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CHANGING SEA LEVELS OF THE AUSTRALIAN EAST COAST.  
SUGGESTED BY LEVELS OF WATER-LAID SAND-DEPOSITS  
AND BY DUNE MORPHOLOGY.

by

D. E. GARDNER.

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## SUMMARY.

Along the East Coast between the Clarence River mouth and Southport, deposits of heavy minerals occur on present-day beaches and on former beaches at elevations, with respect to the present-day deposits, of +1 foot to +2 feet, -5(?) feet, +5 feet, and +10 feet. North Stradbroke Island consists mainly of high sand dunes elongated in the direction of the prevailing wind. They have developed in five successive stages. Associated with them are deposits of organically-bonded, water-laid sand at two separate levels, approximately 45 feet and 100 feet above present sea level. The mineral deposits and dunes are thought to have formed during Late Pleistocene and Early to Late Recent times, the former during or at the end of several intervals of stable sea-level, and the latter during periods of emergence. Correlations are suggested with deposits or erosion surfaces at about the same levels on other parts of the Australian coast.

## INTRODUCTION.

An investigation of beach-sand heavy-mineral deposits between the mouth of the Clarence River, in northern New South Wales, and North Stradbroke Island in southern Queensland, was made by the Bureau of Mineral Resources during the years 1948 to 1950. The work done between the mouth of the Clarence River and Southport comprised detailed boring and sampling of beaches and coastal dunes and portion of coastal plains up to a mile or two inland. The levels of the bore-collars were determined in relation to high water mark on the beaches. On North Stradbroke Island, boring was done by Zinc Corporation and a reconnaissance geological investigation by the Bureau of Mineral Resources. The results of this work are being published by the Bureau, and portions of it which have a bearing on the changing sea-levels are summarized below.

## SAND DEPOSITS: OCCURRENCE.

### Beaches.

The beaches are composed of white quartz sand. They are generally cusped in plan, curving between headlands, tying islands to the mainland, and forming the seaward edges of sandspits. The direction of elongation of the spits shows that the sand moves northwards along the coast.

### Foredune and Parallel Dunes.

A foredune occurs as a ridge at the upper part of the beach, extending along its entire length. It is formed from white quartz sand blown up from the beach, and rises commonly to an elevation of 30 to 40 feet above mean low water. In several areas, parallel ridges up to fifteen in number occur behind the foredune, which they resemble in all respects. They are considered to represent a series of foredunes, which developed in succession as the shoreline advanced in a seaward direction. The parallel dunes are covered by dune-scrub and grasses which stabilize their surfaces. Some foredunes and adjacent parallel dunes are being dissected by blowouts and converted into active dunes elongated in the direction of the prevailing wind, viz. to the north-north-west.

### Coastal Plain.

The coastal plain is a discontinuous fringe of sandy sediment and swamp. It includes, typically, a low-lying area adjacent to the beaches and beach dunes, and a slightly older, more-elevated area covered by heath-like vegetation and termed

heathland. Along most parts of the coast, the heathlands, where they occur, are some distance inland. To reach them from the beach, it is necessary to cross the dunes and then the low-lying part of the coastal plain, which may be, as at Cudgen, 1/2-mile wide. For several miles north and south of Evans Head, heathland areas extend to the coast where they form low cliffs of indurated sand. They are current-bedded and have major planes of stratification which are horizontal or have a slight seaward dip. At 11 miles south of Evans Head they rise to about 10 feet above mean sea level. From 3 1/2 to 6 miles or so north of Evans Head they rise to about 20 feet, and extend westwards towards the village of Broadwater, covered in part by irregular sand-dunes. Some inland areas of heathland investigated by boring contain seams of heavy minerals similar to those in present day beaches, but at higher elevations. At "Macaulays Lead", between Evans Head and Woody Head, about 3,000 feet inland, they are 10 feet higher; near Seven Mile Beach, 1 1/2 miles inland, they are 5 feet higher. The heathlands are firmly indurated by organic matter and a little iron oxide, which coats the sand grains and occupies the pore spaces. In this regard they are distinct from the loose sand in the low-lying parts of the coastal plains, and in the parallel dunes.

#### Transgressive Dunes.

The islands off the southern part of the Queensland coast, and portions of the mainland coast, are made up of massive dunes that attain heights up to 900 feet, and are elongated in the direction of the prevailing wind. They are covered with vegetation that ranges from shrubs to semi-rain forest. To distinguish <sup>them</sup> from the parallel dunes they have been termed transgressive dunes. On North Stradbroke Island, where they have been studied in greatest detail, they are seen to have developed in five successive stages, the later dunes climbing partly over those of the preceding stage. Unlike the parallel dunes, the transgressive dunes are indurated below the surface. On both western and eastern sides, the area of transgressive dunes terminates at an abrupt scarp. On the west the scarp overlooks the tidal channels in Moreton Bay, by whose erosive action it has been cut. On the east, it clearly marks a former shore-line. At its foot is the long Eighteen Mile Swamp, which is skirted on the east by a narrow belt of coastal dunes, and the ocean beach.

#### Organically-Bonded Sand.

Exposed in places along both the western and eastern scarps of the island are deposits of chocolate-coloured sand bonded by black or dark-brown carbonaceous material which fills up the pore space between the sand grains. The deposits are found within two ranges of elevation, determined by aneroid altimeter to be 30 to 60 feet and 90 to 110 feet above sea level. They are seen in places to be horizontally banded, but elsewhere it is difficult to see any sign of structure within them. They resemble closely the sandy and peaty deposits, being formed at present in coastal swamps.

#### MINERAL DEPOSITS: OCCURRENCE.

##### Beach Seams.

During storms heavy minerals are deposited on a beach in the form of a "seam", which is wedge-shaped in cross-section, the broad end being at the top of the beach. The heavy concentrate may be thrown up to the levels reached by extreme high tides, and down beach it may extend to about mean sea level which is about 3 ft. above mean low water. The deposit may be up to 5 feet thick on the southward side of a headland, is commonly about 50 feet wide,

and extends for a considerable distance southwards along the beach, gradually becoming thinner.

#### Former Beach Seams.

Seams similar in all respects to those on present-day beaches are found beneath the parallel dunes, exceptionally up to about 1500 feet landwards from the present beach. They have been intersected in bores along several portions of the coast, and have been exposed by mining at Broadbeach and North Burleigh. Sections along the bore-lines running landwards from Broadbeach and Cudgen Beach, where the belts of parallel dunes are exceptionally wide, indicate that the more landward of the seams are a little higher than those on present-day beaches. A precise measurement of the excess elevation cannot be made, because, firstly the boreholes were in general spaced at 40-foot intervals, and there is no certainty that any of them passed through the lowest part of any seam; secondly, it is very probable that errors up to several inches were made in measuring the depths of some samples. However, it is safe to state that the more landward seams were no less than 1 foot and no more than 2 feet higher than those on and adjacent to the present beaches. The intervening seams appear to have an intermediate level, suggesting that the fall in the level of the seams takes place in two steps. However, there is no certainty of this. At the time of the investigation, mining had proceeded only to about 400 feet from the beach, and the more landward seams were known only from boreholes. At some future time they may be exposed in pits and be accessible for direct measurement. This is most likely in the Cudgen area.

Seams have been found by boring in heathlands up to  $2\frac{1}{2}$  miles inland. Some of these occur at 5 feet, others at 10 feet above the present day beach seams. They differ from present-day seams in that they are partly or entirely indurated like the heathlands in which they occur. It was difficult to bore them with the hand boring equipment that was used, and some holes did not actually go through them. As a result it was not easy to decide the true levels of the bottoms of the +5 foot deposits. Two facts were obvious, firstly, that the deposits were definitely higher than those on present-day beaches, and secondly, that they were much less than 10 feet higher. However, factors such as grain size, where recorded, were used to assist in the interpretation of results and it became clear that they were very close to 5 feet above the present day deposits. Those at +5 feet have been found at Seven Mile Beach  $1\frac{1}{2}$  miles inland, and at North Burleigh, 500 to 800 feet inland. Heathland areas which are correlated with those containing the +5 feet deposits occur inland from Cudgen Beach, Tugun, and North Labrador (3 miles north of Southport), and probably at Tallow Beach and Norries Head. With the exception of the area at North Labrador they have not been tested for heavy mineral deposits.

Deposits 10 feet above those on present beaches are found at Macaulays Lead, which is three-fifths of a mile inland and 5 to 8 miles north of Woody Head ( $3\frac{1}{2}$  miles north of the mouth of the Clarence River), and at Norries Head,  $\frac{1}{2}$  mile inland. Deposits  $2\frac{1}{2}$  miles inland from Evans Head are probably at the same level, but these have not been tested by the Bureau of Mineral Resources. Heathlands that occur near Tallow Beach are probably of the +10 feet level.

At several localities, deposits occur at the seaward edge of the +5 foot heathlands, at some depth below those on present beaches. Their lower portions are indurated, and commonly contain beds of pebbles or cobbles which cannot be

penetrated by hand-boring equipment. Bores have gone down to 2 feet below mean low water without reaching the bottom of the deposits, but the occurrence of coarse rock fragments suggested that they were close to bottom. Since the lower limit of present-day seams is about 3 feet above mean low water, it is clear that these are at least 5 feet lower, and they have been termed the -5(?) foot deposits.

#### Deposits in Transgressive Dunes.

Large low-grade deposits occur in transgressive dunes of the last three stages on North Stradbroke Island. They have clearly been derived from earlier beach concentrates.

#### ORIGIN OF HEATHLANDS, DUNES AND ASSOCIATED MINERAL DEPOSITS.

The coastal dunes, particularly those that form the sandy islands off southern Queensland, are now being eroded by the sea. They must have originated during one or more past periods when large supplies of sand were available, viz., during one or more periods of emergence. The water-laid deposits provide evidence of sea levels, relative to its present level, of approximately +100 feet, +45 feet, +20 feet, +10 feet, +5 feet, -5(?) feet, and +2 feet. These may be related as in Table 1.

**TABLE I.**  
Relations between stable sea levels, indicated by water-deposited sand, and emergences, indicated by dunes.

Sea Level, referred to its present level (ft.)	Emergence	Deposits
0	Emergence that succeeded +2ft. sea (P2 emergence)	Present beach seams
+2		Other parallel dunes and deposits. Landmost deposits beneath parallel dunes.
-5(approx)	P5 emergence	The -5(?) foot deposits P5 transgressive dunes (5th stage)
+5		Heathlands and mineral deposits
	P10 emergence	P10 transgressive dunes (4th stage)
+10		Heathlands and mineral deposits
	P20 emergence	P20 transgressive dunes (3rd stage)
+20		Heathland
	P45 emergence	P45 transgressive dunes (2nd stage)
+45(approx)		Organically-bonded sand, 30-60 ft.
	P100 emergence	P100 transgressive dunes (1st stage)
+100(approx)		Organically-bonded sand, 90-110 ft.

No direct evidence is available of the magnitude of any except the P5 emergence, but some idea of their relative magnitudes can be got from the masses of the corresponding dunes. The P5 emergence was at least 10 feet, and the dunes are well developed. The dunes of the P10 emergence are not as well developed and they probably indicate that the emergence was directly from the +10 foot to the +5 foot level, viz. only 5 feet. The P20 dunes are much larger than the P5 and it must be concluded that they accompanied a recession much greater than 10 feet. Similarly, the P45 and P100 dunes are increasingly more massive and apparently point to increasingly larger emergences. In Table 2 an attempt is made to correlate the heathlands, mineral deposits, and dunes with raised beaches, and surfaces of erosion and deposition observed by Teichert and Fairbridge in Western Australia, and by Browne, David and others elsewhere on the Australian coast.

TABLE 2.

Sand Deposits between Clarence River and North Stradbroke Island, correlated with eustatic movements.

Eustatic Movement	Level of sea Related to Present Sea Level	Sand Deposits.
Contem- poraneous rise in sea level	0	Parallel dunes being converted to transgressive dunes, notably on Stradbroke Island.
Emergence of about 2 feet	Slightly below present sea level *	Parallel dunes and other beach dunes (P2 dunes). Emerged sand flats form portions of the low-lying coastal plain.
Submer- gence of at least 7 feet	+2 ft. *	Deposition of estuarine flats, etc.
Emergence of at least 10 feet.	-5 ft. ** or lower	P5 dunes on Stradbroke Island. Probably also remnants of dunes at Cudgen Head, Norries Head, Tallow Beach and Ballina.
Emergence of 5 feet	+5 ft. *	P10 dunes on Stradbroke Island. Deposition of littoral and estuarine sands which now form +5 ft. heathlands between Lennox Head and North Labrador.
Submer- gence of 40 feet.	+10 ft. *	Deposition of littoral and estuarine sands which form the +10 foot heathlands north and south of Evans Head, and at Norries Head.
Emergence of 50 feet	-30 ft. #	P20 dunes on Stradbroke Island. Probably dune remnants at Ballina, near Broadwater and south of Evans Head.
Submer- gence of about 270 feet.	*20 ft. #	Deposition of littoral and estuarine sands which now appear as heathlands near Broadwater, and (?) south of Evans Head.
Emergence of about 295 feet.	-250 ft. #	P50 dunes on Stradbroke Island.
Submer- gence of about 295 feet	+45 ft. #	Organically-bonded sand at about 30 to 60 feet on Stradbroke Island.
Emergence of 350 feet	-250 ft. #	P100 dunes, rising to 800 feet on North Stradbroke Island.
Submer- gence	+100 ft. #	Organically-bonded sand at about 90 to 110 feet on Stradbroke Island.

\* Based on Teichert (1946), Fairbridge (1947, 1948)

# Based on Browne (1945), David (1950)

\*\* Fairbridge (1948) suggests an emergence of great<sup>er</sup> magnitude.

REFERENCES.

- . Browne, W.R., 1945 - Post-Tertiary chronology for Australia.  
Proc. Linn. Soc. N.S.W., 70 (5).
- David, T.W.E., 1950 - The geology of the Commonwealth of  
Australia, ed. W. R. Browne, Vol. I,  
Ch. XIII.
- Fairbridge, R.W., 1947 - A contemporary eustatic rise in sea  
level? Geog. J. 109, 157
- \_\_\_\_\_, 1948 - The geology and geomorphology of  
Point Peron, Western Australia.  
J. Roy. Soc. W.A., 34, 35-72.
- Teichert, C., 1946 - Geology of Houtman's Abrolhos.  
Proc. Linn. Soc., N.S.W., 71, 145.

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