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HEAVY SANDS INVESTIGATIONS.

SECOND REPORT.

THE RECOVERY OF MONAZITE FROM MOANA BEACH SAND.

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HEAVY SANDS INVESTIGATIONS.

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THE RECOVERY OF MONAZITE FROM MOANA BEACH SAND.

-Abstract-

The treatment of Moana Beach sands has been investigated further with the object of recovering monazite. Further work is recommended.

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1. SUMMARY.

The production of a monazite concentrate from the Moana Beach Sand deposit has been investigated.

The raw materials used in the investigation were:

(a) A primary gravity concentrate.

(b) A monazite concentrate prepared previously from a sample of the beach sand.[1].

Combined magnetic and table concentration tests on a Humphrey spiral concentrate gave the following results:

(i) Almost complete recovery of the monazite in a concentrate which was 0.8 percent by weight of the original beach sand and contained 5.1 percent rare earths.

(ii) Sixty-nine (69) percent recovery of the monazite in a concentrate which was 0.33 percent by weight of the original sand and contained 8.3 percent rare earths.

Flotation tests on a monazite concentrate from previous tests showed that some separation of zircon and monazite could be effected.

Further work on the production of a monazite concentrate is recommended.

2. INTRODUCTION.

Previous work for the production of market grade rutile, zircon and monazite concentrates from Moana Beach sands was not successful.

The present investigation was confined solely to the production of a monazite concentrate.

3. MATERIAL EXAMINED.

The primary gravity concentrate referred to in the summary was prepared by passing the original beach sand through a Humphrey spiral concentrator. This primary concentrate, which was 19.4 percent by weight of the total sand and contained 0.7 percent by weight of monazite, was used for combined magnetic and table concentration tests.

The monazite concentrate used for flotation testing was prepared by bulking several monazite concentrates produced in previous tests.(1). The mineral composition of this product was:

Mineral.	Weight Percent.
Monazite.	49
Opaques, zircon rutile garnet and miscellaneous silicates.	51
TOTAL.....	100

4. EQUIPMENT.

The main laboratory equipment used consisted of the following:

(a) Stearns (Pick-up-type) magnetic separator.

(b) Wilfley table.

(c) 200 gram Fagergren flotation cell.

5. EXPERIMENTAL PROCEDURE and RESULTS.

5.1 Combined magnetic and table concentration of monazite from a primary gravity concentrate.

The object was to ascertain the maximum possible recovery of monazite from the primary gravity concentrate referred to in Section 3.

5.1.1 Magnetic separation of the primary gravity concentrate.

Previous work had shown that monazite separates into the non-magnetic fraction from low intensity magnetic separation. It was decided to pass the primary gravity concentrate through a Stearns pick-up-type magnetic separator to remove the strongly magnetic minerals, namely magnetite, ilmenite, hematite and garnet.

The conditions under which the separation was made and the results of the separation are shown in Tables 1 and 2 respectively.

TABLE 1.

Conditions of Magnetic Separation.

Feed rate.	6 lb/inch/hour.
Current.	1.2 amps.
Belt speed.	40 ft./minute.
Disc peripheral speed.	80 ft./minute.
Height of Disc -leading edge.	3/32 inch.
" " " -trailing edge.	1/8 inch.

TABLE 2.

Results of Magnetic Separation.

Fraction.	Weight percent of Original Beach Sand.	Percent Rare Earths.
Magnetics.	10.7	-
Non-magnetics.	8.7	0.6 (calculated).
FEED (Gravity conc.)	19.4	0.3

As no rare earths were reported in the magnetic fraction, it was not considered necessary to have the non-magnetic fraction assayed. The assay for rare earths was substituted for the mineralogical counts owing to the difficulty in obtaining a satisfactory material balance with the latter method.

5.1.2 Gravity concentrate of the non-magnetic fraction from Section 5.1.1.

Two tabling tests were conducted on the non-magnetic fraction from Section 5.1.1 to ascertain:

(a) The maximum recovery of monazite.

(b) The maximum grade of monazite concentrate.

In the first test, concentrate, middling and tailing fractions were produced, the concentrate fraction being taken at a point considered to give a maximum recovery of monazite.

In the second test, four tabling steps were employed, with the tailing from each stage forming the feed to the next stage. From each of the first three stages a small weight of concentrate was removed with the object of producing high grade monazite fractions. In the fourth stage two larger concentrates were removed.

The conditions and results of the two tests are given below in Tables 3 and 4 respectively.

TABLE 3.

Conditions of Wilfley Table Tests.

	Test 1.	Test 2.
Feed rate (dry solids).	45 lb/hr.	25 lb/hr.
Total water addition.	150 galls/hr.	160 gall/hr.
Length of stroke.	0.5 inches.	0.5 inches.
Frequency of stroke.	250 strokes/min.	270 strokes/min.

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TABLE 4.

Results of Wilfley Table Tests.

Test.	Fraction.	Weight Percent of Orig. Beach Sands.	Rare Earths. Percent.	Rare Earths. Distrib. Percent.	Rare Earths. Cum. Distrib. Percent.
1.	Concentrate.	0.8	5.1	100.0	100.0
	Middling.	1.4	tr.		
	Tailing.	6.5	-		
	FEED (Non-Mag. Fraction.)	8.7	0.5		
2.	Concentrate 1.	0.05	18.3	18.5	18.5
	2.	0.06	15.6	19.0	37.5
	3.	0.03	14.2	8.6	46.1
	4.	0.19	6.1	23.4	69.5
	5.	0.72	2.1	30.5	100.0
	Tailing.	7.65	N.D.		
	FEED (Non-Mag. Fraction).	8.7	0.6		

The results of Test 1, indicate that most of the monazite in the primary gravity concentrate can be recovered by combined magnetic and table concentration in a product representing 0.8 percent weight of the original sand and containing 5.1 percent rare earths. The attempts in Test 2 to produce a high grade concentrate were not successful. Although a concentrate containing approximately 15 percent rare earths and representing 0.14 percent of the original beach sand was produced the recovery of rare earths was only 46 percent.

5.2. Further concentration of a monazite concentrate by flotation.

The common methods of concentration of monazite are gravity, magnetic and high tension separation. It was decided to examine the possibility of concentrating monazite by flotation using two patented methods covering the separation of monazite and zircon. In each case the zircon is floated from the monazite, leaving a monazite rich tailing.

Several preliminary tests were made of each method but due to the shortage of suitable feed material it was impossible to determine the best conditions for optimum separation.

A small quantity of monazite concentrate previously produced from Moana Beach sand was available and was used as feed for all flotation tests.

The results of a test of each method are given in Table 5.

As it was considered important to establish the zircon/monazite selectivity, the flotation fractions were examined mineralogically, in preference to chemical analysis.

The conditions under which the tests were carried out are given below:

Test 1.

The flotation feed was washed with 5 percent hydrochloric acid, and then with a 0.2 percent solution of sodium oleate. The material was then washed with water and floated in the flotation cell.

Test 2.

The flotation feed was conditioned with 0.1 percent sodium hydroxide solution and enough pine oil to give a copious froth. Alternate additions of solutions of sodium oleyl sulphonate and oleic acid were made until the zircon commenced to float. Additions were continued until the froth darkened, at which stage a second concentrate, referred to as a zircon middling was taken.

TABLE 5.

Results of Flotation Tests.

Test No.	Fraction.	Weight Percent	Zircon Percent	Monazite Percent	Zircon Distrib. Percent	Monazite Distrib. Percent
1.	Zircon conc.	13.9	92.0	5.4	38.6	1.4
	Tailing.	86.1	23.6	60.5	61.4	98.6
	FEED.	100.0	33.1	52.8	100.0	100.0
2.	Zircon conc.	3.7	95.4	1.6	12.6	0.1
	Zircon middl.	23.2	44.0	30.0	34.5	12.7
	Tailing.	73.1	21.4	65.2	52.9	87.2
	FEED.	100.0	29.6	54.7	100.0	100.0

Definite trends are shown by the results of both flotation tests. In each case zircon is preferentially floated although the distributions of zircon in the concentrate fractions are low, and as a consequence the ratio of enrichment of monazite in the flotation tailing is low. However, the results warrant further work.

6. OBSERVATIONS and CONCLUSIONS.

The work reported in Section 5.1 of this report, for the recovery of monazite from a primary gravity concentrate indicates that most of the monazite can be recovered with a ratio of concentration of approximately 100 to 1.

The method of treatment adopted to give this result was much simpler than that used for the work reported in R.D. 66, First Report. However, this simplified flowsheet did not take into account the zircon and rutile content of the sand and no attempt was made to recover these two minerals.

Because of the limited amount of monazite concentrate available for testing, only preliminary flotation tests were conducted; but definite trends were established and further work is desirable.

7. RECOMMENDATIONS.

The investigation of this deposit to produce a marketable monazite concentrate should continue.

The object of test work reported previously was to produce saleable rutile, zircon and monazite concentrates. It was not possible to do this with the relatively complex flowsheet adopted. If, however, the main consideration is the recovery of monazite the following simplified procedure can be adopted.

(a) Primary gravity concentration using Humphrey spirals.

(b) Secondary gravity concentration using Wilfley tables with the object of producing a concentrate containing all of the monazite at the highest grade possible.

(c) High tension separation of the final gravity concentrate to produce a monazite/zircon non-conductor fraction.

(d) High intensity induced roll magnetic separation to produce a magnetic fraction containing the monazite.

(e) Flotation as an alternative or supplement to step (d)

Such a flowsheet (Vide Appendix 1) neglects the possibility of producing rutile or zircon at market grade, but in view of the present low market prices for these two minerals it may be more economic to adopt a simple flowsheet and consider the deposit purely as a source of monazite.

(1) REFERENCE..

The following report covers previous work mentioned in this report.

(a) R.D. 66 - First Report - Recovery of monazite rutile and zircon from Moana Beach sands.

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APPENDIX 1.

Recovery of Monazite from Moana Beach Sand.

Beach Sand.

Trash Screen.

Undersize.
Monazite. Magnetite.
Rutile. Limonite.
Zircon. Garnet.
Hematite. Heavy Silicates.
Ilmenite. Quartz.

Oversize.
Reject.

Humphrey Spiral.

Rougher Conc.
Monazite. Ilmenite.
Rutile. Magnetite.
Zircon. Limonite.
Hematite. Garnet.

Rougher Tailing.
Reject.
Heavy Silicates.
Quartz.

Wilfley Table.

Final Gravity Conc.
Monazite.
Magnetite.
Ilmenite.
Hematite.
Zircon.
Rutile.

Tailing.
Reject.
Rutile.
Garnet.
Limonite.

High Tension Separator.

Conductors.
Magnetite.
Ilmenite.
Hematite.
Rutile.

Non-conductors.
Monazite.
Zircon.

High Intensity Magnetic Separator.

Magnetic.
Monazite.

Non-Magnetic.
Zircon.

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