

INVESTIGATIONS ON RIDGE AND RUNNEL TOPOGRAPHY AND ITS INFLUENCE ON BEACH MORPHODYNAMICS

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The barrier beaches of Long Island, like most sandy beaches worldwide, commonly exhibit ridge and runnel topography associated with sand bar development. Conceptual beach morphodynamic models like those presented by Wright and Short (1984) recognize that ridge and runnel topography can control the dynamic response of a beach to incident wave energy. However, it is difficult to isolate the influence of topography on beach and nearshore processes when the topography is constantly shifting in response to hydrodynamic forcing. This problem can be negated on low latitude beaches where ridge and runnel topography is defined by sculpted sandstone and is fixed on the event scale. Field studies on such a beach on the west coast of Puerto Rico indicate that morphodynamic variability is more a function of proximity to shore-normal breaches in the ridge and alongshore variation in the ridge and runnel relief, than variation in wave energy or angle of approach (Turner, 1999).

The sculpted sandstone of low latitude beaches with the ridge and runnel morphology is beachrock (Fig. 1), layers of beach sand cemented in the subsurface by the intergranular precipitation of calcium carbonate. Extensive outcrops of beachrock exposed by shoreline retreat are increasingly common in the tropics and subtropics. Cumulative exposure and erosion of a beachrock formation over a period of months up to decades fosters a gradual increase in the landward and seaward relief of the beachrock units and the development of shore-parallel runnels and shore-perpendicular breaches in the beachrock (Fig. 2). An investigation of the dynamic influence of beachrock exposures with this morphology was conducted over a three-year period using electromagnetic current meters, mechanical flowmeters, sediment traps, and regular beach profiling.

Figure 1. Photo of the west end of the field site near Aguada, Puerto Rico. Distinct beachrock units define a static version of sand bar ridge and runnel topography. Seawater impounded in the runnels on the foreshore flows away from the viewer and out to the shoreface through a breach in the beachrock ridge via a rip current. (Click on thumbnail to get larger image.)

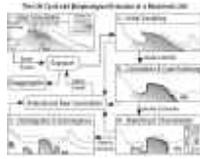


Figure 2. Conceptual model of the life cycle and morphological evolution of beachrock. An exposed beachrock formation that has reached Stage IV in its morphological evolution will influence shoaling wave, nearshore current, and sediment transport processes like a static version of sand bar ridge and runnel topography. (Click on thumbnail to get larger image.)

Beachrock at the field site with high seaward relief effectively attenuates incident gravity wave energy (fig. 3) and retards onshore sediment transport. The landward relief of the beachrock unit acts as the seaward wall of a runnel that blocks offshore return of backwash and forces impounded seawater and entrained sand to flow laterally on the foreshore to low spots and shore-normal breaches in the beachrock formation (Fig. 1). Currents in the shore-parallel beachrock runnels are strongly unidirectional, can flow in the direction opposite incident wave approach, and exhibit a pulsing behavior associated with low frequency fluctuations of the sea surface at discharge points. Longshore current power and frequency composition are better correlated to tide height than to wave height, despite a microtidal range of 30 cm. Median current velocities exceed 30 cm/sec even when wave heights are less than 0.5 m.

Wave Attenuation By a Beachrock Ridge