Department of Mines Laboratory

Launceston, 5th August, 1954.

ORE DRESSING INVESTIGATION

R273.

Pyritic Slate - Branch Creek, Port Sorell.

C O N C E N T R A T I O N O F P Y R I T E.

Sample:

Following a request by the Ben Lomond Mining Co. Ltd., for an ore dressing investigation, a bulk sample of black pyritic slate was obtained by Geologist Mr. T.D. Hughes and submitted by the Director of Mines. The sample weighed 715 lbs.

The sample had a specific gravity of approximately 3. Pyrite is the only noted sulphide mineral and exists both in the free state and as composite grains with quartz.

In the free state pyrite crystals are generally of extremely small grain size and in specimens examined the predominant size ranged from 2 to 10 microns.

In the composite state with quartz, pyrite was present as individual small crystals in minor amounts to sometimes such a predominance of pyrite that the quartz is blackened by them. The pyrite crystals sometimes occur as appreciable aggregates which are cemented together by silica.

The sample was crushed and reduced to produce a sample for analysis with the following results:

Table 1.

	PERCENT
Sulphur, total	23.2
Sulphur as sulphate	0.6
Total iron expressed as Fe_2O_3	31.3

Analysis showing sulphide sulphur as Pyrite.

Table 2.

	PERCENT
Pyrite	42.3
Lead, Copper, Bismuth Nickel, Slenium Zinc not detected	
Arsenic	0.001
Cobalt under	0.01
SiO_2	33.6

Table 2 (continued)

Fe_2O_3	1.4 (exclusive of Fe in pyrite)
TiO_2	0.8
Al_2O_3	7.7
MgO	1.2
Na_2O	1.7
K_2O	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 percent solids with tap water of pH of 8 showed a pH value of 2.1.

Investigation:

Concentration of the pyrite was required to a general specification that the sulphur content of a concentrate should range between 42 and 50 percent.

The Ben Lomond Mining Co. later advised that a minimum grade of 47 percent sulphur was desired and enquiries by the Director of Mines resulted in the information that the grade of concentrate should be as high as possible but not below 48 percent of sulphur.

Utilization of the pyrite concentrate has been considered on a basis of sale to manufacturers of sulphuric acid.

The desired sizing specification was all minus 100 mesh with a minimum quantity of "fines". Sizing at 325 mesh Tyler has been used as the nearest screen size to that shown by the Sulphuric Acid Committee as a 43 micron aperture.

Exploratory examinations have shown that the extremely fine natural particle size of the pyrite precludes high recoveries of high grade concentrates by any known method of gravity concentration and results of concentration by careful classification and tabling are shown in this report to record the results obtained by this method.

Consideration of other possible methods of concentration has resulted in the conclusion that flotation is the most promising means of concentration

and the majority of the investigation was directed to flotation concentration tests.

A total number of sixty tests were performed in obtaining the results reported herein. Many of these tests were exploratory and progressive to determine the optium conditions for production of the desired grade of concentrate with highest recovery. The pursuit of these objectives did not favour investigation of lowest effective reagent consumptions and flotation times but it could be anticipated that the quantities of reagents and flotation times could be reduced in practice.

Details of selected results are given which show the significant features of the problems of concentration and recovery.

NOTE:

No responsibility is accepted for the results shown in this report except in so far as they apply to the sample tested.

SUMMARY.

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

Elements which could be regarded as detrimental in the manufacture of sulphuric acid are notably 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.

4.

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.

	PERCENT.		
	Weight	Sulphur	Sulphur Distribution
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 percent of sulphur with a recovery of 52.5 percent. This increased recovery may be due to the method of addition of the reagent Shiester "O". The rougher concentrate from this test contained 33.3 percent of sulphur and gave a recovery of 81 percent.

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

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

3. Concentration by tabling to a high grade concentrate of 48 percent sulphur gave the very low recovery of 20.3 percent and concentration to a lower grade concentrate of 41 percent sulphur only increased the recovery to 31.6 percent (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 tables. Although grindability tests were not undertaken it is evident that the material will grind much more readily than an average medium-hard one.

5.

6. A test of a concentrate as a moist filtered cake showed practically no chemical instability when stored in a calica 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 percent 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 percent 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 percent respectively. Approximately 3 percent of water soluble compounds are present in the slate and these are mainly ferrous and ferric sulphate with a small quantity of sulphuric acid.

TEST RESULTS.

The results of flotation tests shown in this report are typical of the features investigated and were undertaken in batch flotation machines at pulp densities ranging from 25 to 30 percent solids.

Most of the soluble salts were removed before flotation mainly as a convenient procedure as little effect on flotation was noted by non-removal of the soluble salts.

Tests No. 44, 55, 59 and 53 were undertaken with copper sulphate and xanthates. Tests 47 and 49 were undertaken with copper sulphate and Aerofloats and test 60 with Aerofloats alone. Tests 1,5,7, and 11 show the results of preflotation of carbonaceous and other gangue.

Tests 2,3,4,6, and 10 show the results of removal of slime at various rising velocities for varying periods.

Tests 12, 13, 38 and 39 show the results of table concentration.

Tests, 11, 15 and 51 indicate the results obtained with attempts to depress pyrite with alkalies and cyanide.

Sizings of ground ore, concentrates and tailings are shown.

Flotation without Modifying Reagents.

Test No. 55.

Flotation with Copper Sulphate, Amyl Xanthate, Eucalyptus Oil.

Flotation Conditions-Ball Mill Grind - Minus 100 mesh

Reagents lbs. per ton /Minutes.

	Rougher	Cleaner	Recleaner
Copper Sulphate	2/5	1/5	-
Potassium Amyl Xanthate	2/5	0.5/5	
Eucalyptus Oil	0.25	0.08	0.08
Flotation Time	/20	/10	/2.5
pH value	4		

Product	PERCENT Weight	Sulphur	Percent Sulphur Distribution
Concentrate	31.4	42.5	57.5
Cleaner Sink 2	15.0	25.6	16.5
Cleaner Sink 1	11.9	10.5	5.4
Rougher Tailing	41.7	11.4	20.6

7.

Tabulation showing the grade and recovery of concentrates in Test No.55 at initial rougher concentration and subsequent cleaner flotation.

Product.	Percent. Weight	Percent. Sulphur	Percent Sulphur Distribution.
Rougher Concentrate	58.3	31.6	79.4
First Cleaner Concentrate	46.4	37.0	74.0
Final Cleaner Concentrate	31.4	42.5	57.5

Flotation to Produce High Grade Concentrate

Test No.44.

Flotation to obtain high grade concentrate. The target for minimum grade was 47 - 48 percent sulphur. Rougher flotation followed by two stages of cleaner flotation were required to obtain the desired grade of concentrate.

Ball Mill grind - Minus 100 mesh

Flotation Conditions

Reagents lbs. per ton/Minutes.

	Rougher	Cleaner	Recleaner
Copper Sulphate	2/5	1/5	-
Potassium Amyl Xanthate	2/5	0.5/5	-
Eucalyptus Oil	0.12	0.04	-
Silester "O"	0.2	-	-
Flotation time	/20	/10	/2½
pH value	4		

In the rougher flotation the Silester "O" and Amyl Xanthate were added in two equal stages and the eucalyptus oil in four stages.

Product.	Percent. Weight	Percent. Sulphur.	Percent Sulphur. Distribution.
Concentrate	20.4	47.6	41.8
Cleaner Sink 2	11.9	32.3	16.6
Cleaner Sink 1	16.0	16.1	11.1
Rougher tailing	51.7	13.7	30.5

8.

The above concentrate contained 0.001 percent of arsenic.

The tabulation below shows the results of the three separate stages of flotation in test No.44.

Product.	Percent Weight	Percent Sulphur	Percent Sulphur Distribution
Rougher Concentrate	48.3	33.4	69.5
First Cleaner Concentrate	32.2	41.9	58.4
Final Cleaner Concentrate	20.4	47.6	41.8

Variant of Test No.44
Test No.59

Similar conditions to test No.44 with the variation of additions of Silester "O" as an alcoholic solution instead of additions of the concentrated reagent.

Product.	Percent. Weight	Percent Sulphur	Percent Sulphur Distribution.
Concentrate	26.3	46.3	52.5
Cleaner Sink 2	14.3	29.8	18.4
Cleaner Sink 1	15.9	14.8	10.1
Rougher Tailing	43.5	10.1	19.0

This test shows nearly 11 percent higher recovery and 1.3 percent lower grade concentrate than test No.44.

The tabulation below shows the results at each of the three separate stages of flotation in test No. 59.

Product.	Percent. Weight	Percent Sulphur	Percent Sulphur Distribution.
Rougher Concentrate	56.5	33.3	81.0
First Cleaner Concentrate	40.6	40.5	70.9
Final Cleaner Concentrate	26.3	46.3	52.5

Pretreatment by Attrition
Test No.53.

Ore ground to minus 60 mesh and pulped at 49 percent solids was submitted to attrition for 30 minutes and concentrated by flotation in similar manner to test No.55.

Product.	Percent. Weight	Percent Sulphur.	Percent Sulphur Distribution.
Concentrate	26.2	43.0	48.6
Cleaner Sink 2	20.2	26.1	22.7
Cleaner Sink 1	16.5	14.4	10.2

The tabulation below shows the results of the three stages

of flotation in Test No. 53.

Product.	Percent. Weight	Sulphur.	Percent Sulphur Distribution.
Rougher Concentrate	62.9	30.1	81.5
First Cleaner Concentrate	46.4	35.6	71.3
Final Cleaner Concentrate	26.2	43.0	48.6

Test No's 47,49,57 and 60: Aerofloats.

Tests under variable conditions using Cyanamid aerofloats for promotion of pyrite. Recoveries are inclined in cleaner flotation possibly by the use of reagent 242.

Test 47.

Flotation with copper sulphate, Aerofloat 242 and cresylic acid after addition of Silester "O" and Aerofloat 242 to the ball mill grinding circuit. Grind-100 mesh.

Flotation Conditions.

Reagents lbs. per ton / minutes.	Grind	Rougher	Cleaner	Recleaner.
Silester "O"	0.13		-	-
Copper Sulphate	-	2/5	1/5	0.5/5
Aerofloat 242	0.5	1.25/5	0.25/5	0.12/5
Cresylic Acid		-	0.04	0.04
Flotation Time		/20	/10	/2
pH value		4.4		

Product.	Percent. Weight	Sulphur	Percent Sulphur Distribution.
Concentrate	23.4	45.7	46.1
Cleaner Sink 2	16.0	31.5	21.7
Cleaner Sink 1	16.7	14.5	10.4
Rougher tailing	43.9	11.5	21.8

Concentrate grade and recovery of each of the three stages of flotation is as follows

Product	Percent Weight	Sulphur	Percent Sulphur Distribution.
Rougher Concentrate	56.1	32.3	78.2
First Cleaner Concentrate	39.4	40.0	67.8
Final Cleaner Concentrate	23.4	45.7	46.1

Test 49.

Flotation with Copper Sulphate, Aerofloats 25 and

10.

242 and cresylic acid frother with Silester "O" as modifier in the recleaner. Grind 100 mesh.

Flotation Conditions.

Reagents lbs. per ton/minutes.

	Rougher	Cleaner	Recleaner.
Silester "O"	-	-	0.26/5
Copper Sulphate	2/5	1/5	
Aerofloat 25	0.67/5	0.22	-
Aerofloat 242	0.56/5	-	
Cresylic Acid	0.17	0.08	0.04
Flotation Time	20	10	2.5
pH value	4		

Product.	Percent. Weight	Sulphur	Percent Sulphur Distribution
Concentrate	31.0	43.9	58.7
Cleaner Sink 2	16.0	28.4	19.5
Cleaner Sink 1	11.6	9.7	4.9
Rougher Tailing	41.4	9.5	16.9

The following table shows concentrate grade and recovery at each of the three flotation stages.

Product.	Percent Weight	Sulphur	Percent Sulphur. Distribution.
Rougher Concentrate	58.6	32.9	83.1
First Cleaner Concentrate	47.0	38.6	78.2
Final Cleaner Concentrate	31.0	43.9	58.7

The final concentrate contained 0.001 percent of arsenic.

Test 60.

A duplicate of test 49 but omitting Copper Sulphate.

11.

Product.	Percent. Weight	Sulphur	Percent Sulphur. Distribution.
Concentrate	16.3	43.0	30.2
Cleaner Sink 2	10.5	31.9	14.4
Cleaner Sink 1	18.1	19.9	15.5
Rougher Tailing	55.1	16.8	39.9

Concentrate grade and recovery at each of the three stages of flotation is as follows:-

Product.	Percent Weight	Sulphur	Percent Sulphur Distribution.
Rougher Concentrate	44.9	31.1	60.1
First Cleaner Concentrate	26.8	38.6	44.6
Final Cleaner Concentrate	16.3	43.0	30.2

Whilst concentrate grade at each stage is very similar in all three tests 60, 57 and 49, recovery in test 60 is much lower in every stage, showing the addition of Copper Sulphate to be essential for optimum recovery.

Treatment before Flotation.

Two methods were tested for removal of finest slime and carbonaceous matter prior to flotation with the object of rejection of material which would otherwise contaminate the pyritic concentrate.

The methods tested were flotation of the carbonaceous and micaceous slime with a frother and dispersion agent and results of this method are shown in 1,5,7 and 11. The other method was removal of finest slime by elutriation in water and the details including periods and rising velocities of water are shown in tests No's 2,3,4,6 and 10.

Removal of Organic Gangue by Flotation.

Test	Grind	Reagents Lbs.ton/Min. Sodium Silicate	Du Pont Frother B 23	Flotation Time Minutes	pH	Floated Product. Percent Weight	Sulphur	Sulphur Distribution
	Mesh Bs							
1	60		0.1	15	4.1	32.5	18.4	25.8
5	100	2.7/5	0.1	10	4.2	19.8	17.3	14.7
7	60	1/5	0.08	5	3.8/4.2	10.6	16.7	7.6

See also Test 11

12.

Desliming Prior to Flotation.

Test	Grind	Desliming Operation		pH	Slime Reject		
	Mesh BS	Rising Velocity M.M/sec.	Desliming Time Minutes	After Desliming	Percent Weight	Percent Sulphur	Sulphur Distribution
2	60	1.1	33	6	40.2	16.6	28.7
3	60	0.76	30	5.7	29.6	15.6	19.9
4	60	0.5	165	5.6	33.7	13.1	19.0
6	100	0.5	150	6.1	42.8	15.7	29.0
10	60	0.2	165	7	39.0	12.3	20.7

In tests 4, 6 and 10 slime removal appeared to be substantially complete. In test 10, 20 lbs. soda ash and 5 lbs sodium silicate were added prior to desliming.

Table Concentration.

Classification and concentration on laboratory Wilfley and Deister tables.

Test	Grind. To minus BS mesh.	Classification. at rising velocities M.M./sec.	Concentrate. Percent. Weight	Percent. Sulphur	Sulphur Distribution.
13	16	10 and 20	9.7	44.1	18.4
39	36	20	10.8	46.8	21.8
12	60	10 and 20	17.6	41.7	31.6
38	60	10 and 20	9.8	48.0	20.3

Sizing of Table Concentrate.

Test	38	39
+100 Bs	27.2 percent weight	33.3 percent weight
150	33.0 "	29.7 "
200	14.4 "	13.6 "
300	11.9 "	11.0 "
-300	13.5 "	12.4 "

15.

Gangue flotation with depression of pyrite.

Test 11 shows the results of flotation using lime and sodium cyanide as pyrite depressants.

The tests shows some depression of gangue as 17 percent by weight was floated in 20 minutes as compared with possibly 40 percent without these reagents. After the gangue float the pyrite was floated with copper sulphate and xanthates. Preflotation of gangue showed little if any advantage.

Test 11.

Flotation of carbonaceous matter and other gangue with frothers only after depression of pyrite with lime and sodium cyanide followed by reactivation of the pyrite with copper sulphate and flotation to a rougher concentrate only with a 2:1 mixture of sodium ethyl xanthate and potassium amyl xanthate. Grind minus 60 mesh.

Flotation Conditions.

Reagents lbs. per ton/minutes.

	ROUGHER.	
	Gangue Float.	Pyrite Float.
Lime	14	
Sodium Cyanide	0.5/5	
Eucalyptus Oil	0.34	
Du Pont Frother B 23	0.07	
Copper Sulphate	-	1/5
Mixed Xanthates	-	0.8/5
Flotation Time	/20	/10
pH value	7.8	7.8

Product.	Percent. Weight	Sulphur	Percent Sulphur Distribution.
Gangue Float	17.6	16.7	12.6
Pyrite Concentrate	33.1	36.2	51.7
Rougher Tailing	49.3	16.8	35.7

Rougher Flotation followed by Selective Depression of Pyrite.

Tests 15 and 51 show the results of attempts to depress pyrite after rougher flotation. The procedure did not show any notable advantage.

Test 15.

Flotation to a rougher concentrate with copper sulphate, a mixture of 2 parts sodium ethyl xanthate and 1 part potassium amyl xanthate and eucalyptus oil as frother followed by depression of the pyrite with lime and cyanide to permit selective flotation of organic matter and gangue.

14.

Subsequent reactivation of the pyrite with copper sulphate for flotation with mixed xanthates and eucalyptus.

Grind minus 60 mesh.

Flotation Conditions.

Reagents lbs. per ton/minutes.

	Rougher	Cleaner.	
		Gangue Float	Pyrite Float.
Lime	-	13	
Sodium Cyanide	-	0.75/5	
Copper Sulphate	1/5		1/5
Mixed Xanthates	2/5		
Eucalyptus Oil	0.25		0.75/5 0.04
Flotation Time	20	9	10
pH value	4.2	8.4	8.4

	Percent.		Percent Sulphur
	Weight	Sulphur	Distribution
Carbonaceous Matter etc.	8.0	27.3	9.4
Pyritic Concentrate	28.4	38.7	47.4

Test 51.

Flotation to a rougher concentrate with copper sulphate, amyl xanthate and eucalyptus oil followed by attempted cleaning of the rougher concentrate to sale grade by flotation of the gangue after depression of the pyrite with soda ash and sodium cyanide.

Grind minus 100 mesh.

Flotation Conditions.

Reagents lbs. per ton/minutes.

	Rougher	Cleaner.
Soda Ash	-	47
Sodium Cyanide	-	1/5
Copper Sulphate	2/5	-
Potassium Amyl Xanthate	2/5	-
Eucalyptus Oil	0.25	0.04
Flotation Time	20	5
pH value	4.6	8

14.

Product.	Percent. Weight	Sulphur	Percent Sulphur Distribution
Concentrate	28.7	41.0	50.8
Cleaner Sink	31.6	23.6	32.2
Rougher Tailing	39.7	10.0	17.0

Note the very high consumption of soda ash to raise pH to 8, and failure to depress the pyrite, which floated vigorously in the cleaner without additional promoter.

SIZINGS.

Ore After Crushing to -1 inch. Mesh.	Percent Weight,	Cum.	Crushed Ore-1 in. Soaked 2 days. Percent Wght.	Cum
+½ inch.	21.7 "	21.7	15.1 "	15.1
⅜ inch.	14.2 "	35.9	7.7 "	22.8
¼ inch.	14.1 "	50.0	10.7 "	33.5
6 B.S.	11.6 "	61.6	13.1 "	46.6
14 B.S.	15.3 "	76.9	11.0 "	57.6
36 B.S.	9.9 "	86.8	9.1 "	66.7
60 B.S.	3.9 "	90.7	5.1 "	71.8
200 B.S.	5.8 "	96.5	5.1 "	76.9
-200 B.S.	3.5 "	100.0	23.1 "	100.0

Ore - Ball Mill Grinds.

Mesh B.S.	-10 mesh feed	60 mesh Product.	85 mesh Product.	100 mesh Product.
+22	19.9 p.c.			
36	11.3 "			
44	5.1 "			
60	8.1 "	0.6 percent		
85	7.8 "	8.0 "	5.6 percent	
100	2.0 "	2.6 "	1.5 "	2.1 percent
150	2.6 "	10.5 "	9.4 "	5.7 "
200	0.4 "	10.1 "	7.1 "	5.7 "
-200	42.8 "	68.2 "	76.4 "	86.5 "

16.

Concentrates

Concentrates No's 16 and 44 are flotation concentrates and No.38 is a table concentrate.

Test.	16.	38.	44.
Grind,mesh	60	60	100
Sulphur,percent	39.1	48.0	47.6
Sizing +100 mesh B.S.	8.2percent	27.2percent	0.4 %
150 " "	11.5	33.0	2.9
200 " "	6.7	14.4	4.2
325 " Tyler	13.2	20.2	14.8
-325 " Tyler	60.4	5.2	77.7

The approximate relationship between infrasizer fractions and Tyler 325 mesh screen products for concentrate from test 44 is shown below.

44.

	Weight Percent	Percent Cum.	
+200 mesh B.S.	7.5.	7.5	Equivalent pyrite size + 76 microns
Infrasizer Fraction 1	9.7	17.2	Equivalent pyrite size + 41 microns
" " 2	9.6	26.8	Equivalent pyrite size + 29 microns
" " 3	9.6	36.4	Equivalent pyrite size + 20 microns
" " 4	8.6	45.0	Equivalent pyrite size + 15 microns
" " 5	9.0	54.0	Equivalent pyrite size + 10 microns
" " 6	11.3	65.3	Equivalent pyrite size + 7 microns
" " 7	34.7	100.0	Equivalent pyrite size - 7 microns
+200 mesh B.S.	7.5	7.5	Equivalent pyrite size + 76 microns
+325 " Tyler	14.8	22.3	Equivalent pyrite size - 76 + 43 microns
-325 " Tyler	77.7	100.0	Equivalent pyrite size - 43 microns

If test 44 concentrate was clean pyrite, the amount of Infrasizer 1 fraction plus all coarser material would closely approximate the amount of plus 325 mesh material since the bottom limit for pyrite in Infrasizer 1 fraction is about 41 microns whilst the aperture of the Tyler 325 mesh screen is 43 microns. The discrepancy between the two totals 17.2 and 22.3 is due in part to gangue contamination in the concentrate.

17.

Tailing.

The following tabulation shows the distribution of sulphur of a rougher tailing. The grind was minus 60 mesh and recovery by rougher flotation amounted to 76 percent. This sizing indicates the necessity for finer grinding and most of the later tests were undertaken on minus 100 mesh ore.

Sizing Analysis of -60 mesh Tailing.

Mesh B.S.	Percent. Weight	Percent. Sulphur.	Percent Sulphur. Distribution.
-60 + 85	10.2	26.4	19.2
100	4.1	25.2	7.4
150	16.5	24.3	28.6
200	6.4	21.4	9.8
I.S. 1	3.8	19.5	5.3
2	4.3	13.9	4.3
3	4.6	11.2	3.7
4	3.1	9.2	2.0
5	3.1	8.7	1.9
6	3.8	8.9	2.4
7	40.1	5.4	15.4

Mineragraphic examinations show that all of the pyrite in the tailing is of smaller grain size than the aperture of a 200 mesh screen or in other words the fractions shown above plus 200 mesh size exist as composites with gangue. Ninety six percent of the grains were smaller than 50 microns.

Sgd. W. St.C. Manson.

CHIEF CHEMIST & METALLURGIST

ORE DRESSING INVESTIGATION

R.273.

Appendix I.

Original Report 5/8/54

PYRITIC SLATE, BRANCH CREEK.

At the request of the Ben Lomond Mining Co., tests were conducted with variants to the work published in the original report.

Variations to quantities of reagents were also tested to indicate commercial requirements.

Coarser Grind.

Minus 60 mesh grind as compared with previously reported minus 100 mesh grind.

Recleaner Concentrate	Test 44.	Test 61.
Percent sulphur	47.6	42.3
Percent recovery	41.8	54.1

The first cleaner concentrate of test 44 contained 41.9 percent of sulphur with a recovery of 58.4%. The comparison indicates no advantage provided a 40 percent sulphur is the grade sought but finer grinding results in a higher grade concentrate.

The concentrate from the minus 60 mesh ore was not sized but would be reasonably similar to the concentrate produced from ore ground to minus 100 mesh size.

Secondary grinding and flotation.

Sizing analysis of rougher tailings have indicated losses in plus 200 mesh fractions. This suggests causes such as coatings on the pyrite or that the pyrite is still attached to gangue minerals and reduces floatability.

Tests were conducted by flotation of minus 60 mesh ore followed by regrinding of the rougher tailing to minus 200 mesh size and re-concentration. Although recoveries are increased by this procedure, grade of concentrate dropped due to the low grade of the concentrate from retreatment of the tailings.

Test 70 shows a recovery of 57.2 percent increased to 69.1 percent by regrinding and reflotation of rougher tailings. However, the grade of concentrate dropped from 41.6 percent sulphur to 40.6 percent sulphur.

	Percent.		
	Weight	Sulphur	Recovery
Primary Recleaner Concentrate	31.9	41.6	57.2
Secondary " "	7.6	36.2	11.9
Total " "	39.5	40.6	69.1

Sea Water

Test 68 and 69 are identical except that in 69 sea water was used for grinding and flotation and in test 68 Launceston Municipal supply water was used. The pH value of the sea water was 7.5 and Municipal supply ranges from pH 7 to 8. pH values in rougher flotation ranged from 3.4 to 3.8 and in recleaner flotation 4.2 to 4.4.

Flotation reagents

Rougher 2 lbs copper sulphate, 2 lbs amyl xanthate and 0.5 lbs cresylic acid.

Cleaner 1 lb copper sulphate, 0.5 lb amyl xanthate and 0.1 lb cresylic acid.

Recleaner 0.05 cresylic acid.

	Test Number 68		69	
	Percent Sulphur	Recovery	Percent Sulphur	Recovery
Recleaner Concentrate	41.7	62.2	38.7	74.6
Cleaner Concentrate	36.3	79.3	34.3	82.6
Rougher Concentrate	31.5	83.0	28.3	90.4

The results show that higher recoveries and lower grade concentrates were obtained when using sea water. The degrees of variations are somewhat minor to determine any specific virtue in the use of sea water. However, the test work shows sufficient inducement to give consideration to the use of either fresh or sea water in consideration of commercial treatment of the pyritic slate.

Frothers

Eucalyptus has been used in the majority of tests and a comparison with cresylic acid was desired. The results of the tests shown below are very similar indicating little difference between the two frothers. The appearance of the froth obtained with cresylic acid gives the impression of higher grade concentrate. Choice of the frother would be a matter of economics.

Tests at minus 60 mesh grinds.

Constant flotation conditions

	Reagents lbs ton/Minutes	
	Rougher	Cleaner
Copper sulphate	2	1
Amyl xanthate	2	0.5
Silester 0	0.26	
Flotation time	/20	/10

Recleaner flotation 2½ minutes without additional reagents.

	Test 61	Test 66
Eucalyptus	0.12 lb/ton	
Cresylic acid T.D.		0.2 lb/ton
Recleaner Concentrate		
Recovery, percent	54.1	54.7
Sulphur, per cent	42.3	43.0
Rougher Concentrate		
Recovery percent	84.1	79.7
Sulphur, percent	28.6	29.3

Removal of soluble salts prior to flotation

Comparable tests were conducted us ing copper sulphate, amyl x anthate and cresylic acid. In one test the water soluable salts were removed by repulping and filtration

Grades of recleaner concentrates were each 42.3 percent sulphur and recovery after removal of water soluble salts was 2.6 percent higher than without removal of salts. There is an indicated saving in reagent with prior removal of salts and this feature could only be properly assessed by continuous plant operation. The indicated economy was of the order of 2/- per ton.

Application of removal of water soluble salts in commercial practice would be by mechanical thickening for virtually clear overflow to waste or filtration and repulping. In either method an appreciable capital cost would be involved.

Minimum reagent consumption

Tests were conducted to indicate the probable minimum reagent consumption for desired results. Major reagent consumption takes place in rougher flotation and tests shown below are for batch rougher flotation only. All rougher concentrates contained from 28 to 29 percent sulphur. Reagents expressed as lbs per ton.

These rougher floats suggest that:-

(a) 1 lb of copper sulphate appears to be adequate showing a small improvement over 0.5 lb and no appreciable inferiority to 2 lbs.

(b) Using 1 lb of copper sulphate and 1 lb of either, aerofloat 25, ~~aerofloat 25~~, aerofloat 242 or potassium amyl xanthate should give much the same recovery and grade i.e. 80 percent recovery with a rougher concentrate containing about 30 percent of sulphur.

(4)

In addition to these reagents less than 0.2 lb per ton of frother is required and very small quantities of copper sulphate and promoter in cleaner flotation for production of higher grade concentrate.

Variable Promoter	VARIABLE COPPER SULPHATE		
Aerofloat 25	0.5	1.0	2.0
	PERCENT	RECOVERY	
0.5	74.2	80.7	-
1.0	77.4	77.4	82.9
1.5	76.4	80.0	78.9
2.0	76.1	82.4	82.5
Aerofloat 242			
0.5	74.5	77.4	75.1
1.0	75.4	79.9	83.1
1.5	78.9	81.0	73.9
2.0	-	82.5	84.7
Potas. Amyl Xanthate			
0.5	77.4	79.0	-
1.0	82.4	81.2	-
2.0	-	-	84.0

Concentrate of 40 - 42 percent sulphur

The following tests indicate best results with an objective of 40-42 percent sulphur in the concentrate. There is a very significant improvement in potential economics by production of lower grade concentrate as reported in R273 of 5/8/54. Whereas with a target of 47 - 48 percent of sulphur in final concentrate the yield amounted to approximately twenty (20) percent of the slate. The lower grade concentrate amounted to twice this quantity. Recovery of sulphur units in the higher grade concentrate amounted to about 40 percent and in the lower grade concentrate recovery ranged from 65 - 70 percent.

Thus to produce concentrate equivalent to 1 ton of sulphur (Brimstone) it is indicated that 10.3 tons of slate would be processed if a 47 percent concentrate was required and if a 40 percent sulphur concentrate was required the treatment of only 5.95 tons of slate is indicated.

(5)

Shown below are typical results

Grind	-100 mesh	-100 mesh	-60 mesh
Copper sulphate	3 lbs	3 lbs	1.5 lbs
Aerofloat 25	1.02 "	0.72 "	-
Aerofloat 242	0.56 "	0.60 "	-
Amyl Xanthate			1.25 "
Cresylic acid	0.29 "	0.48 "	0.3 "
Silester "O"	0.26 "	0.26 "	-
Concentrate, percent	40.7 "	37.4 "	36.5 "
Concentrate, percent S	41.3 "	41.5 "	41.6 "
Concentrate, percent recovery	72.4 "	66.9 "	65.4 "

The amounts of copper sulphate in the first two tests are probably un-necessarily large. In the -100 mesh grind aerofloats gave best results and with -60 mesh grinds amyl xanthate was superior.

W. St. C. Manson

CHIEF CHEMIST & METALLURGIST

(21/10/54)

ORE DRESSING INVESTIGATION

R 276

Pyritic Slate, B ranch Creek, Port Sorell

Concentration of Pyrite

Sample

During September a sample of slate was obtained from Branch Creek. This sample was obtained from the same place as sample R 273.

Investigation

Investigation No. 273 had been conducted over a period of two months and it was desired to obtain a fresh sample to check on the results obtained with sample R 273. The results herein should be read in conjunction with ore dressing investigation No. 273.

The sample contained 23 percent of sulphur of which 0.32 percent was present as sulphate. The pH of the ore with distilled water was determined as 2.25.

All tests were undertaken at minus 60 mesh size.

Rougher flotation tests - by closed circuit ball mill grinding.

All rougher float concentrates contained from 30.1 to 30.9 percent of sulphur except with 1 lb of amyl xanthate when the concentrate contained 32.5 percent of sulphur. Copper sulphate used in all rougher floats amounted to 1 lb per ton and Frother, cresylic acid variable and up to 0.35 lb per ton. The promoters used were amyl xanthate and a 1 : 1 mixture of AF 25 and AF 242.

	Sulphur Recovery Percent				
Promoter	0.5 lb	0.75 lb	1 lb	1.5 lb	2.0 lb
Amyl Xanthate	67.9	74.6	79.9	82.8	80.5
AF25 + AF242 (1:1)	69.1	75.2	70.4	72.8	74.1

Work on R273 indicated that better results were obtained with aerofloats treating minus 100 mesh ore and with minus 60 mesh ore amyl xanthate gave the better results.

Commercial milling might be developed using aerofloats as the major promoter with a minor quantity of amyl xanthate as a scavenger reagent in rougher flotation.

Recleaner concentration

Flotation conditions

Reagents lbs/tons

	Rougher	Cleaner	Recleaner
Copper sulphate	1	0.25	-
Cresylic acid	0.35	0.05	0.05
Flotation time, minutes	20	10	2½

Variable promoter.

K. Amyl xanthate Test 11 - 0.5 lb, Test 12 - 1 lb, Test 13-2lbs

	TEST NUMBER		
	11	12	13
Recleaner Concs.%S	43.6	43.1	41.5
Recleaner Concs., Percent Recovery	51.6	55.6	60.1
Cleaner Concs., %S	39.3	36.6	38.0
Cleaner Concs., Percent Recovery	59.2	71.9	67.2

Results with R 273 were slightly better than those obtained in this test and shown below for comparison are two tests of similar grade concentrate.

Recleaner Concs.	R273/76	R276/13
Percent sulphur	41.6	41.5
Percent recovery	65.4	60.1

Summary

The test work with the fresh sample does not show any sensible change in the nature of the slate for concentration by flotation.

Sizing analysis of -60 mesh ore

Fraction B.S.	Percent
-60 +100	12.1
+150	15.1
+200	7.5
-200	65.3

(3)

Sizing analyses of Recleaner Concentrates

Fraction		from Minus 100 mesh ore R273/44		from Minus 60 mesh ore R276/14 & 15	
		Weight		WEIGHT	
		Percent	Cum.	Percent	Cum.
-60 + 100				6.1	6.1
+ 150				10.5	16.6
+ 200		7.5	7.5	5.6	22.2
I.S.	1	9.7	17.2	7.1	29.3
	2	9.6	26.8	7.0	36.3
	3	9.6	36.4	7.5	43.8
	4	8.6	45.0	6.4	50.2
	5	9.0	54.0	6.4	56.6
	6	11.3	65.3	8.5	65.1
	7	34.7	100.0	34.9	100.0

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