

The higher summer temperatures and lower winter temperatures of the middle beach compared with the lower beach reflect the longer exposure time of the middle beach to the more extreme atmospheric temperatures compared to sea-water temperatures generally.

Comparing the results of the physico-chemical analyses with those of other workers, the organic content of Howick beach would seem to be low. Jones (1956), who worked on deposits from 10 fathoms depth off the Cumberland coast and 30 and 50 fathoms depth off the Isle of Man, obtained organic carbon values of 8.3 mg/g, 4.0mg/g and 9.8mg/g respectively. These deposits contained 19%, 13% and 34% material < 0.0313mm diameter respectively. Since Howick deposits all contained < 5% material < 0.066mm diameter and since organic matter seems to be correlated with the sub-sieve fractions of the deposit (i.e., particles < 0.066mm diameter) (Morgans, 1956), the low values for organic content at Howick would seem to be of about the right magnitude.

The low salinities ( $23^{\circ}/_{00}$ – $31^{\circ}/_{00}$ ) found up to 150m down the beach are very similar to salinities recorded by Smith (1955) at Kames Bay, Millport. He gave values of about  $23^{\circ}/_{00}$ – $25^{\circ}/_{00}$  for interstitial water up to 80m down the beach in an area where no surface outflow of fresh-water occurred, and suggested (p 42) . . . “that geological features permit it (the intrusive fresh-water drainage) to flow into the sands of the beach with a sufficient head to maintain brackish conditions in the sand even at high tide. Such conditions may be peculiar to this beach . . . That they may be more common than hitherto noted is suggested by the fact that interstitial salinity lower than that of sea-water has been observed beneath the ebbing tide at Fintray Bay, Isle of Cumbrae, where the beach is totally unlike that at Kames Bay, being exposed, steeply sloped, and of very coarse, loose, gravelly sand and pebbles”. The beach at Howick where the low salinities were recorded contained up to 33% material of a grade > 2.057mm, all of which was broken shell, and up to 42% sand 0.500mm–0.251mm. The beach texture at Howick would thus seem to be somewhere between that at Fintray, gravelly sand and pebbles, and that at Kames Bay where 93%–97% of the substratum was of the particle size class 0.5mm–0.2mm (Watkin, 1942). No attempt was made at Howick to record interstitial salinities while the tide overlay the stations, nor was the origin of the fresh-water investigated, but though the small outflow on to Howick Beach was some 25m–50m from the stations showing the low salinities, it presumably must have had some influence on the brackishness recorded.

A rise in the salinity of the interstitial water of  $1^{\circ}/_{00}$  above that of local sea-water was observed by Southward (1953) on two beaches in the Isle of Man where the maximum surface sand temperature was  $25^{\circ}$  C. The reading of just over  $3^{\circ}/_{00}$  above local sea-water at station 4 at Howick could have been brought about by higher temperatures (maximum recorded at Howick nearly  $28^{\circ}$  C) helped by an off-shore breeze, as noted earlier, causing greater evaporation.

The oxygen content of the interstitial water on both the middle and lower beach was high compared with findings on other beaches. Pearse, Humm and Wharton (1942) recorded 4.67 cc/1 for open sea-water (cf. 5.60ml/1, Howick) and a maximum of 1.9cc/1 (cf. 5.45ml/1, Howick) for interstitial water in the surface sand on Beaufort beaches, North Carolina. Lower values still (maximum 0.35ml/1) for interstitial water 7.5cm below the surface (cf. 3.4ml/1 maximum sub-surface value at Howick) were recorded by J. D. Jones (1955) at Robin Hood's Bay, Filey, and Scarborough Harbour. However, Jones stated that the organic content of the sand at Scarborough was high and the water polluted by fishery activities, but did not give values for the organic content. The freely porous nature of the substratum and virtual absence of a “black sand” sub-surface layer on the middle