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THE PHYSIOGRAPHY OF NORTH STRADBROKE ISLAND AND THE HISTORY OF THE DEVELOPMENT OF THE ISLAND

by

D.E. GARDNER AND J.O. CUTHBERT

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS, SOUTHPORT, QUEENSLAND.

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The Physiography of North Stradbroke Island and the History of the Development of the Island.

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The physiographic units of the island, and the place names referred to in this report are shown on the Military Maps, Queensland Zone 8 No. 182 (Brisbane Valley), Zone 8, No.183 (Brisbane), and No.193 (Beenleigh 1 mile Series), and on Plate 1. at the end of this report.

A. Physiography.

1. The Physiographic Units of the Island. Four areas which make up the greater part of the island are built up mainly of sand dunes, and are distinguished from one another by the heights of the dunes, and the trends of the dune lines. These areas are:-

(a) A narrow Western Area of high fixed dunes adjacent to the west coast, commencing near Dunwich and extending in a southerly direction to about the southern end of Black Snake Lagoon. The dunes have a northerly trend.

(b) A Central and a North-Western Area of high fixed dunes. The Central Area is bounded on the east by the Eighteen-Mile Swamp, and on the south-west by a line running in a southeasterly direction from about a mile north of Lake Kounpee to a point on the southern end of the eastern boundary, about 7 miles south of Blue Lake. The dunes in the Central Area have a marked north-westerly trend, and rise to a height of 700 feet in the northern portion of the area.

The North-Western Area is a continuation of the Central Area beyond a line running approximately from 3 miles north-east of Dunwich to Rocky Point. The dunes are similar to those in the Central Area, but are much lower.

(c) The Southern Area embraces that portion of the island south of the Central Area, which is covered by long north-westerly trending dunes. It is separated from the Southern part of the Western Area by the Western Chain of Lagoons and Swamps.

(d) The Eastern Area, a narrow strip of low, active dunes adjacent to the ocean beach on the east coast, and separated from the Central Area by the Eighteen Mile Swamp.

2. General Description of Each Dune Area.

The old fixed dunes are heavily vegetated and stable.

(a) The North-Western and Central Areas.

(i) The distribution of heavy minerals in the dunes of the Central Area for more than a mile west of the Eighteen Mile Swamp, together with the occurrence of vegetable matter within the dunes suggests two distinct periods of dune formation, separated by an interval during which the dunes of the first period became vegetated and fixed. In a bore put down (near Blue Lake?) by Zinc Corporation, the bore-collar level being approximately 500 feet, fragments of charcoal were found at a depth of 47 feet. Mineral values above this point averaged 2.7% but below it they dropped abruptly to about 0.5%. In a second bore, a quarter of a mile to the east, the mineral values dropped from an average of 3.4% above the 170 feet level to 0.6% below that level. A third bore, a quarter of a mile southwards and about 1 mile east from the swamp, gave similar results, although the percentage of mineral throughout was lower. Similar results were obtained from bores put down in an area extending from one mile north of Blue Lake to about seven miles south of the Lake and extending from the edge of the swamp inland for a distance of about one and a half miles.

In a small area south of the rhyolites near Point Lookout, the upper portions of the dunes have a comparatively high content of heavy minerals.

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2. (ii) Indurated Dune Sand, Limonite and Calcite Accretions, and Kaolinic Bands.

At varying levels, generally higher than 200 feet, portions of the dunes are erratically indurated with limonite, or stained with limonite. Calcareous and limonitic concretions and aggregations are found, and in places limonitic veins appear between typical dune bedding planes. Kaolinic material is occasionally found interbedded with the sand. These occurrences have not been directly observed to be associated with fragments of fossil wood, nor have they been observed to be related in the field to the horizon separating the two periods of dune formation. It is suggested however, that the limonite and calcite were deposited at, or near, the surfaces of the soil through plant or bacterial action in the period when the first stage of dune building had ceased, and the dunes had become vegetated. A possible explanation of the occurrence of the kaolinic bands is given in Section 3.

(iii) Air-Photo Interpretation. In addition to the field evidence mentioned above, an inspection of aerial photographs suggests that, in the Central Area and the southern fringe of the Northwestern Area, two stages of dune building have taken place. Dune sand of the later stage appears to have built onto dunes of the earlier stage.

(b) The Southern Area. The old fixed dunes of the Southern Area contain, in general, less than 1% of heavy minerals. No enrichment is found in the upper portions of the dunes. Aerial photographs do not suggest two stages of dune formation.

(c) The Recent Active Dunes. The low active dunes of the Eastern Area run parallel to the coast but are interrupted by "blowouts" or gaps caused by the south-easterly winds. Adjacent to the blowouts, dunes are building up in the direction of the prevailing winds. These dunes have encroached on the Eighteen Mile Swamp over distances ranging up to half a mile. The blowout dunes have a north-westerly trend similar to that of the fixed dunes of the Central Area.

3. The Old High-Level Swamp Deposits.

Sand cemented by organic material into friable, dark-grey, brown or chocolate-coloured sandstone occurs at varying heights above sea-level -
(a) along the eastern fringe of the high dunes bordering the Eighteen Mile Swamp,
(b) along the western coastline south of Dunwich, and
(c) along the western coastline north of Dunwich, i.e. the western coast of the North-Western Area.

Along the eastern fringe of the old high dunes, the poorly bedded deposits occur on two horizons, the highest at an elevation of 90 to 110 feet, and the lower at 30 to 60 feet. Along the west coast, the poorly bedded, organically-cemented sands have a maximum elevation of about 60 feet at a locality about 3 miles south of Dunwich, and a maximum elevation of about 40 feet near Canaipa. In the north of the island, similar deposits occur at a height of 30 to 60 feet above sea-level.

None of these deposits exhibit the typical bedding of sand dunes, although the constituent grains are small, and have apparently been transported to the localities by wind action. Some of the deposits appear to have a poorly developed horizontal bedding, the individual beds being several feet thick. These deposits were formed from sand which was probably blown westwards across dunes into swampy lagoons behind the dunes.

One organically-cemented deposit which occurs near Canaipa on the west coast from below sea-level up to about 12 feet above sea-level is current-bedded. It has been laid down in shallow water, and may represent a swamp

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deposit which has been encroached upon and re-washed by the sea.

B. The History of the Development of the Island.

1. The Data Upon which the Interpretation of the History has been Based.

The general outlines of the history are based on the following observations and inferences:-

(a) The island consists mainly of exceptionally large sand dunes which could only have been formed during one or more recessions of the coastline, when an adequate supply of sand would be available.

(b) The topography of the Central Area, and the distribution of heavy minerals within the dunes suggests that the dunes were built up in two distinct periods. Evidence of solution and deposition of limonite and calcite, and the occurrence of fossil wood, suggest that, in the interval between the two periods of dune building, the surface of the island was vegetated and stable.

(c) The occurrence, in several widely separated localities, of fossil swamp deposits at elevations of 90 to 110 feet and 50 to 60 feet, point to two periods of stationary sea-level at elevations of approximately 100 feet and 50 feet, respectively, above the present sea-level.

(d) The northerly trend of the dunes adjacent to the west coast, suggests that these dunes were shielded from wind abrasion by the high dunes of the Central Area.

(e) Because of some uncertainty regarding the elevation of the fossil swamp deposits along the western coast, two interpretations of the development of the western portion of the island have been given. The first interpretation assumes that the western northerly trending dunes developed contemporaneously with, or a little earlier than, the first of the Central Area dunes. The second interpretation assumes that the Central Area dunes began to build up during the recession of the sea from the 100 ft. level, while the western dunes developed subsequently, during the recession of the sea from the 50 ft. level. The second interpretation appears to be the more probable.

2. The Stages in the Development of the Island.

In Section 1.A it is stated that the old dunes developed during two periods of falling sea-level. Section 1.B gives a description of the old somewhat consolidated swamp deposits which occur at elevations of 90 to 110 ft., and of 30 to 60 ft. Presumably, these developed as coastal swamps during two periods when the sea-level was approximately 100 ft. and 50 ft. respectively, above the present sea-level. It is considered that the development of the sandy portions of the island commenced shortly after the sea began to retreat from the 100 ft. level, and proceeded in definite stages during two subsequent cycles of rising and falling sea-level. In this section, the development of the island during each of these stages is discussed.

3. The Period when the Sea-Level was 100 Feet above Present Sea-Level.

Just prior to the period when the dune areas commenced to build, North Stradbroke Island was probably represented by two or more islands of solid rock, surrounded by a sea which stood at a level of more than 100 feet above the present sea-level. The rocky area on which Dunwich is now situated was separated from the Point Lookout or eastern area by a deep channel, which ran northwards from the line of the present-day western chain of lagoons and swamps. Sandbanks extended for many miles southward from the Dunwich and Point Lookout areas, their surfaces rising nearly to sea-level just south of the rocky islands, and sloping downwards to greater depths towards the south.

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3. (Later Interpretation:- Instead of "Their surfaces rising ..... towards the South" read, "The surface of the Point Lookout sandbank was at a shallow depth below sea-level for a distance at least 10 miles south from the rocky island. Further south, the surface of the bank sloped downwards to greater depths. The Dunwich sandbank, even at its northern end, was probably much deeper").

4. The Recession of the Sea from the 100 ft. Level.

(a) High Level Swamp Deposits.

During a period of emergence, the sandbank south of the Point Lookout area became exposed at about 100 ft. above present sea-level for a distance of at least 8 miles. South of Dunwich, the sandbank was exposed at about 30 ft. above present sea-level for a distance of at least 3 miles. (Later interpretation:- Instead of "South of Dunwich ..... at least 3 miles", read "South of Dunwich, the sandbank was exposed at a lower level").

The banks to the north of the rocky islands emerged as broad sandy flats. As the sea-level continued to fall, the southern sandbanks continued to emerge in a southerly direction. Dunes built up on their eastern shore-lines, and extensive swamps developed inland from the dunes. Sand which was constantly blowing over the dunes into the swamp, accumulated in poorly bedded fine-grained deposits, discoloured and loosely cemented by gelatinous humic substances. These organic materials sealed the pore spaces in the sand underlying and surrounding the swamps. As a result, the swamps were maintained above sea-level for considerable periods, and thicknesses of up to 30 feet of fine sand and organic material accumulated beneath them. Temporary cessations or minor reversals of the downward movements of the sea-level may have assisted in the building up of the swampy deposits.

(b) The Western Area Dunes.

The dunes which formed during the early stages of the fall in sea-level have been mentioned in section (a). These dunes contributed only a comparatively small proportion of the sand which eventually was deposited on the island, because the only supply of sand available for building them was that provided by the emergence of the sand-bar. On the mainland coast, larger quantities of sand were becoming exposed. When the coastline had receded beyond the eastern limits of the headlands, large volumes of sand moved northwards along it without obstruction. When the mainland shore-line had receded as far as the present position of the Dunwich rocky island, sand accumulated on the southern end of the exposed sand-bar. After a further slight recession, large quantities of sand migrated northwards along the eastern shore-line of the old bar, and were built by the wind into long high dunes back from the shore-line. The swamp deposits were completely covered by these dunes, which appear to-day as the Western Dune Area. (Later interpretation:- Delete "Which appear to-day as the Western Dune Area").

When the shore-line had receded to the eastern edge of the Dunwich island (or headland) i.e. to the Western Trough, a large proportion of the migrating sand moved further north. Part of it contributed to dune building on the northern sandy flats, while portion of it banked up against Moreton Island. When the shore-line had moved eastwards to the Central Area, i.e. some distance east of the present-day Western Chain of Lagoons and Swamps, the processes of dune building which had just come to an end in the Western Area came into action here. As a result, the Western Area was shielded from wind erosion and became vegetated and stable.

(c) The Central and North-Western Areas.

(i) The Building of Dunes along the East Coast.

As the sea-level continued to fall, successive lines of high, northerly-trending dunes were built up along the eastern shore-line. The swampy deposits which had accumulated at a level of 90 to 110 feet were

buried. In the early stages of dune building, sand transported northerly by surf action banked up just south of the rocky portion of the island, where it was blown by the wind into sandhills. Additional supplies of sand reaching the northern end of the beach piled up against the sandhills already there. As this process continued, the sand-mass tended to grow in a southerly direction, and easterly, and its crest tended to shift towards the south. By the end of the period of dune building, the greatest quantities of sand had been deposited some miles - possibly six miles - south, and possibly, to the east of Point Lookout. Very large dunes continued for at least four miles further in a southerly direction, i.e. to the southern extremity of the Central Area.

Probably lower dunes extended much further south, but these do not occur to-day because, as pointed out in Section 5(c) below, the portions of the island south of the Central Area were transgressed during a subsequent advance of the sea.

The eastern margin of the high dunes was parallel to the present beach line of the island, but some distance further east.

(ii) North-Westerly Migration of Dunes.

It is probable that, during the entire period of dune formation, considerable volumes of sand migrated across the island as north-westerly trending dunes. This process must, however, have been retarded by the active development of shielding coastal dunes, and the eastward recession of the coastline.

When the shore-line had receded some distance east of Point Lookout, (it can be expected that, during the recession, the headland extended further eastward), much of the sand which was migrating northerly along the beaches moved beyond the island. The quantities of sand then blowing up from the beach were smaller than the quantities which were removed from the coastal dunes by wind action. As a result, blowouts and northwesterly trending dunes advanced rapidly through and across the older dune masses, and the eastern dune front, receded inland. The great volume of sand behind the original dune front advanced as exceptionally high dunes across the dunes which had preceded them, i.e., the dunes which had been forming prior to the time when the main coastline receded east of Stradbroke Island.

The dune front appears on military maps along a line which runs in a north-easterly direction from the southern end of Koumpee Swamp past the northern end of Blue Lake. The high dunes extend from this front to the northern extremity of the Central Area, i.e., to a line which runs approximately from the northern end of Lake Karboora to Rocky Point. The extremities of the earlier lower dunes extend one to three miles further in a north-westerly direction (these are the dunes of the North-Western Area).

(iii) The High-Dune Portion and the Southerly Triangular Portion of the Central Area.

When the high-dune front had receded inland, the Central Area consisted of two portions, viz., the northerly high-dune portion, and a southerly triangular portion. The huge volume of sand contained in the former had been derived almost entirely from the latter. The southern portion existed as a series of parallel north-westerly trending ridges. At the foot of the high-dune area, the crests of the ridges may have had an elevation of 300 to 400 feet (referred to present sea-level), and the valleys may have been up to 300 feet deep. The general elevation of the area decreased in a south-easterly direction up to the eastern boundary - a dissected, poorly defined escarpment running in a southerly direction from a locality some distance east of Point Lookout. Along the line of the present-day eastern boundary of the dunes, the southern portion of the Central Area probably had an average elevation (referred to present sea-level, of well over 200 feet, although

the bottoms of some of the valleys may have been much lower than 100 feet.

(d) The Western Chain of Lagoons and Swamps.

Some of the north-westerly trending dunes which crossed the island during this period transgressed the Western Trough, converting it into a chain of disconnected lakes and swamps, and in general, raising its level.

(Later interpretation:- Replace this paragraph by:-

(d) The Western Trough.

Some of the north-westerly trending dunes which crossed the island during this period, transgressed the Western Trough north of Lake Koumpee. Wind-blown sand accumulated in the swampy portions of the trough south of the Lake Koumpee forming poorly bedded sandy deposits rich in black organic matter.)

5. The Advance of the Sea to 50 Feet Above Present Sea-Level.

(a) The Eastern Shore-Line.

When the sea-level began to rise, it is probable that the strand line advanced against sandy cliffs, fringed by narrow beaches. Little sand was available for dune building. The northerly drift of sand along the coast (which, though east of Stradbroke Island, was actually the mainland coast) continued though in smaller quantities than during the recession.

(b) Concentration of Heavy Minerals.

As cliff faces collapsed, exposing masses of sand to surf action, some concentration of heavy minerals occurred. (This process may be observed on South Stradbroke Island at present. The southern and eastern coasts of the island are bounded by sandy cliffs, which are being eroded by the sea. Considerable concentrations of heavy minerals appear along the upper portions of the beaches during stormy weather, when the erosion is at a maximum.) The deposits of heavy minerals which formed along the shores of North Stradbroke Island during the advance of the coastline were dissipated in the following ways:-

(i) Portions moved northwards beyond the island in the constant migration of sand along the coast.

(ii) Some of the heavy mineral sand was blown up from the beach into the minor dunes which must have occurred just behind the shore-line.

(iii) Portions were moved westwards by the advancing sea.

(iv) Portions were covered by the advancing sea.

When the strand line had advanced to a short distance east of Point Lookout, it encountered the easternmost portion of the island, viz., the eastern end of the high-dune portion of the Central Area (Section 2.b.(ii), 2.d. (iii) above). The coastline then ran parallel to the present beach line as far north as the high-dune front, where it curved sharply to the north-east. Large deposits of heavy minerals were retained within this flexure, and for many miles southwards along the beach. The deposits were in part moved westwards, and in part covered by the advancing sea.

The eastern extremity of the high-dune area was greatly eroded.

(c) Marine Transgression of the Southern and Western Dunes, and Swamp Deposits.

The southern portions of the Western and Southern Areas were eroded, possibly as far northerly as Ibis Lagoon, and the re-sorted sand was covered by the rising sea. The 6" dark band near Canaipa, containing 2% by weight of fine-grained heavy minerals is apparently the result of concentration when

southern dune sand of the Western Area was re-washed at an early stage of the advance of the sea. The organically-cemented fine-grained, current-bedded sandstone was formed by the re-sorting of the swamp deposits which had accumulated in the Chain of lagoons and swamps.

The advancing sea rose to about 50 feet above present sea-level. Wave-cut platforms were developed around most of the coastline, and in the south of the island, a platform of considerable area probably formed, at about the latitude of Ibis Lagoon. South of this platform, the sea floor sloped away gradually, being about 35 to 40 feet below the high level of the sea near Canaipa (i.e. about 10 to 15 feet above present sea-level).

(Later interpretation:- Section (c) should be replaced by:-

(c) Marine Transgression of the Southern and Western Areas.

(i) The Western Area and Western Trough.

During the rise of the sea to 50 feet above its present level, the portions of the island south of the Central Area, i.e. south of a line running from a mile or two north of Lake Koumpee to a point approximately 7 miles south of Blue Lake, were eroded and covered by the sea. The trough separating the Western Area from the Central Area became a comparatively deep inlet and probably assisted in the erosion of the Western Area. It is possible that during the period of maximum sea-level (50 feet above the present level) a comparatively deep channel was cut through the northern extremity of the submerged western dunes. The submerged western area probably existed as a sand-bank approximately 20 feet below sea-level (30 feet above present sea-level) at about the latitude of Lake Koumpee, and 35 to 40 feet below sea-level (10 to 15 feet above present sea-level) near Canaipa.

It is probable that the Western Area was eroded largely by tidal currents sweeping northerly past its southern corner. The re-sorted dune sand was laid down as current-bedded deposits typical of shallow-water disposition. Local concentrations of heavy minerals appeared. As the erosion of the dunes proceeded northwards, the swampy deposits of the Western Trough were exposed, eroded, and re-deposited, in many places on top of the re-sorted dune sand. As dune and swamp deposits were being eroded simultaneously, it is probable that much of the sediment being deposited was a mixture of sand and organic material derived from both sources. The 6" dark band near Canaipa containing 2% by weight of heavy minerals, is probably a local concentration formed during the re-sorting of dune sands. The organically cemented, fine-grained, current-bedded sandstone overlying the 6" band was derived from swamp deposits of the Western Trough, perhaps with the addition of sand from eroded dunes.

(ii) The Southern Area. A wave-cut, submerged platform occurred between the front of the dunes which formed the southern end of the Central Area, and the edge of the Western (submerged) Trough or Channel. The platform continued southwards just below sea-level to a short distance south of Ibis Lagoon, a distance of about 2 miles. Southwards from this point, its surface sloped downwards to greater depths.

6. Summary of the Development of the Island up to this Period (i.e. Sea-Level 50 feet Above Present Sea-Level).

The events described above accompanied a fall in the sea-level from 100 feet above present sea-level to a considerable depth below present sea-level, and a subsequent rise to about 50 feet above the present level of the sea. The mainland coastline receded from some distance west of the present mainland coast to some distance east of Stradbroke Island, and subsequently advanced again to a position west of the present coastline. During the second period of high sea-level (50 feet above present sea-level), the Western Dune Area from Dunwich southwards almost to Ibis Lagoon, existed at a considerable height above sea-level. Old swamp deposits appeared beneath the dunes south

of Dunwich from a depth of 20 feet below water-level to about 10 feet above water-level. Continuing southwards below sea-level to at least as far as Canaipa, were current-bedded fine-grained sands with beds containing concentrations of heavy minerals.

Separating the Western from the Central Dune Area was a chain of deep lakes.

(Later interpretation:- Instead of "During the second period ..... a chain of deep lakes," read "During the second period of high sea-level (50 feet above present sea-level) the portion of the island south of the Central High-Dune Area, was completely submerged. The Western Area was represented by a sandbank, the upper portions of which were built up largely of current-bedded, fine-grained sand, derived partly from the re-sorted dunes, and partly from the re-sorted swamp deposits of the Western Trough. The portions derived from the re-sorted dunes contained low-grade local concentrations of heavy minerals while the portions derived from the re-sorted swamp deposits were brownish, dark grey or chocolate-coloured because of admixed organic matter.)

The Central Dune Area consisted of a northern high-dune portion and a southern triangular portion. Neither contained any appreciable concentrations of heavy minerals. The northern portion is clearly marked at the present day, and contains the highest dunes on the island. The southern portion, though of much lower elevation, stood at a considerable height above the sea, from just north of Blue Lake, where it abutted the high northern portion, to a point about 7 miles south of Blue Lake. The southern portion appears to-day as the lower parts of the dunes in this area. The occurrence of fossil wood at the tops of these lower dunes indicates that, during this period of high sea-level the area was vegetated and stable. The indurated dune sand and limonite and calcite accretions mentioned in Section A.2.(a) (ii) were probably developed during this period. The kaolinic material which is found interbedded with dune sand could possibly have been deposited by the wind during the period of low sea-level. Portion of the sea-bed to the east may have been stripped of their covering of sand, and underlying kaolinized bedrock - possibly rhyolite - exposed to the wind.

The old swamp deposits which were formed just after the sea had started to recede from the 100 feet-level existed at heights of 40 to 60 feet above the sea beneath a sandy cover of varying thickness. Probably the deposits were eroded where intersected by some of the deeper north-westerly trending valleys.

Deposits of heavy minerals occurred along the beach from the foot of the high-dune portion of the Central Area (about 1 mile north of Blue Lake) to the southern end of the east coast. Lower concentrations of heavy minerals extended eastwards on the sea bed.

The Southern Area, completely submerged, existed as a wave-cut platform fringing the south-western edge of the Central area, and extending for 2 miles in a southerly direction from the southern end of the Central Area. Beyond this point, the platform merged into a sandbank which continued for some miles at an increasing depth below sea-level.

7. The Development of the Island from the Period of the 50-Feet Sea-Level to the Period of the Sub-Recent High Sea-Level.

The subsequent stages in the development of the old dune areas, and some of the lower-level deposits of organically cemented sandstone, took place during a second cycle of retreat and advance of the shore-line. The third or final period of high-sea-level, attained at the end of this second cycle, was the sea-level which prevailed just prior to the sub-Recent emergence of 10 to 15 feet.

(a) The Southern and Western Areas. During the second retreat of the coast line, the submerged platforms were exposed, and with continued lowering of the sea-level, the sandbanks south of the platforms steadily emerged.

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Large quantities of sand were thus made available for dune building. Swampy tracts developed behind the eastern beaches, and in these the typical poorly bedded deposits of wind-transported sand with black humic material, accumulated.

(Later interpretation:- Insert here:- such swampy deposits occur about 3 miles south of Dunwich at an elevation of 30 to 60 feet; near Canaipa, at an elevation of 15 to 40 feet, and along the eastern edge of the southern area. It may be expected that the fall in sea-level was interrupted by one or more periods during which the sea remained for an appreciable interval at a constant intermediate level, or even rose a few feet. Such interruptions would permit the accumulation of considerable depths of swampy deposits.

Dunes. In the initial stages of the recession, the sand moving northwards along the partly exposed platform of the southern area tended to build up at the southern end of the Central Area. The high dunes east-northeast of Ibis Lagoon may have originated in this way. At a later period, dune building would proceed actively at the southern extremity of the fully exposed platform. This may have initiated the high dune-building south-east of Ibis Lagoon. Along the northern portion of the Western Area, relatively low northerly-trending dunes developed as far south as the southern end of Koumpee Swamp. Possibly, at this stage, dunes transgressing the island from the Southern Area formed a bar across the Western Trough and enabled the building of the high dunes southwest of the swamp. This process of dune building apparently continued at least as far south as Horseshoe swamp, the dunes at the eastern edge of the Southern Area building up in advance of the Western Area dunes. North-westerly transgressions of dune sand from the Southern Area formed bars at intervals across the Western Trough.

The swamp deposits and dunes described above formed while the mainland coast was some distance west of Stradbroke Island. When the mainland coast had receded as far easterly as Stradbroke Island, great volumes of sand began to accumulate on the southern tip of ths island. Probably, the high dune area south of Native Companion Lagoon was formed at this stage. The low-lying tract from Native Companion Lagoon to Horseshoe Swamp may represent the low-lying southern end of the island which existed just prior to the recession of the mainland coast to Stradbroke Island. When the mainland coast receded to the eastern edge of the island, the dune-building continued on the Southern Area, and north-westerly trending dunes continued to migrate across the island.

(b) The Central Area.

Dunes. When the sea began to recede from its level of 50 feet above present sea-level, sand began to migrate northwards along the east coast, and was built by the wind into dunes parallel to the coast. These dunes contained a comparatively high proportion of heavy minerals, derived from the concentrations which had formed during the preceding advance of the sea, and from re-concentrated mineral held south of the northern high-dune area a mile north of Blue Lake.

It can be seen in the preceding section that the northward movement of the sand tended to be arrested by the higher areas which had previously emerged. Thus extensive dune building took place near the edge of the 50 ft. platform - south of the Central Area. As a result, the quantities of sand moving northwards along the shore-line of the Central Area were somewhat limited. Massive dunes were developed but not on as large a scale as during the recession of the sea from the 100 ft. level.

When the mainland coast had receded as far as the eastern edge of the Central Area, the coastline of the island had also moved eastwards, practically to the edge of the Point Lookout Headland. Consequently the large quantities of sand drifting along the mainland coast were deposited along the eastern coast of the Central Area only for a short period, viz. until the coastline had receded beyond Point Lookout.

As had happened previously at this stage, during the recession of the sea from the 100 ft. level, heavy deposition of sand onto the island ceased. The sand which had been deposited during earlier stages of the recession migrated in a north-westerly direction. The dunes of the eastern portion of the Central Area

were built up to greater heights from a mile north of Blue Lake to about 7 miles south of the lake and for more than a mile west of the present-day margin of the Area, with sand carrying 8 per cent. or more of heavy minerals. The Central Area further north and parts of the North-Western Area received the remnants of the high-dune area which had been built up during the recession from the 100 ft. level, and which had extended some distance in a north-easterly direction for about a mile north of Blue Lake.

During the second (and final) advance of the shore-line, active dune building ceased, as it had previously during the first advance of the shore-line. As before, the coastline consisted of sandcliffs, fringed by a long, narrow beach on which concentrations of heavy minerals developed.

During the previous advance of the shore-line, the heavy mineral concentrates were retained on the beach south of the foot of the high-dune area, which extended in a north-easterly direction from about a mile north of Blue Lake. Marine erosion during the advance of the sea to the 50 ft. level, and the retreat from that level, together with wind erosion during the retreat from the 50 ft. level, had caused the front of the high dune area to recede some distance west of Point Lookout. Hence, during the final advance of the sea, deposits of heavy minerals were not retained along the beaches until the coastline had reached the solid rock south of Point Lookout. In this locality considerable volumes of sand were deposited with concentrations of heavy minerals a little further south. The upper limit of the sea-level at the end of this final advance was 10 to 15 feet above present sea-level.

8. The Development of the Island since the Final (Sub-Recent) Fall in Sea-Level.

The most prominent features resulting from the sub-Recent fall in the sea-level are the swamps which have developed around the coastline, and the eastern active dune area. The most important feature was the deposition of sand, carrying a comparatively high concentration of heavy minerals, on the dunes just south of the Point Lookout rhyolites.

(a) The Recent Active Dunes. At the present time, a pronounced off-shore bar runs for a considerable distance parallel to the ocean beach. It is probable that the present beach and recent dunes mark the position of an off-shore bar prior to the mid-Recent emergence of ten to fifteen feet. Large quantities of sand made available as a result of the emergence, were moved up by the action of the surf on to the exposed bar and northwards along the bar. The sand was built up by wind action into a line of dunes parallel to the coast. Only a small supply of sand has been moving northwards onto the island since the sub-Recent fall in sea-level. Hence, the only important supply of sand available for building the recent dunes has been the mass of sand raised above sea-level. Most of this has already been shifted beyond the reach of the surf, with the result that, at present, fresh dunes are not forming rapidly enough to protect the earlier dunes from wind erosion. "Blowouts" and north-westerly trending dunes are developing rapidly.

(b) Deposits of Heavy Minerals. The deposits of heavy minerals which had formed just south of the solid rock of the Point Lookout area, together with quantities of dune sand, were carried by the wind on to the high dunes immediately to the east.

9. A Possible Correlation between the Stages in the Development of Stradbroke Island, and the Pleistocene Fluctuations in Sea-Level.

It is suggested that the two major cycles of falling and rising sea-level which have been completed since the commencement of the second-last Pleistocene glaciation provided the conditions under which the sandy portions of Stradbroke Island formed. Thus, the first period of high sea-level, suggested in this report to have been approximately 100 ft. above the present sea-level, may have been the sea-level which prevailed during the Mindel-Riss interglacial stage. Browne (1945) correlated a 100 ft. terrace or erosion bench occurring on the New South Wales, Tasmanian, and Western Australian coasts, with this period. The organically-cemented sandstone occurring on Stradbroke Island at an elevation of 90 to 110 ft. may have formed shortly after the commencement of the Riss glaciation. The fall in sea-level which accompanied this glaciation may have witnessed the main period of

deposition of sand on the island, the development of the older dunes of the Central and North-Western areas, and the bodily migration of sand to form the high-dune portion of the Central Area.

The sea-level during the succeeding (Riss - Wurm) interglacial period was approximately 50 ft. above the present sea-level. Old shore-lines at an elevation of 40 to 50 feet on the north coast of Tasmania (Lewis, 1935) have been correlated (Edwards, 1940) with this interglacial stage. It seems reasonable to correlate also with this interglacial period of high sea-level the transgression of the Southern and Western areas of Stradbroke Island. The formation of the deposits of organically-cemented sandstone at elevations of 30 to 60 feet, the emplacement of the main deposits of heavy mineral-bearing sands on the eastern dunes, and the building up of the high dunes of the southern area, must have taken place during the fall in sea-level which accompanied the final (Wurm) glaciation. The final rise in sea-level to 10 or 15 feet above present sea-level was completed at about the end of the Pleistocene Period, and the subsequent fall to the present sea-level occurred in mid-Recent times.

The Queensland Pleistocene climate provided two well-marked pluvial periods (Whitehouse, 1940). These may have been synchronous with the interglacial stages of high sea-level. If so, suitable conditions existed for the development of considerable thickness of swamp deposits, and for the vegetation of the island during the period of the 50 ft. sea-level.

Conversely, the inter-pluvial periods may have culminated in comparative aridity during the recessions of the sea, providing favourable conditions for the transport of sand by wind action.

10. The Possibility of More Detailed Interpretations and the Prediction of Heavy Mineral Concentrations.

The history of the development of Stradbroke Island as given in this report needs to be substantiated, and the suggested correlation supported in the following ways:- (a) additional field observation of the occurrence of the fossil swamp deposits; (b) examination of the fossil swamp and dune deposits for microfossils; (c) boring to determine the boundaries of the extensions of the solid rock areas of Dunwich and Point Lookout.

It may then be possible to interpret minor events which have been neglected. Thus, during each glacial epoch the intensity of the refrigeration passed through more than one maximum while approaching its climax, (Browne, 1945), and presumably, while receding from the climax. The minor oscillations of the sea-level probably reproduced, on a small scale, the sequences of dune-building, vegetation and fixing of dunes, and concentration of heavy minerals, that were enacted during the major fluctuations of the sea-level. Occurrences at more than one horizon within the Central Area dunes of these deposits of organically-cemented sandstone, indurated sandstone, fossil wood, and bands enriched in heavy minerals, could possibly be correlated with minor oscillations of the sea-level. Similarly, in the Southern Area, the occurrence in a southerly direction of a succession of low-lying, swampy tracts, with high dunes immediately to the south of them, may point to alternating periods of active dune-building and of cessation of dune-building.

Again, if the general outline of the development of the island can be accepted, it should be possible to define the stages in the development of each locality, and predict the possibility of the existence of heavy mineral concentrations, e.g. along the eastern edge of the Western Dune Area, deposits may have formed:- (a) near the northern end where the area approaches the south-easterly trending boundary of the Central Area. Concentrations of heavy minerals could not have been retained here if, during the transgression at the time of the 50 ft. sea level, a channel was cut through the submerged dune area; (b) at various localities further south where the northern movement of sand may have been arrested by the encroachment of dunes from the Southern Area.

The formation of economic deposits of heavy minerals may be dependent upon concentrations during an advance of the sea, and the presence of an obstruction to the northerly movement of the minerals along the beach. This process is

discussed above in Section B.5(b). It is possible that, during a major recession of the sea, the volumes of sand moving northward along the coast may be too great to allow effective concentration of heavy minerals.

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18th May, 1948.

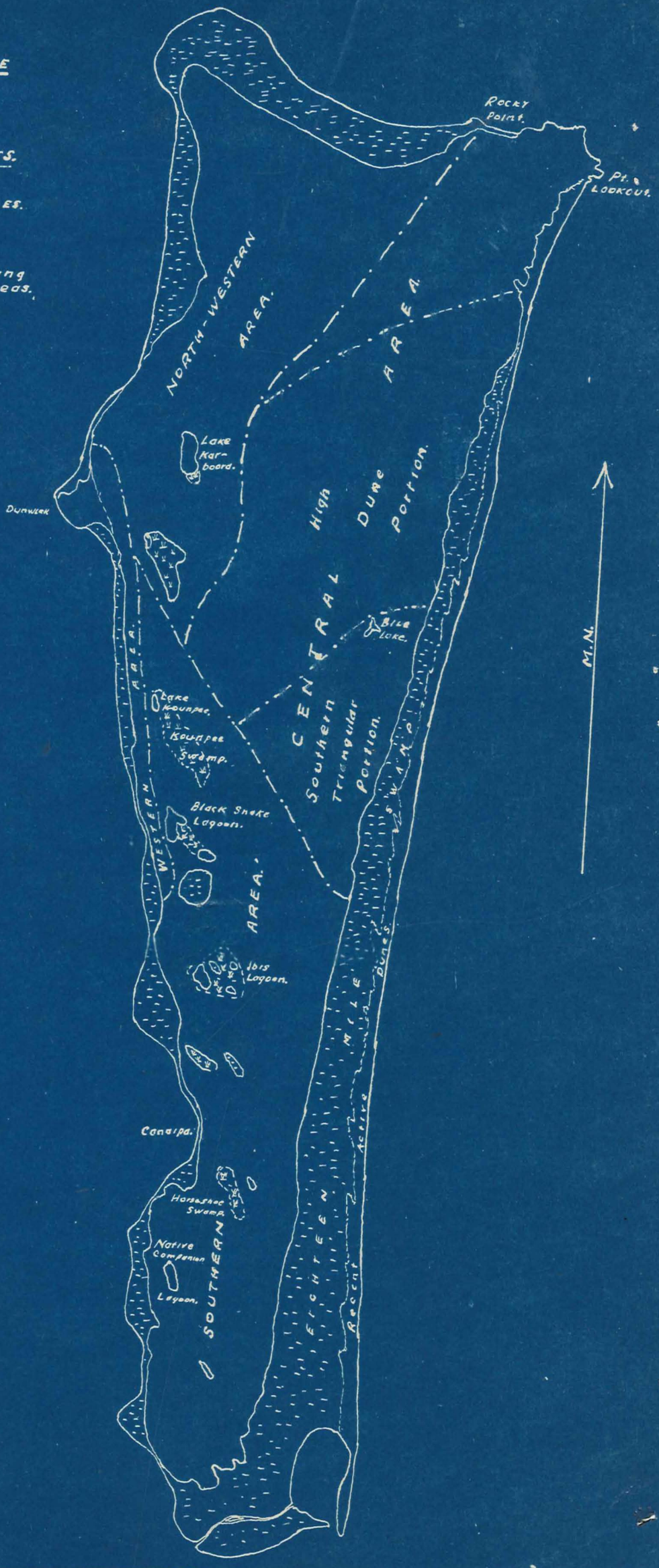
PLATE I.

NORTH STRADBROKE ISLAND.

PHYSIOGRAPHIC UNITS.

SCALE : 1 INCH = 2 MILES.

Coastal low-lying or Swampy areas.



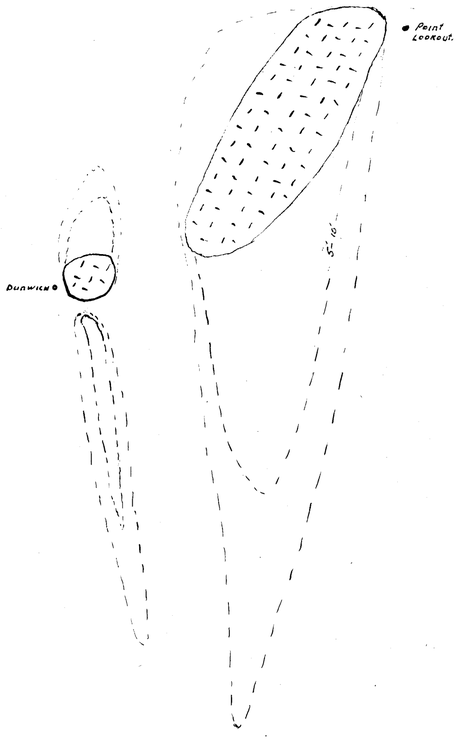


Fig. 1. Sea-level 100 Feet above Present sea-level.

Rocky Islands.

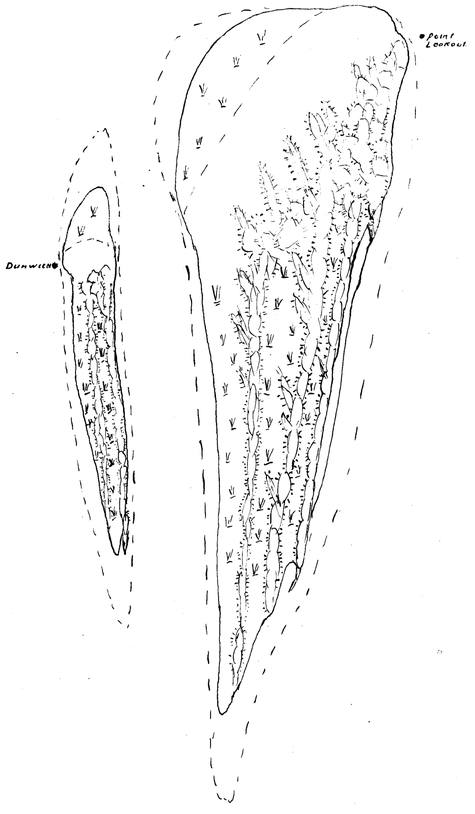


Fig. 2. Early stages of Recession from 100-Foot Sea-Level.

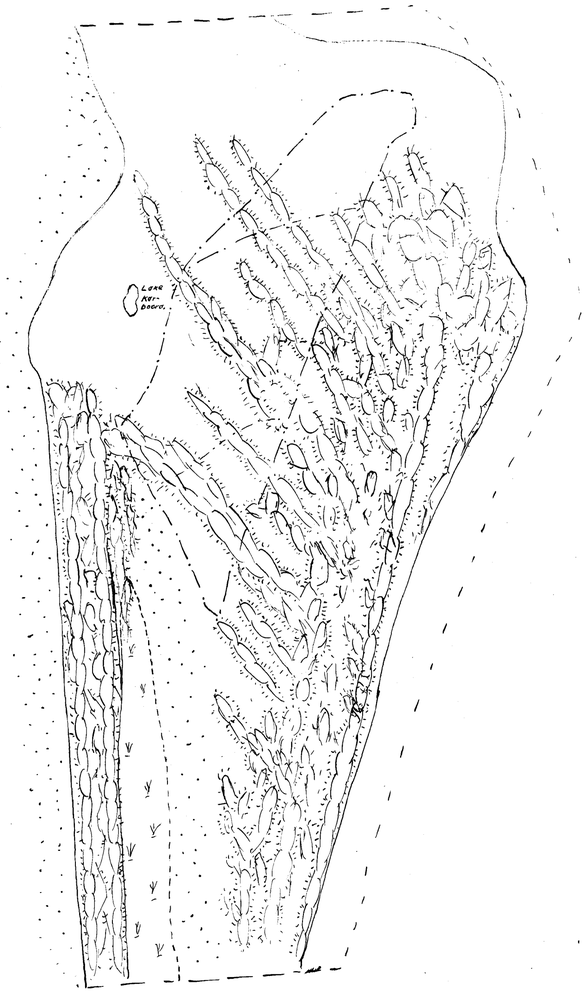


Fig. 3. Advanced stage of recession from 100-Feet Sea-Level.

Boundary of Present-Day Central Area.

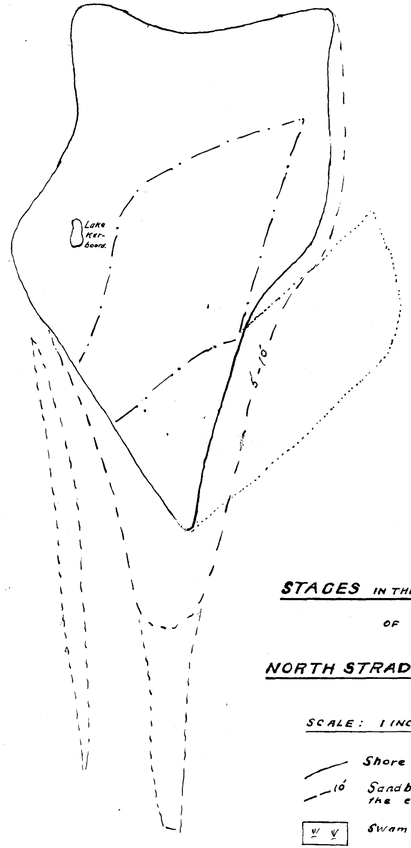


Fig. 4. Sea-level 50 feet above Present sea-level.

Boundary of Present-Day High-Dune area.

Approx. boundary of area from which sand transported to High-Dune area.

STAGES IN THE DEVELOPMENT OF NORTH STRADBROKE ISLAND.

SCALE: 1 INCH = 200 FEET.

Shore line.

10 Sandbank 10 Feet below the existing sea-level.

Swampy.

Low-lying, sandy.

Sand dunes.