KING ISLAND, BASS STRAIT

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INTRODUCTION

King Island is the largest island in the western Bass Strait region and is centred on 39°50'S, 144°00'E (Figure 1). The island is mainly formed of Precambrian rock and Quaternary sediments, with the largest area of Precambrian rock occurring in the south of the island (Figure 2).

Aspects of landscape evolution that have been studied on King Island include Quaternary sea-level changes and neotectonics (Jennings, 1959; Murray-Wallace and Goede, 1995), dune and coastal lake formation (Jennings, 1957a, 1957b), environmental history (Jennings, 1959; D'Costa *et al*., 1993; Orr *et al*., 2000, 2002, in prep.), and soils and regolith formation (Stephens and Hosking, 1932; Orr *et al*., in prep.). Parts of the island have been worked for heavy mineral sands and scheelite was mined for tungsten (Sutherland, 1973).

PHYSICAL SETTING

Geology

Precambrian sedimentary, igneous and metamorphic rock extends from the southeast to the central–northwest part of the island (Jennings and Cox, 1978). Relatively unmetamorphosed sedimentary rocks cover much of southeastern part of the island, and metamorphic sequences and granite occur through the central west (Figure 2). Minor rock types include Cambrian sediments and volcanics, Carboniferous granodiorite, and Tertiary basalt and limestone (Jennings and Cox, 1978; Sutherland, 1973).

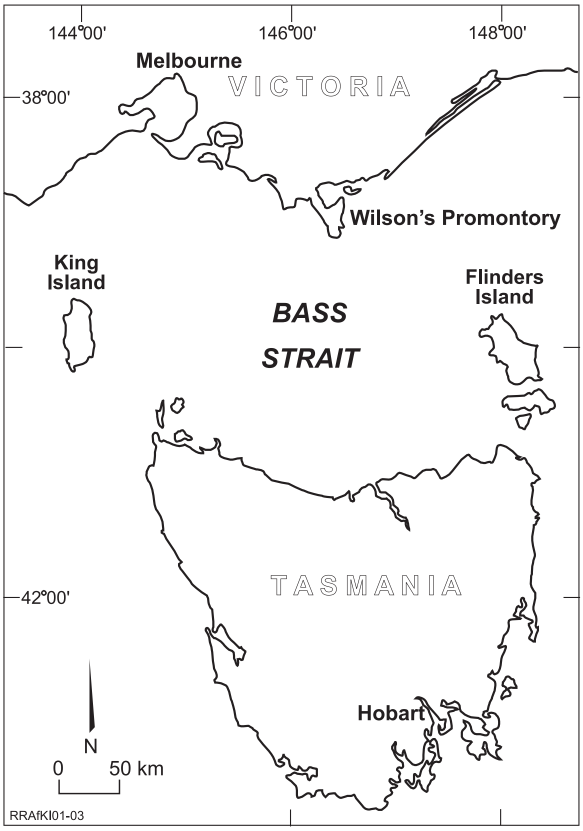

Figure 1. Location of King Island, Bass Strait.

The northeastern and northern portions of the island, and the western coastal margin, consist of Quaternary sediments. These include dune and sheet sands, lagoon sediments and beach deposits. Marine sands and muds underlie Egg Lagoon in the northern part of the island (D'Costa *et al*., 1993) and elsewhere estuarine–marine sediments and granite underlie the Quaternary terrestrial sediments (Jennings, 1959).

Geomorphology

Areas of Precambrian rock constitute the plateau region of King Island. The plateau is highest in the south (<150 m) and decreases in elevation to the north. Small outcrops of Tertiary marine limestone occur both on the plateau and near sea-level suggesting tectonic displacement during the late Cainozoic (Jennings, 1959). Areas of Quaternary sediments are mostly less than 60 m above sea-level. These sediments have buried the Precambrian bedrock in the northern and northeastern parts of the island, except for smaller areas of low granite rises (Figure 2).

The salient features of the Quaternary geomorphology are the Old and New dune systems (Jennings, 1957b, 1959), dune barrage lagoons (Jennings, 1957a), inland sand sheets, coastal emerged marine surfaces, and raised storm beach and beach ridge deposits (Jennings, 1959; Murray-Wallace and Goede, 1995). The coastal Old and New Dunes form an extensive rim around the island, with the Old Dunes located further inland of the New Dunes. These dunes have blocked drainage in places to form lagoons, or coastal dune lakes (Jennings, 1957a). Raised beach and emergent marine deposits have been used to document relative sea-level changes and neotectonic displacements (Jennings, 1959; Murray-Wallace and Goede, 1995).

Climate

King Island has a temperate maritime climate with a mean annual rainfall of around 900 mm (Bureau of Meteorology Australia, 2001). The island has mild summers with no dry season, though rainfall is winter dominated. Mean daily maximum temperatures are 20°C in January and 13°C in July (Bureau of Meteorology Australia, 2001).

Vegetation

Pre-clearing vegetation on the island consisted of wet sclerophyll forest on the higher plateau areas, eucalypt woodland with grassy understories and grasslands, heath woodlands on poorly drained sandy terrain, shrublands and bracken fernlands on dunes, and herbaceous swamp communities and swamp forests (D'Costa *et* *al*., 1993). *Eucalyptus viminalis* was a common tree species of the forests and woodlands. Shrubby understories and shrublands contained a diverse range of shrubs that included *Acacia*, *Banksia*, *Dillwynia*, *Leptospermum* and *Leucopogon* spp., and swamp forests were dominated by *Melaleuca ericifolia* and *Leptospermum lanigerum* (D'Costa *et al*., 1993).

REGOLITH–LANDFORM RELATIONSHIPS

Dune forms and the degree of weathering are closely related in the Old and New Dunes. The Old Dunes have a lower relief, and are more subdued and weathered than the New Dunes (Jennings, 1959). The New Dunes have steep parabolic dune forms and poorly developed soil profiles.

Soil profile development is more advanced in the sand sheets than the dunes and the role of groundwater in profile differentiation is apparent. Relief is very low on the sand sheets and the water table occurs near the surface. Iron is known to be mobile in waterlogged soils and 'coffee rock' horizons (predominantly Bh horizons) are widespread in the sand sheets.

Lagoon sedimentation on King Island is spatially related to the coastal dunes (Jennings, 1957a). Lagoons and coastal lakes have formed by the obstruction of drainages by dunes and the emergence of estuaries created behind sand bars (Jennings, 1957a, 1959). Anaerobic conditions in the lagoons have caused organic matter accumulation, resulting in surface peats and organic muds.

Outcropping weathered bedrock occurs on the inland plateau and on the low granite rises that occur above the level of Quaternary sediments.

REGOLITH CHARACTERISATION

Dune sediments are very different in composition between the east and west coasts. The southern junction between quartz and calcareous coastal sand provinces on the mainland occurs at Wilsons Promontory (Figure 1), and a similar partitioning of sand types occurs between the east and west coasts of King Island and Flinders Island (Bird, 1984). New Dunes of King Island's east coast consist predominantly of quartz sand, whereas the west coast New Dunes are largely calcareous (Stephens and Hosking, 1932; Jennings, 1959). The northern and southern tips of the island have calcareous New Dunes (Stephens and Hosking, 1932). East coast Old Dunes similarly have quartz sands, and west coast Old Dunes are calcareous, except in the south, where more limited occurrences of Old Dunes are quartzose (Stephens and Hosking, 1932). East coast dune sands are consistently coarser than west coast dune sands (Orr *et al*., in prep.).

East coast New Dunes have undifferentiated soil profiles near the coast and Podosol (podzol) profile development inland (Orr *et al*., in prep.), as is typical of siliceous coastal dunes. The east coast Old Dunes have a more well developed B horizon and coffee rock is common (Stephens and Hosking, 1932; Jennings, 1959).

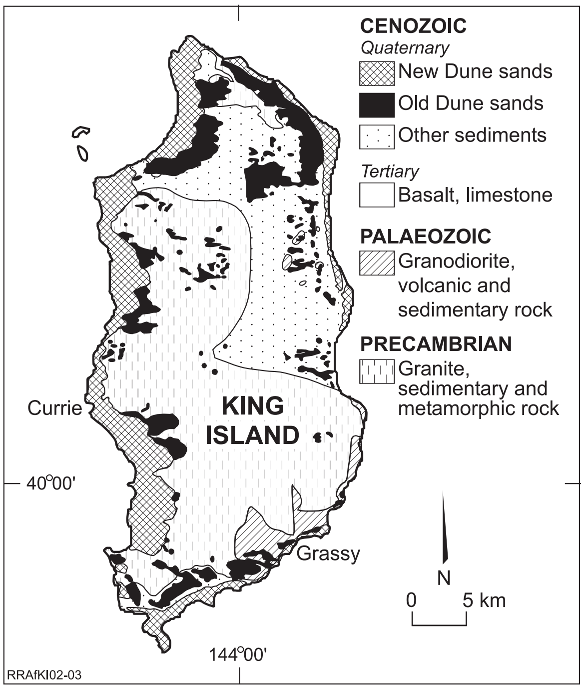

Figure 2. Generalised geology of King Island. (Adapted from Jennings and Cox, 1978; Jennings, 1957b).

Calcium carbonate content and pH is variable in the northern calcareous Old Dunes, and may explain variability in the degree and nature of profile development. Iron is most soluble at lower pH values (McFarlane, 1999) and as calcium carbonate is leached from the upper parts of the dunes, the pH can drop below 6.0 and iron may be leached to form a B horizon. Surface soil pH values of the calcareous Old Dunes before pasture improvement ranged from 5.4 to 8.9, and subsoil sand pH values range from 6.1 to 8.8 (Stephens and Hosking, 1932). Calcium carbonate contents vary from less than 10% for surface horizons with soil development to over 50% for subsoil sands (Orr *et al*., in prep.). Profiles developed on these Old Dunes correspondingly range from minimal A1 horizon development to differentiated profiles with an iron-rich B horizon (Orr *et al*., in prep.). The surfaces of some Old Dune swales have a red horizon or unit termed the Yambacoona Sand (Stephens and Hosking, 1932) which has a ambiguous origin (Orr *et al*., in prep.).

The calcareous New Dunes have a uniformly higher calcium carbonate content and lesser degree of soil profile development. Calcium carbonate contents of over 70% are common. Minimal profile development is characteristic of the New Dunes, limited to A1 horizon formation and variable degrees of secondary calcite formation (Jennings, 1959; Orr *et al*., in prep.).

Sand sheets of northern King Island have widespread development of coffee rock within the upper 2 m of the profiles, associated with a high watertable in these terrains. The sands typically overlie sandy clay units below the coffee rock horizons (Stephens and Hosking, 1932; Orr *et al*., in prep.).

Lagoons formed where drainages have been blocked by dunes and sand bars accumulate sediment carried by coastward draining streams which contain a clay component. Combined with organic matter accumulation, the resulting sediments include organic muds, clays, sandy clays and surface peats (Jennings, 1959; D'Costa *et al*., 1993). Organic matter contents range from 3% to over 60% (Stephens and Hosking, 1932).

Regolith on the plateau developed from Precambrian bedrock has not been studied in detail, with the exception of soil descriptions by Stephens and Hosking (1932). The majority of soils here are acidic duplex soils, probably the equivalent of Yellow Kurosols under the current Australian soil classification. In areas of poor drainage, at the northern and western plateau margins, the soils are largely Podosols, and sandy loam to clay loam textured soils with gradational to duplex profiles. Soils developed on granite rises have sandy loam to clay loam textures and slightly to moderately acidic pH values, with limited development of texture contrast profiles (Stephens and Hosking, 1932).

DATING

Jennings (1959) tentatively assigned a Last Interglacial age (around 125,000 years B.P.) to the Old Dunes and a Holocene age to the New Dunes. This assignment was based on differences in morphology and the degree of weathering between the two dune systems, and the assumption that the dunes formed in association with high sea-level shorelines.

Despite the readily apparent differences in morphology between the Old and New Dune systems, the degree of weathering in the calcareous Old Dunes in the northern part of the island is not as intense as that of comparable calcareous dune systems dated as Last Interglacial, such as in southeast South Australia (see Murray-Wallace *et al.*, 1999).

Recently obtained optically stimulated luminescence (OSL) dates reveal that the calcareous Old Dunes may be much younger than previously thought (Orr *et al*., 2002). Eight OSL dates were determined for locations in the west coast Old Dunes, New Dunes and sand sheets. An age of 10,174 ±733 years B.P. was obtained for sand below the B horizon in an Old Dune profile with soil development, and an age of 10,774 ±1002 years B.P. was obtained for sub-coffee rock sand beneath the base of an Old Dune with minimal soil development (W. Downey, Luminescence Dating Services Africa, written communication, March, 2001; Orr *et, al*. 2002). Two dates of 8,703 ±870 and 8,359 ±746 years B.P. were obtained from Old Dunes with minimal soil development.

New Dunes near the inland margin have an OSL age of 2,503 ±246 years B.P., similar to the Yambacoona Sand at 2,416 ±208 years B.P. The sand sheets had ages of 47,932 ±6,128 and 51,036 ±3,837 years B.P. determined for above and below coffee rock respectively (W. Downey, Luminescence Dating Services Africa, written communication, March, 2001; Orr *et al*., 2002).

Emerged estuarine sediments, which in many places underlie the terrestrial dune and lagoon sediments, have been dated as Last Interglacial at Yellow Rock River, and as Early Pleistocene beneath lagoonal sediments of Egg Lagoon (Murray-Wallace and Goede, 1995). Radiocarbon dating of sediments at Egg Lagoon, adjacent to the sand sheets, indicate ages of 39,400 to >55,000 years B.P. in the upper 3.5 m (D'Costa *et al*., 1993).

REGOLITH EVOLUTION

King Island has developed on a bedrock high of the King Island Rise of the Bass Basin (Sutherland, 1973). During periods of relatively high Quaternary sea-levels, marine–estuarine sedimentation occurred around the bedrock high resulting in the formation of a plain onto which terrestrial sediments were deposited (Jennings, 1959). The terrestrial sediments were deposited in lagoons, and as coastal dunes and beach ridges. Some sediments, particularly at the northeastern and southwestern plateau edges, were also derived from the adjacent plateau and granite rises.

Quartz sands and sandy clays overlying calcareous sands at the northern emerged plain may have been derived from erosion of the adjacent bedrock areas. Deposition of the uppermost material in these northern plains occurred around 50,000 years B.P. These sediments developed Podosol profiles and coffee rock horizons at some stage after this time in association with high groundwater levels (Orr *et al*., in prep.). Lagoons formed from the emergence of estuaries had already been accumulating sediments with freshwater shell assemblages by this time (D'Costa *et al*., 1993).

The northern calcareous Old Dunes were deposited during the late Pleistocene to early Holocene sea-level rise, generally after 11,000 years B.P., producing low relief parabolic dunes and sheets. Soil profile differentiation has developed in the oldest of these dunes, but soil profile development in dunes younger than 9,000 years B.P. is much less pronounced (Orr *et al*., in prep.).

The calcareous New Dunes developed during the latter part of the Holocene in proximity to the high sea-level shoreline (Orr *et al*., in prep.). Profile development over this time has been limited to minimal A1 horizon development and secondary calcite formation. Siliceous Old Dunes and the landward siliceous New Dunes have all developed Podosol profiles, and these dunes have not yet been absolutely dated.

REFERENCES

Bird, E.C.F., 1984. Coasts. Australian National University Press, Canberra. 320pp.

D'Costa, D.M., Grindrod, J. and Ogden, R., 1993. Preliminary environmental reconstructions from late Quaternary pollen and mollusc assemblages at Egg Lagoon, King Island, Bass Strait. Australian Journal of Ecology, 18: 351-366.

Jennings, D.J. and Cox, S.F., 1978. King Island – Flinders Island, Tasmania. Map sheet. 1:250 000 geological series, Sheet SK55-1 and 2. Geological Survey of Tasmania, Hobart.

Jennings, J.N., 1957a. Coastal dune lakes as exemplified from King Island, Tasmania. Geographic Journal, 123: 59-70.

Jennings, J.N., 1957b. On the orientation of parabolic or U-dunes. Geographic Journal, 123: 474-480.

Jennings, J.N., 1959. The coastal geomorphology of King Island, Bass Strait, in relation to changes in the relative level of land and sea. Records of the Queen Victoria Museum, 11: 1-39.

McFarlane, J.D., 1999. Iron. In: K.I. Peverill, L.A. Sparrow and D.J. Reuter (Editors). Soil analysis: an interpretation manual. CSIRO Publishing, Melbourne. 369 pp.

Murray-Wallace, C.V. and Goede, A., 1995. Aminostratigraphy and electron spin resonance dating of Quaternary coastal neotectonism in Tasmania and the Bass Strait islands. Australian Journal of Earth Sciences, 42: 51-67.

Murray-Wallace, C.V., Belperio, A.P., Bourman, R.P., Cann, J.H. and Proce, D.M., 1999. Facies architecture of a last interglacial barrier: a model for Quaternary barrier development from the Coorong to Mt Gambier Coastal Plain, southeastern Australia. Marine Geology, 158: 177-195.

Orr, M.L., Grindrod, J.F., Brown, J., Peel, M., Marsh, D. and Delaney, A. 2000. Aeolian history of northern King Island, Bass Strait. Proceedings of the Quaternary Studies Meeting, "Regional analysis of Australian Quaternary studies: strengths, gaps and future directions", Australian National University, Canberra, February, pp. 87-88.

Orr, M.L., Grindrod, J.F., Brown, J., Peel, M., Marsh, D. and Delaney, A. 2002. Revised dune and soil history of northern King Island, Bass Strait. Proceedings of the 10th Australia and New Zealand Geomorphology Group Meeting, Kalgoorlie, September-October, p.33.

Orr, M.L., Grindrod, J.F., Brown, J., Peel, M., Marsh, D. and Delaney, A. in prep. . Revised dune history of northern King Island, Bass Strait, Australia, and implications for Late Pleistocene environmental change.

Stephens, C.G. and Hosking, J.S., 1932. A soil survey of King Island. CSIRO Australia, Melbourne. Bulletin 70. 53 pp.

Sutherland, F.L., 1973. The geological development of the southern shores and islands of the Bass Strait. Proceedings of the Royal Society of Victoria, 85: 133-144.

WEBSITES

Bureau of Meteorology Australia, 2001. Climate averages for Australian sites. http://www.bom.gov.au/climate/averages.