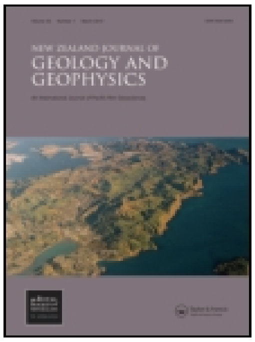

New Zealand Journal of Geology and Geophysics

ISSN: 0028-8306 (Print) 1175-8791 (Online) Journal homepage: http://www.tandfonline.com/loi/tnzg20

Beachrock at Marble Bay, Northland, New Zealand (N8)

David Kear & F. E. Bowen

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BEACHROCK AT MARBLE BAY, NORTHLAND, NEW ZEALAND (N8)

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INTRODUCTION

Bartrum (1941) recorded the presence on parts of the foreshore of Brown's Island, near Auckland (latitude 37° S), of "beach limestone", comprising molluscan shell fragments firmly cemented by calcium carbonate, and enclosing basalt beach boulders. Noting that such rock seemed to have been recorded only from tropical regions, in which it is relatively common, he rejected any implication of a tropical climate at Auckland within the recent past. He suggested that the joints of the very gently sloping lava platform were sealed off by chemical and other deposits and that the fineness of the shelly sand so restricted the movement of the ground water that it became saturated with lime. Precipitation of the carbonate may have resulted from warming of the saturated water during the summer months when the sea, locally shallow and subject to only weak tidal currents, became so warm that its ebb and flow across the beach did not materially reduce the warming effect of the sun on the beach during its exposure.

This note records a second New Zealand occurrence.

GENERAL DESCRIPTION OF LOCALITY

Marble Bay (Sheet N8/7*) lies immediately east of Tauranga Bay, 3 miles (5 km) east of Whangaroa Harbour (latitude 35° S) and is named from the Permian carbonate rock (Hornibrook, 1951; Leed, 1956) exposed at Wherowhero Point, on the eastern headland. The limestone, called marble by Dieffenbach (1843) and Bell and Clarke (1909, p. 45), usually occurs as broken masses in, but is locally in sedimentary contact with, spilitic volcanic rocks. The bay itself is ½ mile (about 1 km) long and faces north. The western headland is composed of indurated, interbedded, Cretaceous sandstone and siltstone overlain by the Plio–Pleistocene Wairakau Andesitic Breccia, and the foreshore is backed by alluvial and beach deposits which are locally cemented by iron oxide and form a small cliff. The beach sand itself is composed predominantly of fragments of limestone and volcanic rock derived from the Permian sequence.

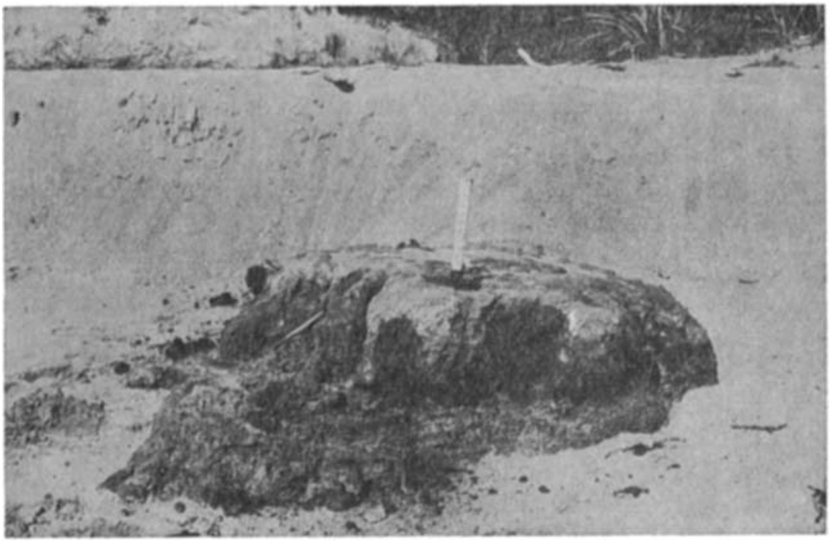
The beachrock occurs high on the beach, on the east side of Taurangaiti Stream mouth, was almost certainly exposed by storm erosion of the covering sand, and has been cliffed (Fig. 2).

Limited available climatic data for the Whangaroa district (Bell and Clarke, 1909; McLintock, 1959, de Lisle, 1964) suggests a mean annual temperature of 15°C (59°F) with summer mean values around 18°C (65°F), and an average rainfall of about 70 in. (180 cm), only about a fifth of which falls in the summer months.

DESCRIPTION OF BEACHROCK

The beachrock is a sandy conglomerate, the sub-angular to rounded sand grains, of about 25 mm median size, being of limestone and volcanic detritus in about equal proportions. The larger, angular fragments, up to 10 cm across are all of limestone. The sand was cemented, in a single stage only, by calcium carbonate crystals (Fig. 3), typically 0·05 mm across, which completely surround the grains but do not fill the voids, a situation corresponding to the "initial stage" of Russell (1962, fig. 6A). X-ray techniques show the presence of aragonite, as well as calcite, in the rock, but staining techniques were inconclusive as to the distribution of aragonite (Messrs J. L. Hunt and D. Clyma, pers. comm.).

*Sheet number of the 1 : 25,000 topographical map series (NZMS 2) published by the Department of Lands and Survey, Wellington, New Zealand.



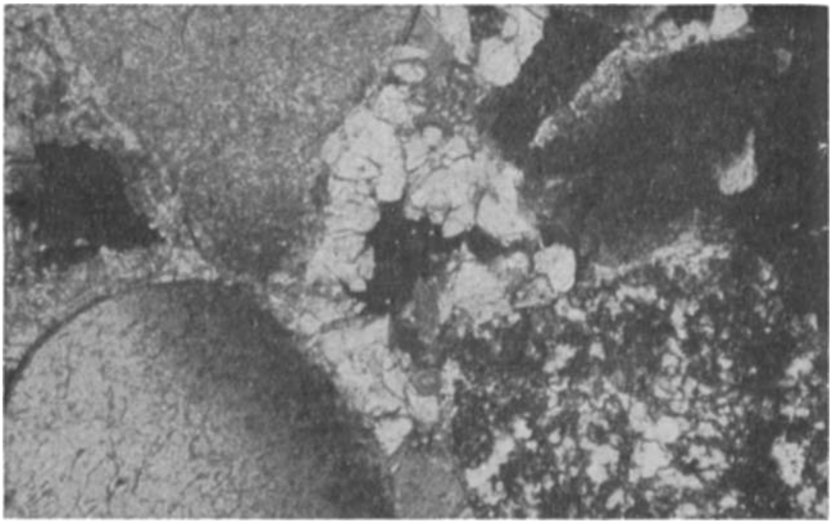
B. N. Thompson, photo

FIG. 2—Beachrock at Marble Bay.

ORIGIN

Bartrum's (1941) assertion that beachrock occurrences in New Zealand cannot be explained by a tropical climate in the recent past is fully endorsed. It should be noted, however, that beachrock has since been reported not only from sub-tropical areas such as south Florida (Ginsberg, 1953), but beyond latitude 35° N in Crete (Boekschoten, 1962, 1963) and, although not *in situ*, in the Rhone delta (43° N) and along the Netherlands coast between 52° and 53° N (van Stratton, 1957).

Most authors are agreed that beachrock forms beneath the surface close to the top of the water-saturated zone of the beach; hence it is only exposed on retreating beaches. Although at many places the beach sands incorporated in the beachrock are dominantly calcareous, that this is not universally so has been shown by Boekschoten (1962, pp. 3–4). Much argument has centred about the source and depositional environment of the cement, which may be calcite, or aragonite, or both. Where both are present the aragonite is usually found enclosing the detrital particles whilst calcite, clearly later, fills the detrital voids. Where only one form is present it is usually possible to distinguish the material coating the particles from that filling the voids. This has led to the two-stage theory of formation of beachrock in which the first stage consists of the sub-surface coating of the detrital matter with calcium carbonate, followed by the filling of the voids when the first-stage material is exposed at the surface (Russell, 1962). Boekschoten (1962, p. 6) has suggested that the initial stage of cementation takes place in a short time, perhaps some days. Russell attributed the calcium carbonate to fresh



D. L. Homer, photo

FIG. 3—Calcium carbonate crystals, of mean size 0·05 mm, acting as cement between limestone and volcanic sand grains. Note the voids between grains.

or brackish water whereas Stoddart and Cann (1965), whilst emphasising the importance of the two-stage lithification, attribute the cementing material to sea water. Since aragonite is unstable and reverts to calcite on exposure to fresh water or moist atmosphere conditions (Cloud, 1962, p. 105), the issue is further complicated. The association of beachrock with brackish or fresh water has been compellingly demonstrated in such places as Crete (Boekschoten, 1962, 1963) and Brazil (Branner, 1904). On the other hand Stoddart and Cann (1965) have equally demonstrated that such an association is inapplicable in British Honduras where the cement is of marine origin. As the latter authors say, "It is at least probable that the problem is not one of the origin of beach rock, but of origins of beach rocks".

The essential features that may be related to beachrock formation at Marble Bay are the presence of fine calcareous material, a north-facing northern New Zealand beach, and a supply of fresh water from Taurangaiti Stream. The material itself is most uncommon, its presence here being due to a unique outcrop of Permian limestone. Outcrops of limestone of any age are rare on the open coast of Northland, although finely comminuted shell material is widespread on its north-eastern beaches (J. C. Schofield, pers. comm.). The northern-facing aspect could result in the actual temperatures there being significantly above the local average. The temperature of the ground water would be unlikely to have been significantly lowered by the incoming of water from the small Taurangaiti Stream during spells of fine, summer weather, and in fact, the stream may have contributed to a local rise in temperature. There is also a strong possibility that the water from Taurangaiti Stream is more calciferous than that of other streams in the region, as it drains areas of Permian volcanic rocks whose association with limestone is clear from the coastal exposures.

CONCLUSION

The formation of beachrock near Whangaroa (latitude 35° S) is considered to be due to the presence of limestone-derived sands on a north-facing beach where the summer temperature is probably slightly above the 18°C local average, and where fresh water, perhaps somewhat more calciferous than normal for the region, is readily available, and may have contributed to a local rise in temperature of the beach ground water.

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