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The development of the Princess Charlotte Bay chenier plain: New results and insights

Dylan Horne [a,*], Brian Lees [a], Matthew Cupper [b], Kathryn Fitzsimmons [c,d]

[a] University of New South Wales, Canberra, Australian Capital Territory 2600, Australia
[b] The University of Melbourne, Victoria 3010, Australia
[c] Australian National University, Canberra, Australian Capital Territory 0200, Australia
[d] Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, D04103 Leipzig, Germany

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ABSTRACT

Chenier plains record changes in the mode of coastal progradation between periods of mudflat accumulation and coarse sediment deposition. The geomorphic development of the Princess Charlotte Bay chenier plain was last considered in the 1980s and the conclusions have contributed to knowledge of muddy coastal morphodynamics. Obtaining new data through the use of luminescence dating techniques provided an opportunity to reassess previous findings. Data were obtained from the south western portion of the bay where the chenier ridges were most distinct whereas previous research had been concentrated on the far eastern periphery of the plain. Optically-stimulated luminescence age estimates and radiocarbon ages from eight of the 11 most seaward chenier ridges yielded a new depositional chronology. The recent chenier sequence in this area began forming with the establishment of the most landward chenier ridge (ridge 1) no more than 4000 yr BP. In the ~1500 years following this, two more chenier ridges were built (ridges 2 and 3, which were not sampled). Ridge 4 was being built at around 2400 yr BP, ridges 5 and 6 at around 2100 yr BP, ridge 7 at around 1900 yr BP, ridges 8 and 9 at around 1300 yr BP, ridge 10 (which was not dated) between 1300 and 820 yr BP, and ridge 11 at around 820 cal yr BP. Comparing the new data to previous data and conclusions yielded new insights into the Holocene development of the chenier plain. These new insights may provide a means for Australian chenier plains to inform contemporary coastal morphodynamics more broadly.

1. Introduction

Chenier plains form in settings where mudflat progradation is periodically interrupted by phases of coarse sediment deposition. Information gained from dating ridges in a chenier plain can contribute to knowledge of palaeoenvironmental changes. Globally, several competing models incorporating both intrinsic and extrinsic controls have been put forward to explain the development of chenier plains (e.g., Anthony, 2006; Augustinus, 1989; Chappell and Grindrod, 1984; Dougherty and Dickson, 2012; Lees, 1987; McBride et al., 2007; Rhodes et al., 1980). Chenier ridges and chenier plains have been studied at a multitude of sites around the Australian coastline (Horne, 2011; Horne et al., 2014). Despite the extensive work undertaken in Australia, knowledge gained has yet to be incorporated into more general models of coastal behaviour and chenier plain studies have largely ceased since the 1980s. Two factors may have contributed to this. The first factor is the use of radiocarbon dating of shell material, where possible sources of error include chemical influences on the shell material from the marine and/or sedimentary environment (e.g., Gillespie and Polach, 1979), or temporal differences between when a shell is formed and when it becomes part of a chenier (e.g., Rhodes et al., 1980; Lees, 1992). Both sources of error can have the effect of overestimating the actual time of emplacement. The second factor is the lack of high resolution palaeoenvironmental records, particularly regarding Holocene sea level changes, for comparison with chenier plain chronological data.

Recent advances have reduced the problems of potentially unreliable chronologies and lack of palaeoenvironmental data for comparison. Firstly, using luminescence techniques to date time of chenier ridge building can avoid the issues associated with radiocarbon methods described earlier. Secondly, a larger body of knowledge regarding Holocene environmental change now exists. This is particularly the case for late Holocene sea level change, in which a debate continues regarding the nature of late Holocene sea level decline (i.e., smooth versus oscillating/fluctuating; e.g., Baker et al., 2005; Lewis et al., 2013; Sloss et al., 2007), and for which evidence of a possible influence on the development of Australian chenier plains has recently been presented (Horne et al., 2014). These recent advances provide an opportunity to re-examine Australian chenier plains in a new light. In turn, this may inform new knowledge about palaeoenvironmental changes and provide an avenue for incorporating chenier plain development knowledge into

* Corresponding author at: School of Physical, Environmental and Mathematical, Sciences, University of New South Wales, Canberra 2600, Australia.
E-mail address: dylan.horne@environment.gov.au (D. Horne).

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more general models of coastal behaviour. This appears to be occurring in other parts of the world where contemporary chenier plain studies are utilising luminescence techniques and improved palaeoenvironmental knowledge to develop a more comprehensive understanding of chenier plain morphodynamics (e.g., Dougherty and Dickson, 2012).

The aim of this study is to obtain and examine new data from one of Australia's largest chenier plains – at Princess Charlotte Bay on the east coast of northern Queensland – with a view to providing a new perspective on the development of the chenier plain, reliability of previous results and plausibility of previous conclusions. Our sampling was undertaken from a different section of the bay than previously examined and includes the use of optically-stimulated luminescence (OSL) and radiocarbon dating as well as a comprehensive survey of the landforms.

2. Site description/regional setting

Princess Charlotte Bay is located on the eastern coast of Cape York Peninsula, Queensland, approximately 220 km NNW of Cairns at 14° S, 144° E (Fig. 1). Opening to the north, it is approximately 50 km across, making it one of the largest bays on the Australian coastline. The area to the south and southwest of Princess Charlotte Bay, the Laura Plain, consists of a gently rising coastal plain containing a mixture of weathered terrestrial deposits, the most extensive of which comprise early to late Pleistocene alluvium and colluvium (Galloway, 1970). This plain extends to the main Cape York Dividing Range and is generally less than 100 m above sea level (Grindrod, 1983). It contains open forest, swampland and isolated riverine jungle and tropical rain forest (Frankel, 1974), and is dissected by a complex drainage system which feeds northward to Princess Charlotte Bay. Closer to the shoreline are the coastal plains, formed from the Quaternary deposition of fluvially-transported terrigenous sediment on which dune deposits and occasional chenier ridges composed of shell and sand are found. Within the coastal plains, longshore differences are apparent in terms of geomorphic units (e.g., beach ridge plains and chenier ridge plains) and the properties of ridges within those categories (e.g., the number of ridges, composition and degree of preservation) (Chappell and Grindrod, 1984; Horne, 2011).

The subhumid to humid tropical climate of the Princess Charlotte Bay region has a very marked seasonal regime. The May to October dry season is characterised by a stable climate with relatively cool temperatures and predominant southeasterly winds. The November to April wet season brings much warmer and wetter conditions. Of the 1000–1200 mm annual rainfall, most (~95%) falls in the wet season.

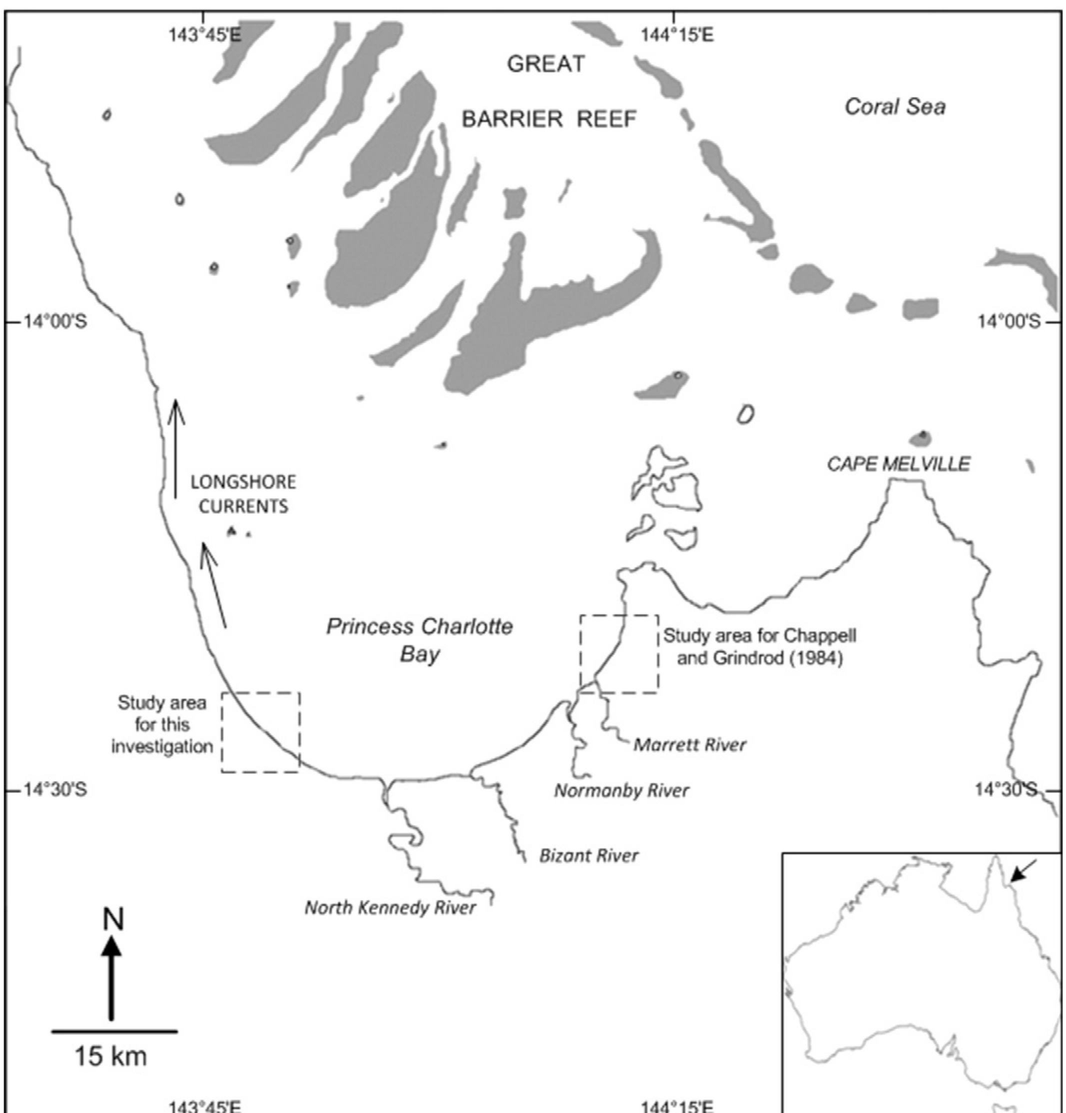

Fig. 1. Location of Princess Charlotte Bay within Australia and the region.
The locations of the current study site and that of Grindrod (1983) and Chappell and Grindrod (1984) are shown. The location and direction of longshore currents are taken from Frankel (1974).