

Sand transport along the Western Cape coast: gone with the wind?

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BEACH SAND SAMPLES WERE COLLECTED between Cape Town and St Helena Bay in order to study sediment composition and transport along the Western Cape coastline. Between Cape Town and Saldanha Bay, the beaches are a mixture of terrigenous and carbonate material. Those between Saldanha Bay and Shelley Point are carbonate-rich. North of Shelley Point, terrigenous-rich beaches were found. The decrease in terrigenous material from Cape Town to Saldanha Bay is a reflection of reduced delivery of terrigenous sand by rivers. The low content of terrigenous material in beach sands between Saldanha Bay and Shelley Point is related to the high biogenic CaCO_3 in the rocky coastal area. In St Helena Bay the high percentage of terrigenous material is contributed by the Berg River. Coastal dune composition also reflects the mineralogy of the beach sand. This work indicates that the terrigenous material delivered by rivers to False Bay and Table Bay move northwards by longshore drift while being mixed with carbonate shell fragments.

The mineralogy and grain size of beach sand between Cape Town and St Helena Bay (Fig. 1) were determined in order to understand the transport of sediment along the Western Cape coastline. Based on the mineralogy of the sands, the beaches can be differentiated into: mixed terrigenous-carbonate beaches south of Saldanha Bay (from 85 wt% terrigenous material at Milnerton Beach¹ to 60 wt% at

Sixteen Mile Beach), carbonate-rich beaches between Saldanha Bay and Shelley Point (up to 83 wt% CaCO_3 at

Diazville Beach), and terrigenous-rich beaches north of Shelley Point (up to 96 wt% terrigenous material in St Helena Bay). The decrease in terrigenous material between Cape Town and Saldanha Bay reflects the reduced delivery of terrigenous sand by rivers. False Bay and Table Bay have perennial rivers that drain catchment areas receiving an average annual rainfall of 600 mm. Ephemeral rivers with small catchment areas drain the semi-arid west coast region south of the Berg River (annual rainfall is 273 mm at Langebaan).

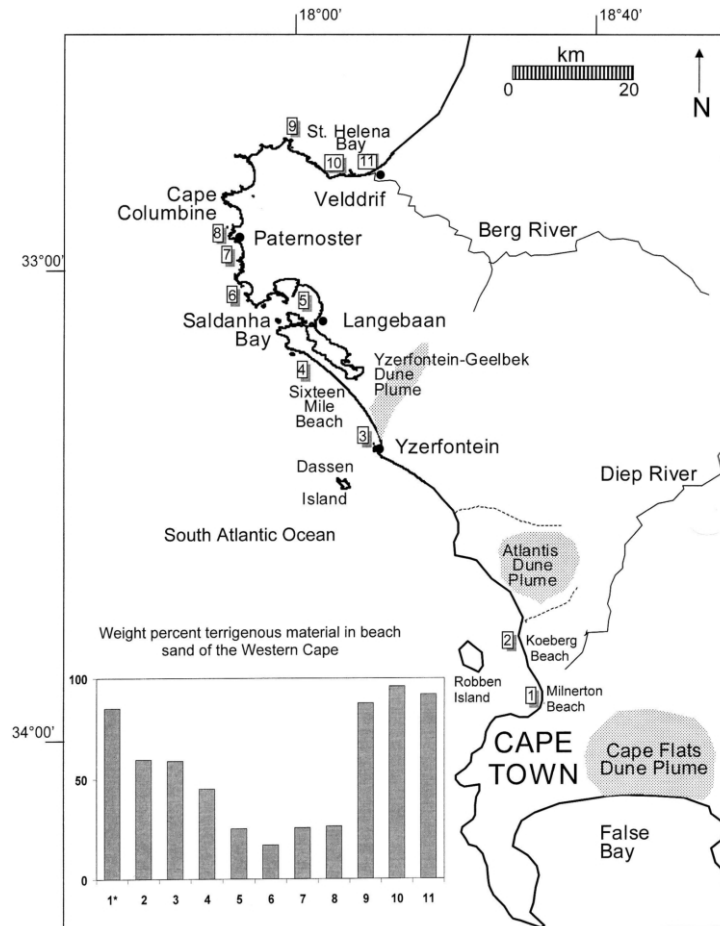


Fig. 1. Location map of the study area. 1, Milnerton beach (*data from McLachlan*); 2, Koeberg Beach; 3-4, Sixteen Mile Beach (south and north); 5, Saldanha Bay; 6, Diazville Beach; 7-8, Paternoster beach (south and north); 9, Shelley Point; 10, Berg River Mouth; 11, c. 500 m north of sample 10.

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The decrease in terrigenous sand supply from south to north is directly reflected in the contracting extent of the coastal dunes, which varies from 243 km² in the Cape Flats, to 88 km² at Atlantis and 43 km² in the Yzerfontein-Geelbek dunefield² (Fig. 1).

The decrease in dunefield size and terrigenous sand fraction of the beach sands from Koeberg to Saldanha Bay may be explained by calculating the amount of material transported by longshore drift and that lost to coastal dunes. The northward net longshore drift over a two-year period at Koeberg Beach³ is estimated to be 0.2 million m³/yr. Large seasonal variations were observed in the volume of sand out to the 15-m bathymetric contour, but loss of sand to water depths greater than 15 m was negligible at Koeberg Beach.³ Sea level rose to its present-day position around 7 kyr ago⁴ and the sand transported by longshore drift since then is ~1400 million m³. Although there is considerable uncertainty about net coastal sand movement, this calculation uses the longshore drift values calculated for Koeberg Beach.³ The total volume of aeolian sand between Koeberg Beach and Saldanha Bay based on an average thickness of the Holocene coastal dunes of 7–10 m, is estimated to be between 1000 and 1200 million m³. Therefore, roughly three-quarters of sand transported north by longshore drift is returned to land as dune deposits. The low content (<20 wt%) of terrigenous material in beach sands along the Cape Columbine Peninsula north of Saldanha Bay indicates that most of the terrigenous material is not transported north along the coast.

Where does the remaining sand transported longshore go? It may be accommodated in the Holocene sediments in Saldanha Bay, which consist of a mixture of fine to coarse carbonate sand.⁵ Alternatively, the low terrigenous material content may reflect dissolution by abundant shell fragments.

A simplified model of the transport of beach sand between Milnerton Beach and Saldanha Bay indicates that terrigenous material transported to the coast by rivers or reworked from coastal dunes moves northward by longshore drift and is mixed with carbonate shell fragments (predominantly from *Choromytilus meridionalis*, *Donax serra* and *Patella* species). These beach sands are deflated to form coastal dunes by strong, predominantly southerly, dry summer winds. Coastal dunes are remarkably resistant to destruction by erosion⁶ and retain most of their wind-blown terrigenous material.² Beach sand

not removed for dune formation is transported northward towards Saldanha Bay. The carbonate-rich beaches between Saldanha Bay and Shelley Point are related to high biogenic CaCO₃ production along the rocky coastline as well as to the lack of terrigenous sediment input by either rivers or longshore drift. A comparative study of surface sediments has shown that present-day biomass production of carbonate is much higher in mixed rocky-sandy parts of Saldanha Bay than in lagoonal or sandy areas.⁵ In St Helena Bay, east of Shelley Point, beach sand composition changes greatly from carbonate-rich to terrigenous-rich because of the input of terrigenous material by the Berg River.

The pioneer coastal dunes also reflect the mineralogy of the beach sand, with the pioneer dunes south of Saldanha Bay being a mixture of terrigenous and carbonate material. In contrast, pioneer dunes between Saldanha Bay and Shelley Point are almost entirely composed of carbonate sand (up to 90 wt%).

This study has emphasized the importance of the input of terrigenous material, the production of biogenic carbonate shell in rocky coastal areas, and the role of longshore drift and coastal dune accumulation of deflated beach sands in understanding the coastal system. The terrigenous material delivered by rivers to False Bay and Table Bay is largely returned to land by the coastal dune systems and, to a lesser extent, to Saldanha Bay. Coastal dunes are prominent features along much of the coastline of southern Africa⁷ and dune stability is an environmental issue in many coastal areas today,^{8,9} including the Cape Peninsula.¹⁰ South African coastal dunefields have prograded seaward since the mid-Holocene sea-level maximum as episodic pulses of sand.^{2,11–15} The coastal dunefields in the Western Cape extend 24 km inland² and supply the coastal plain with carbon-

ate, the dissolution of which over glacial-interglacial cycles has resulted in extensive calcrete formation.^{14,15}

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