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The morphodynamic significance of rapid shoreline progradation followed by vertical foredune building at Pedro Beach, southeastern Australia

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Prograded coastal barriers are accumulations of marine and aeolian sands configured into shore-parallel ridges. A variety of ridge morphologies described around the world reflect differences in origin as a consequence of differing prevailing coastal morphodynamics. The 'morphodynamic approach' described by Wright and Thom (1977) expounds the coastal environmental conditions, hydrodynamic and morphodynamic processes and inheritance of evolutionary sequences over varying temporal scales which interdependently operate to produce an assemblage of coastal landforms adjusted, or adjusting to, a dynamic equilibrium. At Pedro Beach on the southeastern coast of Australia a large sandy deposit of foredune ridges provides an opportunity to explore the morphodynamic paradigm as it applies to coastal barrier systems using optically stimulated luminescence (OSL) dating, ground penetrating radar (GPR) and airborne LiDAR topography. The prograded barrier at Pedro Beach has formed following the stabilisation of the sea level at its present height on the southeast Australian coastline. A series of dune–capped ridges, increasing in height seawards, formed from ∼6000 years ago to ∼4000 years ago. During this time the shoreline straightened as bedrock accommodation space for Holocene sediments diminished. Calculation of Holocene sediment volumes utilising airborne LiDAR topography shows a decline in sediment volume over this time period coupled with a decrease in shoreline progradation rate from 0.75 m/yr to 0.49 m/yr. The average ridge 'lifetime' during this period increases resulting in higher ridges as dune-forming processes have longer to operate. Greater exposure to wave and wind energy also appears to have resulted in higher ridges as the sheltering effect of marginal headlands has diminished. A high outer foredune has formed through vertical accretion in the past 700 years, evidenced by GPR subsurface structures and upward younging of OSL ages, with a sample from 1 m deep within the crest of this dune returning an age of 90 ± 10. An inherited disequilibrium shoreface profile will drive onshore accumulation of sandy sediments forming a prograded barrier; however, if there is no longer 'accommodation space' for sediment, this will be an overriding factor causing the cessation of progradation as occurred ∼4000 years ago at Pedro Beach. Following progradation cessation, excess sediment in the disequilibrium shoreface profile will be moved alongshore as barrier progradation (embayment filling) has diminished the potential of headlands to act as impediments to sediment bypassing in the nearshore. It is hypothesised that the chronology and geomorphology of the Pedro Beach barrier system typifies the changing 'strength of influence' in the interaction between geologically inherited accommodation space, sediment delivery and beach/dune/shoreface dynamics over the mid-late Holocene.

Wright, L. D., & Thom, B. G. (1977). Coastal depositional landforms: a morphodynamic approach. Progress in Physical Geography, 1(3), 412–459.