Coastal barrier evolution in the Gippsland region over the Last Interglacial and Holocene

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Introduction

Coastal sandy barrier systems and associated foredune ridge plains are key archives of past climate, both the position of the sea as well as the degree of storminess. Their beach and dune environments are also highly sensitive to future climate change with landward shifts in the position of the beach and destabilisation of their backing dune fields expected. Barriers are also used to define sediment compartments and their response to changing boundary conditions may be spatially and temporally variable over 100-km scales. Predicting shoreline response is therefore highly complicated as understanding sediment fluxes at this scale is difficult, and often significantly impacted by human activity.

The east Gippsland region of Victoria along Ninety-Mile Beach (NMB) is the only true contemporary barrier island system in Australia, with a series of shorelines inferred to date to MIS 7 (Penultimate Interglacial). It lies at the southern limit of the Subtropical Ridge, a system which is expected to shift further south by the year 2100. As a result the wave climate and related sediment flux is expected to change significantly and for these reasons NMB is identified as being one of the most sensitive sites to future climate change in Australia. NMB is largely free from human development which makes this system an ideal area to study landform evolution in relation to warmer climates.

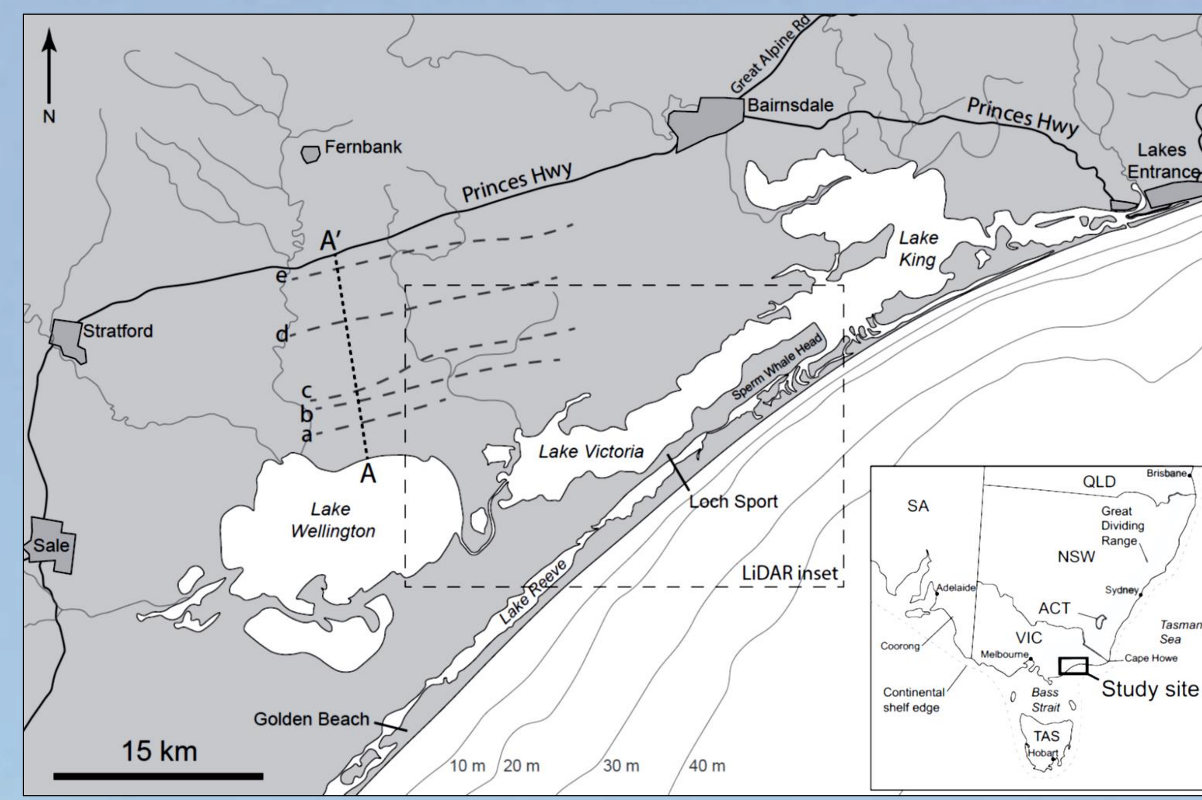

Figure: Location of the Gippsland Barrier system in eastern Victoria, Australia. The lakes are impounded by a regressive barrier plain dating back to MIS 5.

Figure: (a) Dune scarp at McLoughlins Beach cutting through the foredune ridge plain of late Holocene age. (b) GPR data collection at Reeves Beach through a series of blowouts just behind the contemporary foredune. (c) The narrow barrier composed of a single foredune at Seaspray which dates from historical times (last 200 years). (d) The highest, and oldest dated, part of the barrier near Loch Sport.

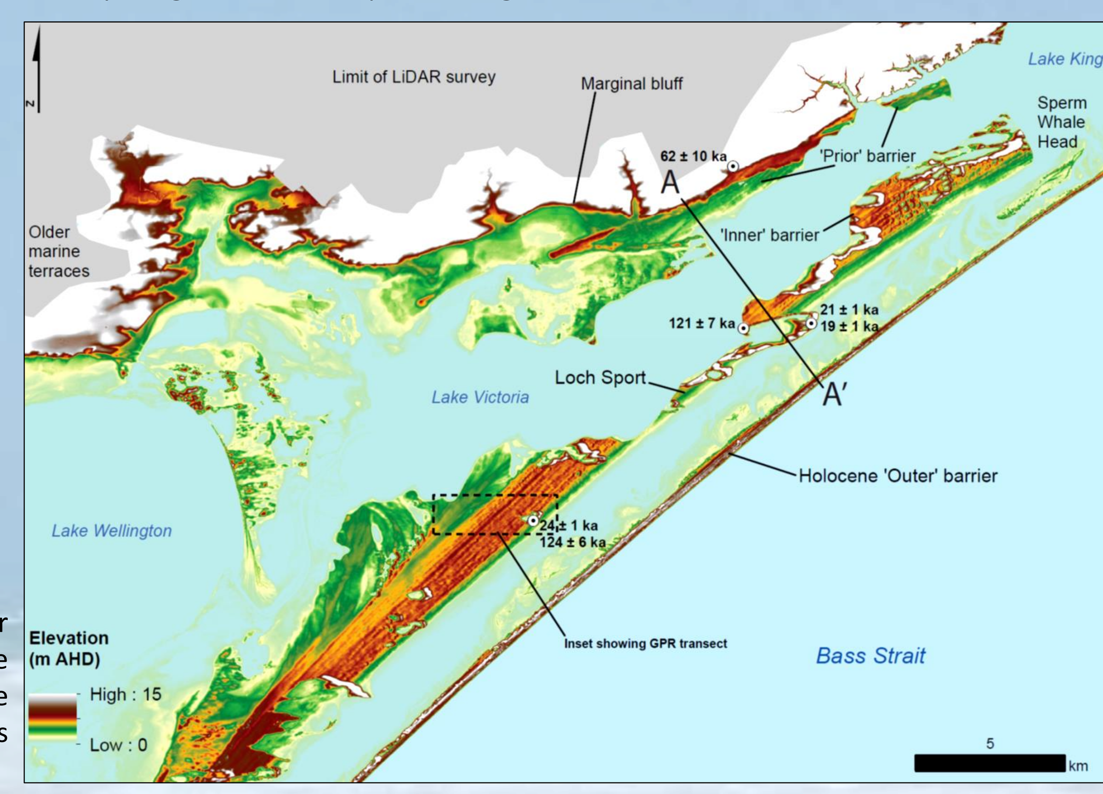

Figure: Aerial LiDAR of the Inner Barrier showing the regressive foredune ridge plain of MIS 5e age. Aeolian reworking of this barrier occurred during the LGM.

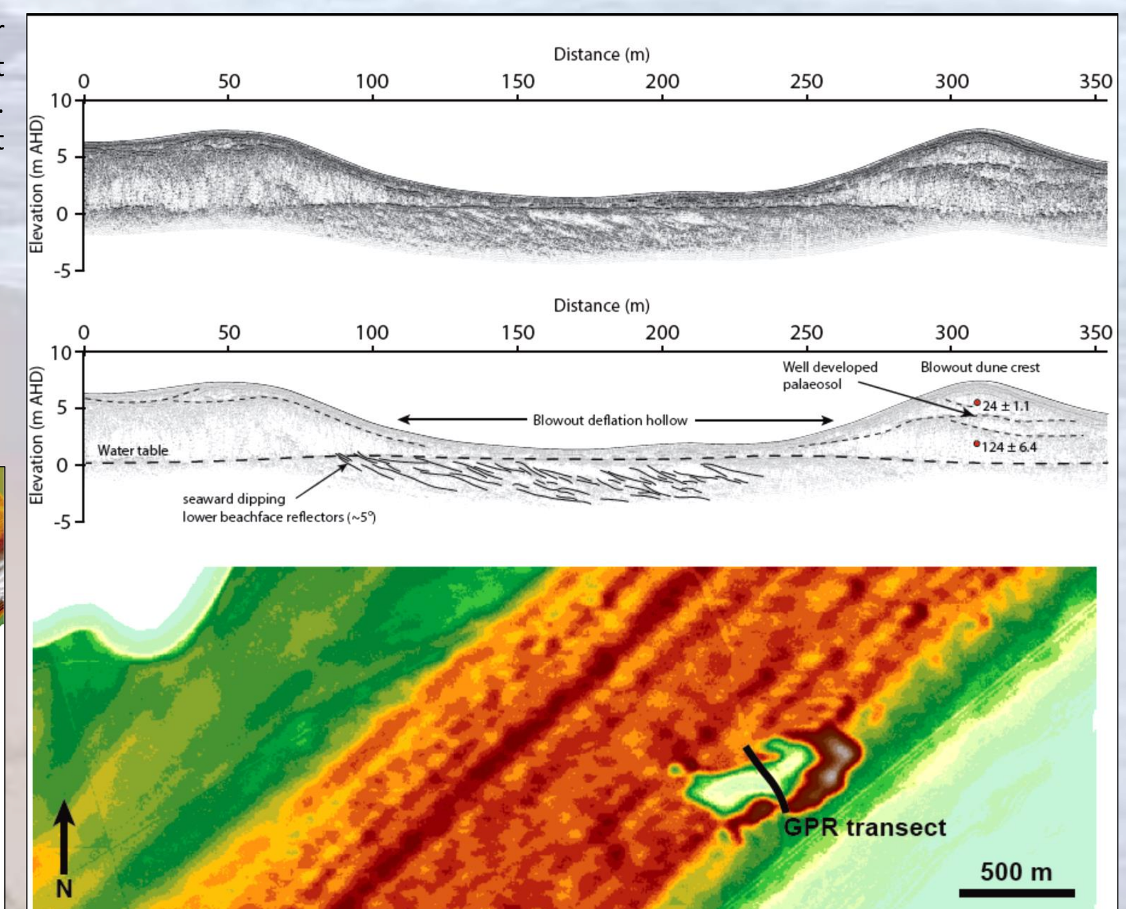

Figure: Ground penetrating radar profile across the dune blowout in the centre of the Inner Barrier. Beach foreset beds are apparent below the deflation basin.

Key Findings

*i. **The Inner Barrier was formed during the peak of the Last Interglacial (MIS 5e) with reworking occurring during MIS 5a.***

*ii. **During the LGM reworking in the form of parabolic dunes occurred over the still vegetated foredune ridges.***

*iii. **Holocene barrier development initiated as soon as the area was flooded by the sea (before 7ka). The barrier accreted until the mid Holocene, after which significant longshore transport occurred coincident with sea level fall from the mid Holocene optimum.***

This barrier development also closed all but one entrance to the Gippsland Lakes system.

*v. **Significant reworking is currently occurring at the southern end of the barrier where the foredunes are orientated at an angle to the present shoreline. This may represent the first response of this coast to changing wave conditions associated with climate change.***

*vi. **A final phase of reworking appears to have occurred in the last 150 years with sediment transferred from the beach and foredune over the older mid Holocene foredune ridges.***

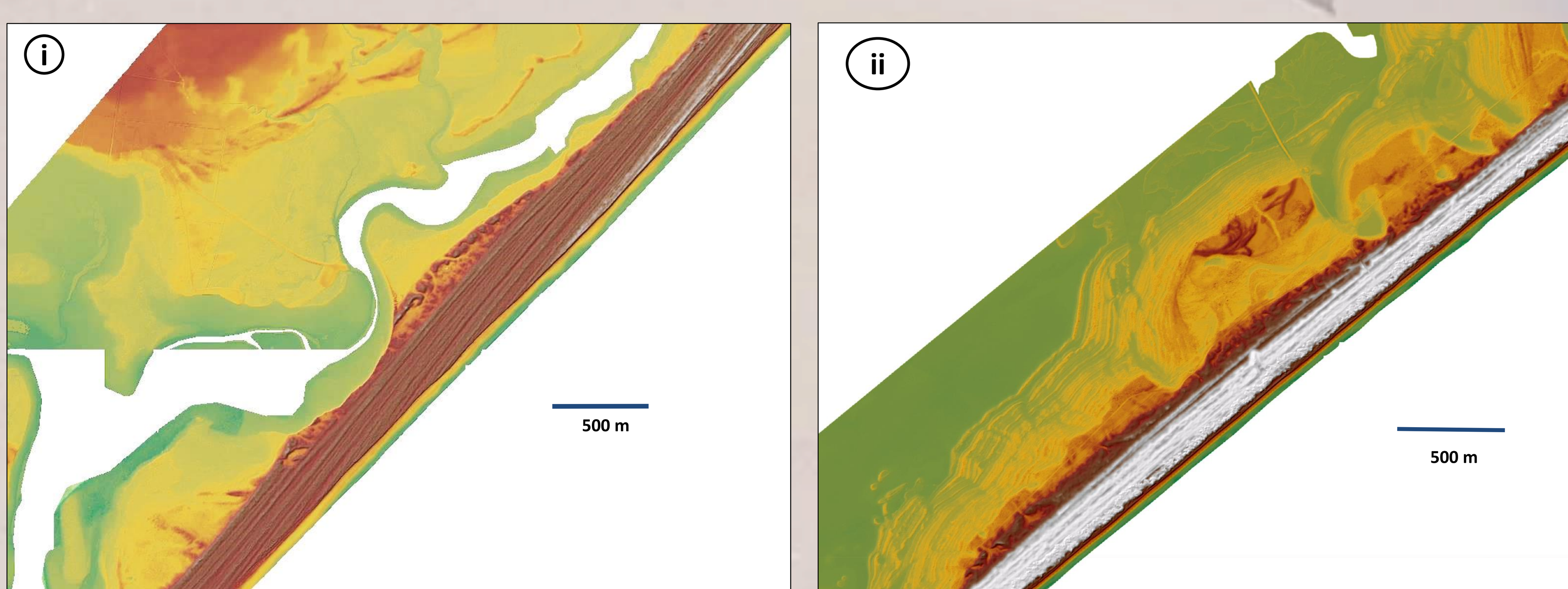

Figure: Aerial LiDAR of the Holocene barrier at (i) McLoughlin's Beach at the southern end of the barrier system and (ii) at Loch Sport in the centre of the region. The orientation of the foredunes at McLoughlin's differs from the modern coast and the shoreline appears to be activity transgressing following a regressive phase at around 3ka. The barrier at Loch Sport is higher, older and is characterised more by vertical rather than lateral accretion than the southern parts of the system.

Methods

(1) Machine augering and radiocarbon dating of shell

(2) Hand augering and OSL dating of individual grains (quartz)

(3) GPR using a Mala System (250 MHz antenna)

(4) Aerial LiDAR collected as part of the Victorian Government Future Coast program.

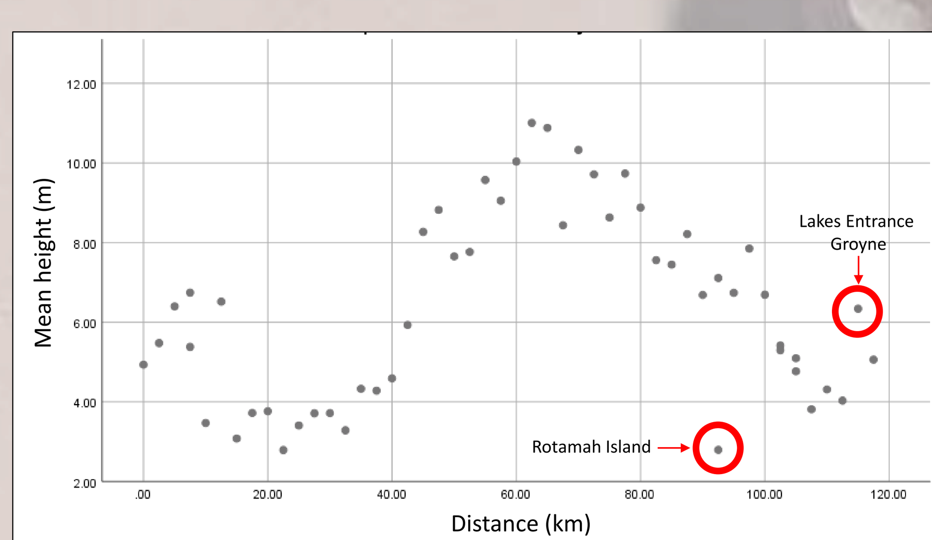

Figure: Morphological character of the Outer (Holocene) Barrier along its entire length from its southern extremity to the mouth of Lakes Entrance.

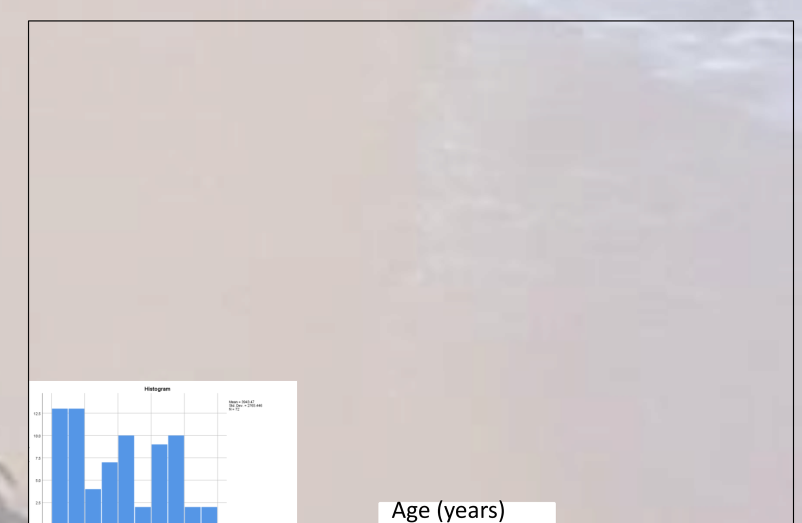

Figure: Distribution of C14 (n = 32) and OSL (n = 40) ages for the Outer Barrier in Gippsland (n = 72). Four distinct phases are evident with (1) initial deposition occurring at the end of the postglacial marine transgressive, (2) coastal progradation at the mid Holocene highstand, followed by (3) reorientation and progradation as sea level fell to present elevations. (4) The final phase is correlated to land use change in the past 150 years.

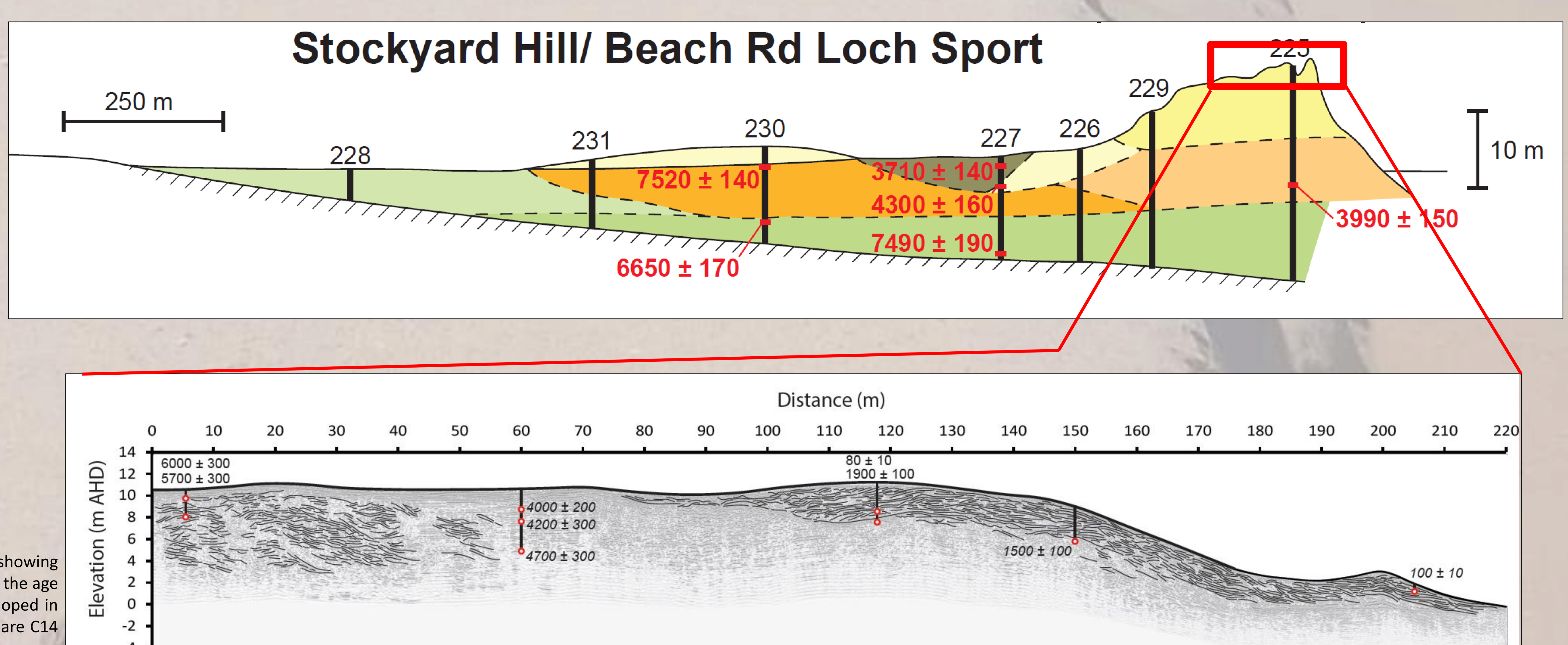

Figure: Cross section through the Holocene barrier sequence at Loch Sport showing the aeolian and marine facies. The 4 phases of barrier evolution (identified in the age frequency histogram) are apparent. The dune system appears to have developed in its current position soon after stabilisation of sea level. The ages in red text are C14 while those on the GPR transect are derived from OSL techniques.

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