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~~DEPARTMENT OF SUPPLY AND SHIPPING~~

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

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RECORDS : 1950. No.7.

PLAN NO : Q25-10D-1 to Q25-10D-3

MINERAL DEPOSITS OF THE PALM BEACH AREA. SOUTH EAST QUEENSLAND.

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SOUTHPORT. QLD. JUNE 1950.

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TABLES.

MINERAL DEPOSITS OF THE PALM BEACH AREA, SOUTH EAST QUEENSLAND.

SUMMARY.

The deposits of heavy mineral sands along the East Coast of Australia, are being investigated primarily to determine their content of monazite. At Palm Beach beneath the foredune and adjacent low trough-like area on the landward side, a total of 47,000 tons of zircon-rutile-ilmenite-monazite concentrate occurs in 200,000 cubic yards of sand. The average grade is 513 lbs of heavy mineral per cubic yard of sand. Scout boring of the coastal plain west of these deposits failed to locate more than traces of heavy minerals. The greater part of the area in which the deposits occur has been built on for residential purposes, but an estimated 12,000 tons of heavy minerals towards the northern end containing 70 tons of monazite is still available for mining. The thoria content of the monazite has been determined to be (6.6 ± 0.3) per cent. The percentages of zircon and of monazite in the concentrates decrease appreciably from the southern end of the area almost to the northern tip, while the percentages of rutile and of ilmenite correspondingly increase. At the northern tip of the area, adjacent to the mouth of Tallebudgera Creek, this steady change in composition is reversed, viz., the percentages of monazite and of zircon increase, while the percentages of rutile and of ilmenite decrease. This variation in the composition of the concentrates suggests that the rate of transport of the heavy mineral grains by the surf and by the tidal current at the mouth of Tallebudgera Creek is related inversely to the specific gravities of the grains.

A. INTRODUCTION.

1. General Purpose of the Investigation. The primary aim of the investigation was to determine the reserves and distribution of monazite in the deposits of heavy mineral sands along the East Coast. These deposits contain most of the known world reserves of Zircon and rutile (Fisher 1949 (a) and (b)) for which they are being exploited at various localities, mainly from North Stradbroke Island in Queensland to Ballina in New South Wales. Monazite forms little more than 0.5 per cent of the mixed concentrates, but can be recovered as a by-product from the separation of the other minerals. The monazite forms a source of supply of cerium and also of thorium. The thorium content of the monazite is determined on the basis of its radioactivity.

2. Situation. Palm Beach is 6½ to 8¾ miles northwards along the Pacific Highway from the Queensland - New South Wales border, between Burleigh Head on the north, and Currumbin Headland on the south. The area is separated from the headlands, respectively, by Tallebudgera Creek and Currumbin Creek. Plans of the Palm Beach Area and its deposits of heavy minerals, with a locality map, are given in Plate 1 at the end of this report.

3. Access. The township of Palm Beach is traversed from north to south by the Pacific Highway, and is approximately ½ mile east of Elanora Railway Station, on the railway from Brisbane to Tweed Heads.

4. Responsibility for Sections of the Report. The various sections of this report were compiled by those who were most directly responsible for the conduct of the respective portions of the work. In general however, each member of the staff assisted in several phases of the investigation. Mr. T.D. Dimmick, now an officer of the Queensland Geological Survey, carried out the preliminary field work in the area. Mr. J. Ward, assisted by Mr. L.R. Lee was responsible for Laboratory work, including the separation and examination of minerals. Miss L.M. Edhouse carried out radiometric determination of quantities of monazite, and investigations of the thoria content of the monazite.

B. TOPOGRAPHY.

The Palm Beach Area comprises a sand dune belt adjacent to the beach, and a low lying coastal plain, which separates the sand dune belt from the higher country to the west. The width of the sand dune strip adjacent to the beach varies from 400 feet to 1000 feet. Its height, referred to mean low water (see footnote) ranges from about 15 to 25 feet, and is mostly within a foot or two of 20 feet. Except for the northernmost 1400 feet and the southernmost 500 feet, the dune strip lies within the boundaries of the Town of Palm Beach.

The coastal plain between the beach dunes and the higher country inland is comparatively narrow, varying in width from about half a mile to a mile and a quarter. Back along the valleys of the two creeks the plain extends another mile or so. Sections of the beach and sandy area showing the surface profile are given in Plate 2. Since most of the land adjacent to the Pacific Highway is built on, the natural surface has been destroyed in may places. However, most sections show a foredune at the top of the beach, and the crests and troughs of the sand ridges parallel to the beach are seen in the profiles of several bore lines where they are still preserved, for example, lines 1066S and 6697S. The Seaward side of the foredune is held reosonably firmly by a long trailing grass, Spinifex hirsutus, characteristic of the sandy areas exposed to the prevailing winds, and occasionally to erosion during stormy periods. Goat's-Foot Convolvulus, a trailing vine, and Guinea Flower, a trailing shrub appear along with the Spinifex. The area behid the foredune has largely been cleared, but patches are still covered by the native vegetation - typical dune scrub, composed of banksia, Cupania, with other low trees, heaths, bracken and grasses.

Portions of the low-lying coastal plain are illustrated in the profiles of the scout boring lines and the western ends of some of the other lines. The northern parts of the coastal plain, extending from about the latitude of 23rd. Avenue northwards to "Tallebudgera Creek", is made up of tidal sand flats in varying stages of reclamation by vegetation, progressing from a nearly pure turf of saltwater couch through a mixed stand of salt-water couch and rush-like sedges to similar flats with stands of swamp sheoak and paper-bark tea-tree. The eastern margin of the coastal plain, adjacent to the coastal dune area, and portions of the western margin of the plain are fringed by swamps which support tall paper-bark, common reed and rush -like sedges. The sandy, but low-lying, central area, traversed in its upper portion by bore line 2636-south, (plate 1, Fig.3.) supports a form of open forest, dominated by scrub-box and bloodwood, with an undergrowth of shrubs, vines, heath, bracken and blady grass. The northern part of the central sandy belt is fringed by a lower area, a little above swamp level, with a somewhat peaty-soil, characterised by paper-bark, blady grass and other grasses, and rush-like sedges.

C. GENERAL GEOLOGY.

The coastal dunes, quite recent in age, are composed of unconsolidated quartz sand, along with small quantities of heavy minerals. The dunes adjacent to the beach overlie "seams" of the heavy minerals - principally zircon, rutile, ilmenite and monazite. These were deposited by the surf during stormy weather on the upper portions of the beach, in periodswhen the beach was a little to the west of its present position. The coastal plain, like the dunes, is recent in age. The plan given in Plate 1. Fig.3. suggests that Currumbin Creek may have flowed through the coastal plain west of the dune strip in a channel now occupied by the narrow swamp which traverses the area from south to north. The Palm Beach Area is bounded on the west by Lower Paloeozioc sediments, which form the divide between Tallebudgera and Currumbin Creeks.

FOOTNOTE. Mean low water is regarded as zero level and has been adopted as the datum for levels in this report. Mean Sea level is approximately 3 feet, and mean high water level is approximately 6 feet.

C. GENERAL GEOLOGY CONT.

Similar sediments form sharp divides to the north and to the south, respectively, of these creeks, and extend to the coast to form Burleigh Heads and Currumbin Headland. The higher portions of the divides are capped by Tertiary basalt.

D. METHOD OF TESTING.

1. Mapping. The deposits of heavy minerals were bored for the purpose of obtaining samples and at the same time, locating boundaries. The position of bores in the dune area were recorded by taping from fences and allotment pegs and were plotted on the Queensland Lands Department plan of Palm Beach, Sheets 1 and 2 (scale : 1 inch equals 4 chains). The northernmost bore lines, which are beyond the boundary of the Palm Beach Township, were mapped by means of a plane table and telescopic alidade. The positions of the scout bores and boundaries within the coastal plain were located by compass-pacing surveys, and plotted on a plan based on the Queensland Lands Department map of the Parish of Tallebudgera. The data are reproduced in Plate 1. Fig. 3, on a scale of 1 inch equals 500 feet. The boundaries of the Palaeozoic sediments were sketched onto the Lands Department Parish and Town Plans, and are approximate only. These boundaries are shown in Plate 1, Figs : 2 and 3.

2. Boring. Preliminary boring and sampling of the beach and dune strip was carried out during April and May 1948, when bores were put down to ground water level. Additional boring was done in April 1949, again to ground water level, to define the boundaries of the heavy mineral deposits. In November, 1949, some of the earlier bores were deepened and sampled below water level. At the same time scout boring was undertaken in the coastal plain.

3. Sampling. During the preliminary boring, samples were taken of any sand which appeared to contain appreciable quantities of heavy minerals. Subsequent bores were sampled in sections from top to bottom, whether mineral appeared to be present or not. The reason for this complete sampling is that concentrates with a comparatively high zircon content tend to be grey rather than black. As a result, sand with several per cent of such concentrate is liable to be left unsampled. The samples were reduced by quartering to a convenient size, about 700 or 1000 cubic centimetres and bagged for despatch to the field laboratory.

4. Laboratory Work.

(a) Estimation of Quantities of heavy minerals. Samples were dried and their weights and volumes were measured. The heavy mineral concentrates were then separated from the samples by means of a laboratory Wilfley Table and the weights and volumes of the dry concentrates were measured. The quantities of heavy minerals in the samples were them expressed as weight per cent and "lbs/per Cu. Yd", (pounds weight of heavy mineral concentrates per cubic yard of sand) and are given in Table 7 at the end of this report.

(b) Determination of Compositions of Concentrates. The average percentage composition of the heavy mineral concentrates in the area was obtained from a composite sample from each bore line. The composition of the composite sample was determined by separating the sample into a magnetic and a non-magnetic fraction on a Frantz Isodynamic Separator and grain counting the two fractions. The monazite content of the sample was determined radiometrically. The average composition of the heavy mineral concentrate in the area is given in Table 3 of this report.

(c) Variation in the Composition of the Heavy Mineral Concentrates and in the Thoria Content of the Monazite. In order to detect any variation which might occur in their compositions the concentrates of the area were grouped into composite samples representative of the heavy mineral in successive portions of Block 2 (shown in plate 1) Figs. 3 and 4) from south to north. A single composite sample was made up to represent Block 1. The composite samples were made up from the various bore lines as shown in Table 1.

Laboratory Work Cont.

TABLE 1. Palm Beach Area : Preparation of Composite Sample to Examine Distribution of Heavy Minerals.

COMPOSITE SAMPLE	BORE LINES FROM WHICH SAMPLES WERE TAKEN TO MAKE UP COMPOSITE.
Block 1.	Line 40W, Line 440W, Line 800W.
C.1.	Line 2240N and line 1890N
C.2.	Line 00 and Line 1066S
C.3.	Line 2966S and Line 4576S
C.4.	Line 6697S and Line 7364S.

Each composite sample was divided into two portions - one portion for the determination of the content of zircon, rutile and ilmenite, the other for the determination of percentage monazite.

(i) Zircon, Rutile and Ilmenite. The sample was separated magnetically on a Frantz Isodynamic Separator giving a magnetic fraction made up mostly of ilmenite with a little monazite and a few grains of garnet and tourmaline, and a non-magnetic fraction of zircon and rutile. The zircon and rutile were separated electrostatically. The magnetic fraction and the zircon and rutile concentrates were weighed. The composition of the magnetic fraction was determined by grain counting.

(ii) Monazite. Geiger-Muller gamma-ray counting equipment was standardised for the monazite of the composite samples of the area by the following method : a quantity of monazite (Footnote 1) was prepared from concentrates of the area. Weighed amounts of this monazite were mixed with weighed amounts of zircon, rutile and ilmenite to form concentrates having the approximate composition of the mixed samples i.e. the composite sample. The counting rates given on the Geiger-Muller equipment by these samples of known monazite content were recorded. The second portion of each of the composite samples was similarly tested by means of the calibrated equipment, and the Geiger-Muller count for each sample was converted into percentage monazite.

(iii) Thoria Content of Monazite. A monazite concentrate was separated from a composite sample representing the whole area. The thoria content of this monazite was tested radiometrically by comparison with a standard monazite containing 6.6% thoria. Monazite concentrates were also separated out from composite samples representing Block 1 and Block 2. As the quantity of monazite obtained from these composites was too small to fill the smallest of the sample containers for which the Geiger-Muller equipment has been calibrated, zircon (Footnote 2) was added to the monazite to make up the required volume of the sample. The standard monazite was then mixed with some of the same zircon, such that the proportions of monazite and zircon approximated to those in the sample to be determined. The thoria content of the monazite in the two samples was then compared radiometrically with the thoria content of the standard monazite.

FOOTNOTE (1) This "monazite" was actually a concentrate containing 99% monazite. It was not necessary to prepare a 100% monazite concentrate to obtain the required results.

FOOTNOTE (2) The zircon is itself considerably radioactive. However, it was chosen to supplement the monazite because its specific gravity and grain size are sufficiently close to the specific gravity and grain size of monazite that little segregation of the minerals occurs after mixing. The radio-activity due to the zircon is pre-determined and the allowance for it is made when estimating monazite and thoria.

E. THE RESULTS OF THE INVESTIGATION.

1. Distribution of Mineral Deposits.

(a) Extent. The plans given in Plate 1, Figs 3 and 4 show that the deposits of heavy minerals occur from the northern end of Palm Beach to approximately 10,000 feet south, and vary in width from 80 feet to 400 feet. The average width is 156 feet. The average thickness of the deposits (Table 3) is 3.3 feet. In the sections of Plate 2 it is seen that nearly all of the heavy mineral occurs beneath the long foredune and the adjacent trough-like depression on the land-ward side. Little heavy mineral occurs on the beach except at the northern tip of the area, a short distance inside the mouth of Tallebudgera Creek.

(b) Shape and Attitude. The deposits extend unbroken for considerable distances parallel to the beach. In cross section, that is, a section in a vertical plane at right angles to the beach, a seam commonly appears wedge shaped, tapering off gradually down the beach and dipping bodily down the beach at an angle of a few degrees. The section on Plate 2 of the 1066S bore line shows that such a seam has been intersected in bore holes 24W and 00. A similar seam of lower grade appears to have been intersected in boreholes 00, 27E and 60E. Commonly two or more seams, each parallel to the beach and dipping towards it, are arranged en echelon and overlapping from east to west, forming a composite deposit.

(c) The levels at which the Deposits Occur. The most important of the deposits occur adjacent to the beach between mean sea level and extreme high tide levels. Wind formed deposits occur in the dunes at higher levels, and minor concentrations due to tidal currents appear at lower levels within the mouth of Tallebudgera Creek. The bottoms of the deposits are mostly at a level of 3.5 to 4.5 feet; that is, eighteen inches or less above mean sea level. At the northern end of the area, adjacent to Tallebudgera Creek, deposits of comparatively low grade, from 120 to 300 lbs of concentrate per cubic yard, persist down to a foot below mean low water, or approximately 4 feet below mean sea level. In the remainder of the area, from line 1890N to 7364S, the logs of three bores report heavy minerals below mean sea level (but above low water level). Each of these three bores was put down near the top of the beach, some time after the bore site had been levelled. It is possible that the upper portion of the beach had by then been built up a foot or two by wind-blown sand. If so, the level of the heavy mineral would be higher than reported. The tops of the deposits are usually 10 to 12 ft. above mean low water, although the sand of lower grade, 120 to 300 lb. per cubic yard, occurs in addition in wind-formed deposits 15 to 18 feet above mean low water. Details of the levels of the deposits are summarised in Table.2.

TABLE 2. PALM BEACH AREA : LEVELS OF DEPOSITS.
Giving the maximum and minimum level in each bore line.

GRADE	LEVELS OF DEPOSITS, REFERRED TO MEAN LOW WATER.	
Lb. per Cu.Yd.	TOP OF DEPOSIT (FT)	BOTTOM OF DEPOSIT (FT)
over 300	Average 11.0 Extreme range 6.5 to 13.4 Usual Range. 10 to 12 ø	Average 4.4 Extreme Range. 1.5 to 8.0. + Usual Range 3.5 to 4.5 ø
120 to 300	Average 11.9 Extreme Range. 6.2. to 18.5 Usual Range 15 to 18 X 8 to 11 ø	Average 4.0 Extreme Range -1 to 11 Usual Range -1 to 1 ≠ 3.5 to 4.5 ø 10 to 12 X

REMARKS.
- ø Deposits fromed by wave action.
- X Deposits formed by wind action.
- \+ It may be necessary to add 1 to 2 feet to the lower level (see notes preceding this table.
- ≠ Deposited at edge of creek, a short distance inside mouth of creek.

(d) Scout Boring in the Coastal Plain. The scout boring in the sandy portions of the coastal plain failed to locate more than faint traces of heavy minerals. Some of the scout bores were sited near spurs and "islands" of Palaeozoic sediments against which deposits of heavy minerals should be retained, if at any time they had been formed in this area. Furthermore, bores put down by the Zinc Corporation (Donaldson and Stuart, 1948) near the "Flanora" and "Inland" lines to depths of 17 to 35 feet failed to find more than traces of heavy mineral. The best sample, from Bore No.8, contained 0.8 per cent by volume of heavy minerals from 29 feet to 35 feet. The results of the boring by the Bureau of Mineral Resources lead to the conclusion that, down to at least several feet below mean low water level, no deposits of heavy minerals occur west of those shown in Plates 1 and 2. Considering the favourable position of the Zinc Corporation bores in relation to the spurs of bedrock, it appears safe to conclude that no deposits occur down to at least 30 ft. below mean low water. Beasley (1948) has recorded that bores sunk to depths of from 30 to 50 feet at the extreme southern end of Palm Beach, in the area around Birch Island, intersected no black sand deposits, although beach sand was encountered throughout all of the bores.

2. RESERVES.

(a) Total Reserves. A summary of the total reserves of heavy minerals and quantities of overburden is given in Table 3, while a statement of the reserves between each pair of bore lines appears in Table. 6. Details of bores and samples are given in Table 7. It has been necessary to decide, somewhat arbitrarily, the minimum grade of mineral-bearing sand which should be included as reserves, and the minimum thickness of sand of any given grade. The minimum grade has been fixed at 120 lbs. weight of heavy mineral concentrate per cubic yd. of sand. This is a little greater than 4 per cent by weight. (Footnote) The minimum quantity of mineral was decided on the basis that the product of thickness of seam in feet and pounds of heavy mineral concentrate per cubic yard should be at least 300. Thus a seam which has a grade of 600 lbs of concentrate per cu.yd. must be at least 6 inches thick, and a seam of minimum grade, viz., 120 lbs per cu.yd. must have a thickness of at least 2ft.6 inches. It may be noted that the tonnage of heavy minerals given in Table 3 is made up almost entirely from deposits of much higher grades than 120 lbs per cu.yd. This becomes clear from the figures given for overall average grade (Table 3) , for the average grades of the various sections of the deposits (Table 6) and for the average grade at each of the bores (Table 7). The sections of the heavy mineral sands in plate 2, are somewhat misleading, in that they appear to show more or less equal quantities of sand of the higher and lower grades. Actually, there are more or less equal thicknesses of the sands, but the quantities of heavy minerals in the higher grade deposits far outweigh the quantities in the lower grade sands. A deposit has been considered to extend across a bore line to the first bore which fails to intersect sufficient mineral of economic grade as defined above. The quantity of mineral encountered at the previous bore is assumed to taper off to the insufficient quantity at the edge of the deposit.

FOOTNOTE. Figures for weight per cent and pounds per cubic yard may be interchanged on the basis that 1 per cent bh weight equals 30 lb. per cu.yd. (approximately). This relationship holds reasonably well up to about 30 per cent, but as the percentage by weight continues to rise above 30, the number of pounds weight of mineral corresponding to each 1 per cent becomes increasingly larger.

TABLE 3. **PALM BEACH AREA : SUMMARY OF QUANTITIES.**

BLOCK AS SHOWN IN PLATE 1 FIG.4.	Area SQ.YDS.	WEIGHT OF HEAVY MIN CONCENTRATE (TONS)	VOLUME		AVERAGE THICKNESS.		AV. GRADE. OF MINERAL DEPOSITS LBS OF CONCENTRATE PER CU. YD.
			MINERAL DEPOSITS CU.YDS.	OVER-BURDEN CU.YDS.	MINERAL DEPOSITS FT.	OVER-BURDEN FT.	
Block 1.	10,984	1,231	11,978	2,431	3.3	0.7	230
Block 2.	174,812	45,881	193,691	260,718	3.3	4.5	531
TOTAL.	185,796	47,112	205,669	263,149	3.3	4.2	513.

AVERAGE COMPOSITION OF CONCENTRATES, AND WEIGHT OF EACH MINERAL.

	MONAZITE	ZIRCON	RUTILE	ILMENITE	GARNET	OTHER MINERALS ø
PERCENTAGE	0.53	40.1	35.6	22.3	0.3 X	1.3
WEIGHT (TONS)	250	18,891	16,772	10,506	142	551.

X. This figure is somewhat low : variable proportions of these minerals are lost when the sand is being tabled

ø The "other minerals " are chiefly tourmaline and Leucoxene, with lesser amounts of epidote, spinel and occasional grains of corundum, staurolite, kyanite and amphibole.

(b) Quantities now available for mining. The plans given in Plate 1 show that southwards from the 900N bore line the deposits occur almost entirely within the boundaries of the Esplanade, and of land which has been largely built on for residential purposes. It is clear that none of this mineral will become available for mining. Of the deposits north of the 900N line most of the heavy mineral lies within the boundaries of D.C.20 and presumably, will eventually be mined. The quantities derived from the data in Table 3 and 4 are :-

Total Reserves North of Bore Line 900N.

Reserves of heavy mineral : 12,000 tons in 69,000 cu.yds of sand.
Average Grade : 396.0 lbs per cu.yd.
Average thickness of deposits : 4.0 ft.
Volume of overburden : 40,000 cu.yds.
Av. thickness of overburden : 2.3 ft.

The Reserves withing D.C.20.

Reserves of heavy mineral : 7000 tons in 35,000 cu.yds of sand.
Average grade : 465 lbs/ cu/yd.
Average thickness of deposits : 5.0 ft.
Volume of overburden : 58,000 cu.yds.
Average thickness of overburden: 2.75 ft.

(c) Past Mining. Some years ago some thousands of tons of heavy minerals were obtained by Rutile Sands Pty Ltd. from D.C.21, between , approximately 26th Av. and 14th Avenue. Using the origin which has been adopted for the bore lines in this report, viz., 27th Ave., this mineral came from the upper part of the beach from about 300 feet south to 4200 feet south. In latter years, the beach front has been severely eroded, and has advanced so far westwards, that any mineral which might be deposited would be outside the western boundary of D.C. 21.

(d) Possible Future Deposits. It is probable that in future years Palm Beach will again be built up and advance in an eastward or seaward direction. Fresh deposits of heavy minerals may then form east of the present property frontages. There is, however, no certainty that this process of building up and formation of new deposits will take place. Only small quantities of heavy minerals appear on the beach during stormy weather, although further north along the coast, e.g. on Miami Beabh, Broadbeach and Mermaid Beach, an estimated 1000 to 2000 tons of heavy concentrates appear annually. The reserves of heavy minerals at present available for mining may be the total future reserves in the Palm Beach Area.

3. Distribution of the Mineral Throughout the area: The percentages of Zircon, rutile, ilmenite and monazite in the composite samples of Table 1, representing portions of the deposits from north to south are given below in Table 4.

TABLE 4. Variation in Mineral Composition of Concentrates.

COMPOSITE.	PERCENTAGE		COMPOSITION.	
	ZIRCON	RUTILE	ILMENITE	MONAZITE.
Block 1.	39.8	36.1.	23.7	0.43
C.1.	38.3	37.4	23.9	0.40
C.2	39.9	36.4	23.3	0.43
C.3	40.5	36.4	22.6	0.52
C.4	40.5	36.1	22.8	0.64

From Plate 3. Fig.1. it is seen that there is a tendency for the percentage of zircon to decrease from south to north while there is a corresponding increase in the percentages of rutile and ilmenite. However, when Block 1 is reached, the percentage of zircon increases a little while the percentages of rutile and ilmenite fall off somewhat. It is of interest to note that some correlation can be made between the distribution of the minerals and their specific gravities. The curves of zircon,"of specific gravity 4.66",and rutile (S.G.4.2) diverge appreciably while the curve due to ilmenite which has an intermediate specific gravity of 4.5, has an intermediate position.

The curve for monazite, Plate 3. Fig. 2. is approximately parallel to that for zircon excepting that part of the curve which represents the most southerly portion of the area. In the case of Zircon the curve flattens out in this position but with monazite the curve continues to rise.

It is suggested that the variations which appear in the compositions of the heavy mineral concentrates are due to differential transport of the minerals. The transporting agent along the main portion of the beach is the surf, and at the northern tip of the beach is the tidal current throught the mouth of Tallebudgera Creek. The surf from the Pacific Ocean strikes the beach from a south-easterly direction, runs up the beach and slightly northwards along the beach and recedes directly down the beach. Due to this action, sand grains move in a zig-zag path northwards along the beach. The monazite and zircon, presumably because of their greater specific gravities, lag behind the rutile and ilmenite. Thus, proceeding from south to north, the concentrates tend to be enriched in rutile and ilmenite, and impoverished in zircon and monazite. At the northern tip of the area, the surf is replaced by the tidal currents within the mouth of Tallebudgera Creek. The mixture of heavy minerals which reaches the northern tip appears to be subjected to a process of selective transportation similar to that which operates along the beach from south to north.

4. <u>The Thoria Content of the Monazite.</u> Figures for the determination of thoria are given in Table 5, from which it is seen that the monazite contains (6.6 ± 0.3) per cent thoria . (The instrumental error is ± 0.3). Hence, the results indicate that within experimental limits, there is no variation in the thoria content of the monazite between Block 1, and Block 2.

ACKNOWLEDGEMENTS.

The Beach Sands Investigation along the Queensland coast has received assistance from the Queensland Mines Department in the provision of lease plans, from the Survey Office, Lands Department in the photographic reproduction and enlargement of drawings, from the Department of Agriculture and Stock regarding the plant life of the areas investigated, and from operating companies who have given information on beach sand mining, past and present. Information regarding Palm Beach has been provided by Rutile Sands Pty Ltd., Currumbin, and by the Zinc Corperation Ltd., Brisbane. In the administrative and supply aspects of the work, much help has been received from the State Controller and officers of the Department of Supply and Development, Brisbane.

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To follow Page 12.

TABLE 5. **PALM BEACH AREA.** **THORIA CONTENT OF MONAZITE.**

MONAZITE CONCENTRATE	BLOCK 1	BLOCK 2.	Entire Area. (BLOCKS 1 & 2.)
MONAZITE CONCENTRATE (M) SEPARATED FROM THE MIXED HEAVY CONCENTRATE OF THE BLOCK.	MONAZITE (M1) 97.9 ZIRCON 0.7 ILMENITE 1.2 OTHER MINERALS. 0.2. 100.0	MONAZITE (M2) 98.2 ZIRCON 1.0 ILMENITE. 0.8 100.0	MONAZITE (M1+M2) 99.2 ZIRCON 0.2 ILMENITE 0.4 CASSITERITE. 0.2 100.0
MONAZITE CONCENTRATE (T) (made up from Monazite Concentrate (M) shown above) TESTED FOR THORIA (IN THE CASE OF BLOCKS 1 AND 2, THIS CONCENTRATE WAS MADE UP BY MIXING CONCENTRATE M WITH ZIRCON)	MONAZITE (M1) 7.7 ZIRCON 92.2 ILMENITE 0.1 100.0	MONAZITE (M2) 29.8 ZIRCON 70.0 ILMENITE 0.2 100.0	THE CONCENTRATE TESTED WAS THE MONAZITE CONCENTRATE (M) SHOWN ABOVE.
MONAZITE CONCENTRATE (C). THIS CONCENTRATE WAS MADE UP BY MIXING THE STANDARD MONAZITE (MS) WITH ZIRCON ETC.	MONAZITE (MS) 7.0 ZIRCON 92.9 ILMENITE 0.1 100.0	MONAZITE (MS) 30.0 ZIRCON 69.7 ILMENITE 0.2 OTHER MINERALS. 0.1 100.0.	MONAZITE (MS) 98.9 ILMENITE 0.8 OTHER MINERALS 0.3 100.0
MASS OF MONAZITE CONCENTRATE (T) (IN GRAMS)	9.910	10.011	10.920
MASS OF MONAZITE CONCENTRATE (C) (IN GRAMS)	9.958	9.771	11.032
EXCESS OVER BACKGROUND (COUNTS PER MINUTE) DUE TO MONAZITE CONCENTRATE (T)	67	199	639
EXCESS OVER BACKGROUND (COUNTS PER MINUTE) DUE TO MONAZITE CONCENTRATE (C)	63	200	635
COUNTS /GRAM /MINUTE OF MONAZITE (M1, M2 and M1+M2) in MONAZITE CONCENTRATE (T) ALLOWING FOR COUNTS DUE TO ZIRCON	$\left(\frac{67-16}{.763}\right) = 66.8$	$\left(\frac{199-13.8}{2.983}\right) = 62.1$	$\left(\frac{639}{10.833}\right) = 58.1.$ (counts due to zircon are negligible)
COUNTS/GRAM/MINUTE OF MONAZITE (MS) IN MONAZITE CONCENTRATE (C) ALLOWING FOR COUNTS DUE TO ZIRCON	$\left(\frac{63-17}{.697}\right) = 66.0$	$\left(\frac{200-12.2}{2.931}\right) = 64.1$	$\left(\frac{635}{10.911}\right) = 58.2$ (counts due to zircon are negligible)
PERCENTAGE THORIA. (≠)	$\left(\frac{66.8 \times 6.6\%}{66.0}\right) = 6.7\%$	$\left(\frac{62.1 \times 6.6\%}{64.1}\right) = 6.4\%$	$\left(\frac{58.1 \times 6.6\%}{58.2}\right) = 6.6\%$

(≠) Calculated on the basis of the thoria content of the standard monazite which chemical analysis gives at 6.6%.

BORE LINES	DISTANCE BETWEEN LINES (YDS).	WIDTH OF DEPOSIT AT LINE. (YDS.)	TOTAL BETWEEN LINES. AREA OF DEPOSIT (SQ.YDS)	WT.OF MIN. (LBS.& TONS)	VOLUME (CUB.YDS.) MINERAL DEPOSITS	OVERBURDEN	AVERAGE THICKNESS (FT.) MINERAL DEPOSITS.	OVERBURDEN	GRADE (LBS/CU.YD.)
800W 440W	120	40 40	4800	1,764,000 787	5804	1,404	4.2	0.9	259
440W 40W	133	40 53	6,184	994,840 444	5,174	1,037	2.5	0.5	192
2240N 1890N	117	160 107	15,620	10,174,554 4,542	24,570	10,331	4.7	2.0	414
1890N 900N	330	107 44	24,915	14,519,010 6,482	32,769	27,324	4.2	3.5	443
900N 00	300	44 77	18,150	6,814,800 3,042	11,700	50,400	3.0	8.3	582
00 1066S	355	77 42	21,122	7,521,385 3,358	18,105	51,475	2.5	7.3	415
1066S 1966S	300	42 55	14,550	9,341,700 4,170	15,000	21,900	3.1	4.5	623
1966S 2966S	333	55 22	12,820	7,019,640 3,134	9,324	15,984	2.2	3.7	752
2966S 3951S	328	22 47	11316	12,859,896 5,741	15,744	9,512	4.2	2.5	817.

TABLE 6 LOCALITY **PALM BEACH AREA.** DETAILED STATEMENT OF QUANTITIES BETWEEN BORE LINES.

BORE LINES	DISTANCE BETWEEN LINES (YDS).	WIDTH OF DEPOSIT AT LINE. (YDS.)	TOTAL BETWEEN LINES. AREA OF DEPOSIT (SQ.YDS)	WT. OF MIN. (LBS.& TONS)	VOLUME (CUB.YDS.) MINERAL DEPOSITS	OVERBURDEN	AVERAGE THICKNESS (FT.) MINERAL DEPOSITS	OVERBURDEN	GRADE (LBS/CU.YD.)
3951S 4576S	208	47 58	10,920	13,847,392 6,182	18,720	12,896	5.1	3.5	740
4576S 5931S	452	58 33	20,566	16,364,660 7,306	32,996	28,024	4.8	4.1	496
5931S 6697S	255	33 66	12,623	2,425,815 1,083	9,435	13,770	2.2	3.8	257
6697S 7364S	222	66 44	12,210	1,884,114 841	5,328	19,092	1.3	5.0	354
TOTAL			185,796	105,531,806 47,112	205,669	263.149	3.3	4.2	513.

TABLE 7 HEAVY MINERAL AND OVERBURDEN IN BORES.

PALM BEACH AREA.

ORIGIN OF CO-ORDINATES : 2240 ft. north of 27th Av. Palm Beach, as shown in Plate 1, Fig.3.

LINE 2240N.

BORE	DEPTH FROM	DEPTH TO	LBS/CU. YD.	O/BRDN FT.
40E	0'0"	3'0"	370	
	3'0"	4'0"	Not Sampled.	
	4'0"	5'0"	210	0.0
	5'	7'	83	
	7'	11'	Trace	
Thickness		5'	204	
00	0'	3'	65	
	3'	6'	90	
	6'	8'6"	77	8.5
	8'6"	9'6"	846	
	9'6"	13'	79	
Thickness		1'	846	
40W	0'	3'	88	
	3'	4'	Not Sampled	
	4'	5'	2564	4.0
	5'	7'	96	
	7'	11'	Trace	
Thickness		1'	2564	
80W	0'	3'	107	
	3'	4'	1690	3.0
	4'	7'	104	
	7'	11'	31	
Thickness		1'	1690	
120W	0'	3'	65	
	3'	6'	164	
	6'	9'	291	3.0
	9'	11'	143	
Thickness		8'	206	
160W	0'	3'	173	
	3'	3'9"	1622	
	3'9"	4'9"	198	0.0
	4'9"	6'6"	2412	
	6'6"	8'	360	
	8'	11'	71	
Thickness		8'	862	
200W	0'	3'	182	
	3'	4'	Not Sampled	
	4'	4'6"	1516	
	4'6"	4'9"	Not sampled	
	4'9"	6'9"	1555	0.0
	6'9"	8'	101	
	8'	10'	157	
	10'	11'	44	
Thickness		10'	486	
240W	0'	3'	170	
	3'	5'	180	
	5'	5'6"	1200	
	5'6"	6'	Not Samples.	0.0
	6'	6'9"	1322	
	6'9"	9'9"	84	
	9'9"	12'	Trace	
Thickness		6'9"	365	
280W	0'	3'	112	
	3'	6'	363	
	6'	9'	60	3.0
	9'	11'	25	
Thickness		3'	363	
320W	0'	3'	301	
	3'	6'	205	
	6'	8'6"	81	0.0
	8'6"	11'	67	
Thickness		6'	253	
360W	0'	3'	163	
	3'	6'	159	
	6'	8'6"	34	0.0
	8'6"	11'	24	
Thickness		6'	161	
400W	0'	3'	58	
	3'	7'	160	
	7'	10'	22	3.0
	10'	11'	not sampled.	
Thickness		4'	160	
440W	0'	3'	34	
	3'	6'	149	
	6'	9'	96	3.0
	9'	11'	17	
Thickness		3'	149	
Total & AV Thickness		4.9	441	2.2
1890N		4.5	370	1.7

TABLE 7 — PALM BEACH AREA.
HEAVY MINERAL AND OVERBURDEN IN BORES.

ORIGIN OF CO-ORDINATES : Line 2240 N approx. 800' west as shown on Plate 1. Fig. 3.

LINE 800 W. (ALSO LINES 440W, 40W, 1890N)

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
Line 800W.				
40N	0'	3'	71	
	3'	6'	421	
	6'	9'	181	3.0
	9'	11'	26	
Thickness		6'	301.	
80N	0'	3'	105	
	3'	6'	141	
	6'	9'	35	3.0
	9'	11'	15	
Thickness		3'	141	
120N	0'	3'	501	
	3'	6'	258	
	6'	9'	111	0.0
	9'	11'	41	
Thickness		6'	379	
160N	0'	3'	289	
	3'	6'	296	
	6'	9'	80	0.0
	9'	11'	32	
Thickness		6'	292	
Average		5'	298	1.5

LINE 440 W.

Line 2240N, 440 ft. west as shown on Plate 1. Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
40N	0'	3'	66	
	3'	6'	96	
	6'	9'	82	1.5
	9'	11'	Trace	
80N	0'	3'	328	
	3'	6'	103	
	6'	9'	80	0.0
	9'	11'	Trace	
Thickness		3'	328	
120N	0'	3'	157	
	3'	6'	109	
	6'	9'	25	
	9'	12'	24	0.0
	12'	15'	53	
	15'	18'	18	
	18'	21'	Trace	
Thickness		3'	151	
160N	0'	3'	268	
	3'	6'	54	
	6'	9'	134	0.0
	9'	11'	87	
Thickness		9'	152	
Average		3.5'	204	0.25

LINE 40 W.

Line 2240N, 40 feet west, as shown in Plate 1. Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
40N	0'	3'	75	
	3'	6'	87	
	6'	11'	Trace	
80N	0'	3'	93	
	3'	6'	102	1.5
	6'	11'	Trace	
120 N	0'	3'	138	
	3'	6'	Trace	
	6'	9'	26	0.0
	9'	11'	30	
Thickness		3'	138	
160N	0'	3'	84	
	3'	6'6"	8	1.5
	6'6"	23'	Trace.	
200N	0'	3'	136	
	3'	14'3"	Trace	0.0
Thickness		3'	136	
240N	0'	1'	72	
	1'	3'	405	
	3'	7'	67	1.0
	7'	11'	Trace	
	11'	14'	43	
Thickness		2'	405	
Average		1.8'	175	0.7

LINE. 1890 N

1890' north of 27th Avenue, and 980' east of Pacific Highway, as shown in Plate 1. Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
00	0'	3'	38	
	3'	6'	58	
	6'	9'	Trace	
	9'	12'	47	
	12'	13'9"	161	
	13'9"	14'3"	625	12.0
	14'3"	17'3"	Trace.	
	17'3"	17'6"	324	
	17'6"	19'	41	
Thickness		5'6"	122.	
40W	0'	3'	111	
	3'	4'	114	
	4'	4'3"	366	
	4'3"	7'3"	22 (?)	
	7'3"	7'5"	897	4.0
	7'5"	8'3"	2607	
	8'3"	11'	156	
	11'	14'	42	
Thickness		7'	415.	

CONTINUED.

TABLE 7 PALM BEACH AREA. HEAVY MINERAL AND OVERBURDEN IN BORES.

ORIGIN OF CO-ORDINATES : 1890' north of 27th Avenue, and 980 east of Pacific Highway, as shown in Plate 1, Fig. 3.

LINE 1890N. CONT.

BORE	DEPTH. FROM	TO	LBS/ CU. YD.	O/BRDN FT.
80W	0'	3'	44	
	3'	6'	167	
	6'0"	6'9"	3070	
	6'9"	10'	178	
	10'	10'6"	2300	3.0
	10'6"	11'6"	492	
	11'6"	12'	1455	
	12'	15'	75	
	15'	16'	82	
Thickness		9'	639	
120W	0'	3'	192	
	3'	6'	46	
	6'	9'6"	63	0.0
	9'6"	12'6"	90	
Thickness		3'	192	
160W	0'	3'	143	
	3'	5'6"	316	
	5'6"	6'3"	1925	
	6'3"	9'6"	Trace	0.0
	9'6"	11'6"	110	
	11'6"	16'	Trace	
Thickness		5'0"	426	
200W	0'	3'	230	
	3'	6'	76	
	6'	9'	104	
	9'	11'	Trace	0.0
	11'	14'	109	
	14'	16'	Trace	
Thickness		3'	230	
240W	0'	3'	143	
	3'	6'	Trace	
	6'	9'	84	
	9'	12'	38	0.0
	12'	15'	Trace	
	15'	16'	28	
Thickness		3'	143	
280W	0'	3'	134	
	3'	6'	51	
	6'	9'	Trace	
	9'	12'	38	0.0
	12'	14'	Trace	
Thickness		3'	134.	
320W	0'	3'	68	
	3'	6'	79	1.5
	6'	11'	Trace	
Average		4.5'	370	1.7
360W	0'	6'	Trace	
	6'	9'	41	
	9'	11'	Trace	
440W	0'	3'	Trace	
	3'	6'	75	
	6'	9'	57	
	9'	11'	52.	

BORE	DEPTH FROM	TO	LBS/ CU. YD.	O/BRDN FT.
520W	0'	3'	104	
	3'	11'	Trace.	
560W	0'	3'	86	
	3'	6'	Trace	
	6'	9'	29	
	9'	11'	Trace	
600W	0'	3'	60	
	3'	6'	37	
	6'	9'	37	
	9'	11'	Trace	
640W	0'	3'	40	
	3'	11'	Trace	
680W	0'	11'	Trace.	
720W	0'	3'	37	
	3'	6'	55	
	6'	11'	Trace	
760W	0'	11'	Trace	
800W	0'	11'	Trace.	
840W	0'	11'	Trace	
880W	0'	3'	Trace	
	3'	6'	"	
	6'	11'	"	
920W	0'	11'	Trace	
1000W	0'	3'	Trace	
	3'	6'	21	
	6'	11'	Trace	
1040 W	0'	3'	Trace	
	3'	6'	14	
	6'	11'	Trace	
1080 W	0'	6'	Trace	
	6'	9'	20	
	9'	11'	Trace	
1120W	0'	3'	6	
	3'	16'	Trace	
1160W	0'	6'	Trace	
	6'	9'	17	
	9'	21'	Trace	
1200W	0'	6'	Trace	
	6'	9'	13	
	9'	11'	Trace	
1240W	0'	6'	Trace	
	6'	9'	12	
	9'	11'	Trace.	

ORIGIN OF CO-ORDINATES : ~~1890' north of 27th Av. and 980' west of~~ Pacific Highway, as shown in Plate 1, Fig.3.

LINE 1890N (Contd) ALSO.900N. & 00.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
1280W	0'	3'	20	
	3'	6'	Trace	
	6'	9'	17	
	9'	11'	Trace	
1320W	0'	16'	Trace.	
1360W	0'	6'	Trace	
	6'	9'	21	
	9'	11'	Trace.	
1440W	0'	11'	Trace	
1520W	0'	11'	Trace	
1600	0'	3'	Trace	
	3'	6'	17	
	6'	9'	28	
	9'	11'	Trace	
1640W	0'	3'	Trace	
	3'	6'	35	
	6'	9'	40	
	9'	11'3"	Trace.	
1680W	0'	6'	Trace	
	6'	9'	32	
	9'	12'	46	
	12'	13'	Trace	
1720W	0'	11'	Trace.	

LINE 900.N.

900' north of 27th. Avenue and 280' east of east fence of Pacific Highway as shown on Plate 1, Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
66E	0'	1'9"	1261.	
	1'9"	2'6"	Not sampled.	
	2'6"	2'9"	606	0.0
	2'9"	4'6"	not sampled.	
Thickness		2'9"	857	
33E	0'	3'	124	
	3'	6'	32	
	6'	9'	75	0.0
	9'	17'	Trace	
Thickness		3'	124	
00	0'	3'	37	
	3'	6'	Trace	
	6'	9'	64	
	9'	12'	Trace	
	12'	15'	74	15.0
	15'	16'	3017	
	16'	21'	Trace	
Thickness		1'	3017.	

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
33W	0'	3'	46	
	3'	6'	49	
	6'	12'	Trace	
	12'	12'10"	2283.	12.0
	12'10"	17'	Trace.	
Thickness		0'10"	2283	
66W	0'	3'	66	
	3'	6'	142	
	6'	9'	187	
	9'	9'6"	2262	3.0
	9'6"	12'	166	
	12'	12'3"	1975	
	12'3"	16'	15	
Thickness		9'3"	327	
Average		2.7'	735.2	7.1

LINE. 00.

33' south of middle of 27th Av. and 211' east of east fence of Pacific Highway as shown in Plate.1. Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
165E	0'0"	1'2"	22	
	1'2"	2'2"	2142	1.16
	2'2"	2'6"	not sampled.	
Thickness		1'	2142.	
132E	0'	5'	252	0.0
99E	0'	5'	95	
	5'	10'	51	7.7 ≠ (Footnote)
	10'	12'	8	
66E	0'	3'	Trace	
	3'	6'	104	
	6'	9'	29	
	9'	12'	Trace	
	12'	13'6"	138	12.0
	13'6"	13'9"	1413	
	13'9"	17'	85	
Thickness		1'9"	320	
44E	0'	12'	Trace	
	12'	14'6"	179	
	14'6"	15'6"	418	12.0
	15'6"	21'	Trace	
Thickness		3'6"	247	
00	0'	6'	Trace	
	6'	9'	115	
	9'	12'3"	Trace	12.25
	12'3"	12'6"	1982	
	12'6"	21'	Trace	
Thickness		0'3"	1982	
66W	0'	5'	19	
	5'	10'	45	12.37
	10'	15'6"	21	
Average		1.5'	415	9.0

≠ FOOTNOTE. Mean overburden due to adjacent bores.

TABLE 7 PALM BEACH AREA.
HEAVY MINERAL AND OVERBURDEN IN BORES.

ORIGIN OF CO-ORDINATES : 33' south of middle of 27th. Ave., and 211' east of east fence of Pacific Highway as shown in Plate 1, Fig. 3.

LINE 00 (contd) ALSO 1066S & 1966S

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
157W	0'	14'3"	Trace	
190 W	0'	21'	Trace.	
232W	0'	9'6"	Not Sampled	
	9'6"	10'	924	
	10'	11'6"	Not sampled	
	11'6"	12'7"	1350	
	12'7"	18'	not sampled.	
265W	0'	21'6"	Trace.	
295W	0'	12'	Trace	
	12'	15'	50	
	15'	21'	Trace	

LINE. 1066S

1066' south of 27th Av, and 265' east of east fence of Pacific Highway as shown in Plate 1.Fig.3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
60E	0'	3'	376	
	3'	6'	83	0.0
	6'	9'	268	
	9'	11'	66	
Thickness		9'	242.	
27E	0'	3'	43	
	3'	9'	Trace	
	9'	12'	295	
	12'	15'	45	9.0
	15'	17'	Trace	
Thickness		3'	295	
00	0'	3'	208	
	3'	6'6"	46	
	6'6"	9'	104	
	9'	10'	1896	0.0
	10'	13'	69	
	13'	16'	33	
Thickness		10'	294	
24W	0'	3'	Trace	
	3'	4'6"	46	
	4'6"	5'	944	
	5'	6'	586	4.5
	6'	6'9"	2578	
	6'9"	8'	33	
	8'	11'	67	
Thickness		2'3"	1329	
66W	0'	21'	Trace	5.62
Average		4.5'	416	4.3'
136W	0'	3'	85	
	3'	16'	Trace.	

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
202W	0'	5'	12	
	5'	16'	33	
	16'	21'	Trace	
332W	0'	21'6"	Trace.	

LINE. 1966S.

1966' south of 27th. Av. and 240' east of east fence of Pacific Highway as shown in plate 1.Fig.3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
114E	0'	2'	Not sampled.	
99E	0'	1'3"	Not sampled.	
	1'3"	1'9"	312	1.25
	1'9"	2'	Not sampled.	
66E	0'	0'4"	Not sampled.	
	0'4"	0'9"	3052	
	0'9"	1'	Not sampled.	
	1'	1'5"	3340	0.33
	1'5"	1'10"	Not sampled.	
	1'10"	2'3"	2928	
	2'3"	4'0"	Not sampled.	
	4'0"	4'5"	3016	
Thickness		4'1"	1258	
33E	0'	7'	97	
	7'	7'6"	99	
	7'6"	9'	774	
	9'	9'9"	152	7.5
	9'9"	10'6"	Not sampled.	
	10'6"	10'8"	1431	
	10'8"	12'	644	
Thickness		4'6"	638	
00	0'	4'	64	
	4'	5'	477	
	5'	9'4"	Not sampled.	
	9'4"	9'6"	755	4.0
	9'6"	12'0"	Trace	
Thickness		1'	477	
33W	0'	5'6"	100	
	5'6"	7'	Not sampled	
	7'	7'6"	96	7.75
	7'6"	7'9"	Not sampled	
	7'9"	8'3"	2582	
	8'3"	10'6"	Not sampled	
Thickness		0'6"	2582.	
66W	0'	17'6"	Not Sampled.	8.0
Average		2.1'	953	4.8
132W	0'	15'	Not sampled.	

PALM BEACH AREA.

ORIGIN OF CO-ORDINATES : 1966' south of 27th Av. and 240' east of east fence of Pacific Highway as shown in Plate 1. Fig. 3.

Line 1966S (Contd) also LINE 2636S. 1984W. & 2966S.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
168W	0'	9'	Trace	
	9'	12'	15	
	12'	21'	Trace.	
198W	0'	15'9"	Trace.	
278W.	0'	16'	Trace	
298W	0'	18'6"	Not sampled.	
478W	0'	5'	9	
	5'	10'	Trace.	
548W	0'	8'	Not sampled.	

LINE. 2636 S.

2636' south of 27th Av. and 250 east of east fence of Pacific Highway as shown in Plate 1. Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
320W	0'	9'	Trace	
	9'	12'	96	
	12'	15'6"	Trace.	
360W	0'	6'	Trace	
	6'	9'	87	
	9'	13'3"	Trace	
480W	0'	4'	Trace	
640W	0'	11'	"	
760W	0'	5'	"	
880W	0'	11'	"	
1000W	0'	4'6"	"	
1120W	0'	4'6"	"	
1240W	0'	11'	"	
1360W	0'	6'	"	
1480W	0'	6'	"	
1600W	0'	11'	"	
1720W	0'	6'	"	
1800W	0'	7'	"	
1920W	0'	8'	"	
2000W	0'	7'	"	
2080W	0'	7'	"	
2120W	0'	7'	"	
2200W	0'	7'	"	
2280W	0'	8'	"	
2360W	0'	11'	"	
2440W	0'	7'	"	
2520W	0'	7'	"	
2600W	0'	7'	"	
2680W	0'	12'	"	
2760W	0'	7'	"	
2840W	0'	7'	"	
2920W	0'	7'	"	

LINE. 1984W.

Bore 1984W on line 2636S, as shown in Plate 1, Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
00	0'	12'	Trace.	
120S	0'	8'	"	
240S	0'	8'	"	
360S	0'	7'	"	
480S	0'	7'	"	
600S	0'	7'	"	

LINE 2966S.

2966' south of 27th. Ave. and 267' east of east fence of Pacific Highway as shown in Plate 1. Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
33E	0'	1'	Not sampled.	
	1'	1'6"	26	2.5
	1'6"	3'	Not sampled.	
00	0'	4'6"	318	
	4'6"	5'	513	0.0
	5'	7'	64	
Thickness		5'	337	
33W	0'	3'	59	
	3'	6'	65	
	6'	9'	100	2.5
	9'	12'	Trace	
	12'	14'9"	88	
	14'9"	17'	21	
Average		2.5'	337	1.3'
66W	0'	6'	Not sampled	
	6'	6'3"	418	
	6'3"	8'	Not sampled	
	8'	8'3"	418	
	8'3"	11'6"	Trace.	
132W	0'	6'	Trace	
	6'	9'	103	
	9'	21'	Trace	
165W	0'	3'	25	
	3'	6'	40	
	6'	21'	Trace	
198W	0'	7'6"	29	
	7'6"	9'	341	
	9'	14'	Trace.	
264W	0'	16'	Not Sampled.	
328W	0'	13'	Trace	
376W	0'	14'6"	Not sampled.	

ORIGIN OF CO-ORDINATES : ~~3951' south of 27th Ave. and 294' east~~ of east fence of Pacific Highway as ~~shown in Plate 1, Fig. 3.~~

LINE 3951S. ~~ALSO Line 4576S.~~

BORE	DEPTH FROM	DEPTH TO	LBS/CU. YD.	O/BRDN FT.
33E	0'	0'4"	Not Sampled	
	0'4"	0'6"	1603	
	0'6"	1'	Not sampled	
	1'	1'6"	1195	0.33
	1'6"	2'	Not sampled.	
	2'	2'9"	2531	
	2'9"	3'6"	Not sampled	
	3'6"	4'	1560	
Thickness		3'8"	966	
00	0'	3'	112	
	3'	6'	282	
	6'	7'3"	2519	
	7'3"	10'	200	3.0
	10'	13'	650	
	13'	16'	43	
Thickness		10'	647	
66W	0'	3'6"	Trace	
	3'6"	4'6"	2873	
	4'6"	5'	Not sampled.	
	5'	5'3"	2156	3.5
	5'3"	5'6"	Not sampled.	
	5'6"	6'3"	2500	
	6'3"	8'	Not sampled	
Thickness		2'9"	1831.	
108W	0'	9'9"	Not sampled	
	9'9"	10'3"	349	9.75
	10'3"	12'6"	Not sampled.	
Average		5.0	924	3.1
132W	0'	10'	Not sampled.	
	10'	102"	808	
	10'2"	14'	Not sampled.	
198W	0'	3'	27	
	3'	6'	27	
	6'	9'	84	
	9'	12'	116	
	12'	15'	22	
	15'	18'	Trace	
264W	0'	18'6"	Trace.	
354W	0'	16'	Trace.	
364W	0'	18'	Trace	
400W	0'	21'	Trace	
430W	0'	9'6"	Not Sampled.	
	9'6"	10'3"	3 49	
	10'3"	18'	Trace.	
466W	0'	16'6"	22	
	16'6"	20'	Trace.	
484W	16'6"	20'	Trace.	

BORE	DEPTH FROM	DEPTH TO	LBS/CU. YD.	O/BRDN FT.
532W	0'	9'	Trace.	
	9'	12'	203	
	12'	20'	Trace.	
616W	0'	6'	35	
	6'	13'	19	
	13'	18'	Trace	
650W	0'	13'	Trace	
700W	0'	13'	Trace.	

LINE. 4576S.

4576' south of 27th Ave. and 285' east of east fence of Pacific Highway as shown in Plate 1, Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/CU. YD.	O/BRDN FT.
25E	0'	1'	Not sampled.	
	1'	2'3"	2283	
	2'3"	2'6"	Not sampled	
	2'6"	2'9"	150	1.0
	2'9"	3'	Not sampled.	
Thickness		1'9"	1652.	
00	0'	8'3"	Trace.	
	6'3"	6'9"	1518	
	6'9"	7'6"	Not sampled	
	7'6"	8'6"	1622	6.25
	8'6"	9'	Not sampled	
Thickness		2'3"	1056	
17W	0'	11'6"	Not Sampled	
	11'6"	12'2"	1279	
	12'2"	12'6"	Not sampled	
	12'6"	13'6"	1568	11.5
	13'6"	14'	Not sampled	
	14'	14'6"	463	
	14'6"	15'	Not sampled.	
Thickness		3'	884	
62W	0'	3'	289	
	3'	6'	129	
	6'	6'9"	517	
	6'9"	8'6"	2181	0.0
	8'6"	10'	166	
	10'	13'	106	
	138	16'	47	
Thickness		10'	571.	
116W	0'	3'	148	
	3'	6'	566	
	6'	9'	30	
	9'	11'	20	0.0
	11'	14'	Trace	
Thickness		6'	357	

TABLE 7 HEAVY MINERAL AND OVERBURDEN IN BORES.

ORIGIN OF CO-ORDINATES : 4576' south of 27th Ave. and 285' east of east fence of Pacific Highway, as shown in Plat 1. Fig. 3.

LINE 4576S (Contd) ALSO 5931S & 6697S

BORE	DEPTH. FROM	TO	LBS/ CU. YD.	O/BRDN FT.
149W	0'	10'	Not sampled	
	10'	10'6"	512	10.0
	10'6"	13'6"	Not sampled.	
Average		5.3'	592	3.8
182W	0'	9'6"	Not sampled.	
	9'6"	10'	201	
	10'	15'	Not sampled.	
	15'	18'6"	Trace.	
382W	0'	6'	Trace	
	6'	10'6"	84	
	10'6"	19'	Trace	
585W	0'	3'	37	
	3'	6'	51	
	6'	9'	69	
	9'	18'	Trace.	

LINE. 5931S

5931' south of 27th Av. and 295' east of east fence of Pacific Highway as shown in Plate 1, Fig. 3.

BORE	DEPTH. FROM	TO	LBS/ CU. YD.	O/BRDN FT.
33E	0'	3'	162	
	3'	5'6"	Not Sampled.	0.0
	5'6"	5'9"	685	
Thickness		3'	162	
00	0'	6'	39	
	6'	7'9"	371	
	7'9"	8'3"	Not sampled	
	8'3"	8'9"	987	
	8'9"	9'6"	Not sampled	
	9'6"	9'9"	1869	6.0
	9'9"	10'6"	Not Sampled	
	10'6"	11'	1066	
	11'	12'6"	Trace	
Thickness		5'	428	
33W	0'	7'	51	
	7'	8'	341	
	8'	11'9"	Not sampled	
	11'9"	12'1"	1096	7.0
	12'1"	14'6"	Not sampled	
Thickness		5'1"	139	
66W	0'	2'	Not Sampled	
	2'	2'3"	364	
	2'3"	8'6"	Not sampled.	2.0
	8'6"	12'	Trace	
	12'	15'	16	
Average		3.9	268	4.6
99W	0'	7'	Trace.	

BORE	DEPTH. FROM	TO	LBS/ CU. YD.	O/BRDN FT.
132W	0'	10'	Trace	
198W	0'	6'	78	
	6'	13'	19	
264W	0'	12'6"	Not Sampled.	
354W	0'	16'	Not sampled.	
450W	0'	14'6"	Trace	
500W	0'	9'	Trace	
	9'	12'	356	
	12'	17'	Trace	
550W	0'	3'	151	
	3'	17'	Trace	
650W	0'	9'	Trace.	
700W	0'	10'	Not sampled.	

LINE. 6697S

6697' south of 27th Ave., and 313' east of east fence of Pacific Highway as shown in Plate 1. Fig. 3.

BORE	DEPTH. FROM	TO	LBS/ CU. YD.	O/BRDN FT.
33E	0'	3'9"	39	
	3'9"	4'	995	3.75
	4'	5'	112	
00	0'	3'	60	
	3'	6'	171	
	6'	7'	131	
	7'	7'6"	737	
	7'6"	10'6"	32	3.0
	10'6"	13'6"	57	
	13'6"	16'6"	55	
	16'6"	21'	Trace	
Thickness		4'6"	225	
33W	0'	3'	76	
	3'	6'	40	
	6'	9'	86	3.4
	9'	12'	31	
	12'	15'	Trace	
	15'	16'	9	
66W	0'	3'	148	0.0
	3'	15'	Trace.	
99W	0'	3'	Not sampled	
	3'	3'9"	422	3.0
	3'9"	9'	Not sampled	
	9'	12'	15	
Thickness		0'9"	422	

TABLE 7 HEAVY MINERAL AND OVERBURDEN IN BORES.

ORIGIN OF CO-ORDINATES : 6697' south of 27th ave., and 313' east of east fence of Pacific Highway as shown in Plate 1, Fig. 3.

LINE 6697S.(contd) ALSO LINE 7364 S. & 8333S.

BORE	DEPTH. FROM	TO	LBS/ CU. YD.	O/BRDN FT.
165W	0'	3'	29	3.37
	3'	9'	Trace	
	9'	12'	16	
	12'	16'	Trace.	
Average		1.4'	235	2.7
231W	0'	16'	Trace	
297W	0'	21'	Trace	
397W	0'	17'	Trace	
547W	0'	17'	Trace	
567W	0'	3'	36	
	3'	6'	31	
	6'	9'	17	
	9'	16'	Trace	
597W	0'	5'	53	
	5'	9'	24	
	9'	10'	Trace	
647W	0'	3'	43	
	3'	11'	Trace.	
755W	0'	3'	Trace	
	3'	6'	22	
	6'	16'	Trace	
897W	0'	11'	Trace	
997W	0'	7'	Trace.	

BORE	DEPTH FROM	TO	LBS/ CU. YD.	O/BRDN FT.
99W	0'	3'	26	8.87
	3'	11'	Trace	
Average		1.1	573	7.7
132W	0'	3'	42	
	3'	11'	Trace	
232W	0'	3'	66	
	3'	6'	141	
	6'	9'	94	
	9'	12'	Trace	
472W	0'	9'	Trace	
	9'	12'	90	
	12'	16'	Trace	
602W	0'	3'	Trace	
	3'	6'	41	
	6'	21'	Trace	
802W	0'	3'	20	
	3'	6'	22	
	6'	16'	Trace.	
902W	0'	4'	Not Sampled	

LINE.7364S.

7364' south of 27th Ave. and 358' east of east fence of Pacific Highway as shown in plate 1, Fig.3.

BORE	DEPTH FROM	TO	LBS/ CU. YD.	O/BRDN FT.
33E	0'	1'	Not sampled	
	1'	1'2"	163	3.0
X.	1'2"	3'	Not sampled	
00	0'	6'	48	
	6'	8'	117	
	8'	8'4"	962	8.0
	8'4"	9'	Not sampled	
	9'	10'	782	
	10'	11'6"	Trace	
Thickness		2'0"	551.	
66W	0'	8'6"	Trace	
	8'6"	9'3"	781	8.5
	9'3"	13'0"	Not sampled	
X.	3'	3'9"	127	
	3'9"	4'	Not sampled.	

LINE 8333S.

8333' south of 27th Avenue and 528' east of west fence of Pacific Highway as shown in Plate 1, Fig. 3.

BORE	DEPTH FROM	TO	LBS/ CU. YD.	O/BRDN FT.
148E	0'	4'	83	
132E	0'	9'	Trace	
	9'	9'4"	56	
	9'4"	11'	not sampled.	
99E	0'	3'6"	69	
	3'6"	4'6"	134	
	4'6"	9'	Trace	
66E	0'	7'6"	not sampled	
	7'6"	8'3"	99	
	8'3"	11'6"	Not sampled.	
00	0'	3'	18	
	3'	6'	66	
	6'	9'	35	
	9'	12'	96	
	12'	15'	30	
	15'	17'	13.	

ORIGIN OF CO-ORDINATES : 8333'south of 27th Av. and 528' east of west fence of Pacific Highway as shown in Plate 1. Fig. 3.

LINE 83338 (contd)

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
66W	0'	8'	Trace	
132W	0'	2'	18	
	2'	5'	12	
	5'	7'	13	
	7'	11'	Trace	
332W	0'	7'	Trace	
412W	0'	3'	7	
	3'	6'	Trace	
	6'	9'	36	
	9'	17'	Trace	
432W	0'	14'9"	Not sampled	
632W	0'	3'	26	
	3'	6'	19	
	6'	16'	Trace	
832W	0'	3'	43	
	3'	12'	Trace	

LINE 93338.

933' south of 27th Ave. and 520' east of west fence of Pacific Highway, as shown in Plate 1, Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
297E	0'	5'	Trace.	
231E	0'	5'	not sampled	
165E	0'	4'6"	Not sampled	
99E	0'	4'	Not sampled	
66E	0'	4'	not sampled.	
33E	0'	3'6"	Trace	
00	0'	3'	Trace	
33W	0'	2'	not sampled	
	2'	2'3"	130	
	2'3"	3'	Not sampled	
99W	0'	3'	62	
	3'	6'	78	
	6'	7'	6	
132W	0'	3'	57	
	3'	6'	26	
	6'	7'	52	
198W	0'	3'	11	
	3'	7'	Trace.	
264W	0'	3'	32	
	3'	6'	Trace	
66W	0'	2'9"	Not Sampled	
	2'9"	3'3"	240	
	3'3"	3'9"	Not sampled.	

ALSO LINE 93338.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
368W	0'	3'	80	
	3'	17'	Trace	
532W	0'	15'	Trace.	

LINE "INLAND" Fence as shown in Plate 1. Fig.3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
720E	0'	11'	Trace	
640E	0'	11'	Trace	
560E	0'	11'	"	
480E	0'	12'	Trace	
400E	0'	11'	"	
320E	0'	11'	"	
240E	0'	11'	"	
160E	0'	7'	"	
80E	0'	12'	"	
00	0'	7'	"	
80W	0'	12'	"	
160W	0'	7'	"	
240W	0'	7'	"	
320W	0'	11'	"	
400W	0'	7'	"	
480W	0'	5'	"	
520W	0'	4'	"	

LINE INLAND NORTH. 250' from T-Joint of two fences on bearing 323° magnetic as showin in Platel.Fig3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
00	0'	11'	Trace	
80W	0'	11'	"	
160W	0'	12'	"	
280W	0'	7'	"	

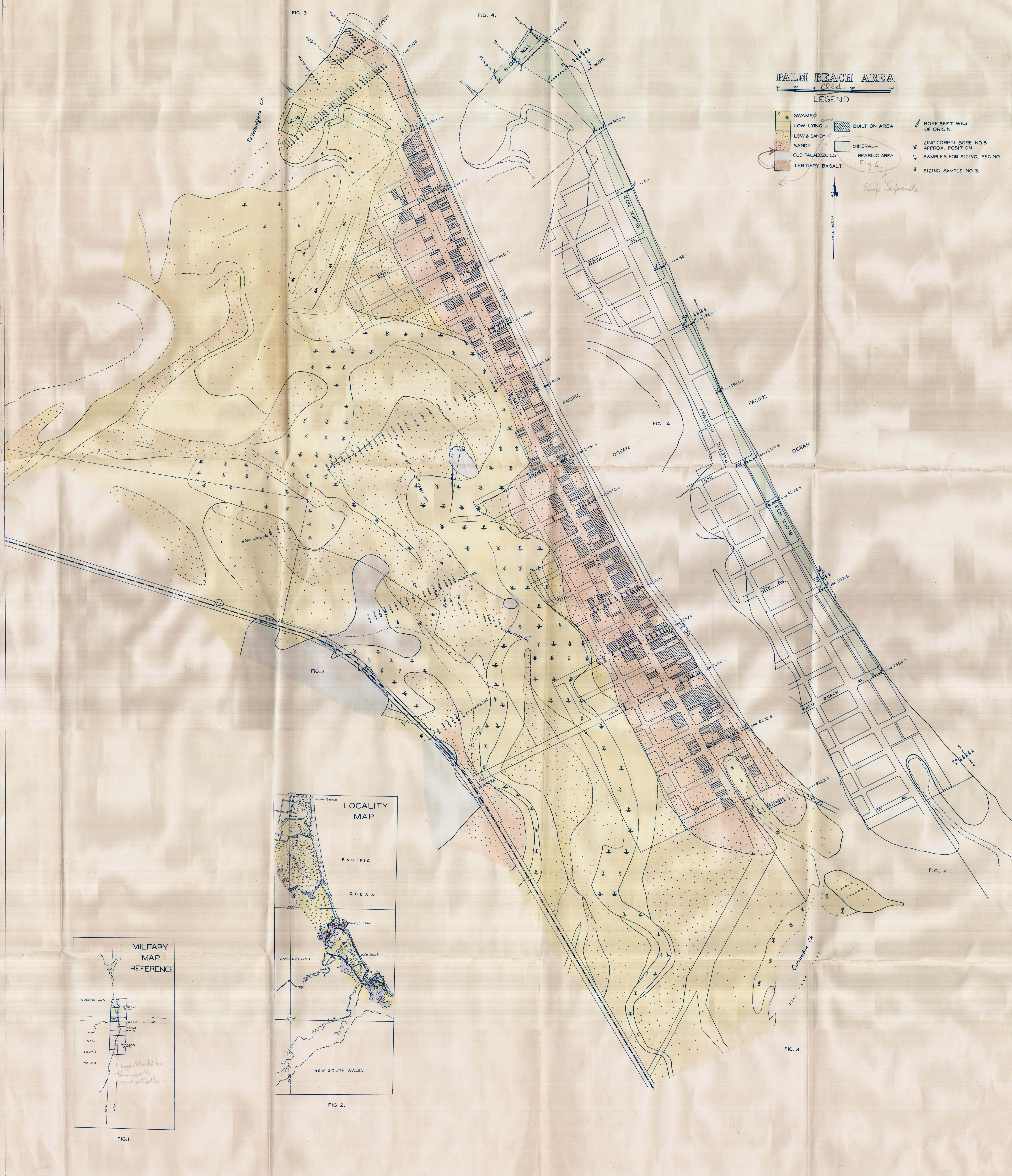
LINE "ELANORA" Railway-Fence as shown in Platel.Fig.3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
80E	0'	9'	Trace	
160E	0'	10'	"	
240E	0'	13'	"	
320E	0'	12'	"	
400E	0'	9'	"	
480E	0'	10'	"	

LINE "INLAND SOUTH" Bore 160W on the "Inland" line is regarded as 160W on the "Inland South" line, as shown in Plate 1 Fig. 3.

BORE	DEPTH FROM	DEPTH TO	LBS/ CU. YD.	O/BRDN FT.
240E	0'	7'	Trace	
360E	0'	7'	"	
480E	0'	7'	"	
600E	0'	7'	"	
720E	0'	7'	"	
840E	0'	7'	"	
960E	0'	11'	"	
1040E	0'	7'	"	
1120E	0'	[illegible]	"	
1200E	0'	11'	"	

PLATE I.



BUREAU of MINERAL RESOURCES, SOUTHPORT

JANUARY 1950

PLAN NUMBER Q25-10D-1

PALM BEACH AREA - SECTIONS

PLATE 2.

SCALE HORIZONTAL 1 INCH = 100 FT.
VERTICAL 1 INCH = 10 FT.

MINERAL CONTENT 120-300 lbs/cu.yd. >300 lbs/cu.yd.

BORE WATER TABLE

PLATE 3

PALM BEACH AREA

LONGITUDINAL VARIATION IN COMPOSITION OF MINERAL CONCENTRATES

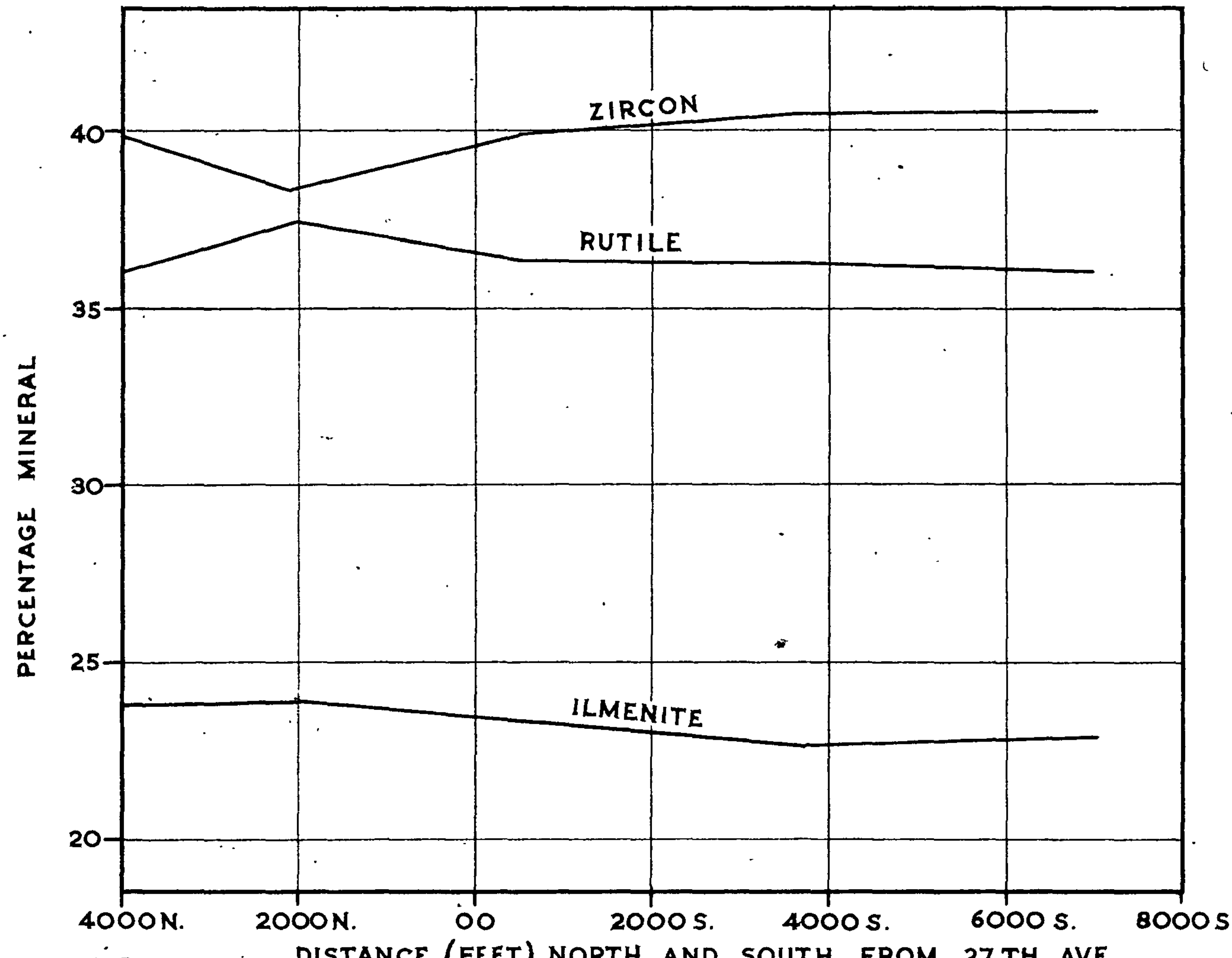


FIG. 1

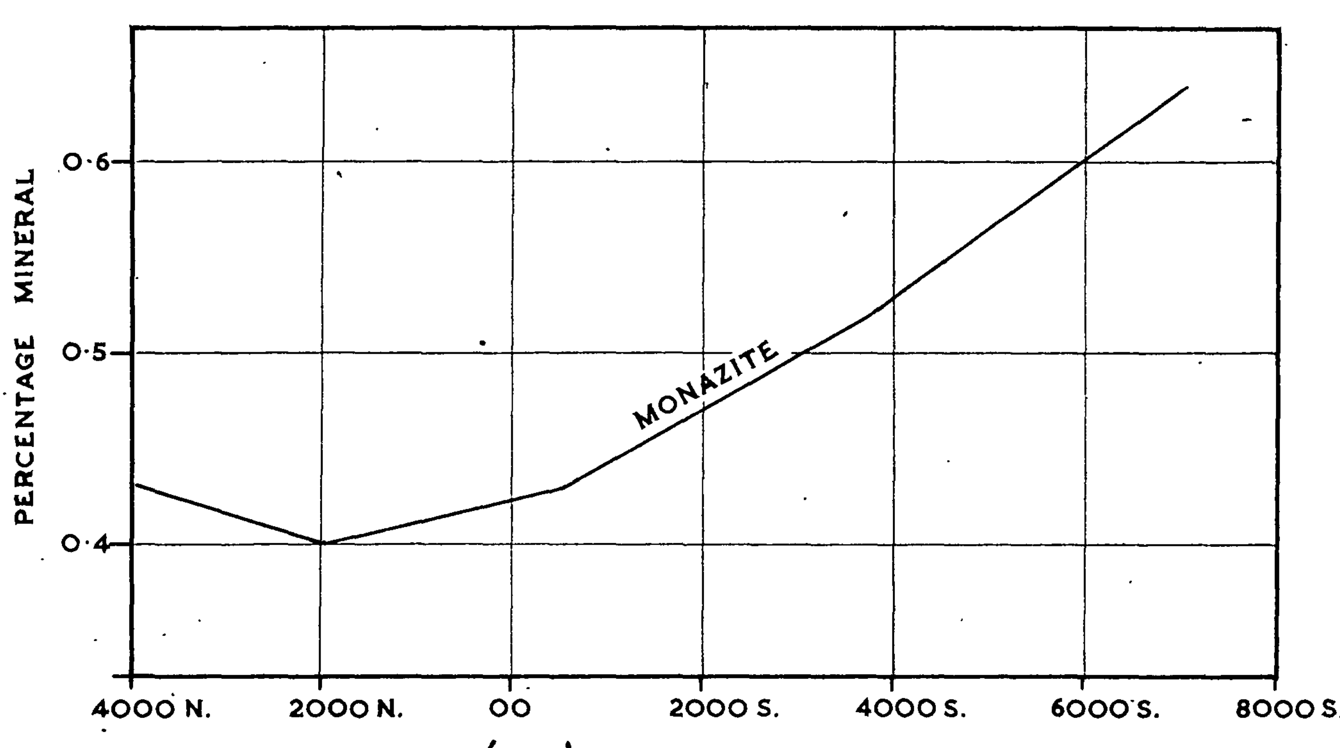


FIG. 2

B.M.R. SOUTHPORT QLD. FEB. 1950

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