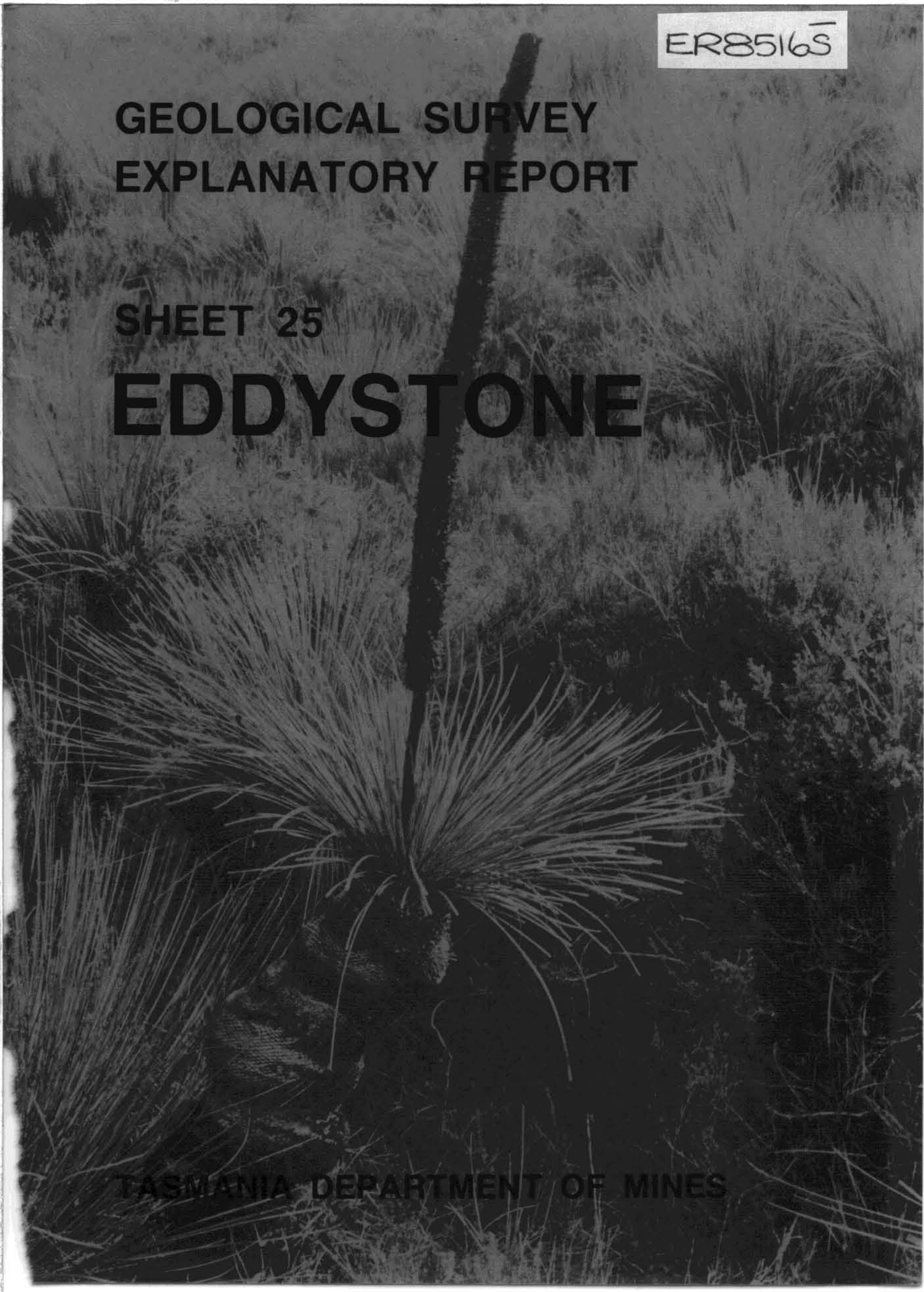
# GEOLOGICAL SURVEY EXPLANATORY REPORT

## SHEET 25

# EDDYSTONE



TASMANIA DEPARTMENT OF MINES

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# GEOLOGICAL SURVEY EXPLANATORY REPORT

GEOLOGICAL ATLAS 1:50 000 SERIES
SHEET 25(8516S)

# EDDYSTONE

*by P. W. Baillie, B.Sc.*

*with appendices by N. J. Turner, B.Sc.(Hons), P. W. Baillie, B.Sc. and M. P. McClenaghan, B.Sc.(Hons), Ph.D.*

*Economic geology by V. M. Threader, M.Sc., B.Sc.(Hons)*

DEPARTMENT OF MINES, G.P.O. BOX 56, ROSNY PARK, TASMANIA 7018 ISBN 0 7246 1939 9

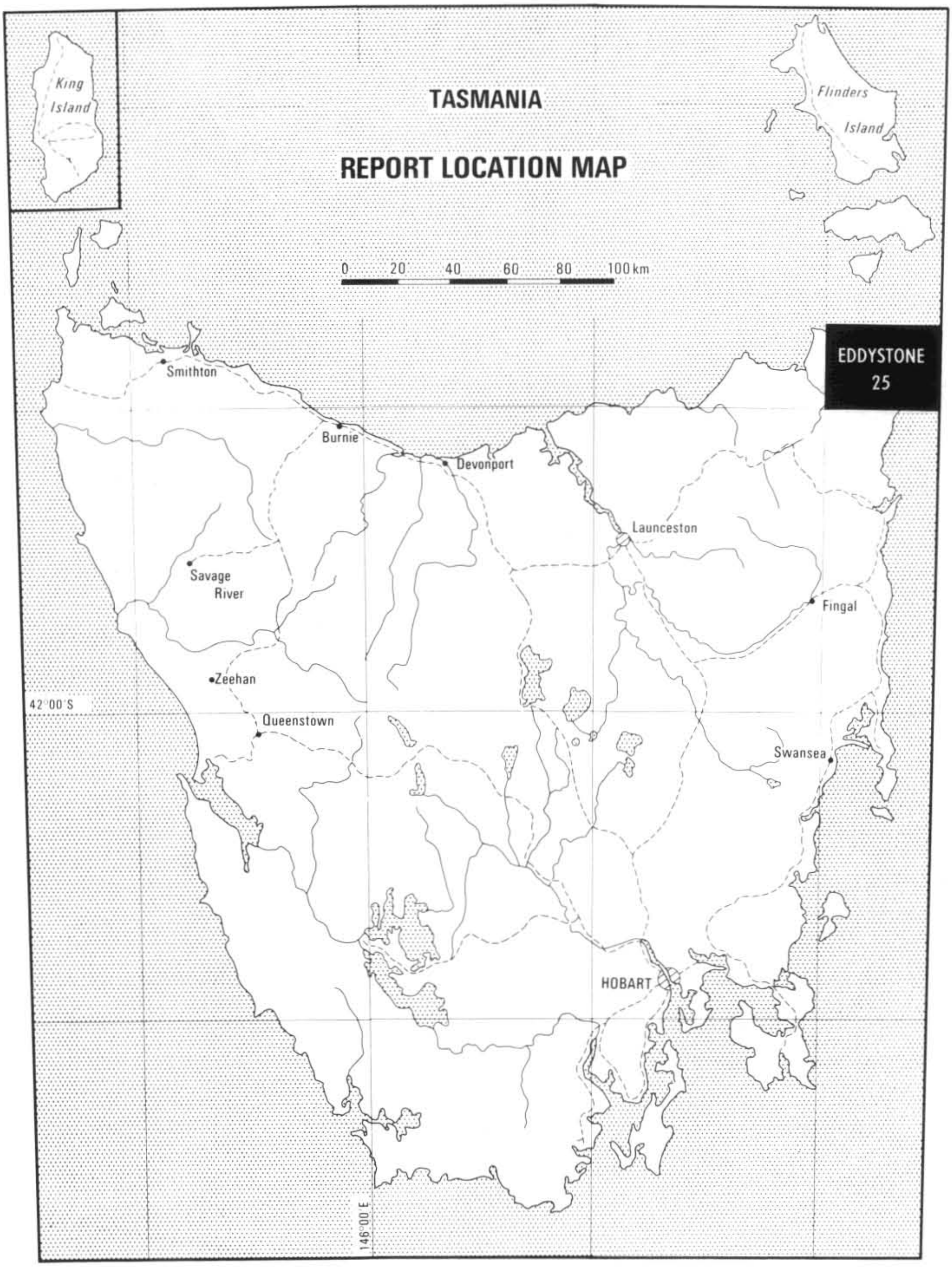


**Figure 1.** *Location of the Eddystone Quadrangle*

5 cm

BAILLIE, P. W. 1986. Geological atlas 1:50 000 series. Sheet 25(8516S). Eddystone. *Explan. Rep. geol. Surv. Tasm.*

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## INTRODUCTION

The Eddystone Quadrangle (fig. 1) is situated about 100 km north-east of Launceston in the far north-east of Tasmania. The only permanent settlements are the town of Gladstone [EQ848650] and the hamlet of Poole [EQ992785]. At the time of writing (June 1985) lighthouses at Swan Island [EQ949907] and Eddystone Point [EQ133610] were manned. A reasonable road network and easy coastal access enables all areas within the Quadrangle to be reached by driving and/or walking in less than half a day.

The Mt William National Park, which was gazetted in 1973, lies largely within the Quadrangle and was created to protect the Forester Kangaroo *(Macropus giganteus)* and its environment.

Much of the area has been cleared for pastoral use, in particular the Rushy Lagoon [EQ857761] and Icena [EQ927695] areas which were cleared when British Tobacco developed the area in the early 1970s.

The Gladstone area has long been associated with alluvial tin mining, and remains so to the present day. Small gold mines have also operated in the area.

Eastern portions of the area were mapped by D. J. Jennings and R. F. McShane as part of a regional study of the Blue Tier Batholith (Groves *et al.*, 1977). Information was collected in the field on air photographs at a scale of 1:31 680 and also on field maps at a scale of 1:15 840. The resulting detailed outcrop map was published as part of Bulletin 55 (The Blue Tier Batholith; Groves *et al.*, 1977).

The present study commenced in the winter of 1977 and the Eddystone 1:50000 map, which largely incorporates the earlier work of Jennings and McShane, was published in 1984 (Baillie, 1984*a*).


## ACKNOWLEDGEMENTS

The mapping was supervised by Dr E. Williams, whose enthusiasm and guidance led to many useful suggestions and improvements to field mapping. Dr Williams also critically read the manuscript. M. J. Clarke assisted with Lower Parmeener Group stratigraphy and also identified the Permian invertebrates. Dr P. R. Williams contributed to many useful discussions, in particular with respect to granite structure during mapping of the granitic rocks of the Gladstone area. He also shares responsibility for mapping George Rocks [EQ118687]. Dr J. W. Hudspeth assisted with the mapping of Swan Island.

The cooperation of landowners and their staff, of the various mine operators of the region, and of the National Parks and Wildlife Service is gratefully acknowledged. I would also like to acknowledge the help and hospitality provided by the lighthouse keepers of Swan Island.


## PREVIOUS WORK

Thureau (1881) provided the first geological observations of the area in which he noted the association of tin with the 'mica trap-rocks' (greisen) which he noted were found in the contact zone between granite and country rock in the Gladstone area. He also observed that Mt Cameron was formed of several varieties of granite. He further noted that the stanniferous 'gravels and washes' were deposited in a system of leads, a philosophy which is continued by tin miners and prospectors to the present day.

Montgomery (1891) observed the presence of Tertiary basalts in the area east of Gladstone and noted that tin ore was probably derived initially from granite bedrock. He described the greisen at the Fly-by-Night mine [EQ852641] and attributed its origin to contact alteration processes. After analysis of the alluvial deposits of the Gladstone district he concluded that some deposits were deposited by fluvial processes, but that others were marine.

Twelvetrees (1916) described the general geology of the south-west portion of the quadrangle and is the first to ascribe a Devonian age to the granites. He mentions the presence of 'diabase' (Jurassic dolerite) on Ringarooma Tier, on the adjoining Boobyalla Quadrangle, but the dolerite continues east on to Eddystone Quadrangle [EQ845780] and the Cape Portland coastal area [EQ848890].

Nye (1927) differentiated between the greisenised granite of the Fly-by-Night mine and later greisen veins. He noted that it was the veins which were particularly stanniferous, especially 'soft mica greisen'.

The granites of the quadrangle were described by Groves (*in* Groves *et al.*, 1977) and, as noted previously, the eastern portion of the map sheet was mapped by Jennings and McShane (Groves *et al.*, 1977). The granites of the Mt William area and the regional geology were described by Jennings (*in* Groves *et al.*, 1977). Petrological aspects of the granites were mentioned in Cocker (1982).

Parmeener Supergroup stratigraphy of the Mexican Hill area [EQ915805] was described by Baillie (1983).

Aspects of the Quaternary geology of the area are described by Bowden (1978, 1983) and Baillie *et al.* (1985).

## PHYSIOGRAPHY

Relief of the area is gentle, with elevation ranging from sea level to a little over 200m. Drainage of the area is by the Ringarooma, Little Musselroe and Great Musselroe Rivers, and by small east-flowing streams east of Mt William [EQ999706] and Bayleys Hill [EQ036628]. Because of low gradients, rivers and creeks generally drain areas of poor outcrop.

The major elevated areas within the quadrangle are the eastern flanks of Mt Cameron [EQ847625] and Second Sugarloaf [EQ865628] in the south-west corner of the area, the eastern slopes of Ringarooma Tier [EQ845780] on the western edge of the map sheet, and the Mt William–Bayleys Hill tract. In general the igneous rocks — granite and dolerite — form areas of positive relief whereas areas underlain by Palaeozoic sedimentary rocks (Mathinna Beds and Parmeener Super-Group) form areas of low relief. There are two important exceptions to this generalisation:

*(a)* where the Mathinna Beds have been affected by contact metamorphism small hills are formed;

*(b)* areas underlain by granodiorite south of Icena [EQ928699] are areas of low relief and are associated with significant Tertiary deposits.

Coastal areas are dominated by flat seaward-sloping plains which develop below a well-defined break of slope at about 30 m. These coastal plains are underlain by Quaternary sediments which have been deposited as a veneer on older rocks (Baillie *et al.*, 1985).

Longitudinal dunes and lunettes formed on the coastal plains during arid phases of the Pleistocene, probably during the later part of the last glacial stage. Lunettes are very well-developed on the coastal plain between Musselroe Bay [EQ950780] and Cape Naturaliste [EQ025706]. Over thirty lunettes are present in this area, with dune crests ranging in length from less than 100 m to over 600 m, and having heights ususally less than 3 m.

Coastal parabolic, or blowout, dunes are developed in several areas, whilst in other areas transverse dunes are associated with present beaches. The beaches occupy over 70% of the coast and their disposition is controlled by prevailing longshore drift conditions; the beach at Little Musselroe Bay [EQ890859] indicates dominant current from east to west whereas the beach at Great Musselroe Bay [EQ952802] indicates current from west to east.

## STRATIGRAPHY

### MATHINNA BEDS (SILURIAN?–DEVONIAN)

The pre-Parmeener Super-Group sedimentary rock sequences of north-east Tasmania are known as the Mathinna Beds and consist of conformable sequences of mudstone and turbidite-derived wackes (Williams, 1978).

In the Eddystone Quadrangle the Mathinna Beds occupy a broad arcuate belt, usually less than seven kilometres in width and extending from Gladstone [EQ618650] in a north-easterly direction to the Musselroe Bay area [EQ966765], and thence in a south-easterly direction to the area lying to the west of Bayleys Hill [EQ015607] on the southern edge of the map sheet. Outcrop throughout the belt is extremely poor; the only areas of relatively good outcrop are present in the Gladstone area. Areas of significant lithic wacke were differentiated during mapping, but their distribution is based entirely on float.

A major proportion of the Mathinna Beds sedimentary rocks has been thermally metamorphosed by granitic rocks of the Blue Tier and Eddystone Batholiths. Prior to granite emplacement the Mathinna Beds were folded and cleaved by associated low-grade dynamic metamorphism. Because of the very poor outcrop structural profiles were not obtained, hence no information is available about stratigraphic thickness in the region.

Individual turbidite beds range in thickness from a few centimetres to over one metre. Beds are commonly either less than 200 mm or greater than 800 mm in thickness. Mudstone intervals between tubidite beds range in thickness from very thin to over one metre, but usually no more than 200 mm. The mudstone interbeds are dark grey when fresh and generally featureless although occasionally laminations are present. They are composed of clay-grade pelitic material and probably represent deposition of mud from suspension (*e.g.* Williams, 1959).

Graded bedding is ubiquitous in sandstone beds. Angular mudstone clasts up to a few millimetres in length may be present near the base of massive beds. In the thicker beds Bouma A–E sequences were occasionally observed, while the thinner beds were commonly seen to consist of B–C or B–E Bouma intervals. A single example of overturned cross-bedding was noted from within a cross-laminated layer. In other cases cross-bedding is of the small-scale or 'festoon' type.

Flute casts are occasionally observed on the soles of sandstone beds.

In thin-section (*e.g.* 85–0251) the sandstones are very poorly sorted and have a maximum grain size of approximatley 0·4 mm. Clasts are angular to well-rounded and consist of predominantly of quartz (common, vein or polycrystalline) with detrital mica and rare feldspar.

As noted previously areas of significant lithicwacke have been differentiated on the map. When fresh, this rock is dark grey in colour and is a fine to very fine-grained sandstone which in thin section (85–0252) is very poorly sorted and contains clasts 0·05–1·0 mm in diameter (average 0·3 mm) supported by a matrix of clay-silt grade which occupies about 40% (visual estimate) of the rock. Quartz is the most common clast type (70% of clasts) and consists of common, vein and polycrystalline varieties; lithic fragments (15%) consist of shale, metaquartzite, chert, and fine-grained felsic volcanic rocks; feldspar (15%) consists of both plagioclase and K-feldspar. Feldspar compositions from this rock as determined by microprobe analysis are listed in Table 1. This rock has been analysed for major oxides and trace elements and the results are included as Table 3.

The age of the Mathinna Beds at Back Creek in Pipers River Quadrangle is Early Ordovician (Banks and Smith, 1968) and at Wrinklers Creek in St Helens Quadrangle it is Early Devonian (Rickards and Banks, 1979). Despite intensive searching at several localities in the Eddystone Quadrangle no fossils have yet been found. It is considered that the rocks of the Eddystone Quadrangle can be more confidently correlated with the St Helens sequences than with the predominantly lutite sequences of the Back Creek–Turquoise Hill area (Marshall, 1970; Banks and Smith, 1968).

*Table 1*

*MINERAL COMPOSITION AND STRUCTURAL FORMULAE OF FELDSPARS FROM SAMPLE 85-0252 AS DETERMINED BY ELECTRON MICROPROBE (Analyst A. V. Brown)*

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $SiO_2$ | 68·43 | 68·33 | 65·52 | 63·98 |
| $Al_2O_3$ | 19·39 | 19·73 | 21·57 | 22·47 |
| FeO | .... | .... | .... | 0·22 |
| CaO | 0·36 | 0·63 | 2·64 | 5·83 |
| $Na_2O$ | 9·59 | 11·31 | 10·27 | 7·50 |
| $K_2O$ | 2·24 | .... | .... | .... |
| Total | 100·01 | 100·00 | 100·00 | 100·00 |
| *Numbers of ions in formula* | | | | |
| Si | 3·0036 | 2·9840 | 2·8805 | 2·8216 |
| Al | 1·0034 | 1·0158 | 1·1180 | 1·1683 |
| Fe | .... | .... | .... | 0·0081 |
| Ca | 0·0169 | 0·0295 | 0·1244 | 0·2755 |
| Na | 0·8162 | 0·9577 | 0·8754 | 0·6413 |
| K | 0·1254 | .... | .... | .... |
| Total | 4·9655 | 4·9869 | 4·9983 | 4·9149 |
| Or | 13·1 | 0·0 | 0·0 | 0·0 |
| Ab | 85·1 | 97·0 | 87·6 | 70·0 |
| An | 1·8 | 3·0 | 12·4 | 30·0 |

## PARMEENER SUPER-GROUP

Rocks of the Parmeener Super-Group (Banks, 1973) crop out in western areas of the region, from north of Gladstone [EQ860704] to the Musselroe Bay area [EQ928807]. In the southern part of the region the rocks are faulted against the Mathinna Beds, whereas in the Musselroe Bay area Parmeener Super-Group rocks have been observed to unconformably overlie granitic rocks.

Although greatly attenuated, a complete sequence of the Lower Parmeener Super-Group of the region underlies paddocks east of The Quakers [EQ884810] and west of Great Musselroe Bay [EQ960820].

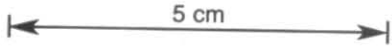
### *LOWER MARINE SEQUENCE* (Ps)

Rocks assigned to the Lower Marine Sequence are by far the most common of the Lower Parmeener Super-Group rocks of the region. They are the only Parmeener rocks known from the Cinderella Hill [EQ860709] and Rushy Lagoon [EQ860750] areas and in the vicinity of The Quakers [EQ880814].

The base of the sequence is exposed in the vicinity of Mexican Hill [EQ922797] where richy fossiliferous bryozoal siltstone and sandstone overlies Devonian adamellite. The siltstone is thinly bedded and contains abundant stenoporids and fenestellids, together with *Eurydesma cordatum* Morris, *Eurydesma hobartensis hobartensis* (Johnston), *Deltopecten illawarensis* (Morris), *Strebloteria* sp, *Stutchburia* sp. and *Trigonotreta stokesi* Koenig. The fauna indicates a Tamarian Zone 2 age (M. J. Clarke, pers. comm.).

The sandstone varies greatly in lithology from coarse pebbly quartz sandstone, well-sorted quartz sandstone, to occasional pebbly siltstone. The pebbles appear to be dropstones and are composed dominantly of quartz and quartzite, although schist, slate and granite also occur. In thin section (85–0285; plate 1) sandstone is seen to be a very poorly-sorted feldspathic lithic sandstone (terminology of Folk, 1968). Clasts are both clastic and biogenic; and range in grain size from 0·05 to 4·0 mm in diameter. The clastic grains are predominantly lithic: rock fragments include quartz-mica schist, phyllite, siltstone, metamorphosed and unmetamorphosed Mathinna Beds rock fragments; quartz consists of common, polycrystalline and vein quartz varieties; feldspar is present as large grains of K-feldspar or perthite. The presence of schist and foliated quartzite implies derivation from a westerly source.

Sandstones are the only Parmeener Super-Group lithologies known from the Cinderella Hill–Rushy Lagoon area (plate 2). Rocks in this area are sparsely fossiliferous but can confidently be assigned to the Lower Marine Sequence (M. J. Clarke, pers. comm.).



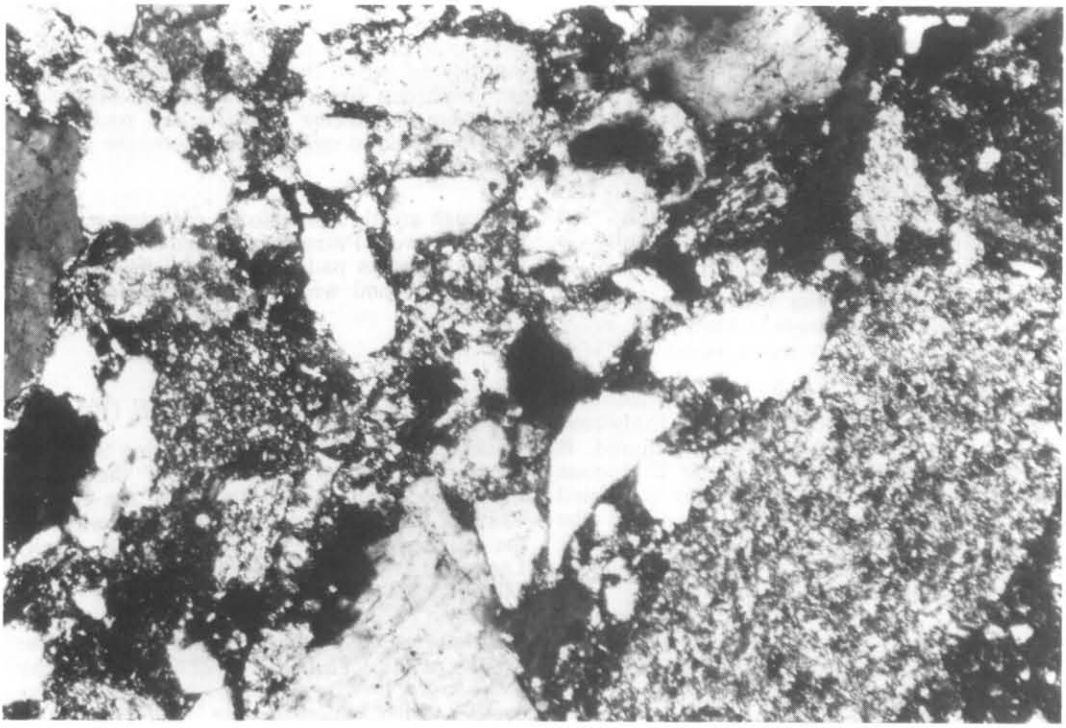



**Plate 1.** *Photomicrograph of Lower Parmeener Super-Group sandstone (85-0285, cross polars).*

**Plate 2.** *Lower Parmeener Super-Group massive-bedded pebbly sandstone, abandoned quarry at EQ860709.*

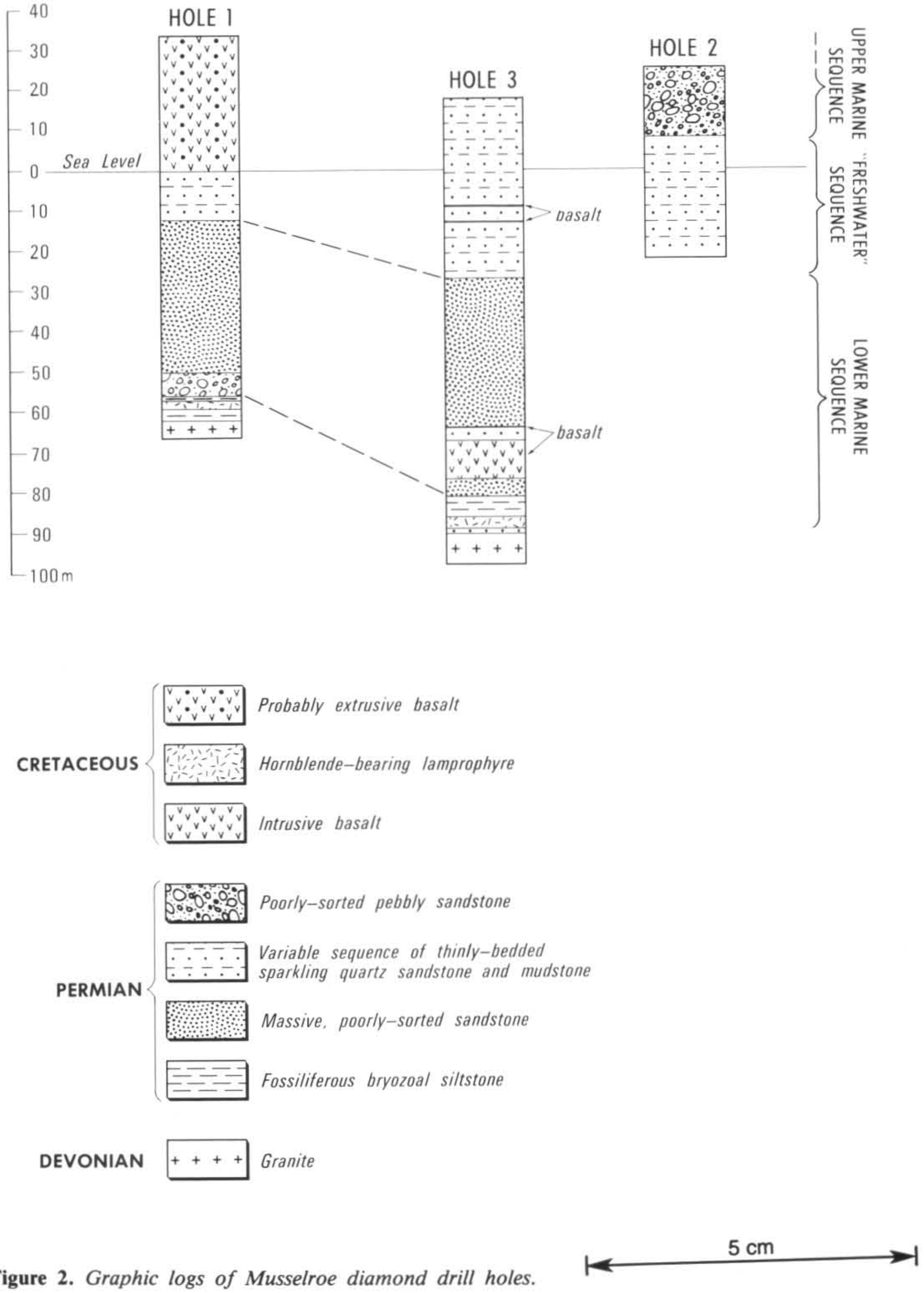



**Figure 2.** *Graphic logs of Musselroe diamond drill holes.*

## FRESHWATER SEQUENCE

Exposed in a dam near Cuckoo Creek [EQ912805] is a thin sequence of sandstone and shale, overlying the Lower Marine Sequence. Minor cross-bedded quartz sandstone, in beds usually less than 20 mm thick, is interbedded with more massive carbonaceous and micaceous sandstone and shale. The sequence is considered to be of freshwater origin and a lithological correlate of the Liffey Group of northern Tasmania.

## UPPER MARINE SEQUENCE

Rocks of the Upper Marine Sequence have only been recognised in a small area north of Cuckoo Creek [EQ913808] where there is abundant float of richy fossiliferous sandstone and siltstone and siltstone with minor pebbly sandstone. Faunal elements include the pelecypods *Deltopecten multicostatus* (Fletcher), *Atomodesma (Aphanaia)* sp., *Etheripecten* sp., the gastropod *Peruvispira* sp., and brachiopods *Trigonotreta wairakiensis* (Waterhouse), *Trigonotreta lethamensis* (Waterhouse), *Terrakea concava* Waterhouse, *Wyndhamia dalwoodensis* Booker, *Fletcherithyris parkesi* Campbell. The age is mid-Lymingtonian Zone 7–8, which suggests the presence of a hiatus between the Freshwater and Upper Marine Sequences (M. J. Clarke, pers. comm.), assuming that the Freshwater Sequence is a biostratigraphic correlate of the Liffey Group.

## STRATIGRAPHIC DRILLING

Because it was known that a complete, although attenuated, sequence of the Lower Parmeener Super-Group of the region was present in the Mexican Hill area and also because of the very poor outcrop (mapping was based almost entirely on rock fragments within the soil) a drilling programme was undertaken in 1982 to determine the stratigraphy. Three fully-cored diamond drill holes were drilled. Figure 2 is a graphic log of the lithologies encountered. Detailed logs of the holes are presented below.

### MUSSELROE No. 1

Altitude: 33·7 m — AMG co-ordinates: 591180mE 5480656mN

| *Depth (m)* | *Description* |
|---|---|
| 0·0–22·5 | Decomposed basalt. |
| 22·5–26·5 | Basalt with few vesicles. |
| 26·5–33·9 | Basalt, often with xenoliths of rounded granite boulders (with maximum diameter of 350 mm). |
| 33·9–46·0 | Grey to very dark grey sandstone, carbonaceous sandstone-siltstone; thin sandy laminae are often cross-bedded. |
| 46·0–84·0 | Grey, dominantly massive poorly-sorted sandstone with some pebbly layers and occasional spiriferid fragments. |
| 84·0–89·9 | Grey, poorly-sorted pebbly sandstone. |
| 89·9–91·0 | Richly fossiliferous bryozoal siltstone with *Deltopecten, Trigonotreta, Eurydesma, Etheripecten*. |
| 91·0–92·8 | Hornblende-rich lamprophyre. |
| 92·8–96·0 | Bryozoal siltstone; last 0.5 m becoming increasingly arkosic and less fossiliferous. |
| 96·0–100·0 | Granite. |

### MUSSELROE No. 2

Altitude: 25·7 m — AMG co-ordinates: 591212mE 5481204mN

| *Depth (m)* | *Description* |
|---|---|
| 0·0–6·0 | Fawn, weathered sandstone. |
| 6·0–14·5 | Grey, poorly-sorted, pebbly sandstone. Occasional Mathinna Beds dropstones less than 200 mm in diameter. |
| 14·5–17·0 | Grey sandy siltstone without erratics. |
| 17·0–38·5 | Coarse to very coarse, angular, sparkling quartzose grit; coarse micaceous quartz sandstone with minor, darker, sandy siltstone. |
| 38·5–47·3 | Dark grey, thinly-bedded, finely-laminated, sometimes bioturbated, often flaser-bedded siltstone-mudstone and sandstone. Sandy layers are less than 30 mm in thickness and may display incipient hydroplastic structures. Sand/shale ratio less than 1. |

### MUSSELROE No. 3

Altitude: 17·7 m — AMG co-ordinates: 591791mE 5481098mN

| *Depth (m)* | *Description* |
|---|---|
| 0·0–4·0 | Alluvium. |
| 4·0–15·0 | Dark grey siltstone with interbedded sparkling quartzose grit. |
| 15·0–21·5 | Dark grey, thinly-bedded, finely-laminated, flaser-bedded siltstone, mudstone and sandstone. |
| 21·5–26·7 | Dirty grey siltstone with interbedded thin, often cross-laminated sandy layers less than 35 mm in thickness. Occasional pebbles present. |
| 26·7–26·9 | Weathered basalt; contacts clearly intrusive. |
| 26·9–28·0 | Poorly-sorted carbonaceous sandstone. |
| 28·0–29·4 | Black carbonaceous mudstone. |
| 29·4–30·6 | Weathered basalt. |
| 30·6–38·0 | Light grey, fine-grained, well-sorted sandstone with occasional streaky muddy laminae. |

| | |
|---|---|
| 38·0–43·5 | Interbedded dirty carbonaceous sandstone, siltstone and occasional layers of grit. Sandstone often shows fine laminae. Bioturbation sometimes present. |
| 43·5–76·5 | Massive, grey, poorly-sorted, medium-grained pebbly sandstone with minor pods of pebbly granule conglomerate. Minor bioturbation present. |
| 76·5–81·6 | Hornfelsed sandstone as above. |
| 81·6–81·7 | Basalt. |
| 81·7–85·6 | Hornfelsed sandstone as above. |
| 85·6–94·5 | Basalt; 200 mm granite xenolith present at 94·2 m. |
| 94·5–97·9 | Poorly-sorted, erratic-rich sandstone with few shell fragments. |
| 97·9–104·0 | Richly-fossiliferous bryozoal siltstone. |
| 104·0–107·0 | Hornblende-rich lamprophyre. |
| 107·2–115·0 | Granite. |

The presence of flaser bedding and bioturbation in correlates of the Liffey Group indicates that conditions were at least partly tidal in the Musselroe area during this time interval.

The basaltic rocks encountered in Holes 1 and 3 have no surface expression and their presence was not anticipated prior to drilling. It was originally thought that they may be Permian in age (Baillie, 1983, 1984*b*) but a K/Ar radiometric age determination indicates that probable intrusive basalts have a mid-Cretaceous age (see Appendix B).

## TERTIARY

Sediments of Tertiary age crop out extensively in the region of the Ringarooma [EQ845675] and Great Musselroe [EQ905645] rivers and Icena Creek [EQ9661619]; drilling has shown the existence of Tertiary sediments in the Rushy Lagoon area [EQ863755]. In the Ringarooma and Great Musselroe areas the sediments have been mined as a source of cassiterite for over one hundred years (plate 3).

With the exception of areas where mining operations have created artificial exposure, the Tertiary sediments are difficult to map as exposure is often very poor. In such areas the existence of Tertiary deposits is recognised largely by the existence of rounded quartz gravel float.

A further indication is the presence of lag and outcrop (often large boulders) of silicified quartz sandstone. Silicified quartz sandstone is found in very close proximity to basalt about 2 km ENE of Cinderella Hill [EQ889719] and its formation at that locality may be associated with basalt extrusion, in which case the deposit may be termed 'greybilly' (Browne, 1972). However, similar deposits found west of the Great Musselroe River [EQ902625] are not at the present time closely associated with basalt and may owe their origin to processes not associated with basalt extrusion or weathering (for discussion see Taylor and Smith, 1975), in which case they may be termed 'silcrete' (Taylor, 1975). Areas where lag and outcrop of silicified quartz sandstone are present are differentiated on the Eddystone map (vertical line overprint).

Clasts present in the deposits reflect local derivation. Clast composition includes vein quartz, slate, quartzite and granite, with common or plutonic quartz becoming more common as grain size decreases. Of great economic importance is the presence of cassiterite, which occurs as grains ranging in size from very fine sand to granules and ranging in shape from sub-rounded (almost euhedral) crystals to well-rounded sand grains.

The Tertiary deposits are very variable in lithology, ranging from gravels composed of cobbles to thick beds of massive clay. Where observed, many of the beds are seen to be lensoid, as noted in the adjoining Ringarooma–Boobyalla region (Brown *in* McClenaghan *et al.*, 1982). Facies present (using the terminology of Miall, 1978) include: massive or crudely-bedded gravel, often imbricated (Facies *Gm)*; stratified gravel, with trough cross-beds (Facies *Gt)*; sand, medium to very coarse grade, may be pebbly, with solitary or grouped trough cross-beds (Facies *St*; plate 4); sand, fine to coarse grade, may have intraclasts and/or crude cross-bedding, broad shallow scours (Facies *Se* or *Ss)*; laminated or massive silt or mud (Facies *Fsc)*; carbonaceous mud (Facies *C)*. Interpretation of these facies (Miall, 1978) indicates that deposition took place on longitudinal bars or as minor channel fills *(Gm, Gt)*, as sand dunes under lower flow regime conditions *(St)*, and as swamp deposits *(Fsc, C)*. The overall deposition system was probably a gravelly sand-bed river. Assuming that maximum bed thickness approximates maximum water depth then the main channels would have been of the order of 2–3 m deep at times of higher flow *(Gm, Gt)*.

Coarser, bouldery deposits found closer to source areas such as Mt Cameron [EQ845626] may have been deposited on alluvial fans.

Figure 3 is an interpretive bedrock geology map on which has been included alluvial tin mines of the region (including those on the adjoining Boobyalla Quadrangle) and which also shows the postulated Tertiary lead system of the area (compiled from various sources).

Sediments from the region have yielded microfloras of mid-Tertiary age (Harris, 1968). Samples were obtained from the Star Hill, Lochaber and Edina mines on the Eddystone Quadrangle as well as the nearby Scotia mine on the Boobyalla Quadrangle (fig. 3) and the Amber Hill mine on the Blue Tier Quadrangle. The microfloral assemblages can be correlated with the Bass and Gippsland Basin sequences and indicate an age in the *Proteacidites tuberculatus* Zone of Stover and Partridge (1973)

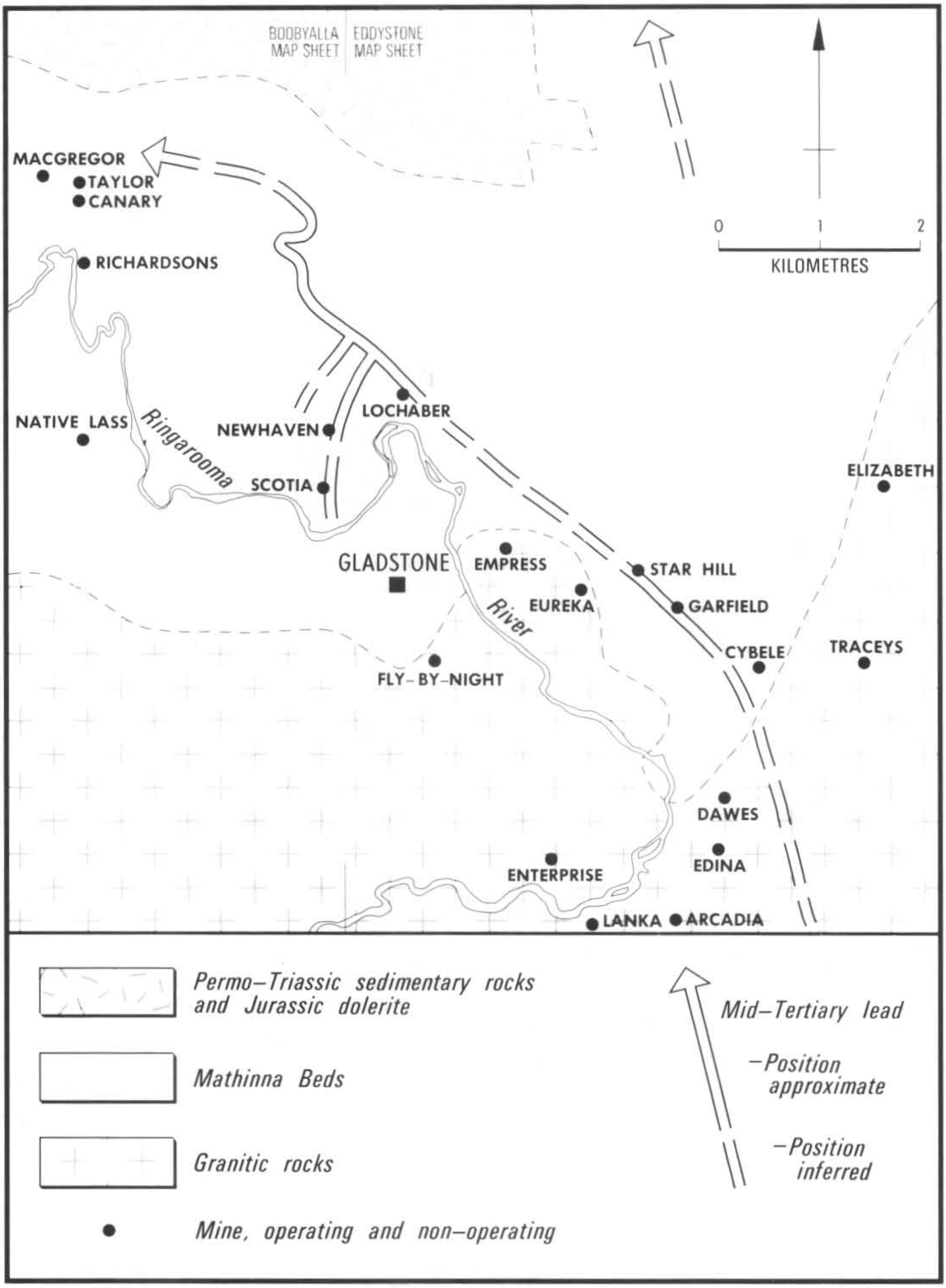



**Figure 3.** *Interpretive bedrock geological map, showing postulated Tertiary lead system.*

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**Plate 3.** *Large-scale cross-bedding in Tertiary sands, Cybele mine, Gladstone.*

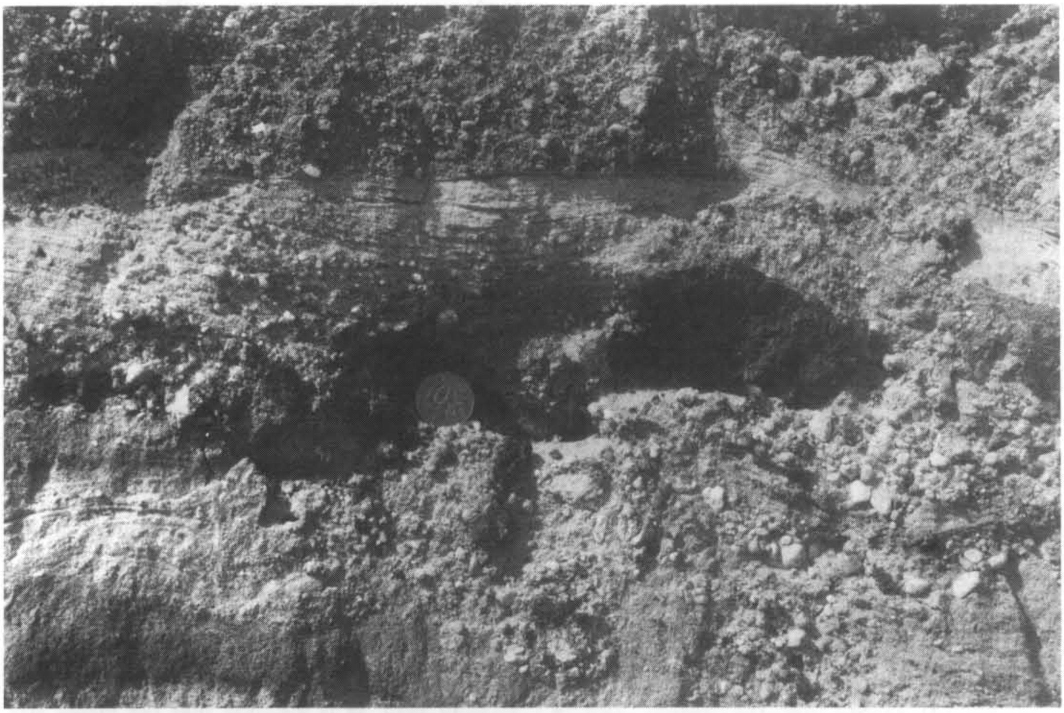

**Plate 4.** *Medium-scale cross-bedding in Tertiary pebbly sands, Cybele mine, Gladstone.*

(S. M. Forsyth, pers. comm.). Hill and Macphail (1983), in a reconstruction of sediments of the same age from the nearby Pioneer area, suggested that a complex multistoreyed *Nothofagus* temperate rainforest was present at the time of deposition of those sediments. The high degree of similarity between the Pioneer microflora to that recorded in the Gippsland Basin (Hill and Macphail, 1983) suggests little regional differentation, implying that conditions similar to those of the Pioneer area prevailed in the Eddystone region. Hill and Macphail further suggest that the rainfall at the time was of the order of 1200–1500 mm per annum, or almost double the present average. This is consistent with the palaeoenvironment suggested by study of the sedimentary sequences.

## QUATERNARY

The Quaternary deposits of the region are essentially the same as those described in the adjoining Boobyalla region (Baillie *in* McClenaghan *et al.*, 1982). Various aspects of the Quaternary geology of the Eddystone Quadrangle have been discussed by Bowden (1978, 1983) and Baillie *et al.* (1985). Table 2 is a stratigraphic framework of the Quaternary of the region.

### *CLAY, SAND, MINOR PEAT AND GRAVEL*

Quaternary sand bodies are found in coastal areas, in particular below a pronounced break of slope which occurs at approximately 30 m above present sea level. The lithology of these deposits ranges from well-sorted quartz sand (plate 5), through finer sand and poorly-sorted sandy clay to occasional beds of almost pure clay, similar to deposits in the adjoining Boobyalla region (Baillie *in* McClenaghan *et al.*, 1982). Foraminifera and mollusc-bearing estuarine sediments were encountered in one of a series of auger holes drilled south of Poole [EQ988777]. Baillie *et al.* (1985) proposed that the estuary formed behind a bay-mouth barrier similar to that at present occurring between Musselroe Bay and Great Musselroe Bay [EQ957795].

In the Stumpys Bay [FQ030733], Cod Bay [FQ065690], and Purdon Bay [FQ091650] areas well-preserved ridges occur. The ridges, which are composed of well-rounded coarse quartz sand are oriented sub-parallel to the contours of the coastal plain and the present shoreline, are interpreted as being former beach ridges (Bowden, 1978). Drilling by Bowden (1978) in the Stumpys Bay area indicates that the Quaternary sands have a maximum thickness of 8 m. Bowden also noted the presence of a podsol soil profile on the ridges and a groundwater podsol in the swales between ridge crests.

Baillie *et al.* (1985) discuss the age of the sediments of the Musselroe Bay and Stumpys Bay areas and conclude that deposition took place during the Last Interglacial, approximately 120 000 years B.P.

### *OLDER AEOLIAN DUNE SAND* (Qpo)

Fields of longitudinal dunes are extensively developed on older sand bodies in the Eddystone Quadrangle, and may extend up and over the flanks of confining hills. For example, the dune system which terminates immediately south of the settlement at Rushy Lagoon [EQ859757] originated on the western flanks of Ringarooma Tier [EQ805763] on the adjoining Boobyalla Quadrangle, and the sand was raised over one hundred metres above is source area. This particular simple dune system is over 6 km in length. The longitudinal dunes of north-eastern Tasmania have been described previously (Baillie *in* McClenaghan *et al.*, 1982; Bowden, 1983) and are considered to have formed during the Late Last Glacial Stage. Bowden (1983) has shown that the dunes have similar characterisitics to the Simpson Desert longitudinal dunes, and that conditions prevailing were colder and drier than the present, and that the westerly winds were stronger and from a slightly more northerly direction than the present dominant winds.

Lunettes are widespread in north-eastern Tasmania and reach their most spectacular development in the whole of Tasmania in the Eddystone Quadrangle. The best development of the lunettes is in the Rushy Lagoon [EQ870760] and Musselroe Bay [EQ968770] (plate 6) areas. Morphological relationships suggest that the lunettes are younger than the longitudinal dunes.

The largest lunettes occur at Rushy Lagoon where they attain heights of greater than 20 m above the old lake floor (plate 7). One lunette in this area is over 2 km in length. Bowden (1978) noted that some lunettes in this area are composed of interbedded sand and clay and concluded that the lakes were subject to dry periods when clay aggregates and sandy clay were blown from the dry lake floor to the leeward shore on the lake. Bowler (1973) suggests that sand/clay alternations in lunettes reflect important changes in the hydrologic and sedimentary regime of the adjacent water body and that quartz sand represents high lake levels while the clays were deposited during saline, low-water regimes.

During the mapping of the Eddystone Quadrangle limited hand-augering was done on the lunettes in the Musselroe Bay area. No clay was detected in these lunettes, which are significantly smaller than those of the Rushy Lagoon area. It is possible that the larger size of the lunettes in the Rushy Lagoon area is related to the presence of clay, as suggested by

5 cm

**Plate 5.** *Large-scale cross-bedding developed in very coarse-grained sands of Late Pleistocene age which probably originated as beach deposits.*

Bowden (1978) who postulated that the presence of clay would restrict downward percolation of surface water, thus favouring lake formation. A possible source of the clay is the abundant dolerite of the area, which weathers to clay.

Because both dune sand (Qpo) and the older sandy deposits (Qpc) are usually seen on the ground as grey clayey sand, in areas where the two sediment types occur together, they have not been differentiated on the Eddystone Map (Baillie, 1984) and are shown as undifferentiated Qpu.

## *YOUNGER AEOLIAN DUNE SAND, BEACH SAND AND GRAVEL* (Qhy)

These deposits, which include those currently being formed, are found in narrow zones in close proximity to the present coast. In the majority of coastal areas the deposits consist of the present beach and a single foredune (*e.g.* Stumpys Bay [EQ030744], Cod Bay [FQ072690].

Larger fields of parabolic blowout dunes are present on Swan Island [EQ935895] and Musselroe Point [EQ993795]. The dunes show little soil development with minor leaching of the upper 300 mm being the maximum development observed.

A feature of the modern beach sands is the large grain size of individual quartz grains. Very coarse-grained sand up to 4 mm indiameter is commonly present. This presumably reflects the fact that granite is a major, proximal, sediment source. Granites of the area range from medium-grained (quartz *c.* 2 mm in diameter) to very coarse-grained (quartz >4 mm in diameter).

A series of ridges which are perpendicular to the coast are present at Little Musselroe Bay [EQ890855]. The ridges are composed of coarse to very coarse quartz sand and although some leaching of the upper 300 mm may be present no significant soil development has taken place. The ridges are clearly associated with the Little Musselroe River which enters the sea in the area. The sand body has been deflected to the west by longshore drift, which is from east to west in this area. Elsewhere in the region longshore drift is west to east (Baillie *in* McClenaghan *et al.*, 1982; herein). The east–west direction of the Little Musselroe Bay area could be a local feature perhaps related to tidal activity. The lack of soil development indicates that the ridges are Holocene in age, a conclusion supported by the finding of several aboriginal artefacts in the area, although it could not be conclusively proved that they were in, and not on, the sand deposits.

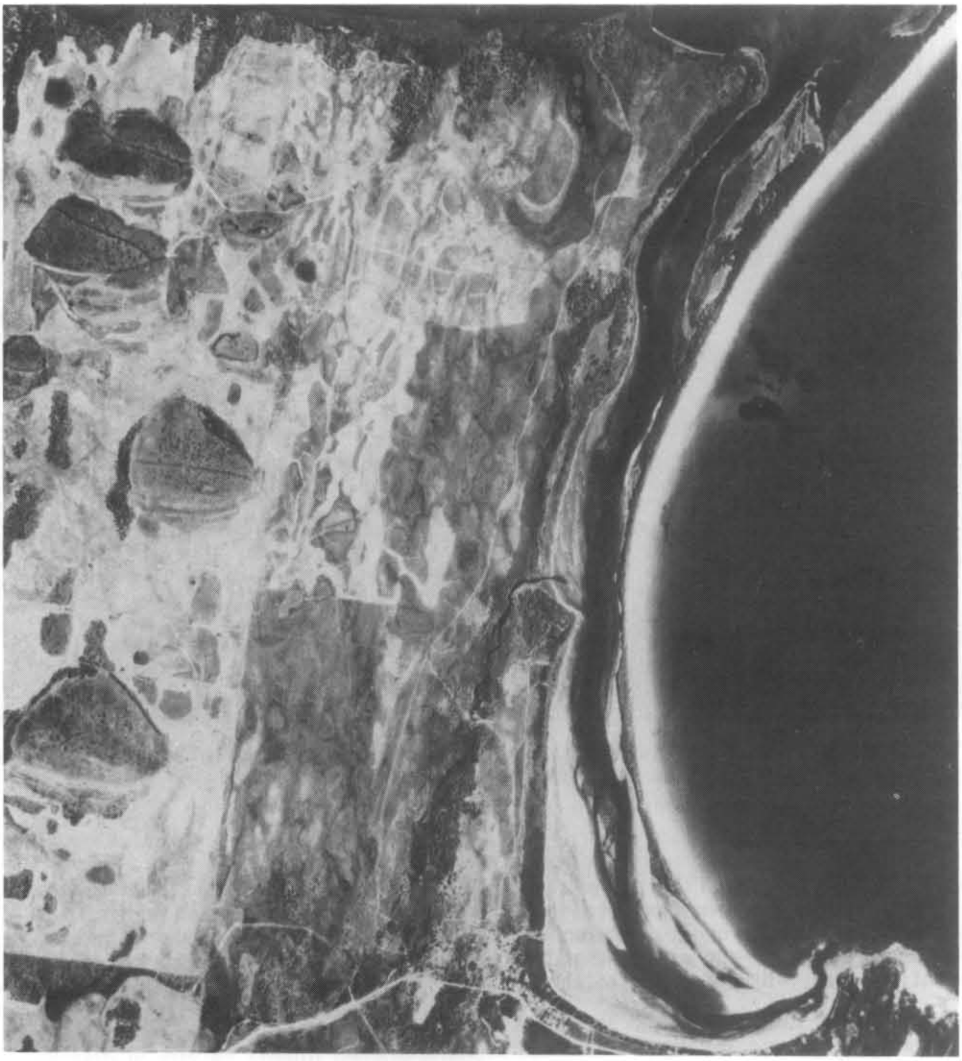

**Plate 6.** *Aerial photograph of lunettes and longitudinal dunes developed south of Musselroe Bay.*

*Table 2*
*QUATERNARY DEPOSITS OF THE EDDYSTONE QUADRANGLE*

| | | Pleistocene | |
|---|---|---|---|
| Series | Holocene | Last Glacial | Last Interglacial |
| Soils | Minor leaching, peat formation | Strong podsdol, groundwater podsol development | |
| Marine and related deposits | Beach sands, gravels | | Marine and estuarine deposits; beach ridges at Stumpys Bay |
| Aeolian | Dune sand | Lunette formation dune sand: sheets and longitudinal dunes | |
| Talus and slope deposits | | Talus, slope deposits | |
| Fluviatile/alluvial | | Alluvial and related deposits | |

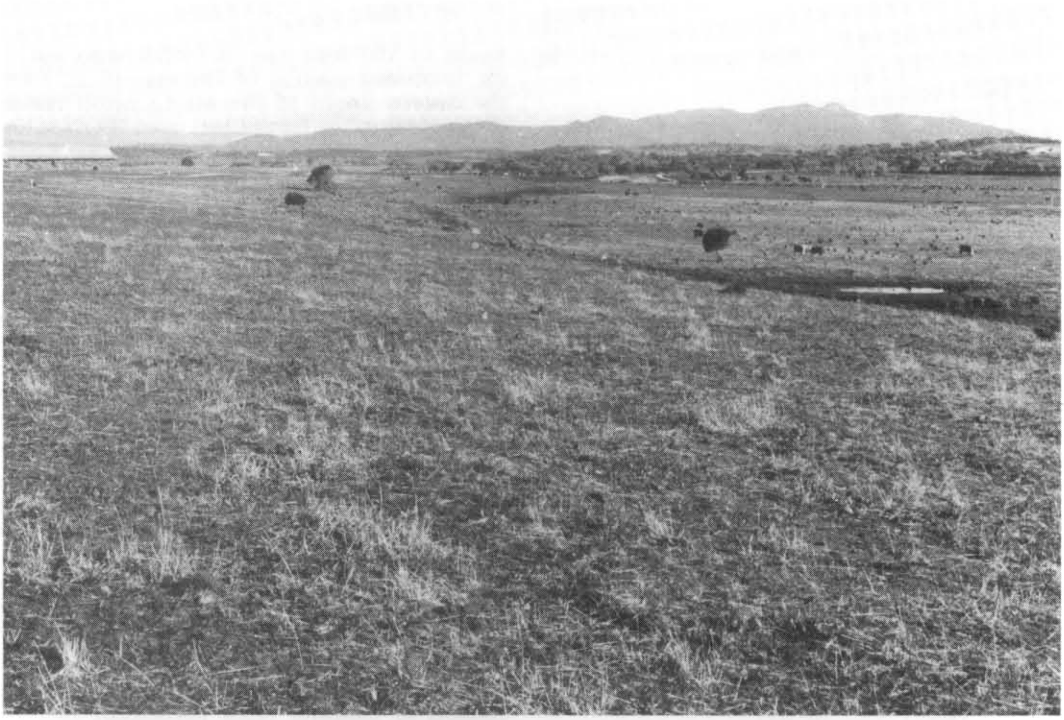

**Plate 7.** *Lunette at Rushy Lagoon viewed towards Mt Cameron. Photograph is taken near dune crest with the margin of the old lake floor clearly visible at right.*

**Plate 8.** *Stratified aboriginal middens formed within Holocene sand dunes, Musselroe Bay.*

Aboriginal middens are extensively developed in the Holocene dunes, usually in sheltered locations, and may reach several meteres in thickness (plate 8).

## *SLOPE DEPOSITS*

Slope deposits, probably gelifluctates of Late Pleistocene age, and similar to mapped deposits occurring in the adjoining Boobyalla region (Baillie *in* McClenagahan *et al.*, 1982), are present in the Eddystone region within areas underlain by Jurassic dolerite, but were not specifically differentiated during mapping.

## *FLUVIAL DEPOSITS* (Qha)

Areas of river alluvium, swamp and marsh deposits have been mapped mainly on the basis of morphology. They are relatively level areas generally either adjacent to watercourses or the site of former lakes. Boundaries shown on the map usually correspond with breaks of slope on the edge of such areas.

Two main types of deposit are present on the Eddystone Quadrangle:

(1) alluvium associated with the Ringarooma [EQ882618] and Great Musselroe [EQ910640] Rivers;

(2) swamp deposits related to infilling of lakes, formerly associated with Late Pleistocene lunettes, *e.g.* Rushy Lagoon area [EQ870750].

# IGNEOUS ROCKS

## DEVONIAN GRANITIC ROCKS

The granitic rocks of the Eddystone Quadrangle belong to the Blue Tier and Eddystone Batholiths. Detailed geochemical studies have not been undertaken, but representative analyses of major oxides and trace elements were carried out on most of the mapped granite types. The analyses and calculated CIPW Norms are shown as Table 3.

Gee and Groves (1971) and Groves (1977) subdivided the rocks of the Blue Tier Batholith into a number of petrological types which formed major bodies, considered to be discrete structural entities (*e.g.* Poimena Pluton, Gardens Pluton) that were each emplaced as a single mass. The practice used in the Eddystone Quadrangle is the same as that used in the adjoining Ringarooma–Boobyalla region (McClenaghan *in* McClenaghan *et al.*, 1982) namely, that the divisions used in this report are without genetic implication and based only on petrological and geochemical character of the granites. Table 4 lists the major bodies in the Eddystone Quadrangle named by Gee and Groves (1971) and Groves (1977) together with the granite-type symbols used in this report falling within the body.

## *BLUE TIER BATHOLITH*

Rocks of the Blue Tier Batholith crop out in the south-east portion of the map sheet, from the eastern slopes of the Mt Cameron massif [EQ845635] to the Icena Creek area [EQ985630], immediately to the east of the Eddystone Road.

### *Biotite-hornblende granodiorite* (Dbg)

This rock-type occupies low-lying country in the vicinity of the Great Musselroe River [EQ910607–EQ916686] and Icena Creek [EQ942684–EQ989626]. In the central part of the area the granodiorite has apparently been intruded by porphyritic, coarse-grained biotite adamellite (Dbapc) [EQ606940–EQ930647], a continuation of a body mapped on the adjoining Blue Tier Quadrangle (McClenaghan and Williams, 1983).

The granodiorite occupies low areas and outcrop is poor, although when it does crop out the rock is usually quite fresh. The rock is uniform in character where observed and is a grey, medium-grained equigranular rock with quartz, plagioclase, K-feldspar, biotite and hornblende. Table 3 includes a representative analysis (802650).

In thin section (85–0257, 85–0263) the rock consists of euhedral green hornblende (0·5–3·0 mm), zoned (< 3·5 mm) subhedral plagioclase which is often altered to sericite, subhedral brown biotite (< 2·0 mm) often associated with hornblende, interstitial K-feldspar, and quartz. Accessory minerals include apatite and zircon, often associated with biotite and hornblende.

A sample was collected from EQ942667 and subjected to K/Ar radiometric analysis. The results indicate a cooling age of $380 \pm 2$ Ma (Higgins and McClenaghan, in prep.).

### *Porphyritic coarse-grained biotite adamellite* (Dbapc)

As noted by McClenaghan (*in* McClenaghan *et al.*, 1982) in the adjoining Boobyalla–Ringarooma region this rock type shows considerable conformity in composition and texture. Contacts with Dbaps in the south-east corner of the Quadrangle [EQ842617, EQ874623] are gradational over several tens of metres. Contacts with Dbge are sharp, and as Dbge truncates a contact between Dbapc and Dbaps, it is concluded that Dbge is younger than both Dbapc and Dbaps. Field relationships from the adjoining Blue Tier Quadrangle (McClenaghan and Williams, 1983) suggest that Dbapc is younger than Dbg (*i.e.* the Poimena Pluton is younger than the Gardens Pluton).

The rock is a grey coarse-grained porphyritic biotite adamellite that has a characterisitc 'biscuit' appearance due to the presence of numerous (20–50%) euhedral phenocrysts (30–50 mm) of K-feldspar.

*Table 3*

*CHEMICAL ANALYSES AND CIPW NORMS, GRANITIC ROCKS AND MATHINNA BEDS, EDDYSTONE QUADRANGLE*

| Analysis no. | 792107 | 792108 | 802648 | 802649 | 802650 | 802651 | 802652 | 802653 | 802654 | 802655 | 802656 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Reg. no. | 85–0253 | 85–0254 | 85–0255 | 85–0256 | 85–0257 | 85–0258 | 85–0259 | 85–0260 | 85–0261 | 85–0252 | 85–0262 |
| Grid Reference | EQ867608 | EQ853645 | FQ131612 | FQ107635 | EQ942667 | EQ990795 | EQ989795 | FQ004723 | EQ963785 | EQ972748 | EQ973705 |
| Map symbol | Dbapc | Dbaps | Deec | Depc | Dbg | Depc | Deef | Deem | Depc | SDs | Ddl |
| $SiO_2$ | 71·60 | 75·10 | 76·34 | 77·14 | 69·70 | 72·18 | 73·24 | 75·35 | 72·43 | 85·95 | 49·01 |
| $TiO_2$ | 0·42 | 0·22 | 0·03 | 0·21 | 0·39 | 0·39 | 0·22 | 0·01 | 0·20 | 0·39 | 1·84 |
| $Al_2O_3$ | 13·40 | 12·30 | 12·73 | 11·23 | 14·25 | 13·41 | 14·00 | 13·29 | 13·95 | 6·15 | 15·77 |
| $Fe_2O_3$ | 0·35 | 0·26 | 0·41 | 0·51 | 0·93 | 0·73 | 0·48 | 0·43 | 0·59 | 0·58 | 1·74 |
| FeO | 2·40 | 1·70 | 0·72 | 1·52 | 2·57 | 2·24 | 1·25 | 0·84 | 1·82 | 1·41 | 9·24 |
| MnO | 0·05 | 0·04 | 0·02 | 0·02 | 0·06 | 0·05 | 0·02 | 0·03 | 0·04 | 0·03 | 0·18 |
| MgO | 0·59 | 0·21 | 0·11 | 0·27 | 1·69 | 0·79 | 0·40 | 0·12 | 0·60 | 0·67 | 7·23 |
| CaO | 1·70 | 1·10 | 0·70 | 1·13 | 3·26 | 1·85 | 0·93 | 0·53 | 1·84 | 0·61 | 9·55 |
| $Na_2O$ | 3·00 | 3·00 | 3·72 | 2·34 | 2·60 | 3·18 | 3·29 | 3·96 | 3·64 | 1·86 | 2·24 |
| $K_2O$ | 4·30 | 4·50 | 4·43 | 4·13 | 3·60 | 3·89 | 4·76 | 4·38 | 3·60 | 1·03 | 0·34 |
| $P_2O_5$ | 0·16 | 0·09 | 0·01 | 0·11 | 0·11 | 0·14 | 0·14 | 0·01 | 0·09 | 0·06 | 0·30 |
| $CO_2$ | 0·00 | 0·04 | 0·05 | 0·08 | 0·07 | 0·05 | 0·12 | 0·05 | 0·06 | 0·04 | 0·26 |
| $H_2O^+$ | 1·00 | 1·00 | 0·50 | 0·62 | 1·06 | 1·00 | 0·90 | 0·53 | 0·94 | 0·65 | 2·38 |
| $H_2O^-$ | 0·14 | 0·14 | 0·18 | 0·14 | 0·12 | 0·29 | 0·18 | 0·16 | 0·30 | 0·27 | 0·37 |
| Total | 99·11 | 99·70 | 99·95 | 99·45 | 100·41 | 100·19 | 99·93 | 99·69 | 100·10 | 99·70 | 100·45 |
| *Trace elements* (ppm) | | | | | | | | | | | |
| Sn | .... | .... | 15 | 19 | <12 | 16 | <12 | <12 | 20 | <12 | <12 |
| Nb | 13 | 15 | 10 | 10 | 8 | 12 | 9 | 12 | 10 | 5 | 6 |
| Zr | 199 | 174 | 69 | 174 | 121 | 178 | 147 | 69 | 146 | 443 | 120 |
| Y | 30 | 68 | 47 | 28 | 15 | 29 | 15 | 61 | 31 | 17 | 38 |
| Sr | 117 | 47 | 58 | 77 | 262 | 123 | 110 | 40 | 159 | 90 | 222 |
| Rb | 263 | 445 | 222 | 202 | 155 | 225 | 195 | 280 | 238 | 48 | 14 |
| Pb | .... | .... | 32 | 30 | 22 | 31 | 27 | 36 | 20 | 13 | 12 |
| Ga | .... | .... | 18 | 17 | 14 | 18 | 17 | 20 | 20 | 6 | 18 |
| Zn | 62 | 58 | 39 | 50 | 46 | 55 | 36 | 50 | 44 | 28 | 96 |
| Cu | .... | .... | <16 | <16 | <16 | <16 | <16 | <16 | 31 | <16 | 26 |
| Ni | .... | .... | 6 | <16 | 12 | 9 | 8 | 6 | 7 | 11 | 49 |
| Co | .... | .... | 8 | 9 | 11 | 10 | 9 | 7 | 9 | 9 | 50 |
| Ba | 552 | 127 | 190 | 362 | 721 | 421 | 695 | 121 | 376 | 155 | 123 |
| Cr | .... | .... | 4 | 6 | 35 | 12 | 6 | 3 | 7 | 38 | 180 |
| Li | 60 | 100 | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| *CIPW norms* | | | | | | | | | | | |
| Qtz | 32·0 | 36·8 | 35·7 | 44·3 | 30·0 | 32·7 | 33·0 | 33·7 | 31·7 | .... | 1·4 |
| C | 1·1 | 0·7 | 0·6 | 1·1 | 0·4 | 0·9 | 2·1 | 1·1 | 0·9 | .... | 0·0 |
| Or | 25·4 | 26·6 | 26·2 | 24·4 | 21·3 | 23·0 | 28·1 | 25·9 | 21·3 | .... | 2·0 |
| Ab | 25·4 | 25·4 | 31·5 | 19·8 | 22·0 | 26·9 | 27·8 | 33·5 | 30·8 | .... | 19·0 |
| An | 7·4 | 4·9 | 3·4 | 4·9 | 15·5 | 8·3 | 3·7 | 2·6 | 8·5 | .... | 32·0 |
| Di | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | .... | 11·0 |
| Hy | 5·0 | 3·1 | 1·2 | 2·7 | 7·6 | 4·9 | 2·6 | 1·5 | 4·1 | .... | 25·4 |
| Mt | 0·5 | 0·4 | 0·6 | 0·7 | 1·4 | 1·1 | 0·7 | 0·6 | 0·9 | .... | 2·5 |
| Il | 0·8 | 0·4 | 0·1 | 0·4 | 0·7 | 0·7 | 0·4 | 0·0 | 0·4 | .... | 3·5 |
| Hap | 0·4 | 0·2 | 0·0 | 0·3 | 0·3 | 0·3 | 0·3 | 0·0 | 0·2 | .... | 0·7 |

## Table 4

### *GRANITE-TYPE SYMBOLS USED IN THIS REPORT AND THE MAJOR GRANITIC BODIES OF GEE AND GROVES (1971) AND GROVES (1977)*

| Gee and Groves (1971)<br>Groves (1977) | | Symbols of granite types used in this report falling within the body | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rock body name | Rock type | Dbg | Dbapc | Dbaps | Dbapf | Dbge | Debg | Depc | Depf | Deeg | Deef | Deec | Deem |
| Blue Tier Batholith | | + | + | + | + | + | – | – | – | – | – | – | – |
| Eddystone Batholith* | | – | – | – | – | – | + | + | + | + | + | + | + |
| Gardens Pluton ($Dg_{16}$) | Biotite-hornblende granodiorite | + | – | – | – | – | – | – | – | – | | | |
| Poimena Pluton ($Dg_6$) | Porphyritic biotite granite/adamellite with fine- to medium-grained groundmass | – | + | + | – | – | – | – | – | – | – | – | – |
| Mt Cameron Sheets ($Dg_1$, $Dg_3$) | Medium- to coarse-grained granite/adamellite, minor porphyritic biotite granite/adamellite, biotite muscovite granite/adamellite, greisenised granite, greisen veins | – | – | + | + | + | – | – | – | – | – | + | – |
| Ansons Bay Pluton ($Dg_7$) | Coarse-grained biotite granite/adamellite, coarse-grained porphyritic biotite adamellite | – | – | – | – | – | + | + | – | – | – | – | – |
| Rushy Lagoon Pluton ($Dg_8$) | Coarse-grained (porphyritic)/adamellite | – | – | – | – | – | – | + | – | + | – | – | – |
| Musselroe Pluton ($Dg_6$) | Porphyritic biotite/adamellite with fine-grained to medium-grained groundmass | – | – | – | – | – | – | + | + | – | – | – | – |
| Mt William Mass ($Dg_1$) | Medium-grained biotite granite | – | – | – | – | – | – | – | – | – | + | – | + |

* The term 'Eddystone Batholith' was not used by Groves, it was first defined by Turner *et al.* (1983) and the definition is published herein (Appendix A).

Full petrological descriptions of this rock-type are given by McClenaghan (*in* McClenaghan *et al.*, 1982) and Groves (1977). A representative analysis of Dbapc from the region is included in Table 3 (792107).

Sparsely-distributed xenoliths are present in most areas, as noted by Turner (*in* McClenaghan *et al.*, 1982) in the adjoining Ringarooma–Boobyalla region. They often have an ellipsoidal shape, parallel to other mineral trends in the body.

Turner (*in* McClenaghan *et al.*, 1982) has suggested that the K-feldspar phenocrysts grew at least partially *in situ*. Two observations from rocks in the Eddystone Quadrangle support this conclusion and provide some constraints on timing of phenocryst development:

(1) in a creek at EQ866615 phenocrysts in Dbapc have clearly developed later than the development of a 20 mm leucocratic vein (fig. 4a);

(2) in the floor of old tin workings at EQ867608 phenocrysts in Dbapc have been cut and dilationally offset by the intrusion of a 30 mm aplite dyke (fig. 4b).

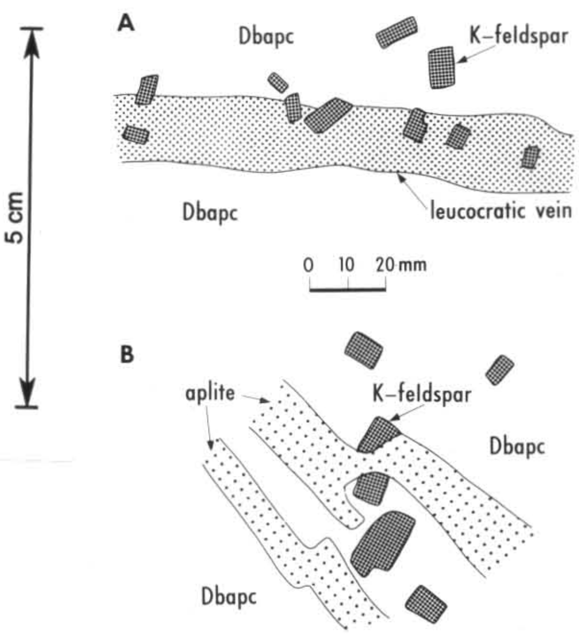


**Figure 4.** *Relationship between leucocratic phenocrysts and aplite dykes, Gladstone area.*

## *Sparsely porphyritic, medium- to coarse-grained biotite-minor muscovite adamellite* (Dbaps)

The rock type occurs in the Gladstone area near Fly-by-Night Creek [EQ850635] and east of Second Sugarloaf [EQ875627]. As noted earlier, contacts with Dbapc are gradational over several metres. Cox (*in* McClenaghan *et al.*, 1982) considered that a continuation of this contact on the adjoining Boobyalla Quadrangle was intrusive, although he also noted a gradational contact.

The rock differs from Dbapc in the following ways:

(1) the groundmass of Dbaps is slightly finer grained than that of Dbapc;

(2) phenocryst abundance is less in Dbaps;

(3) phenocrysts in Dbaps are generally smaller than those in Dbapc;

(4) muscovite is a common accessory mineral in Dbaps, but very rare in Dbapc.

When fresh, the rock is grey in colour and is a medium- to coarse-grained sparsely porphyritic rock with 5–15% tabular K-feldspar phenocrysts. In thin section (85-0254, 85-0264) the groundmass is seen to contain partially altered, zoned, subhedral plagioclase, perthitic K-feldspar brown subhedral biotite, quartz, together with muscovite and zircon. A representative analysis from the region is included in Table 3 (792108).

## *Porphyritic fine- to medium-grained biotite-muscovite adamellite with phenocrysts of quartz and feldspar* (Dbapf)

This granite variety crops out in the vicinity of the Ringarooma River, between EQ856655 and EQ879629. Contacts with other rock-types are sharp, and because Dbapf apparently intrudes Dbaps and that a Dbaps/Dbapf contact is truncated by Dbge it is concluded that Dbapf is intermediate in age between Dbaps (older) and Dbge (younger). It should be noted that this granite type correlates with Dbapq and Dbapq' of the adjacent Ringarooma–Boobyalla area and *not* Dbapf of that area (which contains phenocrysts of feldspar only).

The rock is invariably altered and is a variably (though usually sparsely) porphyritic rock with a fine-grained groundmass of plagioclase K-feldspar, biotite and muscovite. Phenocrysts of K-feldspar are up to about 15 mm in length, while phenocrysts of quartz are usually rounded and less than 10 mm in diameter.

## *Equigranular, medium-grained biotite-muscovite granite* (Dbge)

This rock-type forms a roughly rectangular body, 1 km × 3 km in extent, in the south-east corner of the Eddystone Quadrangle [EQ860625]. As this granite type truncates contacts between Dbaps and Dbapc and also between Dbaps and Dbapf it is concluded that Dbge is the last of the major bodies of the Blue Tier Batholith to have been intruded in the Gladstone region. All contacts with other granite types are sharp and easily recognised in the field.

The body is nearly rectangular-shaped in plan, and as it is totally enclosed by other granites it is concluded that the probable mechanism of intrusion was by stoping.

The rock is pink when fresh and is an equigranular, coarse-grained rock with K-feldspar, plagioclase, quartz, biotite and muscovite. In thin section (85-0286) the rock is seen to be fairly strongly altered; K-feldspar is very cloudy, resulting in the characteristic pink colour of the rock, plagioclase is often altered to sericite. Muscovite is interstitial and also occurs as a replacement of feldspar. Graphic intergrowth between quartz and K-feldspar may be present. Biotite is subhedral, brown in colour, and contains abundant zircon inclusions. The plagioclase may be zoned and oligoclase/andesine in composition.

## *EDDYSTONE BATHOLITH*

The term Eddystone Batholith was introduced by Turner *et al.* (1983; and also as Appendix A herein) for the granitic rocks of far north-eastern Tasmania. Included in the batholith are the Boobyalla, Rushy Lagoon, Musselroe and Ansons Bay Plutons and the Mt William Mass of Groves (1977).

The Eddystone and Blue Tier Batholiths are separated by a screen of Mathinna Beds in most areas, with the exception of part of the Blue Tier Quadrangle [FQ026604-FQ019562] (McClenaghan and Williams, 1983) where the contact is inferred to be a fault. In the Eddystone Quadrangle the Mathinna Beds screen is 3-4 km in width.

Aspects of the regional geology and petrology of the Eddystone Batholith have been described by Groves *et al.* (1977), Cocker (1982) and Kitto (1982).

### *Equigranular, biotite-hornblende granodiorite* (Debg)

This rock-type only occurs at Boulder Point [FQ047728] where it crops out as shore exposure over a distance of approximately 300 m. Sand cover made determination of the relationship with the other granodiorites of the area impossible.

The rock (85-0265) consists of subhedral green hornblende (*c.* 1 mm) usually in close association with brown subhedral biotite ($<5$ mm), together with often strongly-zoned plagioclase, K-feldspar which is often perthitic, and quartz. Plagioclase composition, as determined by the method of Michel-Lévy is in the labradorite field.

Ellipsoidal mafic xenoliths are common and are aligned parallel to a foliation defined by mafic mineral alignment.

In view of the fact that this locality is the only occurrence of granodiorite known from the Eddystone Batholith and that large xenoliths are common in Depc (see discussion in following section) it is considered that this body of granodiorite is a xenolith within the main granitic mass.

### *Variably porphyritic, biotite-garnet granite/adamellite* (Depc)

This variable rock unit is the major rock type of the Eddystone Batholith in the region, and was mapped from the southern edge of the map sheet west of Eddystone Point [FQ605070], to the northern end of Great Musselroe Bay [EQ923847]. The unit includes the Ansons Bay, Musselroe and Rushy Lagoon Plutons of Groves (1977) and two of the three subdivisions of the Ansons Bay Pluton mapped by Jennings and McShane (fig. 30 *in* Groves *et al.*, 1977).

The granites are light grey when fresh and contain from 20-70% (visual estimate) of K-feldspar phenocrysts which have a maximum length of 100 mm. The average grain size of the groundmass ranges from 5 to 15 mm. Three representative analyses from the region are included in Table 3 (802649, 802651, 802654).

A characteristic feature of the rock unit is the occasional presence of garnet which is found closely associated with biotite, and concentrated near the margins of igneous and metasedimentary xenoliths. Pseudomorphs after cordierite (V. J. Wall pers. comm.) are also present in the granite in close proximity to the garnet. The xenoliths range in size from decimetre scale to several tens of metres. For example the mapped small bodies of Mathinna Beds north of Purdon Bay [FQ096662, FQ088672, FQ083677] are almost certainly xenoliths. The igneous xenoliths are usually similar, though distinctly different, from the rocks within which they are found. They are usually finer grained and less porphyritic; some almost equigranular varieties have been observed. The xenoliths invariably are very angular and look as if they were incorporated into the granite magma by 'plucking' or stoping of jointed granite (plate 9).

Garnet-biotite-cordierite occurs as zones or concentrations up to one metre wide at the xenolith margins (plates 10, 11). There is no evidence to support the conclusion that the garnet-biotite-cordierite accumulations are early flow associations (Cocker, 1977). The garnet composition, as determined by electron microprobe is presented as Table 5.

A large xenolith of Mathinna Beds is present at George Rocks [FQ119685], together with a large xenolith of porphyritic biotite granite/adamellite that was previously (Groves *in* Groves *et al.*, 1977) interpreted as an intrusion. Groves (*op. cit.*) also noted the presence of garnet-biotite in the contact zone.

Also present on George Rocks in the vicinity of the large xenoliths are accumulations of sub-rounded enclaves ('pudding stones'; Groves *in* Groves *et al.*, 1977, plates 1, 2) that were probably Mathinna Beds.

5 cm



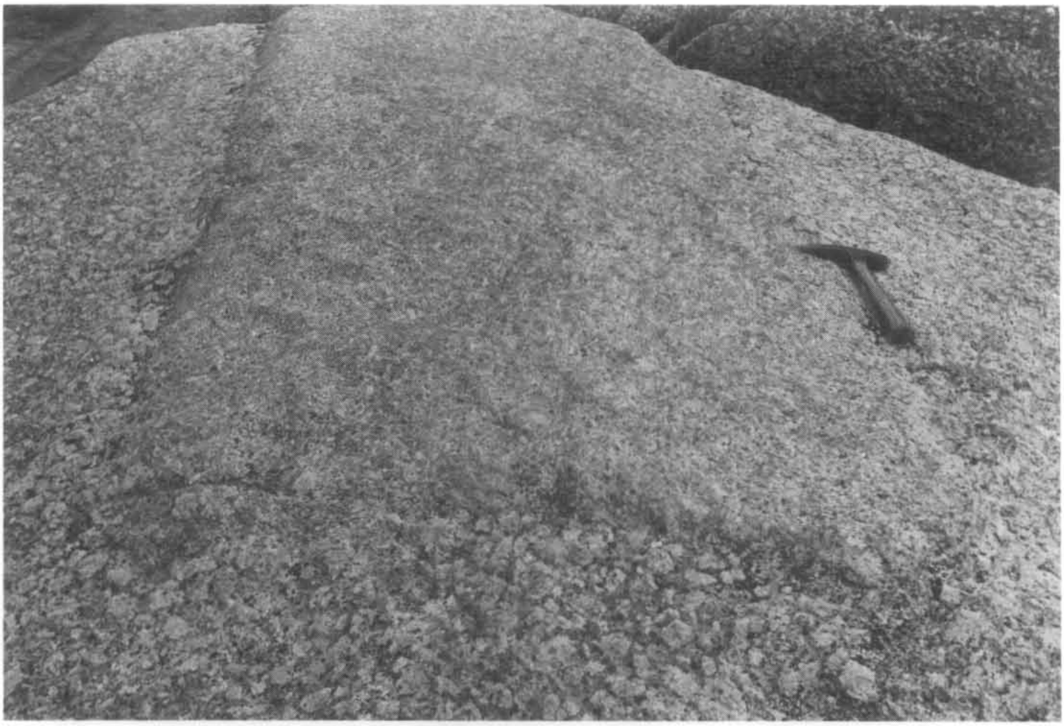

**Plate 9.** *Angular xenolith of coarse-grained porphyritic granite/adamellite within very coarse-grained, very porphyritic granite, Picnic Rocks. Note development of mafic segregations of biotite/garnet at margin.*

**Plate 10.** *Detail of contact between xenolith (at left) and coarse-grained country rock (at right) showing development of mafic segregations of biotite/garnet. The same xenolith as in Plate 9.*

*Table 5*
*MINERAL COMPOSITION AND STRUCTURAL FORMULAE OF GARNETS FROM SPECIMEN 85-0266 AS DETERMINED BY ELECTRON MICROPROBE (Analyst J. L. EVERARD)*

| | 1 | | 2 | | 3 rim | | 3 core | |
|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 35·83 | | 35·77 | | 35·70 | | 35·55 | |
| $TiO_2$ | 0·25 | | 0·28 | | .... | | .... | |
| $Al_2O_3$ | 21·26 | | 21·13 | | 21·13 | | 21·13 | |
| FeO | 36·52 | | 36·99 | | 37·81 | | 36·87 | |
| MnO | 1·08 | | 1·18 | | 1·38 | | 3·51 | |
| MgO | 2·92 | | 2·65 | | 2·09 | | 1·03 | |
| CaO | 1·23 | | 1·26 | | 1·16 | | 1·13 | |
| $Na_2O$ | 0·90 | | 0·77 | | 0·74 | | 0·77 | |
| Total | 99·99 | | 100·03 | | 100·01 | | 99·99 | |
| *Structural formulae* | | | | | | | | |
| Mg | 0·36 | | 0·32 | | 0·26 | | 0·13 | |
| $Fe^{+2}$ | 2·47 | | 2·49 | | 2·56 | | 2·53 | |
| Mn | 0·07 | | 0·08 | | 0·10 | | 0·10 | |
| Ca | 0·11 | 3·01 | 0·11 | 3·00 | 0·10 | 3·02 | 0·10 | 3·01 |
| Al | 1·97 | | 1·95 | | 1·97 | | 1·99 | |
| $Fe^{+3}$ | 0·02 | | 0·04 | | 0·04 | | 0·01 | |
| Ti | 0·02 | 2·01 | 0·02 | 2·01 | 0·00 | 2·01 | 0·00 | 2·00 |
| $Al^{+4}$ | 0·08 | | 0·08 | | 0·08 | | 0·07 | |
| Si | 2·93 | 3·01 | 2·92 | 3·00 | 2·93 | 3·01 | | |
| *Mole % of garnet end-members* | | | | | | | | |
| Almandine | 82·1 | | 82·9 | | 84·9 | | 84·3 | |
| Pyrope | 11·8 | | 10·7 | | 8·5 | | 4·2 | |
| Spessartine | 2·5 | | 2·7 | | 3·2 | | 8·2 | |
| Andradite | 1·2 | | 1·8 | | 2·1 | | 0·7 | |
| Grossular | 1·6 | | 1·0 | | 1·3 | | 2·6 | |
| Melanite | 0·8 | | 0·9 | | 0·0 | | 0·0 | |
| Total | 100·0 | | 100·0 | | 100·0 | | 100·00 | |

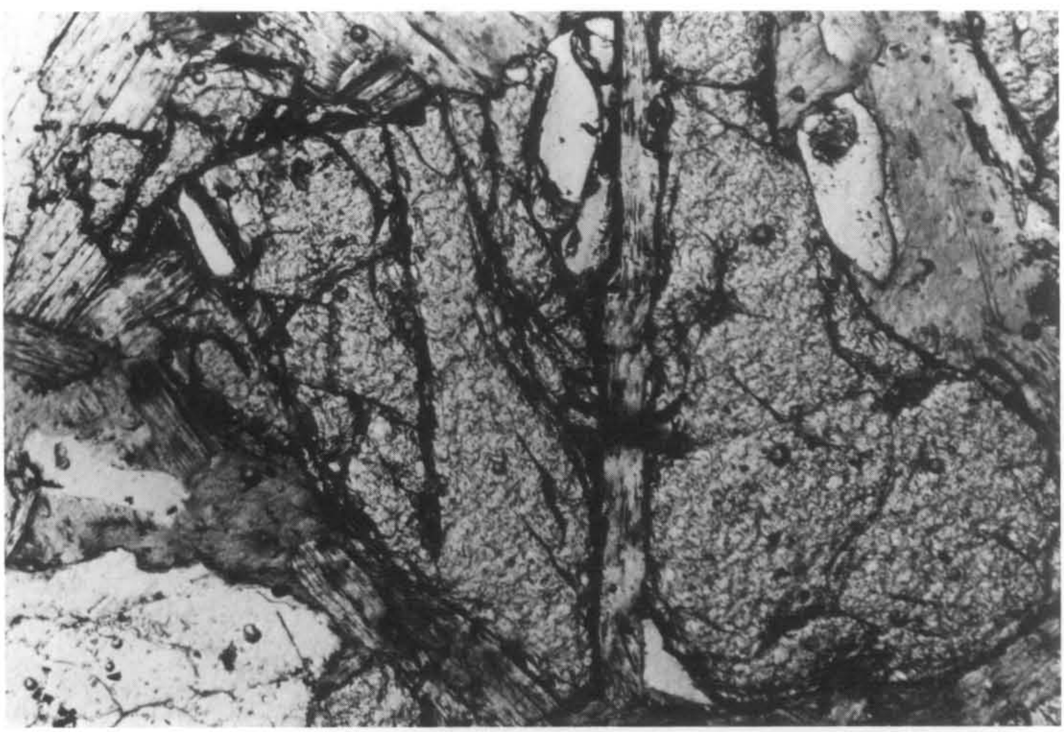

**Plate 11.** *Photomicrograph of mafic segregation showing garnet (high relief), biotite (with strong cleavage), and quartz.*

5 cm

Compositional layering is well-developed in coastal outcrops at the northern end of Great Musselroe Bay [EQ929839]. The layering is sub-horizontal and is probably related to flow. Individual layers range in thickness from 100 mm to greater than one metre. Some layers consist of equigranular biotite-rich adamellite, while other layers consist of porphyritic (often greater than 60% phenocrysts; visual estimate) biotite granite or adamellite (plate 12). Composition is dependant on the proportion of mafic minerals and phenocrysts present. Boundaries between the various compositional layers are usually sharp and some evidence of scouring or erosion of one layer by an overlying layer may be present. The equigranular layers often contain pegmatic zones (plate 13), approximately 50 mm thick, that are lensoid and parallel to a shallow foliation, defined by K-feldspar phenocrysts, which is prominent in the area. Xenoliths are also flattened parallel to the shallow foliation.

Petrographically the granites of Depc (thin sections 85-0256, 85-0258) are very similar and consist of euhedral K-feldspar phenocrysts in a coarse-grained groundmass of subhedral often strongly zoned plagioclase (oligoclase-andesine as determined by the method of Michel-Lévy), subhedral brown biotite (<2 mm) with abundant inclusions of apatite, monozite and zircon, often-perthitic K-feldspar (<5 mm), and quartz which often displays undulose extinction.

Jennings and McShane (fig. 30 *in* Groves *et al.*, 1977) and Kitto (1982) show areas of medium-grained biotite adamellite or alkali-feldspar granite (Mt William Granite of Groves *et al.*, 1977) in the Boulder Point area [FQ049728]. The writer does not agree with this interpretation and, with the exception of the small body of Debg previously discussed, all granites of the area have been assigned to Depc for the following reasons:

(1) it is considered that variations of granite types in the area fall within the range of variation of Depc for the region,

(2) the characteristic pink-coloured medium-grained equigranular granites of the Mt William area are not present at Boulder Point,

(3) garnets are present near one of the contacts between 'Ansons Bay' and 'Mt William' granites [FQ056726] mapped by Jennings and McShane, suggesting the presence of xenoliths, as discussed previously,

(4) although some rocks from the area contain significant muscovite (*e.g.* 85-0267), muscovite does occur at many other localities in rocks mapped as Depc, and none of the rocks from Boulder Point are as pervasively altered as the granites of the Mt William area.

*Porphyritic fine-grained biotite-muscovite adamellite, with phenocrysts of quartz and feldspar* (Depf)

A small body, sufficiently distinctive to warrant differentiating on the map, occurs in the Great Musselroe Bay area [FQ932815].

The rock is invariably altered and a pink/brown colour. It is a fine-grained rock which contains phenocrysts of K-feldspar (<20 mm) and often-rounded quartz (<10 mm). Muscovite is a ubiquitous accessory mineral.

The rock is very similar to Dbapf mapped in the Blue Tier Batholith in the Gladstone region.

*Equigranular, fine-grained, biotite-muscovite adamellite* (Deeg)

A small body of this granite type was mapped 2 km east of Rushy Lagoon [EQ881760]. The rock is altered and pink-coloured when fresh. It is equigranular or sparsely-porphyritic and contains muscovite as a late-stage accessory mineral. The rock is very similar to boides mapped as Dmg and Dmge ('micrograndite') in the adjoining Ringarooma–Boobyalla region (McClenaghan *in* McClenaghan *et al.*, 1982).

*Equigranular, fine- to medium-grained, biotite-cordierite-minor muscovite adamellite* (Deef)

This rock type is confined to the Musselroe Point area [EQ994803], whre it weas previously mapped as the Musselroe Point microgranite (Jennings *in* Groves *et al.*, 1977). The body is well exposed in coastal outcrops, where several critical relationships with Depc are magnificently exposed; in particular directly opposite the spit which forms the boundary between Great Musselroe Bay and Musselroe Bay [EQ990794]. A representative analysis from the unit is included in Table 3 (802652).

When fresh the rock is grey coloured, and is a fine- to medium-grained equigranular to sparsely porphyritic rock which in thin section (85-0259, 85-0260, 85-0269, 85-0270) is seen to consist of euhedral subhedral zoned plagioclase (oligoclase-andesine as determined by the method of Michel-Lévy) whose cores are often partly sericitised, subhedral laths of brown biotite, interstitial K-feldspar and quartz, together with secondary muscovite and accessory apatite crystals.

A characterisitic feature of the rock unit is the presence of dark-grey spots 5–8 mm in diameter (plate 14). The spotting is best developed near the contact with Depc [EQ989795] and the spots consist of micaceous aggregates which are secondary after cordierite. Fresh cordierite has been recorded from the rock (G. B. Everard *in* Groves *et al.*, 1977).

5 cm

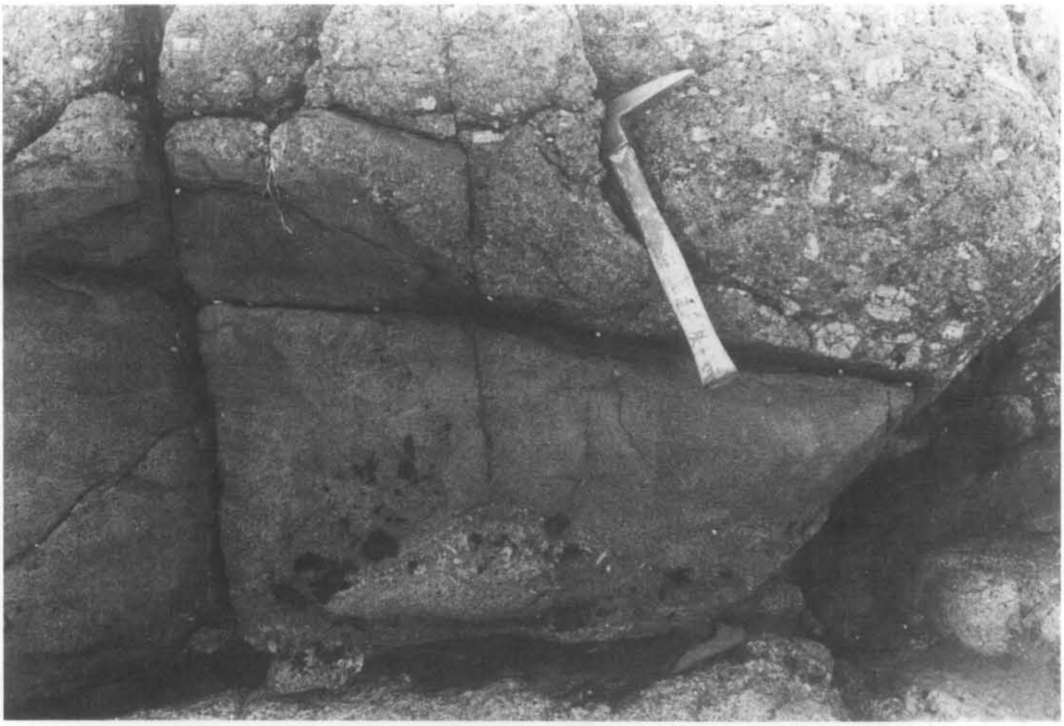

**Plate 12.** *Well-developed layering, showing some evidence of scouring, between porphyritic and non-porphyritic varieties of granite/adamellite* (Depc); *outcrop at northern end of Musselroe Bay.*

**Plate 13.** *Sub-horizontal pegmatite zones, the same locality as Plate 12.*

5 cm



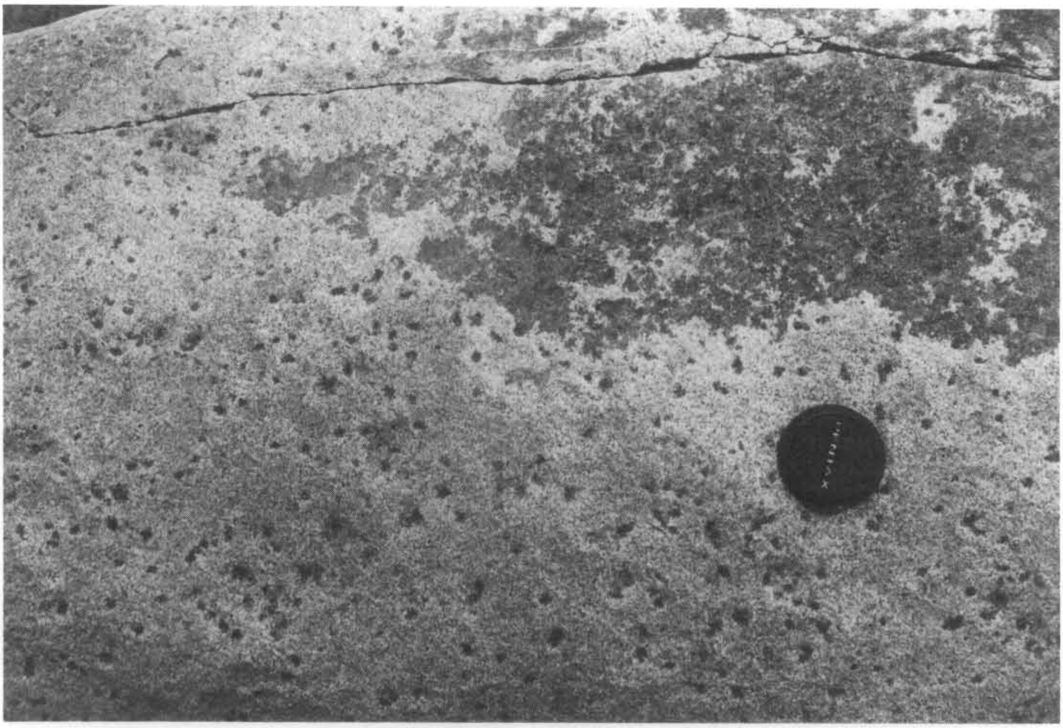

**Plate 14.** *Prominent spots in medium-grained, equigranular adamellite, coastal outcrop at outlet of Musselroe Bay.*

**Plate 15.** *Well-jointed Jurassic dolerite, Little Musselroe Bay.*

## *Contacts between* Deef *and* Depc

Two critical relationships between granite types Deef and Depc are exposed north of Poole in the Musselroe Bay area. The outcrops are important with respect to an understanding of the type and nature of intrusion, and also the genesis of K-feldspar foliations which are a characteristic of the porphyritic granitoids of north-east Tasmania.

The first critical outcrop is located immediately opposite the spit at the entrance of Musselroe Bay [EQ990794]. At this locality Depc is clearly intrusive into Deef. Numerous dykes of Depc, which intrude Deef, range in width from over one metre to less than 5 mm. Many of the thinner dykes have gradational margins, and some were observed to die out and become cracks, which in turn die out over a short distance. A feature of all the dykes is the very prominent alignment of K-feldspar phenocrysts to form a foliation. The resultant foliation is invariably parallel or sub-parallel to the dyke margins (fig. 5), and as there is no great ordering of the dyke orientations it must be concluded that the foliation is the result of flow in the liquidus-phase.

This conclusion is too simplistic because K-feldspar phenocrysts, up to 100 mm in length and also occasionally as Bavino twins, are present both within Deef and as trains of single crystals in dykes. This suggests that growth of some K-feldspar occurred *in situ*.

The second locality occurs near Musselroe Point at EQ990800 where an ?intrusion of coarsely porphyritic medium- to coarse-grained granite/adamellite (Depc) is in turn intruded by rounded 'globes' of medium-grained biotite-muscovite adamellite (Deef). The significance of this outcrop was not realised at the time of mapping and the Eddystone map shows a dyke of fine-grained granite at the locality.

The relationships at the outcrop are interpreted as the incomplete mixing of two melts with different viscosities (V. J. Wall, pers. comm.). Some indication of the nature of the magma is provided by the first outcrop where it was shown that cracking of Deef occurred during intrusion by Depc.

## *Equigranular coarse-grained biotite adamellite* (Deec)

This granite-type is only found in the Eddystone Point area and is the granite used in construction of the Eddystone Lighthouse [FQ133610]. Table 3 includes a representative analysis (802648) of a sample collected from the old lighthouse quarry site [FQ131612].

When fresh the rock is grey in colour and, although nearly always coarse-grained, some minor finer-grained varieties occur. In thin section (85–0255, 85–0271) the rock contains subhedral zoned plagioclase (oligoclase as determined by the method of Michel-Lévy) less than 6 mm in length, subhedral brown or green-brown biotite less than 2·5 mm, together with interstitial often-perthitic K-feldspar and quartz.

Pegmatitic patches are common in the area and have the same mineralogy as the country rocks.

## *Equigranular medium-grained biotite-muscovite granite* (Deem)

This granite-type forms an elongate mass extending from north of Bayleys Hill [FQ027643] to low-lying areas west of Cape Naturaliste [FQ006769]. The rock has been termed the Mt William adamellite (Jennings *in* Groves *et al.*, 1977) and the body has been interpreted as a sub-horizontal sheet (Groves *in* Groves *et al.*, 1977), although this interpretation has been regarded as too simplistic (Jennings, *op. cit.*). As noted by previous workers this granite type lies along a regional contact separating Mathinna Beds sedimentary rocks from porphyritic coarse-grained rocks of the Eddystone Batholith.

The rocks are invariably altered and pink or brownish coloured. In thin section (85–0260, 85–0272) the rock consists of even-grained aggregates of subhedral plagioclase (albite as determined by the method of Michel-Lévy), brown or green-brown biotite and muscovite, K-feldspar (including microcline) which is often perthitic, and quartz. A representative analysis of the rock is included in Table 3 (802653). The rock is an alkali-feldspar granite (Kitto, 1982) similar to the alkali-feldspar granites of the Blue Tier area (McClenaghan and Williams, 1982).

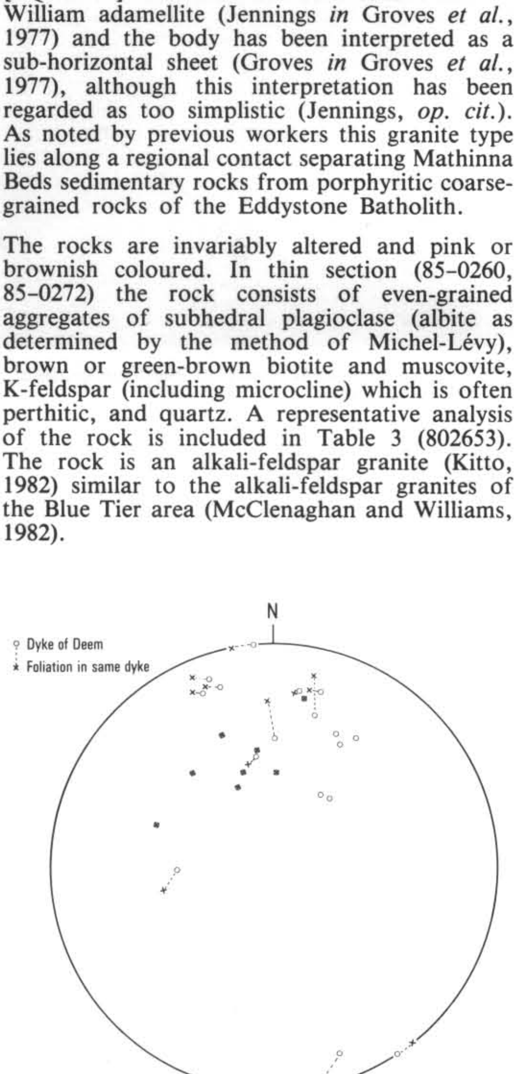


**Figure 5.** *Relationships between dyke orientation and foliation defined by K-feldspar phenocrysts, Musselroe Bay.*

5 cm

## *MINOR GRANITIC INTRUSIONS*

### *Aplite* (Dma)

Late stage felsic dykes are reasonably common throughout the region. They are fine- to medium-grained, with a saccharoidal texture and are composed of quartz and feldspar, with minor amounts of biotite and muscovite. No attempt was made to depict all aplite dykes and veins on the map.

The aplite body at FQ016736, 3·5 km north-east of Mt William is buff-coloured and flinty in appearance and composed of feldspar, quartz and muscovite. It was a quarry site used by aboriginal man in the manufacture of stone implements (Jennings, 1977).

### *Fine-grained granite* (Dmf)

Small bodies of fine-grained granite were mapped at Eddystone Point [FQ134610], Musselroe Point [EQ990800], and Rushy Lagoon [EQ882767].

The occurrence at Eddystone Point is a 150 mm dyke of equigranular, fine-grained, biotite-muscovite granite.

As discussed previously the body at Musselroe Bay was mis-interpreted during mapping and is in fact an intrusion of Deef into Depc.

At the Rushy Lagoon locality a 12 m wide, northerly-trending dyke of equigranular, fine-grained, biotite-muscovite granite intrudes coarse-grained, porphyritic, biotite-minor muscovite adamellite (Depc). It is likely that the intrusive body is related to the larger body of equigranular, fine-grained, biotite-muscovite adamellite (Deeg) mapped less than a kilometre to the south [EQ881760].

### *Pegmatite* (Dmp)

As noted in the discussion of Deec, pegmatite is common in the Eddystone Point area [FQ132612]. The pegmatite occurs both earlier than and later than aplite dykes in the area. The pegmatite occurs as patches and as 'dyke-like' linear bodies which probably represent fluid movement paths, rather than true intrusions.

In the Eddystone Point area easterly trending aplite dykes are consistently earlier than pegmatite formation.

### *Greisen* (Dmg)

A body of greisen occurs at the Fly-by-Night Mine [FQ852641] which occurs near the contact between hornfelsed Mathinna Beds and sparsely porphyritic coarse-grained adamellite (Dbaps). The greisen was first investigated by Montgomery (1891) who described it as a contact alteration product.

In thin section (85–0273) the rock is seen to consist of intergranular quartz (0·5–4·0 mm) and white mica (1·5 mm).

## *DOLERITE DYKES* (Ddl)

Several NNE-trending dykes up to 50 m in width intrude both granitic rocks and the Mathinna Beds in a 7 km wide zone between Icena Creek [EQ960760] and Bayleys Hill [FQ020630]. The dykes are a continuation of a swarm mapped on the adjoining Blue Tier Quadrangle (McClenaghan and Williams, 1983), but which have a north-easterly trend.

The longest, continuously-mapped, dykes on the Eddystone Quadrangle are approximately 5 km in length. A representative chemical analysis is included in Table 3 (802656). Petrographic descriptions of the dolerites are given by Collins (*in* Groves *et al.*, 1977) and McClenaghan (1983). Plagioclase and amphibole compositions, as determined by electron microprobe are included as Table 6. From the analyses it can be inferred that although the rock is altered the original plagioclase composition was high-calcic labradorite, and that original pyroxene has been altered to amphibole group minerals.

The age of the dolerite dykes has long been problematical. Groves *in* Groves *et al.*, 1977) states that their derivation is unknown and Collins (*in* Groves *et al.*, 1977) suggests that they are associated with late-stage crystallisation of the granites. Observations by the author and N. J. Turner near Lady Barron on Flinders Island suggest that the dolerite intruded prior to intrusion of quartz-feldspar porphyry, thus indicating that the dolerite is probably Late Devonian in age.

## JURASSIC DOLERITE

Jurassic dolerite occurs in western areas of the Eddystone Quadrangle from Cinderella Hill [EQ864715] to Little Swan Island [EQ912912]. The Swan Island occurrence is the northernmost known of the great Tasmanian dolerite sheets.

Intrusive relationships between the dolerite and flat-lying sediments of the Parmeener Super-Group are exposed at Cinderella Hill and the Mexican Hill area [EQ925807]. Near Bluebell Creek [EQ901740] the dolerite intrudes Mathinna Beds sedimentary rocks. The presence of a remnant 1·5 km east of this locality suggests the former presence of a major sheet in the area which was almost certainly continuous west to the Ringarooma Tier region and in a northerly direction to Swan Island.

Throughout the region the dolerite displays the characteristic 'slabby' appearance caused by the presence of closely-spaced joints (plate 15), noted by Baillie (*in* McClenaghan *et al.*, 1982) as a feature of Jurassic dolerite in the adjoining Boobyalla Quadrangle.

## CRETACEOUS SHOSHONITES

Shoshonitic rocks, similar to the appinitic rocks of the Cape Portland area (Jennings and

## *Table 6*

## *MINERAL COMPOSITION AND STRUCTURAL FORMULAE OF PLAGIOCLASE AND AMPHIBOLE MINERALS, SPECIMEN 85-0274 AS DETERMINED BY ELECTRON MICROPROBE (Analyst A. V. BROWN). FELDSPAR CALCULATED WITH 8 OXYGENS, AMPHIBOLE WITH 23 OXYGENS*

| | Plagioclase | | | | | Amphibole | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| $SiO_2$ | 51·56 | 58·40 | 53·72 | 53·02 | 59·62 | 43·30 | 40·72 | 39·37 |
| $TiO_2$ | .... | .... | .... | .... | .... | 5·25 | .... | 0·31 |
| $Al_2O_3$ | 30·19 | 25·15 | 29·24 | 29·85 | 25·27 | 7·95 | 10·42 | 17·21 |
| FeO | 0·55 | 0·95 | 0·55 | 0·21 | 0·42 | 15·78 | 19·34 | 9·63 |
| MnO | .... | .... | .... | .... | .... | 0·32 | .... | .... |
| MgO | 0·32 | 0·50 | .... | .... | .... | 9·10 | 13·38 | 5·17 |
| CaO | 13·68 | 7·73 | 11·82 | 12·75 | 7·56 | 12·89 | 6·11 | 16·33 |
| $Na_2O$ | 3·61 | 6·98 | 4·41 | 4·18 | 7·13 | 0·65 | .... | .... |
| $K_2O$ | – | 0·30 | 0·26 | .... | .... | .... | 0·28 | .... |
| Total | 100·01 | 100·01 | 100·00 | 100·01 | 100·00 | 95·24 | 90·25 | 88·02 |
| *Numbers of ions in formula* | | | | | | | | |
| Si | 2·3508 | 2·6239 | 2·4319 | 2·4002 | 2·6602 | 6·6381 | 6·5628 | 6·3368 |
| Ti | .... | .... | .... | .... | .... | 0·6053 | .... | 0·0375 |
| Al | 1·6196 | 1·3322 | 1·5606 | 1·5931 | 1·3293 | 1·4369 | 1·9799 | 3·2657 |
| Fe | 0·0209 | 0·0357 | 0·0208 | 0·0080 | 0·0157 | 2·0232 | 2·6068 | 1·2963 |
| Mn | .... | .... | .... | .... | .... | 0·0416 | .... | .... |
| Mg | 0·0217 | 0·0335 | .... | .... | .... | 2·0791 | 3·2138 | 1·2402 |
| Ca | 0·6670 | 0·3721 | 0·5734 | 0·6185 | 0·3614 | 2·1174 | 1·0552 | 2·8163 |
| Na | 0·3185 | 0·6081 | 0·3871 | 0·3669 | 0·6169 | 0·1932 | .... | .... |
| $K_2O$ | .... | 0·0172 | 0·0150 | .... | .... | .... | 0·0576 | .... |
| Total | 4·9986 | 5·0227 | 4·9888 | 4·9867 | 4·9835 | 15·1348 | 15·4760 | 14·9928 |
| Or | 0·0 | 1·7 | 1·5 | 0·0 | 0·0 | .... | .... | .... |
| Ab | 32·3 | 61·0 | 39·7 | 37·2 | 63·1 | .... | .... | .... |
| An | 67·7 | 37·3 | 58·8 | 62·8 | 36·9 | .... | .... | .... |
| Ca/(Ca + Mg + Fe) | .... | .... | .... | .... | .... | 34·0 | 15·3 | 52·6 |
| Mg/(Ca + Mg + Fe) | .... | .... | .... | .... | .... | 33·4 | 46·7 | 23·2 |
| Fe/(Ca + Mg + Fe) | .... | .... | .... | .... | .... | 32·5 | 37·9 | 24·2 |

## *Table 7*

## *MINERAL COMPOSITION AND STRUCTURAL FORMULAE OF PLAGIOCLASE FROM SPECIMEN MUSSELROE HOLE 1, AS DETERMINED BY ELECTRON MICROPROBE*

| | Phenocrysts | | | | | Groundmass | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| $SiO_2$ | 48·07 | 47·68 | 49·84 | 47·90 | 47·79 | 52·03 | 52·54 |
| $Al_2O_3$ | 33·48 | 33·58 | 32·14 | 33·18 | 33·56 | 30·29 | 29·48 |
| FeO | .... | .... | .... | 0·27 | .... | 0·45 | 1·20 |
| CaO | 16·69 | 17·13 | 15·39 | 16·93 | 17·08 | 13·59 | 12·91 |
| $Na_2O$ | 1·74 | 1·62 | 2·37 | 1·71 | 1·56 | 3·29 | 3·45 |
| $K_2O$ | .... | .... | 0·25 | .... | .... | 0·35 | 0·42 |
| Total | 99·98 | 100·01 | 99·99 | 99·99 | 99·99 | 100·00 | 100·00 |
| *Numbers of ions in formula* | | | | | | | |
| Si | 2·1985 | 2·1838 | 2·2724 | 2·1960 | 2·1879 | 2·3653 | 2·3928 |
| Al | 1·8052 | 1·8132 | 1·7276 | 1·7933 | 1·8114 | 1·6234 | 1·5828 |
| Fe | .... | .... | .... | 0·0104 | .... | 0·0171 | 0·0457 |
| Ca | | | | | | | |
| Na | 0·8179 | 0·8407 | 0·7519 | 0·8317 | 0·8379 | 0·6620 | 0·6300 |
| K | .... | .... | 0·0145 | .... | .... | 0·0203 | 0·0244 |
| Total | 4·9760 | 4·9815 | 4·9759 | 4·9833 | 4·9756 | 4·9781 | 4·9803 |
| Or | 0·0 | 0·0 | 1·5 | 0·0 | 0·0 | 2·1 | 2·5 |
| Ab | 15·9 | 14·6 | 21·5 | 15·5 | 14·2 | 29·8 | 31·8 |
| An | 84·1 | 85·4 | 77·0 | 84·5 | 85·8 | 68·1 | 65·7 |

Sutherland, 1969; Baillie *in* McClenaghan *et al.*, 1982) are a minor but widespread component of rock sequences in the Eddystone Quadrangle.

Intrusive and ?extrusive rocks were encountered in a series of boreholes in the Cuckoo Creek area [EQ913806], and lamprophyre dykes intrude granitic rocks at the northern end of Great Musselroe Bay [EQ927841] (plate 16).the southern end of Cod Bay [FQ084677], and George Rocks [FQ119687]. Hornblende lamprophyre beach boulders are common on Swan Island but no *in situ* outcrops were observed.

## *Cuckoo Creek*

The igneous rocks encountered during drilling in the area (fig. 2) have no surface expression and their presence was not anticipated prior to drilling. The rocks are invariably altered and it is difficult to obtain fresh specimens. In thin section, a specimen from 23·5 m (85–0275) consists of phenocrysts of zoned calcic plagioclase ($<$ 1·5 mm) in a felted groundmass, consisting of laths of plagioclase ($<$0·6 mm), iron oxides and altered glassy material. Electron microprobe analysis (table 7) shows that the phenocrysts are composed of bytownite $An_{77-86}$, while the groundmass plagioclase is labradorite ($An_{59-68}$).

The presence of vesicles in this rock and the absence of significant thermal metamorphism of the underlying rocks suggests that this rock may be a lava.

Basalt also occurs in Musselroe No. 3 Hole where all bodies were clearly intrusive and non-vesicular. In thin section, a specimen from 91·8 m (85–0276) consisted of euhedral phenocrysts of augite ($<$4 mm) in a felted groundmass of augite, labradorite, biotite, iron oxides, and apatite.

Distinct from the basalt, and occurring at 91 m in Musselroe No. 1 and at 104 m in Musselroe No. 3 Hole, is hornblende-lamprophyre. This rock is similar to the Cretaceous lamprophyres of the Cape Portland area which are often hornblende-phyric and have been radiometrically dated as having an absolute age of 101 Ma (McDougall and Green; Appendix 3 *in* McClenaghan *et al.*, 1982).

Table 8 presents major oxide and trace element analyses of basalt samples from Holes 1 and 3 and a sample of lamprophyre from Hole 3, together with calculated Rittmann Norms.

The results clearly show that the two basalts are related, and probably derived from the same magma source, but that there are significant differences when the basalts are compared with the lamprophyre. The $K_2O/Na_2O$ ratio is $>$1·0 and this indicates that all three samples belong to the Shoshonite Association (Joplin, 1968). There is a close fit between the three samples and the trends noted by Sutherland (1973) in a study of the Mesozoic shoshonites of Tasmania. Comparison of the three samples with major oxide analyses from Cape Portland (Jennings and Sutherland, 1969) reveals striking similarities.

*Table 8*
*CRETACEOUS VOLCANIC ROCKS, CUCKOO CREEK AREA*

| Field name | Basalt | Basalt | Lamprophyre |
|---|---|---|---|
| Reg. no. | 85–0275 | 85–0276 | 85–0277 |
| Analysis no. | 830787 | 830788 | 830789 |
| *Oxides* | | | |
| $SiO_2$ | 50·87 | 48·43 | 47·85 |
| $TiO_2$ | 1·28 | 1·21 | 1·14 |
| $Al_2O_3$ | 17·19 | 16·10 | 12·41 |
| $Fe_2O$ | 3·21 | 1·95 | 3·03 |
| FeO | 6·40 | 7·70 | 6·87 |
| MnO | 0·16 | 0·24 | 0·17 |
| MgO | 2·97 | 4·39 | 7·35 |
| CaO | 6·62 | 4·43 | 10·85 |
| $Na_2O$ | 2·38 | 1·30 | 1·83 |
| $K_2O$ | 3·08 | 2·89 | 2·36 |
| $P_2O_5$ | 0·90 | 0·84 | 0·46 |
| $H_2O^+$ | 1·80 | 5·14 | 2·50 |
| $H_2O^-$ | 2·17 | 3·04 | 1·88 |
| $CO_2$ | 0·30 | 1·72 | 1·31 |
| Total | 99·15 | 99·38 | 100·01 |
| *Trace elements* (ppm) | | | |
| Sr | 830 | 310 | 500 |
| Rb | 110 | 105 | 82 |
| Y | 30 | 29 | 22 |
| Zr | 150 | 150 | 105 |
| Nb | 10 | 11 | 6 |
| Ni | <3 | <3 | 55 |
| Ba | 910 | 770 | 610 |
| Cr | <5 | <5 | 180 |
| V | 145 | 130 | 280 |
| Sc | 15 | 12 | 34 |
| Pb | 6 | 6 | <4 |
| As | <10 | <10 | <10 |
| Zn | 120 | 125 | 89 |
| Cu | 11 | 14 | 32 |
| Co | 15 | 45 | 58 |
| *Rittman norms* | | | |
| Quartz | 5·2 | 10·1 | 0·0 |
| Sanidine | 24·5 | 29·7 | 19·7 |
| Plagioclase | 48·5 | 8·2 | 34·5 |
| Nosean | 0·0 | 0·0 | 0·3 |
| Clinopyroxene | 0·0 | 0·0 | 38·0 |
| Orthopyroxene | 15·2 | 10·9 | 0·0 |
| Magnetite | 1·3 | 1·2 | 1·4 |
| Calcite | 0·8 | 4·5 | 3·5 |
| Ilmenite | 0·0 | 0·0 | 1·2 |
| Apatite | 2·0 | 1·9 | 1·0 |
| Cordierite | 2·6 | 33·5 | 0·0 |

The greater degree of alteration of the basalts, significant differences in trace element geochemistry, and stratigraphic relationships led to the suggestion that the basalts were possibly Permian in age (Baillie, 1983; 'possible Permian latites' indicated on Eddystone Map, Baillie, 1984*a*). A subsequent radiometric analysis of a sample from 34·2–34·3 m, Musselroe No. 1A, indicated an age of $98{\cdot}7 \pm 0{\cdot}8$ Ma (Baillie, 1984*b*; Appendix B herein). This age is in close agreement with dates from the Cape Portland area [EQ825876] in the adjoining Boobyalla Quadrangle.

## *LAMPROPHYRE DYKES*

As noted previously, several lamprophyre dykes are known to be present in the region and it is almost certain that many more occur than have been observed.

The dykes are usually less than one metre in width and the form of intrusion is controlled by pre-existing joints; in the dykes observed intrusion was controlled by well-defined joints in granite.

The rocks (85-0279, 85-0280, 85-0281) are strongly altered and contain phenocrysts of calcic plagioclase and altered amphibole in a groundmass of laths of plagioclase, opaques and altered mafic minerals, together with abundant carbonate.

A reasonably fresh specimen, found as a beach boulder on Swan Island contains often-twinned phenocrysts of augite (< 8 mm) in a groundmass of felted laths of zoned calcic plagioclase (< 1.2 mm), opaques and alteration products.

## TERTIARY BASALT

Three small areas of basalt occur on the Eddystone Quadrangle in widely disparate regions.

A small basalt outcrop occurs in the Mt William National Park 3 km south of the trigonometrical point at Boulder Point [FQ044695]. The rock (71-527) consists of phenocrysts of olivine and augite in a flow-banded groundmass of plagioclase laths, augite, and opaques. Maximum phenocryst size is approximately 4 mm. The outcrop may either represent a flow remnant or a small vent (Jennings *in* Groves *et al.*, 1977).

Basalt is found in association with sediments of probable Tertiary age to the east of Cinderella Hill [EQ885720]. The basalt occurs as outcrop and also has been found by drilling. In thin section (85-0283, 85-0284) the basalt consists of acicular plagioclase laths (< 1 mm) in a groundmass of black glass, iddingsitised olivine and augite. The rocks have been altered and carbonate is common.

Small basalt occurrences are present in the Bowens Sugarloaf area [EQ925624, EQ917608] in association with Tertiary sediments. These bodies also are probably the remnants of former more-extensive flows.

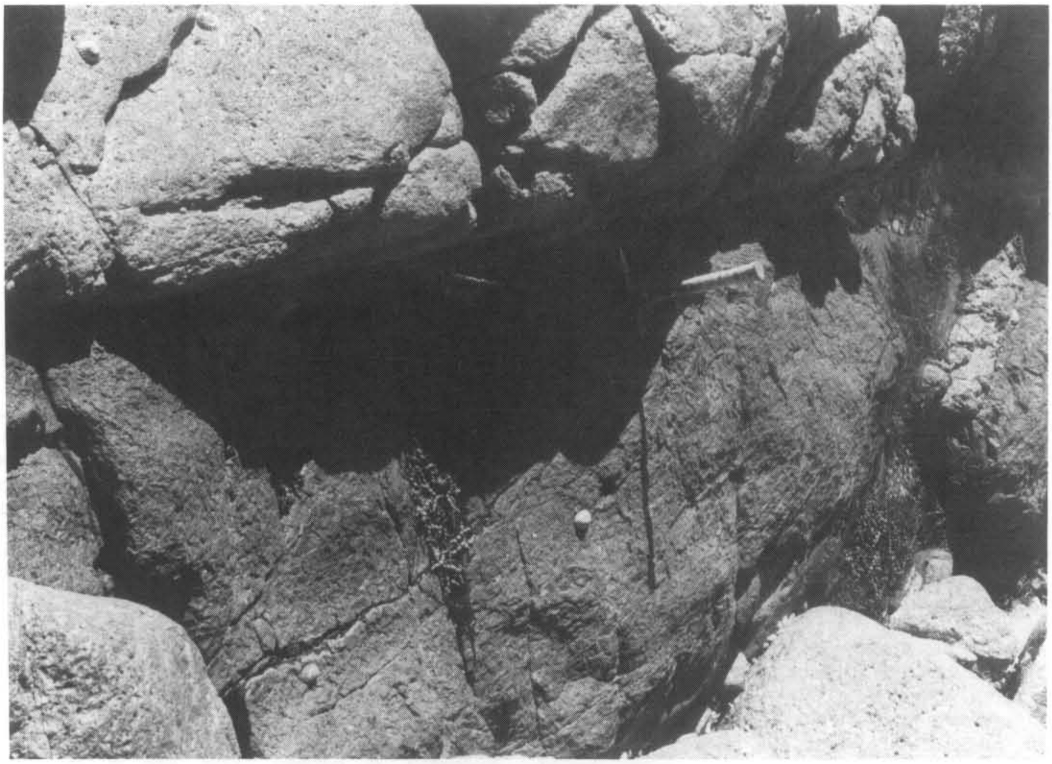

**Plate 16.** *Lamprophyre dyke intruding Devonian granite, Great Musselroe Bay [EQ927841].*

5 cm



# METAMORPHISM AND STRUCTURE

## MATHINNA BEDS

### *DYNAMIC METAMORPHISM*

In north-eastern Tasmania the Mathinna Beds were subject to dynamic metamorphism during folding, prior to granitoid emplacement (Turner, *in* McClenaghan *et al.*, 1982). The metamorphism is represented by fine-grained muscovite-chlorite which crystallised parallel to the axial surface cleavage.

### *CONTACT METAMORPHISM*

Thermal metamorphism of the country rock accompanied granite emplacement and produced metamorphic aureoles, which in the Eddystone region are linear and range in width from 500 m to 2 km.

During mapping the criterion used to delineate aureoles was the presence of spotting in pelites. Hornfelsing of sandstone was found to be an unreliable indicator of thermal metamorphism as hornfelsing can be confused with widespread silicification which is probably related to Tertiary groundwater movements. This was found to be particularly true near areas where ?Tertiary silicified quartz sandstone had been mapped; for example the tract of country lying to the east of Cinderella Hill [EQ905715] includes silicified quartz sandstone of probable Tertiary age, together with sequences of Mathinna Beds (with and without spotted pelites) in which the sandstones have been silicified, presumably by Tertiary groundwater movements.

The width of aureoles, as mapped, is apparently related to granite type. For example the aureole associated with intrusion of Dbg (Gardens Granodiorite) is consistently 1·5–2·0 km in width, whereas the width of the aureole associated with Depc in the Musselroe Bay area is 0·7–1·5 km in width. This variation in width can be related to either *(a)* temperature and depth of intrusion; or *(b)* dip of the granite-country rock contact.

Lack of outcrop in critical areas made it impossible to carry out meaningful studies of interference patterns in overlapping aureoles; for example in the Telegraph Creek area [FQ005640] the contact metamorphism is related to three different intrusions (Dbg, Depc, Deem).

### *STRUCTURE*

Structural data were collected wherever possible from the Mathinna Beds on the Eddystone Quadrangle, but as noted in previous sections outcrop of Mathinna Beds is poor. The best exposed single section is along Fly-by-Night Creek [EQ847646] over a distance of approximately 800 m, and other good exposures are found in old road-metal quarries and some tin mines.

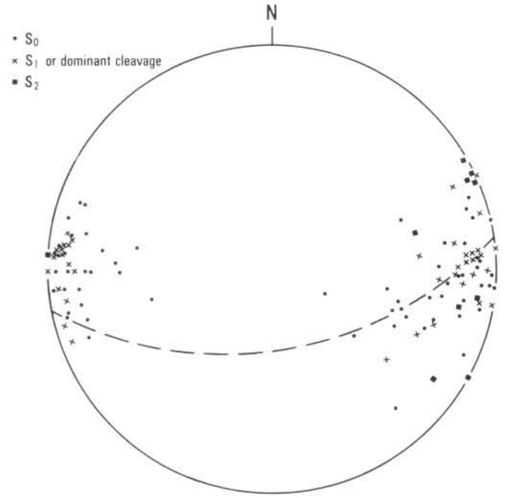


**Figure 6.** *Stereoplot of structural data, Mathinna Beds.*

Figure 6 is a stereoplot of all structural data from the Eddystone Quadrangle, and indicates that the dominant fold trend is northerly, with a gentle plunge to the north. Crenulation cleavage is developed in many outcrops and the principal direction strikes at approximately 155°, although other directions may be developed (fig. 6).

An alternative interpretation of the data (fig. 6) is that $S_1$ could be at an angle ($<25°$) from the fold axis (as is the case elsewhere in north-east Tasmania — Williams, 1970) and that $S_2$ could lie on a small circle with a similar pole to $S_1$.

No precise relationships between cleavage development and thermal metamorphism were determined in the Eddystone Quadrangle, although in the adjoining Boobyalla–Ringarooma region Turner (*in* McClenagahan *et al.*, 1982) showed that deformation occurred both before and after metamorphism.

## GRANITIC ROCKS

Structural data were collected in all granite types in the Eddystone Quadrangle, with the exception of some equigranular varieties in which no preferred orientation of minerals could be ascertained.

The fabric of a granite outcrop is determined by the geometric relationship between apparent lineation of different outcrop surfaces (Williams *in* McClenaghan *et al.*, 1982). In weathered outcrops of porphyritic rocks the three-dimensional form of K-feldspar phenocrysts can be determined and foliations defined, while in other cases phenocryst lineation on a sub-horizontal surface was measured. In coastal outcrops foliations can be determined by study of a number of faces. Fabric of granodiorite outcrops is determined by study of the dominant grain lineation.

## *BLUE TIER BATHOLITH*

### *Granodiorite*

Most outcrops of Dbg show lineations defined by preferred orientation of all mineral species, although the orientation is most obvious in mafic minerals. The lineations reflect the presence of usually very steeply-dipping foliations. In many cases more than one foliation is present in a single outcrop.

Dominant foliation directions measured are north-westerly and west-north-westerly.

### *Porphyritic adamellite* (Dbapc *and* Dbaps)

The determination of fabric in porphyritic rocks in the adjoining Boobyalla–Ringarooma region is fully discussed by Williams (*in* McClenaghan *et al.*, 1982). Dr Williams worked closely with the author during the mapping of the Gladstone area and the methods he applied in his own mapping were applied in the Eddystone Quadrangle mapping.

The regional pattern of steep fabric orientation throughout the mapped portion of the Blue Tier Batholith is shown as Figure 7. Strong maxima are present in the north-westerly and north-easterly directions. The data compare reasonably well the those collected in the adjoining Boobyalla Quadrangle (S. F. Cox; fig. 68c *in* McClenaghan *et al* 1982). The pattern also compares well with the regional pattern of north-westerly and north-easterly maxima in the Ringarooma region (Williams *in* McClenaghan, *et al.*, 1982).

Shallow foliations are also present in many outcrops in the mapped area, but these have not been included in the regional study.

## *EDDYSTONE BATHOLITH*

### *Variably porphyritic adamellite/granite* (Depc)

From a structural point of view this rock is similar to the porphyritic adamellites of the Blue Tier Batholith. Structural data were collected wherever possible, and the regional pattern of steep foliations and horizontal lineations is shown as Figure 8.

Omitted from this diagram are foliations measured in the contact zone in the Musselroe Point area [EQ990793], which as discussed previously (Igneous Geology; fig. 5), are interpreted as having originated by flow.

Shallow foliations are well-developed in many areas, but perhaps their best development is at Picnic Rocks [FQ105636], where several important relationships may be observed. As noted previously (Igneous Geology) xenoliths of granitic rocks are common in this area, and are often associated with biotite-garnet aggregates near their margins. Steep foliations developed in the area penetrate both xenoliths and country rock, whereas shallow foliations appear to abut against the xenoliths. This relationship suggests that the shallow foliation had formed prior to the formation of the steep ones, and so the shallow foliation may be related to either flow or intrusion of the granite body.

The steep foliations and horizontal lineations (fig. 8) show strong north-north-westerly and easterly maxima. This is also true at the outcrop scale where intersecting foliations are commonly observed (see also Williams, *in* McClenaghan *et al.*, 1982).

It is noteworthy that the north-westerly direction is similar to that of one of the maxima of the Blue Tier Batholith (fig. 7).

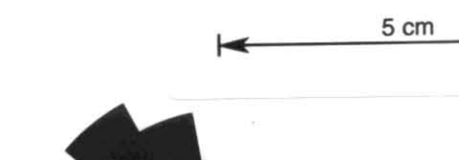


**Figure 7.** *Regional pattern of feldspar foliation. Rose diagram showing north-westerly and north-easterly trends of strike of steeply-dipping foliation and horizontal lineations, Blue Tier Batholith, Gladstone area (73 observations).*


**Figure 8.** *Regional pattern of feldspar foliation. Rose diagram showing NNW and easterly trends of strike of steeply-dipping foliation and horizontal lineations, Eddystone Batholith (157 observations).*

*EQUIGRANULAR MEDIUM-GRAINED GRANITE* (Deem)

A subtle planar fabric is present in this rock type (Mt William Granite) and is defined by the euhedral to subhedral plagioclase (*not* K-feldspar as indicated on Eddystone Map Sheet) crystals less than 10 mm in length. In several instances it was noted that mineral alignments defined by quartz segregations occur in the same directions as the feldspar fabric. Over forty directions of preferred feldspar ± quartz were measured by Dr E. Williams and the author in the Mt William area and the results are shown as Figure 9. Once again a strong north-westerly maxima is present.

*DISCUSSION*

There is a marked major peak in approximately the north-westerly direction which is observed in granodiorite of the Blue Tier Batholith, porphyritic adamellites of the Blue Tier Batholith (fig. 7), porphyritic granites of the Eddystone Batholith (fig. 8), and the Mt William Granite (fig. 9). This maximum approximately corresponds with a crenulation cleavage in the Mathinna Beds (fig. 6), which was also the best-developed crenulation cleavage observed in the region. This north-westerly direction also corresponds to a crenulation cleavage developed on the adjoining Boobyalla-Ringarooma region (Turner, *in* McClenaghan *et al.*, 1982). A similar relationship of coincidence of close correlation of granite foliation peak and the regional $D_2$ fold axis was noted on Maria Island (Baillie *in* Clarke and Baillie, 1984).

Age relationships of the Eddystone and Blue Tier Batholiths probably overlap (Cocker, 1982; Turner *et al.*, 1983; Appendix A herein). They apparently were subject to the same strain conditions which resulted in the formation of the dominant north-westerly foliation as defined predominantly by the feldspar phenocyrsts. The foliation was developed prior to intrusion of aplite dykes (fig. 4a), *i.e.* within the overall period of granite emplacement, and may have resulted from the same stress fields which produced the dominant crenulation cleavage.

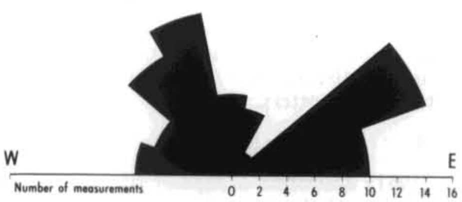


**Figure 9.** *Regional pattern of feldspar foliation. Rose diagram showing north-westerly trends of strike of steeply-dipping foliation and horizontal lineations, Eddystone Batholith* (Deem: *44 observations).*

The conclusions are in good accord with the proposed sequence of intrusion and deformation of the Boobyalla Quadrangle (Turner *in* McClenaghan *et al.*, 1982).

## ECONOMIC GEOLOGY

*V. M. Threader*

### Metallic ores

CASSITERITE

*PRIMARY OCCURRENCES*

Greisenised granite containing cassiterite was exposed below gravel in hydraulic mine workings in the Fly-by-Night Creek, south of Gladstone. The granite was also mined, but no details of production, grade, or remaining reserves are available.

At Murrays [EP856657], a small greisen dyke occurs in slate on Browns Bridge Road on the west bank of the river.

A cassiterite-wolfram lode was discovered in the Royal Tasman gold mine [EP847644] south of Gladstone but no genetic relationship with the gold reef was established.

In summary, there does not appear to have been any economic tin mineralisation in this area apart from the Fly-By-Night greisen at Gladstone.

*SECONDARY OCCURENCES*

The alluvial cassiterite mining fields of north-eastern Tasmania are mainly concentrated in the neighbouring quadrangles of Boobyalla, Ringarooma and Blue Tier. A small area of around 30 km$^2$ in the Gladstone district, constitutes the north-eastern portion of this alluvial field which occupies the south-west corner of the Eddystone Quadrangle.

The primary source of this alluvial cassiterite is the eroded roof of the Blue Tier Batholith where it occurred as greisenised zones, dykes and mineralised quartz veins almost exclusively south and south-west of the Eddystone Quadrangle.

Alluvial cassiterite has been mined in the Gladstone district since the 1880s and is continuing today on a very small scale but world-wide over-production and lower grades have almost completely closed the industry.

There are no known prospective areas remaining in this district and it is not anticipated that an improvement in the tin market will have more than a marginal effect in this part of the alluvial field. Keid (1946) produced a bibliography and summary report on tin mining in the district.

The named alluvial workings, taken from old charts of the district, are in alphabetical order:

Amber Hill [EP862603] (partly in the Blue Tier Quadrangle)

5 cm

Bridge [EP856657]
Cybele [EP892640]
Edina [EP887618]
Empress [EP861655]
Garfield [EP862647]
Lawry [EP874655]
Lanka [EP872607] (partly in the Blue Tier Quadrangle)
Lochaber [EP849675]
Popes [EP853680]
Purdue [EP872615]
Scotia [EP841644]
Star Hill [EP877654]
Tamar [EP867654]

Some of these workings are in channel deposits (tin gutters) and others others are in sheet deposits (drift). The latter type are presumably the result of recycling of the former by river action. Some deposits may contain both types of occurrence.

## GOLD

### *PRIMARY OCCURRENCES*

#### *Musselroe Reef*

Four gold reefs are known west of the Musselroe River and north-west of Gladstone:
Grand Flaneur [EP892751]
Prince Imperial [EP891740]
Bluebell [EP891736]
Portland [EP888703]

Nye (1933) mentions other minor occurences east of the Musselroe River. These contained free gold at the surface and were all quite rich (37 g/t). The gold was associated with pyrite, arsenopyrite and galena. At depth, gold was only found in the sulphide minerals and it was concluded that the surface gold had been liberated from weathered sulphides.

The workings were generally shallow but one shaft was sunk to 30 m.

These gold reefs occur in Mathinna Beds and it has been suggested by Groves and Gee (1971) that this segment of Mathinna Beds was 'rafted' eastwards by the emplacement of the Poimena Pluton.

A pre-Poimena reconstruction would bring these sediments into contact with the belt of Mathinna Beds sediments which contains the Mangana to Waterhouse line of goldfields.

The theory is supported by matching granitic boundaries, by foliation trends in the granite, by buckling of fold trends in the Mathinna Beds and the similarity in gold fineness (in both the Musselroe and Warrentinna goldfields the silver content was frequently higher than gold content).

The theory implies that the gold mineralisation of the line of goldfields and the Musselroe goldfield pre-dated the emplacement of the Poimena pluton with which the tin mineralisation is associated.

#### *Gladstone Reefs*

In 1880 several gold reefs were discovered immediately to the south of Gladstone township. Some very rich ground was worked and a minor gold rush developed but within two years the values had declined and operations ceased. Minor revivals took place in 1909, 1916 and 1931 but were also short-lived (Nye, 1932).

The workings were:
Royal Tasman [EP847644]
North Tasman [EP846646]
Deskford [EP848643]
Lady Tasman [EP849642]
Royal Mint [EP847643]
South Royal Mint [EP848641]
Royal Standard [EP849647]
North Royal Standard [EP847648]
South Royal Standard [EP849645]

These were gold-quartz lodes, roughly parallel and striking NW–SE.

The Royal Standard lode also contained cassiterite, a trace of platinum was recorded in a sample from the Royal Tasman reef and a wolfram-cassiterite lode striking ENE-WSW crossed the Royal Standard lode and was thought to be older than it. These mutual associations were recorded by Twelvetrees (1916), there are no extant mineral specimens available for further study.

Coarse Gold Creek lies to the north of Gladstone in the loop of Ringarooma River. Some patches of alluvial gold were found here, and near them a reef of quartz, 0·7 m wide, containing a little gold. Nye (1932) states that a small amount of cassiterite appears to be present in all the gold reefs of the Gladstone goldfield.

## NON-METALLIC MINERALS

### *CLAY*

A proline (power auger) survey along the Portland, Browns Bridge, Musselroe, Gladstone and Eddystone Roads was conducted in 1968 to search for paper-filler clay. No suitable clays for the purpose were found in this quadrangle but some holes which were drilled north and east of Gladstone intersected weathered Mathinna Beds which were potential brick-making materials. There is no market for brick clay in the district but the occurence may be of interest to potters.

### *MICA*

Jack (1961) described a deposit of muscovite in the abandoned 'tin' workings of the Fly-By-Night mine [EP853642] at Gladstone. He estimated a reserve of 10 000 t of mica and a potential additional reserve of 50 000 t. This was estimated on the basis of at least 10% muscovite in the greisen but the material was fine-grained and much of it was less than 0·6 mm.

## *AGGREGATE*

The lithologies which provided road-making materials in the Eddystone Quadrangle are Mathinna Beds sandstone from pits along the Musselroe Road for use as base coarse aggregate and Tertiary, granite-derived granule sand from pits along the Eddystone Road for use as surface coarse aggregate.

The Mathinna Beds material has a rather high clay content due to presence of interbedded slate in the sequence but is used because no alternative exists.

The granule sand occurs as a lag gravel on the Tertiary sediments where clay has been leached from the surface layers and redeposited at lower levels. There is therefore a layer, usually less than 0·5 m of granule sand over a clay enriched layer. Several pits in this material occur along the Eddystone Road and the area of Tertiary sediments shown on the geological map and occupying more than 50 $km^2$ is prospective for this type of material.

The abandoned sand pits on the Eddystone Road are good examples of bad mining practice where unsystematic working has resulted in low resource recovery and visual pollution.

There is a large resource of washed sand and gravel in the tailings dumps resulting from the hydraulic mining for tin in the area south and west of Gladstone. This material contains little, if any, clay, and would therefore not be suitable as a road aggregate but would be suitable for use as a concrete aggregate and would find a ready market if located close to a population centre.

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## APPENDIX A

### Definition of the Eddystone Batholith

*N. J. Turner*
*P. W. Baillie*
*M. P. McClenaghan*

### INTRODUCTION

A new regional name, the Eddystone Batholith, is introduced for the granitic rocks of far north-eastern Tasmania (fig. 10). The rocks have previously been included in the Blue Tier Batholoith. Introduction of a new name will focus attention on the physical separateness of the rocks from those within the Blue Tier Batholith and on compositional differences between the volumetrically dominant biotite granite/adamellites in the two batholiths.

### DISCUSSION

Parts of the Eddystone Batholith appear on the Boobyalla, Eddystone and Blue Tier 1:50 000 maps sheets. The overall distribution is shown in Figure 1. The batholith is separated from the Blue Tier Batholith by a substantial tract of Mathinna Beds except in part of Blue Tier Quadrangle where the boundary between the two batholiths is a major fault.

Carey (1953) included the Eddystone Batholith in his Furneaux Anticlinorium which he regarded as a regional granitoid structural unit distinct from what is now called the Blue Tier Batholith. Carey's terminology has not been followed by subsequent workers and McDougall and Leggo (1965) included the granitoids of the Eddystone Batholith in their Blue Tier Batholith. Gee and Groves (1971) and Groves (1977) adopted the same practice.

Groves subdivided the granitoids of the Eddystone Batholith into lesser units, namely, the Boobyalla, Rushy Lagoon, Musselroe and Ansons Bay plutons and the Mt William Sheet. Of Groves' units only the Mt William Sheet forms an entity on the 1:50 000 maps. The other units occur in regions of biotite-garnet-minor muscovite granite/ adamellite within which no contacts that could be interpreted as pluton margins have been established. Variations occur in both grain size and texture but individual variants are impersistent. The widespread occurrence of garnet (and cordierite) as an accessory phase distinguishes the biotite granite/ adamellite of the Eddystone Batholith from the biotite granite/adamellite of the Blue Tier Batholith.

Kitto (1982) introduced the term Ansons Bay Batholith for granitoids between Musselroe Bay and Eddystone Point. He also included an area of granodiorite (Gardens Pluton) that is part of the Blue Tier Batholith. Given such confusion and the probability of further confusion with the pluton nomenclature of Groves (see above) we prefer to introduce another name for the batholith rather than to attempt a redefinition of Kitto's term.

Age relationships of the Eddystone and Blue Tier Batholiths may overlap. At Boobyalla a dyke, continuous with garnetiferous granite/ adamellite in the Eddystone Batholith transects the Mathinna Beds screen and intrudes all granitoid types in the northern part of the Blue Tier Batholith. However, Cocker (1982) obtained a Rb/Sr biotite age from George Rocks (fig. 1) of 375 Ma which is older than biotite ages from the largest biotite granite/adamellite body (Poimena Pluton) in the Blue Tier Batholith (368, 373, 373 Ma).

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5 cm



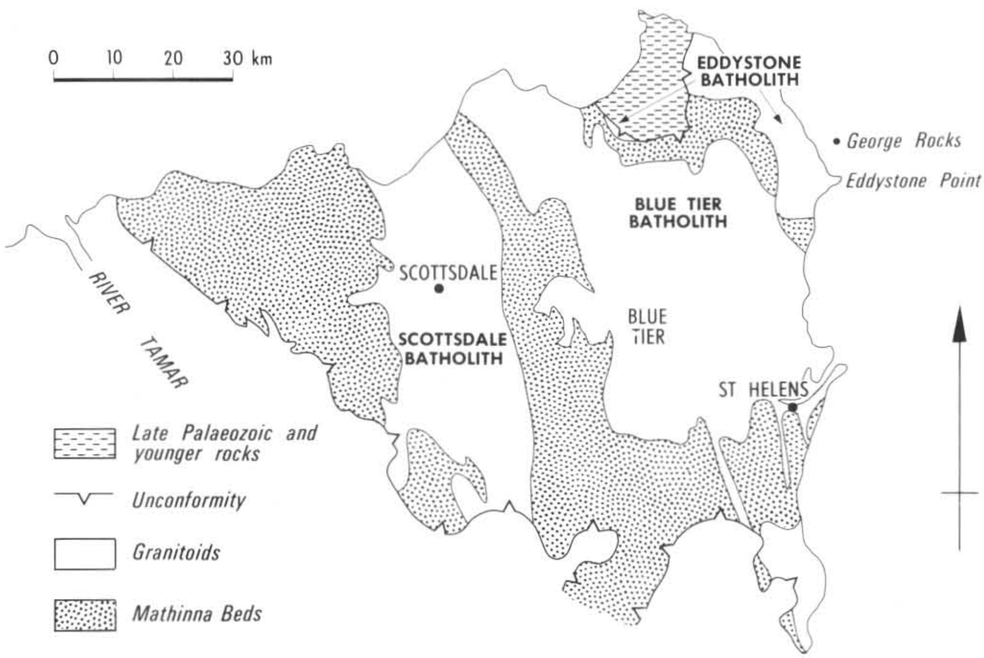


**Figure 10.** *Location map of the batholiths of north-eastern Tasmania.*


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## APPENDIX B

### A radiometric age for volcanic rocks at Musselroe Bay.

*P. W. Baillie*

As part of an investigation into the resources of the Musselroe Bay area, three boreholes were drilled in an attempt to elucidate the Permian stratigraphy of the area (Baillie, 1983). Two of the boreholes revealed the occurrence of intrusive and extrusive shoshonites, the presence of which were not suspected prior to drilling. Although chemically similar to dated Cretaceous rocks in the Cape Portland area, the lack of hydrous-phase minerals and degree of alteration led to the suggestions that the rocks might be Permian in age (Baillie, 1983).

Three core samples were examined for possibly K/Ar dating; one was selected by Dr D. C. Green and a prepared sample was forwarded to Amdel for dating.

The sample subsequently dated was from 34·2–34·3 m, Department of Mines Borehole 1A, Musselroe Bay.

## RESULTS

Standard techniques were used to determine the potassium content in duplicate and for the extraction and isotopic analysis of the argon.

The analyses and calculated age are given below:

| | | |
|---|---|---|
| *%K* | 2·545 | 2·555 |
| *Ar*(x $10^{-10}$ moles/g)* | 4·483 | |
| *Ar*/$^{40}Ar_{total}$* | 0·975 | |
| *Age (x $10^6$ years)* | 98·7 ± 0·8 | |

*Denotes radiogenic Ar

Constants used:

$^{40}K$ = 0·01167 atoms%

$\lambda_\beta = 4{\cdot}692 \times 10^{-10}\ y^{-1}$

$\lambda_\epsilon = 0{\cdot}581 \times 10^{-10}\ y^{-1}$

## DISCUSSION

The determined age is in close agreement with K/Ar ages obtained from hornblende occurring in an intrusive complex (102·3 ± 2·6 Ma), and as dykes (101·3 ± 2·6 Ma) in the Cape Portland area (McDougall and Green, Appendix 3 *in* McClenaghan *et al.*, 1982).

On the basis of evidence from Cape Portland, the Boobyalla area and Durroon 1 (drilled by Esso in 1973), Moore *et al.* (1984) suggested that a minor volcanic episode affected the south-eastern sector of the Bass Basin at about 100 Ma, and that the volcanism was related to the possible tectonic disturbances which produced the marked unconformity between the Early Cretaceous Otway Group sediments and the Late Cretaceous and Eocene Eastern View Coal Measures.

Evidence presented herein extends the known extent of mid-Cretaceous volcanism in north-east Tasmania, although isolated small dykes of hornblende lamprophyre had previously been known from Great Musselroe Bay, Cod Bay and George Rocks (Baillie, 1984; Sutherland and Corbett, 1974).

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