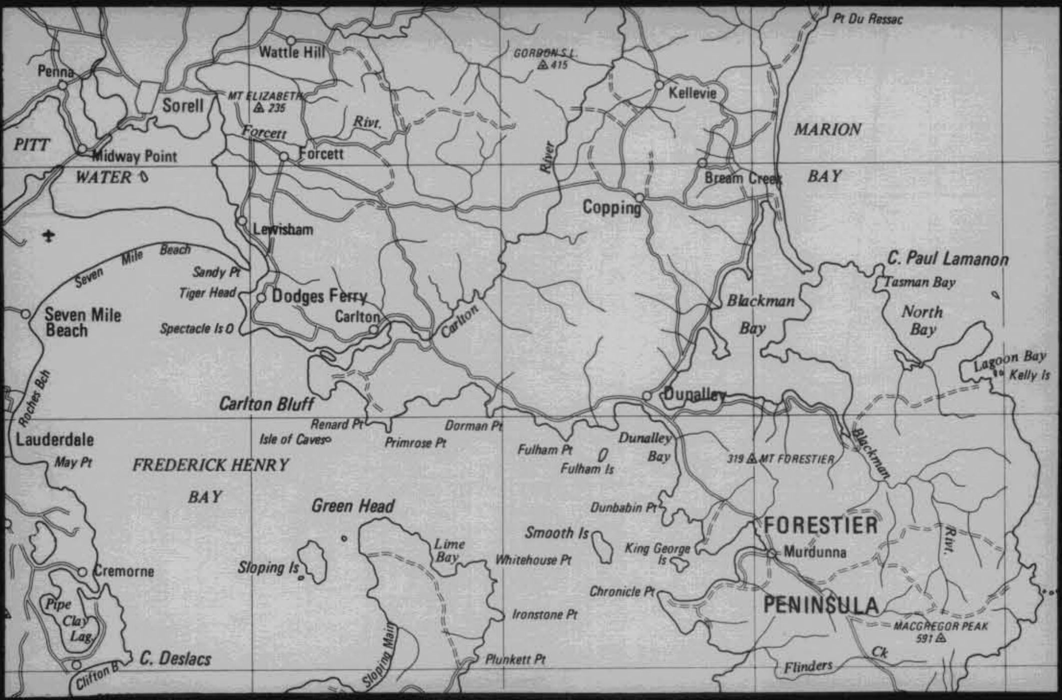
GEOLOGICAL SURVEY EXPLANATORY REPORT

SHEET 83

SORELL



TASMANIA DEPARTMENT OF MINES

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1984

GEOLOGICAL SURVEY EXPLANATORY REPORT

GEOLOGICAL ATLAS 1:50 000 SERIES

SHEET 83(8412N)

SORELL

by A. B. GULLINE, B.Sc.

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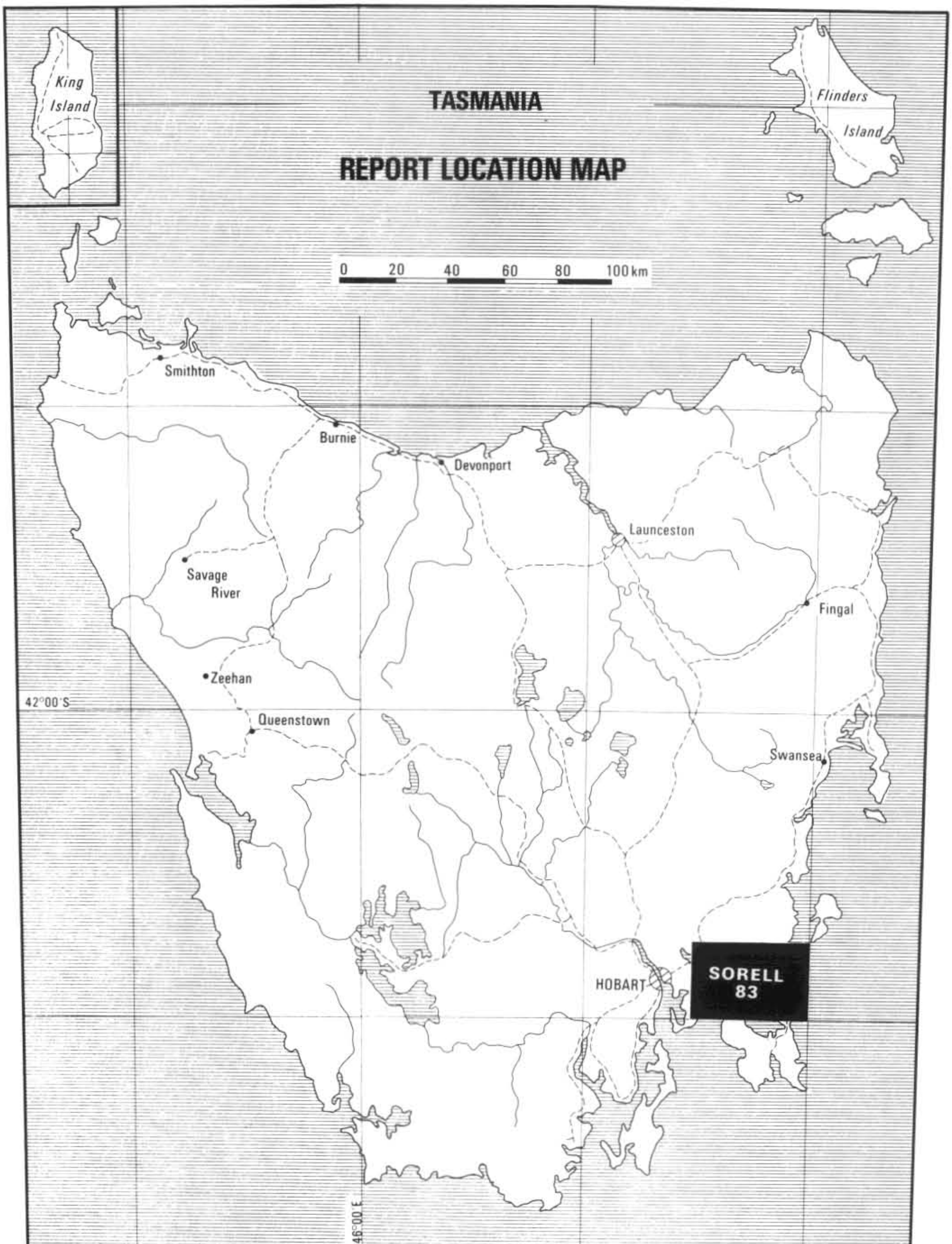

Figure 1. *Location map.*

GULLINE, A.B. 1984. Geological atlas 1:50 000 series. Sheet 83(8412N). Hobart. *Explan.Rep.geol.Surv.Tasm.*

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INTRODUCTION

The Sorell Quadrangle lies to the east of the Hobart Quadrangle, south of the Buckland Quadrangle and extends to the East Coast. It lies between latitudes 42°45' and 43°S and between longitudes 147°30' and 148°E and has a land area of about 500 km^2.

The long coastline of the Sorell-Dunalley region, Forestier Peninsula, north-western tip of the Tasman Peninsula, the Cremorne-Clifton area and numerous small islands yield good exposures, although most of the east coast of Forestier Peninsula is inaccessible. The main streams also provide good exposures.

Quaternary deposits, including extensive areas of windblown sand, conceal underlying rocks in many parts of the quadrangle.

A monument at Tasman Bay is purported to mark the site of the first landing in Tasmania of the Dutch explorer Abel Tasman in 1642.

The area began its development about 1817 when under Governor Sorell immigration was promoted with land being granted to settlers. The first grant in this region was to Joseph Steele who established a farm 'Studley Park' in 1820 at the locality now known as Forcett.

From then on the farming areas spread through the district. Sorell was proclaimed a town in 1866, Copping in 1873, by 1892 a railway was opened between Sorell and Bellerive and the Denison Canal was opened in 1905 as a short cut to small ships carrying freight to and from the East Coast (the canal was envisaged by Sir William Denison while Governor from 1847-1855).

On the Tasman Peninsula development commenced with the Port Arthur penal settlement. Coal was discovered at Saltwater River in 1834 and the seams were worked by the Government using convict labour. Coal prospecting probably assisted in opening up the region but all other seams proved uneconomic. Coal was recorded at Dunalley, Copping and Kellevie.

Agriculture, forestry and associated industries are the mainstays of the area. Its geographical setting has led to the establishment of Dunalley as a fishing port.

The geological investigation was carried out primarily to obtain a rock distribution map and obtain geological information as to the relationships between the rock-units and regional differences of the rocks from those on adjoining sheets.

Mapping was carried out using aerial photographs and contoured base maps at a scale of 1:25 000 and 1:15 840; geological information being gathered from road, bush and coastal traverses wherever possible. Much of the eastern coast of Forestier Peninsula was interpreted from observations taken on the few roads and accessible areas.

Acknowledgements are made to D.J. Jennings for information and specimens from the east coast of the Forestier Peninsula and to Dr M.R. Banks of the University of Tasmania for a series of photographs of the same area.

PHYSIOGRAPHY

The relief ranges from sea level to 350 to 450 m in elevation. East of Sorell most of the northern area of the sheet is of high relief from where there is a gradual uneven decrease in height down to sea level. Valleys extend in a southerly direction from the hills through a dissected topography down to the sea where coastal plains are common and often extend up the lower tracts of the valleys. Other low, flat areas are characteristic of Tertiary basins and are present at Sorell, Penna, Cremorne-Clifton, Carlton, Lewisham and Dunalley. The coastal plains and post-Tertiary deposits indicate a gradual emergence of the land after submergence due to pre-Tertiary faulting and emergence following the last interlgacial epoch. Other indications of this event are the estuaries, marshes, spits and tied islands which are numerous in the coastal areas.

Forestier Peninsula is extremely rugged with a maximum relief of 591 m on MacGregor Peak, 520 m (View Peak) and 480 m (above High Yellow Bluff) on the eastern side and 319 m (Mt Forestier) in the north-west, with lower elevations along the south-west and north-western sides. The east coast consists mostly of precipitous cliffs 100-200 m high with short steep-valleyed creeks, while major drainage is to the south-west and north-west coasts.

DRAINAGE SYSTEM

The major drainage system is that of the Carlton River which rises near Nugent some 5 km north of the Sorell Quadrangle. The river traverses a mountain tract to Kellevie after which it is more mature and has a low gradient. In this section it may be superimposed as it cuts through several dolerite bodies in its south-westerly course. Extensive areas of alluvium have accumulated upstream of the dolerite bodies, indicating their hindrance to river erosion. Because of the distribution of dolerite intrusions in Triassic rocks in this area the course of the river may be consequent.

Upstream from the Arthur Highway bridge alluvium occurs at a height of 20 m above the present level of the flood plain and this is another site where dolerite barred the river. In its lower reaches the Carlton River follows a pre- or Early Tertiary valley, filled with basalt in Tertiary times but subsequently eroded by the river, which from Riverside [570530]* has basalt remnants on each bank down to near its mouth.

The mouth at Frederick Henry Bay is partially barred by a spit forming the south-east end of Carlton Beach.

At the extreme western part of the sheet Orielton Rivulet runs through a long flat area of Tertiary and younger sediments, in which it has cut a deep narrow channel which becomes wider as it enters Orielton Lagoon at Penna.

Sorell Rivulet rises in the hills north of the town where it has a short youthful stage before reaching Tertiary sediments and volcanic rocks which extend to Pitt Water where the rivulet discharges. Iron Creek drains country further to the east and has similar characteristics; it traverses mainly Tertiary rocks to Pitt Water. There are numerous other small water courses draining the area with those on the south and east flowing through alluvial coastal plains (*e.g.* Boomer Creek [680548] and Sedbury Creek [700597]) while Bream Creek]710587] flows along the coast behind the sand dunes of Marion Beach through which it breaches seasonally, discharging into Marion Bay.

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* All localities lie whtin the 100 000 m AMG square EN.

On Forestier Peninsula the main drainage systems are Blackman Rivulet [740487], the course of which is partly dictated by structure, and Sounds Rivulet [705445] and Flinders Creek which drain westwards into Norfolk Bay.

STRATIGRAPHY

The oldest exposed sedimentary rocks belong to the Lower Parmeener Super-Group, which unconformably overlie Devonian adamellite in the Deep Glen Bay area of the Forestier Peninsula.

LOWER PARMEENER SUPER-GROUP (PERMIAN)

Lower Parmeener Super-Group rocks are exposed in four main areas:

(1) South-eastern Forestier Peninsula

(2) Northern Forestier Peninsula

(3) East of Sorell

(4) Along the western margin of the sheet south from Seven Mile Beach to the Clifton Beach area

South-eastern Forestier Peninsula

This coastal section is accessible by boat although landing is only possible at infrequent intervals due to precipitous cliffs, so not much of the sequence can be closely examined.

Permian basal conglomerate overlies adamellite at 794404. Further north along the coast arkose, overlies the adamellite and is best exposed on The Sisters [814430], several small islands off the coast. The rock overlying these basal beds appears to be limestone. The lowest Permian fossiliferous rocks seen were at the north end of Deep Bight where a calcareous rock contains many boulders, probably indicating that it is near basement, and many *Eurydesma* and pectens which are preserved as original shells; the observed thickness was 4 m (plate 1).

Above this is a shaley mudstone which appears unfossiliferous and is probably the local equivalent of non-marine Lower Freshwater beds found in other Permian sequences and in particular resembling the Boullanger Formation of Maria Island. At Deep Bight the non-marine unit is about 6 m thick.

Overlying the shaley mudstone is a calcareous siltstone rich in Productidina such as *Echinalosia preovalis* (Maxwell), *Cancrinella farleyensis* (Etheridge & Dun) and *Anidanthus springsurensis* (Booker) which also occur in this position in the Maria Island succession.

Higher units could not be accurately placed in the Permian sequence because of inaccessibility.

A traverse by D.J. Jennings (1974) down the ridge toward The Sisters gave an incomplete succession starting near the top of a ridge [803425] in fossiliferous mudstone. He then recorded that 'descent was made down 120 m of broken cliff and giant scree through a succession composed mainly of fossiliferous Permian limestone. An upper, massive, fragmental limestone [including much crinoidal debris] overlies an abundantly fossiliferous stropholosiid siltstone and thence down through spiriferid limestone beds,

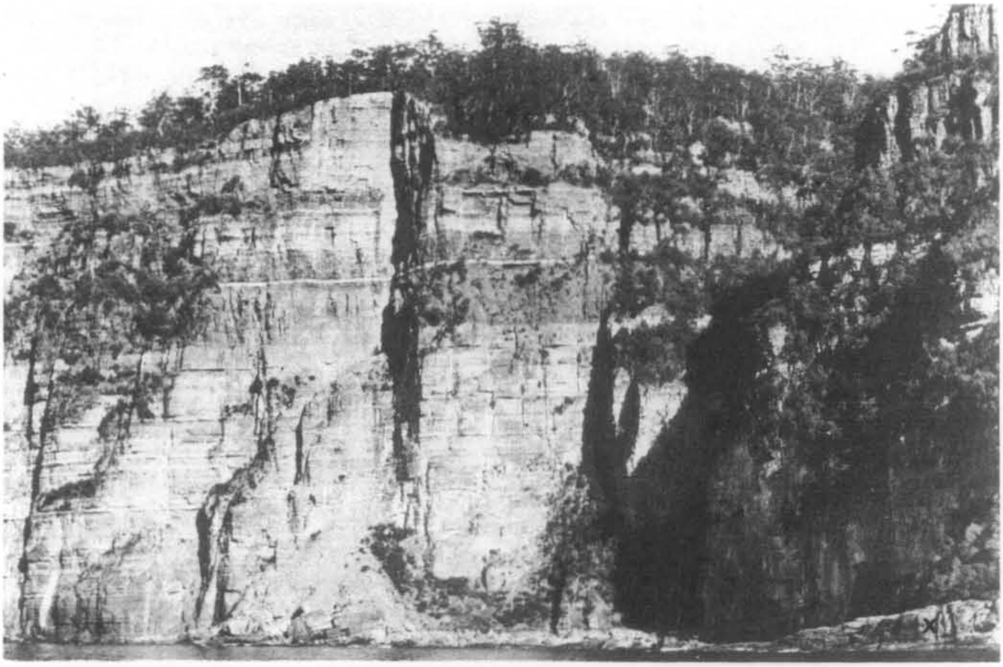

Plate 1. *Lower Freshwater Beds of the Lower Parmeener Super-Group, overlying calcareous beds containing boulders and* Eurydesma *(bottom right).*

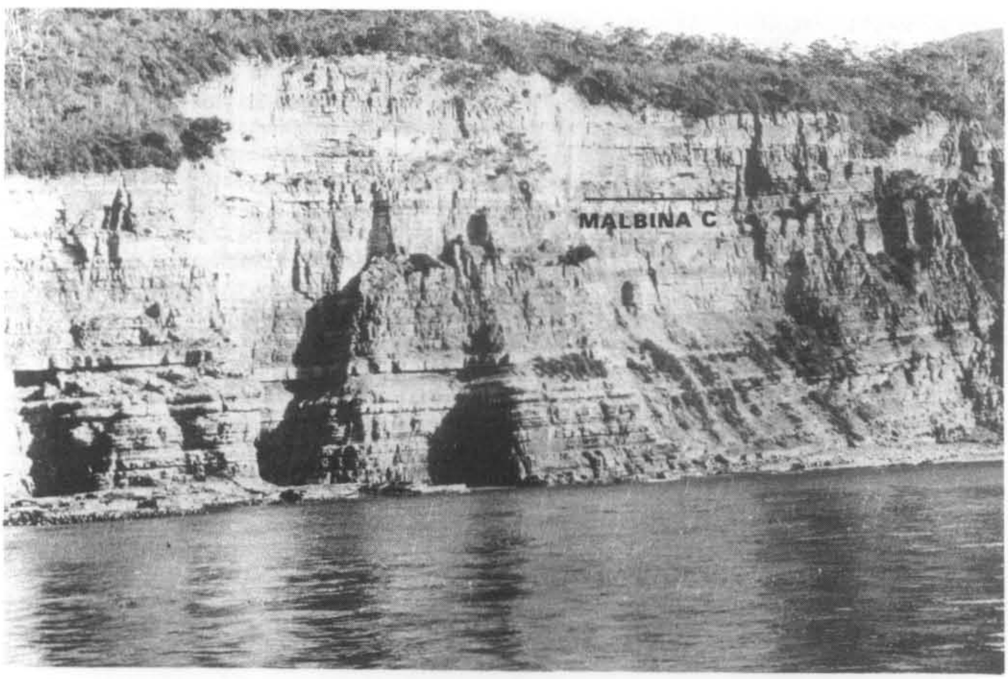

Plate 2. *Lower Parmeener Super-Group succession south of Deep Bight.*

Eurydesma limestone, massive conglomerate and arkose basal beds'. This succession is similar to that on north Maria Island.

It cannot be closely correlated with sequences near Sorell, except in the higher units of the Permian although no equivalent of the Risdon Sandstone could be found. The Ferntree Mudstone is approximately 120 m thick in this section.

Northern Forestier Peninsula

The oldest rocks occur in the cliff at Watsons Bay [745556] (fig. 2), where thin bedded indurated mudstones are in crumpled and folded attitudes against the Jurassic dolerite of Cape Paul Lamanon. Above these beds limestone and calcareous sandstone occur, mainly in thin beds, but at Watsons Bay there appears to be only one section of about 5 m of limestone separated by a fault from the oldest sequence. This limestone horizon lies directly on dolerite to the south of Tasman Bay [752545].

Directly below the limestone are cream sandy mudstone beds containing fossil bryozoans, molluscs and brachiopods. Above it are 40 m of brown to fawn sandy mudstone with apparently few fossils.

The limestone crops out at the bottom of the cliff section at Watsons Bay and dips shallowly in a south-westerly direction so that at Gardiners Cove [737561] the top of it is seen in the shore platform as a rock made up of coarse sand particles, and limestone containing many fossil fragments, the most notable being large *Ambikella* shells.

The overlying mudstone, which contains sparse fossils, occurs as a wave-cut platform. Higher beds following the coast into Blackman Bay are virtually barren of macrofossils. Between Little Chinaman Bay [722553] and Tea Tree Bay [718548] there is a change in lithology from sandy mudstone to muddy sandstone which contains sparkling quartz grains and rounded white quartzite pebbles (as does the Risdon sandstone) but no fossils were apparent in the underlying mudstone as are seen at Mays Hill, on the north side of Wattle Hill and on Mt Elizabeth (fig. 2). Further into Blackman Bay, the light cream coloured Ferntree Mudstone crops out in Tea Tree Bay and at the northern end of Green Point.

Near the top of the N-S ridge west of Tasman Bay sandstone lithologically similar to Risdon Sandstone occurs. Permian detritus covers the slope below this bench-forming rock and no fossiliferous mudstone was found.

Above this the mudstone is paler and finer grained and is considered to be Ferntree Mudstone.

East of Sorell

Beds of the upper marine sequence, the lowest of which is Grange Mudstone occurs near Pawleena [475666], at the northern margin of the map. At this locality the zone fossil, *Cancrinella farleyensis*, occurs in a cream siltstone. At other localities in the Sorell area and along the western margin of the map the base of the Permian section lies above a Jurassic dolerite intrusion, at an unknown height above the *Cancrinella* horizon.

The rock types directly above the dolerite are thin- to medium-bedded yellowish to brownish mudstone beds with thinner shaley mudstone,

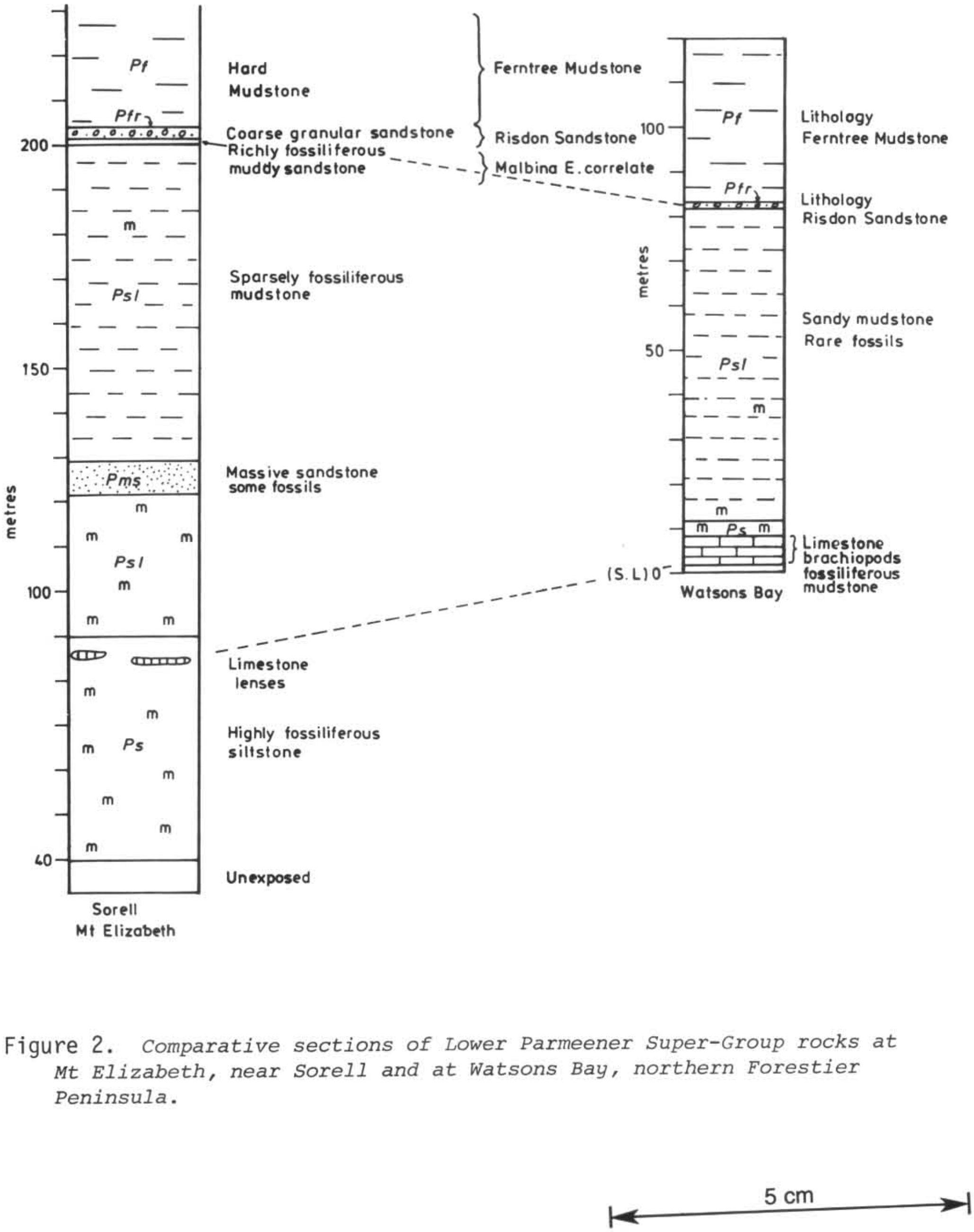

Figure 2. *Comparative sections of Lower Parmeener Super-Group rocks at Mt Elizabeth, near Sorell and at Watsons Bay, northern Forestier Peninsula.*

all being moderately fossiliferous. Fossils are plentiful in the overlying sandy mudstone and thin limestone but become less common higher in this succession which is designated Ps on the map.

On Little Hill, Mt Elizabeth and Table Hill parts of the sequence are covered by detritus from the higher beds. In some areas this material is consolidated and is considered a Cainozoic rock (Qtb). Above it the Permian sequence is indurated by underlying dolerite (and basalt at the Sorell Quarry).

The rocks are low in the Malbina Formation and consist of fossiliferous mudstone, lithologically like Grange Mudstone. There is a sequence of creamy yellow, fine-grained, thinly bedded mudstone with thin limestone (probably lenticular) in the higher part. Fossils are numerous and often have a grey-blue original shell material. This sequence grades sharply upwards into sandy mudstone which is present in 0.3-1 m beds up to the first break in slope of the hills. Fossils are noticeably less numerous as the section is ascended.

At the first break in slope there is a 6-7 m thick, massively bedded sandstone unit. Poorly preserved fossils occur on bedding surfaces. The sandstone is medium-grained, occasionally coarse-grained, and sometimes contains a few pebbles and mud pellets.

Exposure above the sandstone is poor as bedding is thinner and frittery weathering mudstone is the predominant rock type. Blocks of yellowish sandy mudstone containing brachiopods and lamellibranchs occur below a mudstone containing mainly lamellibranchs and occasional *Wyndhamia* which underlies the next resistant unit. This unit consists of several beds of white quartz granule conglomerate with sparkling quartz sand grains, feldspar grains and occasional white quartzite pebbles. The thickness of this unit is 2.5 m on Mt Elizabeth. It does not occur on Little Hill, the summit of which is lower. On Table Hill this unit is thinner and sandstone occurs as lenses up to 0.3 m thick surrounded by mudstone. A mudstone bed containing lamellibranchs occurs directly below these lenses. Above this mudstone of a much paler colour and greater hardness crops out, as on Mt Elizabeth. The section representing the three hills (fig. 2) gives a correlation of the various units with other known Malbina Formations.

Exposure on Wattle Hill is very poor but the lower calcareous beds are represented by blocks on the lower slopes of the hill. Malbina Member E correlate occurs on the northern slopes and is overlain by Risdon Sandstone and Ferntree Mudstone.

The Malbina Member E correlate rich in *Echinalosia ovalis* (Maxwell) and *Terrakea brachythaera* (Morris) occurs east of Wattle Hill [537628].

South Arm area

At Mays Hill [432463], north of Cremorne dolerite underlies a thin succession of indurated fossiliferous rocks faulted against sandy mudstones fairly high in the Malbina Formation correlate. The top of this formation is well exposed in the cliff section. The topmost section is approximately as follows:

	Thickness (m)	
Top	3-4	Well-sorted quartz sandstone with current bedding near top, bands of quartz pebbles and bioturbation near base.
	0.5-1	Frittery mudstone with numerous *Megadesmus*.
	0.3	Thin bedded even-grained sandstone.
	0.3	White pebbly coarse-grained sandstone.
	2.5	Mudstone with fine-grained sandstone and occasional erratics. *Astartila* 2 m above base.
		Mudstone with *Warthia* and lamellibranchs.

This section is considered to be equivalent to the Risdon Sandstone and is underlain by Malbina Member E correlate.

Several short sections of Ps units occur on the sheet. At Mays Point dolerite underlies and intrudes these rocks and becomes sill-like half way up the cliff at the northern end. Here induration is most marked. Beds of white, crystalline, partly silicified limestone (calc-silicate hornfels) up to 0.2 m thick interbedded with darker indurated mudstone beds occur here. Cherty greenish fossiliferous beds are also present and *Wyndhamia* bryozoans and pectens are recognisable.

In a quarry west of South Arm Road near the Clifton Beach turnoff [409431], Ps units are again present and indurated by underlying Jurassic dolerite. To the south, indurated limestone blocks occur along the lower slopes of the ridge to the west of the Clifton Beach Road as far as Watsons Hill near the southern margin of the map. The sequence becomes sandier and fossils rarer southward along the South Arm Road, and at the highest level seen the rock is an unfossiliferous creamy-brown mudstone. This poorly fossiliferous section is a Malbina Formation correlate.

At Cape Deslacs the rocks are less indurated. The sequence consists of fossiliferous sandy mudstone with unfossiliferous, thin beds of iron-stained mudstone and several beds of calcareous mudstones overlain by brown fossiliferous mudstone. The Permian-Jurassic contact dips north at Mays Hill and south at Cape Deslacs at a similar angle.

FERNTREE GROUP CORRELATE

The basal member of this group is the Risdon Sandstone correlate, which is composed of sparkling quartz grains, coarse sandstone often with a feldspathic component, granule layers and larger, well-rounded quartz pebbles.

Overlying the Risdon Sandstone correlate is a succession of hard, cream-weathering mudstone to sandy mudstone with interbedded, thin, finer-grained mudstone which is rarely exposed but is incorporated in the general thin float cover over hillsides.

There is considerable bioturbation in some horizons of the sandy mudstone with the rock seemingly composed completely of worm casts 3-4 mm in diameter.

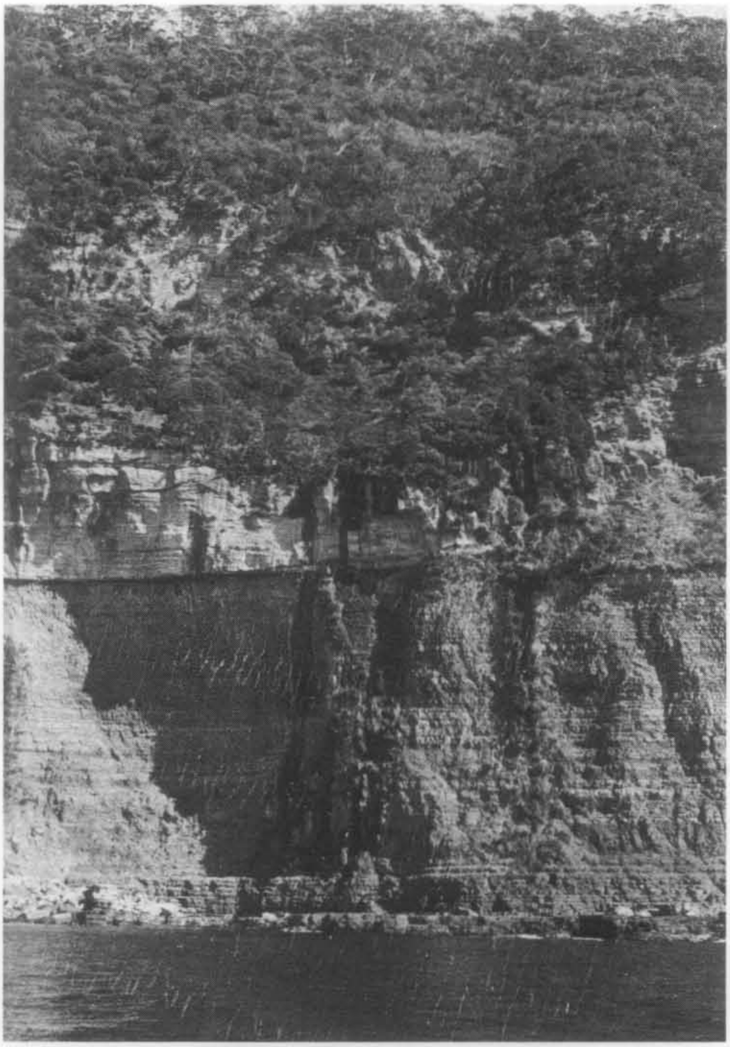

Plate 3. *Sandstone of the Upper Parmeener Super-Group overlying Ferntree Mudstone correlate, Forestier Peninsula.*

Plate 4. *Overturned current bedding in sandstone, lower part of the Upper Parmeener Super-Group, Midway Point.*

Plate 5. *Typical sedimentary structures, lower part of the Upper Parmeener Super-Group, Midway Point.*

Worm burrows were observed in fine-grained hard mudstone in a quarry east of Forcett next to the Tasman Highway [566584]. These were estimated as being up to 100 mm long and 5-10 mm in diameter, tapered, and filled with granules, coarse sand and mud. The burrows were close to, or at right angles to, the bedding plane and spaced at 150-300 mm apart.

Marine fossils are found at a certain horizon in the succession. On the Hobart sheet this horizon is at about 30-40 m from the top. On the Sorell sheet preservation of these fossils is generally as moulds in a zone about 0.6 m thick. Sometimes preservation is very poor in fine mudstone but is better in silty sandstone. In the most productive locality (Cooper Hill, 550593) the fauna mainly consisted of brachiopods and lamellibranchs.

M.J. Clarke (pers. comm.) identified the following fauna from this locality: *Astartila intrepida* (Dana), *Megadesmus grandis* (Dana), *Myonia carinata* (Morris), *Merismopteria macroptera* (Morris), *Vacunella curvata* (Morris), *Etheripecten leniusculus* (Dana), *Stutchburia costata* (Morris), *Terrakea brachythaera* (Morris), *Ambikella spp.* and *Stenopora crinita* (Lonsdale). The Ferntree Group correlate includes occasional beds of medium- to coarse-grained conglomerate and numerous dropstones of varied lithology.

The maximum thickness of the Ferntree Group correlate in the Sorell vicinity is estimated as approximately 180 m on Dixons Hill. At Eaglehawk Neck it is estimated to be 120-140 m thick and no outcrop of Risdon Sandstone correlate could be found.

The presence of Cygnet Coal Measures or their correlate could not be proved, but absence of this unit cannot be assumed because sections between the Lower and Upper Parmeener Super-Group are not exposed in the western part of the map sheet and are practically inaccessible on the Forestier Peninsula.

UPPER PARMEENER SUPER-GROUP (TRIASSIC)

There are very few exposures of basal sandstone resting on Permian rocks. The only good section occurs north of Cape Surville on Forestier Peninsula. In this four kilometre coastal exposure pale coloured quartz sandstone lies conformably on Ferntree Mudstone. It is current bedded, shows some soft sediment deformation, but has few massive beds (similar but more massive sandstone occurs in Eaglehawk Spur). Above this, thinner bedded sandstone occurs with more massive sandstone above. Near the top of the section its grain size decreases and grades into a fairly thick sequence of mudstone and shale (this part of the section is inaccessible and was seen from a boat) (plate 3).

Massive quartz sandstone of which the relationship to the Permian is not known precisely occurs at Midway Point, where it is markedly current bedded; near Dunalley between Little Boomer and Boomer Island; in two coastal outcrops between Gypsy Bay and Dunalley; in the bank of Carlton River below the Tasman Highway and round the coast of the northern tip of Tasman Peninsula.

In most other cases the Triassic sediments consist of interbedded sandstone shale and mudstone as seen on the Forestier Peninsula. Some massive beds of feldspathic sandstone occur on Ragged Tier below basalt at 655600 but were not seen elsewhere.

Plate 6. *Tertiary conglomerate, interbedded with finer grained sandstone, Iron Creek.*

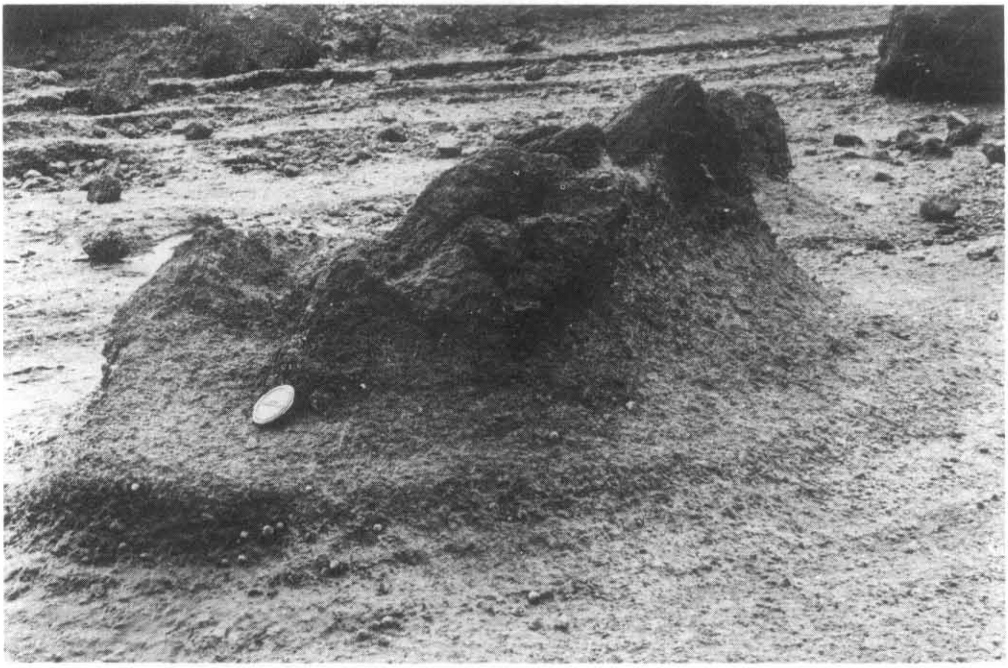

Plate 7. *Tertiary volcanic tephra in thinly-bedded sub-aqueous tuff deposit, Iron Creek.*

In some other areas carbonaceous shale and coal occur associated with feldspathic and lithic sandstone which may be the case at Kellevie (coal is reported from near Kellevie). Thin coal seams and carbonaceous shale occur at Copping and coal is present in shale and quartz sandstone at Dunalley and Saltwater River.

A mud pellet horizon at 600504 contains fossil bone fragments but no fossils were found in other mud pellet horizons. The shale and mudstone horizons seem to be the zones most intruded by Jurassic dolerite and where this has occurred there is considerable baking of the sedimentary rocks into very hard fine, flinty and cherty material. Such rocks were used by aboriginals to make stone implements.

A sequence of coarse quartz sandstone and granule to small pebble conglomerate is present in the topmost beds on the southern side of Big Blue Hill but this appears to be an anomalous rock type. It could not be traced far and may represent a lenticular facies.

The most notable depositional feature of massive Triassic sandstone is current bedding and overturned current bedding.

At Midway Point and in the cliffs around the Tasmania Golf Course these features are well developed (plates 4, 5). The favoured explanation of overturned current bedding is that the forset beds, having been deposited and still subject to current force sometimes suffer liquifaction, and differential movement within the sediment results in folds.

TERTIARY

The oldest Tertiary deposits are probably those at the Penna, Sorell, Forcett, Bream Creek and Clifton Beach areas which are older than the Tertiary basalt. The sub-basalt rocks are of a wide variety. In the tidal reaches of Iron Creek conglomerate containing clasts of basalt, dolerite, mudstone and sandstone, is interbedded with finer grained sandstone (plate 6). The presence of basalt boulders indicates that an earlier eruption preceded the sedimentation. Overlying the conglomerate is another reddish coloured sequence containing beds with a range of thicknesses. Thick beds often contain boulders of volcanic ejectamenta, thin beds are better sorted sandstones, some exhibiting current bedding. This sequence is succeeded by beds of volcanic tephra and scoriaceous basalt (plate 7) which gradually merge into solid basalt near the bridge.

Further down the bay on the eastern slope regular thin beds of possibly sub-aqueous tuff are exposed at low tide. Closer to Sorell an interbasalt sedimentary deposit (claystone) has beds of lapilli tuff interbedded with it [475633]. At Bream Creek at an elevation of between 60-80 m a deposit of sandstone and claystone of Tertiary age is overlain by basalt [684598] and at 687621 basalt overlies a conglomerate of angular to well rounded pebbles, suggesting a bi-modal origin. Other sub-basalt rocks occur in the bank of Iron Creek near the second bridge on the Nugent Road [512662].

Accumulations of scoriaceous material and other volcanic tephra are often overlain by basalt.

Opaline deposits have been found near the surface interlayered with well bedded Tertiary sediments. The origin of these is not fully known except that they are probably replacement of weathered basaltic fragment beds by silica-rich solutions or may be spring deposits.

Plate 8. *Denison Canal, cut in Tertiary sediments, Dunalley.*

Plate 9. *Bed of concretionary ironstone, in unconsolidated Tertiary clay, Pipe Clay Lagoon.*

Spring deposits occur at Flinty Point [489615] where two types of silica were deposited. On the coast there is an extremely hard translucent form while a concretionary type with some ferruginous material occurs nearby.

Silica stone or silcrete, which is generally a qhite coloured silicified deposit of siliceous material, is present near Pawleena [476664], Forcett [515603] and [512583], Pipe Clay Lagoon [438417, 423404, 416419]; the best example is at the last-mentioned location.

At Forcett [512583] only the top of the siliceous material is silicified to any extent and it is underlain by sand containing occasional lumps of silicified material. This silicification could be due to basalt.

The best example of silica stone shows the top layer to be silicified sand overlying less silicified breccia of Permian fragments.

Other Tertiary sedimentary rocks not proven as sub-basalt occur in several areas. Around Penna the upper layers are post-basalt as basalt is known to exist underneath them in adjacent localities. The Penna and Orielton Rivulet occurrences are claystones and mudstones. At Dunalley Canal claystone, with sandstone lenses sometimes contains concretionary ironstone (plate 8). Sandstone occurs at Little Boomer. Inside the mouth of Pipe Clay Lagoon, Tertiary rocks occur as weathered brown clay, bedded concretionary ironstone and fresh grey coloured clay (plate 9).

Dating of these deposits has not yet been attempted but overlying sediments at 430430 have been dated (Colhoun, 1977) as Late Quaternary. The marine sands and gravels are considered to have been deposited during the last interglacial stage. The overlying organic material, deposited in a marsh and pond environment, was dated at between 22 000 and 25 000 years B.P. Aeolian sand is interbedded with the top of the organic deposits and is possibly an indication of the onset of the last glacial stage when vast sand sheets accumulated over much of the lower coastal areas of the Quadrangle.

The underlying Tertiary rocks dip at up to 30°W and are therefore unconformably overlain by the Quaternary deposits as are the dolerite and Permian rocks on the point.

CAINOZOIC

A breccia of fragments of Permian and younger rocks occurs in the Pipe Clay Lagoon area and 3-4 km east of Sorell. This overlies bedrock and conforms in attitude with the hillslopes. It is apparently a consolidated talus deposit and is seen in road cuttings along the Clifton Beach Road, on Watsons Hill, and along and near the Arthur Highway between Iron Creek and the Lewisham Road turnoff. The maximum exposed thickness was about one metre in the last-mentioned locality and a similar thickness was recorded in a dry water hole on the hill at the end of Clifton Beach Road [442425].

Sandstone

A consolidated brownish sandstone occurs on the north-eastern side of Smooth Island at about 2 m above sea level, and is covered by sand. It is similar in appearance to that at South Arm (Mary Ann Bay Sandstone) but no fossils were found in the sample examined. It is a fine-grained quartz sandstone.

Talus

On Permian rocks talus is generally thin and does not deeply cover underlying rocks on hillsides but is thicker on the gentler slopes and at the foot of the hill. Dolerite talus from hills masks some areas almost down to level ground. Basalt hills especially around Copping and the Bream Creek-Kellevie areas have extensive talus slopes and isolated patches of talus occur at considerable distances from the source.

Triassic rock talus is only present as downwashed sand with occasional blocks and pebbles of sandstone. The boundary is particularly hard to locate where windblown sand also occurs.

Windblown sand

Windblown sand is widespread around the coastal area of the sheet and on islands. Where it occurs around rocky coastlines the base is about 6 m above sea level, and above this on more level ground the thickness of sand increases. This unit occurs inland as a mantle of varying thickness over older rocks - the sand does not normally have a distinctive morphology but softens the pre-existing relief. Near Murdunna windblown sand extends from the coast for at least 5 km inland and occurs at 120 m above sea level.

Sand dunes are formed when windblown sand is deposited over a period in distinct areas and accumulates to form ridges. They are present behind all the sandy beaches in a variety of sizes. Dunes are particularly prominent on Seven Mile Beach where the building up of the spit can be best seen on aerial photographs and at least fifty parallel longitudinal dunes or beach ridges can be distinguished. Beach ridges are also well developed at Pipe Caly Lagoon at the back of Clifton Beach. The seaward dunes are generally active and dunes further inland are fixed. Dunes are present behind Marion Beach, Sloping Beach, Clifton Beach, Carlton Beach, Lagoon Bay, Two Mile Beach and Seven Mile Beach. Some dunes are to be found well inland from Carlton Beach and Okines Beach near Dodges Ferry.

Accretion of Quaternary sand has tied numerous islands to the mainland, *e.g.* Boomer Island, Little Boomer and Green Point in Blackman Bay, and Carlton Bluff. Possibly Clifton Beach is a similar tie as may be the area between Lime Bay and Lagoon Beach, Pipe Clay Lagoon to Lauderdale, Lumeah Point in Pipe Clay Lagoon and the area Sommers Bay to King George Sound. Sand spits are well developed at Seven Mile Beach, Marion Beach, Cremorne Beach and Carlton Beach.

At Tea Tree Bay in Blackman Bay a lightly consolidated dark brown sandstone about 2 m thick occurs from sea level to the base of the overlying windblown sand. This sandstone has a grain size ranging from granule to fine sand and may well be water deposited rather than windblown. It may be of Late Quaternary age as is the sand in Pipe Clay Lagoon [430430].

Other Holocene deposits

Although mostly concealed by more recent material there are a few thin accumulations of gravels and boulders. A small creek has cut a steep narrow gorge [689587] through approximately 4.5 m of layered clay and cobbles bottoming on rotten, dark, igneous rock (probably basalt). Behind Marion Beach there is a similar thickness of clay cut by a small creek at 700597.

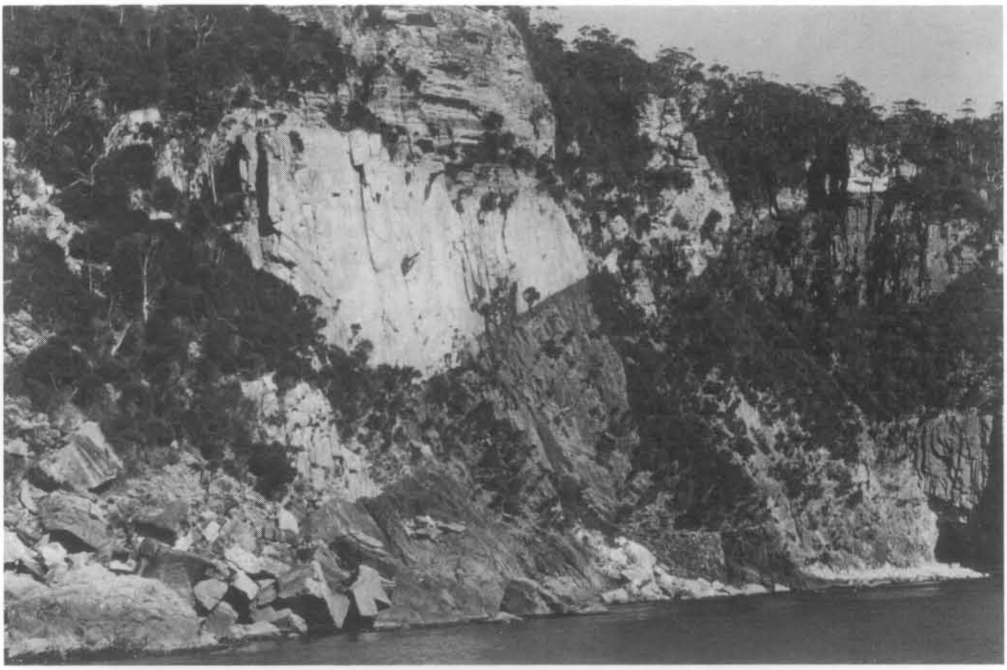

Plate 10. *Jurassic dolerite feeder cutting through Devonian adamellite into Lower Parmeener Super-Group strata, Forestier Peninsula.*

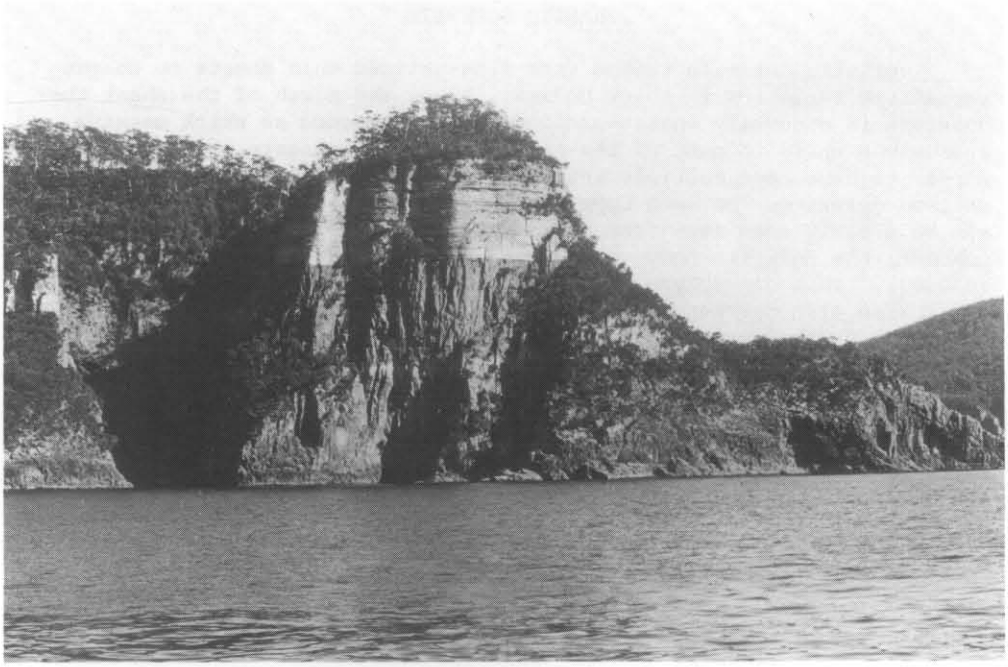

Plate 11. *Massive Jurassic dolerite underlying Lower Parmeener Super-Group strata, Cape Surville.*

A boulder deposit is exposed in the road cutting below the Dunalley church. Inland from Little Boomer a cobble deposit is exposed at the bend in the road. The cobbles are mostly basalt and may have been deposited by a stream prior to the development of the present coastal plain. At the northern end of Marion Bay an extensive alluvial plain occurs with boulders and sand probably deposited by Bream Creek.

Another gravel and cobble deposit occurs near Penna in which there is a deeply incised creek. This deposit is of material derived from Permian rocks and is underlain by Tertiary sediments.

Quaternary marsh and swamp deposits are found mostly in coastal areas where dunes have dammed areas behind them, *e.g.* Sloping Lagoon, Turners Lagoons and the lagoons behind Primrose Beach, Two Mile Beach and Marion Beach.

River alluvium is widespread along the Carlton River where it passes through dolerite gorges. It appears that these rocks barred the river for a period and extensive alluvial deposits were formed in the areas behind the more resistant dolerite.

IGNEOUS ROCKS

DEVONIAN ADAMELLITE

A grey adamellite is exposed from the northern end of Deep Bight along the coast northward through Deep Glen Bay, terminating on the north side of Deep Glen Bluff where it is intruded by, and faulted against, Jurassic dolerite (Plate 10). The Sisters islands are of arkose overlying adamellite which is only slightly above sea level.

JURASSIC DOLERITE

Jurassic dolerite ranges from fine-grained thin sheets to coarse pegmatitic varieties in thick bodies. Along the north of the sheet the dolerite is generally coarse-grained where it occurs as thick massive intrusions while in most of the intrusions into Triassic strata there appear to have been multiple intrusions and chilling resulting in finer grained dolerite. Between Copping and Dunalley a coarsening in crystals can be clearly seen away from a Jurassic dolerite-Triassic sandstone contact; the dolerite body culminates in a hill of granophyric dolerite [670563]. This granophyre is composed of quartz, iddingsitised fayalite and coarse clinopyroxene set in a perthitic intergrowth of plagioclase and K-felspar. Other granophyric bodies occur at Chronicle Point [664430] and in various quarries near Dunalley, Copping, Bream Creek, Connellys Marsh, Nugent Road and Penna.

From west of Dunalley rising up to Big Blue Hill a good example of multiple intrusion of Triassic rocks by Jurassic dolerite can be seen. The general sequence, and approximate elevations (metres a.s.l.) are as follows:

Altitude (m)	*Rock type*
210-400	Jurassic dolerite (Big Blue Hill)
150-210	Triassic sandstone
110-150	Jurassic dolerite
90-110	Triassic mudstone

Plate 12. *Blocks and boulders set in tachylitic and tuffaceous Tertiary volcanic deposits, near Wykeholm Point.*

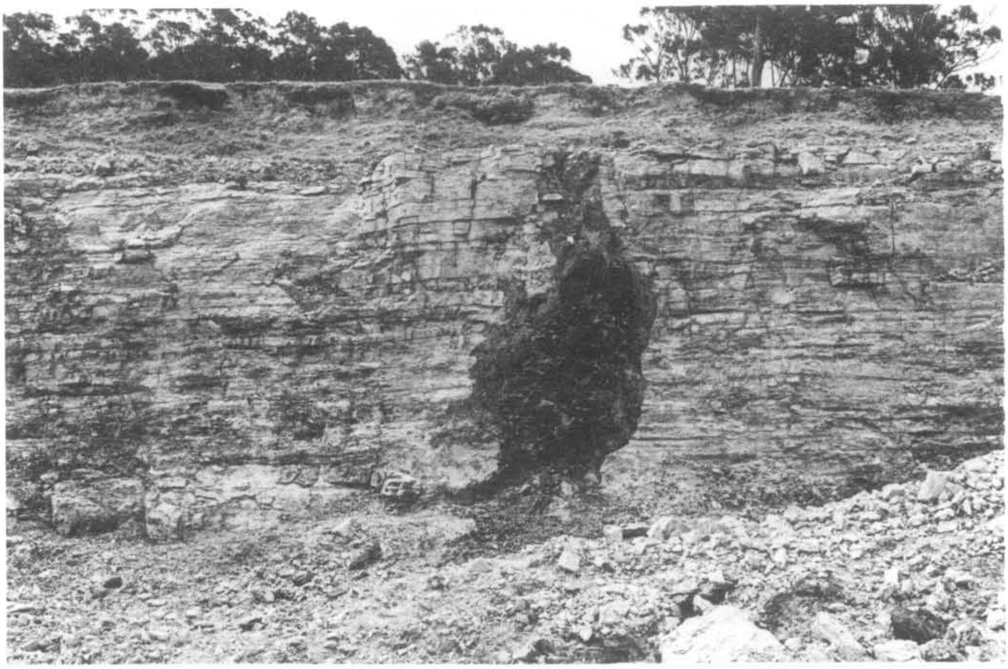

Plate 13. *Tertiary basalt intruding Lower Parmeener Super-Group strata, Sorell.*

60-90	Jurassic dolerite
40-60	Triassic sandstone
0-40	Jurassic dolerite and Quaternary deposits

Similar layering occurs westwards towards Wykeholm Hill, and is evident in the Carlton River and near Kellevie. These dolerite sheets are thinner and less easily traced. Very thin layers of Triassic rocks are contained in the dolerite intrusions on Mt Forestier.

A most significant dolerite feeder for some of the dolerites of the Forestier Peninsula occurs at Deep Glen Bluff and The Sisters bay (Plate 10).

Here the dolerite rose as a transgressive body through the Devonian granite basement, into the Permian strata where it levelled off at a preferred horizon (Plate 11). Further penetration must have occurred as from near Cape Surville the dolerite overlies Triassic strata. Several faults with downthrow to the north have occurred since the Jurassic so the actual mode of intrusion of the dolerite above the basal Permian can only be surmised.

Later stages of intrusion are present at the north end of Roches Beach and the northern end of Dunalley Bay where coarse dolerite is apparently intruded by another fine-grained (chilled) body.

TERTIARY BASALT

Volcanic rocks of Tertiary age (Pliocene) are widely distributed as small and large flows and as dykes and plugs. The largest accumulations of basalt occur around Sorell and Bream Creek.

Volcanic centres

At the north-west tip of Tasman Peninsula, west of Lime Bay, volcanic rocks consisting of basalt and tephra occur - the tephra including volcanic bombs. This is obviously the site of a Tertiary volcano. Further east, forming Ironstone Point, are arcuate lenses of basalt with layers of tephra and scoria. This is considered to be the collapsed vent of a volcano (Brill and Hale, 1954). Mt Stewart may be a volcanic plug.

Near Murdunna [677426] another possible centre is represented by basalt and tephra with much scoriaceous material. The basalt is very rich in olivine and so is probably near a vent.

East of Connellys Marsh, in a cliff section, an extrusive vent is present with the basalt being chilled and possibly exhibiting flow-foot breccia [607503]. Tuff and tephra are present on the east side, Triassic sandstone on the west. There is a wave-cut platform of tachylitic material containing large blocks and boulders of dolerite and other older rocks (Plate 12).

At either side of the mouth of Gilling Brook further indications of vents are present and spring deposits occur on the north side of the mouth at Flinty Point. North of Gilling Brook farm a dyke of basalt may have been an extrusive centre. Basalt occurs at the Sorell quarry [504614] where it is seen as a boss intrusive into Permian strata (Plate 13). Dykes extend some distance from the boss into the Permian rocks and terminate as black manganiferous stains in the joints. A volcanic centre

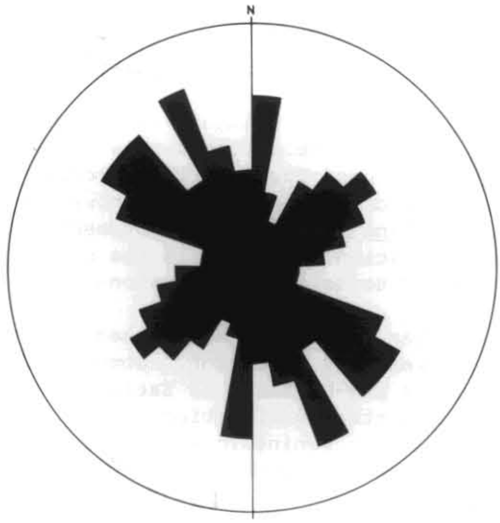

Figure 3. *Distribution of fault directions, Sorell Quadrangle.*

is postulated as occurring downhill from the intrusive site. Other volcanic centres in the Sorell area are indicated on the map.

A dyke of trachybasalt is exposed in a dolerite gravel quarry [671527] to the north-east of Dunalley. When first located it was seen to be about 0.6 m wide and could be traced for 40 m. Some thin dykes were also seen in East Bay about one kilometre south-east of Dunalley.

More than one stage of volcanism can be demonstrated at Sorell, where there are two or more distinct flows. Two separate flows, representing two periods of volcanism, occur at Bream Creek.

Petrology

Eighteen basalt samples were collected from the Sorell Quadrangle for petrological examination by J. Everard (Appendix A). The sixteen samples from around Copping and Dunalley are similar to the olivine-bearing but chemically silica saturated Cainozoic 'tholeiites' common in south-eastern Tasmania and the Midlands, and correspond to the 'Claremont Group' of Sutherland (1976). The other two samples from Wattle Hill area are titanaugite-bearing alkali-olivine basalts and may belong to Sutherland's Risdon Group. Everard also considers that textural differences, particularly those in the ground mass, are attributable to different rates of cooling.

GEOLOGICAL STRUCTURE

The structural events affecting the configuration of the rocks of the Sorell Quadrangle were the intrusion of Jurassic dolerite and post-Jurassic pre-Tertiary faulting.

As previously mentioned (p. 22), the mode of emplacement of dolerite caused some vast block movements. On the east coast of the

5 cm

Forestier Peninsula a dolerite feeder penetrated through granite basement up into Permian strata with contemporaneous faulting facilitating this movement. These faults are in a general north-easterly direction.

North of High Yellow Bluff the Triassic rocks are downfaulted between two NE-trending faults. The uplifted area north of the northernmost fault extends to the north of Tasman Hill where the dolerite is in contact with Upper Permian rocks. This contact shows considerable induration of the sediments and therefore the movement is of Jurassic age at this point. The concentration of faults in the north-easterly direction can in many cases be related to dolerite intrusions.

There are however other directions associated with dolerite intrusions particularly in the north-westerly direction. Some of these faults are contemporaneous and some are pre-Tertiary or Early Tertiary. One major contemporaneous fault in a northerly direction runs through Eaglehawk Neck at the southern end of Forestier Peninsula and, west of the highest point on the road, dolerite abuts Permian rocks in a 200-metre section.

Analysis of the fault directions (fig. 3) indicates a regional predominance of north-westerly trending fractures.

Tertiary sedimentary basins usually developed in depressions formed by pre-Tertiary block faulting, the sediments being deposited in grabens and valleys. The distribution of Tertiary rocks and faults indicate that some major faults are masked by Tertiary and younger sediments. The largest area of Tertiary sediments is in the Penna-Orielton area. These sediments were deposited in a wide graben which is a continuation of the Coal River Basin (Leaman, 1971). Tertiary rocks in the Clifton-Cremorne area lie in the same longitude and in these areas the faults are traceable in part. Seismic reflection data indicate 450 m of sediments at Clifton Beach (Leaman, 1980).

The distribution of the Tertiary sediments at Dunalley suggests a graben structure aligned in a NE-SW direction. All Early Tertiary faults are concealed by later deposits. The Tertiary deposits range from sea level to 20 m whereas at Bream Creek Tertiary sandstone crops out at 80 m. Although no faults are visible the structure formed by them in this locality appears to have been a lake, or post-Tertiary faulting may have occurred to uplift this area.

Where different rock types occur, *e.g.* Permian and Triassic, faults are easily detected and it was found that there was intense faulting around the Forcett area where such rocks occur. Faults in sea cliffs are also readily recognised as seen from Tasman Bay to Little Chinaman Bay where minor faults of 5 to 10 m displacement created zones of weakness and led to the development of several small bays.

The conclusion drawn from these examples is that within the sedimentary rocks faulting was widespread and this is probably also true for the dolerite areas.

The maximum measurable throw of faults in the area is approximately 200 m at Eaglehawk Neck, 100 m at Cape Surville and near Clifton Beach. A greater displacement occurs between Iron Creek and Mt Elizabeth where a difference of 235 m occurs between Triassic sandstone, at near sea level and the Ferntree Mudstone correlate on Mt Elizabeth. There is possibly 100 m of Ferntree missing from the section and the Triassic rocks in the area are low in the succession. This gives a displacement of 335 m plus the thickness of the Triassic succession.

ECONOMIC GEOLOGY

BRICK CLAY

Clay derived from Permian mudstone has been worked in a small quarry at Forcett for the production of cream-coloured bricks. The deposit lies between a highly indurated siliceous mudstone, in fault contact with it, and unconsolidated Tertiary sand.

BUILDING STONE

Triassic sandstone in the massive form has been used in the construction of many of the early buildings and has usually been quarried locally. No sandstone quarries are operating at present but several old sites are known.

COAL

In the early days of the colony coal was found in the Saltwater River area and was mined by the government using convict labour. This was poor grade material mined of necessity until coal of good quality could be brought from other States. Other thin seams were located near Dunalley, Copping and Kellevie but these are too low grade to be suitable for mining.

LIMESTONE

Lenses and thin beds of impure limestone occur in the Permian unit Ps and are indicated Psl on the map. Some of these have been used in the early days of development for agricultural purposes. A sample of the better class stone analysed as follows: acid insoluble - 25.2%; FeO + Al_2O_3 - 1.4%; CaO - 46.7%; MgO - 0.3%.

At several locations dolerite intrusions have metamorphosed the limestone and calc-silicate hornfels has formed from which the lime is not available as it is chemically bound with silica, *e.g.* Mays Point.

ROAD METAL AND GRAVEL

Tertiary basalt is quarried as road base material from near Marion Bay, off the old Bream Creek-Dunalley Road [685598]. Another quarry was operated on the Nugent Road near Sorell [485642].

Top dressing gravel is obtained from scattered quarries in weathered dolerite and granophyre. Operating quarries are near Connellys Marsh, Dunalley and on the Nugent Road at Wattle Hill [527649].

At Forcett [509587], next to the brick clay pit, road metal is crushed from the highly indurated siliceous Permian mudstone. There is a considerable reserve of this rock which owes its hardness to baking by the underlying dolerite and intrusive dolerite dykes.

A less baked area of Permian [504616] mudstone is quarried at the Sorell quarry at the base of Mt Elizabeth and a similar mudstone was quarried near the Clifton Beach turnoff from the South Arm Road [409431]. These two quarries supplied road base material.

SAND

Various sand deposits of Cainozoic age occur at Forcett, White Hills, Dodges Ferry, Carlton, Sandford and Penna.

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APPENDIX A

Petrography of Tertiary basalt, altered dolerite and tuff samples.

J.L. Everard

INTRODUCTION

Twenty-one thin sections were cut of igneous rock specimens (eighteen of basalt, two of altered dolerite, and a tuff) collected by A.B. Gulline during detailed regional geological mapping of the Sorell Quadrangle. The specimens are from the Bream Creek, Copping, Dunalley, Murdunna, Forcett and Wattle Hill areas, and Black Jack Point on Tasman Peninsula. The location of each sample is shown in Figure A1.

X-ray diffractograms of crushed and sieved (<50 µm) portions of the hand specimens were made for some of the rocks, particularly the finer-grained ones, to confirm some mineral identifications made optically.

Ten of the basalt specimens were selected for chemical analysis. In some cases it was necessary to collect further material from the same locality. One analysis (830815) is clearly comparable to some of the other basalts, although a thin section (C045) from nearby is a chilled dolerite. Comparison by X-ray diffraction of the sectioned hand specimen and the analysed crushed sample confirms that they are different rocks. It is likely that the basalt crops out on the south side of the small hill [647580] with dolerite to the north; on the map a small area of dolerite only is erroneously shown (A.B. Gulline, pers. comm.).

The basalts have been petrographically grouped according to the textural terminology of Edwards (1950), extended by McDougall (1959), for Tasmanian Cainozoic basalts. Although this classification is of limited and local application, particularly as there is a continuous gradation between many of the types, here it largely reflects the more fundamental petrological features discussed under Geochemistry.

PETROGRAPHY

COARSE OPHITIC 'MIDLANDS TYPE' THOLEIITIC BASALT : BREAM CREEK AREA

BC33[685583].* This is a relatively fresh, fairly coarse-grained to almost porphyritic, holocrystalline basalt with no flow lamination. The rock consists of phenocrysts of olivine in an ophitic to sub-ophitic groundmass of plagioclase, augite, and opaque minerals.

Phenocrysts of olivine, typically 1-2 mm diameter, are oblong, crudely polygonal, or shortly prismatic subhedra and anhedra. Some are rounded, suggesting resorption into the magma. Olivine is colourless, biaxial negative with a large $2V$ (so Fa >13) and has parallel extinction to (010) cleavage and faces where present. Alteration to dark red-brown iddingsite is confined to some margins and some of the larger irregular fractures.

Irregular, angular augite grains (500µm-2 mm) enclose or partly enclose many plagioclase laths. Individual grains are often clustered and twinned, and are best distinguished under crossed nicols. Augite is very pale yellow-green and non-pleochroic, biaxial positive with a moderate $2V$, and has a maximum extinction angle to the slow ray of about 48°.

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* Analysed specimens.

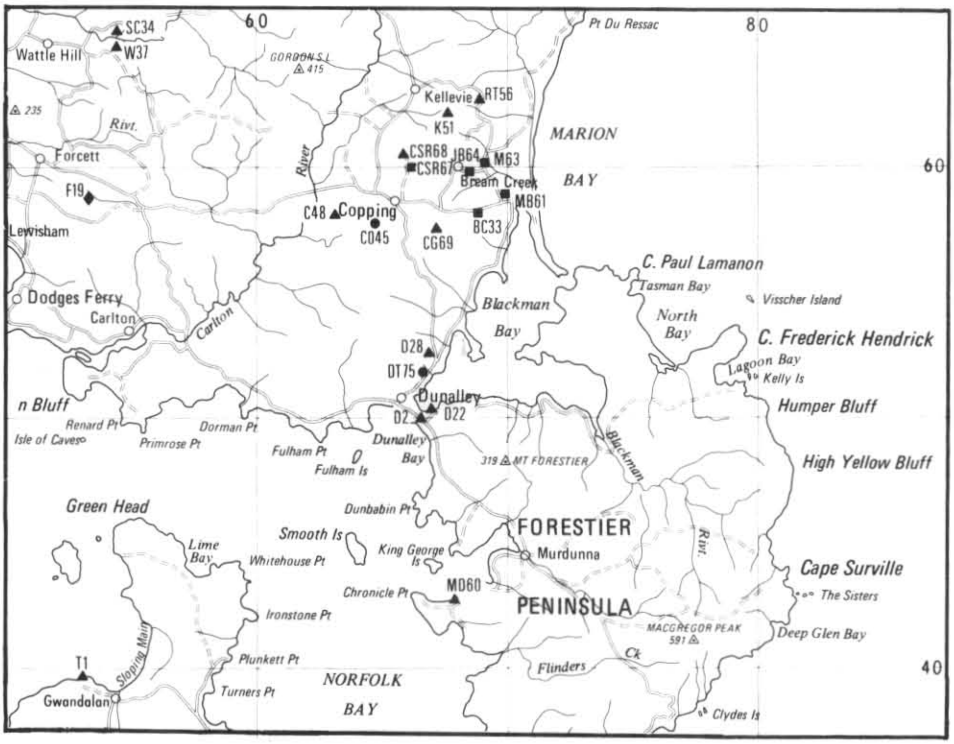

Figure A1. *Location of sample sites. Tholeiitic basalt (■); 'Midlands' type (ophitic texture); BC33, CSR67, JB64, M63, MB61. Alkali olivine basalt (▲) (intergranular texture) - 'Branxholm' and 'Hampshire' types; C48, CG69, CSR68, D2, D22, D28, K51, MD60, RT56, SC41, T1; - 'Burnie' type (finely ophitic texture); W37. Altered dolerite (●); CO45, DT75. Fine-grained crystal-vitric tuff (♦); F19. For sample listing see Table A1.*

5 cm

Table A1. INDEX TO BASALT AND OTHER ROCK SPECIMENS

Field no. (also refers to thin section)	Analysis no.	Plot no.	Location	AMG Reference (EN)
Tholeiitic basalt				
BC33	830814	14	Marion Bay Road	685583
M63	-	-	Bream Creek area	689603
MB61	-	-	Marion Bay Road	698588
JB64	-	-	Bream Creek area	682598
CSR67	830820	20	Tunbridges Hill (foot)	659600
Alkali olivine basalt and basanite				
CG69	830819	19	Allanbys Hill	671577
CSR68	830818	18	West flank of Tunbridges Hill	656604
C48	-	-	2 km west of Copping	634583
K51	830817	17	Benders Hill (top)	677626
RT56	830816	16	Benders Hill (foot)	688628
D2	-		Dunalley Beach (boulder)	663499
D22	830813	13	East Bay, Dunalley	668504
D28 (A & B)	-	-	Arthur Highway, Dunalley	670528
MD60	830821	21	Sommers Beach Road	677426
T1	-		Black Jack Point	531396
SC34	830822	22	2 km east of Wattle Hill	548654
W37			Wiggins Creek, Wattle Hill	547646
-	830815	15	hill, SW of Copping	647579
Altered dolerite				
DT75	-	-	Arthur Highway, Dunalley	665518
CO45	-	-	hill, SW of Copping	647580
Fine-grained crystal-vitric tuff				
F19	-	-	2 km SE of Forcett	536587

Plagioclase laths (150-400µm) are randomly oriented, both within augite grains and in plagioclase-rich parts of the groundmass. The mineral is labradorite (An_{60-65}) (maximum extinction angle of albite twins about 35°, optically positive).

Irregular, angular, equant opaque minerals (40-200µm diameter) are scattered sparingly throughout the section; they are probably ilmenite.

Iddingsitised rims of, and cracks within, olivine phenocrysts sometimes contain a shortly fibrous outward radiating, length-slow mineral of high birefringence, probably anthophyllite.

Plagioclase and augite are generally unaltered.

M63[689603]. This fairly coarse-grained holocrystalline basalt is almost identical to BC33, consisting of olivine phenocrysts in an ophitic groundmass of calcic plagioclase, augite, and minor opaque minerals, and lacking any flow lamination. It differs in having slightly less augite and a greater degree of alteration.

Olivine is extensively rimmed and veined by poorly crystalline, deep red-brown iddingsite (?anthophyllite and iron oxides) and less commonly dirty green bowlingite (?chlorite and iron oxides). Augite is extensively replaced by a similar orange-red alteration, and plagioclase is sometimes cloudy, suggesting incipient replacement by fine-grained epidote (saussuritisation).

MB61[698588]. This is a very similar basalt, differing from BC33 in having a slightly finer, subophitic matrix with somewhat less augite, and more extensive alteration, particularly iddingsitisation of olivine phenocrysts.

JB64[682598]. This rock is another somewhat altered, relatively coarse basalt, very similar to BC33, M63, and MB61. The rock consists of olivine phenocrysts in an ophitic to subophitic groundmass of labradorite, augite, and opaque minerals. Minor colourless, extremely birefringent carbonate, probably calcite, occurs as small irregular anhedral patches within the groundmass. Both plagioclase and augite are idiomorphic against carbonate, which appears to be a late stage igneous mineral rather than a diagenetic introduction.

CSR67[649600]*. This slightly altered, medium- to coarse-grained holocrystalline basalt lacks any flow lamination. It consists of red-brown, completely iddingsitised phenocrysts of olivine (typically one millimeter diameter, but ranging from 3 mm down to granules of a few tens of micrometres) in a subophitic groundmass of plagioclase, augite, former olivine granules, abundant to irregular opaque minerals, and opaline amygdales.

Augite occurs as angular to irregular crystals. Although ophitic inclusions of plagioclase are very abundant, individual grains can be recognised by crystallographic continuity over 1-2 mm in most cases. This augite is optically similar to other basaltic augite from this district (colourless to pale green-brown, non-pleochroic, biaxial positive with a moderate *2V*). It is extensively altered to a colourless, microcrystalline to cryptocrystalline aggregate (possibly serpentine or chlorite, and epidote).

Narrow laths of plagioclase, 150-400µm long, are ophitic against both augite and opal, and have a maximum extinction angle corresponding to labradorite (about An_{55}). Many show a partial to complete alteration to a finely microcrystalline to cryptocrystalline aggregate, possibly mainly fine epidote ('saussurite').

Opal occurs as a late-stage, amygdaloidal filling of irregular vugs and vesicles typically 300µm to 1.5 mm long. The mineral is colourless and poorly crystalline but sometimes nearly uniaxial and positive with low relief, very low light grey birefringence, and poorly developed cleavage. Simple twinning, rectangular zoning, and undulose to fanning extinction are common. A few opaline patches have kelphytic rims 20-50µm wide of a finely fibrous length-slow mineral, possibly natrolite.

The rock is similar to the other four ophitic 'Midlands' type basalts, except for the presence of amygdaloidal opal.

FINE-GRAINED INTERGRANULAR TO INTERSERTAL ALKALI OLIVINE BASALT ('BRANXHOLM' AND PORPHYRITIC 'HAMPSHIRE' TYPES)

Copping and Benders Hill areas

CG69[671577].* This almost unaltered black basalt consists of abundant phenocrysts, chiefly of olivine but also of augite, in a medium- to coarse-grained, intergranular to pilotaxitic groundmass of laths and microlites of plagioclase, between which are granules of augite, opaque minerals, and minor(?) devitrified glass. A flow lamination, defined by the alignment of plagioclase laths, is locally well developed, but on thin section scale there is only a vague overall flow direction.

Olivine phenocrysts, typically 200µm-1 mm diameter, are generally jagged to slightly rounded polygonal subhedra, or less commonly elongate length-slow laths. The mineral is biaxial negative with a large $2V$. Incipient iddingsitisation around rims and along fractures and partings is common, particularly near glassy patches of the groundmass.

The colourless, somewhat small polygonal augite phenocrysts are less abundant and are distinguished by their oblique extinction, smaller $2V$, and positive optic sign.

Plagioclase laths (50-500µm long and 5-20µm wide) are compositionally labradorite (about An_{60}). Opaque minerals occur as abundant angular to oblong blebs (typically 2-10µm).

Sporadic, irregular orange-yellow cryptocrystalline to minutely fibrous patches, often with kelphytic rims, within the groundmass are probably devitrified glass.

CSR68[656604].* This fine-grained black basalt consists of phenocrysts of olivine and an intersertal to intergranular groundmass of plagioclase, finer olivine, augite, and abundant opaque granules and some devitrified glass. The rock is similar to CG69, but lacks flow lamination, has fewer and smaller phenocrysts, a finer grained groundmass, and a greater degree of alteration.

Olivine phenocrysts (length slow, biaxial negative, large $2V$) are typically 200-700µm diameter and range in form from prismatic subhedral to equant, rounded to irregular subhedra, and anhedra. The smaller (50-200 µm) grains and the rims of the larger phenocrysts are altered to orange-brown iddingsite.

Augite (very pale green, non-pleochroic, biaxial positive, oblique extinction) is much less abundant than olivine, and occurs as mottled, incipiently to partially altered polygonal euhedra and subhedra 100-200µm in diameter.

Short (100-400µm) narrow plagioclase laths (about An_{70}) are set in a black aggregate consisting of densely disseminated, fine (20µm to <1µm) equant rounded opaque blebs; subordinate, very small (<10µm) granules and microlites of augite; and a very fine mesostasis. Although superficially a chaotic mixture of opaque dust and devitrified glass, when resolved under high power the mesostasis appears to consist of opaque dust and numerous very small but birefringent plagioclase microlites, with little isotropic glass.

C48[33634583]. This fine-grained, weathered basalt is also similar to CG69. It is slightly more porphyritic, with fewer, larger (250µm-1.5 mm), largely iddingsitised olivine phenocrysts in a medium to fine-grained groundmass. A well developed flow lamination, enveloping the phenocrysts, is defined by alighnment of small, narrow (20-200µm by 2-20µm) plagioclase laths. Under strong magnification, the groundmass is intergranular, with granules (typically 5-30µm) of augite and opaque minerals lying in the interstices between plagioclase laths. Little if any glass seems to be present, although it may be difficult to recognise because of the alteration and strong orange-red ferruginous staining of the groundmass.

An embayed, rounded xenocryst (1.5 mm x 0.5 mm) of quartz (low birefringence, uniaxial positive) is aligned with the flow lamination. It is surrounded by a reaction rim of ?augite, now largely altered to a poorly crystalline, fibrous orange-brown material (possibly 'iddingsite' or iron-rich chlorite).

K51[677626]*. This is another fine-grained basalt similar to those described above. A rather poorly developed flow lamination is present.

The rock consists of abundant, polygonal to rounded, subhedral phenocrysts of partially iddingsitised olivine (200µm-1 mm) and subordinate rectangular to polygonal, typically subhedral phenocrysts of augite (100µm-1 mm), in a fine-grained, intergranular groundmass of plagioclase laths (50-200µm) and microlites, augite granules (5-50µm), abundant opaque blebs (5-20µm), and minor devitrified glass.

The augite phenocrysts, some of which show partial alteration, are pale yellow-green to faintly purplish, weakly pleochroic and biaxial positive. They are probably more titaniferous than those of most other local basalts.

RT56[688628]*. This fine-grained basalt lacks any flow lamination and is the more altered equivalent of K51. Olivine phenocrysts and augite granules and phenocrysts are largely to completely altered to orange-red ('iddingsite') or greenish ('bowlingite'), finely crystalline aggregates. In the groundmass, plagioclase laths are largely saussuritised, and intergranular mafic granules and glass altered to greenish chloritic material.

Dunalley area

D2 (boulder) [663499]. This porphyritic, olivine-rich basalt lacks any flow lamination. It consists of phenocrysts of olivine set in a rather coarse, intergranular to subophitic groundmass of plagioclase laths, augite, olivine and opaque minerals.

Olivine phenocrysts (300μm-3 mm) are irregularly cracked, rounded to crudely polygonal equant subhedra and anhedra. The mineral is biaxial negative with a large 2*V*(so Fa >13). Red-brown to greenish alteration is common, especially around fractures, and a few phenocrysts are completely altered.

Plagioclase laths (150-350μm), the most abundant constituent of the groundmass, are labradorite (about An_{55}). Cloudy, incipiently altered grains of colourless to greenish-brown augite (50-200μm) are intergranular between, to subophitic against, plagioclase. They are distinguished by their cleavage and oblique extinction from olivine anhedra of similar size. Equant, angular opaque grains (3-15μm) are abundant.

D22[668504]*. This very fine-grained basalt is otherwise similar to other local basalts such as K51 and T1. A poorly developed flow lamination is defined by a vague alignment of plagioclase laths.

Fresh to incipiently altered labradorite laths (100-500μm by 20-100μm) and rounded, oblong to crudely polygonal phenocrysts of largely iddingsitised olivine (100-400μm) are set in an altered, dirty brown-green mesostasis. This consists of finer, often saussuritised plagioclase laths and microlites, small granules of (?)augite (5-20μm), and densely disseminated small angular equant opaque minerals (3-15μm), and grades in size down to microcrystalline and cryptocrystalline devitrified basaltic glass.

D28A (dyke) [670528]. This strongly altered medium- to fine-grained basalt has a good flow lamination.

Rounded to polygonal pseudomorphs after olivine (100-300μm) are now thoroughly altered to a yellow-orange to brown fuzzy cryptocrystalline aggregate, possibly consisting of iron oxides, carbonate, serpentine, and clay minerals. Finely fibrous, radiating ?anthophyllite (length-slow, straight extinction) is also present.

Narrow laths of plagioclase (100-600μm by 20-120μm) are abundant and show incipient saussuritisation. The maximum extinction angle (33°) and large, positive 2*V* suggest a composition of about An_{58} (labradorite).

The groundmass consists of disseminated, angular equant opaque minerals (3-30μm) and an altered, dirty green-grown microcrystalline to cryptocrystalline aggregate. This could have been derived from either an intergranular intergrowth of plagioclase and augite, as in other local basalts, or from the devitrification of basaltic glass.

D28B (dyke) [670528]. This strongly altered, fine-grained basalt differs from D28A, from the same outcrop, only in having somewhat smaller (50-200μm) iddingsitised pseudomorphs after olivine.

Traces of unaltered, colourless to pale violet clinopyroxene, with an extinction angle of about 40°, may be titaniferous augite.

An embayed, rounded xenocryst of plagioclase (1.5 mm by 0.9 mm) has very narrow (3-35μm) lamellar multiple twinning. The extinction angle is very low (6°), but in one crystal is of little diagnostic significance.

Murdunna area

MD60[677426]*. This coarsely porphyritic basalt consists of large phenocrysts (up to 5 mm) of olivine, and subordinate augite, set in a rather fine intergranular groundmass of plagioclase laths and microlites, augite and ?olivine granules, and densely disseminated opaque blebs. In places within the groundmass, very finely crystalline plagioclase aggregate may grade to devitrified glass. There is a poorly developed, variable flow lamination defined by local alignment of plagioclase laths.

Olivine phenocrysts range up to 5 mm and down to granules of a few hundred micrometres, but are typically 1-2 mm long. Most are polygonal to prismatic irregularly cracked euhedra and subhedra, and some show slight embayment by the groundmass, suggesting resorption. The mineral is colourless and biaxial with a 2*V* close to 90°, possibly just positive, suggesting a relatively magnesian composition (Fa <13). However some phenocrysts are zoned with a slightly higher birefringence and presumably more iron-rich composition around the rim. Incipient iddingsitisation or bowlingitisation, mainly around fractures, is common.

Augite phenocrysts, which are much less abundant than those of olivine, are smaller (500µm-1 mm), typically angular subhedra. Many are full of inclusions (*i.e.* poikilitic), especially of plagioclase, opaque minerals, and sometimes olivine. Augite has rewelded open fractures in olivine phenocrysts, and so is a relatively late-crystallised mineral. Augite is colourless to very pale green, non-pleochroic, and biaxial positive with a moderate 2*V*.

The intergranular groundmass consists of laths (40-200µm long) and acicular microlites of plagioclase (bytownite, about An_{75}), granules of augite and possible olivine (<3µm), ranging up to the phenocrysts), and densely disseminated equant opaque blebs.

The relatively magnesian olivine and calcic plagioclase suggest that this flow is derived from relatively undifferentiated magma. Before extrusion, a period of slow cooling would be required to allow for crystallisation of large olivine and augite phenocrysts.

Black Jack Point, Tasman Peninsula

T1[531396]. This rock is a very fine-grained black basalt with a well developed flow lamination defined by dark streaks richer in fine-grained opaque minerals and, to a lesser extent, by alignment of plagioclase laths. The rock consists of irregular to polygonal phenocrysts (typically 100-600µm long) of former olivine, most of which are now completely iddingsitised, in a very fine intergranular matrix of narrow laths and microlites of plagioclase (length typically 20-70µm), granules of colourless ?augite (3-15µm), densely disseminated fine opaque blebs (mostly 5-20µm), and minor glass.

The rock is similar to the intergranular basalt of the Copping district, but finer grained and presumably more rapidly chilled.

MEDIUM-GRAINED INTERGRANULAR TO OPHITIC ALKALI OLIVINE BASALT ('BRANXHOLM' AND 'BURNIE' TYPES)

Wattle Hill area

SC34[548654]*. This medium-grained basalt has a moderately well developed flow lamination defined by alignment of plagioclase laths. The rock consists of abundant olivine phenocrysts in a somewhat altered, coarsely pilotaxitic to felty intergranular groundmass of plagioclase laths, titanaugite grains, opaque minerals, and minor ?apatite and ?perthitic feldspar. X-ray diffraction suggests that minor nepheline is also present.

Olivine phenocrysts are equant, rounded to polygonal subhedra and anhedra 100μm-1 mm diameter. The mineral is colourless and biaxial negative with a large *2V*. Only incipient iddingsitisation is present.

The groundmass consists chiefly of crowded, intermatted to crudely aligned, narrow plagioclase laths and needles (50-100μm x 5-40μm). A cloudiness caused by incipient to partial saussuritisation largely masks the optical properties, but the plagioclase may be more sodic (possibly an andesine) than other basalts from the Sorell Quadrangle.

Titanaugite grains are small (50-250μm) irregular to oblong or lath-like subhedra. They display a weak to moderate pleochroism from pinkish-purple to pinkish-yellow, oblique extinction, and a biaxial figure with a moderate *2V* (about 40°-50°). Coarse (30-100μm) angular equant opaque minerals are abundant.

Within the groundmass are some irregular, late-formed patches, a few hundred micrometres across, of a poorly crystalline substance with low relief and birefringence, similar to plagioclase. Extinction is uneven and undulose. This is probably finely crystalline (few tens of micrometres) microperthite.

Rods and needles (30-150μm long) of colourless, high relief (?)apatite are prominent in these microperthitic patches. Thus it is probably a late-formed accessory mineral.

Texturally the basalt shows some similarities to the 'Branxholm type' basalt described by Edwards (1950) and common in northern Tasmania.

W37[547646]. This fine-grained titanaugite-bearing basalt is similar to SC34, but contains only a few phenocrysts. These include irregular, roughly equant anhedra up to one millimetre diameter of olivine (colourless, biaxial, large *2V*) and clustered anhedra and subhedra (also up to one millimetre) of colourless to pale yellow-green, sometimes zoned augite (biaxial positive, moderate *2V*). This phenocrystal augite appears to differ from groundmass titanaugite.

The great bulk of the rock is a pilotaxitic to finely ophitic groundmass of plagioclase, titanaugite, and opaque minerals.

Densely packed laths and less commonly irregular anhedra of plagioclase (100-300μm long) are crudely aligned to define a flow lamination. They are probably labradorite of about An_{60} and form a finely ophitic to subophitic intergrowth with angular, irregular subhedra and anhedra (50-200μm) of titanaugite (pinkish purple to greenish, weak pleochroism, biaxial positive, moderate *2V*). Equant angular opaque minerals (20-70μm) are also abundant in the matrix. Some fine-grained olivine and nepheline may be present.

The rock is somewhat altered, with patches showing saussuritisation of plagioclase, red-brown iddingsite-like alteration of titanaugite and possible olivine, and ferruginous staining of the groundmass.

The relative lack of phenocrysts, compared to SC34, may be caused by crystal settling before extrusion. The rock is also an alkali-olivine basalt, texturally similar to the ophitic 'Burnie type' described by Edwards (1950).

HYPERSTHENE DOLERITE, DUNALLEY

DT75[665518]. This rock is an altered, fine-grained dolerite with a strong orange-brown ferruginous staining largely obscuring the igneous texture. It consists of a subophitic to intergranular intergrowth of plagioclase, augite, hypersthene, and opaque minerals.

Both augite and hypersthene occur as irregular to oblong subhedra and anhedra, with extensive orange-brown alteration. Augite has extinction oblique to the cleavage and is biaxial positive with moderate *2V*, whilst hypersthene has parallel extinction and is biaxial negative with a rather low *2V* (suggesting an intermediate composition near $En_{50}Fs_{50}$).

Plagioclase (labradorite, about An_{60}) forms stubby laths 100-300µm long, and less commonly equant subhedra and anhedra. It is unaltered or shows incipient saussuritisation.

Opaque minerals, which are less abundant than in most of the local basalts, occur as large (40-200µm) irregular angular anhedra.

The rock is a fine-grained, rapidly cooled tholeiitic dolerite. The presence of hypersthene rather than pigeonite suggests that it is relatively undifferentiated, and as neither quartz nor olivine were observed, it is probably just saturated.

QUARTZ DOLERITE, COPPING

CO45[647580]. This is a strongly altered, fine-grained rock with no phenocrysts. It consists of an ophitic intergrowth of short, narrow laths (50-200µm by 10-40µm) of plagioclase (about An_{60}) with angular, subhedral to anhedral equant grains (100-200µm) of augite (biaxial positive, *2V* about 35°). Subordinate anhedral quartz is present often in quite large (100-500µm) grains. In contrast to the local basalt, very little primary opaque material is present. The groundmass is very fine and is probably mainly devitrified glass.

Augite shows varying degrees of alteration to a dark brown, almost cryptocrystalline opaque aggregate.

The rock is an altered, fine-grained, chilled, quartz dolerite. The slide is very similar to one from a chilled margin of a dolerite body at Spring Hill, in the Oatlands Quadrangle, (S.M. Forsyth, pers. comm.).

FINE-GRAINED CRYSTAL-VITRIC TUFF, FORCETT AREA

F19[536587]. This tuff consists of pseudomorphs of iddingiste after olivine, narrow laths of feldspar, and flattened bubbles, beads, and shards of devitrified glass in a groundmass of black volcanic dust. A crude layering is defined by variations in the darkness of the groundmass, alignment of plagioclase laths, and flattening of shards.

Deep red-brown, completely iddingsitised olivine crystals (40-200µm) are characteristically crudely polygonal to oblong.

Laths and microlites (up to 150µm x 30µm, but typically much smaller) of feldspar, predominantly plagioclase, are much smaller and less abundant than in local basalt. Generally their long axes are randomly oriented, but sometimes they are subparallel to the depositional layering.

The glassy structures include nearly round, to more commonly flattened elliptical bubbles, typically 50-150μm in diameter with a surface thickness of 10-30μm. Their interiors are usually filled with fine black volcanic dust, although many of the smaller ones are glassy throughout (*i.e.* bead-like). These bubbles and beads grade, with increasing flattening, into crescent-shape or irregularly curved shards, the direction of flattening defining a depositional layering. All glassy structures are composed of a pale off-yellow cryptocrystalline devitrified glass.

The black groundmass contains myriads of tiny (<1μm to 10μm) opaque blebs, granules of iddingsitised olivine and (?)augite, and much cryptocrystalline volcanic dust and (?)devitrified glass.

A few broken quartz anhedra are present. Most are a few hundred micrometres across, but one elongate, fractured grain is 2 mm long. These are probably reworked non-volcanogenic detrital grains from Triassic or Permian country rocks.

GEOCHEMISTRY

Major, minor and trace element analyses of ten of the above basalt samples are presented in Table A2, and CIPW and Rittmann norms in Table A3. Included in the calculation of the CIPW norms were Zr (as zircon), Cr (as chromite) and Ba (included with Ca).

The criteria of Manson (1967) was used in deciding which analyses are acceptable for further petrological consideration. Only one, 830820, falls outside Manson's "basalt screen", because of excess H_2O content; the relatively high Fe_2O_3/FeO suggests that it has also been appreciably oxidized. The thin section (CSR68) contains amygdales of opaline silica and completely iddingsitised olivine phenocrysts.

A triangular plot of F:P:A(:Q) ratios, based on the Rittmann norms, enables the classification of Streckeisen (1967, 1980) for volcanic rocks to be applied (fig. A2). Most of the analyses plot as basalts, except for the more undersaturated 830818 which is a basanite, and 830817 which lies just within the phonolitic basanite field.

Chemically the rocks fall into two distinct groups. The coarse ophitic basalts of the Marion Bay-Bream Creek area are tholeiites with high Hy in the CIPW norm, whilst the remainder, usually with appreciable normative Ne, are alkali olivine basalts. An alkali-silica plot (fig. A3), on which the line separating Hawaiian tholeiites and alkali olivine basalts (Macdonald and Katsura, 1964), confirms this classification. At a given SiO_2 content, the alkali olivine basalts are considerably richer in alkalis than are the tholeiites, which contain lower K_2O than most other published analyses of Tasmanian tholeiites.

Significant differences between the two groups occur also in minor and trace element content: the alkali olivine basalts are richer in TiO_2, P_2O_5, Sr, Ba, Rb, Zr and Nb than the tholeiites. The lower Ti/Zr and Y/Nb values of alkali olivine basalts have been used to distinguish them from tholeiites (*e.g.* Pearce and Cann, 1973), although the trace element characteristics of continental tholeiites in particular do not appear to be well known (*e.g.* Holm, 1982).

A plot of the analyses on an AFM diagram (fig. A5) shows considerable

Table A2. ANALYSES OF BASALTIC ROCKS

	Tholeiitic Basalts		Alkali Olivine Basalts & Basanites							
Field No.	BC33	CSR67	D22	-	RT56	K51	CSR68	CG69	MD60	SC34
Analysis No.	830814	830820	830813	830815	830816	830817	830818	830819	830821	830822
SiO_2	48.05	47.96	47.80	47.31	45.30	45.12	44.01	46.03	45.38	47.60
TiO_2	1.08	0.99	1.55	1.39	1.50	1.60	1.38	1.45	1.52	2.53
Al_2O_3	14.41	15.75	16.50	15.70	14.29	14.97	14.31	15.39	14.54	14.76
Fe_2O_3	2.81	5.63	4.26	2.44	3.35	2.91	2.99	3.12	3.16	4.59
FeO	8.63	5.23	6.02	6.97	7.50	7.89	7.05	6.69	6.94	8.34
MnO	0.16	0.11	0.15	0.14	0.15	0.15	0.14	0.13	0.14	0.15
MgO	9.49	7.21	6.61	9.12	9.95	10.14	10.12	9.57	11.10	5.92
CaO	9.16	7.90	7.47	8.81	10.79	9.59	11.67	10.17	9.91	7.35
Na_2O	2.67	2.16	4.48	4.02	2.78	3.43	3.73	2.53	2.76	4.24
K_2O	0.40	0.44	1.44	1.37	1.12	1.23	0.79	1.04	0.87	1.91
P_2O_5	0.32	0.27	0.82	0.94	1.10	1.03	1.25	0.76	0.76	0.95
H_2O^+	1.48	3.42	1.58	1.14	1.61	1.64	1.74	2.07	1.81	0.79
H_2O^-	0.66	2.87	0.23	0.10	0.27	0.28	0.20	0.51	0.21	0.33
CO_2	0.08	0.06	0.09	0.09	0.11	0.08	0.06	0.08	0.07	0.11
SO_3	0.07	0.05	0.07	0.06	<0.05	0.06	0.06	0.06	0.12	<0.05
Traces (as oxides)	0.22	0.18	0.30	0.37	0.35	0.35	0.39	0.33	0.34	0.31
Total	99.69	100.23	99.37	99.97	100.17	100.47	99.89	99.93	99.63	99.88
Trace Elements (ppm)										
Sc	23	21	17	22	26	22	24	22	23	22
V	165	145	130	170	185	175	180	170	175	170
Cr	390	290	125	300	330	300	290	290	350	300
Co	48	35	36	36	46	43	40	41	45	36
Ni	240	145	110	195	200	220	200	195	280	195
Cu	59	58	41	41	51	51	56	45	51	41
Zn	92	87	94	75	87	82	83	79	74	75
As	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Rb	16	14	31	39	28	31	16	30	27	39
Sr	300	320	960	1100	1000	990	1200	970	930	1100
Y	23	19	27	27	27	29	31	27	25	27
Zr	82	69	260	240	180	190	185	165	160	240
Nb	13	13	71	73	68	68	85	54	51	73
Ba	200	175	530	650	580	590	720	530	480	650
Pb	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
K/Rb	208	261	386	292	332	410	329	288	267	387
Ca/Sr	218	176	56	57	77	70	69	75	76	53
Ti/Zr	79.0	86.0	35.7	34.7	50.0	44.7	50.5	52.7	57.0	46.0
Y/Nb	1.77	1.46	0.38	0.37	0.40	0.36	0.43	0.50	0.49	0.42

Table A3. CIPW AND RITTMANN NORMS OF BASALTIC ROCKS

	Tholeiitic Basalts		Alkali Olivine Basalts & Basanites							
Field No.	BC33	CSR67	D22	-	RT56	K51	CSR68	CG69	MD60	SC34
Analysis No.	830814	830820*	830813	830815	830816	830817	830818	830819	830821	830822
CIPW Norms										
Q	-	6.37	-	-	-	-	-	-	-	-
Or	2.36	2.60	8.51	8.10	6.62	7.27	4.67	6.15	5.14	11.29
Ab	22.59	18.28	32.58	24.05	18.86	18.22	13.02	21.41	20.97	31.39
An	26.16	32.00	20.69	20.77	23.23	21.84	19.99	27.59	24.74	15.62
Ne	-	-	2.89	5.40	2.52	5.85	10.04	-	1.29	2.43
Di	13.96	4.35	8.93	13.64	18.67	15.42	23.99	14.44	15.64	11.96
Hy	15.62	19.39	-	-	-	-	-	2.58	-	-
Ol	9.59	-	12.51	17.93	17.69	19.84	15.92	15.70	20.08	12.01
Mt	4.07	8.16	6.18	3.54	4.86	4.22	4.33	4.52	4.58	6.65
Ilm	2.05	1.88	2.94	2.64	2.85	3.04	2.62	2.75	2.89	4.80
Ap (OH)	0.76	0.64	1.94	2.22	2.60	2.44	2.96	1.80	1.80	2.25
Cm (Fe)	0.09	0.06	0.03	0.06	0.07	0.06	0.06	0.06	0.07	0.01
Z	0.01	0.01	0.04	0.04	0.03	0.04	0.03	0.03	0.03	0.06
H_2O^+	1.47	3.41	1.55	1.10	1.56	1.60	1.69	2.04	1.78	0.75
H_2O^-	0.66	2.87	0.23	0.10	0.27	0.28	0.20	0.51	0.21	0.33
Other†	0.28	0.22	0.35	0.37	0.32	0.35	0.36	0.35	0.40	0.27
Total	99.67	100.24	99.37	99.96	100.15	100.47	99.88	99.93	99.62	99.82
(Fe/Fe+Mg)px,ol	0.28	0.13	0.19	0.23	0.21	0.23	0.20	0.19	0.18	0.28
Mol%An, plag.	52.2	62.3	37.4	44.9	53.7	53.0	59.1	54.8	52.6	31.9
Rittmann Norms										
Quartz	-	2.9	-	-	-	-	-	-	-	-
Sanidine	-	-	6.8	6.9	5.0	6.1	2.0	3.6	1.9	13.9
Plagioclase	57.3	61.9	60.5	51.9	48.7	46.6	39.2	57.8	54.6	50.2
Nepheline	-	-	4.4	5.6	2.7	6.2	10.5	-	1.4	3.6
Clinopyroxene‡	30.0	31.5	9.4	14.4	20.5	16.7	26.7	18.0	17.4	12.9
Olivine	9.0	-	13.5	16.0	17.4	18.5	15.8	15.9	19.9	12.4
Magnetite	1.6	1.7	1.8	1.6	1.6	1.7	1.6	1.3	1.4	2.2
Ilmenite	1.1	1.2	1.6	1.3	1.4	1.5	1.1	1.5	1.5	2.3
Apatite	0.7	0.6	1.8	2.0	2.5	2.3	2.8	1.7	1.7	2.1
Calcite	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.3
Total	99.9	100.0	100.0	99.9	100.1	99.8	99.9	100.0	100.0	99.9
Colour Index	41.7	34.4	26.3	33.3	40.8	38.5	45.3	36.7	40.2	30.0

* altered sample (see text)

† principally CO_2, SO_3 and SrO

‡ including diopside (830813, 830815, 830816, 830817, 830818, 830821), augite (830819), subcalcic augite (830814), titanaugite (830822), pigeonite (830820).

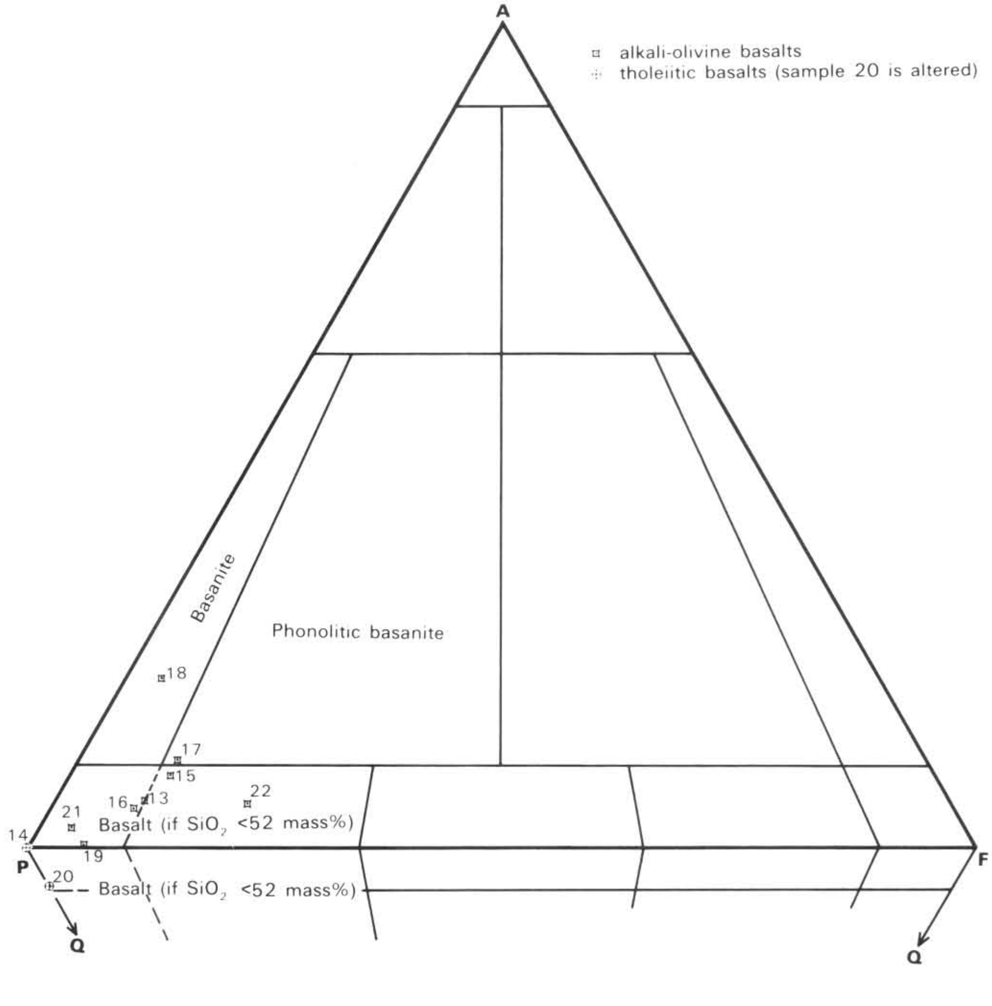

Figure A2. *Rittman normative minerals plotted on a PFA(Q) diagram, with classification of volcanic rocks proposed by Streckeisen (1967) shown in part. P = plagioclase; F = felspathoid (nepheline + Leucite + sodalite); A = alkali feldspar (sanidine + orthoclase + anorthoclase); Q = quartz; P + A + (F or Q) = 100. Sample 20 is altered, with opaline amygdales.*

5 cm

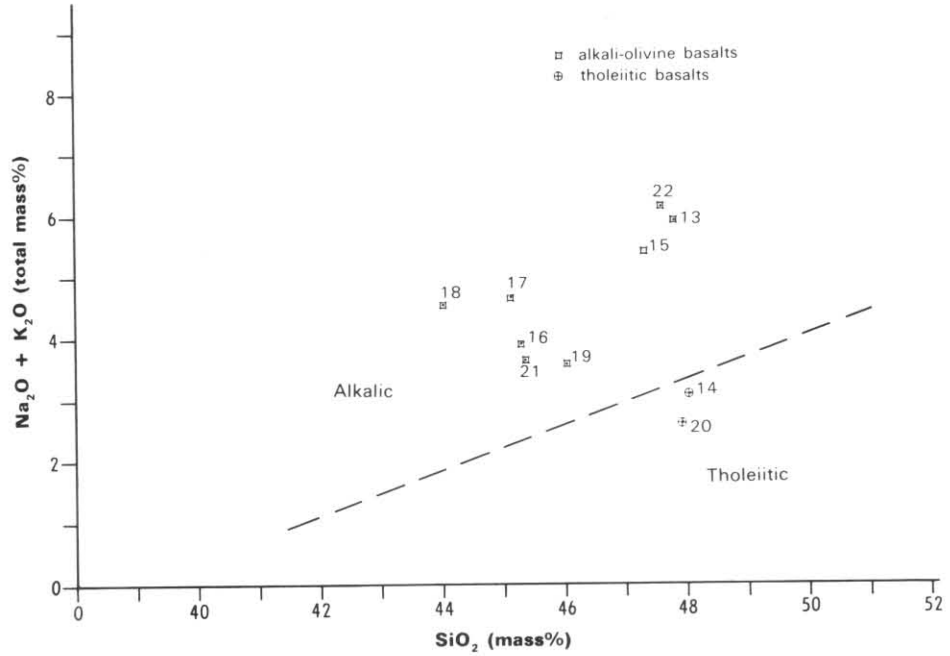

Figure A3. *Alkali-silica diagram of basaltic rocks. Alkali and tholeiitic fields from Hawaiian basalts, after Macdonald and Katsura (1964). Sample 20 is altered, with opaline amygdales.*

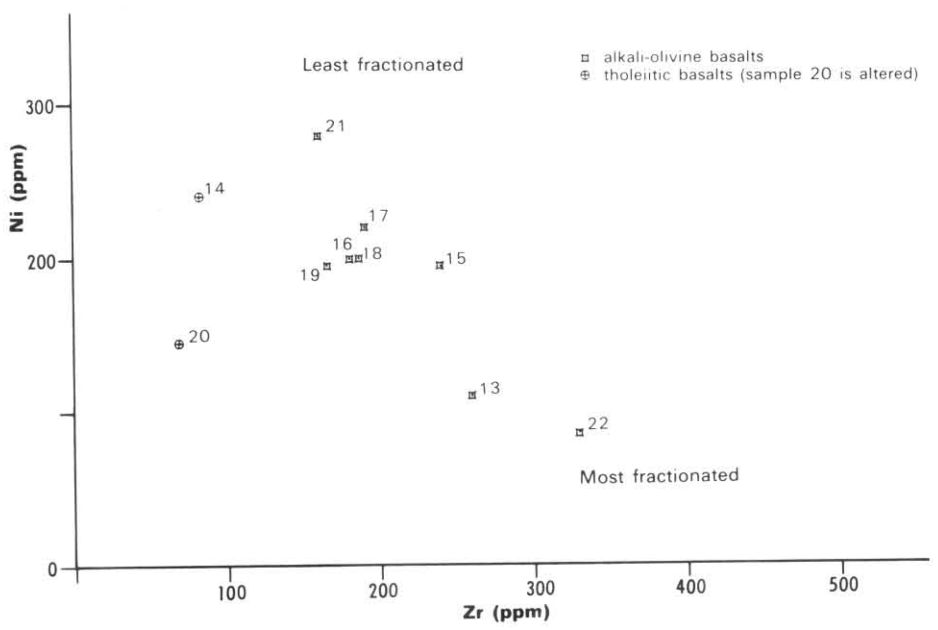

Figure A4. *Ni-Zr plot of basaltic rocks.*

5 cm

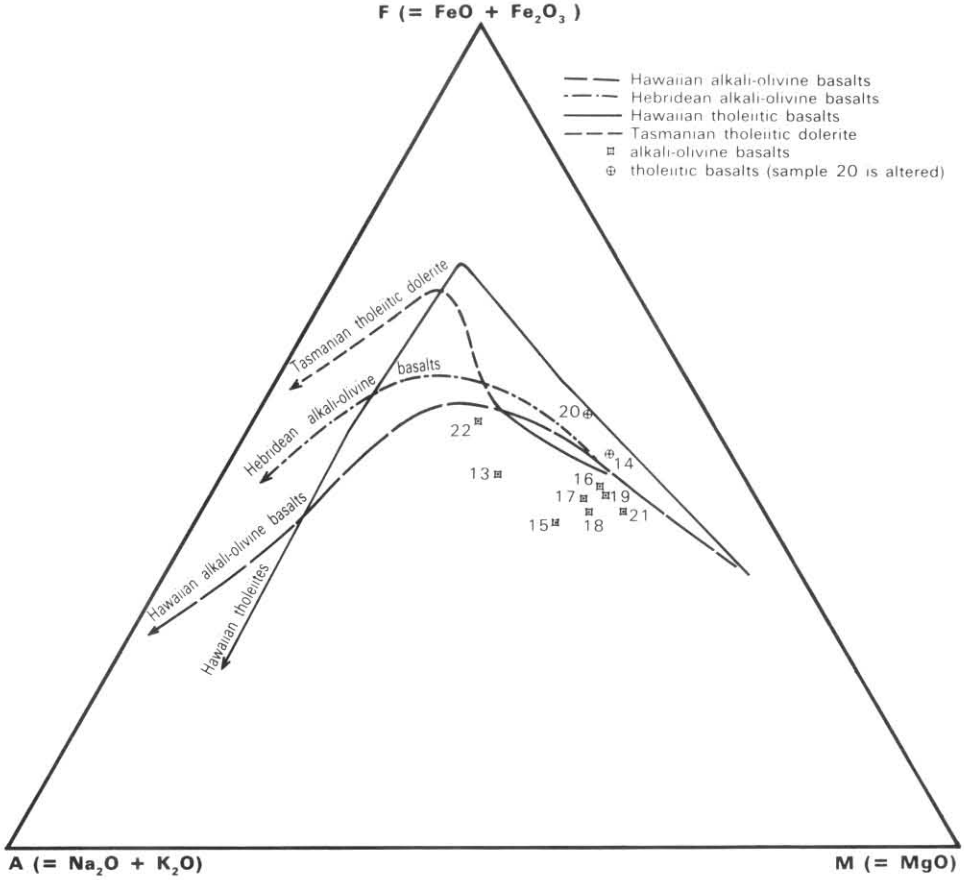

Figure A5. *AFM diagram, based on mass% of various oxides, recalculated to 100. Generalised differentiation trends shown for comparison. Hawaiian alkali olivine basalts after Macdonald and Katsura, 1964; Hebridean alkali olivine basalts after Thompson* et al., *1972; Hawaiian tholeiitic basalts after Macdonald and Katsura, 1964; Tasmanian tholeiitic dolerite after McDougall, 1964.*

5 cm

scatter, and no clear trend is defined. The alkali olivine basalts plot slightly below the classic alkali basalt trends of Hawaii (Macdonald and Katsura, 1964) and the Hebrides (*e.g.* Thompson *et al.*, 1972), whilst the tholeiites lie near the Hawaiian tholeiitic trend (*ibid*). The alkali olivine basalt analyses from Wattle Hill (830822) and Dunalley (830813) appear to be the most differentiated, and that from near Murdunna (830821) the least, of those samples analysed.

This is in accord with a plot of Ni against Zr (fig. A4). Nickel is readily incorporated in the olivine lattice and consequently removed from the melt during olivine crystallisation, whilst zirconium is an incompatible element and will accumulate in the melt. The broad trend of falling Ni with increasing Zr amongst the alkali olivine basalts suggests that olivine fractionation is the major cause of compositional variation. However, there is considerable scatter and other mechanisms such as fractionation of pyroxene or plagioclase and/or slightly differing source compositions are probably involved.

REGIONAL SIGNIFICANCE

The basaltic rocks from the Sorell Quadrangle are part of the Tasmanian Cainozoic Volcanic Province (*e.g.* Edwards, 1950; Spry, 1962; Sutherland, 1969) and in particular are in many respects an eastward continuation of the pattern of vulcanism in the Hobart (Sutherland, 1976) and Brighton (Sutherland, 1977) Quadrangles. In these areas both tholeiitic and alkali olivine basalts are also present. Sutherland noted that the tholeiitic basalts are confined to the Derwent and Richmond fault troughs, where they form large flows flooding old valleys that drained these troughs in the Claremont-Pontville and Richmond-Campania areas. He termed these basalts the Claremont Group. The alkali olivine basalts (Risdon Group) are more scattered and widespread, occurring in small plugs and flows around and between these structural lows. This type passes transitionally into the third, the more alkaline Southern Hobart Group.

The coarsely ophitic tholeiites of the Marion Bay-Bream Creek area appear to represent another eastern zone of Claremont Group basalt, although the structural environment is less clear than in the other two areas. The remainder of the samples represent generally smaller flows and plugs of alkali olivine basalt comparable to the Risdon Group. The Wattle Hill basalts, which appear to be part of a larger flow, are somewhat more alkaline and titaniferous, with more sodic plagioclase, than the other alkali olivine basalts. They are relatively differentiated and may be transitional to Southern Hobart Group type basalts.

The age relationship of the two types is unclear, although the presence of ophitic tholeiite (CSR67, 830820) at the base of Tunbridges Hill [659600] which is capped by alkali olivine basalt (CSR68, 830818) suggests that the tholeiitic type may, at least in part, be older.

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