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MINES BRANCH INVESTIGATION REPORT

IR 70-56 September, 1970

THE RECOVERY OF HEAVY MINERALS FROM A SAMPLE OF PRECONCENTRATED BEACH SAND FROM SABLE ISLAND, NOVA SCOTIA

by

G.O. Hayslip

Mineral Processing Division

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THE RECOVERY OF HEAVY MINERALS FROM A SAMPLE OF PRECONCENTRATED BEACH SAND FROM SABLE ISLAND, NOVA SCOTIA

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SUMMARY OF RESULTS

From a sample of preconcentrated beach sand, 6.28% of the material was recovered in a concentrate containing 55.6% TiO_2 and 10.36% of the material was recovered in another concentrate containing 36.1% TiO_2. Also, 2.52% of the material was recovered as a zircon concentrate containing 52.65% ZrO_2.

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INTRODUCTION

The purpose of the investigation was to determine the amounts of heavy minerals present in the sand and to explore various methods of recovering these minerals.

Shipment

A 300-lb sample of preconcentrated beach sand was received from Lakefield Research of Canada Limited at the request of Mr. N.H. Ursel, President, Sable Island Mines Limited, Suite 801, 85 Richmond Street West, Toronto 1, Ontario.

Origin of Sample

The sample received at the Mines Branch had been riffled out of a larger sample received by Lakefield Research. This larger sample, in turn, was said to have been concentrated from beach sand at a ratio of concentration of approximately 4 to 1. The origin of the beach sand was Sable Island which is about 100 miles off the coast of Nova Scotia.

Sampling and Analysis

No sampling was done on the original shipment. Samples were riffled out of the products, produced, for mineralogical studies or chemical analyses. All chemical analyses were done by Bondar-Clegg & Company Ltd., 768A Belfast Road, Ottawa, Ontario.

Characteristics of the Material

The grains of sand ranged from 35 to 100 mesh in size. Nearly all of the grains were rounded and worn so that their crystal form could not be determined by visual means. Identification of individual grains was usually done by X-ray diffraction studies.

The principal minerals present were quartz, garnet, ilmenite, diopside, hornblende, zircon, feldspar, and rutile. Of these minerals those most difficult to distinguish between were some garnet, ilmenite, and rutile. Garnet ranged in colour from pale translucent pink to an almost opaque, brownish black. Rutile ranged from an opaque black to translucent light red or brown. It is also suspected that some rutile is colourless and has not been distinguished from zircon.

OUTLINE OF INVESTIGATION

The standard procedure for treating this type of material is to concentrate the heavy minerals by gravity methods and then separate the different heavy minerals according to their electrical properties. Thus the sand was tabled to reject most of the quartz and feldspar.

The usual method of treating the heavy minerals is to dry the material and treat it using an electrostatic separator. As the table concentrate was already wet, it was decided to attempt to make an initial separation using wet high-intensity magnetic separation. This procedure was not successful, so a dry, high-intensity magnetic separation procedure was used. Further separations of the different products were made using an electrostatic separator. Final cleaning of the products was done by a variety of methods including flotation, tabling and additional magnetic separations.

Tabling

The sand was fed to a laboratory model, Deister shaking table at a feed rate of approximately 100 pounds per hour. Concentrate, middling, and tailing products were made; the middling product was repassed to make another set of products and the concentrates and the tailings from each pass were combined.

TABLE 1

Results of Tabling Test

Product	Weight %	TiO_2 %	Distn % TiO_2
Table conc	44.23	18.4	98.9
" midd	2.95	1.0	0.3
" tail	52.82	0.12	0.8
Feed (calcd)	100.00	8.23	100.0

High-Intensity Magnetic Separation

Tests were made passing some of the table concentrate through the Jones wet high-intensity magnetic separator but the results were poor. To make a clean separation it was necessary to make several passes of material through the separator. It was decided, therefore, to dry the material and pass it over a Wetherill dry high-intensity magnetic separator. This machine can make three separate concentrates, each one resulting from a higher magnetic field, and a non-magnetic tailing. The first concentrate produced contained any magnetite present plus ilmenite and a small amount of garnet and was kept separate. The second and third concentrates, each containing ilmenite and garnet, were combined and treated together.

TABLE 2

Results of High-Intensity Magnetic Separation Test

Product	Weight % orig feed	TiO_2 %	Distn % TiO_2 in test
No. 1 mag conc	3.54	39.8	18.7
No. 2 mag conc	35.16	16.0	74.8
Non-mag tail	5.53	8.85	6.5
Feed (calcd)	44.23	17.01	100.0

The No. 1 magnetic concentrate was cleaned by passing it over a Carpco electrostatic separator to make a TiO_2 concentrate, a middling and a tailing. The middling product was repassed and the concentrates were combined. The middling from the second pass and the two tailings from the electrostatic separation were added to the No. 2 magnetic concentrate.

The No. 2 concentrate was passed over the Carpco electrostatic separator to make a TiO_2 concentrate, a middling, and a garnet tailing. The concentrate and tailing were repassed to improve the grade of each product. The reject material from each pass was added to the middling which was repassed several times, each time recovering a portion of concentrate and tailing material. A small quantity of middling material was left finally. This operation would be simplified in a continuous operation by recirculating the middling to the original feed.

TABLE 3

Results of Electrostatic Separation of Magnetic Concentrates

Product	Wt % of orig feed	TiO_2 %	Fe %
Carpco conc from No. 1 mag conc	2.94	42.0	
Carpco conc from No. 2 mag conc	13.02	43.4	36.8
Carpco midd	0.30		
Carpco tailing* from No. 2 mag conc	22.44	0.49	

*garnet concentrate

Flotation of Rutile

Because the No. 1 magnetic concentrate had been removed at a low field strength, it was felt that there would not be any rutile present in this fraction. This view was confirmed by a microscopic examination which did not reveal any grains resembling rutile. The No. 2 magnetic concentrate did contain a considerable number of different-coloured grains which were assumed to be rutile and it was decided to make a separation by flotation.

A good separation of rutile from ilmenite had been made by Lakefield Research using Duomac T, hence it was decided to use this reagent. Similar results were obtained but it was necessary to use a much greater quantity of the reagent. This could have been caused by a deterioration of the reagent or by a difference in the water.

To carry out the test, 1000 grams of concentrate was added to a 500-gram D-1 flotation cell running at 1900 rpm. The reagent additions and operating conditions were as follows:

TABLE 4

Operating Conditions

Stage	Reagents added lb/ton		Time, min	
	Duomac T	MIBC	Cond	Float
No. 1 float	0.20	0.05	2	1
	0.20	0.05	2	2
	0.20		2	1½
No. 2 float	0.20	0.05	2	1½

TABLE 5

Results of Flotation

Product	Wt % of orig feed	TiO_2 %	Fe %	Distn % TiO_2 in test
No. 1 conc	7.42	33.8	44.5	44.4
No. 2 conc	3.42	55.3	28.5	33.5
Float tailing	2.18	57.3	25.8	22.1
Feed (calcd)	13.02	43.4	37.2	100.0
No. 2 conc + Float tailing	5.60	56.1	27.4	55.6

Zircon Concentration

Zircon, being non-magnetic, was concentrated in the Wetherill non-magnetic tailing with other minerals of low magnetic attractability. To produce a zircon concentrate, the Wetherill non-magnetic tailing was passed over a Carpco electrostatic separator to recover some additional rutile. The tailing was then passed over a Stearns high-intensity magnetic separator, which had a higher field strength than the Wetherill separator, and some additional material was removed. This final non-magnetic tailing was then wet-tabled to produce a zircon concentrate.

TABLE 6

Results of Zircon Concentration

Product	Wt % of orig feed	TiO_2 %	ZrO_2 %	Fe %
Wetherill non-mags (feed)	5.53	8.85		
Carpco conc	0.68	51.4		11.02
" tailing	4.85			
Stearns mag conc	1.41	2.70		
" non-mag tailing	3.44			
Zr table conc	2.06	4.90	48.4	
" " midds	0.54			
" " tailing	0.84			

Another procedure used was to pass the Wetherill non-magnetic tailing over the Stearns separator at a higher field strength and remove some additional material. The non-magnetic tailing from this separation was then wet-tabled to produce a zircon concentrate.

TABLE 7

Results of Zircon Concentration (alternative method)

Product	Wt % of orig feed	TiO_2 %	ZrO_2 %
Wetherill non-mags (feed)	5.53	8.85	
Stearns mag conc	1.70	8.52	
" non-mag tailing	3.83	8.4	40.0
Zr table conc	2.52	9.23	52.65
" " midd	0.73		27.14
" " tailing	0.58		0.70

DISCUSSION OF RESULTS

From the results obtained, it has been shown that the conventional procedure of treating such sands, i.e., gravity concentration plus electrostatic and magnetic separation, is suitable for this material. The use of high-intensity magnetic separation ahead of electrostatic separation is not necessary and additional testing would be required to show if it has any advantage.

It is possible that some of the titanium-bearing minerals could be concentrated into a higher-grade product and the overall recovery improved slightly but it is doubtful if it would be economically feasible.

Additional testing should result in a higher grade of zircon concentrate.

Although rutile was identified in the titanium concentrates, the difficulty of positively differentiating between rutile and ilmenite and zircon made separate production of a rutile concentrate impractical. In a full-scale operation, a method for doing this could be developed if desired.

CONCLUSIONS

The calculated grade of the preconcentrated sand sample was 8.23% TiO_2. Concentrates amounting to 6.28% and 10.36% of the weight of material and averaging 55.6% and 36.1% TiO_2 respectively were produced.

A zircon concentrate amounting to 2.52% of the weight containing 52.65% ZrO_2 with a middling product amounting to 0.73% of the weight and containing 27.14% ZrO_2 were also produced.

The above figures give the minimum amounts of titanium and zircon minerals that can be easily recovered by using standard procedures. A slight additional recovery of these minerals might be made by using a more complicated procedure.

ACKNOWLEDGEMENTS

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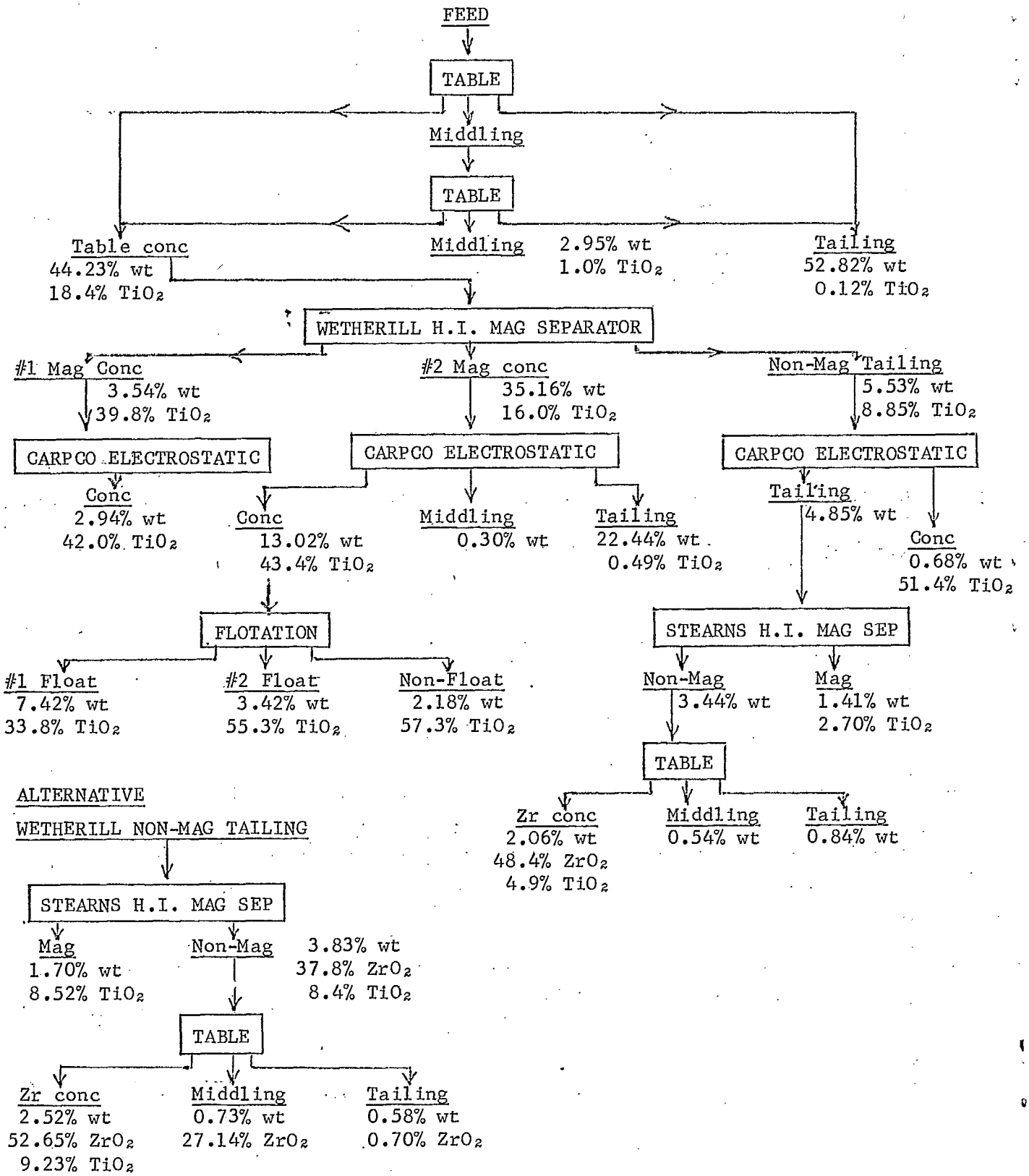

Figure 1. - Flowsheet of Procedures