A preliminary report on the geology and geomorphology of the Big Punchbowl – Long Point area, Moulting Lagoon, Freycinet Peninsula

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Introduction

The author undertook a reconnaissance survey of the geology and geomorphology of these two areas for the Tasmanian Land Conservancy (TLC), because there had been few previous surveys in the area, and there was a paucity of the basic information needed for understanding and management. It was also a new area for me, and hence of considerable interest.

Two short field days were conducted in late February, 2015, in association with a TLC-run field day at the Big Punchbowl, and three full days were conducted in late March. Most of this time was spent on foot traverses across the areas (~4 days at Big Punchbowl, 1 day at Long Point). Three aerial photos covering the area were purchased for the study. The TLC block boundaries are shown on Figure 3.

The Moulting Lagoon area, and the Apsley Marshes area to its north, are designated RAMSAR Wetland Sites, and Moulting Lagoon – Great Oyster Bay is listed as a Geosite (2410) in the DPIPWE Natural Values Atlas, based on the 'long-lived graben system possibly related to Gondwana break up'.

General Physiographic Setting

The Big Punchbowl and Long Point areas lie to the east and west respectively of the main outlet channel from Moulting Lagoon, a major wetland area fed by the Apsley River to the north and debouching via a long and complex tidal channel into Oyster Bay to the south (Fig 1). A long E-W sand barrier, the Nine Mile Beach spit, separates the large wetland area from the open sea, with the channel outlet located at its eastern end. The second major river in the area, the Swan, debouches from the west into the channel zone at the SW corner of the wetland. Extensive salt marshes are present around the edges of the lagoon and channels, on the various shallow islands in the channel, and covering much of the Long Point area.

Figure 1. General map of the Moulting Lagoon area

The Long Point peninsula lies mostly near sea level, except for a narrow central sand dune which extends roughly N-S for two km, and has a maximum height of 19 m. Most of this peninsula is made up of salt

marsh, sedgeland and grassland, with a sparse open forest along the sand dune. The Big Punchbowl peninsula, by contrast, comprises an undulating plateau 20-35 m above sea level, underlain by consolidated Cainozoic sediments with areas of sand cover. A steep scarp separates this plateau from a narrow strip of salt marsh around the northern and western coast, while the southern coast is flatter and marshy. Much of the peninsula is covered by woodland and open forest, dominated by sheoaks (*Allocasuarina littoralis*) and black peppermint gums (*Eucalyptus amygdalina*), except where cleared for farming. Large areas adjacent to the TLC block have been partially cleared and windrowed in the past (clearly visible on 2010 air photos), but allowed to regrow as tea tree - kunzea scrub.

An area underlain by Jurassic dolerite just south of the TLC block is still being farmed (mainly sheep grazing), and a similar area of rocky dolerite forms the southern part of the Long Point block.

General Geology

The Moulting Lagoon area is considered to represent the northern part of the Oyster Bay Graben (a downfaulted valley), a large Cainozoic structure bounded by the uplifted spine of Devonian granite on the Freycinet Peninsula to the east, and occupying most of Great Oyster Bay (Fig 2). The eastern margin of the graben is marked by a line of intermittently exposed faults between the granites and Jurassic dolerite, extending from the Bicheno area down the eastern side of Moulting Lagoon to Coles Bay, and reappearing on Schouten Island and the southern peninsula. The western side of the graben is rather poorly defined, with no large faults mapped.

There appear to be two arms to the graben in the northern part, a narrow (2-3 km wide) arm extending north from Swansea to near Cranbrook, and a larger eastern one (~6 km wide) extending through the Moulting Lagoon area. The two arms are separated by a broad area of dolerite centred on the Grange Hills.

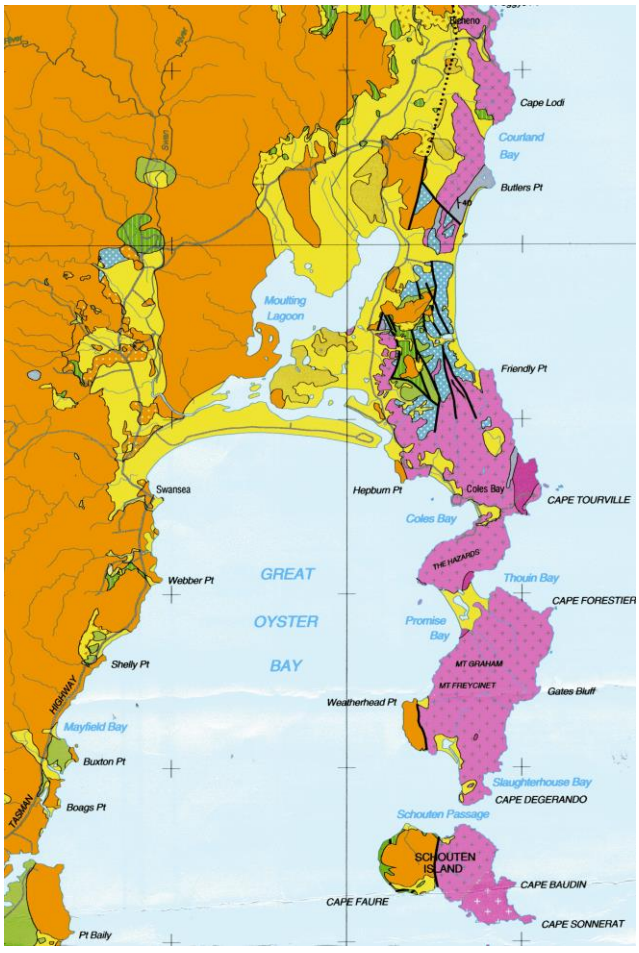

Figure 2. General geology of the Moulting Lagoon – Oyster Bay area, from State 1:250 k map. Devonian granites in purple, Permian mudstones blue, Triassic sandstones green, Jurassic dolerite orange, Tertiary sediments yellow-brown and dotted brown, Quaternary yellow. Long Point area is erroneously shown as entirely underlain by dolerite.

Rocks younger than the granite comprise three units – Permian mudstones at the base, Triassic sandstones, and Jurassic dolerite. This three-fold sequence sits above the granite in the area of Mt Peter and Mt Paul (Fig 2), but elsewhere is mostly down-faulted, with only the dolerite visible at surface. Thus dolerite forms the basement to the graben through the Moulting Lagoon area, and in part in the Swansea-Cranbrook area, probably with some Triassic sandstone. This bedrock dolerite is exposed in the central part of the main graben at Woolshed Point, where a farm has been developed on the clay-rich soils, and also on the western side of the channel near Opening Hole. These dolerite occurrences suggest the graben-fill is relatively shallow.

The main filling of the graben, as exposed in the Big Punchbowl area, consists of fairly well consolidated siliceous sandstones and fine conglomerates presumed to be of Cainozoic (Tertiary) age. These have been

mapped across the peninsula containing the Big Punchbowl, and also north of Moulting Lagoon along the eastern side of Apsley Marshes (Fig 2). Work by Leaman and Richardson (1981) and Shaw (1982) suggests a maximum thickness of about 300 m of these sediments. Overlying and obscuring these sandstones are extensive younger deposits, mostly unconsolidated, of alluvium, wind-blown sand, colluvium, and a variety of coastal and lagoonal sediments, of presumed Holocene age. The equivalent of the Cainozoic sediments in the Swansea-Cranbrook arm, as exposed on the Tasman Highway in places, are horizontally-bedded clays and sandstones which have been pollen-dated, from water bores, as Eocene (S. Forsyth, pers. comm.).

As noted by Montgomery (1891), the clay-rich Tertiary sediments of the Swansea area may have been formed when this area was a brackish lagoon similar to Moulting Lagoon. However, the Tertiary sandstones around the Big Punchbowl area appear to be alluvial deposits derived from the granite area to the east.

The 1:250k geological map (Fig 2) shows a small area of granite at White Rock Bay, in the SE corner of Moulting Lagoon. The author examined this site, and found that there was indeed granite in the area, but that it was in the form of boulders, some as large as 6 m across. These granite boulders were mixed with equally large boulders of dolerite, over an area of a hectare or so. The large boulders were contained in a matrix of grit and smaller boulders and pebbles, including a few of siliceous rocks probably derived from the basal pebble-rich Permian beds. Such an unusual boulder deposit made up of large clasts derived from the rocks occurring just to the east suggests an active fault scarp, and I interpret the deposit as having formed against the graben margin during the active Tertiary faulting period.

A possibly similar deposit was examined at Buckley's Rocks, where the River Rocks Road intersects the channel at Swanick Bay. A considerable number of large dolerite boulders project out of the water and sand in this area, and the lack of consistency in the joint patterns between blocks strongly suggests that they could be loose boulders. Hence, this could also be a very coarse boulder deposit also developed at the graben-margin fault scarp.

Detailed Geology of the Big Punchbowl and Long Point Areas

The author has compiled a preliminary geological map for this area (Fig 3), based on his traverses and observations, but further field checking is recommended.

Jurassic dolerite

The oldest rock is the Jurassic dolerite, which forms low rises to 20 m altitude at Woolshed Point and along the coast at Opening Hole. The impression gained from walking the contact in both areas is that the dolerite shelves under the younger rocks.

Cainozoic (Tertiary) sandstones and grits

These rocks occur extensively across the Big Punchbowl peninsula, but were not seen at Long Point. Outcrops are common along the coastal scarps and foreshores, along some of the bulldozed tracks, and on some of the low hills. A quarry of about an acre is present in this rock type at the track junction cum staging point just south of Big Punchbowl.

The rocks are generally well consolidated to hard, due in part to an iron-rich cement. They are typically yellow-brown to reddish brown in colour, due to the iron staining, and some outcrops have been heavily iron-impregnated to form a cellular ironstone. The typical rock type is a coarse-grained quartz-rich sandstone, often with abundant granules of visible white quartz. Virtually all of the quartz appears to be of granitic origin. Also common are granule-grade sandy conglomerates, and less common pebbly conglomerates, with rounded siliceous pebbles, and occasional feldspar fragments, up to 3 cm across. Mudstones have not been seen, but could well be present in deeper sections.

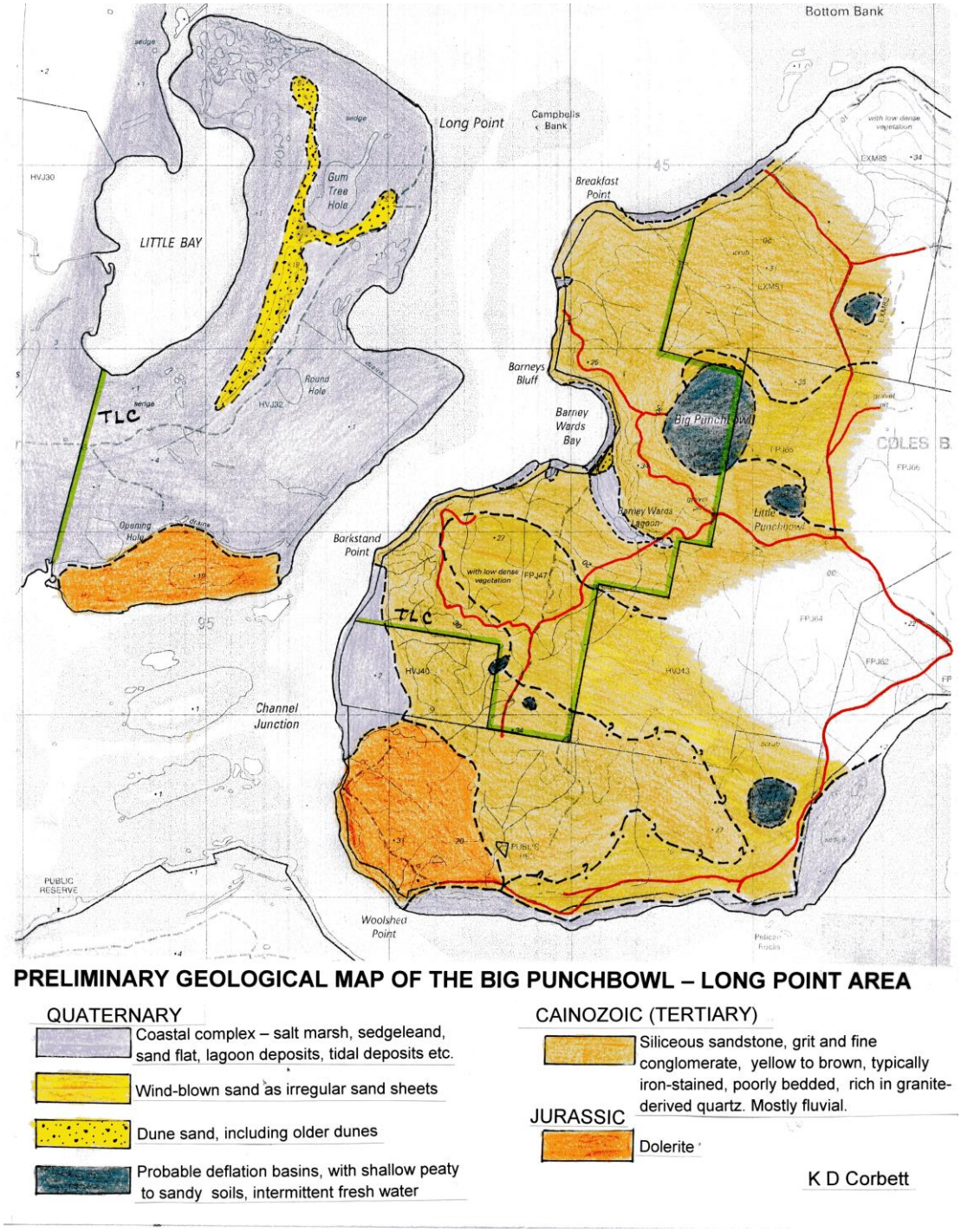

Figure 3. Geolocal map of the Big Punchbowl – Long Point area.

The rocks are poorly bedded, with faint horizontal bedding seen in a few places, and rare traces of cross-bedding. These features, and the sandy nature of the rocks, suggest a fluvial environment, and the rocks are interpreted to represent the fluvial outwash deposits from the granite hills to the east into the bottom of the graben. The age of the rocks is not known, although comparison with the sediments in the Swansea arm of the graben suggests they could be early Tertiary.

Figure 4. Typical gritty sandstone from Cainozoic outcrop

Probable deflation basins

The Big Punchbowl is the largest of a series of shallow flat-bottomed sub-circular depressions scattered around the eastern peninsula, and apparently eroded into the Cainozoic basement sandstones (Fig 3). They mostly lie at altitudes of 20-30 m, except for the one in the SE, at about 5m, and have a more or less continuous rim of the order of 5 m high. The Big Punchbowl is about 500 m across, several others are about 200m, and the two smallest are about 100 m across. The depressions contain fresh water after periods of heavy rain, but appear to be dry for much of the time. Evidence in the form of progressive vegetation growth around the margins of the Big Punchbowl suggests the wetted area has been shrinking for a considerable period, with the present water margin well inside the actual raised rim. A small amount of water was present at the eastern side in March 2015 (Figs 5,6).

Figure 5. Eastern margin of Big Punchbowl, March 2015

Figure 6. Looking west across Big Punchbowl, with remains of duck hide

The Big Punchbowl is essentially in pristine condition, but several of the others examined have been roughly cleared and cultivated, presumably for the deeper soils, and two have had water holes excavated within them. The floor of the Big Punchbowl is more or less covered with freshwater sedgeland/rushland, with an outer margin almost free of vegetation, and a zone of low shrubbery extending beyond that to the foot of the actual rim (Fig 5).

The origin of these basins has not been properly studied, but their formation as deflation basins (i.e. wind-eroded depressions from a previous glacial period) seems most likely. Some preliminary geomorphological analysis of the general Moulting Lagoon area by Ian Household (pers. comm.), in connection with the RAMSAR nomination, concluded that Little Bay, in the Long Point area, was almost certainly a deflation hollow, and that the large Moulting Lagoon basin itself probably had a similar origin. The deflation origin for Little Bay is strongly supported by the presence of the large lunette-like sand dune just to its east (Fig 3). No such sand dune is present at Big Punchbowl, however, although traversing indicates a considerable amount of wind-blown sand extending from its eastern margin further east. A wombat burrow dug in this sand indicates a depth of at least a metre in one place (Fig 7). Some old channelling and ridging in this general area suggested that some early bulldozing and land clearing might have been done, which could have modified any pre-existing dune form.

Figure 7. Wind-blown sand about 10 m east of Big Punchbowl. Note shrubby heath vegetation with *Hibbertia* sp.

The exposed floor of Big Punchbowl around the margins typically shows a lag deposit of pebbly sand, with a few larger fragments (to 5 cm or so), and a few scattered Aboriginal flints. The sandy lag is what would be expected from wind erosion of the underlying Cainozoic gritty sandstones. A shallow peaty to sandy soil appears to be present under the sedgy material in the central part. Recent auger drilling in the central part of the basin has revealed an upper peaty layer followed by a clayey layer, to about 1 m, followed by about 3 m of coarse sand and fine sand, with a lower layer containing charcoal fragments (Dr Sally Bryant, pers comm.). It remains to be seen whether this depth of sandy material is related to the depression, or represents part of the Cainozoic basement.

It is concluded that Big Punchbowl, and the smaller freshwater basins, were formed as deflation hollows during Pleistocene glacial times, and that any associated lunette dunes have been 'blown out' or otherwise modified.

Wind-blown sand sheets

Areas of wind-blown whitish sand are not uncommon across the plateau area of the eastern peninsula. They are difficult to map accurately because of their patchy nature, and their general resemblance to the sandy soils developed on the Cainozoic sandstone substrate, although the latter are typically coarser and more gritty. Two main areas of thicker development of these sands have been identified, one on the southern part of the TLC block, and one extending east from Big Punchbowl (Fig 3). A good exposure of the sand layer at a 'gravel pit' 500 m ENE of Big Punchbowl shows it to be about 1 m thick and evenly fine-grained, with roots penetrating to the base. The upper loose sand has been scraped off at this location, to reveal a lower layer of harder iron-stained yellow-brown sand, possibly representing old dunes, but of unknown thickness (Fig 8).

Figure 8. Wind-blown sand layer overlying older semi-consolidated iron-stained sand, 'gravel pit', 500 m ENE of Big Punchbowl

Figure 9. Rich heath flora on sand sheet soils 700 m south of Barney Ward's Lagoon, with abundant grass trees.

A notable feature of the sand sheet areas is the denser and richer heath flora which is supported by the deeper soils (Fig 9), compared those on the rather thin soils on the Cainozoic sediments. This flora is typified by grass trees (*Xanthorroea australis*), wedding bush (*Rininicarpus pinifolius*), and *Hibbertia sericea*.

Dune sands

The main development of dune sand is on the Long Point peninsula, where a more or less continuous dune up to 20 m high rises abruptly from the surrounding salt marsh, grassland and sedgeland. The dune is up to 150 m wide and extends for some 1750 m through the central part of the peninsula, about 300 m east of the shore of Little Bay (Fig 3). The dune provides an excellent view to the east, across the main outlet channel to the eastern plateau and the higher country beyond (Fig 10). The dune divides at its northern end, with a second arm extending NE around Gum Tree Hole. Two derelict shacks are located on this NE arm, where a line of some 8 blue gums has been planted. The top of the dune has a rounded, complex form in the central part, and is vegetated with grass, bracken and a sparse woodland of sheoaks, wattles and eucalypts, supplemented by numerous recent plantings (Fig 10). The upper western face shows erosion in places, exposing older iron-stained partly-consolidated sand beneath the white younger sand. The eastern side shows signs of having encroached on the salt marsh area in the past, but appears to be vegetated and stable for the present.

Figure 10. View eastwards from sand dune across salt marshes and Round Hole, the main outlet channel, the eastern plateau of the Big Punchbowl area, and beyond to Mt Paul.

Figure 11. Top of the sand dune showing sheoaks and recent plantings by TLC.

A second zone of low sandy dune-like country extends from the southern end of Little Bay southeastwards to the main channel, and is occupied by tall grassland. Its origin is uncertain, but it may be related to a former channel.

A small area of coastal sand is present near sea level at Barney Wards Bay, on the eastern peninsula (Fig 3), at the outlet of the small valley containing Barney Wards Lagoon. This sand may be partly of beach ridge origin. Regionally, there are extensive sand dunes on the peninsula at Point Meredith and the Nine Mile Beach spit.

Coastal and near-shore deposits

Coastal and near-shore deposits form most of the Long Point peninsula but are much more limited on the eastern peninsula (Fig 3). The deposits have not been examined in detail, and are for the most part covered by dense to sparse salt marsh vegetation, grassland or shrubbery. A transition is apparent from areas such as Round Hole (Fig 10), which are intermittently inundated and remain bare of vegetation, to others which are slowly being colonised by salt marsh plants as conditions dry out (e.g. Fig 12), to other slightly higher areas which have converted to grassland, sedgeland and shrubbery (Fig 13).

Figure 12. Colonising salt marsh on drying lagoon area on southern part of Long Point peninsula. Grassland and small sand ridge behind.

Figure 13. Salt marsh and grassland east of the sand dune on Long Point peninsula. View eastwards across channel to Mt Peter.

On the eastern peninsula, the typical situation is a narrow discontinuous terrace of salt marsh, 30-100 m wide and fractionally above sea level, fronting the low cliffs of Cainozoic sandstone (Fig 14). The bench is typically covered with a dense green sward dominated by *Sarcocornia* and *Carpobrotus*. A burrow in the terrace near Barney Wards Lagoon showed about 15 cm of peaty material underlain by soft sand with abundant organic fragments. At the back of the bench in the NE corner of Barney Wards Bay, what appears to be a fresh water spring at the base of the low cliffs is probably responsible for the local presence of numerous manferns (*Dicksonia antarctica*) and abundant smaller ferns (Fig 15).

Figure 14. Salt marsh terrace, northern side of Barney Wards Bay.

Figure 15. Man ferns and other ferns at back of terrace indicating fresh water spring, Barney Wards Bay.

The valley containing Barney Wards Lagoon appears to be an offshoot of the coastal complex, in the process of drying out and converting to a fresh water lagoon (Fig 3). The valley floor around the small lagoon is sparsely covered with colonising *Selliara radicans*, a salt-tolerant perennial herb. Several other smaller intermittent lagoons of this type are present along western coast.

A broad area of slightly raised salt marsh is present south of Barkstand Point (Fig 3), extending some 400 m inland. This area appears to be rarely inundated, and has been partly (but not successfully?) cultivated.

Aboriginal remains

In the course of our traverses we came across a number of Aboriginal stone artefacts. These included both sharpened flakes and heavier core-stone-like pieces, and were of several different rock types, including hornfelsed mudstone, cherty silica, and fine-grained dolerite. Some out-of-place pieces of dolerite up to 20 cm across were also noted. A number of the artefacts were located around the shore of the Big Punchbowl, several on the access track to this area, and others scattered over a wide area. No particular concentrations were noted, although the number of pieces at Big Punchbowl suggests this was probably used as a camping-hunting area in season.

Conclusions

The Moulting Lagoon area is a large complex wetland – graben area with a long and complex history, about which very little is known. There is clearly a need for a comprehensive geological- geomorphological survey, preferably accompanied by some stratigraphic drilling and dating work, and some geophysical surveys, to decipher the Tertiary- Quaternary history. Any research aimed at determining the previous history is to be encouraged. The extent and significance of wind erosion – deflation – in the formation of the lagoons and basins is one of the many issues awaiting study.

Most of the Big Punchbowl peninsula is underlain by Cainozoic fluvial sandstones derived mainly from the granitic rocks to the east. The coarse breccia of granite and dolerite boulders seen at White Rock Bay, and possibly also the dolerite breccia-like deposit at Buckleys Rocks, could represent the proximal equivalent of these sediments near the eastern graben margin. The presence of bedrock dolerite to the SW of Big Punchbowl, and just across the channel at Opening Hole, suggests a relatively shallow thickness (less than 300 m?) to these graben-fill Cainozoic sediments.

The Long Point peninsula features a well-developed lunette-type sand dune presumably related to the deflation of the Little Bay depression, but the other likely deflation hollows, including Big Punchbowl, do not have such well-defined dunes, although there is much wind-blown sand. The reason for this difference is uncertain. Sheets of the wind-blown sand are fairly extensive across the eastern peninsula, and carry a richer heath flora due to the deeper soils.

The Big Punchbowl area acquired by the TLC remains in nearly pristine condition, despite considerable land clearing and cultivation just off the boundaries. Acquisition of the eastern margin of the Big Punchbowl itself, and some of the well-preserved forested ground to the N and NE of this, would obviously be worthwhile, but much of the adjacent ground to the east and south appears to be relatively degraded by previous land clearing and therefore less valuable.

The Long Point peninsula has considerable interest in terms of its geomorphological history and the transitions apparent in the coastal vegetation complex from areas still subject to inundation to those now above sea level.

Acknowledgements

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