

TR2-164-168

R. 315

NICKEL ORE—BEACONSFIELD

Hydrometallurgical Extraction of Nickel

Sample

Samples of nickel bearing rocks were received from Mr. T. D. Hughes from leases owned by the Ben Lomond Mining Company at Anderson's Creek near Beaconsfield. The samples were analysed for nickel, and this sample was selected by the Ben Lomond Mining Company for extraction tests and contained 0.82%. The rock is serpentine, and the nickel mineral is a silicate, probably garnierite. Analysis of the nickel minerals and rocks are shown in C.S.I.R.O.'s Mineragraphic Investigation No. 682, February, 1957 (Nickeliferous Serpentine and Rodingite).

Analysis of the Sample

	Percent
SiO ₂	43.04
Al ₂ O ₃	0.19
Fe ₂ O ₃	4.75
FeO	0.96
MnO	0.30
TiO ₂	Nil
CaO	Nil
MgO	35.38
Cr ₂ O ₃	0.38
Loss on Ignition	14.44
Nickel	0.82
Cobalt	0.02
As, Cu, Bi, Pb	Nil
Sulphur	Trace

Investigation

The Ben Lomond Mining Company requested an investigation to determine the extractions of nickel obtainable by boiling the ground ore with dilute sulphuric acid for a period of four hours, and the effect of the addition of common salt on extraction. The treatment appreciably attacks the rock as well as the nickel mineral, and it was requested that the extracts be processed to selectively precipitate the iron and nickel with caustic soda to determine the quality of the nickel product and quantities of reagents required. In addition variations to the strength and type of acid were tested. Retreatment of residues and fineness of grind were also investigated.

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

Summary

1. Both the nickel mineral and the rock are attacked by boiling dilute sulphuric acid and extractions of the nickel have been obtained ranging from 45.9 to 88.5%.

The quantities of sulphuric acid used in these tests range from 352 to 1980 lb. per short ton of rock. Details of these results are shown in tables.

2. All tests reported, other than Test 11, were made on material crushed to — 16-mesh B.S. size and results with the two grinds are very similar as follows:—

	lb. H ₂ SO ₄	Nickel Extraction %
Test 6	660	65.6
Test 11	660	66.6
Test 6A	1320	79.9
Test 11B	1320	80.3

3. The effect of common salt is shown by comparison of Tests 5 and 6.

	lb. H ₂ SO ₄	Salt lb.	% Nickel Extraction
Test 5	660	Nil	64.4
Test 6	660	126	65.6

4. Selective precipitation of iron and nickel with caustic soda is effective as only 0.8% of the nickel in solution remained in the iron precipitate, and 99.9% of the iron was precipitated at a pH value of 3. At a pH value of 8.5, 94.5% of the nickel was precipitated in a product which contained 55.7% of nickel after ignition and 0.1% of iron.

Research

Exploratory tests were undertaken and selected results are reported which show the major features of interest in sulphuric acid extraction of the nickel.

All tests were undertaken by boiling at atmospheric pressure for a period of four hours. The pulps were filtered and washed with 1% sulphuric acid.

The sample was ground to two sizings for the tests.

1. —16-Mesh B.S. Size

Sizing Analysis

	Percent		Percent Distribution
	Weight	Ni	Ni
-16 + 25.. ..	23.9	0.86	24.8
+ 44.. ..	21.2	0.75	19.2
+ 60.. ..	8.9	0.83	8.9
+100.. ..	11.9	0.76	10.9
-100.. ..	34.1	0.88	36.2

2. Fine Grind 79% — 200-Mesh

Test Details

Test No.	Grind No.	Reagents			Nickel Extraction
		Lb. per Short Ton of Ore			
		H ₂ SO ₄	Water	Salt	Percent
2	1	352	3,650	126	45.9
2A	1	660	3,340	126	27.8
2 + 2A	..	..	..	..	73.7
5	1	660	3,340	Nil	64.0
6	1	660	3,340	126	65.6
6A	1	660	3,340	126	14.3
6 + 6A	..	..	..	..	79.9
8	1	660	3,340	126	45.8
9	1	660	3,340	Nil	66.2
3	1	1,210	2,792	126	77.6
11	2	660	3,340	126	66.6
11A	2	660	3,340	126	13.7
11B	2	660	3,340	126	8.2
11 + 11A	..	..	..	..	80.3
11 + 11A	..	..	..	..	..
+ 11B	..	..	..	..	88.5

In Test 9 the acid was added in concentrated form and after heating for two hours water was added and the pulp boiled for a further two hours.

Test 2A, 6A, 11A and 11B are consecutive tests where the residues from the previous tests were given further treatments. Test 8 was given a preliminary calcination at 560° centigrade for half an hour. A test with 550 lb. of commercial hydrochloric acid and 3550 lb. of water per short ton of ore is shown for comparison.

Weights of Residues from Acid Extractions

Test No.	Percent of Ore
2	88.1
2A	70.6
5	76.7
6	78.2
6A	61.6
8	76.8
9	78.7
3	70.0
11	79.3
11A	61.7
11B	50.0
13	77.0

Analysis of acid solution after treatment of ore with 660 lb. of acid, 3340 lb. of water and 126 lb. of common salt per short ton of ore.

	<i>Lb. Short Ton Extracted</i>
Ni	9.2
SiO ₂	1.4
Fe	10.2
MnO	1.2
MgO	259.4

**Test 3. Residue
Sizing Analysis**

<i>Fraction</i>	<i>Percent</i>		<i>Percent Distribution</i>
	<i>Weight</i>	<i>Ni</i>	<i>Ni</i>
- 16 + 25.. .. .	23.1	0.28	29.7
+ 44.. .. .	20.9	0.23	22.0
+ 60.. .. .	9.0	0.20	8.3
+100.. .. .	13.9	0.20	12.7
-100.. .. .	33.1	0.18	27.3
Composite	100.0	0.22	100.0

Precipitation of Nickel from Acid Solution

Procedure.—Solution heated to near boiling. Oxidation of iron by addition of chloride of lime.

Partial neutralization of residual sulphuric acid with caustic soda and selective precipitation of iron by addition of caustic soda to pH value of 3.0, removal of ferric hydrate by filtration and precipitation of the nickel as hydrate by further addition of caustic soda to pH value of 8.5.

Addition of Reagents

	Lb Reagents per short ton of Ore
Chloride of lime	10
Caustic soda to precipitate iron	55.5
Caustic soda to precipitate nickel	19.5

94.5% of the nickel was recovered from the solution, and the ignited precipitate contained 55.7% of nickel. The precipitate amounted to 17 lb. weight per short ton of ore. The ignited iron precipitate amounted to 15.6 lb. per short ton of ore and contained 0.48% of nickel, and 90.2% of iron oxide. The filtrate from the nickel precipitate contained 0.004% of nickel, or 4.7% of the total in solution.

Nickel and Iron Distribution from Treatment of Acid Solution

Nickel in iron precipitate	0.8
Nickel in nickel precipitate	94.5
Nickel in filtrate	4.7
Iron in iron precipitate	99.9
Iron in nickel precipitate	0.1