High-resolution OSL dating of cut-and-fill beach deposits for assessing beach erosion history in Bengello Beach at Moruya, SE Australia

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Quartz optically-stimulated luminescence (OSL) dating can determine the depositional age of very recent (tens of years) sediments in optimal environments such as beach and dune field. Very rarely, extreme storms can cause significant beach retreat and thus estimating their extent and frequency is critical for coastal property. However, modern beach observation is generally too short for the infrequent nature of such events. Prograded beach deposits resulting from long-term beach erosion and deposition, if dated continuously from the recent past to present, potentially provide a record of the beach erosion history. Here we show a geological assessment of extreme beach retreat in Bengello Beach at Moruya, southeastern Australia, based on high-resolution quartz OSL dating coupled with Bayesian modeling, and ground-penetrating radar (GPR) surveys. Beach monitoring since 1972 reveals that the Bengello Beach has shown a typical cut-and-fill pattern, in which the beach retreats several tens of meters in relation to storm events and immediately recovers within the following few years. A storm event caused extreme beach retreat of up to 50 m in 1974. Since then, no storm event has been associated with retreat exceeding 30 m. It has thus been argued that the 1974 erosion was an event that happens once in 50–100 years. The beach monitoring defines a beach profile envelope, and indicates that the upper foreshore deposits can only be preserved as stratigraphic records during rapid beach recovery following a large retreat deeper than the envelope. Thus, ages of the preserved upper foreshore deposits are considered as roughly corresponding to timings of large-scale retreat. Sediment samples for OSL dating were collected from the subsurface of the beach-ridge plain behind Bengello Beach. Sample sites were located at 5–10 m intervals along a shore-normal transect extending from the modern foredune to 120 m inland. The GPR profile confirmed all the samples were taken from prograded upper foreshore deposits. The most landward, oldest sample was dated as 510 yr, indicating that the net seaward accretion rate of beach-ridge plain is 0.24 m/yr, concordant with the average rate since the mid Holocene. Other OSL ages show four events of beach retreat at 350, 180, 130, 90 yr, and also reflect the presence of the beach scarp resulting from the 1974 event. Assuming a constant rate of beach accretion of 0.24 m/yr, the retreat of the four events is estimated as 45–55 m, respectively, similar to that in 1974. A 40-m interval of beach deposits following the 350 yr event, shows four identical OSL ages ranging from 350 to 330 yr, and is associated with a 150 yr gap before the unit immediately seawards. This suggests beach retreat was relatively modest during 330–180 yr. At Bengello Beach, extreme beach retreat, including that in 1974, happened at least five times over the last 350 years at a variable recurrence interval of 50–150 years.

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