:

Your letter of February 11 to John Abramo has been referred to me for action.

You are hereby authorized to conduct the sedimentologic and geochemical studies on the core from AM-443 for preparation of the Professional Paper on the Anderson Mine.

Very truly yours,

UNION ENERGY MINING DIVISION

Dean J. Soderstrom

Dean J. Soderstrom
Manager of Project Development

DJS/pjd

cc: J.A. Abramo
D.T. Arrieta

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

3-37
~~2-26~~

Minerals Exploration Company,
Post Office Box 50324,
Tucson, Arizona 85703 U.S.A.

Attn: Mr. J.A. Abramo

INVOICE No. 5056

DATE March 30th 1979

TERMS Net 15 days

Account for March 1979

Services rendered re: Anderson Uranium Project.

Minimum monthly fee	$1,000.00

Unused time will be accumulated and credited toward future visits.

Long Distance Telephone and Telegraph	$ 9.00
Photostating and Duplicating	$ .77
Total Account for March	$1,009.77
Outstanding Account for February 1979 (copy attached)	$2,045.31
Total Accounts Owing (U.S. Funds)	$3,055.08

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

Minerals Exploration Company
Post Office Box 50324
Tucson, Arizona 85703
U.S.A.

Attn: Mr. J.A. Abramo

INVOICE No. 5029

DATE February 28th 1979

TERMS Net 15 days

Account for February 1979

Services Rendered re Anderson Uranium Project.

A.H. Ross	0.4 days @ $500./day = $200.00	
M.E. Grimes	2.0 days @ $325./day = $650.00	
A.S. Hayden	2.8 days @ $325./day = $910.00	
E.W. Ward	0.7 days @ $325./day = $227.50	$1,987.50
Long Distance Telephone and Telegraph		$ 34.52
Photostating and Duplicating		$ 23.29
Total Account for February		$2,045.31

COPY

3-37

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

Minerals Exploration Company
1846 West Grant Road, ste. 108
Tucson, Arizona 85705 U.S.A.

Attn: Mr. J.A. Abramo

INVOICE No. 5148

DATE June 29th 1979

TERMS Net 15 days

Account for June 1979

Services rendered re Anderson Uranium Project.

Minimum monthly fee	$1,000.00

Credit balance in unused time $3,710.00 as at June 29th, in favour of Anderson Project to be applied to future visits or other assigned work.

Long Distance Telephone and Telegraph	$ 15.84
Total Account for June	$1,015.84
Outstanding Account for May (copy attached)	$1,000.00
Total Accounts Owing (U.S. Funds)	$2,015.84

TELEPHONE
366-1653

A. H. ROSS & ASSOCIATES
CONSULTING CHEMICAL & METALLURGICAL ENGINEERS
SUITE 1706
80 RICHMOND STREET WEST
TORONTO, ONTARIO, CANADA M5H 2A4

Minerals Exploration Company
Post Office Box 50324
Tucson, Arizona 85703
U.S.A.

Attn: Mr. J.A. Abramo

INVOICE No. 5114

DATE May 31st 1979

TERMS Net 15 days

Account for May 1979

Services rendered re Anderson Uranium Project:

Minimum monthly fee	$1,000.00

Credit balance as at May 31st 1979, in favour of Anderson Project $2,755.00 to be applied to future visits or other assigned work.

Total Account (U.S. Funds)	$1,000.00

COPY

5-55

Minerals Exploration Company
Mine Development Group
1846 W. Grant Road, Suite 108
P.O. Box 50387
Tuscon, Arizona 85703
Telephone: (602) 884-8073

union 76 MINERALS

J. ABRAMO
JUL 3 1979
Mgr. Met. Opr.

Head Office:
P.O. Box 54945
Los Angeles, California 90054
(213) 486-6929

July 3, 1979

Mr. Tom Bailey
Woodward-Clyde Consultants
Three Embarcadero Center, Suite 700
San Francisco, California 94111

RE: ANDERSON URANIUM PROJECT

Dear Tom:

Review and consideration has been given to your June 22, 1979 letter discussing the additional funds required because of the extra consulting services provided for the authorized chemical and physical investigations of selected geological materials from the Anderson Project. The sum of $7,500 for the additional services is approved. However, the following items should be noted:

(1) All future requests for additional services should not be undertaken until Woodward-Clyde has provided a written cost estimate and received written approval.

(2) Accounting for all future services should be set up so costs are broken out for each individual item rather than the lump sum system used in this letter.

(3) Results and determinations made from (1) the Anderson site visit, and (2) the microscropic examination and evaluation of additional soil samples has not yet been included in the draft of the report: "Chemical and Physical Investigation on Lakebed Sediments from the Anderson Uranium Project". This will be discussed in forthcoming comments on the draft report. Complete billing should not be presented for payment until the final report has been accepted.

(4) Since the draft report discussed above does not contain the results of some chemical analysis and the permeability results of the lakebed liner material, we have considered the draft report to be a preliminary draft report. Therefore, we feel that upon completion of these tests another draft report be issued for comment before preparation of the final report. Our forthcoming comments on this report will reflect this concept.

(5) It is understood the completion of the above referenced report will require no additional funds for completion.

With respect to the rewrite of the baseline hydrology report and water quality section of the environmental report, your proposal of $6,000 to complete the work is acceptable. A service contract for this work is enclosed. The following items should be noted:

(1) Water Development's final report on hydrology is near completion. No work should begin until you have received this report.

(2) Since this rewrite will be included in the AAEC application in its entirety, the page and figure numbers will need to be coordinated to save us from redoing work for inclusion in the AAEC application. Also as a result of the work currently underway on the new feasibility study, a number of the figures in the report will require some minor revision. These revisions will be coordinated with you as soon as possible. Also, since the rewrite will be submitted prior to the completion of the AAEC application to NRC, the final copies will require an index and binding to stand as a separate report.

(3) Realizing there has been a delay in approving this work, it is hoped that a draft of this report can be completed by August 1, 1979. It is requested that you confirm a draft completion date at your earliest convenience.

Data necessary for you to complete a more accurate cost estimate for the rewrite of the baseline radiological consideration will be sent to you as soon as it is available. At that time we will write a service contract for that work.

If you have any questions about the contents of this letter, please contact me.

Very truly yours,

MINERALS EXPLORATION CO.

G.C. Dohm, Jr.
Mine Development Manager

GCD/mlm

Enclosure

cc: J.A. Abramo
T.L. Larson
R.Y. Salisbury

Service Contract
Minerals Exploration Company

union 76
MINERALS

This number must appear on all documents

A.F.E. No.	Contract No.
108	79-7

Project Name/Location
Anderson Mine - Yavapai Co., AZ

THIS AGREEMENT entered into this 3rd Day of July, A.D. 19 79

between Minerals Exploration Company, 1846 W. Grant Rd., Tucson, Arizona 85703 (ADDRESS)

(Minerals),

and Woodward-Clyde Consultants

Three Embarcadero Center, Suite 700, San Francisco, CA 94111 (ADDRESS) (Contractor),

WITNESSETH:

In consideration of the mutual agreements herein contained, it is agreed as follows:

1. DESCRIPTION OF SERVICE(S) TO BE PERFORMED BY CONTRACTOR
Contractor shall:

Conduct work for the rewriting of the Hydrology and Water Quality Section of the Anderson Uranium Project Environmental Report as per labeled in the enclosed Exhibit 'A'.

at the following location(s)

Such Service(s) to commence on or before July 3, 1979 and to be completed by/within Sept. 1, 1979

2. TERMS OF PAYMENT
Minerals shall pay Contractor at the following rates (including terms of payment) for the above: Contractor will bill MINERALS for each 30 days work at the rates described in Exhibit 'A'. Payment to be within 30 days following receipt of contractor's invoice.

3. OTHER TERMS AND CONDITIONS

ALL PROVISIONS APPEARING ON THE REVERSE SIDE OF THIS CONTRACT ARE A PART OF THIS CONTRACT. CONTRACTOR HAS READ AND AGREES TO THE SAME.

Contractor _____ Bond ☐ is ☒ is not required

_____ Lic. No. _____ Minerals Exploration Company

By _____ By _____

Title _____ Title Manager, Mine Development

FORM ME-3C23 (REV. 11-78) PRINTED IN U.S.A.

COST OF REWRITING HYDROLOGY AND WATER QUALITY
SECTION OF ANDERSON URANIUM PROJECT ENVIRONMENTAL REPORT

Subject	Cost (Thousands)
Evaluation and Preparation of Section	
Baily	1.4
Champlin	1.5
Kiefer	1.6
Typing, Editing, Proofing, and Illustrating[a]	1.5
Total	6.0

[a]Assumes that WCC will prepare 10 cpies of the final section.

EXHIBIT 'A'

Minerals Exploration Company
Mine Development Group
1846 W. Grant Road, Suite 108
P.O. Box 50324
Tuscon, Arizona 85703
Telephone: (602) 884-8073

union 76
MINERALS

Head Office:
P.O. Box 54945
Los Angeles, California 90054
(213) 486-6929

July 10, 1979

Mr. Tom Bailey
Woodward-Clyde Consultants, Inc.
Three Embarcadero Center, S. #700
San Francisco, CALIF. 94111

Dear Tom:

Enclosed are our comments on the draft report titled "Chemical and Physical Investigation on Lakebed Sediments From the Anderson Uranium Project Site" dated June 8, 1979. To make the comments easier to follow, comments have been incorporated into a copy of the draft report.

Basically, we have considered the draft report to be a preliminary draft report because it did not contain all laboratory test results including the permeability tests currently being conducted. Without the inclusion of these test results it was not possible to finalize the conclusion section to the degree needed. Therefore, we request that when the report is completed with all data and conclusions it should be issued as a draft for comments prior to preparation of the final report.

Also, I recommend that an executive type of summary be written as a cover letter to the final report to state what the purpose of the report is and what the conclusions are. This will give a quick management overview of the report in layman terminology.

I will be happy to discuss these comments with you if necessary.

Very truly yours,

MINERALS EXPLORATION CO.

Terrence L. Larson

Terrence L. Larson
Environmental Engineer

TLL/mlm

Enclosure

cc: G.C. Dohm, Jr.
R.J. King, Jr.
D.J. Soderstrom

"PRELIMINARY"
DRAFT COPY

CHEMICAL AND PHYSICAL INVESTIGATION ON

LAKEBED SEDIMENTS FROM THE ANDERSON URANIUM PROJECT SITE

By

WOODWARD-CLYDE CONSULTANTS

June 8, 1979

Contains comments from
Minerals Exploration
7/6/79

INTRODUCTION

In January 1979, Minerals Exploration Company contracted Woodward-Clyde Consultants to conduct chemical and physical investigations of the waste rock, ore, tailings impoundment liner, and subliner material on the Anderson Uranium Project site. The objectives of these investigations were as follows:

These should be addressed in the conclusion

- determine the potential for the seepage of radiological and/or toxic materials from the tailings impoundment during the life of the project and after project termination
- determine the potential for leaching radiological and/or toxic materials from waste dumps
- determine the probable disposition of seepage from the impoundment and leachate from waste dumps.

At the time this study was initiated, the tailings disposal area for the proposed mill was to be located in an exhausted portion of the surface mine. Overburden and waste rock from the ore zone was to be deposited to the east-northeast and west-northwest of the active mine in the vicinity of well established drainage courses. The waste rock examined in this study generally consisted of noneconomic portions of the ore zone. The ore consisted of mineralized portions of Tertiary lakebed sediments lying immediately below the ore zone that could serve as an in-place liner for the tailings impoundment once the ore was removed. The subliner material consisted of that portion of the lakebed sediments that underlies the liner material.

Still is

However, positive drainage is still achieved the statement is ambigious

A map should be provided showing were material came from and from what zones — this has been provided to WCC

Since this study was begun, the location of the proposed tailings impoundment has been changed and the impoundment is being redesigned. However, it is believed that the results of the chemical and physical investigations are still largely applicable to the facility.

why? — doesn't the field trip and other data give enough to a positive supported statement?

A total of five chemical analyses have been conducted on samples of each of the four materials. These analyses are: acid titre, water extraction, ammonium acetate extraction, acid extraction, and total content. The results of the acid titre are still being analyzed and will be reported at a later date. The results of the other four tests are discussed in this report.

Why the 4 tests what are they expected to do?

Results will be in the final report

Samples of all four materials have been examined microscopically and Atterberg limit determinations and compaction tests have been conducted on a sample of the liner material (Appendix A). Tests to estimate the permeability of the liner material using water and a synthetic tailings liquor were begun in the first week of June 1979. The results of these tests will be reported at a later date.

While it was not the original intent of this study to evaluate ionic distribution coefficients for the materials and extracts involved, a number of questions concerning the mobility of radionuclides through on-site geologic materials have prompted an attempt to estimate values of those coefficients. Estimated distribution coefficients for uranium-238, thorium-230, and radium-226 are provided in this report for each of the leaching agents (i.e., water, acid, and ammonium acetate) used in the investigations.

explain what a distribution coefficient is.

METHODOLOGY

All of the tests used for the chemical investigations were derived from standard procedures described in the U.S. Department of Agriculture Handbook No. 60 (1969). Detailed descriptions of pertinent methodologies are provided in Appendix B.

RESULTS AND DISCUSSION

Microscopic Examination

Examination of the waste rock, ore, liner, and subliner material with a high-power light (polarizing) microscope showed little sedimentary differences or variations in basic physical composition between the materials. All four materials are very fine grained (generally <10μ and >0.5μ in size) with a distinctly particulate nature. Most of the particles were granular with well-defined, sharp outlines, and no rounding. None of the materials exhibited significant visible signs of chemical weathering.

what about discussing the microscopic of the other samples here?

See pg 8. It says there is chemical weathering

The four materials were remarkably subject to dispersion by water, which may account for the limited "swelling" capacity of the liner material described in the tailings dam design report prepared by Dames & Moore (1978). For the most part, swelling clays did not appear to make up a very large portion of the total mass of the materials.

Total Content

Because of their apparent common physical nature, the four materials were composited for the analysis of metals content. The results of this analysis are provided in Table 1.

The principal components of the composite sediment sample (hereafter termed lakebeds) in order of decreasing molar concentration were silica ~~(1.1)~~ 1.0977, aluminum (0.111), calcium (0.0911), magnesium (0.0716),

Hard to Read

Table 1. METALS ANALYSIS OF COMPOSITE SEDIMENT SAMPLE

Elements	Chemical Determination (g/100g)	(moles/100g)	Arc Spectroscopy (g/100g) >10	1-10	0.1-1	0.01-0.1	0.001-0.01	<0.001
Sodium	0.21	0.00913			x			
Potassium	0.70	0.0179			x			
Magnesium	1.74	0.0716			x			
Calcium	3.65	0.0911			x			
Iron	2.6	0.0466		x				
Silica	65.95	1.0977	x					
Boron	<0.1							x
Selenium	0.000134							
Vanadium	0.032					x		
Molybdenum	<0.008							
Aluminum	3.0	0.111		x				
Titanium					x			
Manganese						x		
Copper							x	
Nickel							x	
Strontium							x	
Berylium								x
Lead								x
Silver								x
Zinc								x
Cobalt								x
Chromium								x

iron (0.0466), potassium (0.0179), and sodium (0.00913). The identified metals comprised a total of only 0.347 moles/100 grams of material which is roughly 30 mole percent of the silica.

Elaborate o what the sample is composed of besides met and silica

For the most part, it appears that the bulk of the cations identified by the analysis (including titanium in the arc spec) could be contributed by minor amounts of mafic minerals, such as amphiboles or pyroxenes, and some biotite. The microscopic examination of the materials revealed only very sparing quantities of identifiable feldspars. Therefore, the conclusion must be drawn that the melt from which the lakebeds were derived was very rich in silica with a dusting of dark minerals that had probably formed prior to the eruption.

Very sketchy discussion of geologic model — expand for clarit

Based on what? what is time period? Fit to use in construction

The potential for the lakebeds to weather to an appreciable montmorillonitic content appears quite good. The samples analyzed in this study were taken from subsurface corings. They probably have not been weathered to a significant degree because of the combined effects of low rainfall and the relative impermeability of the sediments. Depending on the term of exposure and potential for prolonged wetting and leaching, outcrop material may show significant montmorillonitic features.

Either they do or they don't — relate to the microscopic examination

a) What about permeability tests on these materials?

b) Also see pg 4 & 8 not consistent

Water Extraction

The quantity of soluble cations and radioactive elements present in the four materials is provided in Table 2 both in terms of concentration in the extract and original sample weight (normalized). All of the major

Table 2. SOLUBLE CATIONS AND RADIOACTIVE ELEMENTS IN THE LAKEBED SEDIMENTS

meq not meg

Elements	Waste Rock		Ore		Liner		Subliner	
Major Components	millimoles/100g	meg/100g	millimoles/100g	meg/100g	millimoles/100g	meg/100g	millimoles/100g	meg/100g
Sodium	37.0	3.5	34.0	2.9	16.7	1.6	7.1	0.41
Potassium	0.8	0.08	0.8	0.07	0.7	0.07	0.14	0.008
Magnesium	3.8	0.73	8.3	1.4	1.78	0.34	0.06	0.007
Calcium	6.3	1.20	13.5	2.3	3.0	0.57	0.10	0.011
Silica	2.0	53.0 μg/g	0.92	22.0 μg/g	0.82	22.0 μg/g	0.50	8.0 μg/g
Minor Components	micromoles/100g	meg/100g	micromoles/100g	meg/100g	micromoles/100g	meg/100g	micromoles/100g	meg/100g
Iron	30.0	1.7	0.8	0.04	4.0	0.22	<0.9	<0.03
Boron	<480	<5	1060.0	10.0	<470	5	<790	<5
Selenium	0.7	0.053	0.6	0.044	<0.1	<0.005	<0.1	<0.005
Vanadium	<11	<0.5	16.0	0.7	<10	<0.5	<17	<0.5
Molybdenum	94.0	8.5	96.0	7.9	5.0	0.5	<4	<0.2
Radioactive Components	pCi/l	pCi/100g	pCi/l	pCi/100g	pCi/l	pCi/100g	pCi/l	pCi/100g
Uranium-239	102.0	54.7	3380.0	578.0	149.0	45.6	15.7	4.79
Thorium-230	31.0	2.96	0.43	0.037	8.3	0.80	0.73	<0.042
Radium-226	23.1	2.18	4.7	0.402	20.0	1.9	2.2	0.128
Thorium-232	2.9	0.27	<0.2	0.017	3.5	0.34	<0.63	<0.036
Thorium-228	1.26	0.11	0.47	0.040	1.28	0.12	<0.3	<0.017
Radium-228	<31.0	<2.96	<23.0	<2.0	<38.0	<3.7	<47.0	<2.68

nonradioactive components of the materials and most of the minor components showed a decrease in solubility with depth. In most cases, soluble cations appear to have accumulated to some degree in the ore horizon. Exceptions to these findings include anomolously low concentrations of soluble iron and anomolously high concentrations of soluble boron in the ore zone. Any guesses as to why & significance

Concentrations of soluble uranium were highest in the ore zone, as would be expected. However, both soluble thorium-230 and radium-226 were well below the levels indicated by the concentration of uranium. A similar, though less defined, trend was also observed for other thorium and radium species. The most mobile (i.e., soluble) thorium and radium was present in the wast rock.
waste

Ammonium Acetate Extraction

The total ion exchange capacity of the materials is presented in Table 3. Total exchangeable cations in the materials decreased from the waste rock through the proposed liner material to the subliner. This may be due to the relative decomposition of the sediment horizons by chemical weathering. Total exchangeable bases also decreased with depth except for an apparent accumulation in the ore horizon (Table 3). This indicates that the ore horizon may have represented an ancient limit to the zone of aeration in the lakebed sediments, with a concomitant accumulation of various elements and minerals that were leached from higher horizons. Based on hydrologic evaluations conducted by Water Development Corporation, this limit may no longer exist.

see pg 4 - says no chemical weathering?

Okay, so what is happening now? what is current limit?

Table 3. ION EXCHANGE CAPACITY OF THE LAKEBED SEDIMENTS (meg/100g)

	Waste Rock	Ore	Liner	Subliner
Total Exchangeable Cations	84	66	65	54
Total Base Exchange	97	102	83	48
Difference	13	36	18	-6

Total base exchange measures the presence of both cations and other components such as colloids, oxides, and hydroxides that may act as cations. In all the materials except the subliner, total exchangeable bases were higher than total exchangeable cations (Table 3). It is likely that some hydroxylated forms of aluminum and iron created by chemical weathering were acting as cations in the base exchange determination. Assuming that all of it was acting as an exchangeable base, the iron identified in the composite analysis (Table 1) would be more than adequate to account for the differences between exchangeable cations and bases reported in Table 3. In the subliner material, total exchangeable cations were higher than total exchangeable bases (Table 3). This result is probably due to analytical error since the two measures should be at least equal.

Van Olphen (1963) has reported a total exchangeable cation value of about 89.5 meq/100g (geometric mean) for a montmorillonite clay using various mono- and di-valent ions (separately) for testing. While the data for total exchangeable cations in Table 3 might be construed to indicate that a substantial portion of the materials were montmorillonitic, neither simple physical dispersion tests nor microscopic examination substantiate this assertion. It would be more prudent to say that due to their general composition, grain size, and the presence of clean, angular particulate surfaces that are exceptially active, the materials approach the exchange capacity of montmorillonite.

Table 4 presents the concentrations of cations (including radioactive elements) that were extracted from the materials with ammonium acetate. The table also includes comparable data for soluble cations and the concentrations of exchangeable cations. Except for sodium and magnesium, between 90 and 100 percent of the extractable portions of the major ions were exchangeable. Exchangeable sodium constituted only 63 percent of the total that was extracted from the waste rock and ore, 69 percent of the total extracted from the liner material, and 94.5 percent of the sodium extracted from the subliner. Over 90 percent of the extractable magnesium was exchangeable in all of the materials except the ore where only about 82 percent of the extracted element was exchangeable.

The total quantity of silica in the materials decreased with depth; however, the amount of exchangeable silica increased significantly from the wast waste rock (70 percent of the total extractable) to the subliner (93.6 percent of the total extractable). This reaction may be attributable to ion exchange in the form of charged colloids.

Of the extracted radioactive ions, uranium was almost entirely exchangeable. Extracted thorium-230 and radium-226 were also essentially 100 percent exchangeable in the ore, but only 61 and 83 percent exhangeable, respectively, in the waste rock. These relationships may be the result of solution attack by the ammonium acetate on carbonates associated with the uranium mineral grains rather than actual exchangeable features of the radioactive components of the materials. However,

Table 4. EXTRACTABLE AND EXCHANGEABLE CATIONS IN THE LAKEBED SEDIMENTS

meq not mg

Elements	Waste Rock Ext	Waste Rock Sol	Waste Rock Exch[a]	Ore Ext	Ore Sol	Ore Exch	Liner Ext	Liner Sol	Liner Exch	Subliner Ext	Subliner Sol	Subliner Exch
Major Components (meq/100g)												
Sodium	9.5	3.5	6.0	8.0	2.9	5.1	5.2	1.6	3.6	7.5	0.41	7.09
Potassium	2.2	0.08	2.12	1.7	0.07	1.63	1.8	0.07	1.73	2.0	0.008	1.99
Magnesium	10.7	0.73	9.97	7.7	1.4	6.3	10.5	0.34	10.16	7.5	0.007	7.49
Calcium	66.7	1.2	65.5	55.0	2.3	52.7	50.0	0.57	49.43	37.5	0.011	37.49
Minor Components (g/g)												
Iron	<1.25	1.7	-	<1.25	0.04	-	<1.25	0.22	-	<1.25	<0.03	-
Silica	175	53	122	150	22	128	175	22	153	125	8	117
Boron	<125	<5	-	<125	10	-	<125	<5	-	<125	<5	-
Selenium	<0.125	0.053	-	0.175	0.044	-	<0.125	<0.005	-	<0.125	<0.005	-
Vanadium	<12.5	<0.5	-	12.5	0.7	-	<12.5	<0.5	-	<12.5	<0.5	-
Molyedenium	<10	8.5	-	15	7.9	-	<10	0.5	-	<10	<0.2	-
Radiactive Components (pCi/100g)												
Uranium - 138 238	241	8.6	233	4375	293	4082	170	14.2	155.8	62.5	0.81	61.7
Thorium - 230	1.23	0.47	0.76	19.7	<0.02	19.7	1.10	0.25	0.85	<0.34	<0.007	<0.33
Radium - 226	2.05	0.35	1.7	116.8	0.20	116.6	12.5	0.59	11.9	2.45	0.15	2.3
Thorium - 232	0.05	0.043	0.007	1.39	<0.01	1.39	<0.38	0.10	<0.28	<0.34	<0.006	<0.33
Thorium - 228	0.1	0.02	0.08	1.90	0.02	1.88	2.20	0.04	2.16	0.84	<0.003	0.84
Radium - 228	<1.3	<0.47	<0.83	<124	<0.96	<124	<43.5	<1.14	<42.4	<53.6	<0.75	<53

[a]Ext = extractable
Sol = soluble
Exch = exchangeable

no such parallel was observed for calcium and magnesium, two nonradioactive elements with analogous chemistry to radium.

By averaging the results of the ammonium acetate extraction for all the materials, the total concentration of each of the major nonradioactive components as well as iron and silica can be compared to the average proportion that is extractable, soluble, and exchangeable (Table 5). Approximately one percent of the alkali and alkali earth metals that are present in the lakebed sediments are in a soluble form. Approximately 19 percent of these metals are in exchangeable form. Sodium represents the bulk of the alkali and alkali earth metals that are soluble while calcium constitutes most of the exchangeable alkali and alkali earth metals. Although significant proportions of silica are either soluble or exchangeable, the quantities are small relative to the total silica content of the materials.

Acid Extraction

Fifty grams each of waste rock, ore, liner, and subliner material were extracted with 500 milliliters of 1.5 pH sulfuric acid. The concentrations of cations and radioactive elements removed from the materials by this reagent are given in Table 6.

A comparison of the results for calcium, iron, and pH suggest that the ore and liner material have the highest carbonate content of the lakebed sediments and are capable of buffering the quantity of acid used in this test. The subliner material apparently lacks significant

Table 5. COMPARISON OF AVERAGE AMMONIUM ACETATE EXTRACTION TO TOTAL CONTENT OF COMPOSITE SEDIMENT SAMPLE[a]

Elements	Composite Sample (meq/100g)	Average Extractable meq/100g	%[b]	Average Soluble meq/100g	%	Average Exchangeable meq/100g	%
Major Components							
Sodium	9.13	7.55	82.7	2.10	23.0	5.45	59.7
Potassium	17.9	1.93	10.8	0.057	0.32	1.87	10.4
Magnesium	143.2	9.1	6.4	0.619	0.43	8.48	5.92
Calcium	182.2	52.3	28.7	1.02	0.56	51.3	28.2
Minor Components	µg/g	µg/g	%	µg/g	%	µg/g	%
Iron	26,000	<1.25	0	0.50	0	-	0
Silica	659,500	156	0.024	26	0.00	130	0.02

[a] Radioactive elements were not determined for the composite sample; therefore, they are not reported in this table.

[b] % = percent of total content.

[c] Boron, selenium, vanadium, and molybdenum are not included since their concentrations in the extracts were often below the level of detection.

Table 6. ACID EXTRACTION FROM THE LAKEBED SEDIMENTS
(4 hour equilibration)

Elements	Waste Rock	Ore	Liner	Subliner
Major Components (meg/100g)				
Sodium	6.52	4.78	3.47	6.09
Potassium	0.72	0.38	0.85	0.82
Magnesium	7.16	5.0	4.33	7.83
Calcium	50	50	65	95
Minor Components (µg/gm)				
Iron	3.0	0.02	0.05	3.5
Silica	44.0	15.0	20.0	75.0
Boron	0.17	2.3	0.14	0.015
Selenium	0.43	0.315	0.40	0.64
Vanadium	0.08	0.37	0.04	0.57
Molybdenum	16.0	34.0	19.0	15.0
pH	4.2	7.8	8.0	2.4
Radioactive Components (pCi/100g)				
Uranium-238	36.4	425.3	73.7	54.7
Thorium-230	<1.5	60.2	28.2	<2.5
Radium-226	5.12	31.3	15.5	2.44
Thorium-232	<0.72	<0.94	<0.96	<0.82
Thorium-228	<1.5	<0.94	<2.8	<0.82
Radium-228	<10.7	<16.9	<15.1	<14.5
pH	4.2	7.8	8.0	2.4

concentrations of carbonates, while the carbonate content of the waste rock is intermediate to the ore/liner and subliner.

Table 7 provides a comparison between the composite sample of the materials (Table 1) and the average results of the acid extraction for major and minor components. The acidic solution extracted sodium and magnesium at a scale similar to the ammonium acetate (Table 4), was about 1/3 as effective in extracting potassium, and was approximately 20 percent more effective in extracting calcium than the ammonium acetate. Although the relative amounts of individual alkali and alkali earth metals extracted by the acid varied from that extracted by ammonium acetate, the total amount of metals extracted remained roughly the same for both reagents. This suggests that the basic particulate structure of the materials was not degraded by the acid attack.

The acid did release significant quantities of selenium and molybdenum. The average concentration of selenium extracted by the acid was approximately 0.46 mg/l, which is nearly 50 times higher than the proposed EPA drinking water criterion and 10 times higher than the proposed EPA livestock watering criterion for this element. What does this mean to us problem wise - please relate to what we are doing and how to address it or handle it in the conclusions.

Another acid extraction was conducted on the materials in which the pH of the sediment/acid mixture was maintained at 1.5. In this test, the amount of calcium extracted was approximately 1/3 less than the amount released by the limited supply of sulfuric acid (Tables 6 through 9). This reduction may be attributed to the relative insolubility of calcium

Table 7. COMPARISON OF AVERAGE ACID EXTRACTION TO TOTAL CONTENT OF COMPOSITE SEDIMENT SAMPLE[a]

Element	Composite Sample	Average Acid Extraction	Percent of Composite Sample
Major Components (meq/100g)			
Sodium	9.13	5.215	57.1
Potassium	17.9	0.6925	3.87
Magnesium	143.2	6.08	4.25
Calcium	182.2	65.0	35.68
Minor Components (μg/g)			
Iron	26,000	1.64	0.0063
Silica	659,500	38.5	0.0058
Boron	<1000	0.69	≥0.069
Selenium	1.34	0.455	33.96
Vanadium	320	0.265	0.083
Molybdenum	<80	21	≥26.3

[a] Radioactive elements were not determined for the composite sample; therefore, they are not reported in this table.

Table 8. ACID EXTRACTION FROM THE LAKEBED SEDIMENTS WITH THE pH STABILIZED AT 1.5

Elements	Waste Rock	Ore	Liner	Subliner
Major Components (meg/100g)				
Sodium	7.4	8.2	5.4	7.8
Potassium	1.0	<1.0	3.0	1.0
Magnesium	13.0	39.0	29.0	15.0
Calcium	25.0	21.0	22.0	28.0
Minor Components(μg/g)				
Iron	150.0	3400.0	2100.0	150.0
Silica	740.0	1450.0	1850.0	1420.0
Boron	<100	<100	<100	<100
Selenium	0.075	<0.025	0.04	<0.025
Vanadium	6.0	390.0	18.0	8.0
Molybdenum	<1	22.0	<1	<1

Table 9. COMPARISON OF AVERAGE ACID EXTRACTION (pH STABILIZED AT 1.5) TO TOTAL CONTENT OF COMPOSITE SEDIMENT SAMPLE [a]

Element	Composite Sample	Average Acid Extract	Percent of Composite Sample
Major Components (meq/100g)			
Sodium	9.13	7.2	78.9
Potassium	17.9	≤1.5	≤8.4
Magnesium	143.2	24.0	16.8
Calcium	182.2	24.0	13.2
Minor Components (μg/g)			
Iron	26,000	1450.0	5.58
Silica	659,500	1365.0	0.207
Boron	<1000	<100	≤10
Selenium	1.34	≤0.041	≤3.1
Vanadium	320	105.5	33.0
Molybdenum	<80	<6.25	≤7.8

[a] Radioactive elements were not determined for the composite sample; therefore, they are not reported in this table.

sulfate. Less selenium and molybdenum was also extracted when the pH was stabilized at 1.5. On the other hand, much higher concentrations of sodium, potassium, magnesium, iron, vanadium, and silica were released in this test than in the test using smaller quantities of acid. In total, only 16 percent of the alkali and alkali earth metals identified in the composite sample were extracted when the pH was held at 1.5. This is 25 percent less than the total alkali and alkali earth metals extracted by ammonium acetate or a limited quantity of acid.

The quantities of radioactive elements released by the limited amount of sulfuric acid (Table 6) suggests that the carbonate content of the sediments affects the mobility of many components. The acid extracted approximately the same amount of radium and somewhat less uranium from the subliner material than the ammonium acetate. As discussed above, this horizon of the lakebed sediments contains relatively small amounts of carbonates. The quantity of uranium extracted with acid from the ore and liner material was much lower than the quantity extracted with ammonium acetate. These two horizons contain relatively high concentrations of carbonates. Much more radium was released from the ore with ammonium acetate than with acid, although radium extraction from the liner material was about the same for both reagents. The acid extracted much more thorium-230 from the ore and liner material than the ammonium acetate. This may be accounted for by the relative solubility of thorium in a sulfate form.

Comparison of Results

A review of the extraction analyses indicates that acid is more effective than water in mobilizing radioactive and nonradioactive components of the waste rock, ore, liner, and subliner materials, but that the most effective leaching agent is ammonium acetate. Commonly used to test the cation exchange capacity of soils because it acts as a buffer that theoretically holds the pH at 7, ammonium acetate appears to be most effective in this case because of its higher ionic strength relative to the water and acid. In chemical terms, a higher ionic strength, regardless of cause, leads to sharply depressed activity coefficients for all components. The result of this reduction is a marked increase in the mobilization of the components. This mobilization may be by increased solubility of existing minerals or salts in the materials or by ion exchange.

The amount of uranium-238, thorium-230, and radium-226 released from the materials by the reagents is presented in Table 10 as a percent of the total content in the composite sediment sample. Uranium was more readily mobilized than both the thorium and radium, with ammonium acetate being the most effective leaching agent. Radium-226 was also mobilized primarily by ammonium acetate. In most cases the amount extracted was small; however, ammonium acetate removed radium from the waste rock almost as readily as it released uranium. In general, thorium-230 was not mobilized to a significant extent. The only exception to this occurred in the ammonium acetate extraction of the liner material.

Table 10. EXTRACTABILTY OF RADIOACTIVE ELEMENTS FROM THE LAKEBED SEDIMENTS (GIVEN AS A PERCENT OF TOTAL CONTENT)

Radionuclide	Waste Rock			Ore			Liner			Subliner		
	Water	Acid	NH_4Ac	Water	Acid	NH_4Ac	Water	Acid	NH_4Ac	Water	Acid	NH_4Ac
Uranium-238	10.0	6	59.0	11.0	9.0	52.0	11.0	12.0	64.0	4.0	19.0	36.0
Thorium-230	0.3	<0.1	8.0	<4.9E-4	0.3	0.07	0.1	1.6	0.2	0	<0.5	<0.2
Raduim-226	0.8	0.3	53.0	0.04	0.2	2.2	0.3	0.8	2.4	0.05	0.5	1.5

Water and acid were about equally effective as leaching agents for the radioactive elements.

Ammonium acetate may remove uranium and radium from cation exchange sites or it may mobilize these elements by disturbing the electrostatic charge balance between very fine particles or colloids and the principal substrate. While these two reaction modes are different and subject to different controls, the overall results are the same. Radioactive elements in the materials are mobilized primarily by the solution with the greatest ionic strength.

Distribution Coefficient

On the basis of the following general equation:

$$M\text{—}X = M^{+} + X^{-}$$

M = concentration in pCi/ml of the radionuclide "cation"
X = exchange site
M—X = concentration in pCi/g of the radionuclide remaining on the mineral or earth material in question

the distribution coefficient (K_D) can be determined from the following equation:

$$\frac{(M^{+})(X^{-})}{(M\text{—}X)} = K_D$$

Since X^{-} is present in a large amount, it can be represented as unity; therefore, the equation can be reduced to:

$$\frac{(M^{+})}{(M\text{—}X)} = K_D$$

By convention, (M) is in concentration units per milliliter and (M—X) is in concentration units per gram. Consequently, the units of K_D are milliliters/gram since the concentration units are common.

for the solute and various sample types

Table 11 shows the results of the K_D estimates where data are available. The overall effective K_Ds for uranium, thorium, and radium are on the order of 1.4, 3.1, and 2.9, respectively. Since these values are notably different from those reported by Battelle for their Yucca Flats study, it may be conservative to use them as a basis for on-site design criteria.

Either it is or it isn't and about by how much

Units — I can't go to pg 25 and get any of these values — also it would be nice if the units were the same as those in the NRC GEIS

units

Table 11. DISTRIBUTION COEFFICIENTS FOR THE LAKEBED SEDIMENTS

	Water	Acid	Ammonium Acetate
Uranium-238			
Waste Rock	0.123	6.85E-3	5.75E-2
Ore	0.153	1.02E-2	4.33E-2
Liner	0.131	1.31E-2	7.23E-2
Subliner	0.081	2.31E-2	2.27E-2
geometric mean	0.119	1.206E-2	4.49E-2
Thorium-230			
Waste Rock	3.20E-3	—	3.47E-3
Ore	—	3.19E-4	5.96E-5
Liner	1.20E-3	1.7E-3	1.03E-4
Subliner	—	—	—
geometric mean	1.92E-3	7.37E-4	2.78E-4
Radium-226			
Waste Rock	8.60E-3	2.91E-4	4.45E-2
Ore	4.87E-4	2.35E-4	9.1E-4
Liner	3.11E-3	8.63E-4	9.98E-4
Subliner	9.23E-4	4.998E-4	6.05E-4
geometric mean	1.86E-3	4.14E-4	2.23E-3

CONCLUSIONS

There is little obvious physical or mineralogical difference between the waste rock, ore, liner, and subliner material examined in this study, but there are significant geochemical differences between them. In general, about the same proportions of major cations were exchanged from each of the materials. However, the total quantity of exchangeable cations varied significantly between horizons with the highest concentrations present in the waste rock, approximately equal quantities of exchangeable cations present in the ore and liner material, and the smallest concentrations present in the subliner material. As could be expected from ion exchange theory, the cations were much more subject to release from the materials by solutions with a high ionic strength than by water or dilute acid.

The ion exchange capacity of the materials approaches that of a montmorillonite clay. All of the materials are capable of buffering acids and their structure does not appear to be significantly damaged by acid attack. However, this capability appears to vary between horizons depending primarily on the overall ion exchange capacity of each with the liner material exhibiting the greatest buffering action and the subliner material the least.

by who & for what purpose?

During this study, questions have been raised about the presence of carbonate in the materials. If high concentrations of lime were present in the tailings impoundment liner or subliner, prolonged exposure to acid solutions could result in severe degradation of the liner or subliner. Little calcite was identified in the materials during the microscopic

Based on?
What is recommendation?

examination. In addition, water quality studies conducted for the Anderson Project ~~environmental report~~ license applications have shown that the anion content of the natural waters associated with ~~them~~ the lakebeds is dominated by bicarbonate ion. At depth where circulation would be impeded and perhaps stagnant conditions would exist, the pH of the interstitial water would be on the order of 9 or 10 if carbonate was present in substantial quantities. Sampling of these waters has indicated a pH on the order of 8.

The uranium and thorium series are out of equilibrium in the materials and the daughters of these elements tend to zone apart from the ore. Of the radioactive elements studied, uranium appears to be the most mobil in aqueous solutions. Both uranium and other radionuclides can be leached from the materials by dilute solutions. Now what — please relate to what we a doing and how

The determination of distribution coefficients for radionuclides was not originally intended as part of this study. However, with the information that became available, it appeared appropriate to derive estimates for the distribution coefficients of the major radioactive elements. The overall effective distribution coefficents (reported as pK_D) for ~~uranium~~, thorium, and radium were found to be on the order of 1.4, 3.1, and 2.9, respectively. These values are significantly lower than those used in the initial design of the tailings impoundment dam and liner. what units Any conclusions?

It should be noted that the use of the type of data generated during this study for the determination of distribution coefficients presumes homogeneous samples with equivalent detection and analysis capability, as

well as the presence of the radionuclides in a common available chemical form. It is uncertain that the entire amount of the radionuclides present in the materials was available to solution or exchange. Some of them may have been locked in impermeable crystal forms. In addition, quantitative balance was not achieved between the different extraction tests. Typically, the total concentration of cations detected, both in solution and in the residual, was higher in the samples treated with acid than those treated with water and, in most cases, ammonium acetate. This indicates problems with analytical methodology (e.g., masqueing and self-adsorption) that may be resolved in the future if additional studies are conducted specifically for the determination of distribution coefficients. For the purpose of this study, composites of the data were used with no weighting other than that provided by geometric mean determinations in order to allow for these problems in analytical methodology.

this should have been brought up before rather than presented in the conclusions

what does this mean? Are we doing a research project? Haven't we gained anything? This should be discussed before the conclusions

not a conclusion

The following items should be discussed in the conclusions:

1) Address the 3 objectives as listed on page 1
2) What is mobilization in the liner and through the liner in terms of radiological, heavy metals, & toxic constituents
3) Will the tailings liquor form a calcium sulfate seal or will the liquor destroy the liquor? Address the carbonate iss
4) What happens to the boron & selenium and what are their probable concentrations?

APPENDIX A

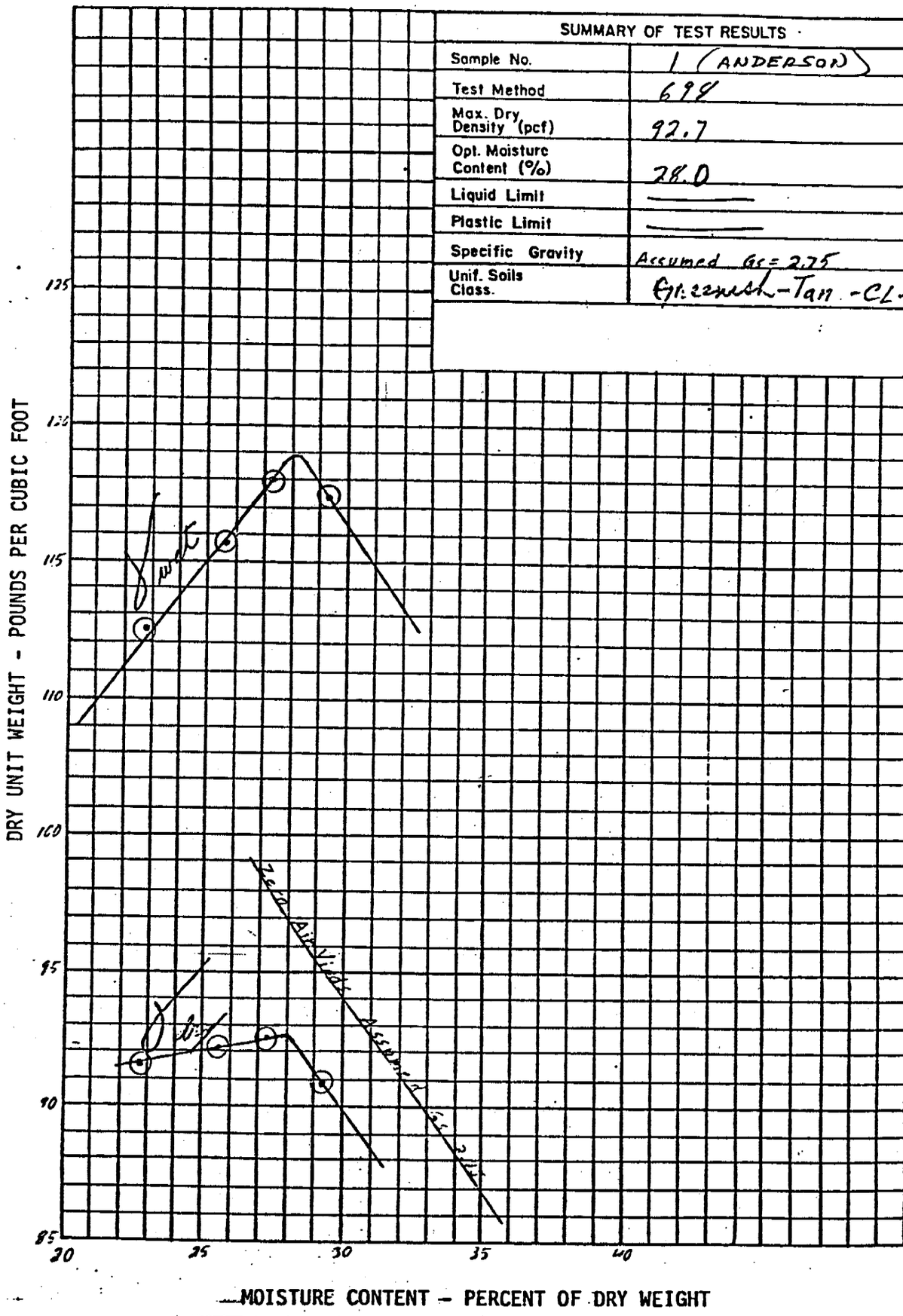
COMPACTION TEST

PROJECT NAME Shooting Canyon PROJECT NO. 60245B-001 DATE 5/01/89

DESCRIPTION OF SAMPLE

TESTED BY R. Toscano REDUCED BY R. Toscano CHECKED BY C. Wason

SUMMARY OF TEST RESULTS	
Sample No.	1 (ANDERSON)
Test Method	698
Max. Dry Density (pcf)	92.7
Opt. Moisture Content (%)	28.0
Liquid Limit	—
Plastic Limit	—
Specific Gravity	Assumed Gs = 2.75
Unif. Soils Class.	Gy: Brown-Tan -CL-



WOODWARD - CLYDE CONSULTANTS

ATTERBERG LIMIT DETERMINATIONS

(Performed On Soil Fraction Passing No. 40 Sieve)

PROJECT NAME Shootering PROJECT NO. 60245B-0001 DATE 5/7/79

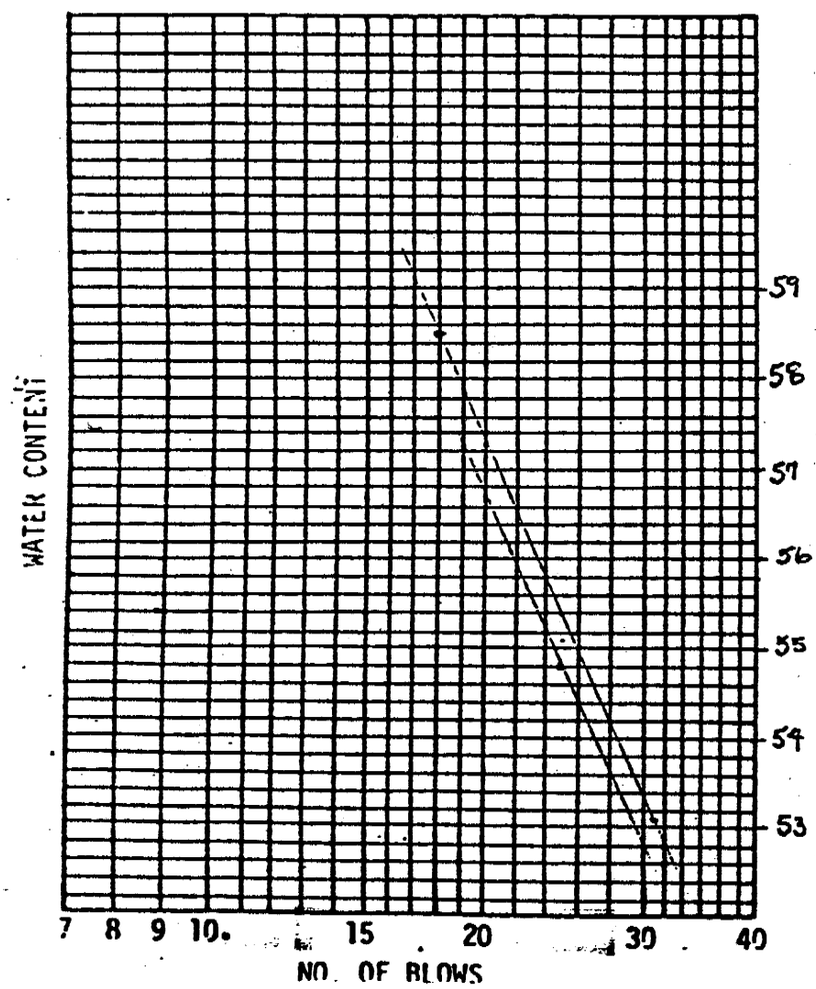
TESTED BY HGO REDUCED BY HGO CHECKED BY OHG

SAMPLE NO. Anderson #1

LIQUID LIMIT				PLASTIC LIMIT	SHRINKAGE LIMIT	
CONTAINER NO.	SC-1	SC-2	SC-3	SC-4	WT. DISH + WET SOIL	
NO. OF BLOWS	31	25	18	—	WT. DISH + DRY SOIL	
WT. CONT. + WET SAMPLE	36.18	35.61	35.88	32.72	WT. DISH	
WT. CONT. + DRY SAMPLE	30.49	30.08	29.86	30.40	WT. DRY SOIL	
WT. OF WATER	5.69	5.53	6.02	2.32	WT. WATER	
WT. OF CONTAINER	19.78	19.98	19.57	19.57	VOL. WET SOIL	
WT. OF DRY SOIL	10.71	10.10	10.29	10.83	VOL. DRY SOIL	
WATER CONTENT W %	53.1	54.8	58.5	21.4	VOL. CHANGE ON DRYING ΔV	
					WATER CONTENT %	
					ΔV/WT. DRY SOIL %	
					SHRINKAGE LIMIT	

SAMPLE NO.

LIQUID LIMIT				PLASTIC LIMIT	SHRINKAGE LIMIT	
CONTAINER NO.					WT. DISH + WET SOIL	
NO. OF BLOWS					WT. DISH + DRY SOIL	
WT. CONT. + WET SAMPLE					WT. DISH	
WT. CONT. + DRY SAMPLE					WT. DRY SOIL	
WT. OF WATER					WT. WATER	
WT. OF CONTAINER					VOL. WET SOIL	
WT. OF DRY SOIL					VOL. DRY SOIL	
WATER CONTENT W %					VOL. CHANGE ON DRYING ΔV	
					WATER CONTENT %	
					ΔV/WT. DRY SOIL %	
					SHRINKAGE LIMIT	



SUMMARY

SAMPLE NO. ANDERSON #1

DESCRIPTION: GREENISH TAN-CH -

LIQUID LIMIT - 55.1

PLASTIC LIMIT - 21.4

PLASTICITY INDEX - 33.7

SHRINKAGE LIMIT -

SAMPLE NO.

DESCRIPTION:

LIQUID LIMIT -

PLASTIC LIMIT -

PLASTICITY INDEX -

SHRINKAGE LIMIT -

REMARKS:

COMPACTION TEST

PROJECT NAME Shoetering CANYON PROJECT NO. 602458-001 DATE 5/7/79

SAMPLE NO. 1 (Andersen DESCRIPTION OF SAMPLE

TESTED BY R. Tascano C. Wason REDUCED BY R. Tascano CHECKED BY C. Wason

SPECIFIC GRAVITY Assumed Gs = 2.75 TEST METHOD 698

CYLINDER: Volume 941.40 cm.^{3} Weight 1942

DENSITY	16 %	18 %	20%	22
DETERMINATION NO.	1	2	3	4	5
WT. CYLINDER & COMPACTED SOIL gms.		3638	3687	3722	3713
WT. CYLINDER gms.		1942	1942	1942	1942
WT. COMP. SOIL gms.		1696	1745	1780	1771
WET DENSITY PCF		112.5	115.7	118.0	117.4
DRY DENSITY PCF		91.6	93.1	93.5	90.9

WATER CONTENT - AFTER TEST

DETERMINATION NO.	1	2	3	4	5
WT. ~~CONT.~~ & WET SOIL gms.		1092	1039	1060	1036
WT. ~~CONT.~~ & DRY SOIL gms.		889	827	832	802
WT. WATER gms.		203	212	228	234
WT. CONTAINER gms.		—	—	—	—
WT. DRY SOIL gms.		889	827	832	802
WATER CONTENT %		22.8	25.6	27.4	29.2

INITIAL WATER CONTENT

DETERMINATION NO.	1	2	3	4	5
WT. CONT. & WET SOIL gms.					
WT. CONT. & DRY SOIL gms.					
WT. WATER gms.					
WT. CONTAINER gms.					
WT. DRY SOIL gms.					
WATER CONTENT %					

WOODWARD - CLYDE CONSULTANTS

APPENDIX B

METHOD 1 - EXTRACTABLE CATIONS[1]

Extractable cations are defined as the milliequivalents per 100 grams soil of sodium, potassium, magnesium and calcium which are extracted from soil by 1N ammonium acetate.

Reagents: 1.0N Ammonium Acetate Solution: To approximately 750 ml of distilled/deionized water add 57 ml of conc. acetic acid and then 68 ml of conc. ammonium hyrdoxide. Dilute to a volume of 1 liter and adjust to a pH of 7.0 by the addition of more ammonium hyrdoxide or acetic acid.

Procedure: I. Ammonium acetate extractable cations: Weigh 4 grams ±.04 gr. of air dried, ball-milled, sieved medium and fine textured soils or 6 grams ±.06 gr. of coarse textured soil into a 100 ml. centrifuge tube. Determine the air dry moisture content as directed in Method 2. Add 33 ml. of ammonium acetate solution to the centrifuge tube, stopper with a rubber stopper and shake for 5 minutes. Remove the stopper and centrifuge at maximum rpm until supernatent is clear (approx. 5 min.). Decant the supernatent as completely as possible into a 100 ml volumetric flask. Perform the extraction two more times combining the extracts in the volumetric flask. Dilute to volume with the extraction solution, mix, and analyze for Na, K, Mg, Ca. Calculate meq/100 g. using equations 1 and 2. Determine the pH of the solution. The pH of an ammonium acetate extraction reveals the following about the soil[2]

$pH < 7$ unsaturated soil
$pH \approx 7$ saturated soil
$pH > 7$ free carbonates

Calculations: 1) Convert mg/l of each cation to meq/l.

meq Na/l = (mg Na/l)/23.0
meq K/l = (mg K/l)/39.1
meq Mg/l = (mg Mg/l)/12.15
meq Ca/l = (mg Ca/l)/20.0

Total extractable cation concentration is the sum of the milliequivalents of Na, K, Mg and Ca.

2) Conversion of concentration of cations from meq/l to meq/100 gm soil:

$$\frac{\text{meq. cations}}{\text{100 gm soil}} = \frac{(\text{meq. cations/l})(\text{extract volume, l})(100)}{(\text{wt. soil sample extracted, gm.})}$$

[1] Saline and Alkali Soils, Agricultural Handbook No. 60, pg. 100-101.
[2] P.R. Hesse, A Textbook of Soil Chemical Analysis, Section 7:2:2, pg. 98.

METHOD 2 - SOLUBLE CATIONS

Soluble cations are defined as the milliequivalents per 100 gm. soil of sodium, potassium, calcium and magnesium which are dissolved in the distilled water extract of a saturated soil paste.

Procedure: Prepare a saturated soil paste and saturation extract according to Method 3.

Analyze the extract for sodium, potassium, magnesium and calcium.

Determine the saturation percentage of the soil paste by Method 4.

Calculations: 1) Convert cation concentrations from mg/l to meq/l:

$$\text{meq Na/l} = (\text{mg Na/l})/23.0$$
$$\text{meq K/l} = (\text{mg K/l})/39.1$$
$$\text{meq Mg/l} = (\text{mg Mg/l})/12.15$$
$$\text{meq Ca/l} = (\text{mg Ca/l})/20.0$$

Total soluble cation concentration is the sum of the milliequivalents of the Na, K, Mg and Ca.

2) Conversion of concentration of cations from meq/l to meq/100 gm soil:

in percent

$$\frac{\text{meq. cations}}{\text{100 gm. soil}} = \frac{(\text{meq. cations/l})(\text{\% Paste Saturation})}{1{,}000}$$

Derivation of equation (2)

% saturation of the soil paste is defined as grams of saturation extract solution per 100 gm. soil, which is equivalent to the volume of saturation extract in ml per 100 gm. soil, assuming the density of the solution to be unity. Note that the volume used is the total volume of extract obtained from the % saturation determination on the paste, and not the volume extract obtained by vacuum filtration of the paste.

$$\text{\% water saturation of the soil paste} \cong \frac{\text{gm water}}{\text{100 gm soil}}$$

$$\cong \frac{\text{ml water}}{\text{100 gm soil}}$$

Therefore, the equation converting to meq cations/100 gm soil becomes:

$$\text{meq. cations/100 gm soil} = \frac{(\text{meq. cations/l})(\text{ml water/100g}) \times 100\text{g}}{1{,}000 \text{ ml/l}}$$

$$= \frac{\text{meq cations/l (\% Saturation)}}{1{,}000}$$

METHOD 3 - PREPARATION OF SATURATED SOIL PASTE AND EXTRACT[1]

Materials: 250 ml beaker or larger, depending upon size of sample and a spatula.

Procedure: 1) Prepare the saturated soil paste by adding distilled water to a 200 - 1,000 gm sample of soil while stirring with a spatula. The soil water mixture is consolidated from time to time during the stirring process by tapping the container on the table top. At saturation the soil paste glistens as it reflects light, flows slightly when the container is tipped and the paste slides freely and cleanly off of the spatula for all types of soils except those with a high clay content. After mixing, the sample should be allowed to stand for an hour or more and then the criteria for saturation should be rechecked. If the paste stiffens or no longer glistens remix with more water. If the paste is made too wet more dry soil may be added.

2) Saturation extract: After preparing a saturated soil paste cover the beaker with parafilm and allow to stand approx. 16 hours. Transfer the saturated paste to a Buchner funnel with a filter paper in place and apply vacuum. Collect the extract in a bottle or test tube. Pyrex should not be used if boron is to be determined. If the initial filtrate is turbid it can be refiltered through the soil or discarded. Vacuum extraction should be terminated when air begins to pass through the filter.

If carbonate and bicarbonate determinations are to be made on the extract a drop of a solution containing 1000 mg/l of sodium hexametaphosphate should be added to every 25 ml aliquot of the extract taken for analysis. Do not contaminate the entire extract with sodium hexametaphosphate if other analyses are to be performed. Approximately one fourth of the moisture in a saturated soil paste can be removed by vacuum filtration so sample volumes can be adjusted to obtain sufficient extract for analysis.

3) Saturation Percentage: Determine the saturation percentage of the saturated soil paste according to Method 4 .

[1]Saline and Alkaline Soils, Agriculture Handbook No. 60 pg. 84 - 85.

METHOD 4 - MOISTURE CONTENT[1] OF SOIL

Percent moisture content of a soil is the loss in weight on drying x 100/weight of oven-dried soil.

Procedure

1) Weigh a 100 ml beaker. Record as Weight #1
2) Transfer at least 25 grams of representative soil sample or saturated soil paste into the beaker.
   Weigh again. Record as Weight #2.
3) Dry the sample at 105° C to constant weight (several hours), cool to room temperature and weigh again. Record as Weight #3.

Calculations

$$\text{Moisture content in percent } \frac{\text{Wt. \#2 - Wt. \#3}}{\text{Wt. \#3 - Wt. \#1}} (100)$$

[1]Saline and Alkali Soils, Agricultural Handbook No. 60 pg. 107.

METHOD 5 - EXCHANGEABLE CATIONS

Exchangeable cations are defined as the difference between ammonium acetate extractable cations and soluble cations, expressed in meq/100 gm soil.

EC = AAEC - SC units are meq/100 gm soil

EC = Exchangeable Cations
AAEC = Ammonium acetate extractable cations (Method 1)
SC = Soluble cations (Method 2)

METHOD 6 - TOTAL EXCHANGEABLE BASES[1]

Reagents:

0.2M Hydrochloric acid - standardized
0.1M Ammonium hydroxide - standardized
1.0M Ammonium Acetate - Standardized

Procedure:

1) Extract the sample as directed in Method 1, Exchangeable Cations, or use 10 ml of that extract.

2) Evaporate 10 ml of extract to approximately 2 ml on a hot plate. Transfer the residual extract to a small crucible. Rinse the original glass dish with hot distilled water and add washings to the crucible.

3) Slowly and carefully evaporate the solution to dryness, avoiding spattering. When the residue is dry heat the residue in a muffle furnace at 485° C for 1 hour. Cool.

4) Add 20 ml of 0.2M hydrochloric acid to the crucible with a pipet, breaking up the residue with a glass rod. NOTE: 20 ml of hydrochloric acid should be sufficient to neutralize the bases. If it has been determined that this quantity is not sufficient, then more acid may be quantitatively added.

5) If the residue is black or grey, it contains manganese which should be dissolved by adding 3 drops of 30% hydrogen peroxide solution and boiling for several minutes.

6) Digest in a hot water bath for 30 minutes, cool and titrate with 0.1M ammonium hydroxide solution using methyl red as the indicator.

Can't Read

[1] A textbook of soil chemical analysis, P.R. Hesse, Chemical Publishing Co., Method 7-3 [illegible]

METHOD 6 - TOTAL EXCHANGEABLE BASES CONTINUED

Calculations:

1) $\frac{(\text{Vol. } NH_4OH)(\text{N. } NH_4OH)}{\text{N. HCl}}$ = Vol. HCl, unreacted

2) (Total Vol. HCl) - (Unreacted Vol. HCl) = Volume HCl neutralized by soil sample

3) Meq. HCl neutralized by soil = (ml HCl)(N. HCl)
= meq. exchangeable bases

4) Wt. soil sample aliquot =

$\frac{\text{Vol. extract evaporated}}{\text{Total volume extract from Method 1}}$ (Wt. original soil sple.)

5) $\frac{\text{Meq. exchangeable bases}}{\text{100 gm.}} = \frac{\text{Meq. exchangeable bases (100)}}{\text{wt. soil sample aliquot, gm.}}$

METHOD 7 - TOTAL METALS ANALYSES[1]

Ia. Accurately weigh about 1.0 gram of soil which has been air dried, ball-milled and sieved (0.15 mm) into a 250 ml tall form beaker and add 20 ml of concentrated nitric acid. Cover the beaker and cautiously heat on a hot plate to oxidize organic matter. Add 10 ml of 60% perchloric acid and digest the mixture until dense white fumes appear.

b. Cool the solution and dilute to about 25 ml with warm distilled water. Filter through Whatman No. 41 paper into a 200 ml volumetric flask and dilute to volume with distilled water. Analyze the filtrate for the elements of interest by atomic absorption spectrophotometry.

II. Crude Silica Determination[2]

Cautiously ignite the filter paper from Ib. to constant weight in a platinum crucible using a muffle furnace at 1,100° C. Cool and weigh. Record the result as crude silica.

[1] A Textbook of Soil Chemical Analysis, P.R. Hesse, Chemical Publishing Co. Inc., New York. Section 16:2:4 Part II.

[2] Ibid., Section 15:5:1.

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

J. ABRAMO
MAR 17 1978
Mgr. Met. Opr.

SCW
5.16

copy to
Larson
R Marshall
Schubmehl

March 15, 1978

Mr. John A. Abramo
Manager, Metallurgical Operations
Minerals Exploration Co.
P.O. Box 50324
1846 W. Grant Road, Suite 108
Tucson, Arizona 85705

Re: HRI Project 4407

Dear John:

As requested in your letter of February 27, 1978, assays we have obtained thus far on the master composite raffinate, our Sample No. 1070-129-5, are:

	g/l		g/l
Total dissolved solids	45.8	As	0.013
Total suspended solids	<0.01	P	0.11
Alkalinity	Acidic	F	0.21
SO_4	36.1	Al	1.31
Fe, total	1.93	Mo	<0.005
Fe, dissolved	1.93	Hg	<0.0001
Cl	0.33	K	0.31
Cr	0.003	Cu	0.003
Ni	0.005	Cd	0.0003
Mn	0.065	V	0.078
Zn	0.017	Na	0.72
SiO_2	0.18	Mg	2.10
Pb	0.0007	Ca	0.32
U, total	0.0004	Total organic carbon	0.020
Th, total	<0.001		

When completed, the following outstanding assays will be reported by John Jarvis of our analytical department:

Solid tailings (1070-50-5)	Radiometric	^{226}Ra
		^{230}Th
		^{210}Pb
	Fluorimetric	U, total
Raffinate (1070-129-5)	Radiometric	^{226}Ra
		^{228}Ra
		^{230}Th
		^{232}Th
	Chemical	Hardness
		Nitrate
		Boron
		Selenium

Best regards.

Sincerely

HAZEN RESEARCH, INC.

E. L. Coltrinari
Assistant Vice President

ELC:mgp
cc: J. Jarvis

J. ABRAMO
APR 24 1978
Mgr. Met. Opr.

HAZEN RESEARCH, INC.
4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

Date: April 20, 1978
HRI Project: 4407
HRI Series:
Samples Received:

Mr. John A. Abramo
Manager, Metallurgical Operations
Minerals Exploration Co.
P. O. Box 50324
Tucson, Arizona 85705

REPORT OF ANALYSIS

3.21

Analysis	Solid Tailings (1070-50-5)	Raffinate (1070-129-5)
Ra^{226} ± Precision*	$2.1 \times 10^{-4} \pm 0.2 \times 10^{-4}$ µCi/gm	$0 \pm 9 \times 10^{-8}$ µCi/ml
Th^{230} ± Precision*	$7.9 \times 10^{-5} \pm 0.8 \times 10^{-5}$ µCi/gm	$3.32 \times 10^{-5} \pm 0.05 \times 10^{-5}$ µCi/ml
Pb^{210} ± Precision*	$1.45 \times 10^{-4} \pm 0.02 \times 10^{-4}$ µCi/gm	----
Ra^{228} ± Precision*	----	**
Th, Total, g/l	----	<0.001
Hardness (EDTA), as $CaCO_3$, g/l	----	12.8
Nitrate, as N, mg/l	----	1.4
Boron, mg/l		16
Selenium, mg/l	----	0.010

By: John C. Jarvis
John C. Jarvis
Manager, Analytical Laboratory

eah

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

**Results to follow.

copy to Marshall Salway

	solids
Ra_{226}	210 ± 20
Th_{230}	79 ± 8
Pb_{210}	145 ± 2
Ra_{228}	—

	Raffinate
Ra_{226}	0 ± .09
Th_{230}	33.2 ± 0.50
Pb_{210}	—
Ra_{228}	waiting for

$\mu = 1 \times 10^{-6}$

$\rho = 1 \times 10^{-12}$

.016

.0014

.00001

APPENDIX 2

SURFACE ROCK GEOCHEMISTRY

ANDERSON DEPOSIT

One hundred and two surface rock grab samples were collected at the Anderson Deposit and analyzed for uranium, arsenic, copper, molybdenum, manganese, selenium and vanadium. The samples were collected from two sections, the locations of which are indicated on the accompanying locality plan. Section A is situated at the east end of the property and Section B is situated in the central part of the property, approximately between holes 39 and 153. The samples each represent a small rock grab sample - usually only one or two pieces of rock.

The samples were all analyzed for seven elements and the results are shown on the accompanying analyses lists, and sections. Preliminary inspection of the results suggests that uranium itself is the most definitive, and certainly yields the most easily interpreted results. Some of the other elements move in sympathy with uranium, but individually, with the exception of V_2O_5, they are not important. Our data base at Anderson, and in other areas, is not yet sufficiently large or representative of lake sediments, for the data to be evaluated statistically. This approach may be attempted at some later date.

Section A

Fifty three samples were collected over a vertical interval of approximately 240 feet. The fine grained mudstone, carbonaceous shale unit does not appear to be present. The nearest significant mineralization is approximately 2000 to 3000 feet east or southeast.

The overlying capping conglomerate essentially contains no uranium. The sandstone conglomerate unit of Ljung and Pavlak (1976) is, in this locality,

a sandstone siltstone unit with minor conglomerates near the top of the unit. This unit is interpreted as essentially anomalous throughout, although some samples were below level of detection. The average uranium content is 5.75 ppm and eleven samples have uranium contents greater than 5.75 ppm. V_2O_5 is also anomalous over some intervals. The limestone, chert, mudstone unit contains only very low uranium values but does contain quite anomalous V_2O_5 values, and can overall be interpreted as anomalous. Average U_3O_8 content was 3.8 ppm and eight samples had uranium values greater than 3.8 ppm. The basal unit is a sandstone-conglomerate and essentially contains no uranium.

Section B

In section B, which is within the main mineralized zone, the capping conglomerate again contains no uranium. The sandstone conglomerate unit in this locality is more typical of Ljung and Pavlak's unit. It may be slightly anomalous in the lower half of the unit but at this point in time our data base is insufficient to be definitive. The limestone, chert mudstone unit is anomalous throughout for both uranium and vanadium, with values ranging up to 20 ppm U_3O_8, and 600 ppm V_2O_5. Average U_3O_8 content was 10 ppm. Only a part of the lowermost unit - mudstone, carbonaceous shale - is exposed in this section. Values range from 5 ppm to 98 ppm U_3O_8.

CONCLUSIONS

Surface rock sampling would have defined the Anderson area as a potentially prospective sequence of lake sediments. This method thus has potential in exploration for other uranium, prospective lake-bed sequences, and should be used in conjunction with scintillometer traversing.

During the sampling, counts of more than twice background were recorded in two localities only. Both of these localities were in Section B; near the base where 98 and 19 ppm U_3O_8 were found in random rock grab samples, and in the limestone sequence where 20 ppm U_3O_8 was found. In some other

areas, counts of one and a half background were noted but increases and decreases in counts were gradational, and in a reconnaissance survey would probably not be rated as significant.

The samples have a wide "spread" in values and it would appear that at least five samples from any reasonably large exposure are required before results are readily interpretable.

Sampling should be restricted to finer grained samples i.e., medium/coarse sand size or finer.

Analyses from future samples should be restricted to uranium, copper and vanadium and it may be feasible to further restrict this list with additional data. Uranium itself is the most valuable element, but further study may indicate that vanadium and copper are also of value. Vanadium is concentrated in the calcareous rock, but we have insufficient data from outside the Anderson area to judge whether or not this is significant in terms of uranium exploration.

SECTION A

Sample No.	Description	U_3O_8	As	Cu	Mo	Mn	Se	V_2O5
A1	Basal Capping	-2	-10	19	-1	375	-1	100
A2	Conglomerate	-2	-10	19	2	520	-1	100
A3		-2	-10	18	-1	550	-1	80
A4		-2	-10	20	-1	565	-1	100
A5		2	-10	17	-1	575	-1	70
A6		-2	-10	17	2	494	-1	80
A7 to A30	Sandstone Conglomerate unit - mainly sandstones and siltstones in this section	2	-10	20	-1	640	-1	60
A8		2	-10	17	-1	450	-1	60
A9		3	-10	17	-1	480	-1	60
A10		4	-10	17	1	520	-1	70
A11	Indurated, silicified tuff with minor pyrite	3	-10	14	-1	440	-1	70
A12		6	-10	26	-1	1000	-1	140
A13	Hard tuffaceous sandstone	7	-10	16	-1	480	-1	80
A14	Semi-hard band of tuffaceous sandstone	8	-10	23	-1	680	-1	120
A15		7	-10	25	-1	910	-1	230
A16		10	-10	26	-1	1200	-1	220
A17		5	-10	28	-1	430	-1	140
A18		5	-10	15	-1	410	-1	80
A19		-2	-10	13	-1	410	-1	70
A20	Fine-grained calcareous bed	-2	-10	8	-1	485	-1	70
A21		3	-10	32	-1	520	-1	190

SECTION A

Sample No.	Description	U_3O_8	As	Cu	Mo	Mn	Se	V_2O_5
A22	Fine grained calcerous bed	2	-10	15	-1	665	-1	60
A23		3	-10	15	-1	645	-1	60
A24		-2	-10	16	-1	375	-1	90
A25		8	-10	38	-1	725	-1	210
A26		7	-10	15	-1	530	-1	30
A27		7	-10	26	-1	430	-1	120
A28		14	-10	43	-1	970	-1	210
A29		6	-10	11	-1	915	-1	60
A30		6	-10	43	-1	605	-1	210
A31 to A47	Limonite, chert mudstone unit	2	-10	11	-1	645	-1	210
A32		3	-10	12	-1	720	-1	40
A33	Siltstone	2	-10	15	-1	535	-1	160
A34		4	-10	7	-1	320	-1	130
A35	Siltstone	4	-10	16	-1	410	-1	190
A36		3	-10	12	-1	495	-1	980
A37	Siltstone	9	-10	56	-1	550	-1	420
A38		3	-10	12	-1	685	-1	30
A39		6	-10	12	1	540	-1	440
A40		-2	-10	6	-1	440	-1	520
A41		4	-10	10	-1	205	-1	290
A42	Very thin sandstone interbed	6	-10	13	-1	220	-1	490
A43		3	-10	6	-1	325	-1	2700
A44		2	-10	10	-1	225	-1	390

Sample No.		U_3O_8	As	Cu	Mo	Mn	Se	V_2O5
A45		4	-10	15	-1	270	-1	190
A46		5	-10	16	-1	500	-1	160
A47		3	-10	21	-1	295	-1	150
A48	Basal sandstone conglomerate unit	2	-10	16	3	675	-1	120
A49		-2	-10	17	-1	335	-1	100
A50	Mudstone/siltstone	-2	-10	34	2	365	-1	60
A51	Carbonaceous siltstone	-2	-10	17	-1	355	-1	70
A52	Unit is absent here.	-2	-10	15	2	710	-1	80
A53		-2	-10	18	-1	450	-1	100

SECTION B

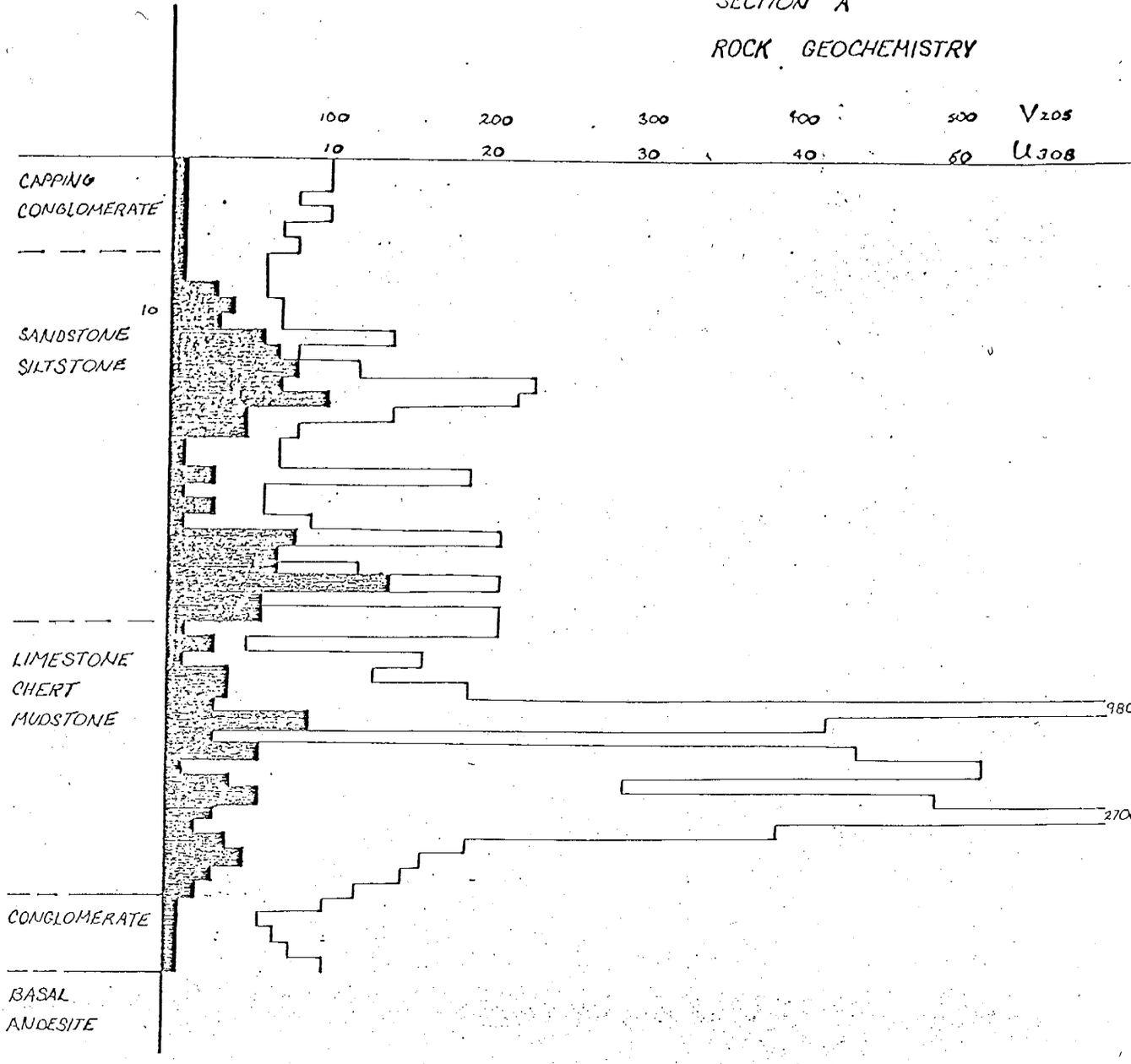
Sample No.	Description	U_3O_8	As	Cu	Mo	Mn	Se	V_2O5
A54 to A57	Mudstone, siltstone, carbonaceous shale unit	98	-10	25	-1	545	-1	500
A55		19	-10	31	-1	445	-1	200
A56		5	-10	45	-1	340	-1	340
A57		5	-10	38	-1	415	-1	130
A58 to A72	Predominantly limestone - some mudstone & siltstone	9	-10	19	-1	335	-1	80
A59	Sandstone interbed	15	-10	18	-1	320	-1	170
A60		17	-10	8	1	1000	-1	80
A61	Limestone with silicified "plant stems"	20	-10	9	-1	645	-1	100
A62		3	-10	8	1	545	-1	170
A63		5	-10	7	-1	580	-1	190
A64		9	-10	10	1	1200	-1	130
A65	Thin (6") sandstone	16	-10	21	2	805	-1	440
A66		20	-10	13	-1	830	-1	210
A67		4	-10	10	-1	585	-1	110
A68		6	-10	11	-1	265	-1	90
A69		6	-10	6	-1	485	-1	70
A70		9	-10	9	1	405	-1	600
A71		4	-10	9	-1	210	-1	330
A72		-2	-10	10	-1	455	-1	300
A73 to A89	Sandstone/conglomerate unit	4	-10	13	-1	835	-1	60
A74		3	-10	13	1	790	-1	50
A75		2	-10	14	-1	920	-1	40

SECTION B

Sample No.	Description	U_3O_8	As	Cu	Mo	Mn	Se	V_2O_5
A76		-2	-10	12	-1	560	-1	30
A77		2	-10	10	-1	145	-1	20
A78		3	-10	11	-1	630	-1	30
A79		2	-10	12	-1	790	-1	30
A80		-2	-10	11	1	605	-1	20
A81		2	-10	12	1	745	-1	40
A82		4	-10	16	1	915	-1	60
A83	Mostly Conglomerate	-2	-10	15	6	660	-1	50
A84	" "	-2	-10	14	1	480	-1	40
A85	" "	-2	-10	13	-1	225	-1	60
A86	" "	-2	-10	13	-1	570	-1	60
A87	" "							
A88	" "	2	-10	16	-1	465	-1	100
A89	" "	-2	-10	15	-1	605	-1	30
A94	Basalt	-2	-10	48	-1	1000	-1	380
A95	"	-2	-10	50	2	1100	-1	380
A96	"	-2	-10	54	5	910	-1	360
A97	Capping Conglomerate	-2	-10	18	-1	620	-1	120
A98	" "	-2	-10	16	1	540	-1	90
A99	" "	-2	-10	20	-1	630	-1	120
A100	" "	-2	-10	31	-1	685	-1	160
A101	" "	-2	-10	17	-1	450	-1	60
A102	" "	-2	-10	17	-1	620	-1	140
A103	" "	-2	-10	10	-1	455	-1	90

SECTION B

Sample No.	Description	U_3O_8	As	Cu	Mo	Mn	Se	V_2O_5
A104	Capping conglomerate	2	-10	14	-1	435	-1	90
A105	" "	-2	-10	20	1	540	-1	100
A106	" "	-2	-10	17	-1	565	-1	90



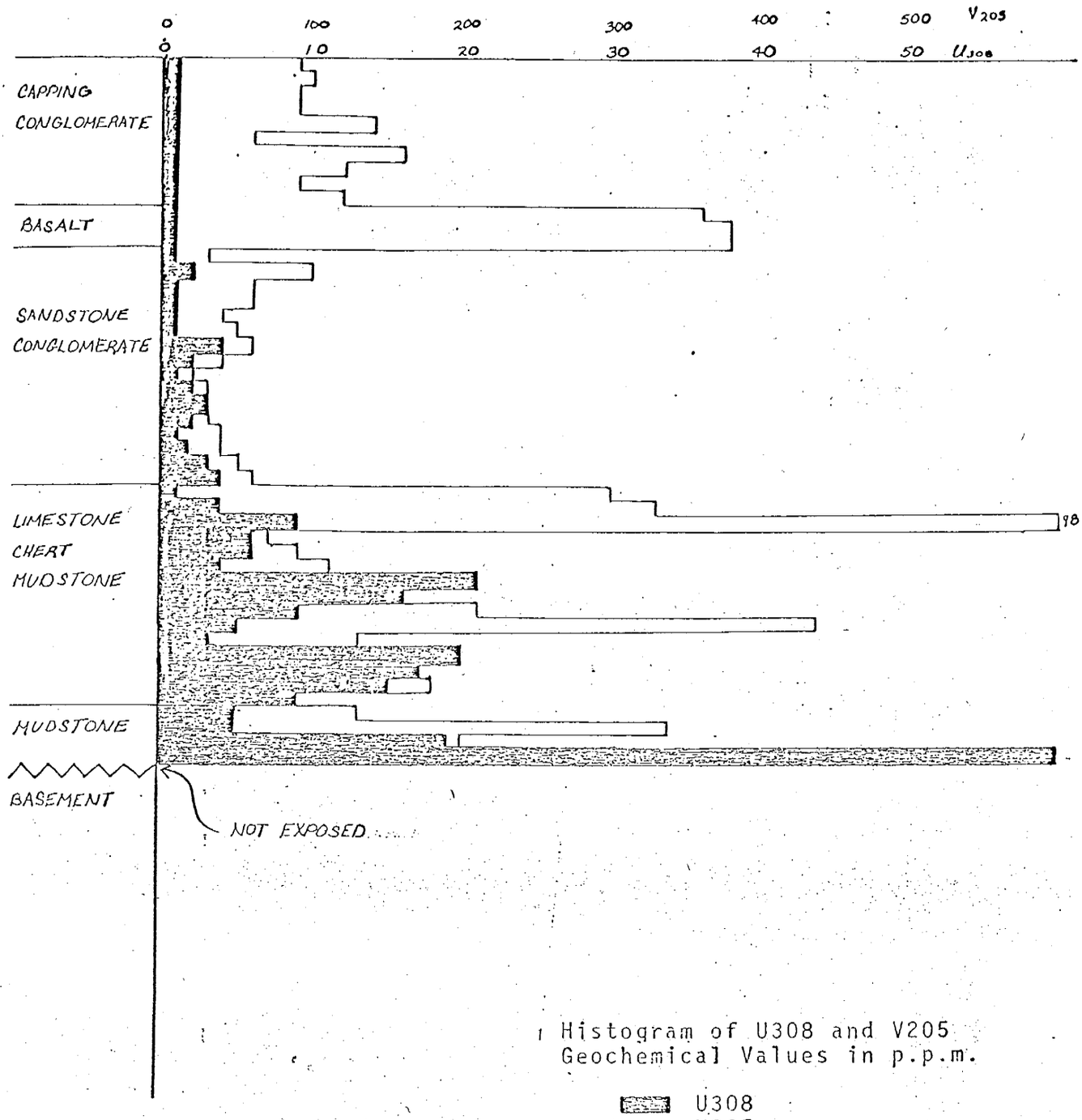
Histogram of U308 and V205

Geochemical values in p.p.m.

U308
V205

NOTE: Vertical Section is not to Scal

ROCK GEOCHEMISTRY



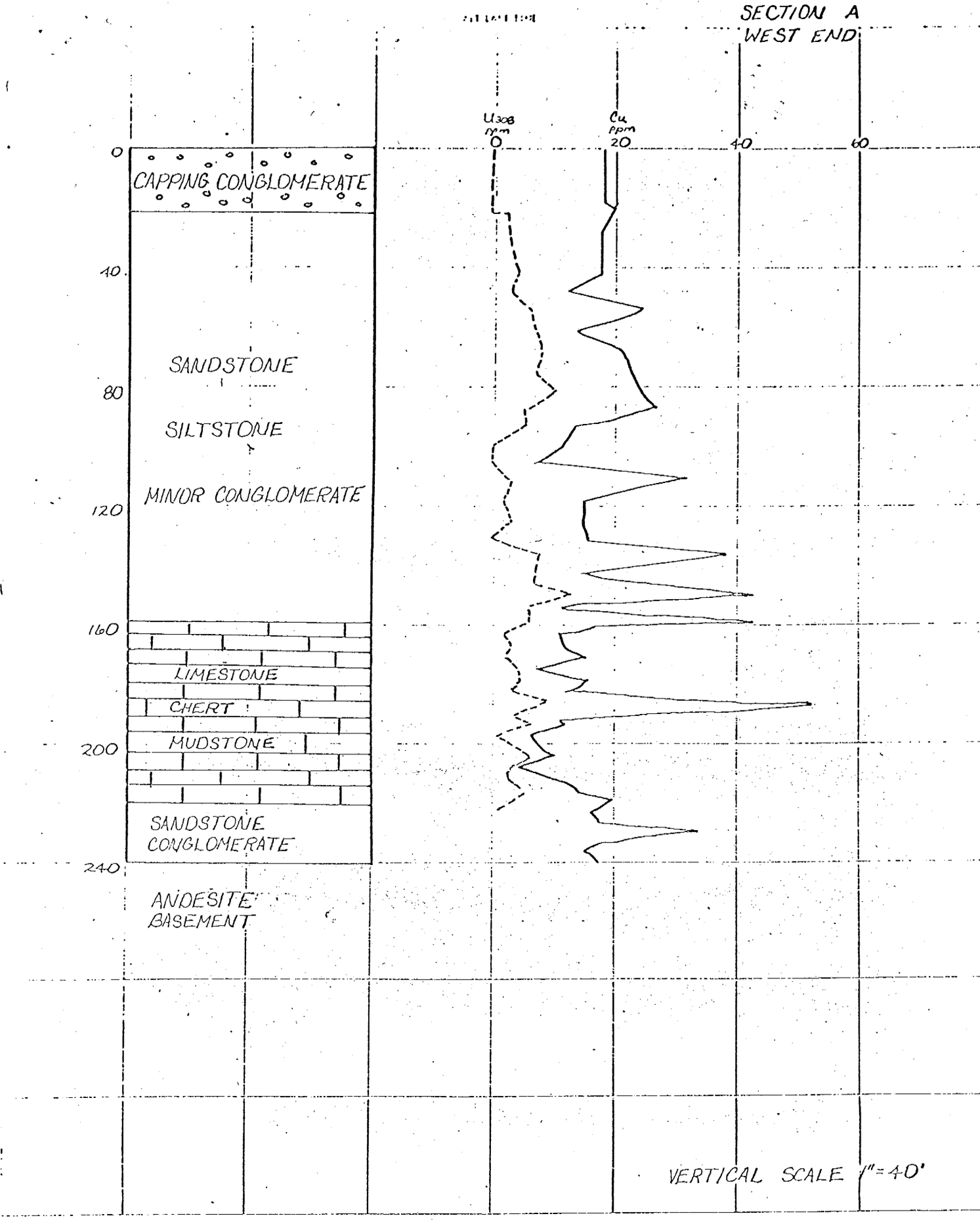
Histogram of U308 and V205
Geochemical Values in p.p.m.

U308
V205

NOTE: Vertical Section is not to Scale

ANDERSON DEPOSIT

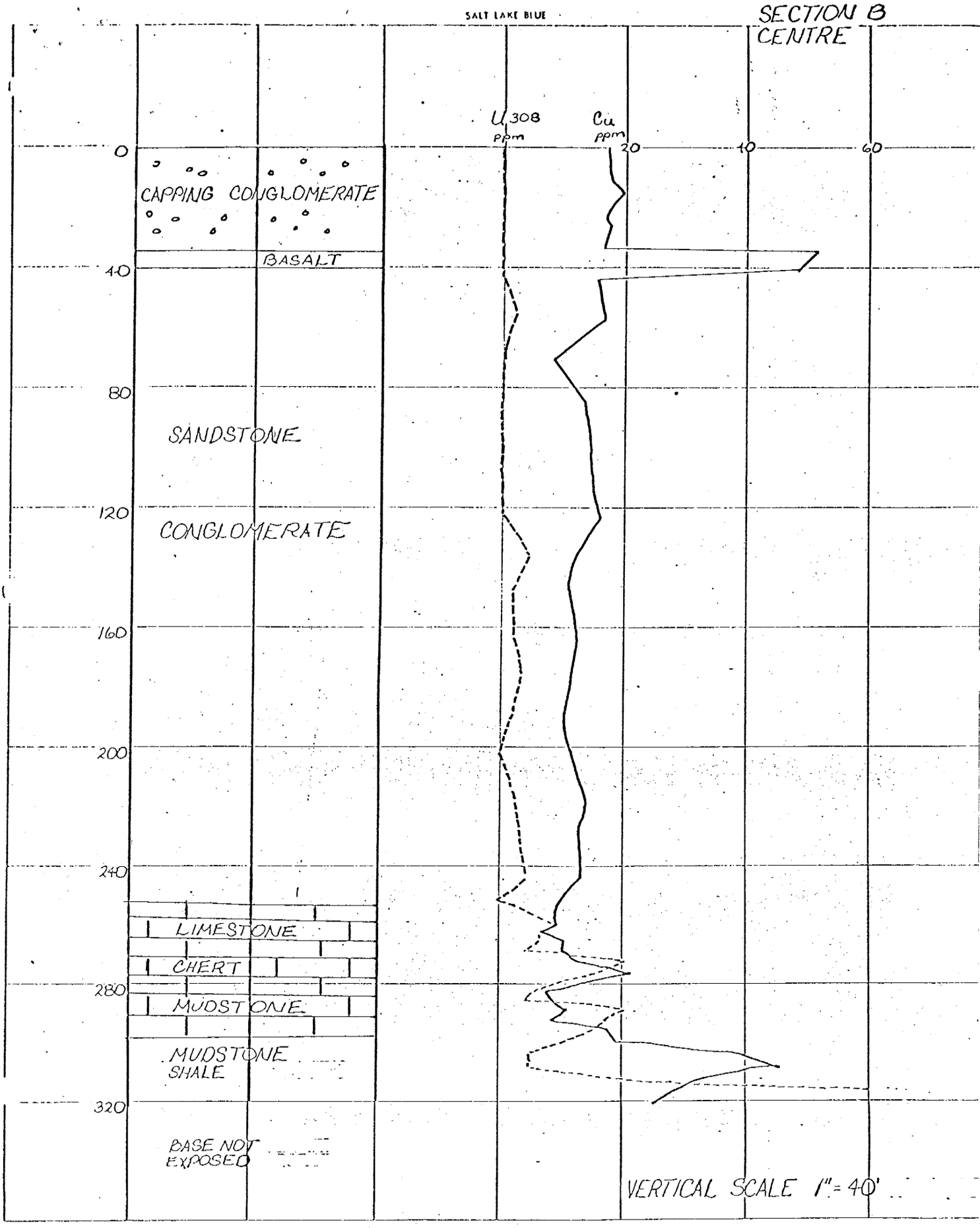
SECTION A
WEST END

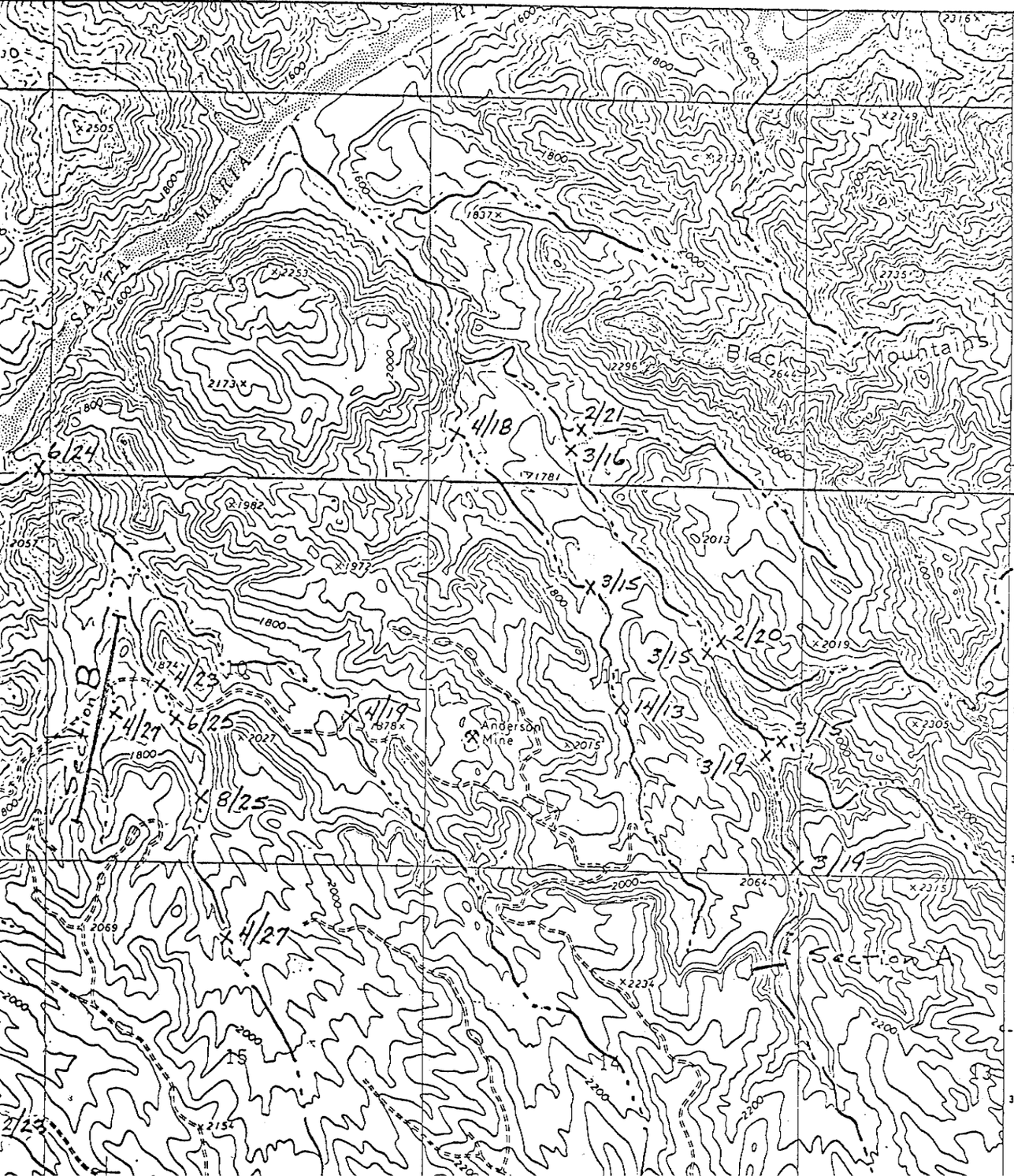


ANDERSON DEPOSIT

SALT LAKE BLUE

SECTION B
CENTRE





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Boundary of Lyung &
Geological Plan

x 4/18 Sample point with U
values in ppm.

Rock chip sample se

Minerals Exploratio
STREAM SEDIMENT GEOCHEM
Anderson Deposit
Yavapai Co., Az.
Data by R. McNeil, Nov

APPENDIX 3

STREAM SEDIMENT GEOCHEMISTRY

ANDERSON DEPOSIT

Twenty nine stream sediment samples were collected from the vicinity of the Anderson deposit. The sample locations and results are shown on the accompanying plan in relation to the boundary of Ljung and Pavlak's geological plan of Anderson.

Geochemical results are available for copper and uranium only. Vanadium will be available at a later date.

The copper geochemistry does not define the Anderson mineralization and is not of value for future stream sediment reconnaissance programs.

U_3O_8 values readily define the mineralization at Anderson and prove that stream sediment sampling is a potentially useful method for use in future reconnaissance. Previous mining may have contributed to the high values of 14, 13 and 14 ppm U_3O_8 respectively at the west end of the property, but mainly lower values, generally ranging from 4 to 8 ppm, with one value of 19 ppm U_3O_8, were obtained from streams which drained essentially undisturbed terrain. Values obtained from two streams at their juncture with the Santa Maria River were anomalous and it is obvious that a third stream would have been anomalous if sampled.

Before statistical studies such as determination of threshold can be undertaken, additional results are needed from outside the immediate Anderson area. However, it is known that samples from streams draining sediments stratigraphically above the lake sediment units (as defined by Ljung and Pavlak) gave results ranging from below level of detection (-2) to 3 ppm U_3O_8.

At this point in time values of 4 ppm U_3O_8 or greater can be regarded

as anomalous, with values of 6 ppm or more as highly anomalous.

SAG TEST Samples

Soft

Hole#	Lith	Ore Zone Relationship
129c	Grn Sltst + Thin Lignite	280'10" – 281 OZ = Lignite Smple = Grn Sltst + Thin Lignite
129c	Grn Sltst Carb Alert	Smple Below Ore Zone of Lignite 283'10" – 284
129c	Grn Sltst	Above Carbonaceous OZ 327'6" – 328
129c	Lignite	No OZ nearby 390 – 390'4"
129c	Lignite	In Ore Zone? 371 – 371'3"
384c	Lignite	Similar 397'6" – 397'11"
384c	Carb Sltst Gry	Sltst Carb Gry Grn Above 361'8 – 362
384c	Lignite	442'5" 442'11"
373c	Carb Sltst	Similar 366'8 – 367
378c	Carb Sltst + Grn Sltst Carb	Below 354' – 354'6"
28c	Sndy Sltst Grn	Above + Sandier than OZ 395'6" – 396
28c	Sndy Sltst Grn	Above, 6" Sndy Sltst Similar 389'6" – 390
486c	Sltst Grn Carb trash Com	Above Less Carb, Silty than OZ 443 – 443'6"
486c	Lignite w/Grn Sltst	Sltyer than OZ 447'8" 448'6"

Hard

Hole#	Lith	Ore Zon Relationship
129c	Lignite Calc Cntd w/ Silica	Below Similar Lith 347 – 347'10
129c	Ls trace Carb	Below OZ of Lignite 334 – 344'3"
129c	Calc Carb Sltst	Above OZ 352'7" – 352'9"
371c	Carb Sltst	Above Ore Zone 409'10" – 410'9"
308c	Lignite Calc	Below, Similar 74'6" – 75
40c	Sltst + Silic	Above Similar? 66'4" – 67
325c	Silic Sltst + Ls	Above 135'4" – 135'11"
384c	Carb Sltst Silic?	Above 419 – 419'6"
384c	Carb Sltst Silic	Below 401 – 401'6"
384c	Carb Sltst, Silic	Below 368 – 368'6"
152c	Carb Sltst Silic	Above 123'8" – 124
373c	Calc carb Siltst ~~374'5"~~	Below 374'1" – 374'5"
486c	Carb Sltst Ls + Grn Sltst	Above Lignite Zone 509'6" – 510
486c	Limy Carb Sltst	Limyer Than Ore Zone 503'6" – 504
486c	Carb Trash	
486c	Limy Carb Slts	501'6" – 502 Above OZ

SX RAFFINATE NEUTRALIZATION

A raffinate sample produced during the latter part of the SX run was neutralized with reagent grade $Ca(OH)_2$ at ambient temperature to determine lime consumption and liquor assay at pH's 8.0 and 9.2. Test results, detailed in the appendix section, summarize as follows:

$Ca(OH)_2$ CONSUMPTION

pH	$Ca(OH)_2$ Consumption lb/gal Raffinate	lb/lb U_3O_8 1/
5.2	0.095	107
6.7	0.105	117
7.0	0.106	120
8.0	0.110	124
9.2	0.138	155

1/ The liquor before SX contained 0.17 g/l U_3O_8.

LIQUOR ASSAYS

Analytical data for the raffinate and pH 8 and 9.2 solutions are given in Table 13.

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Note whether any other nuclear fuel cycle facilities are located within a 50-mile radius of the site.

The degree of detail to be provided will generally depend on the distance from the plant. Nearby activities (generally within 5 miles of the plant) should be described in greater detail than those at greater distances.

2.3 Regional Historic, Scenic, Cultural, and Natural Landmarks

Areas valued for either their historic, scenic, cultural, or natural significance may be affected. The Environmental Report should include a brief discussion of the historic, scenic, cultural, and natural significance, if any, of the site and nearby areas with specific attention to the sites and areas listed in the *National Register of Historic Places* and the *National Registry of Natural Landmarks.* The 1972 cumulative revision of the *National Register of Historic Places"* is in the *Federal Register* of March 15, 1972, 37 F.R. 5428; additions are published in the *Federal Register* on the first Tuesday of each month. The *National Registry of Natural Landmarks* appears in the *Federal Register* of January 29, 1972. Also, the applicant should discuss its consultation with the appropriate State Liaison Officer for Historic Preservation concerning properties under consideration for nomination to the *National Register of Historic Places.* The Environmental Report should contain evidence of contact with the Historic Preservation Officer for the state involved and a copy of his comments concerning the effect of the undertaking on historic, archaeological, and cultural resources. State Liaison Officers are listed in the *Federal Register* of March 15, 1972 and supplemented in December 1972. In addition, indicate whether or not the site has any archaeological significance and explain how conclusions were reached. If such significance or value is present, describe plans to ensure its preservation.

State whether new roads, pipelines, and utilities connected with the proposed project will pass through or near any area or location of known historic, scenic, cultural, natural, or archaeological significance.

2.4 Geology

Describe the major geological aspects of the site and its environs. The discussion should note the stratigraphy, structure, and tectonic history. Comment on regional continuity, faulting, dip, and strikes of water-bearing formations that will be affected. An inventory of economically important minerals, in addition to the uranium ore, should be included when mining operations are planned. Any effect that planned operations might have on the future availability of other mineral resources should be noted.

Detailed geological data at building sites and in the vicinity of tailings ponds or other effluent impoundments, sanitary landfills, and sewage disposal facilities should be included. These data should include strike and dip and lateral and vertical distribution of permeable layers, shales, and clays, and data on any fault, fracture, or joint pattern which may exist. Locations of local outcrops where seepage from landfills, impoundments, and sewage facilities is likely to occur should be noted.

The location of groundwater with respect to tailings ponds, liquid impoundments, sanitary landfills, and sewage disposal facilities is important for the assessment of possible groundwater contamination. The discussion should include a statement concerning the hydraulic properties (permeability and porosity) of the materials between the groundwater and the above facilities.

2.5 Seismology

Discuss the seismicity (including history) of the region. Where possible, associate seismic events with tectonic features identified in the geology discussion. Furnish a regional earthquake epicenter map showing site location.

2.6 Hydrology

The effects of plant construction and operation on ground and surface water sources are of prime importance. The information indicated in the following sections should be presented in sufficient detail to allow an independent review to be made of the effects of construction and operation on both resources.

2.6.1 Groundwater

Describe the hydrology of the region that affects the local groundwater aquifers, formations, sources, and sinks. Describe the recharge potential of the immediate plant area, including vertical and horizontal permeabilities of the natural and modified terrain, as well as that of tailing areas. Describe the present and projected regional use; tabulate existing private users within the area influenced by the proposed activities and all local and regional public users (amounts, water levels, locations, and drawdown); indicate gradients and seasonal variations in groundwater levels beneath the site.

2.6.2 Surface Water

Describe the location, size, shape, and other hydrologic characteristics of water bodies in the environs of the site.

Include a description of upstream and downstream river control structures and downstream water supply users (including location, amount, and purpose, i.e., domestic, agricultural, etc.), and provide a topographic map showing the major hydrologic features. Assuming failure of any site dams or solid process waste piles under severe flood-producing conditions, analyze and describe any injurious effects to downstream residents from flood waters or contaminants in the waste. Where

Seismic Survey Anderson Mine

The developmental crew suggests that the following parameters be used and ~~requested~~ extensive information pertaining to the areas of interest we have at Anderson Mine. Seismic survey lines be run perpendicular and parallel to the dominate northwest-Southeast structural trend at Anderson Mine.

January 23 Seis
Strat Bob Eliz

Engineering Parameverameter

Ripability
Slope Stability

Hydrology