CHAPTER 6

GEOLOGY OF THE MORNINGTON PENINSULA

by

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GENERAL.

The bedrock of the Mornington Peninsula is well exposed along its axis, and consists of strongly folded Ordovician and Silurian sediments, intruded by granitic plutons of probable Upper Devonian age. The Peninsula is essentially a horst with a prominent graben to the west (the Port Phillip Sunkland) and a lesser negative area to the east (the Western Port Sunkland). The strike of the major faults is NNE-SSW, parallel to the trend of the folded Palaeozoic sediments, although several cross faults and diagonal faults are known (Keble, 1950). Several faults have shown recurrent movement and probably date back to the Palaeozoic. Many faults were active during the Tertiary and this movement has persisted to Recent times, with earthquake tremors originating in the Selwyn Fault zone. This fault, on the western edge of the Peninsula, is very important having a throw of over 2,000 ft. during the Cainozoic.

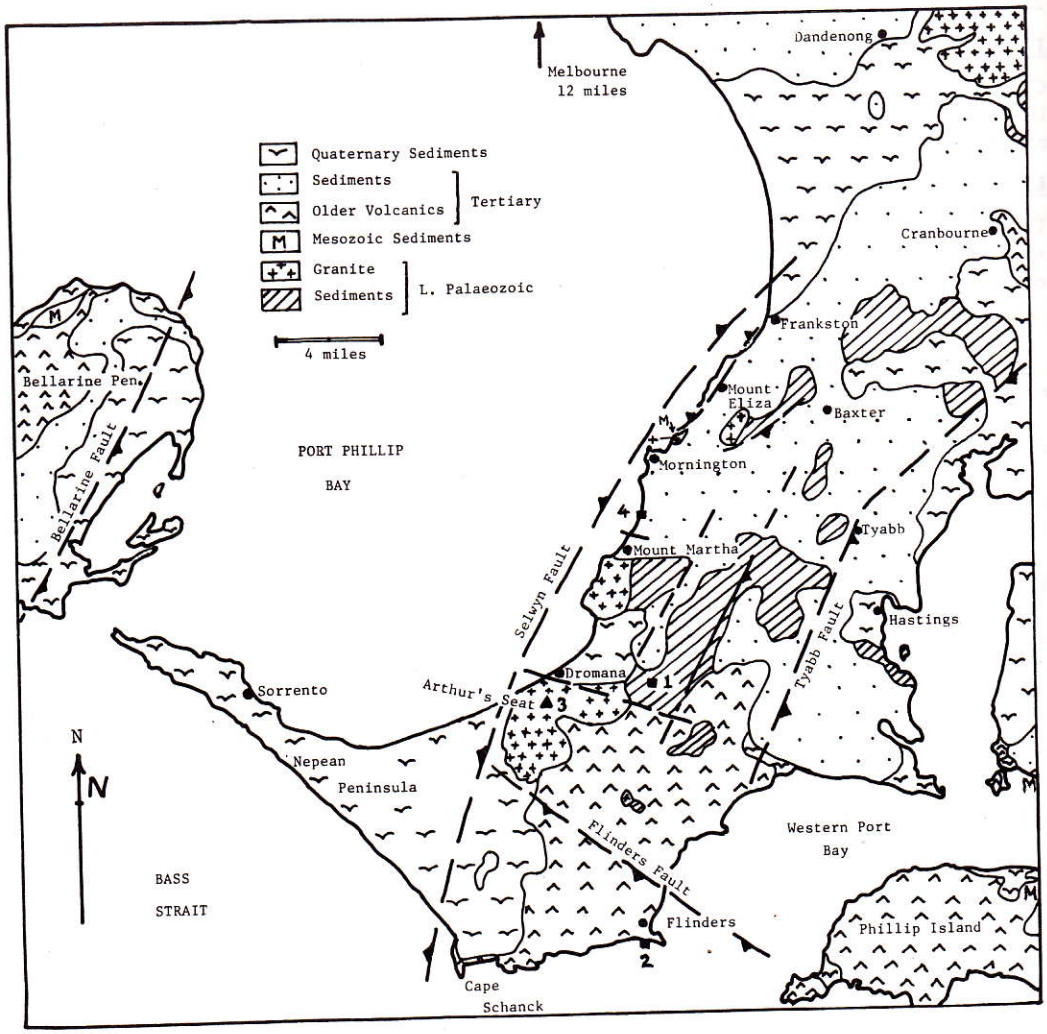

Fig. 1. Geological map of the Mornington Peninsula (after Keble, 1950).

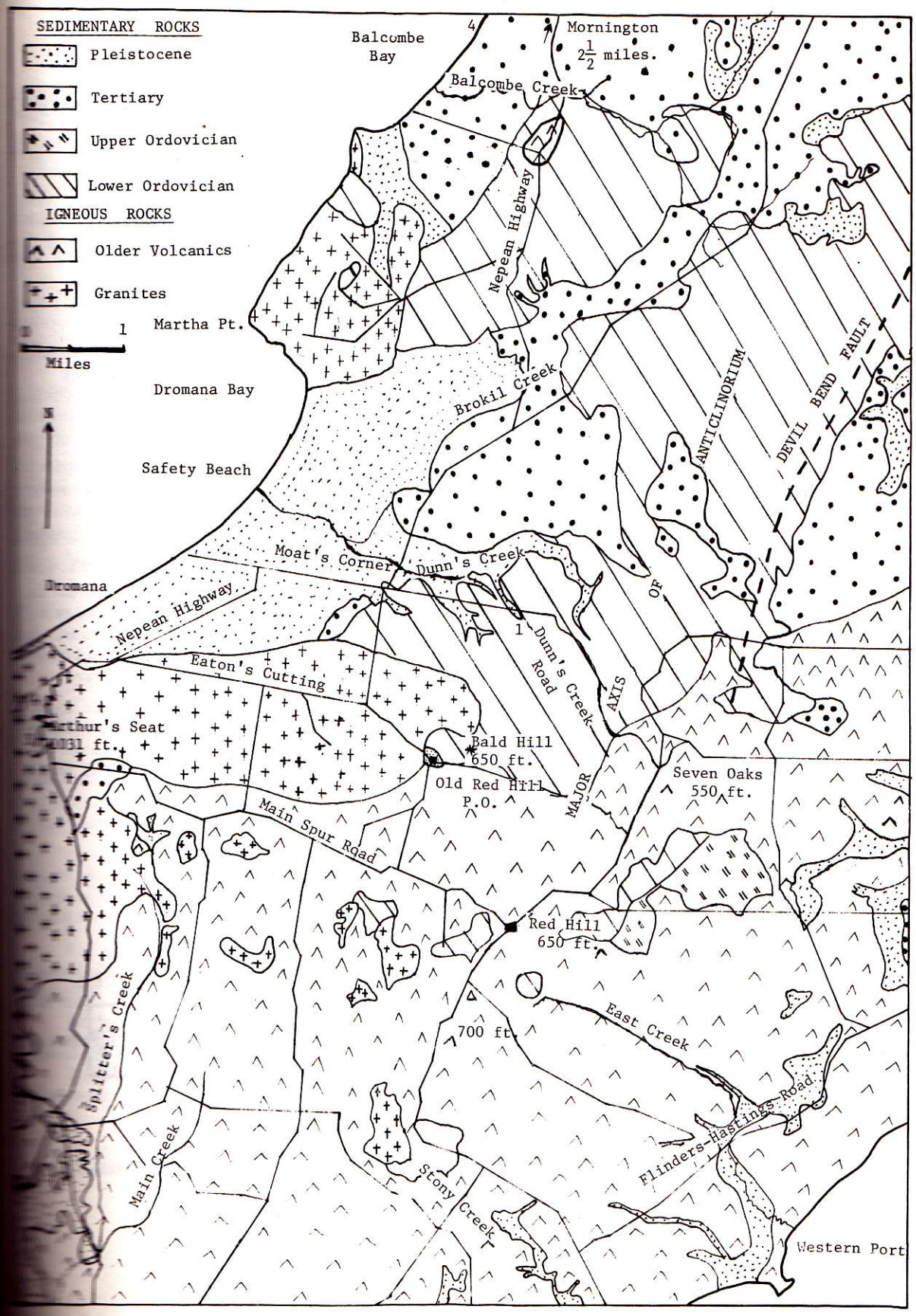

Fig. 2. Geological Map of the Arthurs Seat and Red Hill area (Keble, 1950).

PALAEOZOIC.

The Palaeozoic sediments are geosynclinal and have been folded into a broad anticlinorium with its main axis striking at 020°, parallel to the length of the Peninsula. The axis passes through McIlroy's Quarry, 4 miles east of Dromana, where the oldest strata of Lancefieldian (La2) age are exposed (Locality 1). East of this axis progressively younger beds are exposed including those of Bendigonian and Castlemainian age, followed by Middle and Upper Ordovician, and some Silurian sediments on the eastern side of the Peninsula (Keble, 1950).

The Ordovician sediments are estimated to be some 10,000 ft. thick, and consist of silty, generally fine grained sandstones (greywackes), graptolitic shales and slates, in a monotonous thin-bedded sequence deposited mainly under deep marine anaerobic conditions. A succession of beds within the Lancefieldian consists of light coloured unfossiliferous sandy shales and medium sandstones, and is thought to have been deposited under shallow marine conditions ("Kangerong Stage" of Keble, 1950).

The greywackes are quartz rich, with some mica, chert and soda feldspar. They were probably turbidity current deposits whereas the interbedded dark shales accumulated during the quiet periods and frequently contain graptolites and pyrite (Hills and Thomas, 1953). The Ordovician strata have been silicified to a certain degree, but this has not affected the graptolites. No conglomerates, limestones or volcanic-derived sediments are known.

The succeeding Silurian sediments consist of lighter coloured mudstones, shales, medium to coarse grained sandstones and a conglomerate. Fossils include brachiopods, crinoids, polyzoa and some graptolites. Shallow marine neritic conditions are indicated.

Igneous rocks of probable Upper Devonian age include the Dromana Granite with associated dacites at Arthur's Seat, the Mount Martha Granodiorite and the Mount Eliza Granodiorite.

Around the summit of Arthur's Seat is a small patch of rhyodacite and a hornblende dacite, which have been intruded by the Dromana Granite (Baker, 1938) (Locality 3). The granite is a medium, even-grained rock with abundant greenish orthoclase. In thin section it consists of quartz, orthoclase perthite, oligoclase and biotite. The oligoclase is often blocky due to intergrowth with orthoclase and sometimes possesses saussuritized cores. Xenoliths are scarce. Joints and small faults are common, especially to the north-west near Selwyn Fault.

The Mount Martha Granodiorite is generally grey, medium grained and consists of quartz, zoned poikilitic oligoclase, orthoclase microperthite and abundant biotite. Some hornblende is associated with biotite in dark coloured clots and has been largely altered to biotite. The Mount Eliza Granodiorite is similar but contains a greater proportion of biotite (Keble, 1950).

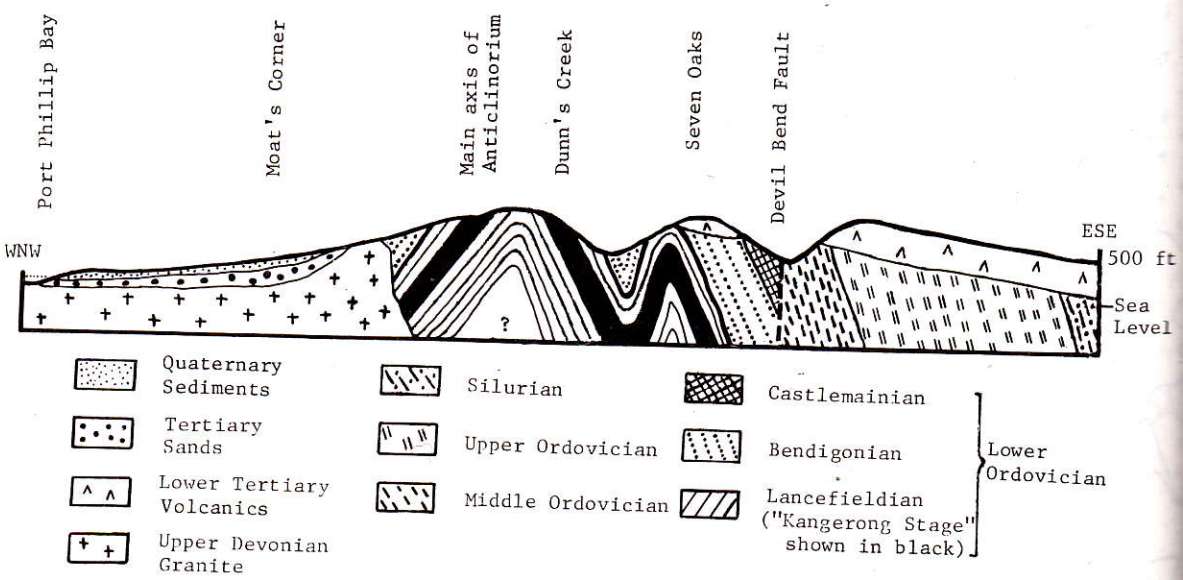

Fig. 3. Geological section across the Mornington Peninsula.

A raft of Palaeozoic sediments outcrops on the coast road about half a mile south of Mount Martha township. It consists of grey micaceous hornfels and quartzite. Xenoliths are also abundant in the surrounding granodiorite which is closely jointed and sheared.

MESOZOIC.

The Mesozoic sediments of the Peninsula occur in a very small infaulted remnant exposed on the shore platforms at Sunnyside Beach, 2 miles NE of Mornington. They consist of fluviatile arkosic sandstones and grey mudstones with a well preserved Lower Cretaceous flora.

TERTIARY.

The Tertiary sedimentary sequence on the Peninsula is generally flat-lying and thin (less than 300 ft.) but thickens considerably into the flanking troughs, especially into the Port Phillip Embayment where it is at least 1200 ft. thick beneath a Quaternary cover of 450 ft. It is best exposed along the Mt. Martha-Frankston coastline (Locality 4).

Deposition may be regarded as having occurred in three phases - an early Tertiary terrestrial and volcanic phase; a marine transgression during the Miocene; and a final regressive phase leading to a return to terrestrial sedimentation in the late Tertiary. A period of intense leaching and ferruginization then occurred.

As well as being intercalated in the sediments of the early Tertiary deposition phase, basalts (Older Volcanics) cover much of the southern part of the Mornington Peninsula where they reach great thicknesses and form impressive cliffs along the Cape Schank-Flinders-Phillip Island coastline (views between Localities 2 and 3).

Older Volcanics.

South of the Flinders Fault these lavas are at least 1300 ft. thick but elsewhere on the Peninsula they are usually less than 150 ft. thick. The lavas were extruded as many, often thin, sub-aerial flows, separated by short intervals of weathering and erosion, with occasional deposition of fluviatile sediments and lignites as at Hastings.

Several closely related varieties of basalt occur. Textures range from medium to fine grained and often with much interstitial glass. Their petrology has been described by Edwards (1938) who distinguished three main types.

1. The Crinanites consist of doleritic olivine-analcite basalts which have a few phenocrysts of olivine set in a matrix of ophitic titanaugite and labradorite, with some ilmenite, needles of apatite, and interstitial analcite. Aegirine and biotite may also be present. This type is common towards the south.

2. The Moorooduc Type consists of titanaugite basalts common in the north of the area present also at Flinders and Cape Schanck. They are medium-grained with olivine phenocrysts in a matrix of ophitic titanaugite and labradorite, and abundant interstitial glass. Chilled phases with more glass also occur.

3. The Flinders Type is widespread throughout the area and is characterized by the absence of titanaugite, and by ophitic structure. Olivine is present as phenocrysts in a matrix showing flow structure, and consisting of augite, labradorite, iron ore and green glass.

Although Keble (1950) indicated a few possible extrusion centres on his map, the source of most of the voluminous lavas on the Mornington Peninsula is still unknown.

Zeolites are commonly associated with the basalt along the Flinders-Cape Schanck coastline, and include analcite, natrolite, phillipsite, gmelinite, stilbite, thomsonite, and chabazite.

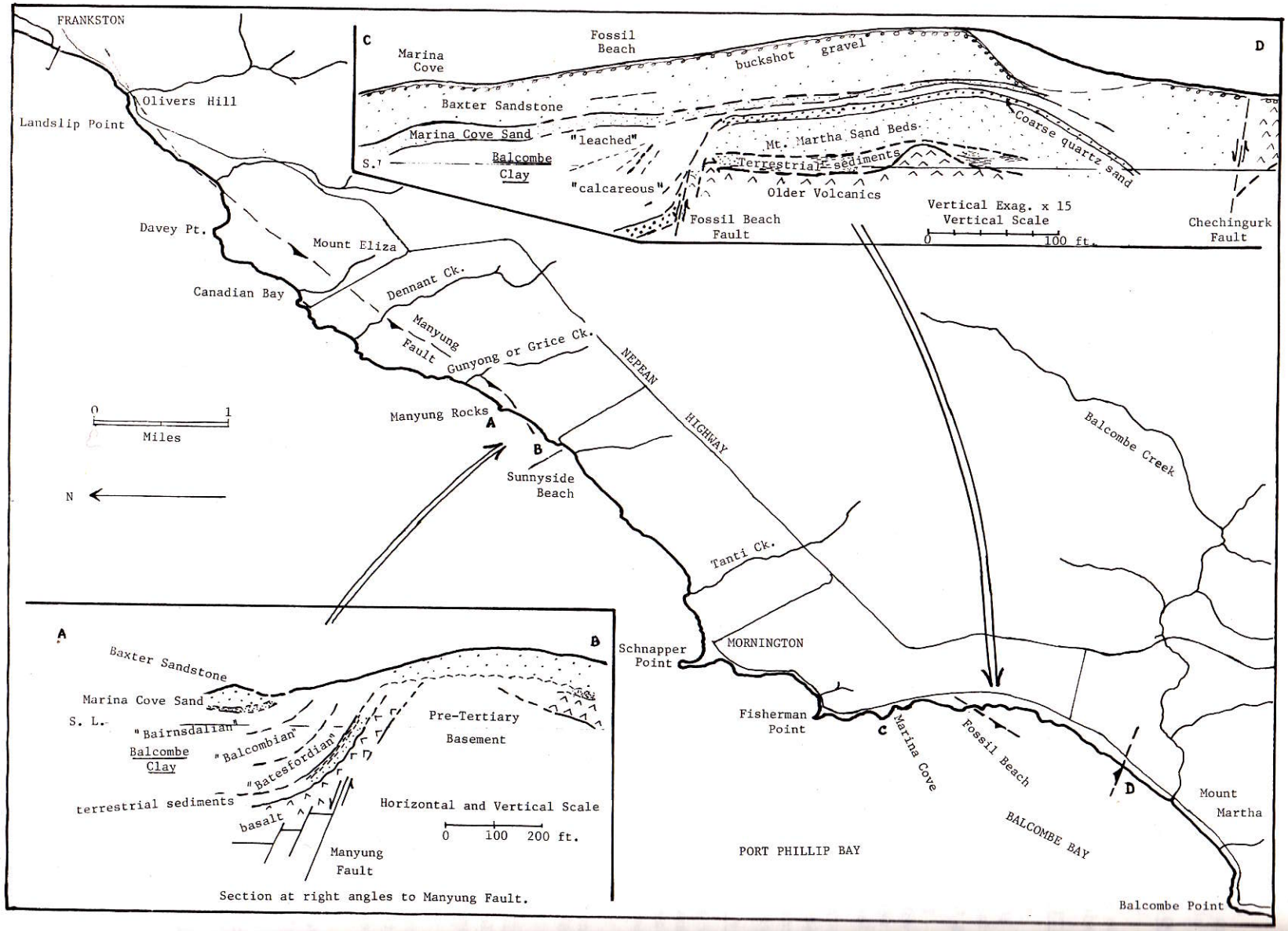

Fig. 4. Geological coastal sections, and locality map, of Mornington district (Gostin, 1968).

Tertiary Sediments.

In the first phase fluviatile sediments were deposited including gravels, sands and finer carbonaceous silts intercalated with which are ? Oligocene basalts.

The marine transgression began during the Early Miocene. At Flinders (Locality 2) a 20 ft. thick remnant of coarse to fine friable limestone (calcarenite) of Batesfordian age overlies the basalt directly, or with a thin pebble bed at the base.

Between Mt. Martha and Fossil Beach (Locality 4), the Older Volcanics and overlying terrestrial sediments are succeeded by the Mt. Martha Sand Beds which represent the onset of littoral or near-shore conditions. These consist of fine grained, rounded and well sorted quartz sands, and are about 30 ft. thick, although their equivalent further north at Manyung Rocks is much thinner. A thin very coarse quartz sand unit follows the Mt. Martha Sand Beds.

These coarse, paralic sediments in the Mornington District were succeeded in the Balcombian by a widespread development of deeper water calcareous and richly fossiliferous clayey silts known as the Balcombe Clay (Gostin, 1966). The type section of the Balcombian stage is at Fossil Beach, Mornington (Singleton, 1941, p.25) (Locality 4) where the Balcombe Clay is some 70 ft. thick: however, some 4 miles NE at Manyung Rocks, this unit is 170 ft. thick and ranges from Batesfordian to Bairnsdalian in age. Equivalent beds are found further north at Frankston and as isolated remnants on the central horst of the Peninsula.

In the Sorrento Bore of the Nepean Peninsula, a similar facies of consolidated "marl" and "sandy marl" occurs and marine sedimentation in the area was probably continuous from at least the Miocene up into Pleistocene times.

The fauna of the Balcombe Clay is chiefly mollusca, foraminifera and other microfossils, but includes bryozoa, sponges, corals, brachiopods, echinoids and fish. A large bibliography relating to this is listed in Singleton (1941).

The maximum transgression in the Balcombian and Bairnsdalian was followed by slow withdrawal of the sea. Overlying the Balcombe Clay in the Mornington District is a thin (average 10 ft. thick) but persistent unit of a very fine, very well sorted, quartz sand, the Marina Cove Sand in which marine fossils are rare. This was deposited in a very shallow marine environment during the Upper Miocene (Gostin, 1966). The regression was completed with deposition of the fluviatile Baxter Sandstone probably in the Cheltenhamian (Upper Miocene). It is a widespread unit, usually about 40 ft. thick overlying the Marina Cove Sand, and is in part unconformable with older formations. It consists mainly of poorly sorted coarse quartz sands and clayey sands. Cross-bedding is common and wood fragments occur. The unit has been subsequently leached and heavily ferruginized.

QUATERNARY

In the southwest, the Nepean Peninsula extends westward towards Sorrento and Portsea. This region of low and hummocky topography consists mainly of Pleistocene dune limestone (aeolianite) developed as a bar across the Port Phillip Sunkland. It is thinly mantled by Recent dunes and swamp deposits

Fig. 4. Geological coastal sections, and locality map, of Mornington district (Gostin, 1965).

ITINERARY

LOCALITY 1 - McIlroy's Quarry.

This quarry, 4 miles E of Dromana, on Dunn's Creek Road, is on the axis of the Palaeozoic anticlinorium and exposes the oldest of the Ordovician beds of the Lancefieldian stage (La 2). The beds consist almost wholly of bluish dark grey shales, the darker beds containing Clonograptus tenellus, C. rigidus, C. flexilis, C. magnificus, Tetragraptus decipiens, Bryograptus victoriae, B. clarki.

IN TRANSIT.

Proceeding east and then south to Red Hill and thence to Shoreham on the shores of Western Port Bay, the road traverses Lower Tertiary Older Volcanics which is largely weathered into rich red brown soils. Thence to Flinders.

LOCALITY 2 - Flinders ocean foreshore.

On the south side of golf links a low cliff of bryozoal and foraminiferal calcarenite overlies an eroded surface of Lower Tertiary basalt. Veins of calcite penetrate the joints in the upper weathered portion of the basalt. A thin discontinuous layer of basalt gravel and quartz sand underlies the calcarenite which shows indistinct beds of various grain size. Fossils include foraminifera, polyzoa, corals, calcisponges, echinoid spines and plates, brachiopods, bivalves and sharks' teeth.

IN TRANSIT

Proceeding west towards Cape Schanck the road includes the scenic views of the coastline eroded into the layered basalt flows.

LOCALITY 3 - Arthur's Seat

Arthur's Seat (1,030 ft.) is the highest point on Mornington Peninsula. The view from the Tower includes the low lying Nepean Peninsula to the west, the low hills, about 500 ft. high, of Mt. Martha and Mt. Eliza (granodiorites) to the north, and the Dandenong Ranges on the horizon. The physiographic expression of Selwyn Fault is clearly marked.

Several hundred yards down the road towards Dromana strongly jointed granite and infaulted rhyodacite occur.

LOCALITY 4 - Fossil Beach, Mornington.

Fossil Beach Fault, active only during the Miocene, passes through this locality 2 miles south of Mornington. On the upthrown southern side, weathered Lower Tertiary Older Volcanics are overlain by fluviatile sands and gravels. The near-shore marine Mt. Martha Sand Beds (20 ft. thick) follow, and are overlain by 9 ft. of clayey, very coarse sand. The Balcombe Clay follows, often stained or partly cemented with yellow jarosite.

On the downthrown northern side of the fault, the succession of Balcombe Clay (ca. 35 ft. exposed), Marina Cove Sand (9 ft.) and Baxter Sandstones (15 + ft.) may be seen. Here the Balcombe Clay is a homogeneous grey fossiliferous clayey silt with an average carbonate content of 20%, with layers of hard spheroidal carbonate concretions containing 80% carbonate. The old kilns were used to produce lime from these concretions. Exposed sections are olive coloured, the upper part of which is leached and oxidised, gypsum being produced from the original calcium carbonate and disseminated pyrite. The abundant fauna is chiefly mollusca, foraminifera and other microfossils, but includes bryozoa, sponges, corals, echinoids and fish. This is the type section of the Balcombian Stage. The coast is littered with ferruginized blocks of the Baxter Sandstones.

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