

Building of tropical beach ridges, northeastern Queensland, Australia: Cyclone inundation and aeolian decoration

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Processes associated with tropical cyclones are thought responsible for building coarse sand beach ridges along the northeastern Queensland coast, Australia. While these ridges are expected to be geological records of the past cyclone, they question the general consensus of the aeolian genesis of sandy beach ridges. To explore the ridge-forming process, we carried out the GPR survey, auger drilling, pit excavation, grain-size analysis, and OSL dating for coarse sand beach ridges at the Cowley Beach, northeastern Queensland. The Cowley Beach is a mesotidal beach characterized by a low-tide terrace and steep beach face. Ten beach ridges are recognized along the survey transect that extends 700 m inland from the shore. 37 OSL ages are younger seawards, indicating the seaward accretion of the ridge sequence over the last 2700 years. The highest ridge is +5.1 m high above AHD (Australian Height Datum). Two GPR units are bounded by a groundwater surface at c. +1.5 m AHD. The upper unit is characterized by horizontal to hummocky reflectors punctuated by seaward dipping truncation surfaces. These reflectors in places form dome-like structure that appears to be the nucleus of a beach ridge. The shape and level (+2.5 m AHD) of the dome are similar to those of the present swash berm. The lower unit shows a sequence of reflectors that dip at an angle of present beach face. The sequence is dissected by truncation surfaces, some of which are continuous to those in the upper unit. Coarse sand mainly forms beach ridge deposits below +4.0 m AHD, while a few higher ridges have an upward fining layer composed of medium sand above +4.0 m, which is finer than aeolian ripples found on the backshore during the survey. In addition, pumice gravel horizons underlie the examined ridge crests. The sequence of seaward dipping reflectors indicates that the Cowley Beach, like other many sandy beaches, has prograded during onshore sand accretion by fairweather waves and has been eroded by storm waves. It is evident that increased water level and high waves associated with tropical cyclones are responsible for ridge building between +2.5 and +4.0 m AHD. However, astronomical tide should be critical rather than rare, intense cyclones for frequent coastal inundations up to +4.0 m AHD, just 1.5 m higher than the high-tide swash limit. The medium-grained sand layer on a few beach ridges higher than +4.0 m AHD can be accounted for by aeolian origin, but pumice gravels indicate the contribution of cyclone inundation. The building process of the ridges at Cowley Beach is thus most likely a mixture of fairweather swash and cyclone inundation modulated by tides, and aeolian processes during cyclonic and non-cyclonic conditions. For the reconstruction of the past cyclone based on these ridges, the roles of higher astronomical tides and aeolian processes should be taken into account.