

ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED  
West Coast Department

68-531

REPORT ON INVESTIGATION INTO A PYRITE DEPOSIT

AT BRANCH CREEK, PORT SORELL

EXPLORATION LICENCE

12/67

By

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16th September, 1968

Report No. 95

## Investigation into the Pyrite Deposit at Branch Creek

### Summary

The pyritic shales of Branch Creek in the Latrobe District of Tasmania were examined for their potential as a source of sulphur for sulphuric acid manufacture. The examination involved geological mapping, sampling of the exposed pyritic shale sequence, and metallurgical (ore-dressing) investigations.

On the results of the metallurgical tests the project was abandoned because of uneconomic recoveries of the available sulphur.

### Location

The exploration licence area is situated on the right bank of the East Arm of Port Sorell. Its S.W. corner lies by Frankford Highway at the point where it crosses the East Arm. The area is some 25 square miles. Branch Creek runs E - W across the centre of the E.L. area.

Access is attained by the Seven Mile Beach road which leaves the Frankford Highway, some sixteen miles by road from Devonport.

### History

From 1953 - 1955 the Department of Mines investigated the deposit in the immediate vicinity of Branch Creek on behalf of the Ben Lomond Mining Company. Geological mapping was followed by trenching and diamond drilling. Two trenches and five diamond drill holes were completed. From these an estimated ore reserve of three quarters of a million tons of ore averaging about 12.5% sulphur was obtained. Ore dressing investigations at the time indicated that only low recovery rates would be attained and this, set against the 1955 price of raw sulphur, apparently militated against continuing the investigation. The Ben Lomond Company then abandoned its interest in the project.

In 1966, the rising price of elemental sulphur and proposals for the establishment of a sulphuric acid plant to make acid using pyrite as a source of sulphur caused the Company to examine the deposit and an exploration licence for the area was taken out. This report covers the investigations made under that licence.

### Geology

The Branch Creek pyritic shales are part of a sequence of Cambrian slates, shales, quartzites and limestones forming the western limb of a large anticline, striking approximately North-South. The core of the anticline consists of a considerable but undetermined thickness of Precambrian schists which form the hills lying to the east of the exploration area.

The Cambrian sequence, placed by Hughes (1953) in the Carbine Group consists of a well bedded set of slates and shales with occasional thicker beds of a blue-grey

quartzite and dolomitic limestone. Deposition appears to have gone on in a slowly sinking basin with the slates and shales representing sedimentation in deeper water and the quartzites and limestones in shallower water. The very fine nature of the pyritic shales seem to indicate periods when the water was deeper than normal. The rocks generally dip steeply to the west throughout the area, but minor folding is evident and easterly dips are not uncommon.

The Cambrian succession only outcrops in creek beds and along the sea shore, where the ground level is below the contact between the steeply dipping Cambrian beds and the relatively thin and flatlying tertiary sandstones and gravels which form the surface rocks over most of the area. Occasional upfaulted blocks of Cambrian sediments show as inliers within the Tertiary sediments.

The only area where pyritic shales have been found is in Branch Creek itself, elsewhere the sequence is more slatey and quartzitic and relatively pyrite free.

The pyrite mineralisation of Branch Creek is syngenetic with the shales and indicates fairly deep water sedimentation under anaerobic conditions. This association of pyrite with black shale is not unusual.

The pyrite appears to exist in two forms, one is the normal cuboid crystalline form with the usual pale yellow colour, and the other is in very small particles which are black in appearance and indistinguishable from the carbonaceous matter in the shale when seen in the hand specimen. The size range of this black pyrite is from two to ten microns. The pyrite occurs in a gangue consisting mostly of quartz and sericite with up to 22% of carbonaceous matter - very typically black shale constituents.

#### Sampling and Assaying

Sampling was confined to the slate and shale sequence within the bed of Branch Creek between the road-bridge in the west and the point where the slates pass under a cemented wash in the east, covering a cross strike distance of some fifteen hundred feet. Within this zone every outcrop was channel sampled on the surface, each sample being two feet in length. A total of ninety-one samples were so taken and were assayed at Rosebery for sulphur and iron.

Generally, the assays for sulphur were exceedingly low, primarily because of decomposition of pyrite under surface oxidation. Since in pyrite the Fe:S ratio is 46.6:53.4 it is considered that the Fe assays give a better guide to the probable sulphur content of the rock below the zone of weathering. Also it was found that where the highest iron assays occurred the sulphur values were higher than normal.

3.

Only two areas carried iron assays greater than 10% (the estimated minimum economic grade for sulphur is 10%), one, in the 'D' series (see sampling plan), is approximately 450' upstream from the road bridge, and assayed at 11.5% Fe and 10.7% S over 4', which lies almost along strike from the Department of Mines borehole No. 5 - 62' at 14.5% S. The other covers the 'O' and 'P' series, which are closely adjacent. The 'O' series is a highly carbonaceous black shale, assayed at 11.25% Fe over 30' and the 'P' series, is a grey mudstone/shale assayed at 19.2% Fe and 18.2% S over 8'. Both the 'O' and 'P' series samples were taken adjacent to the trenches and boreholes made in the investigations, done on behalf of the Ben Lomond Mining Co.

The sampling results indicated that there was a potential for a pyrite mining operation in the area if sufficient reserves could be found - which appeared likely, and if sufficient sulphur could be recovered from the deposit to satisfy a sulphuric acid plant and the mining economics. With this in mind a large sample of about 100 lbs. was taken from the richer part of the 'O' series for ore-dressing examination.

#### Ore-Dressing Investigation

The sample taken for ore-dressing tests was given a preliminary examination in the Rosebery Experimental Mill and the problem was then passed to the Government Laboratories in Launceston for the development of a full Box - Wilson programme.

The complete metallurgical reports are attached to this report.

Essentially the investigations showed that to attain a concentrate with a sulphur grade high enough for sulphuric acid manufacture, 48% S, the recoveries were too low for economic exploitation of the deposit and in reverse, with satisfactory recoveries the grade of the concentrate is too low for making acid. The cause of the low recoveries being the very small size of a large proportion of the pyrite.

#### Conclusions and Recommendations

The investigation confirmed the existence of a fairly substantial deposit of pyrite bearing shales averaging more than 10% S, the indicated ore being sufficient to justify an extended prospecting programme. However, ore dressing tests show that the pyrite cannot be satisfactorily concentrated to give the grade required for acid manufacture and economic recovery.

It is recommended that the prospect be abandoned.

*D. O'N. Hackett*  
D. O'N. Hackett.

ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED  
West Coast Department

Rosebery  
11th July, 1968

Investigation No. 247      Programme 1      Bulletin 1

Date Work Originated                      8th November, 1967

Date Work Completed                      26th June, 1968

Subject      FLOTATION - Possibility of Producing a  
Pyritic Concentrate from Branch Creek Shale.

Object      To determine if a pyritic concentrate, suitable  
for acid production, can be made by flotation  
of the pyrite contained in Branch Creek Shale.

Summary      A preliminary survey of sized fractions of the  
ore crushed to minus  $\frac{1}{4}$  inch, was made to de-  
termine the fineness of grind required to  
achieve good liberation of the pyrite. A  
sample for flotation testing was then prepared  
by grinding, and two preliminary flotation  
tests were carried out to give an indication  
of the flotation properties of the ore. The  
results of these tests, and other preliminary  
information, aided the preparation of a Box-  
Wilson programme. The Box-Wilson programme  
was carried out at the Department of Mines  
Laboratory, Launceston, and a report, which  
outlines the procedure and gives results and  
conclusions, has been received. This report,  
and extracts from a report on a similar pro-  
gramme carried out at the same laboratory in  
1954, are appended.

\* Li, C. H., Worksheet gives optimum conditions;  
Chem-Eng., 7th April, 1958.

### Conclusions

1. The only valuable mineral, present in this ore in significant quantities, is pyrite, which occurs as finely disseminated particles averaging 5 microns in size. The gangue minerals are quartz and sericite occurring as extremely small particles, with a smaller amount of carbonaceous material also present.
2. Recovery of sulphur in rougher concentrates was very low, the best test giving a recovery of 75% of the sulphur at a grade of 30%.
3. It is possible to produce a cleaner concentrate assaying 44% sulphur at an overall recovery of 60%.
4. Production of a pyritic concentrate suitable for acid production is not feasible according to the results of this investigation. To produce a concentrate assaying 48% sulphur (acid grade concentrate), the overall recovery would be considerably less than 60% and such a low recovery would not be economical.

### Results and Discussions

Sample: Approximately 70 lb. of pyritic shale from Branch Creek, Port Sorell, was received on the 8th November, 1967. The sample was prepared for laboratory testing by first removing earthy material which would not normally be treated, and then crushing to minus  $\frac{1}{4}$  inch. The bulk sample was thoroughly mixed, and a portion removed and ground to minus 65 mesh Tyler for preliminary flotation testing. A further 22 lb of this sample was sent to the Department of Mines Laboratory for completion of the testing programme. Chemical analyses and spectrographic examination of a portion of the sample were carried out at Risdon to try and detect the presence of further recoverable values. No such values were detected, and details of the results of this work are given in the sample description in Exhibit 1 of the Appendix.

### Flotation Testing

The two preliminary rougher flotation tests were carried out under conditions similar to those adopted for the flotation of pyrite from mill residue, (Investigation 62), using potassium isopropyl xanthate as the collector and MIBC as the frother. The results are set out below, and are reported more fully in Exhibit 2 of the Appendix.

#### Results of Preliminary Rougher Flotation Tests.

Flotation Test No.	Collector lb/ton	pH	Percent solids	Chemical Analysis S%	Percent Recovery S
1	0.15	3.2	8.4	39.2	59.3
2	0.22	2.6	35.0	26.5	61.2

Recovery of sulphur was very low in the rougher concentrate, and an increase of collector made little difference. The grade achieved in Test No. 1 was by far the better of the two, and was probably due to the low pulp solid content and the lower collector addition. These results showed that it would be difficult to float the pyrite, and a finer grind, better promotion of the pyrite and use of a gangue depressant would probably be required if better results were to be achieved.

The above conclusions were useful for the preparation of a Box-Wilson programme for further test work. Copper sulphate was tested as a promoter for the pyrite, and Cyanamid Reagent 633 was used to depress the siliceous and carbonaceous gangue. The other variables adopted for the programme were pH, degree of grinding, pulp solids content, potassium isopropyl xanthate addition, and flotation time. This part of the Investigation was completed by the Department of Mines, and the results were reported in Ore Dressing Investigation R.564,

which is appended as Exhibit 3. For the sake of completeness, extracts from Ore Dressing Investigation R.273, which report test work carried out on Branch Creek Shale in 1954, is included as Exhibit 4 of the Appendix.

Metallurgist

Chief Metallurgist

RJP/jd

Investigation No. 247

Programme 1

Bulletin 1

APPENDIX

EXHIBIT 1

Sample Description.

EXHIBIT 2

Flotation Tests

EXHIBIT 3

Department of Mines Laboratory Ore  
Dressing Investigation R. 564 -  
Flotation of Pyrite.

EXHIBIT 4

Extract from Department of Mines Laboratory  
Ore Dressing Investigation R. 273, (5th  
August, 1954), Pyritic Slate - Branch Creek,  
Port Sorell - Concentration of Pyrite.

- 6 -

EXHIBIT 1SAMPLE DESCRIPTIONDesignation: Pyritic shale from Branch Creek.Samples Delivered: 8-11-67 by Mr. D. Hackett of the Geology Department.Sample Quantity: Approximately 70 Lb.Sample Container: two sacks.Sample Description: The sample consisted of lumps of pyritic shale, up to 12 inches in largest dimension. Earthy material, containing some iron oxide, was clinging to some of the lumps, but this was removed before further treatment of the sample. The shale itself was black in colour suggesting that it might be carbonaceous, and contained a considerable amount of very finely disseminated pyrite. Quartz and sericite are the other major mineral constituents.CHEMICAL ANALYSIS

The following chemical analysis and spectrographic examination was carried out at Risdon.

Fe	Total S	SO <sub>4</sub> /S	Sulphide S	Insol.	Loss on ignition (at 800°C)
%	%	%	%	%	%
16.1	15.9	1.45	14.45	45.1	22.2

Spectrographic Examination

Major constituents

Minor constituents

Traces

Si, Fe.

Na, Al, Mg, Ti.

Cu, Pb, Zn, Co, Ni &lt; 0.001%

Ca, Ba &lt; 0.05%

No other elements detected.

010

108011

EXHIBIT 2.

FLOTATION TEST No. 1.

**PURPOSE:** To test the possibility of producing a pyritic concentrate from Branch Creek Shale. Flotation Tests.

**SAMPLE:** Pyriforous shale from Branch Creek.

**PROCEDURE:** 450 grams of -65 mesh material was fed to the 5 litre flotation cell, scrubbed for 9 minutes, conditioned with xanthate for 5 minutes and floated for 9 minutes to produce a rougher concentrate.

**RESULTS:**

OPERATION	Time Mins.	% Solids	pH		MIBC	Reagents — lb./ton feed								
			Start	Fin.		Potassium isopropyl xanthate								
Scrubbing	9	8.4	3.2	3.2										
Conditioning	5	8.4	3.2	3.2		0.15								
Rougher flotation	9	8.4	3.2	3.5	0.183									

PRODUCT	% Wt.	Chemical Analysis %					Per Cent Distribution				
		Fe	S				Fe	S			
Head (calculated)	100.0	17.4	22.3				100.0	100.0			
Rougher Concentrate	33.7	31.3	39.2				60.5	59.3			
Rougher tailing	66.3	10.4	13.7				39.5	40.7			

**OBSERVATIONS and REMARKS:** This material has a very low initial pH, no acid was added. The pump density was extremely low due to a miscalculation.

011

FLotation TEST No.

108012

See Flotation Test No. 1.

Flotation Tests.

PURPOSE:SAMPLE:PROCEDURE:RESULTS:

See Flotation Test No. 1

1125 grams of -65 mesh material was fed to the 2.5 litre flotation cell to give a pulp content of 35%. Scrubbing time was 11 minutes and amount of xanthate used was increased to approximately 0.2 lb/ton. Other conditions were as for Flotation Test No. 1.

OPERATION	Time Mins.	% Solids	pH		MIBC	Reagents — lb./ton feed								
			Start	Fin.		Potassium isopropyl xanthate								
Scrubbing	11	35	2.6	2.6	Excess of this rea- gent was used	0.22								
Conditioning	5	35	2.6	2.6										
Rougher flotation	9	35	2.6	3.4										

PRODUCT	% Wt.	Chemical Analysis %					Per Cent Distribution				
		Fe	S				Fe	S			
Head(calculated)	100.0	17.1	20.6				100.0	100.0			
Rougher concentr- rate	47.5	21.6	26.5				59.9	61.2			
Rougher tailings	52.5	13.1	15.2				40.1	38.8			

OBSERVATIONS and REMARKS:

The increased amount of collector appears to have increased recovery, but a large amount of frother was required.  
It would seem that lower densities would give a better grade.

EXHIBIT 3

Department of Mines Laboratory

Ore Dressing Investigation

R.564

Flotation of Pyrite

Launceston, 20th May, 1968.

ORE DRESSING INVESTIGATION

R.564

Flotation of Pyrite

Introduction

A sample of Branch Creek ore, containing finely disseminated pyrite was supplied by the Electrolytic Zinc Company for pyrite concentration tests to see if a concentrate suitable for the manufacture of sulphuric acid could be made.

Object

To concentrate the pyrite by flotation and find the set of conditions which give the highest recovery of sulphur, using the Box-Wilson method of analysis.

Sample

The sample received consisted of about 22 lbs. of black material which had been crushed to  $\frac{1}{4}$ ". The sample was screened on a 10 mesh screen and the screen oversize was crushed in the laboratory rolls, then re-screened on the 10 mesh screen. This procedure was repeated until all the material passed through the 10 mesh screen.

The sample was thoroughly mixed and out into 22 samples of 500 gms.

Note:- a. No responsibility will be accepted for the results in so far as they apply to the sample supplied for test work.

b. All screens used were of the British Standard Screen Series.

c. Launceston tap water was used throughout the test work.

Test Work

From the analysis of the head sample the following results were obtained.

14.7 per cent total iron.

4.1 per cent HCl soluble iron.

14.3 per cent sulphur.

That is the ore contained approximately 22.3 per cent pyrite and 6.5 per cent pyrrohotite or approximately 29 per cent of iron sulphides.

Tests N1 to N5 inclusive were concerned only determining the ball mill grinding time at 60 per cent solids to reduce 500 gms. of the -10 mesh ore to (a) 90 per cent passing 100 mesh, (b) 90 per cent passing 200 mesh.

In the subsequent flotation tests, ball mill grinding time was such that it gave either grind (a) or grind (b). Sizing analysis of tests N4 and N5 are shown on table 1 and 2. It was decided to use levels of soda ash addition as a control rather than two set pH levels since floating at two different pulp densities meant that the different water additions affected the pH and it would have been very difficult to maintain the two required pH levels.

DEPARTMENT OF MINES LABORATORYSheet No. R.564/2.

Tests N6 and N13 were the actual flotation tests with test conditions and reagent additions as shown in table 3. All reagent additions stated are in lbs./long ton. The flotation cell used was the Denver D1 Laboratory cell and the agitator speed was kept constant at 1450 RPM. for all tests. The results of the tests are shown in table 4.

Conclusions

Most tests gave very poor sulphur recoveries. Test N13 gave the best result. In this test 75.4 per cent of the sulphur was recovered in a concentrate assaying 35.3 per cent sulphur.

The Box-Wilson analysis of the results is given on table 5 with the best path indicated.

(K. J. Austin),

METALLURGIST.

(L. J. Rhodes),

SENIOR METALLURGIST.

(H. K. Wellington),

Chief Chemist & Metallurgist.

Sheet No. R.564/3.

Test N4.Table 1. Sizing Analysis of Ball Mill Discharge.

<u>Fraction</u>	<u>Weight</u>	<u>Per Cent.</u>		<u>Per Cent Distribution</u>		
		<u>Cum.Wght.</u>	<u>T.Fe</u>	<u>S</u>	<u>T.Fe</u>	<u>S</u>
+60 mesh	1.7	1.7	15.0	14.9	9.6	9.8
100 mesh	7.8	9.5				
150 mesh	7.7	17.2	17.4	17.9	9.1	9.6
200 mesh	9.0	26.2	18.0	18.8	10.9	11.8
-200 mesh	73.8	100.0	14.1	13.4	70.4	68.8
Composite	100.0	-	14.8	14.4	100.0	100.0

Details: 2 minutes 39 seconds wet grind 60 per cent solids.  
Wet split on 200 mesh and 100 mesh then dry screened.  
pH of pulp: 4.1

Test N5Table 2. Sizing Analysis of Ball Mill Discharge.

<u>Fraction</u>	<u>Weight</u>	<u>Cum.Wght.</u>	<u>Per Cent Distribution</u>	
			<u>T.Fe</u>	<u>S</u>
+60 mesh	0.1	0.1	15.3	14.4
100 mesh	1.0	1.1		
150 mesh	2.8	3.9	15.8	15.7
200 mesh	6.1	10.0	16.3	16.4
-200 mesh	90.0	100.0	15.4	15.1
Composite	100.0	-	15.5	15.2

Details: 6 minutes 45 seconds wet grind 60 per cent solids.  
Wet split on 200 mesh and 100 mesh then dry screened.  
pH of pulp: 4.7

Abbreviations used in the tables.

T.Fe Total iron.  
C Concentrate  
T Tailing  
F/D Feed

DEPARTMENT OF MINES LABORATORY.

Sheet No. R.564/4.

Table 3. Flotation Conditions.

<u>Test No.</u>	<u>Addition of Na<sub>2</sub>CO<sub>3</sub> lbs/ton</u>	<u>pH Control</u>		<u>Density of Pulp before Flotation % Solids</u>	<u>Grind 90% Passing Mesh Stated</u>	<u>Reagent Addition.</u>			<u>Time of Flotation</u>	
		<u>pH Readings After Conditioning Before Flotation</u>	<u>At End of Flotation</u>			<u>Aero Depressant 633 lbs/ton</u>	<u>Copper Sulphate lbs/ton</u>	<u>Isopropyl Xanthate lbs/ton</u>		<u>Methyl Isobutyl Carbinol lbs/ton</u>
N6	-	3.1	2.9	11	100	1.0	0.1	0.5	0.08	10
N7	11.2	5.9	4.7	11	100	-	0.4	0.5	0.08	5
N8	11.2	6.1	4.6	25	100	1.0	0.1	-	0.08	5
N9	-	4.1	3.9	25	100	-	0.4	-	0.08	10
N10	-	4.6	4.1	11	200	-	0.1	-	0.08	5
N11	11.2	6.3	4.1	25	200	-	0.1	0.5	0.08	10
N12	11.2	6.4	4.3	11	200	1.0	0.4	-	0.08	10
N13	-	4.4	3.4	25	200	1.0	0.4	0.5	0.08	5

DEPARTMENT OF MINES LABORATORY.

Sheet No. R.564/5.

Tests N6-N13Table 4. Flotation Tests Results.

<u>Product</u>	<u>Wght.</u> <u>(Gms)</u>	<u>Per Cent</u>			<u>Units</u>		<u>Per Cent</u> <u>Distribution</u>	
		<u>Wght.</u>	<u>Total</u> <u>Fe</u>	<u>S</u>	<u>Total Fe</u>	<u>S</u>	<u>Total Fe</u>	<u>S</u>
<u>N6</u> C.	45.6	9.7	16.5	15.2	160.05	147.44	9.9	9.5
T.	424.6	90.3	16.2	15.5	1462.86	1399.65	90.1	90.5
F/D.	470.2	100.0	16.2	15.5	1622.91	1547.09	100.0	100.0
<u>N7</u> C.	59.5	12.7	26.1	27.7	331.47	351.79	20.1	22.7
T.	408.1	87.3	15.1	13.7	1318.23	1196.01	79.9	77.3
F/D.	467.6	100.0	16.5	15.5	1649.70	1547.80	100.0	100.0
<u>N8</u> C.	53.3	11.7	12.5	10.8	146.25	126.36	9.7	8.6
T.	401.5	88.3	15.4	15.3	1359.82	1350.99	90.3	91.4
F/D.	454.8	100.0	15.1	14.8	1506.07	1477.35	100.0	100.0
<u>N9</u> C.	174.0	37.7	21.6	23.1	814.32	870.87	51.5	56.2
T.	287.4	62.3	12.3	10.9	766.29	679.07	48.5	43.8
F/D.	461.4	100.0	15.8	15.5	1580.61	1549.94	100.0	100.0
<u>N10</u> C.	47.3	10.4	15.0	13.0	156.00	135.20	9.2	8.8
T.	408.1	89.6	17.2	15.7	1541.12	1406.72	90.8	91.2
F/D.	455.4	100.0	17.0	15.4	1697.12	1541.92	100.0	100.0
<u>N11</u> C.	150.0	32.9	14.0	12.8	460.60	421.12	28.4	26.6
T.	306.3	67.1	17.3	17.3	1160.83	1160.83	71.6	73.4
F/D.	456.3	100.0	16.2	15.8	1621.43	1581.95	100.0	100.0
<u>N12</u> C.	125.3	27.4	21.6	22.0	591.84	602.80	36.8	38.6
T.	332.1	72.6	14.0	13.2	1016.40	958.32	63.2	61.4
F/D.	457.4	100.0	16.0	15.6	1608.24	1516.12	100.0	100.0
<u>N13</u> C.	145.4	33.0	32.0	35.3	1056.00	1164.90	66.4	75.4
T.	295.0	67.0	7.96	5.66	533.32	379.22	33.6	24.6
F/D.	440.4	100.0	15.9	15.4	1589.32	1544.12	100.0	100.0

Table 5. Box-Wilson Analysis.

Line	Experiment:	A	B	C	D	E	F	G	H
1.	Factor								
2.	Studies	Na <sub>2</sub> CO <sub>3</sub>	Grind	CUSO <sub>4</sub>	Density	Isopropyl Xanthate	R633	Flot. Time	
3.	Base Level	5.6	105	0.5	18	0.25	0.25	7.5	
4.	Unit	5.6	37.5	0.5	7	0.15	0.25	2.5	
5.	High Level	<u>11.2</u>	<u>150</u>	<u>1</u>	<u>25</u>	<u>0.4</u>	<u>0.5</u>	<u>10</u>	
6.	Low Level	0	75	0	11	0.1	0	5	Data
7.	Sample 1. TestN10	0	75	0	11	0.1	0	5	8.8
8.	2. N7	<u>11.2</u>	<u>150</u>	0	11	<u>0.4</u>	<u>0.5</u>	5	22.7
9.	3. N12	<u>11.2</u>	75	1	11	<u>0.4</u>	0	<u>10</u>	38.6
10.	4. N6	0	<u>150</u>	1	11	0.1	<u>0.5</u>	<u>10</u>	9.5
11.	5. N11	<u>11.2</u>	75	0	25	0.1	<u>0.5</u>	<u>10</u>	26.6
12.	6. N9	0	<u>150</u>	0	<u>25</u>	<u>0.4</u>	0	<u>10</u>	56.2
13.	7. N13	0	75	1	<u>25</u>	<u>0.4</u>	<u>0.5</u>	5	75.4
14.	8. N8	<u>11.2</u>	<u>150</u>	<u>1</u>	<u>25</u>	0.1	0	5	8.6
15.	Effect	-6.67	-6.55	2.22	10.90	17.42	2.75	1.92	
16.	Effect Times unit	-37.4	-245.6	1.11	76.3	2.61	0.69	4.80	
17.	Change								
18.	Best Path	-31.8	-140-6	1.61	94.3	2.86	0.94	12.30	

DEPARTMENT OF MINES LABORATORY

Launceston 26th. June, 1968.

ORE DRESSING INVESTIGATION

R.564.

Flotation of Pyrite - Part 11.Object.

To concentrate pyrite from Branch Creek ore by flotation conditions indicated by the best path established by the Box-Wilson method of analysis in the first part of this investigation. In addition a cleaner concentration stage has been included in each test.

Test Work.

The results of the best path for  $\text{Na}_2\text{CO}_3$  addition, size of grind, and pulp density indicated in Table 5 of the report on the first part of this investigation were considered strange and difficult to apply.

The Box-Wilson analysis sheet was studied and a second table was prepared in which pulp density and the sulphur recovery obtained were expressed as a decimal part of unity instead of a percentage e.g. a pulp density of 25% solids was expressed as 0.25, and a sulphur recovery of 56.2% was expressed as 0.562. This second Box-Wilson analysis chart is shown on Table 6 in this report. The results of the best path for  $\text{Na}_2\text{CO}_3$  addition, size of grind, and pulp density appear to be more meaningful.

Conditions chosen for the next test (NI4) were those for line 31, with the figures rounded off for convenience. The actual conditions used were as follows:-

<u>Soda Ash</u>	<u>Grind</u>	<u>CuSO<sub>4</sub></u>	<u>Pulp Density</u>	<u>Potassium</u>	<u>Reagent</u>	<u>Flot.</u>
<u>lbs/ton</u>	<u>90%</u>	<u>lbs/ton</u>	<u>% Solids</u>	<u>Iso-Propyl</u>	<u>R633</u>	<u>time</u>
				<u>Xanthate</u>	<u>lbs/ton</u>	<u>minutes.</u>
				<u>lbs/ton</u>		
-	75 u	2.0	25	0.8	0.3	8

The reasons for the deviation from the suggested path are as follows:-

- Grind - time for 90% - 75 micron grind already established.
- $\text{CuSO}_4$  addition. Effect figure for  $\text{CuSO}_4$  in original Box-Wilson analysis sheet was in error by a factor of 10.
- 25% solids was maximum pulp density possible when washing 500 grms. of 60% pulp from the ball mill.
- Iso-propyl xanthate was increased because it was thought to have most influence on recovery.

The results of this test are shown on Table 7. Recovery was almost identical with the recovery in Test NI3, but grade was slightly lower.

The rougher concentrate was cleaned in a cleaner float with six drops of M.I.B.C. added and a flotation time of 5 minutes.

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Conditions of Test N15 were chosen by averaging the  $\text{CuSO}_4$ , potassium iso-propyl xanthate, and reagents R633 additions, and the flotation times in Test N13 and N14. The conditions used in test N15 were as follows:-

<u>Soda Ash</u> <u>lbs/ton</u>	<u>Grind</u> <u>90%</u>	<u>CuSO<sub>4</sub></u> <u>lbs/ton</u>	<u>Pulp Density</u> <u>% Solids</u>	<u>Potassium</u> <u>iso-propyl</u> <u>Xanthate</u> <u>lbs/ton</u>	<u>Reagent</u> <u>R633</u> <u>lbs/ton</u>	<u>Flot.</u> <u>time</u> <u>minutes</u>
-	75u	1.5	25	0.6	0.4	6.5

The results of this test are shown in Table 7. The rougher concentrate was cleaned in a cleaner float with similar conditions as in Test N14, except 0.6 lbs/ton of potassium iso-propyl xanthate was added in addition. The cleaner float was found to be sluggish, and a xanthate addition was made to provide better flotation. The amount of addition was relative to the feed in the rougher flotation. No doubt the xanthate addition is the reason for the improvement of the cleaner flotation results of Test N15 and Test N14.

Conclusions.

It is possible to recover 75% of the sulphur in the Branch Creek ore in a concentrate assaying about 30% sulphur. By the addition of potassium iso-propyl xanthate in a cleaning operation, it is probable that 60% of the sulphur would be recovered in a concentrate assaying 44% sulphur.

Senior Metallurgist.Chief Chemist & Metallurgist.

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Line	Experiment R.564		Object: Branch Creek Pyrite							Data: Table 6				Date:	
1	Factors		A	B	C	D	E	F	G	Error of single test $\sigma$ 0.24 $\sigma = 2.43 \times$ smallest effect				1 = ABCD = BCE = - ADE	
2	Studies		*S.A.	G.	C.S.	D.	KI-px R633	F.T.		Error effect = $\sigma^2/8$ = 0.354 $\sigma$				= ACF = - BDF = ABG	
3	Base Level		5.6	105	0.5	0.18	0.25	0.25	7.5					Interaction of factors.	
4	Unit		5.6	3.75	0.5	0.07	0.15	0.25	2.5						
5	High Level		11.2	150	1	0.25	0.4	0.5	10	H	J	K	L	M	N
6	Low Level		0	75	0	0.11	0.1	0	5	Data	Calculation		Effect of each factor		
7	Sample 1 Test 10N		0	75	0	0.11	0.1	0	5	0.088	0.315	0.796	2.464	0.308	Average
8	2	N7	11.2	150	0	0.11	0.4	0.5	5	0.227	0.481	1.668	-0.524	-0.0655	B
9	3	N12	11.2	75	1	0.11	0.4	0	10	0.386	0.828	-0.152	0.178	0.0223	C
10	4	N6	0	150	1	0.11	0.1	0.5	10	0.095	0.840	-0.372	-1.394	-0.1743	BC = AD = -E
11	5	N11	11.2	75	0	0.25	0.1	0.5	10	0.266	0.139	0.166	0.872	0.109	ABC = D
12	6	N9	0	150	0	0.25	0.4	0	10	0.562	-0.291	0.012	-0.220	-0.0275	AC = BD = -F
13	7	N13	0	75	1	0.25	0.4	0.5	5	0.754	0.296	-0.430	-0.154	-0.0193	AB = CD = -G
14	8	N8	11.2	150	1	0.25	0.1	0	5	0.086	0.668	0.964	0.534	-0.0668	A
15	Effect		-0.07	-0.06	.022	.109	0.17	0.27	.019						
16	Effect times unit		.37	2.45	.011	.007	.026	.007	.048	* Variables					
17	Change		-.4	-2.63	.012	.008	.028	.007	.051	S.A. = Soda Ash ( $\frac{1}{2}$ lbs/ton)					
18	Best path		5.2	102.4	0.51	0.188	0.28	0.26	7.55	G. = Grind 90% passing in microns					
19			4.8	99.800	.52	.196	0.31	0.26	7.60	C.S. = Copper Sulphate (lbs/ton)					

021

...../:

Line Experiment: R.564

Object: Branch Creek Pyrite

Data: Table 6

Date:

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Line	Experiment	A	B	C	D	E	F	G	
20		4.4	97.1	0.54	.204	0.33	0.27	7.65	Ki. Px = Potassium iso-propyl Xanthate (lbs/ton)
21		4.0	94.5	0.55	.213	0.36	0.28	7.71	F.T = Flotation time (minutes)
26		2.0	81.4	0.61	.253	0.50	0.32	7.96	D. = Density
27		1.6	78.7	0.62	.262	0.53	0.32	8.01	
31	Test N14	0	68.2	0.67	.294	0.64	0.35	8.22	

022

DEPARTMENT OF MINES LABORATORY

Sheet No. R564 Part 11/4

Table 7

<u>Product</u>	<u>Per Cent</u>			<u>Per Cent Distribution</u>	
	<u>Wght</u>	<u>S</u>	<u>Fe</u>	<u>S</u>	<u>Fe</u>
N14 Cleaner FC	16.2	42.0	37.9	45.9	36.9
Cleaner FT	23.2	18.7	19.9	29.3	27.7
Rougher FC	39.4	28.3	27.3	75.2	64.6
Rougher FT	60.6	6.05	9.72	24.8	35.4
Head	100.0	14.8	16.6	100.0	100.0
N15 Cleaner FC	19.4	44.1	39.9	57.4	45.5
Cleaner FT	11.3	11.0	14.4	8.4	9.6
Rougher FC	30.7	31.9	30.5	65.8	55.1
Rougher FT	69.3	7.35	11.0	34.2	44.9
Head	100.0	14.9	17.0	100.0	100.0

EXHIBIT 4.

Extract from Department of Mines Laboratory.

Ore Dressing Investigation.

R.273

(5th. August, 1954)

Pyritic Slate - Branch Creek, Port Sorell

Concentration of Pyrite.

Extract from R.273.Pyritic Slate - Branch Creek, Port Sorell.CONCENTRATION OF PYRITE.

Analysis showing sulphide sulphur as Pyrite:

Table 2.

	<u>Per Cent</u>
Pyrite	42.3
Lead, Copper, Bismuth, Nickel, Selenium Zinc not detected.	
Arsenic	0.001
Cobalt                    under	0.01
SiO <sub>2</sub>	33.6
Fe <sub>2</sub> O <sub>3</sub>	1.4 (exclusive) of Fe in pyrite)
TiO <sub>2</sub>	0.8
Al <sub>2</sub> O <sub>3</sub>	7.7
MgO	1.2
Na <sub>2</sub> O	1.7
K <sub>2</sub> O	1.8
Gold	Trace
Silver	Trace
Moisture at 105°C	1.7
Carbon	3.0

The slate is slightly acidic as shown by the following test. The ground sample after agitation at 25 per cent solids with tap water of a pH of 8 showed a pH value of 2.1.

SUMMARY.

1. The sample of black pyritic slate contained 23.2 per cent of sulphur of which 22.6 per cent was present as sulphide sulphur. This percentage of sulphide sulphur is equivalent to 42.3 per cent of pyrite.

Elements which could be regarded as detrimental in the manufacture of sulphuric acid are notable absent. The gangue minerals are mostly quartz and sericite and exist as extremely small particles.

The pyrite exists mostly as crystals of very small sizes and a good deal of it is present in sizes ranging from 10 to 2 microns. Some pyrite exists as composites with quartz etc.

2. Concentration by flotation has shown higher recoveries than gravity methods due to the losses of the finest pyrite by gravity concentration. Similarly, deficiencies in recovery in flotation are considered to be caused by the extremely small grain sizes of some of the pyrite. The pyrite is observed in two groups (1) free grains of moderate size which concentrate readily and appear as the normal pale yellow coloured pyrite and (2) black material which is only floated with difficulty and is mainly of very small grain size. Some of this black material contains composites of pyrite and gangue.

Due to the moderate proportion of free, easily recoverable yellow grains of pyrite, highest quality concentrate could only be obtained with low recovery and attempts to produce best recoveries have resulted in appreciable depreciation in quality.

Results of test No. 44 are typical of best results by flotation and the results of rougher, cleaner and recleaner flotation shown below indicate clearly the connection between grade of concentrate and recovery.

	Per Cent		
	<u>Weight</u>	<u>Sulphur</u>	<u>Sulphur</u> <u>Distribution</u>
Rougher Concentrate	48.3	33.4	69.5
First Cleaner Concentrate	32.3	41.9	58.4
Final Recleaner Concentrate	20.4	47.6	41.8

Test 59 resulted in a final concentrate containing 46.3 per cent of sulphur with a recovery of 52.5 per cent. This increased recovery may be due to the method of addition of the reagent Silester "0". The rougher concentrate from this test contained 33.3 per cent of sulphur and gave a recovery of 81 per cent.

Flotation with copper sulphate and amyl xanthate without modifying agent as used in test 44 resulted in concentrates containing 2 to 5 per cent less sulphur but with increased recoveries ranging from 57.5 per cent in the final concentrate with 42.5 per cent sulphur to 79.4 per cent recovery in rougher flotation with a concentrate containing 31.6 per cent of sulphur (test 55).

Several rougher flotation tests have produced recoveries ranging from 85 to 93 per cent in concentrates ranging from 28 to 30 per cent of sulphur. Details of these tests are not shown.

3. Concentration by tabling to a high grade concentrate of 48 per cent sulphur gave the very low recovery of 20.3 per cent and concentration to a lower grade concentrate of 41.7 per cent sulphur only increased the recovery to 31.6 per cent (test 38 and 12).

Details are shown of twenty-three tests in which various procedures are given. Major features shown are pre-treatments before flotation by either elutriation or flotation to remove slime. Copper sulphate was found to be necessary to activate the pyrite and reported results include flotation of the pyrite with xanthates or Aerofloats with and without the use of modifying or depressing agents. The optimum flotation conditions were difficult to maintain or repeat in the batch flotation tests reported herein.

Should it be required to demonstrate more accurately the grade and recovery obtainable and the most economic reagent requirement consideration could be given to operation of the continuous pilot flotation plant which is installed at the Departmental laboratories in Launceston.

5. The slate is very soft and breaks down to the degree shown in the table. Although grindability tests were not undertaken it is evident that the material will grind much more readily than an average medium - hard ore.

6. A test of a concentrate as a moist filtered cake showed practically no chemical instability when stored in a calico bag for 3 days as indicated by no change in temperature of the concentrate. After the test the sample was dried in an air oven at 105°C without any noted signs of oxidation. After drying, the sample contained 0.25 per cent of sulphur as sulphate.

7. Although the investigation has been extensive it may still be possible with variations to grinding and flotation treatments to further increase recovery without material reduction in grade. However, it is considered that any such possible increase would not be substantial.

8. The black colour of the slate is caused by the finest pyrite which appears to be black and does not show the usual pale yellow colour. Carbonaceous matter also contributes to the colour and quantity of this substance is indicated by the analysis which shows 3 per cent of carbon.

9. Water soluble salts of potash and soda have been stated as existing in the slate and examinations have shown that the quantities of water soluble potash and soda present amount to 0.01 and 0.02 per cent respectively. Approximately 3 per cent of water soluble compounds are present in the slate and these are mainly ferrous sulphate with a small quantity of sulphuric acid.



