PROCESSES OF SEDIMENTATION ON THE SHOREFACE AND CONTINENTAL SHELF AND THE DEVELOPMENT OF FACIES PAKIRI, NEW ZEALAND

Thesis submitted by

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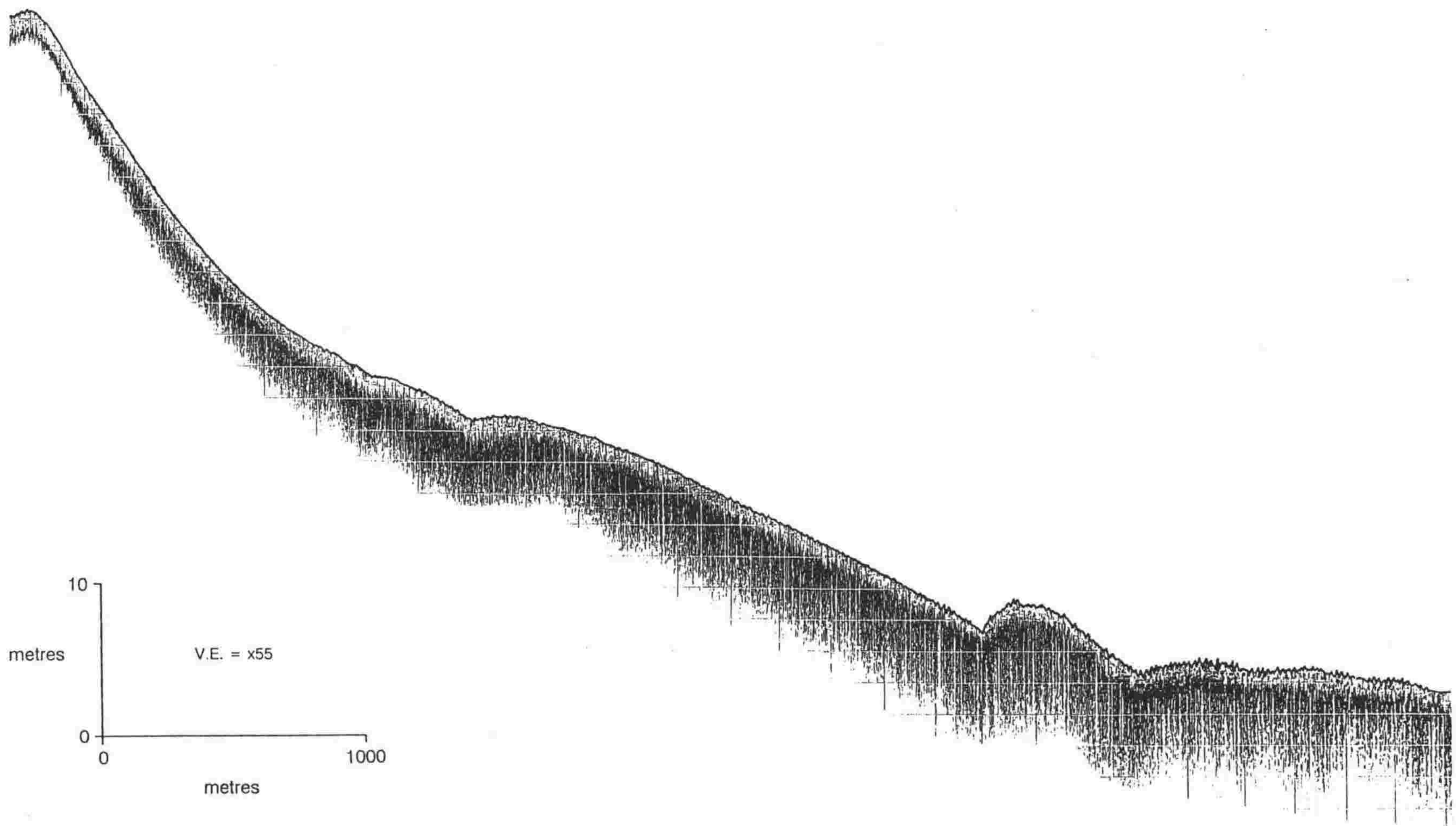
Frontispiece A typical shore-normal echosound record across the shoreface and continental shelf, Walkway transect (08.05.89), Pakiri Bay, New Zealand.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ABSTRACT

This dissertation presents the results of research of physical and biological processes of sedimentation on the shoreface and continental shelf in Pakiri Bay, on the east coast of the Northland Peninsula, New Zealand. These environments comprise the subtidal portion of the Pakiri sand body.

Sand bodies that are contiguous with unconsolidated sediments of coastal barriers are characteristic of the embayed east coasts of the Auckland and Northland Regions, yet little is known of their geomorphology. Existing models of shoreface and shelf sedimentation afford limited assistance because they were developed in different environments. Factors that distinguish the study area from other coasts include tectonic stability, lack of modern (non-biogenic) sediment inputs, the predominance of currents related to shoaling surface waves, and a sea level stillstand for the last 6,500 years.

The model of sedimentation developed is derived from intensive field investigation of the morphology, sedimentology and ecology of the Pakiri Bay shoreface and continental shelf. Investigations of sediment transport entail interpretations of the sediments and sedimentary structures of the seabed, application of existing sediment transport models and the analysis of morphodynamic data.

The geomorphology of the Pakiri sediment body is characterized by a regular pattern of morphologic components and associated sediment types. Alongshore variation in these characteristics is generally minor compared with shore normal variation. The shoreface comprises a curvilinear concave surface, that extends offshore from the alongshore bar approximately 1500 m, to water depths of about 22 m. The inner continental shelf comprises an equally curvilinear, mostly convex, surface that slopes seaward to the relatively flat middle continental shelf. Secondary morphological variations result from the presence of large-scale bedforms on the middle continental shelf and landward margin of the inner shelf.

The sediments of the shoreface are fine, very well sorted quartz-feldspathic sands of 2 ϕ mean grain size. The inner shelf sediments grade offshore from a medium sand to very coarse sands and fine gravels (mean grain size 0.0 to 0.5 ϕ). In contrast the sediments of the mid shelf are very fine sands (mean grain size 2.0 to 2.5 ϕ), with a mud content of 5 to 10 percent.

Carbonate skeletal debris, derived mostly from molluscs, comprises a significant proportion of inner and mid shelf sediments. The concentration of carbonates in the sediments increases offshore from 0 to 5 percent on the shoreface to 30 percent at the base of the inner shelf. The carbonate fraction of the sediments is size graded on the inner shelf and mid shelf in accordance with the grain size characteristics of the non-carbonate fraction.

A model of the distribution and abundance of living macrobenthos (mostly of the phyla mollusca) is derived from benthos surveys in Pakiri Bay. Species that are diagnostic of high and low energy environments are characteristic of the shoreface and middle continental shelf respectively. The pattern of carbonate concentration in the sediments of the subtidal sediment body does not correlate with the pattern of modern biogenic production. Highest levels of modern shell production occur across the shoreface, whereas carbonate concentrations are greatest at the base of the inner shelf. Hypotheses are advanced to explain this dichotomy.

The geomorphology of the shoreface and inner continental shelf is seen as a response to modern processes of sedimentation. Sediment transport occurs primarily in response to currents related to shoaling waves. Two process regimes are recognized. During typically calm (swell wave) conditions the fine sands of the shoreface may be transported landward as a result of an onshore mass transport current. During severe storm events this process may transport bed sediments landward across the inner shelf and middle continental shelf, forming the characteristic sediment and morphologic patterns observed. However, during such events this onshore flow is probably counteracted by return flows that are able to transport eroded foreshore and inshore sediments seaward.

Key words: Sedimentation, shoreface, continental shelf, wave dominated, carbonate sedimentation, sediment body, facies.

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