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Geotechnical investigation of sorted bedforms evolution and maintenance processes

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Sorted bedforms are described as asymmetric sequences of bathymetrically depressed coarse sand zones and fine sand zones. They influence large-scale sediment budgets and can provide geological insight about past environments. In particular, understanding of their evolution and maintenance might improve the understanding of hydrodynamic forces and weather events on the formation of structures on the continental shelf and in coastal areas. Recently, numerical models suggested that sorted bedform evolution and maintenance was governed by self-organizing patterns as a consequence of sediment transport and bed composition. This study aimed for the geotechnical investigation of sorted bedforms on the continental shelf off the Coromandel Peninsula, New Zealand, to monitor sediment strength in the upper decimeter of the seafloor as an indicator for recent and on-going sediment remobilization. The dynamic penetrometer Nimrod was deployed by divers along three transects crossing the Southern and Northern transition as well as the central coarse sand zone (characterized by large ripples) of a ca. 100 m wide sorted bedform. Additionally, sediment samples were taken at each position. Comparing the Northern and Southern transition, the bathymetrically smoother Northern transition showed a sharp difference in grain size (fine sand zone 0-10m from the transition edge: d50= 0.1mm; opposing coarse sand zone: d50= 1.1-2.3mm) correlating well to the geotechnical results: deceleration of the probe (dec.) of 90-125g with a corresponding quasi-static bearing capacity after consideration of changes in penetration velocity and penetration surface area of (qsbc.) 75-105kPa in the fine sand zone, and dec.=40-65g and qsbc.=25-45kPa in the coarse sand zone. On the other hand, more diffuse sedimentary and geotechnical results were unraveled along the transect crossing the Southern transition (fine sand zone 0-10m from the transition edge: d50= 0.1-0.25mm, dec.=65-90g, qsbc.=55-60kPa; opposing coarse sand zone: d50= 0.7-1.0mm, dec. =50-60g, qsbc.=35-40kPa). The measurements along the centre transect in the coarse sand area revealed mainly a homogeneous sediment strength (dec.=60-70g, qsbc.$\sim$40kPa), whereas slight differences in grain size were noted for the crests (d50=1.0-1.1mm) and troughs (d50=1.2-1.5mm). Vertical layering in terms of a less dense top layer of 2-6 cm thickness was only observed in the coarse sand areas and in the fine sand zone at the Southern transition. Consequently, the sedimentary and geotechnical results supported the concept of self-organizing patterns along the sorted bedform by displaying a reworked surface of the coarse sand zone that likely goes along with fine sediment erosion. Furthermore, the results suggested sediment erosion at the Northern transition that may be an explanation for the bathymetrically smoother appearance, whereas sediment deposition at the Southern transition would explain the more diffuse transition in grain size and sediment strength. Thus, this study introduced a new method to investigate morphodynamics in coastal areas, delivered complementary geotechnical data on the sorted bedforms off the Coromandel Peninsula, and hinted at recent sediment remobilization processes supporting current theories about sorted bedform evolution and maintenance.