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HRI Project 4133
Copy No. 5

ACID LEACHING OF ANDERSON MINE SAMPLES

for

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INTRODUCTION AND SUMMARY

In October, 1976, the Minerals Exploration Company authorized Hazen Research, Inc. to perform metallurgical studies on samples from the Anderson Mine property near Wickenburg, Arizona. This report covers data generated during the evaluation of an acid leaching process. Three sets of samples were evaluated during the course of the studies. These were Middle and Lower Zone bulk samples, old core samples, and fresh core samples. The process evaluated was conventional concurrent acid leaching, amine solvent extraction with ammonium sulfate stripping, and precipitation of ammonium diuranate.

The two bulk samples were taken at surface outcrops. The optimum leaching conditions for these samples were:

Size	minus 28-mesh
Temperature	60°C
Time	6 hours
Pulp density	50% solids
Oxidant	1 lb/ton sodium chlorate
Acid	To control at 0.8 to 1.0 pH

The acid requirements were 140 and 260 lb sulfuric acid per ton of Middle and Lower Zone ores, respectively. Tests at these conditions gave uranium extraction from the Middle Zone of 98%, and 95% from the Lower Zone.

A second series of tests was then made on individual hole composites from 14 old drill cores. The leach conditions were similar to the above although up to 18 pounds per ton sodium chlorate was necessary to maintain good oxidation. The uranium solubilizations were from 66 to 98%, and the acid consumptions were as high as 783 pounds per ton.

A third series of tests was performed using fresh cores. These cores were composited to represent three mining areas. These composites contained considerable organic and from 5 to 11% CO_2. Leaching at the conditions used above solubilized from 87 to 93% of the uranium. The acid consumptions were 245 to 585 pounds per ton, and up to 27 pounds per ton sodium chlorate was required for good oxidation.

Flotation of the organic from these ore composites was evaluated. The flotation concentrate contained a weight-proportional amount of uranium. Roasting and acid leaching the concentrate showed good extraction of the uranium, 91 to 97%; however, the need for chlorate addition was not eliminated. Leaching of the flotation tails also required considerable chlorate to maintain oxidation.

A final series of leaching tests was performed on a composite of cores from areas 2 and 3. Leaching time, acid addition, and oxidation conditions were varied in these tests. The results indicate that the time should not exceed eight hours as the acid consumption continues to increase with time and large additions of sodium chlorate do not economically increase the uranium extraction. Oxygen pressure leaching was evaluated as a means of avoiding the chlorate addition. Oxidation of the organics was very exothermic and effective, with extractions of over 90% being achieved in only two hours.

Vanadium extractions throughout all of the tests were 40 to 45%. The very low concentrations in the leach solutions preclude direct recovery of the vanadium; therefore, no attempt was made at recovery. If neutralization of raffinates would be a requirement in the final process design, there might be a potential for vanadium recovery from the neutralization solids.

The nature of the ore does not lend itself to good settling. Thickening tests showed unit areas nominally at 6-7 square feet per ton per day.

Recovery of the uranium from the leach solutions, using a continuous amine solvent extraction unit, was very efficient with raffinates as low as 0.2 ppm U_3O_8. The uranium was stripped from the amine with a 150 g/l ammonium sulfate solution at 4.5 pH. Ammonium diuranate precipitated from the strip solutions was of good quality and had the following analysis:

U_3O_8	81.4-83.3%
Mo	0.06-0.1%
V_2O_5	0.08-0.16%
P_2O_5	0.025%

The molybdenum content can be lowered by operating the first strip stage at less than 3.5 pH whereas the addition of a water wash stage on the loaded solvent should permit lowering of the vanadium.

DESCRIPTION OF ORE SAMPLES

BULK SAMPLES (MIDDLE AND LOWER ZONES)

There are two principal horizons known as the Middle Zone and the Lower Zone in the Anderson ore deposit. Two bulk samples were received from the ore body representing these zones. The analyses of these samples were as follows:

Chemical Analyses, %	Middle Zone	Lower Zone
U_3O_8, analyzed	0.039	0.043
U_3O_8, average calculated	0.045	0.050
V_2O_5	0.07	0.14
Mo	0.001	0.001
CO_2	0.75	3.20
Fe	3.05	3.06

CORE SAMPLES

Cores from 14 holes were received on November 18, 1976. On intervals where the core was crushed, three-fourths of the coarse reject and all the fine reject was used to prepare individual composites. Where the core was split, one-fourth was saved and the remaining core and rejects were used for individual composites. These core composites provided the samples for the second stage of leach studies. Analyses of the composites are listed below:

Hole No. AM-	Grade U_3O_8, %	CO_2, %
1C	0.025	13.4
7C	0.047	0.24
13C	0.027	9.2
16C	0.035	9.6
17C	0.041	1.9
18C	0.063	15.5
26C	0.115	14.3
49C	0.075	17.3
51C	0.018	12.0
113C	0.045	0.63
119C	0.125	13.3
135C	0.086	5.0
149C	0.055	0.34
Average	0.058	-

AREA COMPOSITES 1, 2, AND 3

Eighteen fresh drill cores were received on December 1, 1976, and January 17, 1977. Information was supplied to Hazen Research by Mr. G. C. Dohm, Jr., on the desired holes and footages to be combined to give three composites representing potential periods of mining. One-fourth of each drill core was saved and the remainder was used to make the three composites.

The samples were analyzed chemically for uranium, vanadium, molybdenum, and carbonate content and by semi-quantitative X-ray fluorescence analysis for minor elements. The analyses are shown in the following table.

Mining Period	Percent		
	Composite 1 Early	Composite 2 Middle	Composite 3 Late
Chemical Analysis			
U_3O_8	0.039	0.054	0.058
V_2O_5	0.06	0.09	0.11
Mo	0.002	0.007	0.006
CO_2	11.4	9.7	5.5
X-ray Analysis			
Copper	0.014	0.021	0.014
Zinc	0.020	0.026	0.022
Arsenic	0.001	0.011	0.012
Iron	1.4	1.7	1.7
Nickel	0.040	0.086	0.014
Rubidium	0.011	0.014	0.021
Barium	0.072	0.077	0.099
Strontium	0.060	0.120	0.110
Titanium	0.110	0.066	0.130
Zirconium	0.024	0.036	0.034
Molybdenum	0.002	0.006	0.008
Uranium	0.025	0.042	0.067
Manganese	0.051	0.025	0.044
Yttrium	0.006	0.006	0.006
Lead	--	0.016	0.010
Vanadium	--	0.071	0.008
Chromium	--	0.007	0.044

Bond Work Indices were measured for grinding each of the composites to 65-mesh. The indices were as follows:

Area composite 1	11.8 kwh/ton
Area composite 2	12.0 kwhr/ton
Area composite 3	12.8 kwhr/ton

These indices were determined when alkaline leaching appeared the more favorable method of treatment. Coarser grinds acceptable for acid leaching, 28- or 35-mesh, probably would have work indices of less than 6 kwhr/ton. This lower value would be similar to typical sedimentary ores where it is not necessary to grind finer than the natural grain size.

ORE BODY ANALYSIS

The Anderson Mine ore body consists of interbedded layers of high calcite shales and siltstones, very low calcite shales and siltstones, and lignitic sediments. Therefore, the uranium-bearing strata can contain 0 to 75% calcium carbonate and up to 10% carbon.

The significance of this on processing the core samples was underestimated initially, at least until all the individual core intervals had already been composited. This compositing precluded evaluating the many combinations of ore types in the acid leach studies. However, portions of the analytical pulps were composited to measure the carbonate content of most ore zones and to estimate the carbon content of some ore zones. The values determined are listed in Table 1.

The color values, presumably proportional to the organic content, show little or no correlation with the carbonate content. Therefore, analysis of one or the other would be inadequate for characterizing the ore zones. The distribution of carbonate, uranium, and quantity of ore (feet of core) for the ore zones analyzed is tabulated in Table 2. These data

indicate that one-half the uranium and 37% of the ore tonnage are in zones containing less than 1% CO_2. However, almost 20% of the uranium is contained in ore zones with more than 12% CO_2.

Table 1 (1 of 2 pages)

Analyses for Uranium, Carbonate and, Organic in Anderson Core Samples

Hole	Interval	Total Feet	U_3O_8 %	Distribution	CO_2 %	Color 1/
7	19-21	2	0.181	2.3	0.13	
	98-101	3	NA	NA	0.03	
13	126-128	2	0.032	0.4	8.8	
	131-138	7	0.017	0.8	5.9	
16	305-309	4	0.150	3.9	11.4	
17	131-134	3	0.023	0.5	8.4	
	148-150	2	0.031	0.4	0.31	
	199-205	6	0.032	1.25	0.01	
26	630-638	8	0.042	2.2	24.9	
	720-724	4	0.108	2.8	0.22	
	737-740	3	0.026	0.51	18.7	
49	612-621	9	0.041	2.4	9.5	
	631-637	6	0.032	1.2	4.2	
51	406-408	2	0.081	1.1	0.33	
	439-442	3	0.036	0.7	23	
	445-447	2	0.093	1.2	0.30	
	464-468	4	0.357	9.3	0.12	
79	45-47	2	0.028	0.4	8.6	
	63-64	1	0.021	0.1	8.2	
113	299-303	4	0.034	0.9	0.07	
	339-344	5	0.044	1.4	0.1	
119	32-32	1	0.076	0.5	0.06	
	113-115	2	0.030	0.4	16.7	
	119-124	5	0.041	1.3	25	
	131-132	1	0.228	1.5	22.7	
135	383-389	6	0.042	1.7	0.15	
	459-473	14	0.098	8.9	8.44	
149	382-386	4	0.047	1.2	0.36	
	408-411	3	0.070	1.4	0.15	
184	473-483	10	0.046	3.0	4.5	3.2
	505-509	4	0.043	1.1	21	2.5
	531-533	2	0.042	0.6	4.7	4.5
	660-662	2	0.075	1.0	0.21	2.0
	671-673	2	0.073	0.9	5.7	4.5
222	109-113	4	0.050	1.3	32	
	116-117	1	0.032	0.2	11	
229	123-123	2	0.063	0.8	13	
	144-150	6	0.030	1.2	24	
244	77-79	2	0.020	0.3	0.20	
254	123-125	2	0.014	0.2	0.07	
273	36-38	2	0.128	1.7	0.03	
	134-141	7	0.033	1.5	3.2	
	175-177	2	0.043	0.8	0.04	

Table 1 (2 of 2 pages)

Hole	Interval	Total Feet	U_3O_8, %	Distribution	CO_2, %	Color 1/
274	55-57	2	0.029	0.4	0.08	
275	47-53	6	0.101	3.9	12.9	3.0
289	80-82	2	0.062	0.8	9.0	2.5
	138-156	18	0.028	3.2	6.7	2.5
	260-262	2	0.054	0.7	0.31	2.0
337	424-427	3	0.043	0.8	15	3.0
390	279-281	2	0.58	0.8	0.13	3.0
412	129-135	6	0.241	9.3	0.71	4.5
	141-143	2	0.056	0.7	9.2	3.0
431	561-566	5	0.066	2.1	17	3.5
	577 579	2	0.029	0.4	13	3.5
	587-589	2	0.032	0.4	4.0	2.5
434	529-531	2	0.029	0.4	0.10	1.0
	536-538	2	0.025	0.3	0.06	1.0
435	98-101	3	0.078	1.5	0.04	1.0
	130-132	2	0.047	0.6	0.03	
	178-180	2	0.032	0.4	3.6	
436	220-223	3	0.075	1.5	0.09	1.0
	272-274	2	0.017	0.2	2.1	1.0
444	343-345	2	0.335	4.3	0.18	4.5
	365-367	2	0.026	0.3	0.07	3.5
	412-414	2	0.028	0.4	8.6	3.5
	423-425	2	0.039	0.5	0.17	5.0
	563-567	4	0.045	1.2	0.49	4.0

1/ Scale

1 Light beige
2 Light grey
3 Medium grey
4 Dark gray
5 Black

Table 2

Distribution of Carbonate and Uranium in Anderson Core Samples

CO_2, %	Uranium Distribution		U_3O_8, %				Cumulative Feet, Distribution, %
	%	Cumulative	Average	Cumulative	Cumulative 1/	Feet	
0-0.09	9.9	9.9	0.044	0.044	0.063	34	14
0.10-0.30	27.2	37.1	0.110	0.079	0.066	38	29
0.31-0.75	13.9	51.0	0.107	0.085	0.056	20	37
0.76-2.0	0	51.0	--	0.085	0.056	0	37
2.1-4.0	2.6	53.6	0.030	0.078	0.049	13	43
4.1-6.0	6.5	60.1	0.037	0.070	0.051	27	54
6.1-8.9	13.9	73.9	0.051	0.065	0.054	42	71
9.0-12.0	8.1	82.0	0.069	0.066	0.056	18	78
12-16	6.0	87.9	0.071	0.066	0.052	13	83
16-20	3.0	91.0	0.047	0.065	0.046	10	87
20-25	6.6	97.6	0.046	0.063	0.046	22	96
25-32	2.6	100	0.045	0.063	0.045	9	100

1/ Cumulative average U_3O_8 beginning with highest CO_2 zones.

ACID LEACHING STUDIES

MIDDLE AND LOWER ZONE BULK SAMPLES

The initial portion of the acid leaching program was designed to evaluate the effects of time, temperature, and sulfuric acid and sodium chlorate additions on the leaching of uranium from the Middle and Lower Zones of Anderson ore body. Two bulk samples provided the feed for these studies.

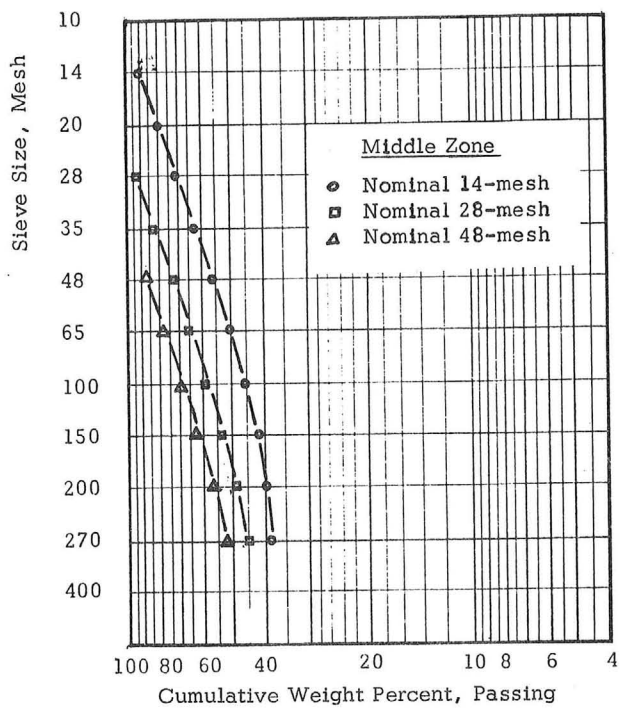
Splits were taken from each blend and dry-ground to nominal 14-, 28-, and 48-mesh sizes. Figure 1 plots the screen analyses of the three sizes for each ore.

The acid leaching studies were performed in two sets. In the first set the additions of reagents were controlled by measurements of the leach pulp pH and emf. In the second set, the reagent additions were fixed. The leaching procedure was to pulp the dry ore in water, bring the pulp up to temperature, add the reagents and digest for a predetermined time. At the conclusion of the leach, the pulp was filtered and washed, first with one displacement of 1.5 pH water, then one displacement of demineralized water.

The detailed results from each series of tests are tabulated in Appendix B-1 and B-2. Both ore zones were very amenable to acid leaching with most uranium extractions greater than 95%.

The effect of each variable on the uranium and vanadium extractions was determined by fitting a logarithmic least squares curve to the data. The quality of the fit was evaluated by calculating the Coefficient of Determination for each curve. The Coefficient of Determination, r^2,

Screen Analysis of Middle and Lower Zones
Anderson Mine Composites



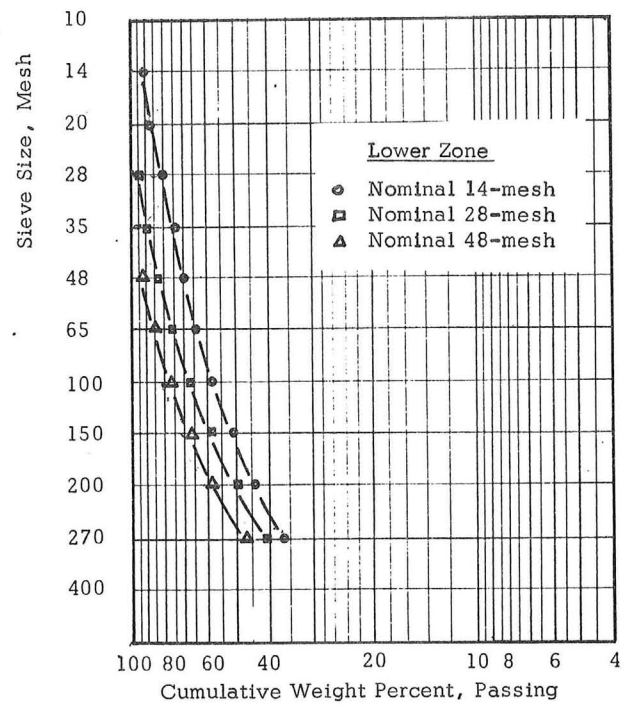


Figure 1

estimates the decimal percentage of the variance of the dependent variable which can be explained by changes in the independent variable. The closer r^2 is to unity, the more variance is explained. Values of r^2 approaching zero indicate the fit of the data has no statistical significance.

The effect of temperature on the acid leaching of the uranium and vanadium is plotted in Figure 2. The plots show slight increases and decreases in the residual values as the temperature is increased. However. the only Coefficient of Determination having significance is the vanadium extraction from the lower zone, which showed increasing vanadium extraction with increasing temperature.

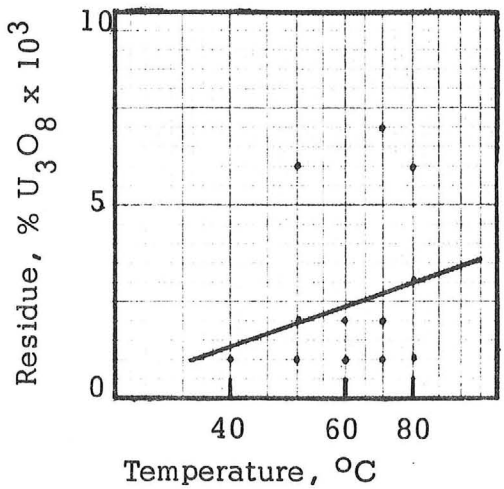
The effect of time on the acid leaching of the uranium and vanadium is plotted in Figure 3. The plots show only slight changes in the residual values with time, indicating the leach time may be as short as four hours.

The effect of sodium chlorate addition on the acid leaching of the uranium and vanadium is plotted in Figure 4. For both ore zones, the uranium extraction improves slightly with oxidant addition; whereas the vanadium extraction decreases with oxidant addition. The Coefficients of Determination for the vanadium are fairly significant, 0.16 and 0.42, indicating that oxidant addition should be a minimum.

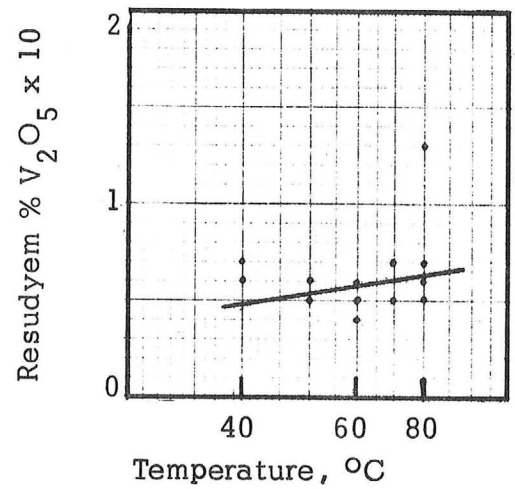
The effect of ore size on the acid leaching of the uranium and vanadium is plotted in Figure 5. The uranium extraction improves slightly with finer grinding; however, none of the curves show significant Coefficients of Determination. Figures 6 and 7 compare the screen analyses of the acid leached residues of the 14- and 28-mesh residues with their respective head.

The effects of residual free acid and the acid addition of the leaching of the uranium and vanadium are plotted in Figures 8 and 9. The residual values from the Middle Zone decreased with increasing free acid;

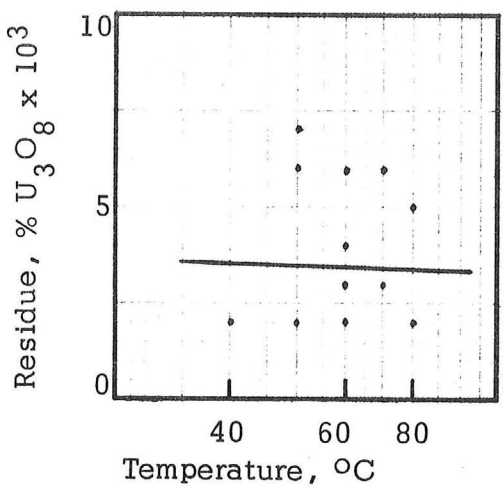
Effect of Temperature
on Leaching of Anderson Mine
Middle and Lower Zone Samples



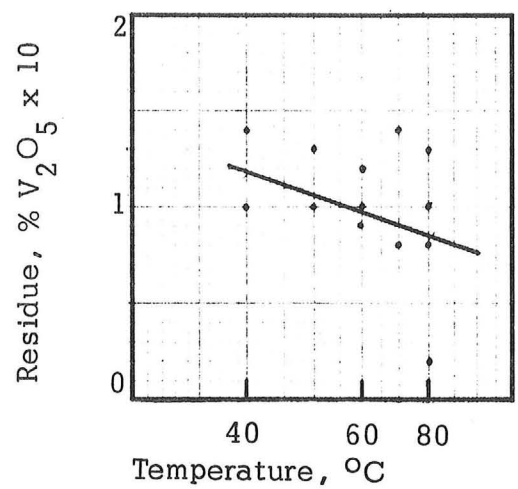
Middle Zone
Uranium: $r^2 = 0.05$



Middle Zone
Vanadium: $r^2 = 0.06$



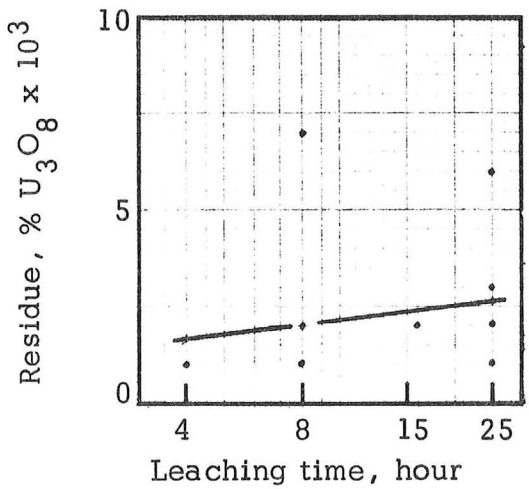
Lower Zone
Uranium: $r^2 = 0.001$



Lower Zone
Vanadium: $r^2 = 0.16$

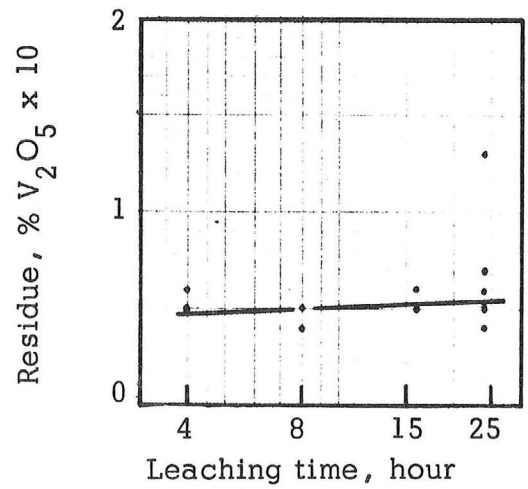
Figure 2

Effect of Time on Leaching
on Anderson Mine Composites



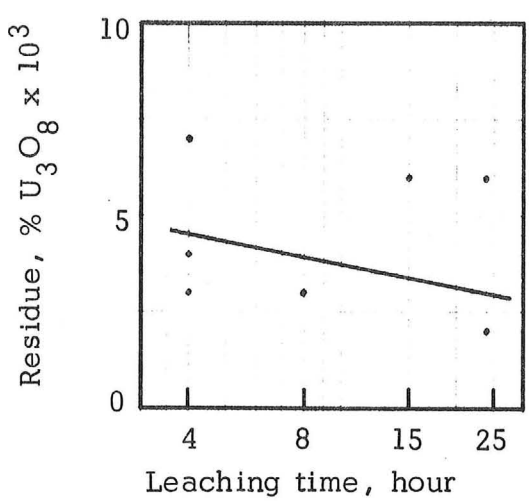
Middle Zone

Uranium: $r^2 = 0.03$

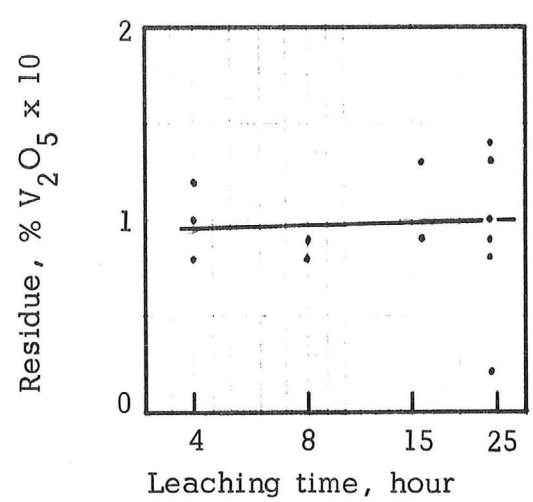


Middle Zone

Vanadium: $r^2 = 0.09$



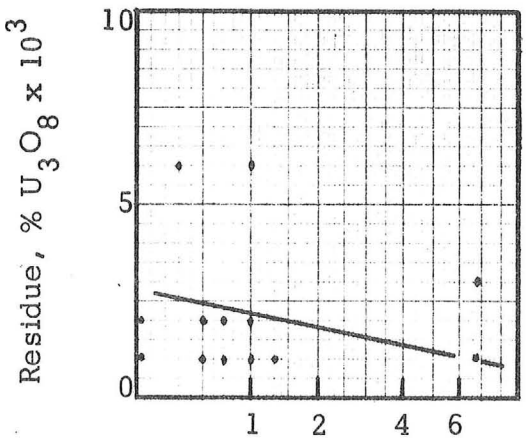
Lower Zone
Uranium: $r^2 = 0.11$



Lower Zone
Vanadium: $r^2 = 0.006$

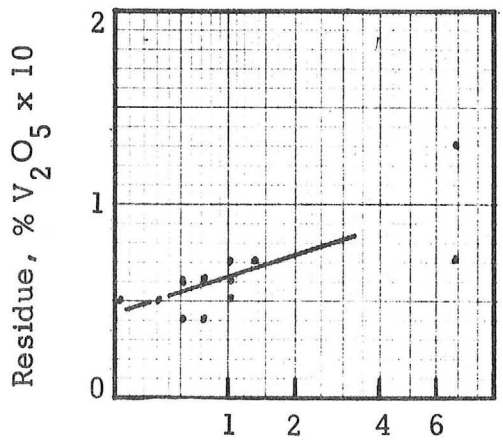
Figure 3

Effect of Oxidant Addition on
Leaching of Anderson Mine Composites



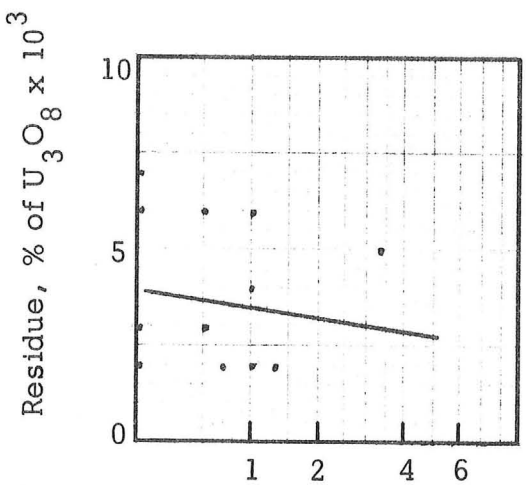
Oxidant addition, lb/T
$NaClO_3$

Middle Zone
Uranium: $r^2 = 0.02$



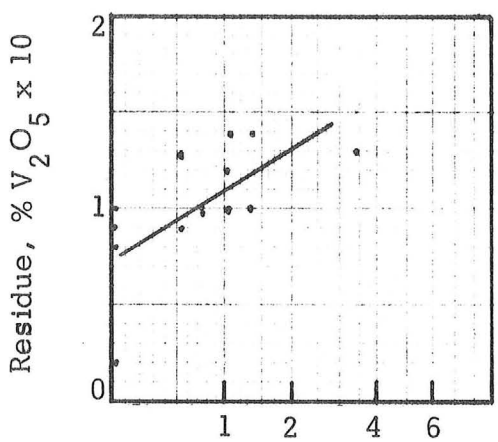
Oxidant addition, lb/T
$NaClO_3$

Middle Zone
Vanadium: $r^2 = 0.16$



Oxidant addition, lb/T
$NaClO_3$

Lower Zone
Uranium: $r^2 = 0.02$

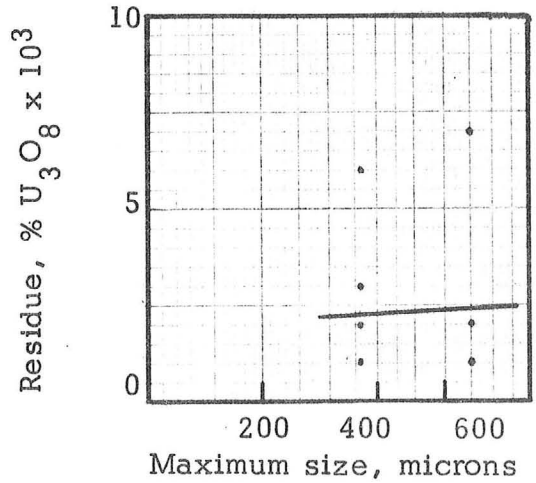


Oxidant addition, lb/T
$NaClO_3$

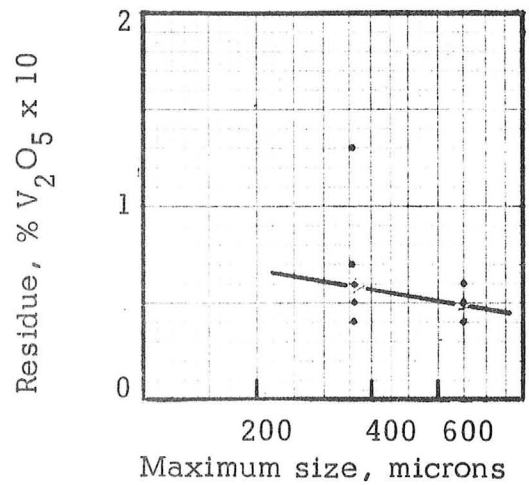
Lower Zone
Vanadium: $r^2 = 0.42$

Figure 4

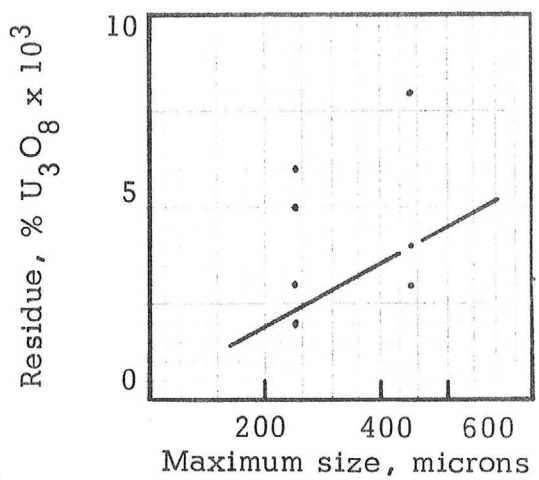
Effect of Grind on Leaching
of Anderson Mine Composites



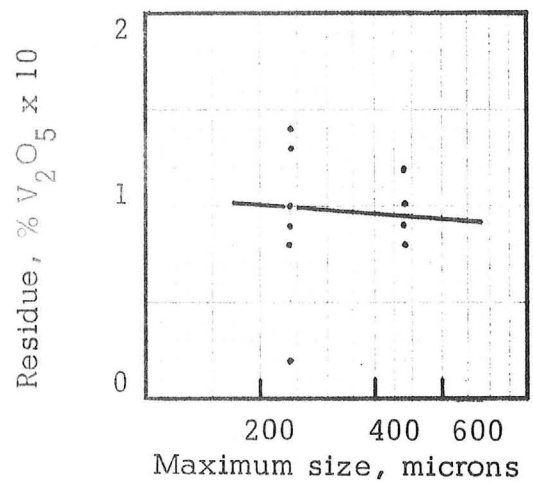
Middle Zone
Uranium: $r^2 = 0.0005$



Middle Zone
Vanadium: $r^2 = 0.06$



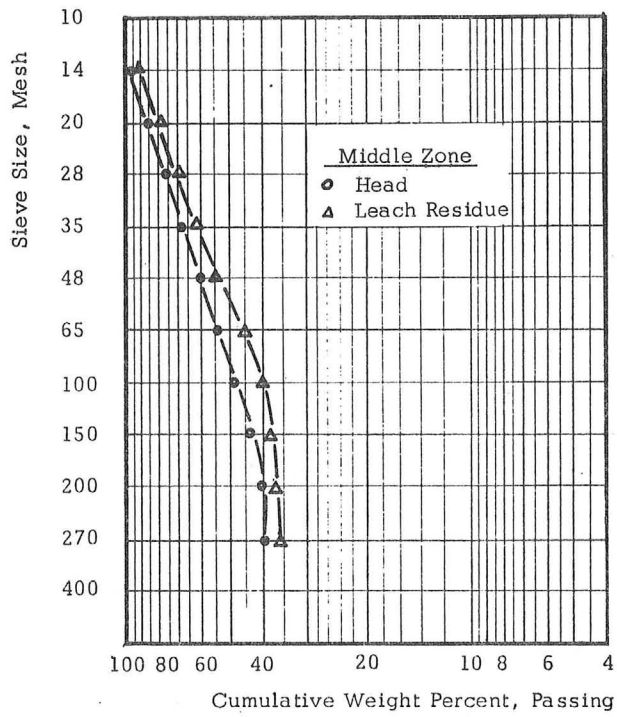
Lower Zone
Uranium: $r^2 = 0.04$



Lower Zone
Vanadium: $r^2 = 0.01$

Figure 5

Screen Analysis of Head and Acid Leach Residue
on Minus 14-mesh Anderson Mine Composites



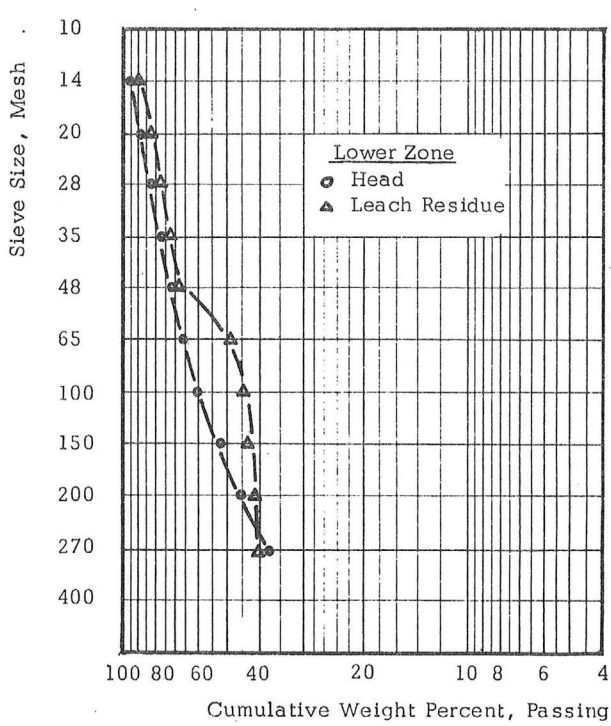
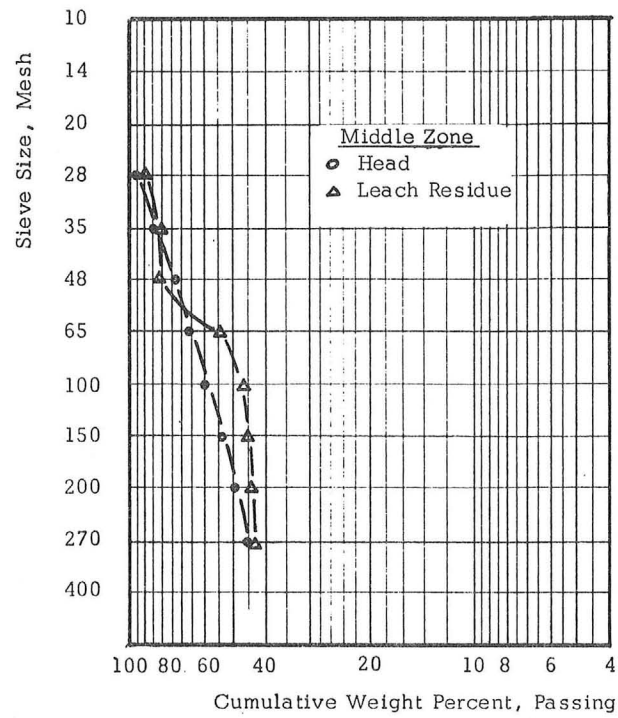


Figure 6

Screen Analysis of Head and Acid Leach Residue
on Minus 28-mesh Anderson Mine Composites



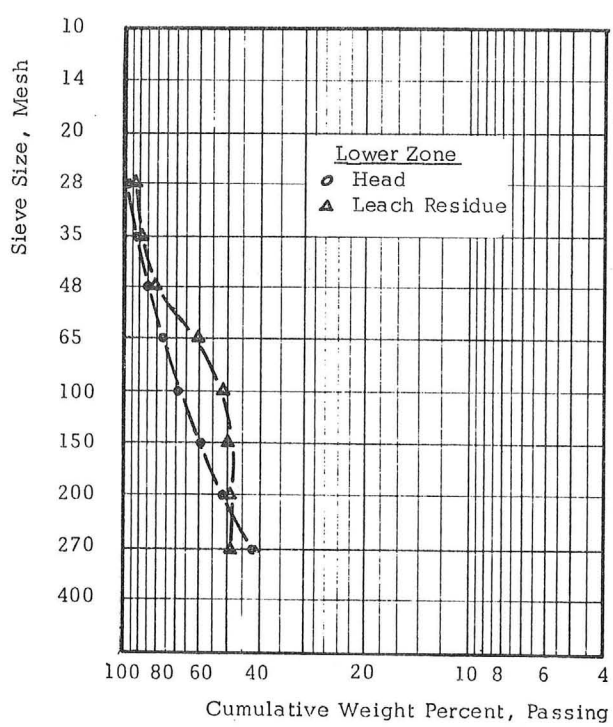
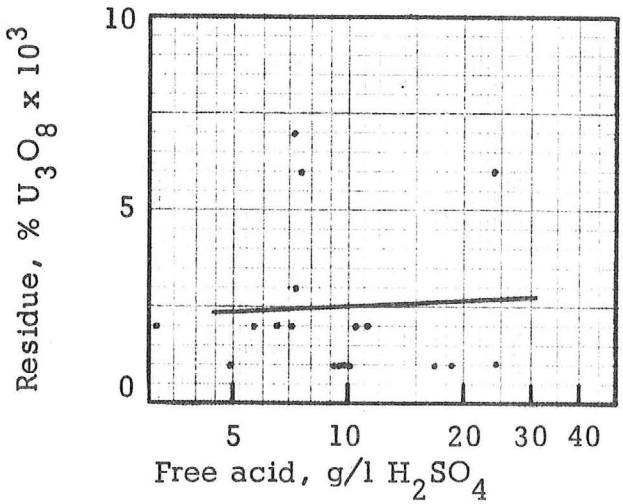
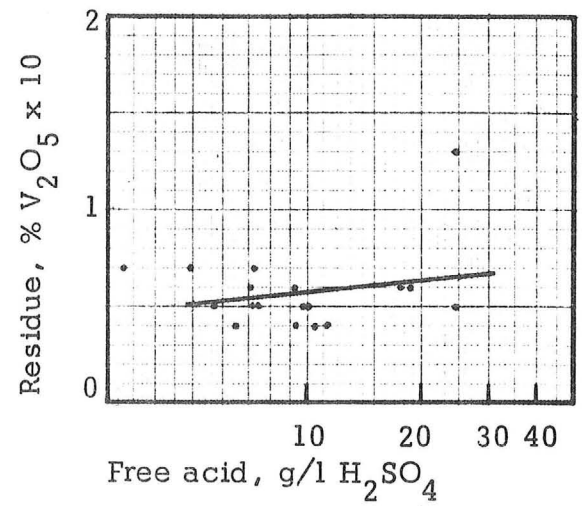


Figure 7

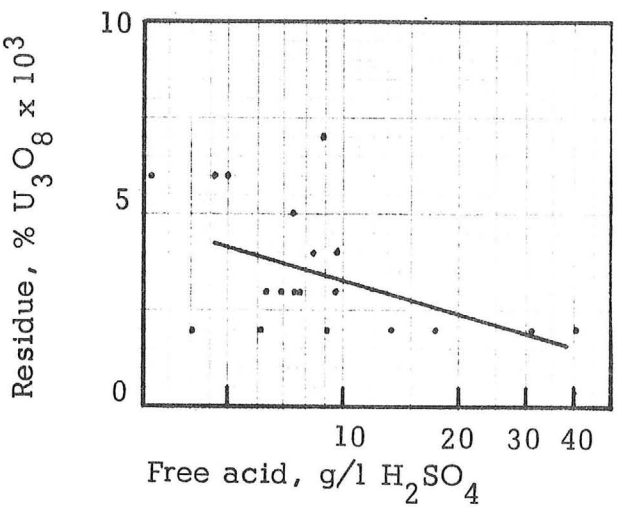
Effect of Final Free Acid Concentration
on Leaching of Anderson Mine Composites



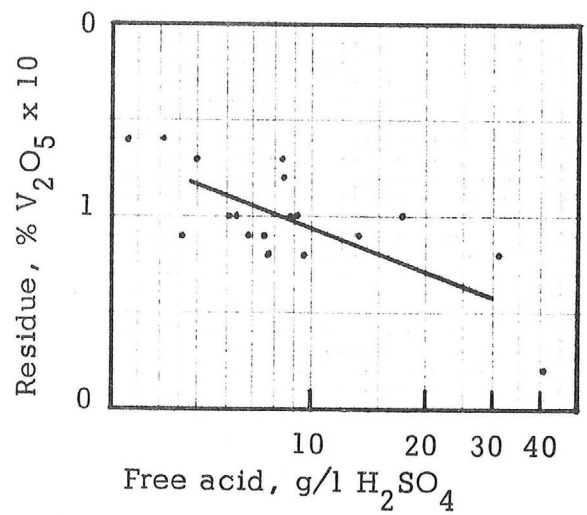
Middle Zone
Uranium: $r^2 = 0.0004$



Middle Zone
Vanadium: $r^2 = 0.07$



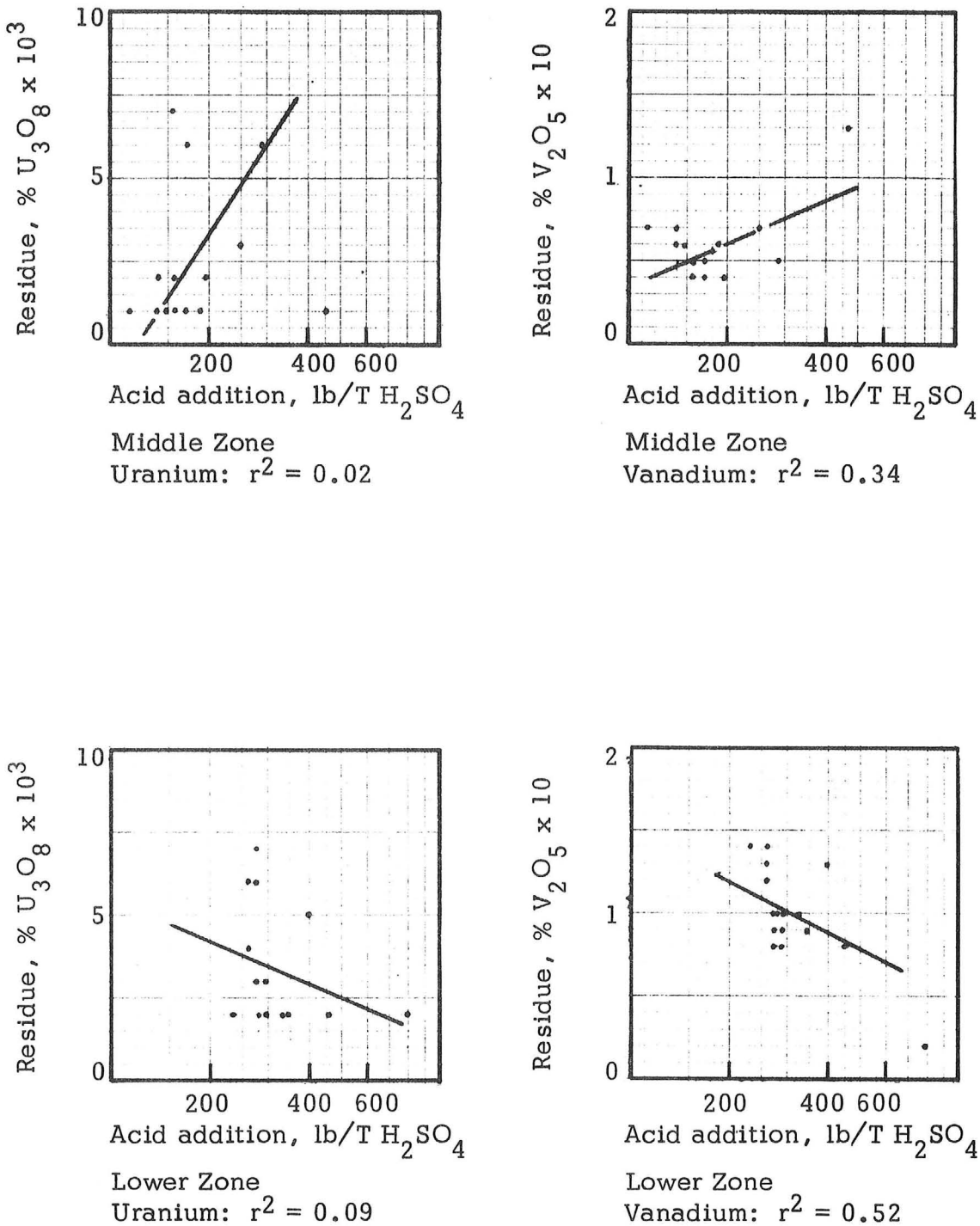
Lower Zone
Uranium: $r^2 = 0.21$



Lower Zone
Vanadium: $r^2 = 0.55$

Figure 8

Effect of Sulfuric Acid Addition on
Leaching of Anderson Mine Composites



Middle Zone
Uranium: $r^2 = 0.02$

Middle Zone
Vanadium: $r^2 = 0.34$

Lower Zone
Uranium: $r^2 = 0.09$

Lower Zone
Vanadium: $r^2 = 0.52$

Figure 9

hri

whereas, they increased with increasing acid addition. This infers that, although the residual free acid is affected by the acid addition, it is affected more by the acid consumption. The acid consumption during the leaching is affected by a combination of the ore size, leaching temperature, and retention time. The residual values from the Lower Zone did not show the above phenomena with the residual acid having little effect on the residual uranium and vanadium. The vanadium and uranium extractions did increase slightly with increasing acid addition.

Analysis of the leaching tests indicated that the optimum leaching conditions, considering all of the variables, would be 60°C, for six hours, 50% solids using ore ground to 80% passing 28-mesh, and an addition of one lb/ton sodium chlorate. The acid addition should be controlled at 0.8 to 1.0 pH, requiring 140 lb/ton for the Middle Zone and 260 lb/ton for the Lower Zone. Tests at these conditions gave uranium extractions of 98% from the Middle Zone and 95% from the Lower Zone.

OLD CORE SAMPLES

Tests were run on 14 core samples received in mid-November, 1976. Agitation leaches were performed on minus 28-mesh composites from each hole. Common leach conditions, based on the results from the Middle and Lower Zone tests, were chosen. These were 33% solids, 60°C for six hours with sulfuric acid and sodium chlorate added to control the pH at 1.0 and emf at > 500 mv during the first four hours.

The leach results are summarized in Table 3, and the detailed data are tabulated in Appendix C.

Table 3

Extraction of Uranium from
Anderson Mine Core Hole Composites

Hole No.	Assay Head U_3O_8, %	Assay Head CO_2, %	Residual Uranium U_3O_8, %	Solubilized Uranium, %	Acid Added, lb/ton
AM-1C	0.025	13.4	0.004	85.3	807
AM-7C	0.047	0.24	0.003	95.0	170
AM-13C	0.027	9.2	0.002	94.1	536
AM-16C	0.035	9.6	0.006	84.8	597
AM-17C	0.041	1.9	0.001	98.0	151
AM-18C	0.063	15.5	0.017	72.7	776
AM-26C	0.115	14.3	0.027	75.0	801
AM-49C	0.075	17.3	0.026	66.2	724
AM-51C	0.055	3.3	0.012	80.0	305
AM-79C	0.018	12.0	0.003	82.9	837
AM-113C	0.045	0.63	0.005	89.6	161
AM-119C	0.125	13.3	0.022	80.8	743
AM-135C	0.086	5.0	0.015	82.4	247
AM-149C	0.055	0.34	0.013	77.3	60
Average Grade	0.058			83.2	
weighted avg	0.058			80.9	

The data show uranium extractions of 66% to 98%. Core samples with CO_2 content > 10% are less amendable to acid leaching. In most cases these samples had the lower uranium solubilizations.

These core samples did not respond to acid leach as well as the Middle and Lower Zone samples. The acid additions were very high and one-half the samples had acid consumptions greater than 550 lb/ton.

AREA COMPOSITES

Fresh drill core samples from the Anderson Mine were received on December 1, 1976, and January 17, 1977, for amenability testing. One-fourth of each drill core sample was saved and the remaining drill cores and their rejects were used to make three area composites. Each composite was crushed to pass 6-mesh. Portions were split out for head samples and the balance of the sample was ground to give a nominal 28-mesh grind and provided the feed for the leach amenabilities.

Table 4 and Figures 10, 11, and 12 show the weight and uranium distributions for the three 28-mesh composites. The distributions indicate that the uranium is evenly disseminated throughout the ore.

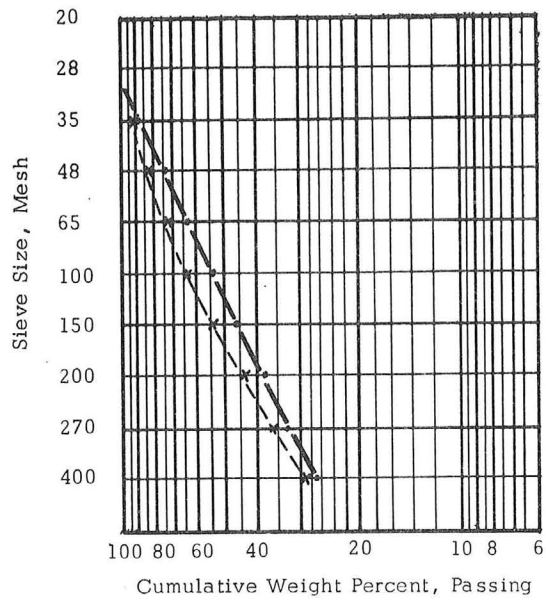
Acid leach amenability tests, using the three 28-mesh composites, were performed. The conditions were 1.0 pH, 50% solids, 60°C, and six hours retention time. The results of these tests are summarized in Table 5, the data are tabulated in Appendix D, and individual data sheets are in Appendix E.

Table 4

Screen Analysis on Anderson Mine Ore Composite

Mesh Size	Weight, %	Cumulative Weight, % Retained	Cumulative Weight, % Passing	U_3O_8 %	U_3O_8 Distribution, %	U_3O_8 Passing, %
Area 1						
35	10.6	10.6	89.4	0.022	6.3	93.7
35 x 48	15.2	25.8	74.2	0.028	11.5	82.2
48 x 65	10.5	36.3	63.7	0.031	8.8	73.4
65 x 100	9.6	45.9	54.1	0.037	9.6	63.8
100 x 150	8.1	54.0	46.0	0.044	9.6	54.2
150 x 200	8.4	62.4	37.6	0.046	10.4	43.8
200 x 270	5.1	67.5	32.5	0.052	7.2	36.6
270 x 400	5.5	73.0	27.0	0.050	7.4	29.2
-400	27.0	--	--	0.040	29.2	--
Area 2						
35	5.7	5.7	94.3	0.047	5.5	94.5
35 x 48	8.4	14.1	85.9	0.053	9.2	85.3
48 x 65	9.4	23.5	76.5	0.047	9.1	76.2
65 x 100	8.5	32.0	68.0	0.054	9.5	66.7
100 x 150	7.6	39.6	60.4	0.051	8.0	58.7
150 x 200	8.0	47.6	52.4	0.043	7.1	51.6
200 x 270	6.1	53.7	46.3	0.044	5.5	46.1
270 x 400	8.0	61.7	38.3	0.044	7.3	38.8
-400	38.3	--	--	0.049	38.8	--
Area 3						
35	6.2	6.2	93.8	0.071	7.8	92.2
35 x 48	12.9	19.1	80.9	0.064	14.6	77.6
48 x 65	9.3	28.4	71.6	0.063	10.4	67.2
65 x 100	8.9	37.3	62.7	0.063	10.0	57.2
100 x 150	8.4	45.7	54.3	0.054	8.0	49.2
150 x 200	9.0	54.7	45.3	0.050	8.0	41.2
200 x 270	5.7	60.4	39.6	0.046	4.6	36.6
270 x 400	7.5	67.9	32.1	0.049	6.5	30.1
-400	32.1	--	--	0.053	30.1	--

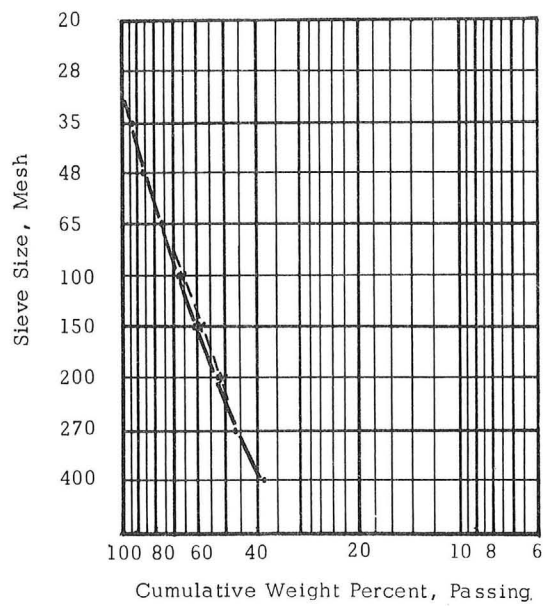
Screen Analysis



Area Composite No. 1

• Weight
x Uranium

Figure 10



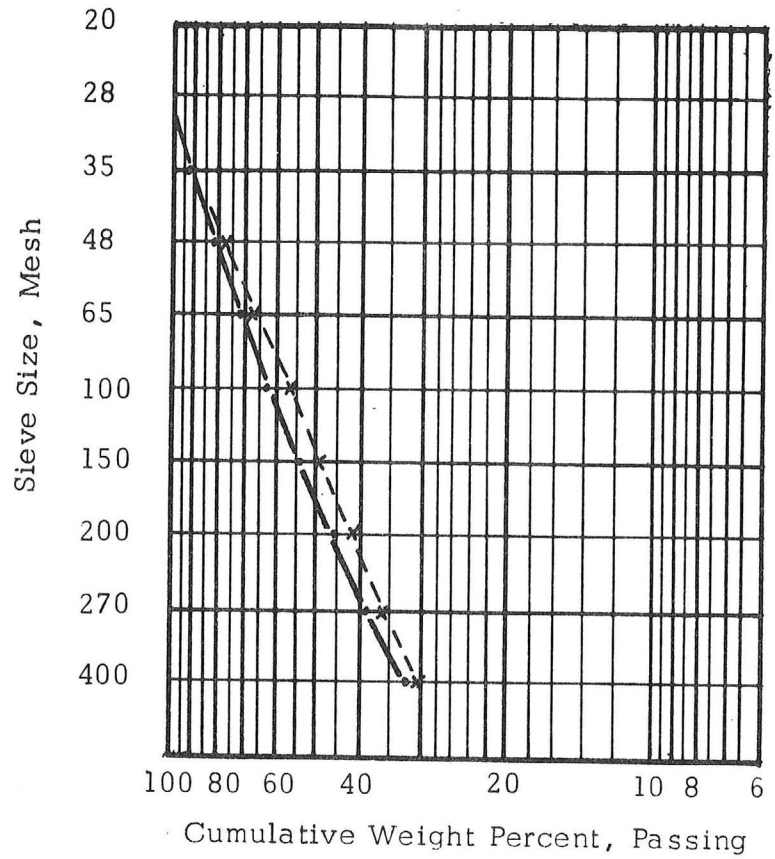
Area Composite No. 2

• Weight
x Uranium

Figure 11

hri

Screen Analysis



Area Composite No. 3

• Weight
× Uranium

Figure 12

Table 5

Extraction of Uranium from
Anderson Mine Composites 1, 2, and 3

Test No.	Sample Identification	Grade, % U_3O_8	Residual Uranium % U_3O_8	Solubilized Uranium, %	Acid Added lb/ton
1009-68	Composite 1	0.039	0.004	88.9	585
1009-69	Composite 2	0.054	0.004	92.5	562
1009-70	Composite 3	0.058	0.008	86.8	245

These tests show uranium solubilizations from 87% to 92%. Acid consumptions were 245 to 585 lb/ton. Sodium chlorate additions of 13 to 27 lb/ton were required to maintain oxidation. The ore acid leached relatively well, but the acid and oxidant requirements are large.

Flotation of Organic

The presence of organic hydrocarbons was observed in most of the Anderson Mine samples. Froth flotation was evaluated for organic removal or concentration. A number of flotation tests were performed on the three area composites using minus 65-mesh and 28-mesh ore. Attritioning of the ore was followed by flotation of organic at 1.5 pH, with 13 lb/ton of kerosene as promoter and 0.1 lb/ton Dowfroth 250 as frother. Settling tests were conducted on the flotation tail pulps. Flotation concentrations were calcined at 350°C, 400°C, and 500°C for two hours and added to the flotation tails for leaching, or the concentrates and tails were leached separately.

Table 6 shows that the floated material had uranium contents similar to the head ore. Some of the concentrate contained significant amounts of organic. The flotation concentrates, after calcining, were readily amenable to acid leaching; see Table 7 and Appendix F.

Thickening of the flotation tails required unit areas ranging from 4 to 7 sq ft/ton per day; see Table 8.

Acid leaches also were performed on the flotation tails, with and without added calcined concentrate. The leaches are summarized in Table 9 and are detailed in Appendices G-1 and G-2. The flotation and calcining of the concentrates greatly reduced the sodium chlorate requirements for good oxidation.

Ambient Leach Optimization

The remaining material from the area composites 2 and 3 was blended for use in the final series of leaching tests. These leaches, tabulated in Appendix H and detailed in Appendix I, evaluated the effects of leaching time, temperature, and acid and chlorate additions on the uranium extraction.

Because of the large number of tests, some with conflicting results, the data were analyzed using calculated arithmetic means and standard deviations. In this way there can be some evaluation of whether or not the differences seen are statistically significant. Table 10 lists the analysis of the results.

Table 6

Flotation of Organic from Anderson Mine Ore
Area Composites 1, 2, and 3

Test No.	Flotation Procedure	Flotation Composite No.	Flotation Acid Addition lb/ton	Concentrate, % Wt	Concentrate, % U_3O_8	Btu/lb
1009-75	65-mesh ore, pH adjusted at 1.5, floated with 13 lb/ton kerosene and 0.1 lb/ton DF-250	1	512	7.4	0.033	599
1009-77	65-mesh ore, pH adjusted at 1.5, floated with 13 lb/ton kerosene and 0.1 lb/ton DF-250	2	532	10.3	0.019	932
1009-73	65-mesh ore, pH adjusted at 1.5, floated with 13 lb/ton kerosene and 0.1 lb/ton DF-250	3	288	8.3	0.039	<50
1009-78	Attritioned 28-mesh ore at 1.5 pH, floated with 13 lb/ton kerosene and 0.1 lb/ton DF-250	1	596	10.2	0.027	397
1009-79	Attritioned 28-mesh ore at 1.5 pH, floated with 13 lb/ton kerosene and 0.1 lb/ton DF-250	2	492	8.4	0.087	728
1009-80	Attritioned 28-mesh ore at 1.5 pH, floated with 13 lb/ton kerosene and 0.1 lb/ton DF-250	3	280	10.2	0.061	1144

Table 7

Treatment of Anderson Mine Flotation Concentrate

Test No.	Composite No.	Roasting Temp °C	Concentrate Grade U_3O_8, %	Leaching Conditions 1/ Sodium Chlorate Addition Concentrate lb/ton	Total Ore lb/ton	Residue, % U_3O_8	Uranium Extraction, %
1009-84	1	350	0.027	11.4	0.6	0.0032	90.6
1009-87	1	400	0.027	3.8	0.2	0.002	94.2
1009-85	2	350	0.087	14.3	0.6	0.0044	96.6
1009-88	2	400	0.087	4.8	0.2	0.003	97.3
1009-86	3	350	0.061	12.1	0.6	0.0054	94.0
1009-89	3	400	0.061	4.0	0.2	0.005	94.3

1/ 60°C, 6 hours, 33% solids, 1.0 pH.

Table 8

Comparison of Flocculants on Settling Flotation Tail Pulp
Anderson Mine Ore

Test No.	Flotation Tail Composite No.	lb/ton Superfloc 16	lb/ton Polyhall 1080	Terminal Density % Solids	Unit Area ft^2/ton/day
1009-78	1	0.2	--	53.5	4.7
1009-79	2	0.2	--	61.5	6.6
1009-80	3	0.2	--	69.7	4.4
1009-81	1	--	0.2	57.7	4.9
1009-82	2	--	0.2	54.8	6.4
1009-83	3	--	0.2	65.4	3.6

Table 9

Leaching of Flotation Tails

Test No.	Composite No.	With Concentrate	Roast Temperature °C	H_2SO_4 Addition Float lb/ton	H_2SO_4 Addition Leach lb/ton	H_2SO_4 Addition Total lb/ton	$NaClO_3$ Addition lb/ton	Filtrate pH	Filtrate emf	Residue U_3O_8, %	Uranium Extraction %
1009-75	1	Yes	500	512	181	693	4.8	--	--	0.004	89.7
1009-77	2	Yes	500	532	98	630	7.9	--	--	0.005	91.3
1009-73	2	Yes	500	288	216	504	8.2	--	--	0.006	87.6
1009-81	1	No	--	596	190	786	8.2	0.7	440	0.0036	91.8
1009-82	2	No	--	492	199	691	16.6	0.8	430	0.0055	91.0
1009-83	3	No	--	280	140	420	17.5	0.9	430	0.0051	89.1

Table 10

Statistical Analysis of Data from
Acid Leaching Anderson Mine Ore

Variable	Number of Data	Mean Value ± Std Deviation
Calculated head	40	0.0675 ± 0.0035% U_3O_8
Uranium in residue	39	0.0075 ± 0.0015% U_3O_8
Uranium extraction	39	88.8 ± 2.2%
Uranium in residues		
4-hour time	14	0.0070 ± 0.0011% U_3O_8
>8-hour time	20	0.0079 ± 0.0019% U_3O_8
<11 lb/ton $NaClO_3$	9	0.0092 ± 0.0010% U_3O_8
11 to 20 lb/ton $NaClO_3$	19	0.0068 ± 0.0013% U_3O_8
>21 lb/ton $NaClO_3$	7	0.0078 ± 0.0016% U_3O_8
Acid Consumptions at:		
4 hr, <500 lb/ton added	2	404 ± 13
8 hr, <500 lb/ton added	7	403 ± 42
16 hr, <500 lb/ton added	7	441 ± 35
8 hr, >500 lb/ton added	3	470 ± 7
16 hr, >500 lb/ton added	4	439 ± 17
24 hr, >500 lb/ton added	3	499 ± 3
Vanadium Extractions:		
All tests	38	44.8 ± 7.1%
<500 lb/ton acid	27	41.8 ± 5.0%
>500	11	52.9 ± 6.2%
4 to 8 hours	14	41.7 ± 7.0
12 or more hours	16	49.3 ± 6.2
20 or less lb/ton $NaCLO_3$	27	46.3 ± 7.4
>20 lb/ton $NaCLO_3$	6	41.8 ± 5.0

The data, with regard to the uranium, indicate that the leach time should not exceed 8 hours with a 500 lb/ton acid addition since the acid consumption increased with time and the uranium extraction decreased. Chlorate addition is indicated to be best at 11 to 20 lb/ton. However, the test with a 2-lb/ton chlorate addition had a residue of 0.0090% U_3O_8. Using the means from the 11-20 lb/ton chlorate data, 0.0068% U_3O_8 and 16.6 lb/ton sodium chlorate, the difference in residue values is 0.0022% or $2.20 using $50 U_3O_8; whereas, the cost difference in chlorate is $2.19 (14.6 lb times $0.15).

The vanadium results show increasing vanadium extractions with increasing leaching acid addition and time and decreasing extractions with increasing oxidant. These are what one would normally expect and 40 to 40% would seem to be a reasonable value to use.

Pressure Leaching

The large organic content of the Anderson Mine ores requires large amounts of chemical oxidants for complete oxidation. Pressure leaching, using air or oxygen, is a possible method of achieving oxidation without high chemical expense. Five acid pressure leaches were performed using the blend of area 2 and 3 composites. The conditions evaluated were:

Temperature	135°C
Time	2-3 hours
Oxidant	Air or oxygen
Total pressure	60-100 psig
Acid addition	500 lb/ton

The results from these leaches are tabulated in Table 11 and are detailed in Appendix J.

Table 11

Acid Pressure Leach Anderson Mine Ore
Composite Areas 2 and 3

Test No.	Oxygen or Air Total Pressure, psi	Time, Hours	Acid Consumption, lb/ton	Residue U_3O_8, %	Uranium Extraction, %
1009-134	60	2	436	0.0069	90.2
1009-135	60	3	438	0.0069	89.3
1009-136	100 (air)	3	449	0.008	87.5
1009-137	100	3	407	0.009	86.8
1009-158 1/	100	2	404	0.006	91.4

1/ 25 g ferric sulfate added to this test.

The data above show that uranium solubilizations of about 90% can be expected and that oxygen is the better oxidant. Addition of ferric sulfate in Test 1009-158 gave the best results, with uranium solubilization over 91%.

These tests show higher residual uranium values than the conventional agitation leaches for the same composite. This probably is due to the shorter leaching time.

Thickening Tests

Several tests were conducted on leached pulps to study the settling characteristics of this composite. Different flocculants were evaluated. The results of these tests are summarized in Table 12, and data sheets from three of the tests are included in Appendix K. The thickening tests do not show small unit areas (nominally 6-7 sq ft/ton per day).

Table 12

Comparison of Flocculants on Settling
Anderson Mine Ore

Test No.	lb/ton NALCO 6WM-867	NALCO 5WM-537	Superfloc 16	Polyhall 1080	Jaguar MDD	MG-200	Terminal Density % Solids	Unit Areas ft^2/ton/day
1009-90-A	0.16	--	0.08	--	--	--	43.5	5.6
1009-90-A	0.16	--	--	0.04	--	--	39.4	6.7
1009-103	--	--	--	--	0.16	--	37.1	10.1
1009-104	--	--	0.16	--	--	--	46.4	12.0
1009-105	--	--	--	--	--	0.16	44.3	5.1
1009-106	--	--	--	0.16	--	--	44.0	5.9
1009-128	--	0.30	--	--	--	--	42.8	16.9
1009-130	--	0.45	--	--	--	--	44.8	9.9
1009-132	--	0.60	--	--	--	--	40.9	7.4
1009-137	--	--	--	--	--	0.16	44.2	4.5
1009-139 1/	--	--	--	--	--	0.16	49.2	3.3
1009-147	--	--	--	--	--	0.15	38.7	7.0
1009-148	--	--	--	--	--	0.18	37.2	5.3
1009-149	--	--	--	--	--	0.20	39.3	6.2

1/ Initial pulp density, 15.5% solids.

URANIUM SOLVENT EXTRACTION

Four continuous extraction tests were performed utilizing a solvent containing 3% Alamine 336, 2% isodecanol, and 95% kerosene. Leach solution composites which contained from 0.161 to 0.220 g/l U_3O_8 were used as feed. The tests were carried out in an 8-stage box-type mixer-settler unit with 6 sq inch mixers and 15 sq inch settlers. The mixing was done with low speed, low shear pumping turbines. Mixing time was about one minute with the phase ratios in the mixers controlled at 1.5-3 parts organic to one part aqueous.

The uranium was extracted in four stages and the solvent was stripped in four stages. The strip solution was made of 150 g/l $(NH_4)_2SO_4$, and the pH was controlled with NH_4OH between 3.7 and 4.5.

Detailed analyses from the continuous solvent extractions runs are included in Appendix L. The system worked very well with regard to uranium extraction. Raffinates containing less than 1 ppm U_3O_8 were readily achieved, indicating extractions of greater than 99.9%. The maximum loading on a 3% amine solvent from these low grade solutions appears to be 2 g/l U_3O_8, which may limit the maximum uranium concentration in the strip. We did not run long enough for the strip to reach equilibrium. The maximum strip product concentration was 5.7 g/l U_3O_8.

A small amount of solids collected at the strip interfaces, mostly due to overshooting the pH at the start. These moderated in volume as the run progressed and the amount remaining at the end was removed by filtration for X-ray spectrographic analysis. The results of these analyses are tabulated in Table 13.

The analyses indicate no unusual problems with fine ore particles comprising the extraction solids, and an ammonium uranate comprising the strip solids.

Table 13

X-Ray Fluorescence Analysis of Solvent Extraction Solids

Element	Percent		
	4th Stage Extraction 1009-138-7	5th Stage First Strip 1009-138-9	8th Stage Last Strip 1009-138-15
Copper	0.007	0.018	0.017
Zinc	0.021	0.059	0.11
Arsenic	0.006	0.010	0.009
Iron	2.1	1.4	0.51
Nickel	0.028	0.019	0.009
Strontium	0.017	0.005	0.010
Titanium	0.089	--	--
Zirconium	0.016	0.042	0.13
Vanadium	0.073	0.034	0.024
Chromium	0.045	0.027	--
Molybdenum	0.14	0.10	0.67
Uranium	0.24	0.96	9.8
Manganese	0.034	0.010	0.007
Lead	--	0.006	--
Rubidium	--	0.008	0.020
Yttrium	--	0.003	0.005

An extraction isotherm was developed at the termination of the continuous run utilizing soda ash scrubbed solvent and a composite of solutions from tests 1009-134, 135, and 136.

The data from this isotherm are tabulated in Table 14 and plotted in Figure 13.

Table 14

Uranium Extraction Isotherm of Anderson Mine Leach Solution by 3% Alamine 336

Description	U_3O_8, g/l	
	Aqueous Phase	Organic Phase
Feed	0.237	--
	0.021	2.15
	0.016	2.00
	0.014	1.86
	0.012	1.71
	0.008	1.56
	0.006	1.40
	0.005	1.25
	0.004	1.09
	0.003	0.94
	0.002	0.79
	0.002	0.63
	0.001	0.47
	0.001	0.31
	0.0006	0.16
	0.0003	0.0002

Uranium Solvent Extraction Isotherm

Feed: Leach solutions from tests 1009-134, 1009-135, and 1009-136, 0.237 g/l U_3O_8.

Solvent: 3% Alamine 336, 3% isodecanol in kerosene, after scrubbing, from continuous solvent extraction test.

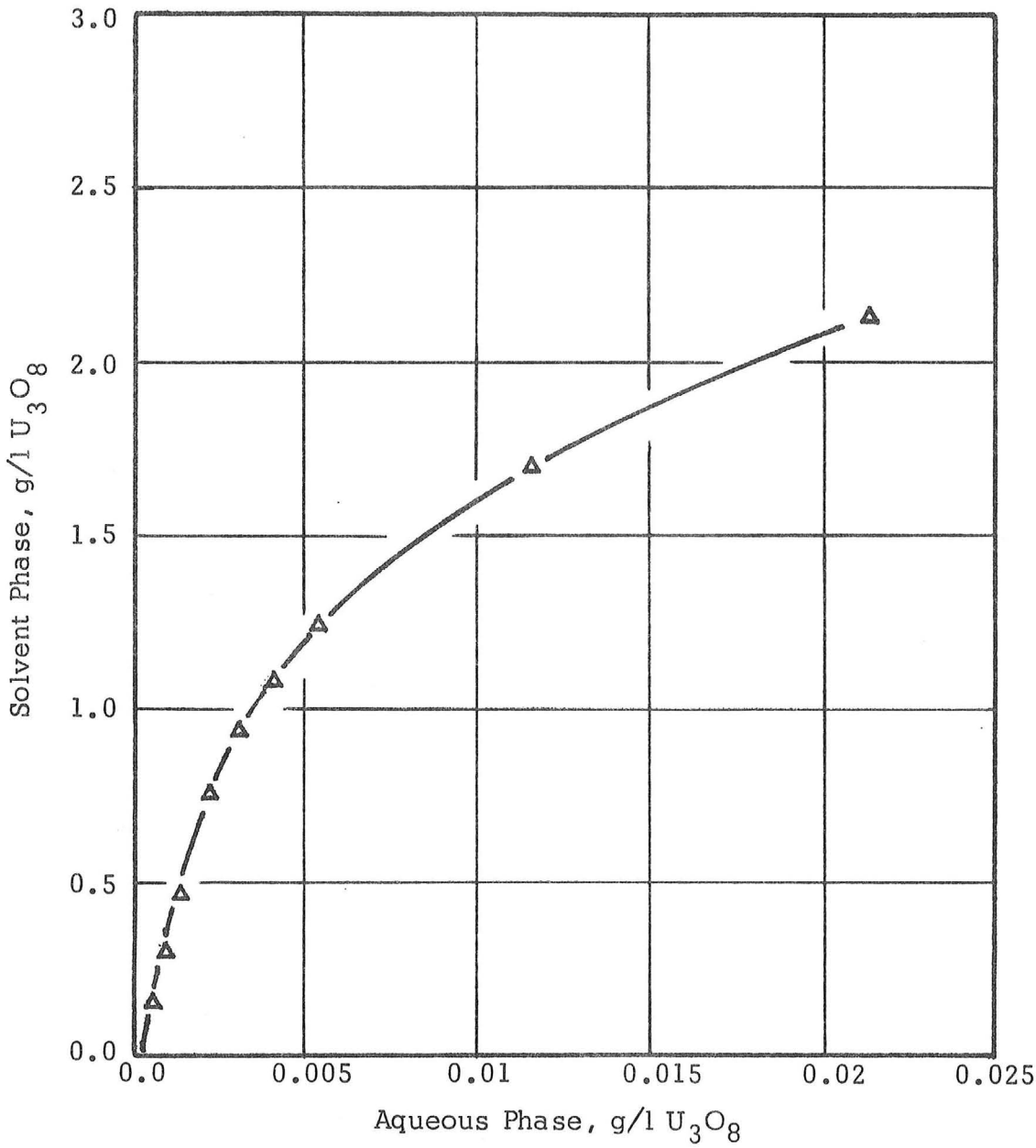


Figure 13

The amount of mixing time necessary for adequate uranium transfer from the leach solution to the lean solvent was determined. The data listed in Table 15 show that 15 seconds is an adequate mixing time.

Table 15

Effect of Mixing Time on Uranium Transfer Rate into 3% Alamine 336 Anderson Mine Leach Solution

Contacts: 2 organic/1 aqueous

	Feed: 0.237 g/l U_3O_8		
Mixing Time Seconds	Break Time Seconds	Aqueous U_3O_8 %	Equilibrium 1/ %
15	81	0.0012	99.7
30	83	0.0006	99.9
60	89	0.0003	100
90	92	0.0004	100

1/ Assumes 100% at 60 seconds.

Settler dispersion band widths at various flow rates were determined for the extraction stages, using a continuous flow apparatus. The data from these tests, Table 16, show that the settler areas can be less than 0.959 ft/gpm total flow.

Table 16

Effect of Flow Rate on Dispersion Band Width During Extraction of Uranium by 3% Alamine 336 from Anderson Mine Leach Solution

Mixing phase ratio: Organic to aqueous flow 1.6

Settler Area ft^2/gpm total flow	Band Width, inches
0.60	1/2
0.48	1
0.43	1-1/2
0.41	2
0.37	2-1/2
0.34	3

YELLOW CAKE PRECIPITATION

A composite of product strip solution from the continuous solvent extraction runs and a composite strip solution remaining in solvent extraction cells were used for uranium precipitation studies. The strip solutions contained 5.77 and 4.53 g/l U_3O_8, respectively.

Conventional ammonium diuranate precipitation was performed on these two composites. The strip solution product was heated to 50°C and pH adjusted to 7.0 with ammonium hydroxide. The ammonia addition was 0.5 lb NH_3 per lb U_3O_8. The precipitate slurry was digested for two hours. M-59 flocculant was added and the precipitate was settled, filtered and washed with demineralized water.

The same procedure as above was used for strip solution from extraction solvent cells, except that temperature was held at 80°C for one hour retention time, The ammonia addition was 0.9 lb NH_3 per lb U_3O_8.

Table 17 compares the analyses of the two oven-dried yellow cake products.

The ammonium diuranate precipitation in both cases recovered 99.9% of the uranium.

Table 17

Uranium Product Analyses

Analysis	Ammonium Diuranate 50°C	80°C
U_3O_8	81.4	83.3
Mo	0.059	0.14
V_2O_5	0.16	0.08
P_2O_5	0.025	0.024

APPENDIX A

APPENDIX A-1

TESTING PROCEDURES

Leaching

Most leaches were performed using ore dry ground to nominally 28-mesh. Generally, 300 grams of dry ore was pulped in demineralized water in a tall-form, 1000-ml beaker. The beaker was placed in a thermostatically controlled water bath, agitated with a variable speed propeller stirrer, and brought to the desired temperature. In the tests where fixed additions of sulfuric acid or sodium chlorate were made, these were added as 1000 g/l sulfuric acid solution and 100 g/l sodium chlorate solution.

Reagent additions to tests were as follows:

Initial addition	H_2SO_4 to target pH
1/2 through 4 hours	H_2SO_4 to target pH, $NaClO_3$ to maintain 500 mv
4 through 6 hours	H_2SO_4 to target pH, $NaClO_3$ to maintain 500 mv

At the conclusion of the leach the entire pulp was filtered, washed with two or more displacements of 1.5 pH demineralized water and two or more displacements of unacidified demineralized water. The primary and wash filtrates were kept separate and the solids were dried.

FLOTATION OF ORGANICS

These tests were performed using 500 g of ore, dry ground to 28-mesh and pulped with demineralized water in the flotation cell. The pulp density used was approximately 25% solids. Sulfuric acid was added to control the pH about 1.5. The pulp was conditioned for about two minutes with kerosene and Dowfroth-250 for collector and frother. After conditioning, the concentrate was collected for 30 minutes, the tails were settled to 50% solids, and the concentrate was filtered, washed, and dried. Generally, the dry concentrate was calcined using a 2 x 4-inch tray in a muffle furnace set at 500°C. The muffle door was propped open to permit air circulation. The calcine concentrate was then added to the settled flotation tails for acid leaching or leached separately.

SETTLING TESTS

Settling tests were performed on flotation tails and acid leach pulps. The pulps were transferred to one-or two-liter graduated cylinders and, if necessary, were diluted with demineralized water to just slightly more than the desired feed percent solids.

The flocculant dosages were diluted to about 80 ml with demineralized water. The diluted flocculant was added to the pulp with a pipette tip. The level of the pulp-supernatant interface was measured against the elapsed time from the cessation of agitation. The Kynch method of calculation was used to determine the unit areas required for settling.

APPENDIX B

Table B-1

(Page 1 of 2)

Anderson Mine Ore pH Controlled Acid Leach Tests
Middle Zone, Composite 1

Test No.	976-1	976-3	976-9	976-11	976-17	976-19	976-25	976-27
Leach Conditions								
Feed size, mesh	-28	-28	-28	-28	-28	-28	-28	-28
Temperature, °C	80	80	60	60	40	40	80	80
Time, hour	24	24	24	24	24	24	24	24
H_2SO_4 addition, lb/ton	249.3	453.3	156	194.7	113.3	149.3	186.6	289.3
$NaClO_3$ addition, lb/ton	6.7	6.7	0	0.7	1.3	0.7	0.7	0.3
Filtrate								
Volume, ml	960	980	455	425	455	425	460	490
pH	1.1	0.8	1.1	1.0	1.3	1.1	1.1	1.0
emf, mv	640	580	455	460	630	625	460	460
H_2SO_4, g/l	7.29	24.50	6.50	11.18	4.85	18.72	16.8	24.3
U_3O_8, g/l	0.143	0.152	0.176	0.206	0.173	0.190	0.205	0.205
Wash								
Volume, ml	-	-	590	605	600	600	590	590
U_3O_8, g/l	-	-	0.071	0.069	0.062	0.068	0.071	0.037
Residue								
Weight, g	274.5	262	279	278	280.5	282.5	277.2	278.7
U_3O_8, %	0.003	0.001	0.002	0.002	0.001	0.001	0.001	0.006
V_2O_5, %	0.07	0.06	0.04	0.04	0.07	0.06	0.06	0.05
Mo, %	-	-	-	-	-	-	-	-
Extraction								
U_3O_8, %	94.5	98.3	95.6	95.8	97.6	97.7	98.0	88.0
V_2O_5, %	9.5	23.8	47.6	47.6	4.8	19.0	19.0	33.3
Mo, %								
Acid consumption, lb/ton	203	293.3	125	149	92	69.3	112	192.4
Settling Characteristics								
Terminal density, % solids	-	-	-	-	-	-	-	-
Unit area, ft^2/ton/day	-	-	-	-	-	-	-	-

Table B-1

Test No.	976-29	976-31	976-33	976-35	976-37	976-39	976-41	976-43	976-45	976-47	976-69
Leach Conditions											
Feed size, mesh	-28	-28	-28	-28	-28	-14	-14	-14	-14	-14	-14
Temperature, °C	60	50	60	50	70	70	70	60	60	50	60
Time, hour	8	24	16	16	24	8	4	8	4	4	6
H_2SO_4 addition, lb/ton	170	170	155	140	140	155	170	155	140	155	140
$NaClO_3$ addition, lb/ton	0.5	1.0	0.0	0.5	1.0	0.0	0.0	0.5	1.0	0.0	1.0
Filtrate											
Volume, ml	480	440	495	345	360	440	470	450	450	405	200
pH	1.0	1.0	1.1	1.1	1.2	1.0	0.95	1.0	1.0	0.9	1.0
emf, mv	445	480	435	640	475	430	435	465	660	430	630
H_2SO_4, g/l	9.42	7.49	5.70	7.14	3.25	7.23	9.83	10.47	9.28	10.04	13.3
U_3O_8, g/l	0.200	0.200	0.189	0.212	0.221	0.228	0.210	0.196	0.228	0.206	0.358
Wash											
Volume, ml	400	400	430	400	420	410	390	410	400	420	405
U_3O_8, g/l	0.093	0.070	0.085	0.125	0.110	0.044	0.100	0.098	0.101	0.101	0.156
Residue											
Weight, g	284	284.5	283.5	283	286.7	293	288.6	287	290	298.7	282
U_3O_8, %	0.001	0.006	0.002	0.002	0.002	0.007	0.001	0.002	0.001	0.001	0.001
V_2O_5, %	0.04	0.05	0.05	0.06	0.07	0.05	0.05	0.04	0.06	0.05	0.060
Mo, %	-	-	-	-	-	-	-	-	-	-	-
Extraction											
U_3O_8, %	97.9	87.0	95.8	95.6	95.6	852.2	97.9	95.7	98.0	97.7	98.0
V_2O_5, %	47.6	33.3	33.3	19.0	4.8	28.6	33.3	47.6	19.0	28.6	19.5
Mo, %											
Acid consumption, lb/ton	129	141	129	112	127	130	127	110	101	114	106
Settling Characteristics											
Terminal density, % solids	-	-	-	-	-	-	-	-	-	-	-
Unit area, ft^2/ton/day	-	-	-	-	-	-	-	-	-	-	-

Table B-2

Anderson Mine Ore Fixed Reagent Addition Acid Leach Tests
Lower Zone, Composite 2

(Page 1 of 2)

Test No.	976-30	976-32	976-34	976-36	976-38	976-40	976-42	976-44	976-46	976-48	976-70
Leach Conditions											
Feed size, mesh	-28	-28	-28	-28	-28	-14	-14	-14	-14	-14	-14
Temperature, °C	60	50	60	50	70	70	70	60	60	50	60
Time, hour	8	24	16	16	24	8	4	8	4	4	6
H_2SO_4 addition, lb/ton	290	290	275	260	260	275	290	275	260	275	260
$NaClO_3$ addition, lb/ton	0.5	1.0	0.0	0.5	1.0	0.0	0.0	0.5	1.0	0.0	1.0
Filtrate											
Volume, ml	460	405	460	345	500	450	440	455	440	450	212
pH	1.0	1.2	1.2	1.2	1.3	1.1	0.95	1.1	1.0	0.95	1.15
emf, mv	475	525	430	640	490	445	450	480	650	440	590
H_2SO_4, g/l	7.52	6.30	4.57	5.04	3.33	7.71	9.61	6.85	8.44	8.94	12.8
U_3O_8, g/l	0.225	0.264	0.223	0.260	0.208	0.261	0.276	0.273	0.273	0.237	0.406
Wash											
Volume, ml	410	420	420	405	420	420	410	410	410	420	400
U_3O_8, g/l	0.120	0.118	0.085	0.090	0.069	0.118	0.127	0.123	0.116	0.093	0.186
Residue											
Weight, g	288.5	298.5	283	295	292	294.5	295	280.7	280.7	281	288.1
U_3O_8, %	0.003	0.002	0.006	0.007	0.006	0.003	0.003	0.003	0.004	0.007	0.003
V_2O_5, %	0.09	0.10	0.09	0.13	0.14	0.08	0.08	0.09	0.12	0.10	0.12
Mo, %	-	-	-	-	-	-	-	-	-	-	-
Extraction											
U_3O_8, %	94.6	96.3	89.1	85.9	88.4	95.0	95.2	95.4	93.7	88.1	94.9
V_2O_5, %	38.1	28.6	40.5	9.5	2.4	42.9	42.9	40.5	19.0	33.3	17.9
Mo, %	-	-	-	-	-	-	-	-	-	-	-
Acid consumption, lb/ton	255	265	256	244	245	242	250	246	101	238	227
Settling Characteristics											
Terminal density, % solids	-	-	-	-	-	-	-	-	-	-	-
Unit area, ft^2/ton/day	-	-	-	-	-	-	-	-	-	-	-

Table B-2

Test No.	976-2	976-4	976-10	976-12	976-18	976-20	976-26	976-28
Leach Conditions								
Feed size, mesh	-28	-28	-28	-28	-28	-28	-28	-28
Temperature, °C	80	80	60	60	40	40	80	80
Time, hour	24	24	24	24	24	24	24	24
H_2SO_4 addition, lb/ton	393.3	797.3	281.3	342.7	233.3	280	329.3	452
$NaClO_3$ addition, lb/ton	3.3	0.0	0.7	0.7	1.3	1.3	0.7	0.0
Filtrate								
Volume, ml	1,170	1,010	455	470	445	430	470	530
pH	1.1	0.6	1.1	1.0	1.3	1.1	1.1	0.9
emf, mv	635	465	465	460	625	505	460	455
H_2SO_4, g/l	8.40	40.59	6.09	13.32	4.12	9.13	17.4	31.1
U_3O_8, g/l	0.145	0.180	0.204	0.219	0.187	0.213	0.225	0.214
Wash								
Volume, ml	-	-	605	605	600	600	600	610
U_3O_8, g/l	-	-	0.079	0.078	0.076	0.085	0.075	0.065
Residue								
Weight, g	274	259	282.5	281.5	286.7	281	276.2	271.2
U_3O_8, %	0.005	0.002	0.002	0.002	0.002	0.002	0.002	0.002
V_2O_5, %	0.13	0.02	0.10	0.09	0.14	0.10	0.10	0.08
Mo, %	-	-	-	-	-	-	-	-
Extraction								
U_3O_8, %	92.5	97.2	96.2	96.4	95.7	96.2	96.5	96.6
V_2O_5, %	14.3	88.1	33.3	40.5	4.8	33.3	33.3	47.6
Mo, %	-	-	-	-	-	-	-	-
Acid consumption, lb/ton	324	524	253	281	215	239	252	303
Settling Characteristics								
Terminal density, % solids	-	-	-	-	-	-	-	-
Unit area, ft^2/ton/day	-	-	-	-	-	-	-	-

APPENDIX C

Table C-1

Anderson Mine Drill Core pH Controlled Acid Leach Tests

Hole No. AM-	1C	7C	13C	16C	17C	18C	26C	49C	51C	79C	113C	119C	135C	149C
Test No.	976-71	976-72	976-73	976-74	976-75	976-76	976-77	976-79	976-80	976-81	976-82	976-83	976-84	976-84
Head Analysis														
% Uranium	0.025	0.047	0.027	0.035	0.041	0.063	0.115	0.075	0.055	0.018	0.045	0.125	0.086	0.055
% Vanadium	0.023	0.041	0.061	0.056	0.074	0.089	0.053	0.069	0.102	0.028	0.094	0.071	0.115	0.130
% CO_2	13.4	0.24	9.2	9.6	1.9	15.5	14.3	17.3	3.3	12.0	0.63	13.3	5.0	0.34
Leach Conditions														
Feed size, mesh	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28
Temperature, ^{o}C	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Time, hour	6	6	6	6	6	6	6	6	6	6	6	6	6	6
H_2SO_4 addition, lb/ton	807	170	536	597	151	776	801.3	724	305.3	837	161.3	743	247	60
$NaClO_3$ addition, lb/ton	18.5	16.7	14.9	9.2	6.3	6.9	4.0	6.0	3.3	4.8	2.7	5.4	12.0	11.3
Filtrate														
Volume, ml	350	310	335	275	425	350	345	350	450	260	520	320	450	475
pH	0.72	0.78	0.90	1.1	1.1	1.3	1.3	1.8	0.80	1.1	0.90	1.1	1.5	1.5
emf, mv	410	543	522	385	600	390	405	360	423	435	414	400	412	420
H_2SO_4, g/l	18.5	16.7	14.9	9.2	6.3	6.9	5.2	1.7	17.1	12.6	14.5	12.4	3.8	4.3
U_3O_8, g/l	0.109	0.276	0.149	0.156	0.213	0.193	0.396	0.249	0.253	0.068	0.180	0.428	0.291	0.180
Wash														
Volume, ml	440	400	450	410	410	465	455	400	400	405	400	420	465	435
U_3O_8, g/l	0.082	0.052	0.074	0.054	0.107	0.154	0.290	0.191	0.072	0.033	0.072	0.281	0.160	0.096
Residue														
Weight, g	320.1	187.5	258.4	194.7	288.4	306.9	332.4	321.5	297.9	213.8	285.2	276.0	293	287.1
U_3O_8, %	0.004	0.003	0.002	0.006	0.001	0.017	0.027	0.026	0.012	0.003	0.005	0.022	0.015	0.013
V_2O_5, %	0.01	0.02	0.046	0.040	0.056	0.030	0.020	0.050	0.080	0.012	0.090	0.040	0.090	0.103
Mo, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Extraction														
U_3O_8, %	85.3	95.0	94.1	84.8	98.0	72.7	75.0	66.2	80.0	82.9	89.6	80.8	82.4	77.3
V_2O_5, %	53.6	50.0	22.2	26.4	26.4	65.5	58.5	22.2	23.2	55.9	8.9	40.5	23.5	23.5
Mo, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acid consumption, lb/ton	723	106	470	557	124	743	778	717	241	783	96	686.4	229	39.6
Settling Characteristics														
Terminal density, % solids	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unit area, ft^2/ton/day	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX D

Table D-1

Anderson Mine Ore pH Controlled Acid Leach Tests on Composites 1, 2, and 3

Test No.	1009-68	1009-69	1009-70
Leach Conditions			
Feed size, mesh	-28	-28	-28
Temperature, °C	60	60	60
Time, hour	6	6	6
H_2SO_4 addition, lb/ton	633	667	287
$NaClO_3$ addition, lb/ton	13.0	23.0	27.0
Filtrate			
Volume, ml	205	210	200
pH	0.85	0.7	0.75
emf, mv	450	445	625
H_2SO_4, g/l	19.48	35.17	18.67
U_3O_8, g/l	0.275	0.329	0.465
Wash			
Volume, ml	605	590	585
U_3O_8, g/l	0.079	0.133	0.111
Residue			
Weight, g	318	309.5	304
U_3O_8, %	0.004	0.004	0.008
V_2O_5, %	-	-	-
Mo, %	-	-	-
Extraction			
U_3O_8, %	88.9	92.5	86.8
V_2O_5, %	-	-	-
Mo, %	-	-	-
Acid consumption, lb/ton	585	562	245
Settling Characteristics			
Terminal density, % solids	-	-	-
Unit area, ft^2/ton/day	-	-	-

APPENDIX E

E-1

URANIUM ACID LEACH AMENABILITY

No. 1009-68

Sample No. Composite 1

0.039	% U_3O_8	11.4	% CO_2
0.06	% V_2O_5	0.24	% S
0.002	% Mo	0.143	% PO_4

Conditions: 60 °C, 6 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	60		1.0	430	512	3.3
1	60	1.4	0.9	500	531	6.7
2	60	1.45	0.9	530	564	10.0
3	61	1.3	0.9	510	617	13.0
4	59	1.1	0.9	630	633	
6	59	1.0		490		
Filtrate	25	0.85		450		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4			
Leach head						
%		0.039				
Grams	300	0.117				
Filtrate						
g/l		0.275	19.48			
Grams	205	0.056				
Wash						
g/l		0.079				
Grams	605	0.048				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
6 hour, %		0.004				
Grams	318	0.013				
Percent solubilized						
___ hour						
___ hour						
___ hour						
6 hour		88.9				
Calculated head, %		0.039				

Acid consumption, 585 lb/ton

hri

E-2

URANIUM ACID LEACH AMENABILITY

No. 1009-69

Sample No. Composite 2

0.054	%U_3O_8	9.7	% CO_2
0.09	%V_2O_5	0.74	% S
0.007	%Mo	0.209	% PO_4

Conditions: 60 °C, 6 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	60		1.0	310	507	3.3
1	65	1.6	0.9	445	587	6.7
2	63	1.3	0.9	470	600	13.0
3	60	1.1	0.9	495	613	21.3
4	60	1.3	0.9	570	667	23.0
6	60	1.3		480		
Filtrate	25	0.7		445		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4			
Leach head						
%		0.054				
Grams	300	0.162				
Filtrate						
g/l		0.329	35.2			
Grams	210	0.069				
Wash						
g/l		0.133				
Grams	590	0.078				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
6 hour, %		0.004				
Grams	309.5	0.012				
Percent solubilized						
___ hour						
___ hour						
___ hour						
6 hour		92.5				
Calculated head, %		0.053				

Acid consumption, 562 lb/ton

hri

URANIUM ACID LEACH AMENABILITY

No. 1009-70

Sample No. Composite 3

0.058 % U_3O_8 5.5 % CO_2
0.11 % V_2O_5 0.80 % S
0.006 % Mo 0.227 % PO_4

Conditions: 60 °C, 6 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	60		1.0	310	267	3.3
1	60	1.5	1.0		273	6.7
2	60	1.1	1.0	450		13.3
3	65	1.0		450		20.0
4	63	1.1	0.9	460	287	23.3
6	60	1.25		550		27.0
Filtrate	25	0.75		625		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4			
Leach head						
%		0.058				
Grams	300	0.174				
Filtrate						
g/l		0.465	18.67			
Grams	200	0.093				
Wash						
g/l		0.111				
Grams	585	0.065				
Residue						
___ hour, %						
___ hour, %						
___ hour, %		0.008				
6 hour, %	304	0.024				
Grams						
Percent solubilized						
___ hour						
___ hour						
___ hour						
6 hour		86.8				
Calculated head, %		0.061				

Acid consumption, 245 lb/ton

hri

APPENDIX F

Table F-1

(1 of 2 pages)

Anderson Mine Ore Flotation Concentrate Roast-Acid Leach on Composites 1, 2, and 3 1/

Test No.	1009-84	1009-85	1009-86	1009-87	1009-88	1009-89
Sample Composite	1	2	3	1	2	3
% U_3O_8	0.040	0.049	0.052	0.040	0.049	0.052
Attrition						
H_2SO_4 addition, lb/ton	-	-	-	-	-	-
Acid consumption, lb/ton	-	-	-	-	-	-
Flotation Concentrate 1/						
Weight, g	26.3	21.0	24.7	26.3	21.0	24.7
% U_3O_8	0.024	0.083	0.054	0.024	0.083	0.054
Roasting Conditions						
Temperature, °C	350	350	350	400	400	400
Time, hour	2	2	2	2	2	2
Atmosphere	Air	Air	Air	Air	Air	Air
Leach Conditions						
Temperature, °C	60	60	60	60	60	60
Time, hour	6	6	6	6	6	6
H_2SO_4 addition, lb/ton	61	162	162	114	190	162
$NaClO_3$ addition, lb/ton	11.4	14.3	12.1	3.8	4.8	4.0
Filtrate						
Volume, ml	46	48	48	80	60	60
pH	0.9	1.0	0.95	-	-	-
emf, mv	>700	490	> 700	-	-	-
H_2SO_4, g/l	20.1	14.7	17.2	-	-	-
U_3O_8, g/l	0.085	0.274	0.212	0.066	0.235	0.192
Wash						
Volume, ml	145	150	150	144	150	146
U_3O_8, g/l	0.013	0.045	0.037	0.0084	0.025	0.192

1/ Flotation concentrates after roasting leached individually.

Table F-1

Test No.	1009-84	1009-85	1009-86	1009-87	1009-88	1009-89
Residue						
Weight, g	19.6	16.6	19.1	20.3	17.0	19.0
U_3O_8, %	0.0032	0.0044	0.0054	0.002	0.003	0.005
Extraction						
U_3O_8, %	90.6	96.6	94.0	94.2	97.3	94.3
Acid consumption, lb/ton	-	57	65	-	-	-
Total acid consumption, lb/ton	-	-	-	-	-	-
Settling Characteristics 2/						
Terminal density, % solids	-	-	-	-	-	-
Unit area, ft^2/ton/day	-	-	-	-	-	-

APPENDIX G

Table G-1

Anderson Mine Ore Flotation Concentrate Roast-Acid Leach on Composites 1, 2, and 3

Test No.	1009-75	1009-77	1009-73
Sample Composite	1	2	3
% U_3O_8	-	-	-
Attrition			
H_2SO_4 addition, lb/ton	512	532	288
Acid consumption, lb/ton	-	-	-
Flotation Concentrate 1/			
Weight, g	40.2	57.0	42.0
% U_3O_8	0.033	0.019	0.039
Roasting Conditions			
Temperature, °C	500	500	500
Time, hour	2	2	2
Atmosphere	Air	Air	Air
Leach Conditions			
Temperature, °C	80	80	80
Time, hour	6	6	6
H_2SO_4 addition, lb/ton	181	98.4	216
$NaClO_3$ addition, lb/ton	4.8	7.9	8.2
Filtrate			
Volume, ml	655	640	595
pH	-	-	-
emf, mv	-	-	-
H_2SO_4, g/l	12.75	11.44	22.6
U_3O_8, g/l	0.169	0.109	0.202
Wash			
Volume, ml	785	765	845
U_3O_8, g/l	0.092	0.056	0.083

/ Flotation concentrate after roasting added to the leach.

Table G-2

Test No.	1009-75	1009-77	1009-73
Residue			
Weight, g	518	471	456
U_3O_8, %	0.004	0.005	0.006
Extraction			
U_3O_8, %	89.7	91.3	87.6
Acid consumption, lb/ton	-	-	414
Total acid consumption, lb/ton			
Settling Characteristics 2/			
Terminal density, % solids	-	-	-
Unit area, ft^2/ton/day	-	-	-

Table G-1

(3 of 4 pages)

Anderson Mine Ore Flotation Tail Acid Leach Tests on Composites 1, 2, and 3 1/

Test No.	1009-78	1009-79	1009-80	1009-81	1009-82	1009-83
Sample Composite	1	2	3	1	2	3
% U_3O_8	0.040	0.049	0.052	0.040	0.049	0.052
Attrition						
H_2SO_4 addition, lb/ton	596	492	280	-	-	-
Acid consumption, lb/ton	561	490	277	-	-	-
Flotation Tail						
Weight, g	246	252	230	242.5	241	229
% U_3O_8	0.040	0.055	0.044	0.040	0.055	0.044
Leach Conditions						
Temperature, °C	60	60	60	80	80	80
Time, hour	6	6	6	6	6	6
H_2SO_4 addition, lb/ton	154.5	143	96	190	199	140
$NaClO_3$ addition, lb/ton	4.0	9.5	10.4	8.2	16.6	17.5
Filtrate						
Volume, ml	240	260	250	320	335	355
pH	0.8	0.85	0.8	0.7	0.8	0.85
emf, mv	460	460	465	440	430	430
H_2SO_4, g/l	25.2	19.0	22.0	30.0	24.5	16.2
U_3O_8, g/l	0.098	0.260	0.254	0.078	0.200	0.165
Wash						
Volume, ml	530	545	490	535	520	515
U_3O_8, g/l	0.031	0.077	0.051	0.026	0.068	0.051

Table G-1

Anderson Mine Ore Flotation Tail Acid Leach Tests on Composites 1, 2, and 3 1/

Test No.	1009-78	1009-79	1009-80	1009-81	1009-82	1009-83
Residue						
Weight, g	237	245	223.5	216.5	214	207
U_3O_8, %	0.0033	0.0062	0.0068	0.0036	0.0055	0.0051
Extraction						
U_3O_8, %	91.7	89.2	85.1	91.8	91.0	89.1
Acid consumption, lb/ton	90.3	92	39	84	108	74
Total acid consumption, lb/ton	651	582	316	-	-	-
Settling Characteristics 2/						
Terminal density, % solids	53.5	61.5	69.7	57.7	54.8	65.4
Unit area, ft^2/ton/day	4.7	6.6	4.4	4.9	6.4	3.6

1/ Flotation tails leached individually.
2/ Settling data obtained before leaching.

APPENDIX H

Table H-1

Anderson Mine Ore pH Controlled Acid Leach Tests on Composite 1009-90-0

Test No.	1009-99	1009-100	1009-95	1009-103	1009-101	1009-102	1009-96	1009-97	1009-98	1009-104	1009-105	1009-106	1009-143
Leach Conditions													
Feed size, mesh	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28
Temperature, °C	60	60	60	60	80	80	80	80	80	80	80	80	80
Time, hour	4	4	8	18	4	4	8	8	8	18	18	18	18
H_2SO_4 addition, lb/ton	450	380	495	480	539	467	420	580	487.5	462.5	569	485	620
$NaClO_3$ addition, lb/ton	20	10	30	10	20	30	20	20	30	10	10	30	30
Filtrate													
Volume, ml	295	230	350	1530	230	252	275	190	270	1555	1520	1510	1540
pH	0.7	1.0	0.9	1.15	0.5	0.7	1.25	0.55	0.85	1.15	1.0	1.1	1.1
emf, mv	435	415	410	415	395	395	365	380	380	415	405	410	365
H_2SO_4, g/l	18.3	7.5	20.4	8.1	34.5	19.3	8.1	45.2	18.1	7.8	12.5	9.1	14.71
U_3O_8, g/l	0.381	0.401	0.352	0.129	0.462	0.45	0.358	0.513	0.401	0.133	0.148	0.136	0.138
Wash													
Volume, ml	1100	1085	990	565	1000	1000	1000	990	990	550	550	585	330
U_3O_8, g/l	0.108	0.108	0.109	0.053	0.143	0.140	0.104	0.141	0.131	0.045	0.054	0.051	0.090
Residue													
Weight, g	452	415	408	408	417	414	424	428	423	407	400	408	401
U_3O_8, %	0.0082	0.0012	0.0068	0.011	0.0074	0.0072	0.0085	0.0062	0.0072	0.011	0.0087	0.011	0.0087
V_2O_5, %	0.068	0.072	0.067	0.062	0.063	0.063	0.068	0.051	0.063	0.063	0.045	0.060	0.040
Mo, %	0.006	0.007	0.006	0.007	0.006	0.007	0.007	0.006	0.007	0.007	0.007	0.007	0.008
Extraction													
U_3O_8, %	86.2	81.8	89.3	83.5	89.0	89.5	84.9	90.0	88.7	83.8	88.0	84.0	87.4
V_2O_5, %	28.3	30.1	36.2	40.9	38.6	39.0	32.7	49.1	37.9	40.2	57.9	42.8	-
Mo, %	3.6	0	14.3	0	10.7	0	0	7.1	0	0	0	0	0
Acid consumption, lb/ton	394	360	428	409	446	413	397	475	434	395	461	406	490
Settling Characteristics													
Terminal density, % solids	-	-	-	49.2	-	-	-	-	-	65.6	60.6	60.9	-
Unit area, ft^2/ton/day	-	-	-	10.1	-	-	-	-	-	12.0	5.1	5.9	-

Table H-1

(Page 1 of 2)

Anderson Mine Ore Fixed Reagent Addition Acid Leach Tests on Composite 1009-90-0

Test No.	1009-147	1009-148	1009-149	1009-159	1009-160	1009-161	1009-122	1009-123	1009-124	1009-130	1009-112	1009-113
Leach Conditions												
Feed size, mesh	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28
Temperature, °C	80	80	80	80	80	80	80	80	80	80	60	60
Time, hour	8	8	8	24	24	24	12	12	12	16	16	16
H_2SO_4 addition, lb/ton	500	500	500	530	530	530	470	470	470	490	500	500
$NaClO_3$ addition, lb/ton	12	9	6	2	4	6	16	16	12	20	16	20
Filtrate												
Volume, ml	1620	1620	1630	105	105	120	118	154	118	1550	655	655
pH	1.25	1.25	1.25	1.1	1.1	1.1	1.1	1.1	1.25	1.2	1.0	1.0
emf, mv	370	370	370	285	295	300	370	372	360	385	385	385
H_2SO_4, g/l	11.65	12.36	11.42	11.78	13.24	12.36	12.0	10.2	9.0	10.3	14.2	12.5
U_3O_8, g/l	0.108	0.110	0.105	0.465	0.495	0.455	0.656	0.612	0.552	0.131	0.530	0.563
Wash												
Volume, ml	340	360	350	410	410	420	970	985	975	400	4030	3920
U_3O_8, g/l	0.052	0.050	0.049	0.164	0.166	0.165	0.167	0.151	0.141	0.074	0.139	0.138
Residue												
Weight, g	296.5	296	298	196	196	193	419	419	403.5	397	1527	1611
U_3O_8, %	0.0080	0.0084	0.0081	0.009	0.009	0.009	0.0056	0.0051	0.0056	0.0078	0.0065	0.0094
V_2O_5, %	0.061	0.063	0.061	0.050	0.060	0.050	0.059	0.057	0.060	0.055	0.057	0.057
Mo, %	0.007	0.007	0.007	-	-	-	-	-	-	0.007	0.007	0.007
Extraction												
U_3O_8, %	88.9	88.7	88.7	86.6	87.0	88.0	91.1	92.0	91.0	88.3	90.1	85.7
V_2O_5, %	43.6	42.1	43.6	54.2	44.9	54.7	42.1	44.2	43.4	49.1	45.8	42.8
Mo, %	0	0	0	-	-	-	-	-	-	0	0	0
Acid consumption, lb/ton	361	353	364	502	498	496	448	450	452	398	468	473
Settling Characteristics												
Terminal density, % solids	52.0	48.9	53.2	-	-	-	-	-	-	62	-	-
Unit area, ft^2/ton/day	7.0	5.3	6.2	-	-	-	-	-	-	9.9	-	-

Table H-1

(Page 2 of 2)

Test No.	1009-114	1009-115	1009-120	1009-121	1009-125	1009-118	1009-119	1009-126	1009-128	1009-132
Leach Conditions										
Feed size, mesh	-28	-28	-28	-28	-28	-28	-28	-28	-28	-28
Temperature, °C	60	60	80	80	80	80	80	80	80	80
Time, hour	16	16	8	8	12	8	8	16	16	16
H_2SO_4 addition, lb/ton	500	500	500	500	500	530	530	530	530	530
$NaClO_3$ addition, lb/ton	24	28	12	20	12	16	16	12	20	16
Filtrate										
Volume, ml	690	725	114	172	176	126	140	1560	1570	1550
pH	1.0	1.0	0.7	0.8	0.95	0.65	0.7	1.1	1.1	1.1
emf, mv	395	390	385	390	385	380	385	390	395	390
H_2SO_4, g/l	13.8	13.3	27.0	20.0	18.8	34.0	26.5	9.8	10.8	12.5
U_3O_8, g/l	0.563	0.582	0.435	0.502	0.542	0.576	0.542	0.131	0.131	0.137
Wash										
Volume, ml	3840	3820	1000	1005	980	1000	1010	450	430	420
U_3O_8, g/l	0.142	0.170	0.172	0.153	0.146	0.160	0.160	0.067	0.062	0.072
Residue										
Weight, g	1530	1516	397.5	397	395	393	393	408	405	397
U_3O_8, %	0.0071	0.0065	0.0059	0.0057	0.0054	0.0053	0.0057	0.0070	0.0068	0.0083
V_2O_5, %	0.057	0.054	0.060	0.060	0.054	0.057	0.048	0.046	0.046	0.046
Mo, %	0.007	0.007	-	-	-	-	-	0.006	0.007	0.007
Extraction										
U_3O_8, %	89.6	91.6	90.4	91.4	91.8	91.8	91.4	89.1	89.4	88.4
V_2O_5, %	45.7	49.0	44.2	44.4	50.2	47.7	55.8	56.1	56.5	57.2
Mo, %										
Acid consumption, lb/ton	469	467	432	452	459	462	472	442	434	419
Settling Characteristics										
Terminal density, % solids	-	-	-	-	-	-	-	-	57.9	56.3
Unit area, ft^2/ton/day	-	-	-	-	-	-	-	-	16.9	7.4

APPENDIX I

URANIUM ACID LEACH AMENABILITY

No. 1009-95

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2

0.107 % V_2O_5 — %

0.007 % MO — %

Conditions: 60 °C, 8 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	53		1.0		350	30
1	60	1.65	1.0	580	385	
2	60	1.4	1.0	545	435	
3	60	1.1	1.0	515	445	
4	60	1.25	1.0	485	475	
6	60	1.2	1.0	475	495	
8	60	1.25		465		
Filtrate	25	0.9		410		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5	Mo	
Leach head						
%		0.058		0.107	0.007	
Grams	400	0.232		0.428	0.028	
Filtrate						
g/l		0.352	20.4			
Grams	350	0.123				
Wash						
g/l		0.109				
Grams	990	0.108				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
8 hour, %		0.068		0.067	0.006	
Grams	408	0.028		0.273	0.024	
Percent solubilized						
___ hour						
___ hour						
___ hour						
8 hour		89.3		36.2	14.3	
Calculated head, %		0.065				

Acid consumption, 428 lb/ton

hri

URANIUM ACID LEACH AMENABILITY

No. 1009-96

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2
0.107 % V_2O_5 — %
0.007 % Mo — %

Conditions: 80 °C, 8 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	66		1.5		325	20
1	74	2.3	1.5	560	345	
2	76	1.95	1.5	480	375	
3	76	1.7	1.5	430	385	
4	76	1.75	1.4	420	410	
6	76	1.7	1.5	415	420	
8	79	1.85		380		
Filtrate	25	1.25		365		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5	Mo	
Leach head						
%		0.058		0.107	0.007	
Grams	400	0.232		0.428	0.028	
Filtrate						
g/l		0.358	8.10			
Grams	275	0.098				
Wash						
g/l		0.104				
Grams	1000	0.104				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
8 hour, %		0.0085		0.068	0.007	
Grams	424	0.036		0.288	0.030	
Percent solubilized						
___ hour						
___ hour						
___ hour						
8 hour		84.9		32.7	0	
Calculated head, %		0.060				

Acid consumption, 397 lb/ton

hri

URANIUM ACID LEACH AMENABILITY

No. 1009-97

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2

0.107 % V_2O_5 — %

0.007 % Mo — %

Conditions: 80 °C, 8 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0			1.0		390	20
1	64	1.45	1.0	550	450	
2	74	1.2	1.0	485	470	
3	76	1.2	1.0	460	490	
4	76	1.35	1.0	455	525	
6	76	1.3	1.0	460	580	
8	79	1.15		450		
Filtrate	25	0.55		380		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5	Mo	
Leach head						
%		0.058		0.107	0.007	
Grams	400	0.232		0.428	0.028	
Filtrate						
g/l		0.513	45.2			
Grams	190	0.097				
Wash						
g/l		0.141				
Grams	990	0.140				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
8 hour, %		0.0062		0.051	0.006	
Grams	428	0.027		0.218	0.026	
Percent solubilized						
___ hour						
___ hour						
___ hour						
8 hour		90.0		49.1	7.1	
Calculated head, %		0.066				

Acid consumption, 475 lb/ton

hri

URANIUM ACID LEACH AMENABILITY
No. 1009-98

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2
0.107 % V_2O_5 — %
0.007 % Mo — %

Conditions: 80 °C, 8 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0			1.2		332.5	30
1	65	1.9	1.2	600	372.5	
2	74	1.6	1.2	510	417.5	
3	76	1.4	1.2	465	432.5	
4	76	1.4	1.2	450	457.5	
6	75	1.45	1.15	440	487.5	
8	79	1.35		420		
Filtrate	25	0.85		380		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5	Mo	
Leach head						
%		0.058		0.107	0.007	
Grams	400	0.232		0.428	0.028	
Filtrate						
g/l		0.401	18.1			
Grams	270	0.108				
Wash						
g/l		0.131				
Grams	990	0.130				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
8 hour, %		0.0072		0.063	0.007	
Grams	423	0.030		0.266	0.030	
Percent solubilized						
___ hour						
___ hour						
___ hour						
8 hour		88.7		37.9	0	
Calculated head, %		0.067				

Acid consumption, 434 lb/ton

hri

URANIUM ACID LEACH AMENABILITY

No. 1009-100

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2

0.107 % V_2O_5 — %

0.007 % Mo — %

Conditions: 60 °C, 4 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	60		1.45		330	10
1	60	2.25	1.4	495	355	
2	60	1.7	1.5	460	365	
3	60	1.9	1.5	440	380	
4	60	1.58		435		
Filtrate	25	1.0		415		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5	Mo	
Leach head						
%		0.058		0.107	0.007	
Grams	400	0.232		0.428	0.028	
Filtrate						
g/l		0.401	7.5			
Grams	230	0.092				
Wash						
g/l		0.108				
Grams	1085	0.117				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
4 hour, %		0.0112		0.072	0.007	
Grams	415	0.046		0.299	0.029	
Percent solubilized						
___ hour						
___ hour						
___ hour						
4 hour		81.8		30.1	0	
Calculated head, %		0.064				

Acid consumption, 360 lb/ton

hri

URANIUM ACID LEACH AMENABILITY

No. 1009-104

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2

0.107 % V_2O_5 — %

0.007 % Mo — %

Conditions: 80 °C, 18 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	76		1.5	550	380	10
1	80	2.0	1.5	420	400	
2	80	1.9	1.5	395	420	
3	80	1.8	1.5	380	437.5	
4						
6	80	1.8	1.4	410	462.5	
8						
18	80	1.9		330		
Filtrate	25	1.15		415		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5	Mo	
Leach head						
%		0.058		0.107	0.007	
Grams	400	0.232		0.428	0.028	
Filtrate						
g/l		0.133	7.8			
Grams	1555	0.207				
Wash						
g/l		0.045				
Grams	550	0.025				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
18 hour, %		0.011		0.063	0.007	
Grams	407	0.045		0.256	0.028	
Percent solubilized						
___ hour						
___ hour						
___ hour						
18 hour		83.8		40.2	0	
Calculated head, %		0.069				

Acid consumption, 395 lb/ton

hri

URANIUM ACID LEACH AMENABILITY
No. 1009-148

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2
0.107 % V_2O_5 — %
0.007 % Mo — %

Conditions: 80 °C, 8 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read/Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	73			500	9
1					
2	76	1.2	430		
3					
4	80	1.3	380		
6	80	1.5	355		
8	80	1.55	345		
Filtrate	25	1.25	370		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5	Mo	
Leach head						
%		0.058		0.107	0.007	
Grams	300	0.174		0.321	0.021	
Filtrate						
g/l		0.110	12.36			
Grams	1620	0.178				
Wash						
g/l		0.050				
Grams	360	0.018				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
8 hour, %		0.0084		0.063	0.007	
Grams	296	0.025		0.186	0.021	
Percent solubilized						
___ hour						
___ hour						
___ hour						
8 hour		88.7		42.1	0	
Calculated head, %		0.074				

Acid consumption, 353 lb/ton

hri

URANIUM ACID LEACH AMENABILITY
No. 1009-159

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2
0.107 % V_2O_5 — %
0.007 % Mo — %

Conditions: 80 °C, 24 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read/Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	80			530	2
1					
2	84	1.0	415		
3					
4	78	1.1	370		
6	80	1.35	360		
24	84	1.65	265		
Filtrate	25	1.1	285		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5		
Leach head						
%		0.058		0.107		
Grams	200	0.116		0.214		
Filtrate						
g/l		0.465	11.78			
Grams	105	0.049				
Wash						
g/l		0.164				
Grams	410	0.067				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
24 hour, %		0.009		0.05		
Grams	196	0.018		0.098		
Percent solubilized						
___ hour						
___ hour						
___ hour						
24 hour		86.6		54.4		
Calculated head, %		0.067				

Acid consumption, 502 lb/ton

hri

URANIUM ACID LEACH AMENABILITY
No. 1009-160

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2
0.107 % V_2O_5 — %
0.007 % Mo — %

Conditions: 80 °C, 24 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read/Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	80			530	4
1					
2	84	1.0	440		
3					
4	78	1.1	380		
6	80	1.35	375		
24	84	1.6	290		
Filtrate	25	1.1	295		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5		
Leach head						
%		0.058		0.107		
Grams	200	0.116		0.214		
Filtrate						
g/l		0.495	13.24			
Grams	105	0.052				
Wash						
g/l		0.166				
Grams	410	0.068				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
24 hour, %		0.009		0.006		
Grams	196	0.018		0.118		
Percent solubilized						
___ hour						
___ hour						
___ hour						
24 hour		87.0		44.9		
Calculated head, %		0.069				

Acid consumption, 498 lb/ton

URANIUM ACID LEACH AMENABILITY
No. 1009-161

Sample No. 1009-90-0 — 0.058 % U_3O_8 — 7.54 % CO_2
0.107 % V_2O_5 — %
0.007 % Mo — %

Conditions: 80 °C, 24 hr, 50 % solids

Data

Elapsed Time, hr	Temp °C	pH Read	pH Adjusted	emf mv	H_2SO_4 Cum lb/ton	$NaClO_3$ Cum lb/ton
0	80				530	6
1						
2	84	1.0		450		
3						
4	78	1.1		390		
6	80	1.35		380		
24	84	1.6		295		
Filtrate	25	1.1		300		

Metallurgical Balance

	Weight/ Volume	Uranium U_3O_8	H_2SO_4	V_2O_5		
Leach head						
%		0.058		0.107		
Grams	200	0.116		0.214		
Filtrate						
g/l		0.455	12.36			
Grams	120	0.055				
Wash						
g/l		0.165				
Grams	420	0.069				
Residue						
___ hour, %						
___ hour, %						
___ hour, %						
24 hour, %		0.009		0.05		
Grams	193	0.017		0.097		
Percent solubilized						
___ hour						
___ hour						
___ hour						
24 hour		88.0		54.7		
Calculated head, %		0.070				

Acid consumption, 496 lb/ton

hri

APPENDIX J

Table J-1

Anderson Mine Ore Fixed Reagent Addition Acid Pressure Leach Tests on Composite 1009-90-0

Test No.	1009-134 1/	1009-135 2/	1009-136 3/	1009-137 4/	1009-158 5/
Leach Conditions					
Feed size, mesh	-28	-28	-28	-28	2-8
Temperature, °C	135	135	135	135	135
Time, hour	2	3	3	3	2
H_2SO_4 addition, lb/ton	500	500	500	500	500
$NaClO_3$ addition, lb/ton	0	0	0	0	0
Filtrate					
Volume, ml	695	605	670	1490	565
pH	1.0	1.0	1.1	1.1	0.95
emf, mv	390	390	3 50	410	450
H_2SO_4, g/l	13.5	12.69	10.79	11.14	23.47
U_3O_8, g/l	0.261	0.231	0.237	0.140	0.297
Wash					
Volume, ml	990	945	1005	360	910
U_3O_8, g/l	0.066	0.093	0.064	0.075	0.082
Residue					
Weight, g	389.5	396	401	401.5	390.8
U_3O_8, %	0.0069	0.0069	0.008	0.009	0.006
V_2O_5, %	0.061	0.061	0.070	0.065	0.067
Mo, %	0.007	0.007	-	-	0.007
Extraction					
U_3O_8, %	90.2	89.3	87.5	86.8	91.4
V_2O_5, %	44.4	43.5	34.4	39.0	38.8
Mo, %	3.6	0	-	-	0
Acid consumption, lb/ton	436	438	449	406.5	404

1/ Pressure leach: 135°C, 2 hours, oxygen at 40 cc/min, 60 psi.
2/ " " " 3 hours, " 40 " 60 psi.
3/ " " " 3 hours, air at 40 cc/min, 100 psi.
4/ " " " 3 hours, oxygen at 40 cc/min, 100 psi.
5/ " " " 2 hours, " 40 cc/min, 25 g ferric sulfate, 100 psi.

APPENDIX K

KYNCH PROCEDURE - THICKENING TEST DATA

PROJECT: _____
NOTEBOOK: _____
PAGE: _____
DATE: _____
BY: _____

OBJECTIVE: Settling test on acid leached pulp 1009-106

FLOCCULANT: Polyhall 1080 AMOUNT: 0.16 lb/ton

Settling Rate			Pulp Density Measurements		
Level ml	Time min		Feed Pulp	Terminal Pulp	Clear Liquor
2000	0	Volume, ml	2000	670	1330
1960	2	Gross pulp weight, g	3254		
1760	5	Tare, g	946		
1640	7	Net pulp weight, g	2308	928	1380
1570	9	Gross dry weight, g			
1490	11	Tare, g			
1420	13	Net dry weight, g	408	408	
1360	15	Density, g/l	1154	1385	1038
1300	17	Solids, %	17.7	44.0	
1220	20				
1180	23				
1145	25				
1100	30				
1060	35				
1030	40				
1000	45				
940	60				
900	75				
860	90				
820	105				
800	120				
780	135				
750	165				
750	195				
720	225				
Terminal Level 18 hrs					

Time rake installed 2 min

Thickener rake rotation: 6 min/rev

Terminal Density Calculation

Clear liquor volume: 1330 ml

Clear liquor weight: 1330 ml x 1038 g/l = 1380 g

Terminal pulp wt: 2308 g feed pulp - 1380 g clear liquor = 928 g

Terminal pulp: 60.9 Solids, %

Thickener Unit Area Requirement

Initial height, H_o: 1.37 ft

Initial pulp density, $C_o = (31.3 \times 10^{-6})$ (feed solids content, g solids/liter slurry) = ton/ft^3

$C_o = (31.3 \times 10^{-6}) \times 204 = 6.385 \times 10^{-3}$ ton/ft^3

Critical time, T_x = 0.052 days

Unit area, $UA = \frac{T_x}{C_o H_o} = \frac{0.052}{6.385 \times 10^{-3} \times 1.37}$

UA = 5.9 ft^2/ton/day

Liquor Clarity: Clear

OBSERVATIONS:

KYNCH PROCEDURE - THICKENING TEST DATA

PROJECT: _____
NOTEBOOK: _____
PAGE: _____
DATE: _____
BY: _____

OBJECTIVE: Settling test on acid leached pulp
1009-132

FLOCCULANT: NALCO 5WM-537 AMOUNT: 0.6 lb/ton

Settling Rate			Pulp Density Measurements		
Level ml	Time min		Feed Pulp	Terminal Pulp	Clear Liquor
2000	0	Volume, ml	2000	705	1295
1980	2	Gross pulp weight, g	3285		
1910	5	Tare, g	946		
1840	7	Net pulp weight, g	2339	971	1368
1760	9	Gross dry weight, g			
1700	11	Tare, g			
1630	13	Net dry weight, g	397	397	
1560	15	Density, g/l	1169	1377	1056
1500	17	Solids, %	17.0	40.9	
1420	20				
1360	23				
1320	25				
1280	27				
1230	30				
1190	33				
1160	35				
1110	40				
1020	50				
990	55				
970	60				
940	70				
910	80				
840	100				
820	120				
790	155				
770	180				
760	200				
750	220				
Terminal Level 18 hrs					

Time rake installed 2 min

Thickener rake rotation: 6 min/rev

Terminal Density Calculation

Clear liquor volume: 1295 ml

Clear liquor weight: 1295 ml x 1056 g/l = 1368 g

Terminal pulp wt: 2339 g feed pulp - 1368 g clear liquor = 971 g

Terminal pulp: 56.3 Solids, %

Thickener Unit Area Requirement

Initial height, H_o: 1.35 ft

Initial pulp density, $C_o = (31.3 \times 10^{-6})$ (feed solids content, g solids/liter slurry) = ton/ft^3

$C_o = (31.3 \times 10^{-6}) \times 198.5 = 6.213 \times 10^{-3}$ ton/ft^3

Critical time, T_x = 0.062 days

Unit area, $UA = \frac{T_x}{C_o H_o} = \frac{0.062}{6.213 \times 10^{-3} \times 1.35}$

UA = 7.4 ft^2/ton/day

Liquor Clarity: Clear

OBSERVATIONS:

KYNCH PROCEDURE - THICKENING TEST DATA

PROJECT: _____
NOTEBOOK: _____
PAGE: _____
DATE: _____
BY: _____

OBJECTIVE: Settling test on acid leached pulp 1009-137

FLOCCULANT: MG-200 AMOUNT: 0.16/lb/ton

Settling Rate			Pulp Density Measurements		
Level ml	Time min		Feed Pulp	Terminal Pulp	Clear Liquor
2000	0	Volume, ml	2000	670	1330
1860	1	Gross pulp weight, g	3240		
1620	2	Tare, g	946		
1480	3	Net pulp weight, g	2294	908	1386
1400	4	Gross dry weight, g			
1340	5	Tare, g			
1260	6	Net dry weight, g	401.5	401.5	
1240	7	Density, g/l	1147	1355	1042
1200	9	Solids, %	17.5	44.2	
1170	9				
1150	10				
1120	11				
1100	12				
1060	15				
1040	17				
980	20				
970	23				
960	25				
920	30				
900	35				
860	40				
850	45				
810	60				
810	75				
--	--				
800	135				
760	165				
750	195				
720	225				
Terminal Level 18 hrs					

Time rake installed 2 min

Thickener rake rotation: 6 min/rev

Terminal Density Calculation

Clear liquor volume: 1330 ml

Clear liquor weight: 1330 ml x 1042 g/l = 1386 g

Terminal pulp wt: 2294 g feed pulp - 1386 g clear liquor = 908 g

Terminal pulp: 59.9 Solids, %

Thickener Unit Area Requirement

Initial height, H_o: 1.35 ft

Initial pulp density, $C_o = (31.3 \times 10^{-6})$ (feed solids content, g solids/liter slurry) = ton/ft^3

$C_o = (31.3 \times 10^{-6}) \times 201 = 6.291 \times 10^{-3}$ ton/ft^3

Critical time, T_x = 0.038 days

Unit area, $UA = \frac{T_x}{C_o H_o} = \frac{0.038}{6.291 \times 10^{-3} \times 1.35}$

UA = 4.5 ft^2/ton/day

Liquor Clarity: Clear

OBSERVATIONS:

hri

APPENDIX L

Table L-1 (1 of 4 pages)

Continuous Solvent Extraction Data Sheet

Feed	100 ml/min	Start time	11:00
Solvent	7 ml/min	End time	14:15
Strip	1 ml/min		
Scrub	--		

Solvent Phase

Extractant, 3% Alamine 336
Extractant, 2% isodecanol
Diluent, 95% kerosene

Aqueous Phase

Leach liquor, 1009-90-1

Analytical Data

Stage	U_3O_8	V_2O_5	Mo	SO_4	Cl	H_2SO_4
1 Organic						
Aqueous	0.0078	0.107	<0.001	--	--	--
2 Organic						
Aqueous	0.0032	--	<0.001	--	--	--
3 Organic						
Aqueous	0.0089	--	<0.001	--	--	--
4 Oranic						
Aqueous	0.0627	--	<0.001	--	--	--
5 Organic						
Aqueous	2.55	0.007	0.0035	--	--	--
6 Organic						
Aqueous	3.16	--	0.0035	--	--	--
7 Organic						
Aqueous	1.97	--	0.011	--	--	--
8 Organic						
Aqueous	0.101	<0.005	0.036	107.0	0.25	--
Raffinate	0.0045	0.120	<0.001	--	--	8.6
Product						
Feed	0.174	0.104	<0.001	28.3	0.96	

Table L-1 (2 of 4 pages)

Feed	100 ml/min	Start time	11:15
Solvent	10 ml/min	End time	13:45
Strip	1 ml/min		
Scrub	--		

Solvent Phase

Extractant, 3% Alamine 336
Extractant, 2% isodecanol
Diluent, 95% kerosene

Aqueous Phase

Leach liquor 1009-116-0

Analytical Data

Stage	U_3O_8	Mo	V_2O_5	H_2SO_4
1 Organic	0.088	0.05	--	--
Aqueous	0.0011	<0.001	0.190	--
2 Organic	0.201	0.04	--	--
Aqueous	0.0017	<0.001	--	--
3 Organic	0.674	0.09	--	--
Aqueous	0.0074	<0.001	--	--
4 Organic	2.06	0.05	--	--
Aqueous	0.052	<0.001	0.189	--
5 Organic	1.64	0.05	--	--
Aqueous	4.0	0.006	0.007	--
6 Organic	0.875	0.05	--	--
Aqueous	4.1	0.007	--	--
7 Organic	0.169	0.05	--	--
Aqueous	2.8	0.027	--	--
8 Organic	0.029	0.06		
Aqueous	0.48	0.016		
Raffinate	0.0007	0.001	0.181	10.94
Product	3.09	0.0037	0.009	--
Feed	0.163	<0.001	0.190	12.12

Table L-1 (4 of 4 pages)

Feed	100 ml/min	Start time	10:30
Solvent	7 ml/min	End time	12:30
Strip	1 ml/min		

Solvent Phase

Extractant, 3% Alamine 336
Extractant, 2% isodecanol
Diluent, 95% kerosene

Aqueous Phase

Leach liquor 1009-138-0

Analytical Data

Stage	U_3O_8	V_2O_5	SO_4	Cl
1 Organic	0.015	--	--	--
Aqueous	0.0004	--	--	--
2 Organic	0.083	--	--	--
Aqueous	0.0003	--	--	--
3 Organic	0.80	--	--	--
Aqueous	0.0034	--	--	--
4 Organic	2.08	--	--	--
Aqueous	0.073	--	--	--
5 Organic	1.12	--	--	--
Aqueous	6.79	0.005		
6 Organic	0.51	--	--	--
Aqueous	6.36	--	--	--
7 Organic	0.13	--	--	--
Aqueous	3.52	--	--	--
8 Organic	0.03	--	--	--
Aqueous	1.36	--	--	--
Raffinate	0.0002	0.299	--	--
Product	5.66	0.006	--	--
Feed	0.161	0.303	52.6	1.70