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AEC RESEARCH AND DEVELOPMENT REPORT

TOPICAL REPORT WIN-91

AMENABILITY TESTING OF LA BAJADA ORE

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TOPICAL REPORT WIN-91

Amenability Testing of LaBajada Ore

By

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April 17, 1958

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ABSTRACT

Data are presented on the results of acid and carbonate leaching studies on samples of ore from the LaBajada Mine of the Lone Star Mining Company, Santa Fe County, New Mexico.

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INTRODUCTION

On February 4, 1957, two samples of ore were received from the U.S.A.E.C. at Grand Junction, Colorado from the Lone Star Mining Company, Santa Fe County, New Mexico. The samples were marked LaBajada #1 Shaft (Stockpile) and LaBajada #2 Shaft (Stockpile). The samples were given our numbers 374-1 and 374-2 but, because of the low uranium assays, test work was terminated after preliminary tests indicated an acid consumption of 400 to 700 pounds per ton.

On March 4, 1957, four additional samples of LaBajada ore were received from the U.S.A.E.C. at Grand Junction, Colorado. These samples were marked Shaft #1 NW172, Shaft #1 NE142, Shaft #1 NW 142, and Shaft #2 Dump. These samples were given our numbers 374-3, 374-4, 374-5, and 374-6, respectively. Because of the low uranium content of Sample 374-4, it was composited with Samples 374-3 and 374-5 to form composite Sample 374-7. A seventh sample was received on June 19, 1957 and was given our number 374-8.

This report describes tests conducted to determine the amenability of these ores to processing by acid and alkaline leaching.

SUMMARY AND CONCLUSIONS

Seven samples of ore from the LaBajada Mine of the Lone Star Mining Company, Santa Fe County, New Mexico were submitted to this laboratory for amenability testing. Of the samples received, four assayed less than 0.07 per cent U_3O_8 and did not warrant testing. Preliminary acid leaching tests were conducted on Samples 3, 4, and 5 and detailed acid and carbonate leaching studies were conducted on a composite of Samples 3, 4, and 5 and on Sample 8, the latter representing ore from the stockpile at the Grants, New Mexico Buying Station.

All of the samples are composed principally of quartz, clays, and dolomite, with minor sulfides, phosphates and probably siderite. Leaching studies on the two principal samples showed that uranium extractions in excess of 90 per cent can be obtained by either acid or carbonate leaching. Acid requirements range from 500 to 1000 pounds per ton and sodium carbonate consumption is above 100 pounds per ton. Oxidant requirements are also high.

The physical properties of the leached pulps are extremely poor. The pulps are viscous and satisfactory settling rates are obtained only at very low pulp densities and after the addition of large amounts of flocculants.

On the basis of the laboratory tests, it is evident that the LaBajada ores, as represented by the samples submitted for testing, are not amenable to processing in conjunction with other more amenable ores by reason of their refractory behavior, their high reagent consumption, and their poor physical properties.

PRELIMINARY INVESTIGATIONS

A. Sample Description and Preparation

The samples submitted for testing were originally received at the Grand Junction Pilot Plant where they were crushed and sampled prior to shipment to the Winchester Laboratory. Identification of the various samples is as follows:

<u>Sample Number</u>	<u>Source</u>	<u>Date Received</u>	<u>Weight Pounds</u>
374-1	LaBajada #1 Shaft (Stockpile)	2/4/57	72.25
374-2	LaBajada #2 Shaft (Stockpile)	2/4/57	77.25
374-3	LaBajada Shaft #1 NW 172'	3/4/57	103.5
374-4	LaBajada Shaft #1 NE 142'	3/4/57	82.5
374-5	LaBajada Shaft #1 NW 142'	3/4/57	116.25
374-6	LaBajada Shaft #2 Dump	3/4/57	97.0
374-7	LaBajada Composite of 374-3,4,5		
374-8	Grants Lot 477	6/19/57	50.25

The samples were prepared for testing by crushing to minus 10-mesh with steel rolls in a closed circuit with a 10-mesh vibrating screen. Head samples were obtained by riffing and portions of the remainder were split into 500-gram test charges.

B. Chemical and Spectrographic Analyses

Chemical analyses of the samples are shown in Table 1. Spectrographic analyses of Samples 374-7 and 374-8 are presented in Table 2.

C. Mineralogy

All of the ores had been crushed prior to shipment and were not suited for determination of their rock type and structure. Mineralogically, the samples are composed of quartz, dolomite, and clay with minor amounts of pyrite, chalcopyrite, altered micas, apatite, and barite. Uranium is present as uraninite or pitchblende.

Table 1

Chemical Analyses

<u>Constituent</u>	<u>Sample</u> <u>374-1</u>	<u>Sample</u> <u>374-2</u>	<u>Sample</u> <u>374-3</u>	<u>Sample</u> <u>374-4</u>	<u>Sample</u> <u>374-5</u>	<u>Sample</u> <u>374-6</u>	<u>Sample</u> <u>374-7</u>	<u>Sample</u> <u>374-8</u>
U ₃ O ₈	0.073	0.036 ^{0.043}	0.218	0.053	0.295	0.043	0.193	0.353
Mo	--	--	0.028	0.024	0.045	--	0.028	0.074
Fe	--	--	--	--	8.66	--	12.3	5.99
CaO	--	--	3.86	3.10	14.7	--	7.11	12.77
MgO	--	--	--	--	--	--	4.53	7.9
Al ₂ O ₃	--	--	--	--	--	--	3.94	7.8
SiO ₂	--	--	--	--	23.7	--	30.3	29.2
P ₂ O ₅	--	--	--	--	0.91	--	0.86	1.08
V ₂ O ₅	--	--	--	--	0.10	--	0.11	0.12
CO ₂	--	--	--	--	--	--	8.3	14.5
Soluble SO ₄	--	--	--	--	0.50	--	1.12	0.23
S=					6.28		10.0	1.42

Table 2Qualitative Spectrographic Analyses

<u>Constituent</u>	<u>Assay, Per Cent</u>	
	<u>Sample</u>	<u>Sample</u>
	<u>374-7</u>	<u>374-8</u>
Al	M	M
Ba	Mn	Mn
Ca	M	MM
Co	m	m
Cr	m	m
Cu	M	M
Fe	M	M
Li	mt	t
Mg	M	Mn
Mn	m	m
Mo	m	mt
Na	Mn	M
Ni	Mn	m
Si	MM	MM
Sr	Mn	Mn
Ti	M	Mn
U	Mn	Mn
V	mt	m
Zr	m	m

Code :

MM	=	>10.0%	m	=	0.01-0.1%
M	=	1.0-10%	mt	=	0.001-0.01%
Mn	=	0.1-1.0%	t	=	<0.001%

TEST WORKA. Acid Leaching Tests

Acid leaching tests were conducted to determine the effects of acid and oxidant concentration, leaching time, leaching temperature, and roasting on uranium extraction. The leaching tests were conducted at 40 per cent solids on pulps prepared by grinding 500 gram test charges in a rod mill to minus 35-mesh. The leached pulps were filtered and washed on Buchner funnels with water acidified to pH 1.0, and the filter cakes were then repulped with pH 1.0 water, refiltered, and washed. Uranium extractions reported are based upon assays of the feed and washed residues.

Of the seven samples submitted for testing, Samples 374-1, 2, and 6 were too low in uranium content to warrant investigation. Preliminary leaching tests were conducted on Samples 374-3, 4, and 5 and more detailed studies were made on Sample 374-7, which represented an equal weight composite of Samples 374-3, 4, and 5, and on Sample 374-8 representing a sample from Lot No. 477 at the Buying Depot in Grants, New Mexico.

Table 3 summarizes the results of the preliminary acid leaching tests on Samples 374-3, 4, and 5.

Table 3Preliminary Acid Leaching Tests

Sample Number	<u>Leaching Conditions</u> ^{1/}			<u>Terminal Conditions</u>		<u>Residue Assay</u>	% U ₃ O ₈ Ext'n
	<u>Time, Hours</u>	<u>Lb/Ton</u>		<u>pH</u>	<u>Emf(mv)</u>	<u>% U₃O₈</u>	
374-3	4	500	40	0.20	-510	0.026	88.3
	6	500	40	0.30	-530	0.0084	96.2
	8	500	40	0.50	-515	0.0080	96.4
374-4	4	500	40	0.20	-505	0.0062	88.4
	6	500	40	0.30	-535	0.0041	92.3
	8	500	40	0.50	-540	0.0043	91.9
374-5	4	950	60	1.20	-470	0.190	41.8
	6	1000	60	1.00	-510	0.127	62.4
	8	1000	60	1.05	-510	0.090	72.5

^{1/} All tests made at ambient temperature and minus 35-mesh at 40 per cent solids.

Samples 374-7 and 374-8

Acid leaching tests on Samples 374-7 and 374-8 were conducted on pulps prepared by grinding a 500-gram charge for five minutes in a laboratory rod mill at 50 per cent solids. Screen analyses of the ground pulps are shown in Table 4.

Table 4

Screen Analyses of Test Charges
Five-Minute Grind

Tyler Screen Mesh	<u>% Weight Distribution</u>	
	<u>Sample 374-7</u>	<u>Sample 374-8</u>
+20	0.02	0.0
-20 +28	0.02	0.0
-28 +35	0.10	0.0
-35 +65	8.91	4.8
-65 +100	16.60	17.3
-100 +150	12.60	12.5
-150 +200	9.85	10.8
-200 +325	15.10	15.1
-325	<u>36.80</u>	<u>39.5</u>
	100.0	100.0

Results of the leaching tests are presented in Tables 5 and 6. The test data show that uranium extractions in excess of 92 per cent can be obtained from the composite Sample 374-7 by leaching at ambient temperature for 16 to 24 hours with 500 to 550 pounds of sulfuric acid and 15 to 20 pounds of MnO₂ per ton of ore. Leaching at 75°C increased the consumption of oxidant but did not improve uranium extractions. Roasting prior to leaching was detrimental to extraction.

Sample 374-8 is more refractory and satisfactory uranium extractions were not obtained except by leaching at 75°C. Under these conditions, approximately 95 per cent extraction was obtained in six to eight hours using 1000 pounds of acid and 20 pounds of MnO₂ per ton.

Table 5

Acid Leaching TestsSample 374-7

<u>Leaching Conditions</u> ^{1/}				<u>Terminal Conditions</u>		<u>Residue Assay</u>	<u>% U₃O₈ Ext'n</u>
<u>Time, Hours</u>	<u>Temp °C</u>	<u>Lb/Ton</u>		<u>pH</u>	<u>Emf(mv)</u>	<u>% U₃O₈</u>	
		<u>H₂SO₄</u>	<u>MnO₂</u>				
<u>Effect of Time</u>							
8	Amb.	500	25	1.00	-450	0.060	70.6
16	Amb.	500	15	1.20	-440	0.015	92.9
24	Amb.	550	15	0.80	-430	0.015	92.5
48	Amb.	550	20	1.00	-405	0.012	94.2
<u>Effect of Temperature and Oxidant</u>							
4	75	500	45	1.00	-390	0.073	63.3
6	75	525	50	0.90	-385	0.046	76.9
8	75	525	60	0.95	-390	0.038	80.1
24	75	600	75	1.10	-370	0.015	92.6
<u>Effect of Roasting</u> ^{2/}							
6	75	550	50	1.10	-395	0.101	58.1
8	75	575	55	1.15	-400	0.064	73.5
24	Amb.	550	30	0.95	-400	0.041	84.5

^{1/} Minus 35-mesh ore, 40 per cent solids.^{2/} Roasted for two hours at 450°C.

Table 6

Acid Leaching TestsSample 374-8

<u>Leaching Conditions</u> ^{1/}				<u>Terminal Conditions</u>		<u>Residue Assay</u>	<u>% U₃O₈ Ext'n</u>
<u>Time, Hours</u>	<u>Temp °C</u>	<u>Lb/Ton</u>		<u>pH</u>	<u>Emf(mv)</u>	<u>% U₃O₈</u>	
		<u>H₂SO₄</u>	<u>MnO₂</u>				
<u>Effect of Time</u>							
2	Amb.	800	20	1.00	-355	0.212	43.3
4	Amb.	850	25	1.00	-380	0.206	44.9
8	Amb.	875	25	1.00	-375	0.180	51.9
16	Amb.	875	25	1.20	-350	0.108	72.0
24	Amb.	875	20	1.05	-365	0.114	70.3
48	Amb.	900	25	1.00	-380	0.095	74.3
<u>Effect of Temperature</u>							
6	75	1000	20	0.75	-320	0.020	94.8
8	75	1000	20	0.75	-320	0.014	96.4

^{1/} Forty per cent solids, minus 35-mesh ore.

B. Carbonate Leaching

The extraction of uranium from LaBajada ore samples by carbonate leaching was studied. Charges of ore were ground to minus 65-mesh in the laboratory rod mill and leached for six to 96 hours at 80°C with a solution containing 50 grams of Na_2CO_3 and 20 grams of NaHCO_3 per liter. Pulp density of the leach ranged from 25 to 50 per cent solids, depending upon the quantity of leaching reagents required. Oxidation was accomplished by bubbling air through the pulp at 15 to 60 ml per minute per 500 grams of ore, equivalent to from one to four cubic feet per minute per ton. The leached pulps were filtered and washed on Buchner funnels with hot water.

The results of the leaching tests are presented in Table 7 and show that the uranium extractions are markedly affected by the per cent solids during leaching, the concentration of leaching reagents, and the rate of aeration. The dependence on the concentration of leaching reagents is due primarily to the high consumption of reagents (90 to 210 pounds per ton) by the ore with the result that at the usual initial concentration of 50 grams of Na_2CO_3 and 20 grams of NaHCO_3 per liter, most of the reagents are consumed. Consequently, it is necessary to increase the initial reagent concentration or to decrease the per cent solids during leaching to insure having an active level of carbonate and bicarbonate present at all times.

All the pulps were difficult to filter and wash and the residues had to be repulped to achieve consistent results. The reagent consumption during leaching was excessively high in all cases because of the high sulfide content of the ores.

C. Thickening Tests

Acid Leached Pulps

Thickening tests were conducted by acid leaching Sample 374-7 at optimum conditions. The pulps were then diluted in three increments with water containing a flocculant and transferred to a two-liter graduate, equipped with a picket mechanism rotating at 1/10 rpm, for determination of settling rates and terminal density. The flocculant used was Separan 2610. Good settling rates were obtained at an initial pulp density of approximately 10 per cent solids, after addition of 0.95 pound of Separan per ton, but the pulps entered compression at less than 15 per cent solids. The terminal density was 39.0 per cent solids. The results of these tests are summarized in Table 8.

Table 7

Carbonate Leaching Tests

<u>Sample Number</u>	<u>Time, Hours</u>	<u>% Solids</u>	<u>Grams/Liter</u>		<u>Air ML/Min</u>	<u>Residue</u> <u>Assay</u>	<u>% U₃O₈ Ext'n</u>	<u>Na₂CO₃ Consumption Lb/Ton</u>
			<u>Na₂CO₃</u>	<u>NaHCO₃</u>		<u>% U₃O₈</u>		
374-3	24	40	50	20	60	0.133	39.0	110.4
	24	40	100	20	60	0.057	73.9	150.0
374-5	24	40	50	20	60	0.117	61.9	80.4
	24	40	100	20	60	0.022	92.7	171.2
374-7	6	40	50	20	15	0.091	55.0	--
	24	40	50	20	15	0.071	64.9	--
	48	40	50	20	15	0.068	66.4	--
	72	40	50	20	15	0.041	79.7	--
	96	40	50	20	15	0.054	73.3	211.3
	24	40	50	20	60	0.074	62.7	97.9
	24	40	75	30	60	0.040	79.7	--
	24	33	50	20	60	0.048	75.6	--
	24	25	50	20	60	0.031	84.4	200.0
	24	33	100	40	60	0.020	90.5	147.2
374-8	24	50	50	20	15	0.165	54.2	60.0
	24	50	50	20	60	0.040	88.9	50.0
	48	50	50	20	60	0.028	92.8	93.0

Table 8Thickening TestsSample 374-7

<u>Separan</u> <u>Lb/Ton</u>	<u>F</u>	<u>D</u>	<u>R</u>	<u>A</u>	<u>Terminal</u> <u>Density</u>	<u>Time,</u> <u>Hours</u>
0.95	9.1	1.80	2.48	3.90	39.0	16
0.95	6.7	1.80	0.02	320.0		

Carbonate Leached Pulps

Thickening tests were made on carbonate leached pulps prepared by leaching Sample 374-8 under near optimum conditions. Tests were conducted in the same manner as the acid leached pulps above. Test results indicate good flocculation only at high dilutions with 0.75 pound per ton of Separan. A terminal density of 42.2 per cent solids was reached in 20 hours. The results of these tests are presented in Table 9.

Table 9Thickening TestsSample 374-8

<u>Separan</u> <u>Lb/Ton</u>	<u>F</u>	<u>D</u>	<u>R</u>	<u>A</u>	<u>Terminal</u> <u>Density</u>	<u>Time,</u> <u>Hours</u>
0.75	8.38	1.36	1.92	4.85	42.2	20
0.75	6.18	1.36	1.30	4.95	42.2	20

F = Initial dilution - tons solution/ton of ore

D = Final dilution - tons solution/ton of ore

R = Settling rate - feet/hour

A = Thickener area - sq. ft./ton/day = $1.33 \frac{(F-D)}{R}$

D. Filtration TestsAcid Leached Pulps

Filtration tests were made on acid leached pulp from Sample 374-7. The ore was ground to minus 35-mesh and leached at 40 per cent solids for 16 hours at room temperature with 550 pounds of H₂SO₄ and 20 pounds of MnO₂ per ton of ore. The filtration was so poor that it was not possible to form a filter cake except after addition of over a pound of Separan per ton of ore and further testing was abandoned.

Carbonate Leached Pulps

Filtration tests were made on carbonate leached pulp from Sample 374-8 prepared by leaching minus 65-mesh ore for 24 hours at 25 per cent solids and 80°C with 50 grams of Na_2CO_3 and 20 grams of NaHCO_3 per liter. The leached pulp was thickened to 33 per cent solids by addition of 0.75 pound of Separan per ton prior to filtration with a 0.1 square foot test leaf. Results of these tests are shown in Table 10.

Table 10Filtration TestsSample 374-8

<u>Separan</u> <u>Lb/Ton</u>	<u>Cycle</u> <u>Time,</u> <u>Minutes</u>	<u>Cake</u> <u>Thickness</u> <u>Inches</u>	<u>%</u> <u>Moisture</u>	<u>Lb/Sq.Ft/Day</u>
0.75	8	1/16	52.9	26.3
0.75	16	1/8	50.0	15.1