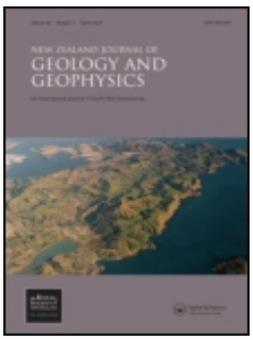

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BOREHOLE SURVEY OF NORTH ISLAND IRONSANDS FROM NEW PLYMOUTH TO KAIPARA HARBOUR

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Summary

A reconnaissance survey in 1949 indicates that on the beaches between the mouth of the Mokau River, 56 miles north of New Plymouth, and the township of Muriwai, 35 miles north-west of Auckland City, there is available over 600 million tons of magnetically recoverable ironsand assaying 58% Fe.

The most important deposit, that near Lake Taharoa, just south of Kawhia Harbour, contains some 173 million tons of ironsand in concentrations varying from 41% Fe in dune sands to 87% Fe in beach concentrates.

INTRODUCTION

Earlier records filed in the Department of Mines, and published work by Hutton (1940, 1945), Fleming (1946), Beck (1947), Finch (1947), had established quantities and grades of ironsand at Patea, Fitzroy, west of the Wanganui River, Waitara, and between the Wanganui and Whangaehu rivers, but no attempt had been made to assess the value of the many deposits along the coast north of New Plymouth. A committee of the Department of Scientific and Industrial Research decided that a survey of the ironsands north of New Plymouth should be made, and one of the authors (D.S.N.) was detailed to undertake this survey in collaboration with the New Zealand Geological Survey.

PRELIMINARY AERIAL SURVEY

An aerial survey of the coastline from Wanganui to the Kaipara Harbour was first made to give a preliminary assessment of the relative importance and accessibility of the different deposits and to provide a comparison of the quantities and grade of the sands with those areas already surveyed between Wanganui and Fitzroy, New Plymouth.

As a result of this survey it was decided that the following deposits warranted sampling, Waitara being included for comparison with previous work:

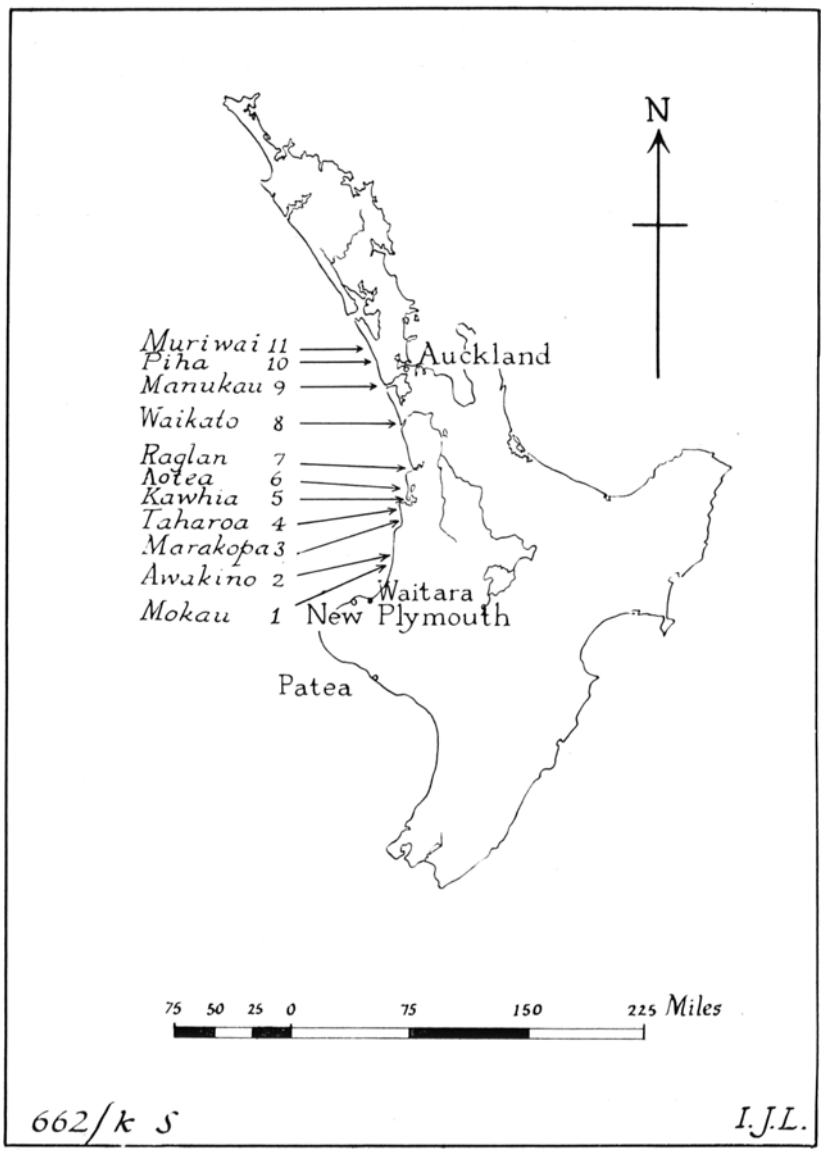


FIG. 1.—Locality map.

Waitara, Mouth of Mokau River, Mouth of Awakino River, Mouth of Marakopa River, Lake Taharoa, Kawhia Harbour, Raglan Harbour, Aotea Harbour, Waikato Heads, Manukau Heads, Piha, and Muriwai.

METHOD OF SAMPLING

Samples were taken with a 3 in. diameter posthole borer, which could be operated manually to a depth of about 25 ft but was difficult to handle efficiently at depths of more than 15 ft, and could not be used to obtain samples below water level.

On each deposit several scout holes were put down to obtain samples roughly representative of the whole deposit. Where deposits several hundred feet thick were encountered, a series of holes was drilled at increasing heights above sea-level.

The sand from each hole was collected on a canvas sheet, thoroughly mixed, and then reduced to about 20 lb by standard coning and quartering procedure. Where a relatively low dune of about 30 ft in height was being sampled, two holes each 15 ft deep were drilled on the side of the dune, one 15 ft above the other, and the samples combined as one sample representative of the full height of the dune.

The location of the holes is shown in Fig. 1, their approximate spot height above sea-level, their depth, and the percentage of magnetically separable ironsand in the samples are shown in Figs 2 to 11.

LABORATORY TREATMENT OF SAMPLES

The samples were dried and representative fractions of approximately 4 lb each were put through a wet Magnetic Separator (Martin, 1949) at Dominion Physical Laboratory. The magnetic field was adjusted until the resulting concentrate simulated what would be obtained on a practical scale, namely one having an iron content of about 58% which, on present information, is considered to be the maximum economic limit in iron content attainable by wet magnetic concentration. Individual concentrates, expressed as percentages by weight of the original material, are shown in Table 1.

TABLE 1.—Percentage of Magnetically Recoverable Ironsand.

Sample No.	Locality	Percentage of Magnetically Separable Ironsand (Approx. 58% Fe)
N1	Waitara, New Plymouth	19
N2	Mouth of Mokau River (Fig. 2)	24
N3	Mouth of Mokau River	37
N4	Mouth of Mokau River	49
N5	Mouth of Awakino River (Fig. 3)	63
N6	Mouth of Awakino River	65
N7	Mouth of Marakopa River (Fig. 4)	44
N8	Mouth of Marakopa River	57
N9	Mouth of Marakopa River	62
N10	Mouth of Marakopa River	51

Sample No.	Locality	Percentage of Magnetically Separable Ironsand (Approx. 58% Fe)
N11	Kawhia Hbr., north head (Fig. 6)	6
N12	Kawhia Hbr., north head	2
N13	Kawhia Hbr., north head	9
N14	Kawhia Hbr., north head	7
N15	Kawhia Hbr., north head	5
N16	Kawhia Hbr., north	0·6
N17	Kawhia Hbr., north head	6
N18	Kawhia Hbr., north head	11
N19	Kawhia Hbr., north head	13
N20	Kawhia Hbr., north head	28
N21	Lake Taharoa Area (Fig. 5)	41
N22	Lake Taharoa Area	45
N23	Lake Taharoa Area	87
N24	Lake Taharoa Area	61
N25	Lake Taharoa Area	81
N26	Lake Taharoa Area	71
N27	Raglan Hbr., north head (Fig. 8)	31
N28	Raglan Hbr., north head	14
N29	Raglan Hbr., north head	9
N31	Aotea Hbr., north head (Fig. 7)	6
N32	Aotea Hbr., north head	3
N33	Aotea Hbr., north head	5
N34	Waikato Heads, north side (Fig. 9)	7
N35	Waikato Heads, north side	9
N36	Waikato Heads, north side	5
N37	Manukau Heads, north side (Fig. 10)	46
N38	Manukau Heads, north side	25
N39	Manukau Heads, north side	21
N40	Piha area (Fig. 10)	9
N41	Piha area	6
N42	Piha area	60
N43	Piha area	31
N44	Piha area	12
N45	Muriwai (Fig. 11), south end, sample from seaward dune	41
N46	Muriwai, south end, 100 yds E of N45	12
N47	Muriwai, south end, 100 yds E of N46	38
N48	Muriwai, south end, 200 yds E of N47	18
N51	30 miles N of Muriwai, Kaipara sth head	0·8
N54	20 miles N of Muriwai, 6 ft section of seaward dune	0·3
N55	10 miles N of Muriwai, 10 ft section of seaward dune	0·5
N56	5 miles N of Muriwai, 20 ft section of seaward dune	0·6
N57	4 miles N of Muriwai, 30 ft section of seaward dune	0·9
N58	3 miles N of Muriwai, 30 ft section of seaward dune	2
N59	2 miles N of Muriwai, 15 ft section of seaward dune	10
N60A	1 mile N of Muriwai, 15 ft section of seaward dune	10
N60B	1 mile N of Muriwai, 150 yds E of N60A	13
N61A	½ mile N of Muriwai, 15 ft section of seaward dune	33
N61B	½ mile N of Muriwai, 200 yds E of N61A	13
N61C	½ mile N of Muriwai, 200 yds E of N61B	9
N61D	½ mile N of Muriwai, 400 yds E of N61C	22
Trig. XXX	Patea, at trig. station on top of dune	24

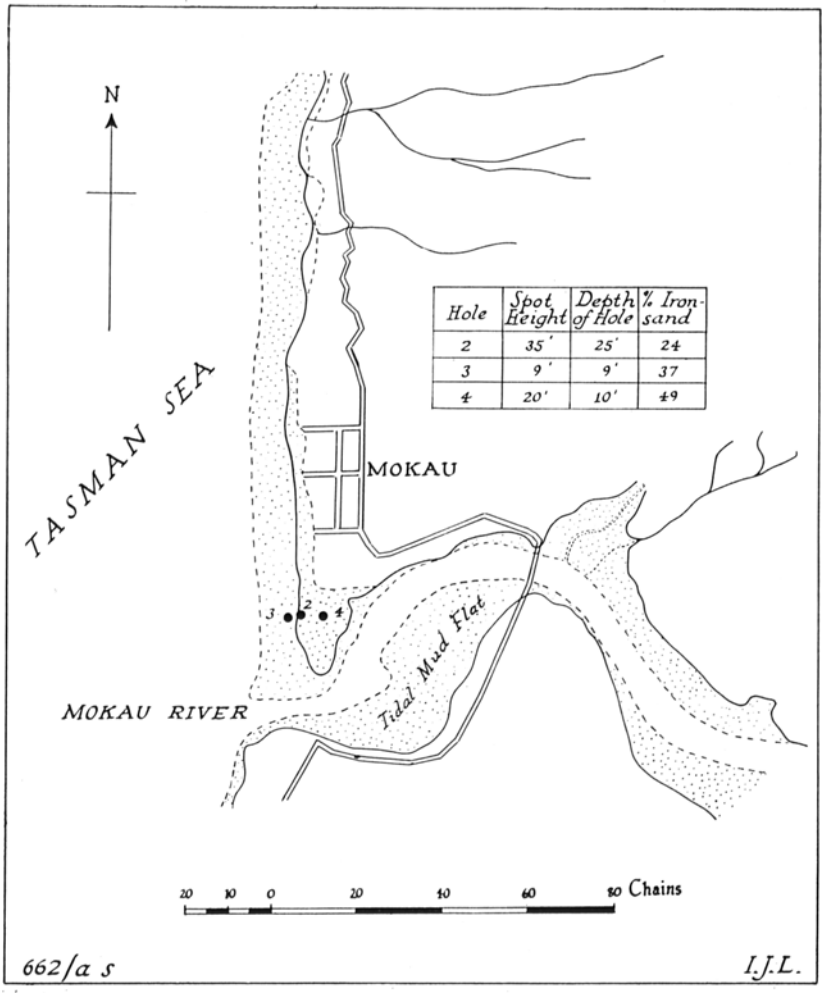
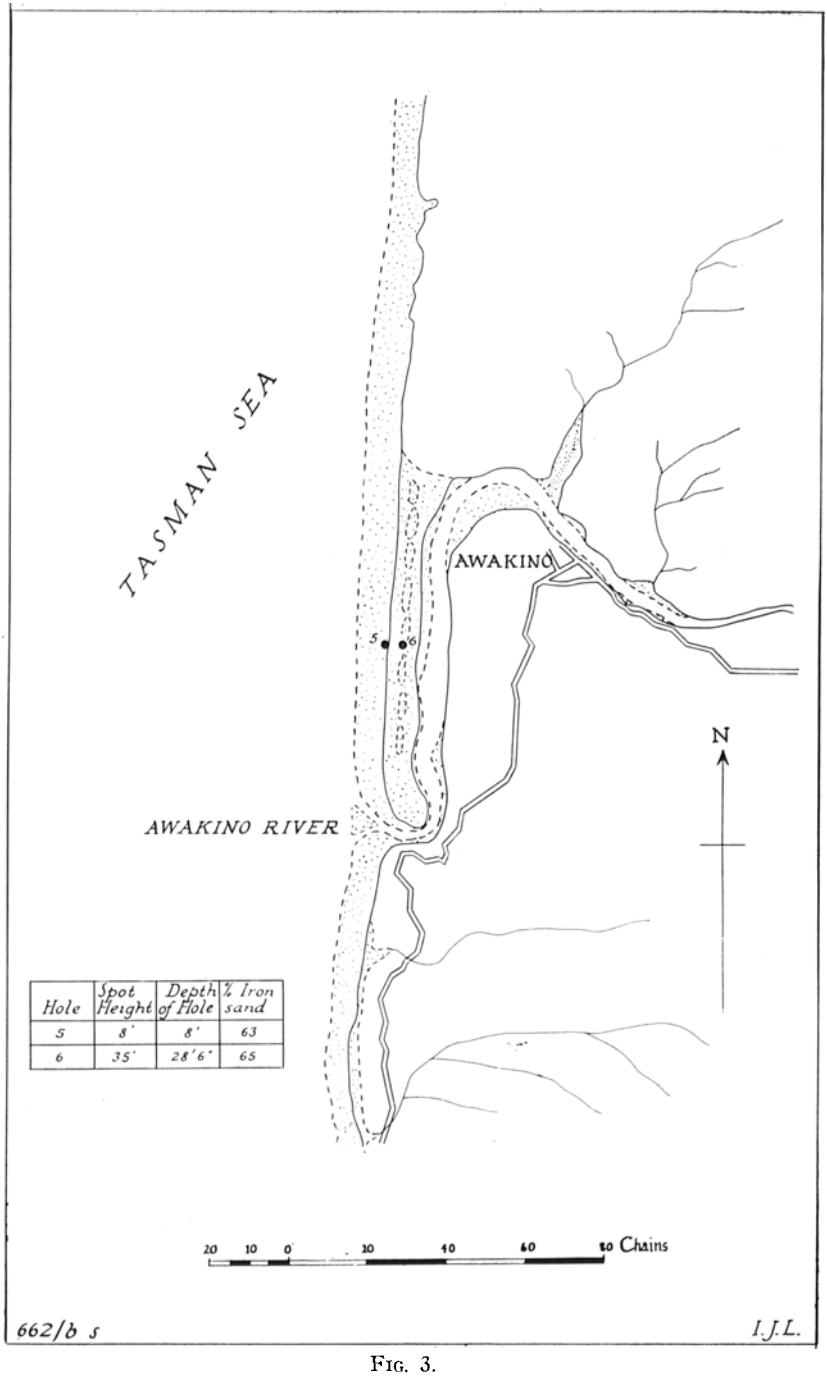


FIG. 2.

The final sample shown in Table 1, taken at Patea on the return journey to Wellington, is interesting in that it gives a comparison with typical Patea dune sand.

METHOD OF ASSESSING QUANTITIES OF SAND

To avoid lengthy and costly field work, it was considered sufficient for the purposes of a reconnaissance survey to compute roughly the quantities of sand in individual areas from contour plans prepared by the Aerial Survey Branch of the Department of Lands and Survey.

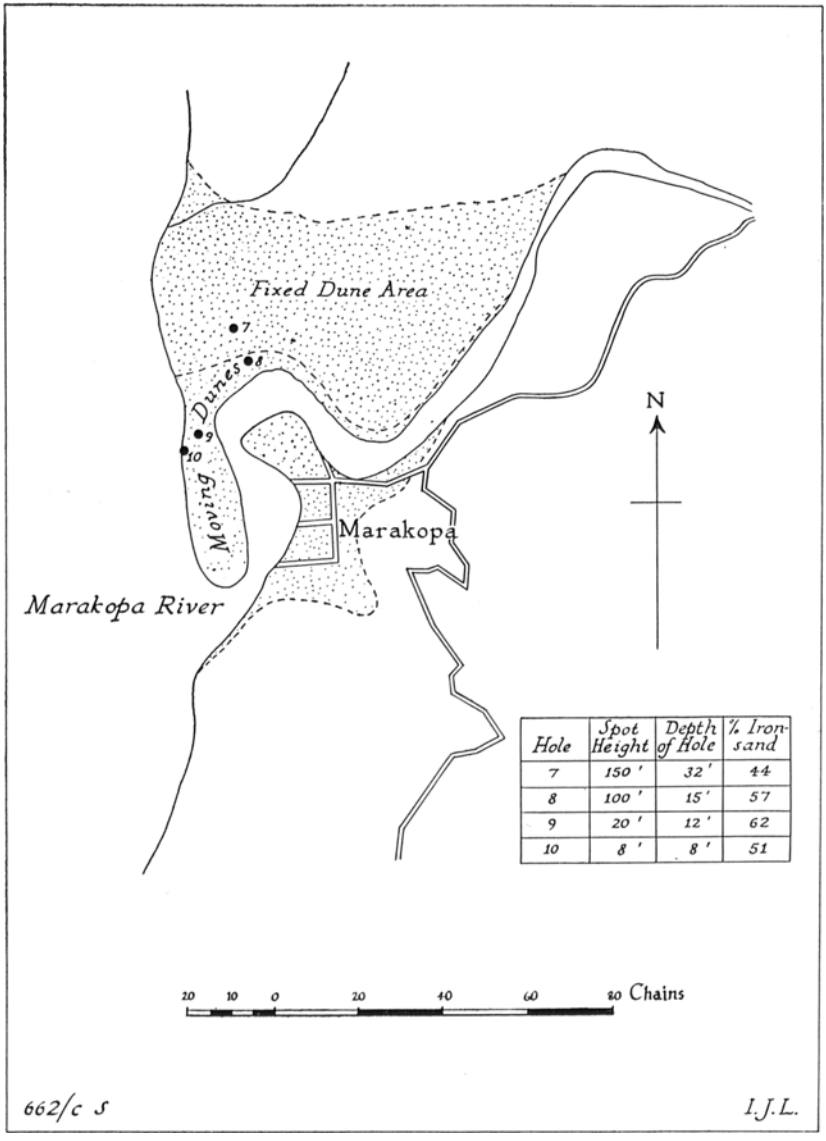


Hole	Spot Height	Depth of Hole	% Iron sand
5	8'	8'	63
6	35'	28'6"	65

FIG. 3.

These plans were contoured at 50 ft intervals from aerial photographs, control being given by sea-level and points that could be identified in the photographs and tied in with existing survey data.

Owing to lack of information about the possible extension of the ironsands below sea-level, only the quantities of sand above sea-level



Hole	Spot Height	Depth of Hole	% Iron-sand
7	150 '	32 '	44
8	100 '	15 '	57
9	20 '	12 '	62
10	8 '	8 '	51

FIG. 4.

have been computed, but in most of the areas surveyed further quantities of sand probably extend below sea-level, particularly in old lagoon or dune areas behind the present foreshore, e.g., Muriwai, Lake Taharoa.

The method of computation, though not very accurate, is sufficiently reliable to indicate the order of the quantities in the respective areas.

Areas within each contour line were measured by planimeter, and volumes of sand obtained by multiplying the average of two contour areas by the 50 ft interval between them. Tonnages of sand were calculated by taking 1 cu. yd. of sand at 1·5 tons.

The smaller deposits and the low-lying ones did not warrant obtaining contoured plans, and for these the area was measured by planimeter from New Zealand Geological Survey field plans, and an average depth of sand was assessed from field notes.

Volumes and tonnages of total sand and recoverable ironsand for each area are shown in Table 2.

It is emphasized that the figures given for recoverable ironsand indicate merely the order of the quantities, as it will be obvious that insufficient samples were taken for reliable figures to be given for the average percentage of recoverable ironsand in each area.

TABLE 2.—Quantities of Ironsand.

Locality	Total Quantity of Sand		Recoverable Ironsand (approx. 58% Fe)	
	Cu. yd × 10^6	tons × 10^6 (1 cu. yd = 1·5 tons)	Average % in samples taken	Tons × 10^6
Mokau	7·0	10·5	37	3·9
Awakino	6·0	9·0	64	5·8
Marakopa	36·62	54·93	53	29·1
Lake Taharoa	274·20	411·3	64*	263·2*
Kawhia Hbr.-N. Head	1,367·01	2,050·5	9	184·5
Aotea Hbr.-N. Head	333·51	500·26	5	25·0
Raglan Hbr.-N. Head	323·63	485·45	18	87·3
Waikato Heads	854·49	1,281·73	7	89·7
Manukau Hbr.-N. Head	11·3	17·0	31	5·3
Piha	2·3	3·45	24	0·8
Muriwai (2 mi south end)	58·54	87·8	20	17·6

*The authors consider that the figure of 64% for the average percentage of recoverable ironsand (the arithmetic mean of the figures given for the six drill hole results shown on the plan of the locality) is much too high for assessment purposes as it is unduly weighted by the high results of the four samples taken near the present beach. An average percentage of 42%, giving an estimated tonnage of ironsand concentrate of 172·7 × 10^6 tons, is considered to be a more realistic and conservative estimate.

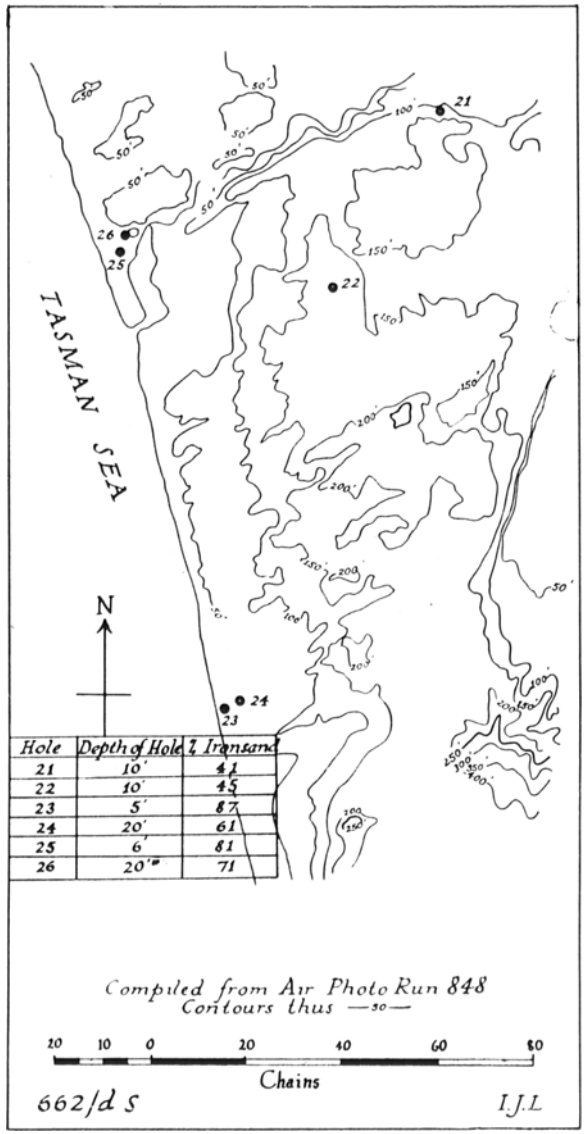


FIG. 5.—Lake Taharoa area.

OTHER LOCALITIES NOT SAMPLED

In this section can be included deposits between Wanganui and New Plymouth observed during the aerial survey, but which have not yet been surveyed for the quantity or quality of their ironsand. It is considered that the areas mentioned warrant investigation in the final assessment of New Zealand ironsands resources.

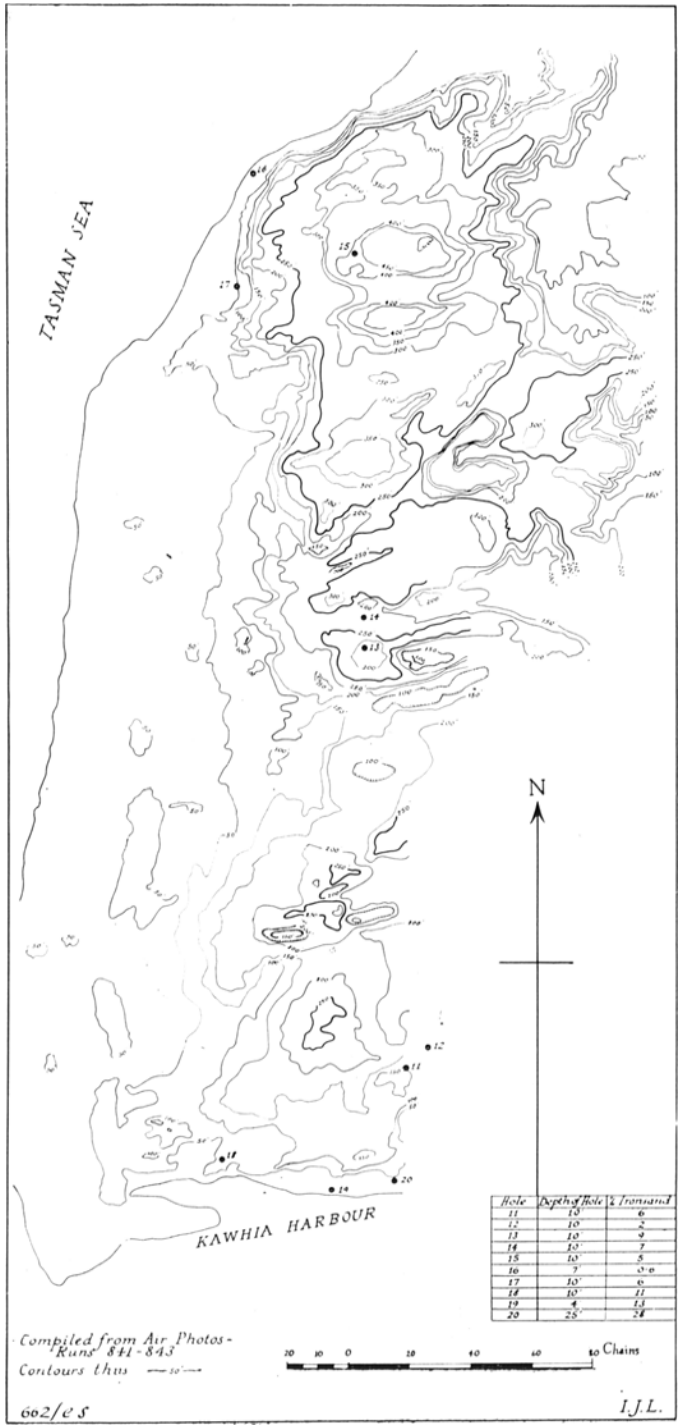

TASMAN SEA
KAWHIA HARBOUR
N
Hole | Depth of Hole | % Ironsand
11 | 10 | 6
12 | 10 | 2
13 | 10 | 9
14 | 10 | 7
15 | 10 | 5
16 | 7 | 3·0
17 | 10 | 6
18 | 10 | 11
19 | 4 | 13
20 | 25 | 24
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FIG. 6.

West of the area reported on by Fleming (1946), between the Waitotara and Patea rivers, is an extensive area between the railway line and the coast which is covered by sand, partly as active dunes along the coast, but mostly under pasture. A large part of this area along the coastline could be worked without encroaching on better farm areas inland, though measures to prevent landward migration of dunes might be necessary.

West of the Patea deposits investigated by the Department of Mines and by Hutton (1940) is an area of dunes generally about a mile wide but narrowing towards Hawera. Apart from the narrow coastal strip, most of this dune area is under pasture.

North of New Plymouth, apart from the areas sampled, are the following small areas on which the ironsand appeared from the air survey to be of high grade, but because of their inaccessibility and small size they were considered not worth sampling at present:

The beaches at Urenui and Waitoitoi, small areas at the mouths of the Tongaporutu and Mohakatino rivers, the beach at Whareorino, the beach in the bay north of Tirua Point. Much farther north, between Piha and Muriwai, is a small area at Bethells.

GENERAL DISCUSSION OF DEPOSITS

Table 2 indicates that the Lake Taharoa area is potentially the most important deposit and field evidence confirms this, though access to the area is difficult, either by land or sea. Deep drilling will be necessary to prove this deposit but from surface evidence and the samples taken it contains a vast quantity of high-grade ironsand. An indication of the potential importance of the deposit is given by comparing it with that at Patea, where, according to records of the Department of Mines, there are 14,000,000 tons of potential concentrate assaying 53·4% soluble Fe (Mason, 1945). The Taharoa deposit contains about 173 million tons assaying 58% soluble Fe.

The next deposit in order of potential importance is that at Muriwai, where the southernmost two miles of beach and dune area above sea-level contains some 17·6 million tons of recoverable ironsand, of 20% grade. Evidence of subsidence indicates the probable extension of the ironsand below sea-level, an important factor in this locality, as other conditions are suitable for mining by bucket or suction dredging, the most economical method known. If the sand persists to a depth of about 30 ft below mean sea-level, which on geological evidence seems probable, this method of mining and concentration could be applied, and a preliminary concentrate containing some 58% Fe could be produced at very low cost per ton. Drilling below water level would be necessary to prove the depth. If the ironsand persists to a depth of 30 ft below mean sea-level, the quantity of recoverable iron ore would be nearly twice the figure given in Table 2.

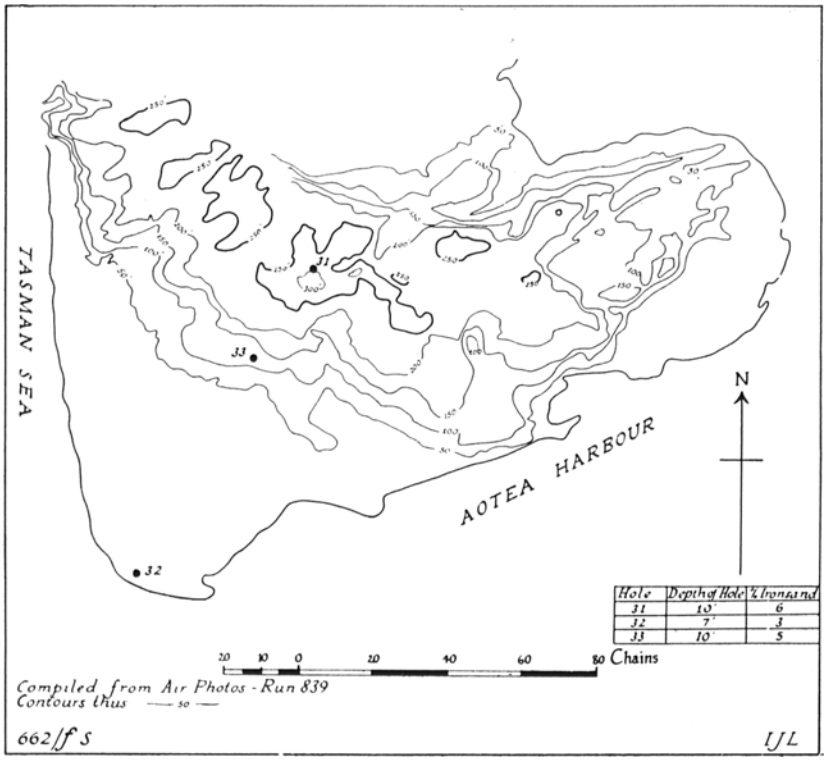


FIG. 7.

Probably next in order of potential importance is the deposit at the mouth of the Marakopa River, where there are some 29 million tons of recoverable ironsand of 53% grade. Though larger and of higher grade than the Muriwai deposit it is considered by the writers to be not so important economically because of the greater difficulty of access and the fact that the deposit is not suitable for mining by dredging. Mining and transport costs would therefore be much higher than for Muriwai.

The small deposits at the mouth of the Mokau and Awakino rivers are also high grade in comparison with the Patea deposit, and here again inaccessibility and small size may prevent development.

The huge sand deposits in the Kawhia, Aotea, and Raglan harbour areas, as well as that at Waikato Heads, are low in ironsand content, and it is doubtful if they will ever warrant development.

The quantity of recoverable ironsand at Piha is too small to warrant much consideration, and as the locality is developing as a seaside rsort it is unlikely that mining of ironsand would be permitted.

Comparing the areas surveyed with the better known ironsand areas between Wanganui and New Plymouth, it would seem that generally the grade of the ironsand is higher to the north than to the south of New Plymouth. Access, both by land and sea, to the deposits south of New Plymouth is considerably better than to the northern deposits. Generally, the northern deposits do not form such good farming land as the southern ones. In any area to be worked, consideration would have to be given to the regeneration of vegetation in order to combat serious sand drift. At Muriwai and Waikato Heads, if these areas were worked, the expense of reafforestation would have to be considered.

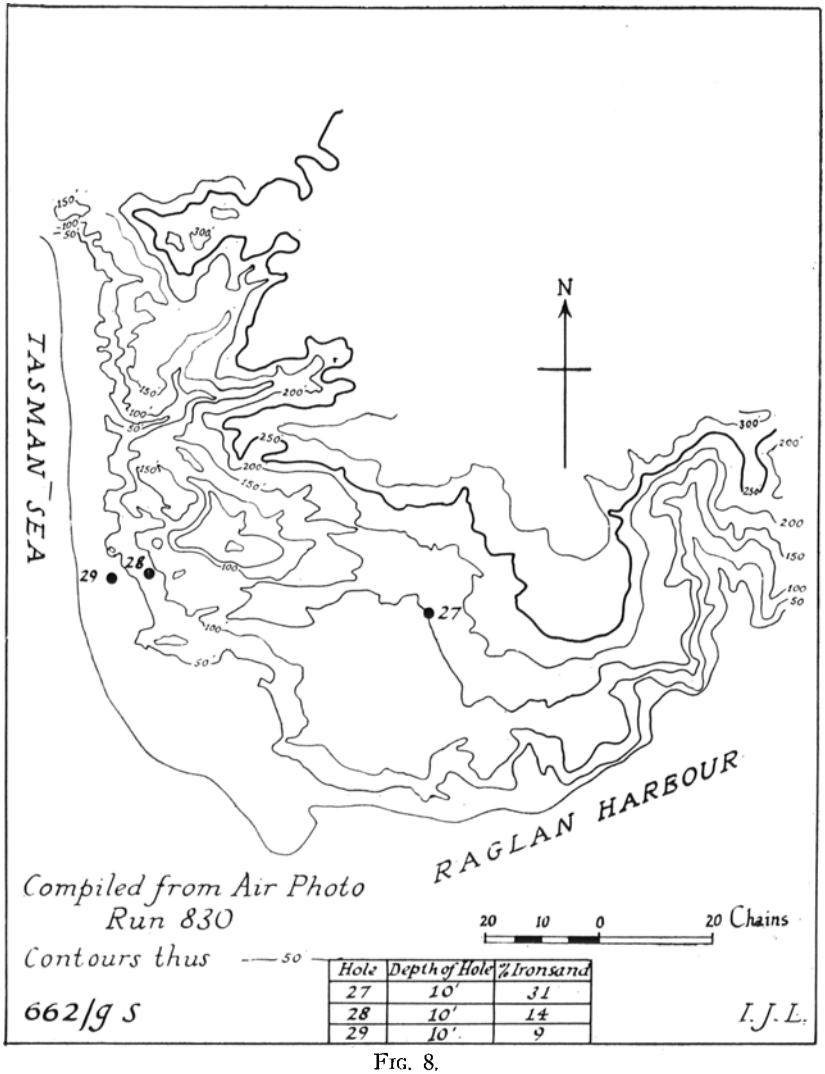


FIG. 8.

To facilitate comparison of the northern with the southern areas, figures available for the areas between Wanganui and New Plymouth are shown in Table 3.

TABLE 3.—Quantitative Figures available from Previous Work.

Locality	Total Sand (tons) (approx.)	Titanomagnetite Concentrate (tons) (approx.)
Waitara, New Plymouth (Beck, 1945)	31,469,000	7,687,000
Fitzroy, New Plymouth (Hutton, 1945)	1,120,000	500,000
Patea (Mason, 1945)	45,000,000	14,000,000 (53·4% Fe)
West of Wanganui (Fleming, 1946)	143,355,000	22,807,345
Wanganui-Whangaehu (Finch, 1947)	69,600,000	Very low grade; doubtful if worth working.

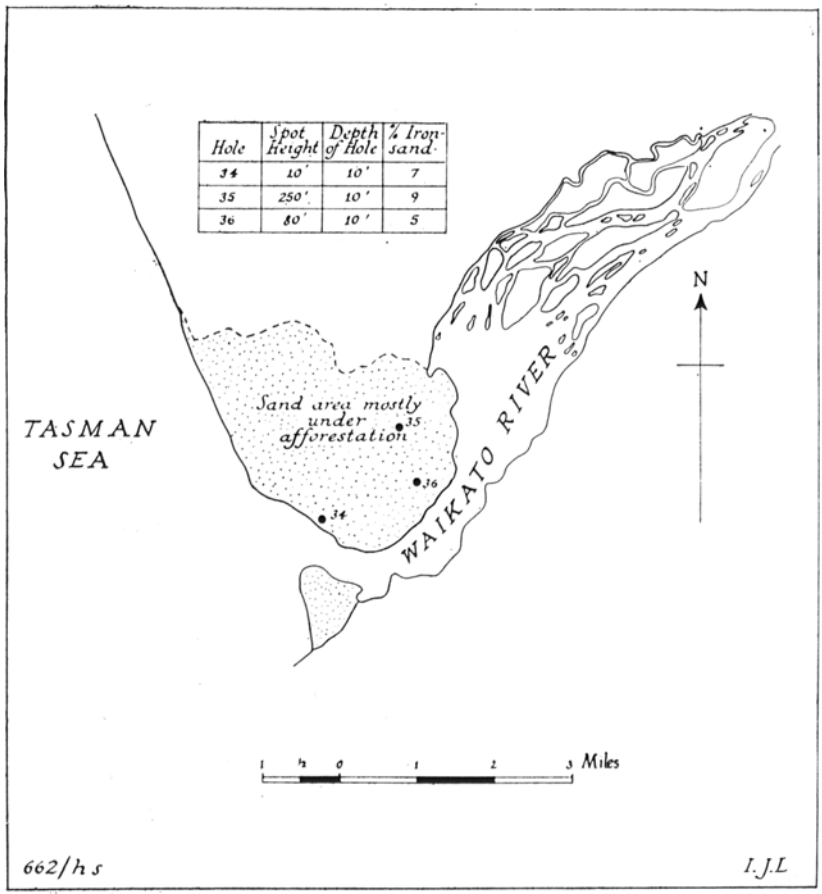
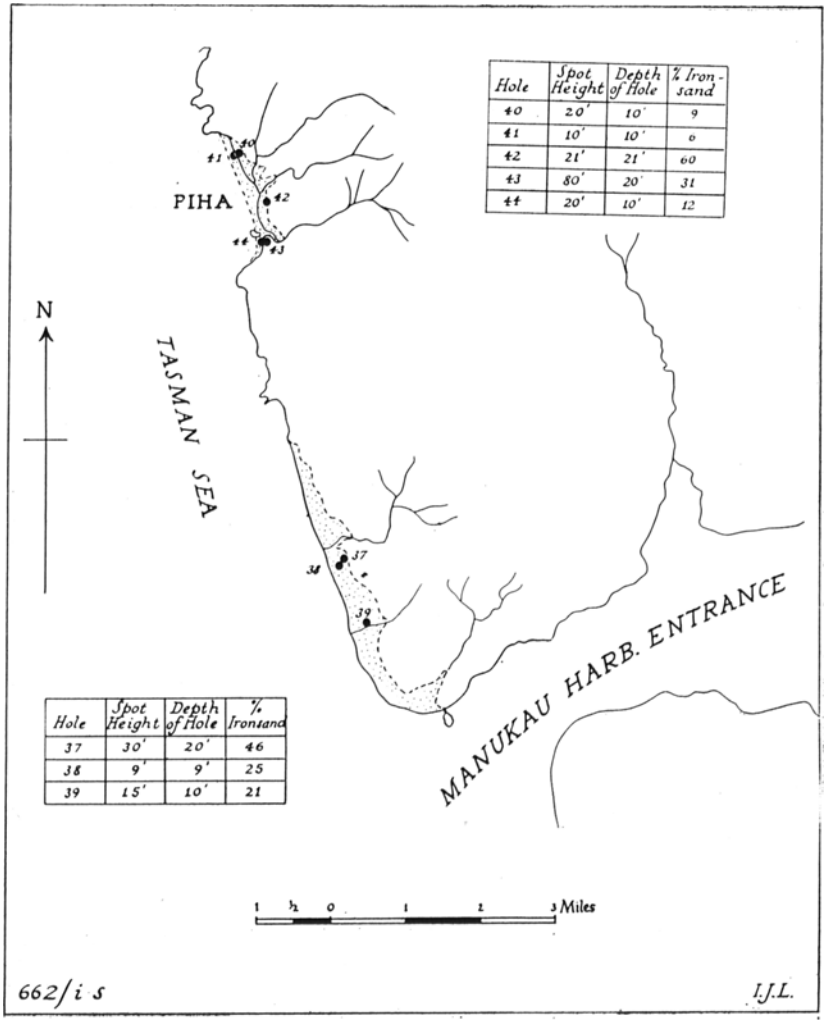


FIG. 9.

DEPOSITS CONSIDERED AS POSSIBLE SOURCES OF ILMENITE

Though the main consideration in this paper, is the assessment of North Island ironsands as a source of iron and steel, with possible by-product titanium and vanadium, it should also be pointed out that some deposits contain ilmenite, possibly important as a source of titanium and its compounds, with by-product iron.

For many years it has been known that the main mineral of most North Island ironsand deposits is titanomagnetite, containing some



Hole	Spot Height	Depth of Hole	% Iron-sand
40	20'	10'	9
41	10'	10'	0
42	21'	21'	60
43	80'	20'	31
44	20'	10'	12

Hole	Spot Height	Depth of Hole	% Ironsand
37	30'	20'	46
38	9'	9'	25
39	15'	10'	21

FIG. 10.

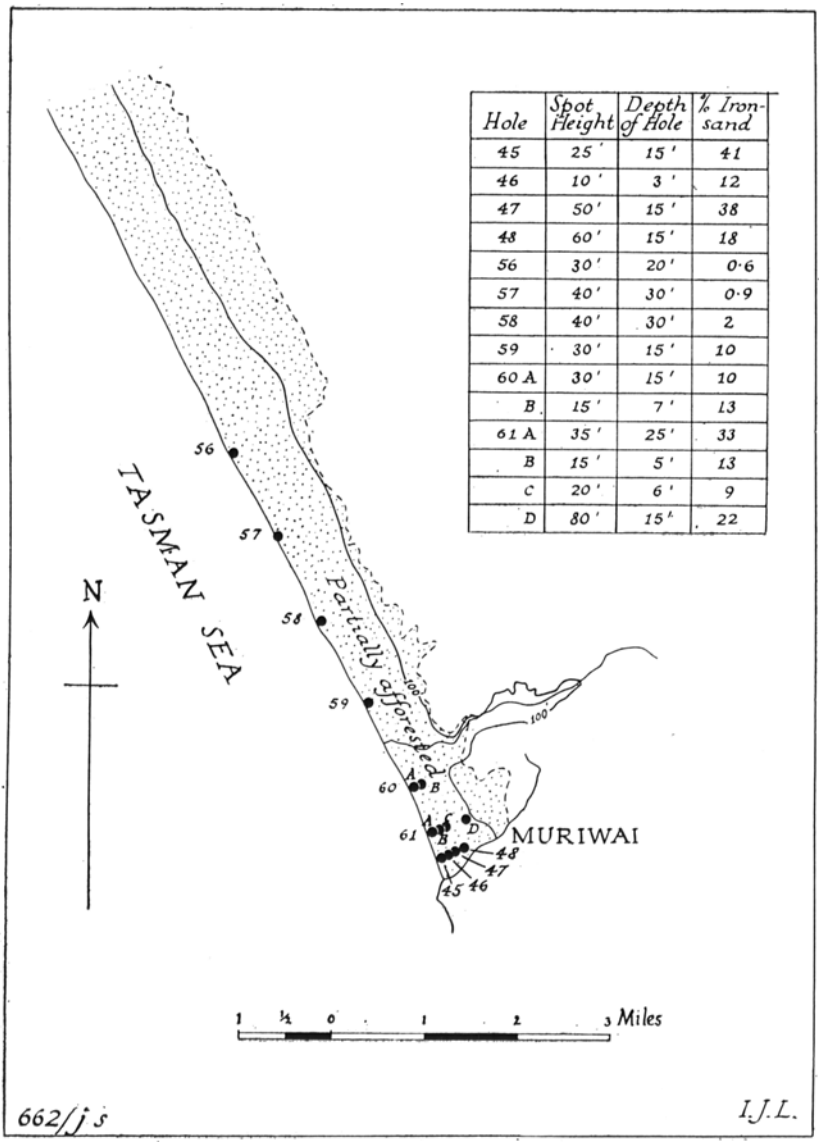


FIG. 11.

58% iron, 5% titanium, and 0·2% vanadium, important as a source of iron. Only comparatively recently has it been known that ilmenite, containing some 27% titanium and 32% iron, occurs in some North Island deposits (Nicholson *et al.*, 1958).

All samples taken on the present survey were examined for their ilmenite content by Mr J. J. S. Cornes and Dr J. Finch of Dominion Laboratory. Samples, from which the titanomagnetite had been removed by Mr J. Mautner at Dominion Physical Laboratory by wet magnetic separation, were subjected to dry magnetic separation by Mr Cornes to give ilmenite concentrates. Grain counts of the concentrates were made by Dr Finch to give approximate percentages of ilmenite. Results are shown in Table 4.

TABLE 4.—Percentages of Ilmenite.

Sample Number	Locality	Approx. Percentage of Ilmenite
N.34	Waikato Heads	0·2
N.35	Waikato Heads	1·5
N.36	Waikato Heads	0·2
N.37	Manukau Heads	16·9
N.38	Manukau Heads	6·6
N.39	Manukau Heads	2·8
N.40	Piha	3·4
N.41	Piha	3·5
N.42	Piha	12·1
N.43	Piha	6·8
N.44	Piha	3·0
N.45	Muriwai south end	11·0
N.46	Muriwai south end	6·5
N.47	Muriwai south end	8·2
N.48	Muriwai south end	7·1
N.51	Kaipara Hbr. south head	2·7
N.54	20 miles north of Muriwai	0·01
N.55	10 miles north of Muriwai	0·08
N.56	5 miles north of Muriwai	0·05
N.57	4 miles north of Muriwai	0·2
N.58	3 miles north of Muriwai	0·8
N.59	2 miles north of Muriwai	3·5
N.60A	1 mile north of Muriwai	3·1
N.60B	1 mile north of Muriwai	1·8
N.61A	½ mile north of Muriwai	7·4

Table 4 shows that the Muriwai (south end) and Manukau Heads deposits, as well as being potentially important as sources of titanomagnetite for iron and steel, may assume some importance as potential sources also of ilmenite for titanium and iron. In the future this may be a strong factor in favour of developing these deposits in preference to some of the more southerly ones.

It will also be noted that ilmenite occurs only in deposits north of the mouth of the Waikato River.

It should be pointed out that North Island ilmenites are similar to the South Island ones (see Nicholson *et al.*, 1958) in that they have a low

TiO_2 content when compared with important overseas sources of titanium-bearing sands. This is shown in the following table.

TABLE 5.—Comparison of New Zealand and Foreign Ilmenites.

Locality	Percentages			
	Fe	TiO_2	V_2O_5	Cr_2O_3
*Manukau Heads, Auckland	39·9	42·5	0·15	0·02
*Nine Mile Beach, Westport	32·5	45	< 0·05	< 0·01
Pure ilmenite $FeO \cdot TiO_2$	36·8	52·7	Nil	Nil
Pure 'arizonite' $Fe_2O_3 \cdot 3TiO_2$	28·0	60·0	Nil	Nil
Foreign Ilmenites (Gillson, 1949)				
†Travancore (India) "Quilon"	24·7	60·4	0·36	0·17
†Jacksonville, Florida, U.S.A.	22·7	60·3	N.D.	N.D.

*From Dominion Laboratory unpublished reports.
†These are 'arizonites', but are marketed as ilmenites.

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