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SMITHTON

TASMANIA DEPARTMENT OF MINES

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SMITHTON

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INTRODUCTION

Previous literature and nomenclature

A. V. Brown

The earliest detailed study of the Smithton Basin was by Nye *et al.*, (1934), who defined the geology of the Smithton Quadrangle in five 'Stages'. Their first two grey-green stages consisted of a 'White Quartzite Stage' at the northern end of Beacom Hills (previously White Hills) and, a 'White Quartzite Stage', at Briant Hill (previously Bryant Hills). Carey and Scott (1952) later grouped these two stages together as the 'Bryant Quartzite'. By doing so they combined the quartzitic sequence, which crops out on the northern part of Briant Hill ('Grey-green Quartzite Stage'), and which is now known to be part of the Precambrian Cowrie Siltstone correlate (Lennox *et al.*, 1982), with the quartzite succession on the northern end of Beacom Hills ('White Quartzite Stage'), which is now known to be part the younger siliceous clastic sequence, the Forest Conglomerate and Quartzite (Lennox *et al.*, 1982). In the Beacom Hills area, the Forest Conglomerate and Quartzite overlies a laminated quartzite sequence, which is similar to that at Briant Hill, but which is a part of the Precambrian Cowrie Siltstone. The term 'Bryant Hill Quartzite' / 'Bryant Quartzite' is now redundant as it refers to a small part of the Cowrie Siltstone correlate.

Stage three of Nye *et al.*, (1934) consisted of two sub-stages; a dolomite substage (IIIa), their 'Irishtown Dolomite', which extended from Wiltshire in the north to Nabageena in the south; and a chert substage (IIIb) which occupies the southern end of Briant Hill. Stage four was 'Slates, breccias, and limestone', being the north-south area of interbedded siltstone, mudstone, greywacke and minor, tuff and basic volcanic breccia running from Smithton, south, past Scotchtown. This succession is considered to be a correlate of the Crimson Creek Formation of the Dundas Trough to the south-east (see Brown, 1986). Stage five was another dolomite stage and consisted of the dolomitic rocks which underlay the Duck and Montagu River plains, which they termed 'Duck River Dolomite' or 'Smithton Dolomite'.

Hills and Carey (1949) used the term 'Smithton Dolomite' to refer to numerous areas of carbonate / dolomite successions throughout Tasmania, most of which is considered to be a correlate of the Success Creek Group of the Dundas Trough (see Brown, 1986). Carey and Scott (1952) combined the two dolomite sequences of Nye *et al.*, (1934), their 'Duck River or Smithton Dolomite', and their 'Irishtown Dolomite' into one succession, the 'Smithton Dolomite'. Gulline (1959) correlated the 'Black River Dolomite' with the dolomite sequence at Irishtown and South Forest ('Irishtown Dolomite'), which had already been correlated with the 'Smithton Dolomite' by Carey and Scott (1952), and the notion of the one dolomite succession for the whole of the Smithton Basin was consolidated (e.g. Gee, 1968; Williams, 1978; Lennox *et al.*, 1982).

Gee (1968) recognised the unconformable relationship between the Cowrie Siltstone and the Forest Conglomerate and Quartzite along the foreshore of the Black River, and correlated the 'Black River Dolomite' and the Forest Conglomerate and Quartzite, in the Black River area, with the 'Smithton Dolomite' in the Smithton area.

Spry (in Hughes, 1957) considered that 'Smithton Dolomite' had precedent over 'Duck River Dolomite' and that it was established in the literature. He then formally defined the formation, with the type area being given as immediately west of the Duck River, north of the Smithton–Marrawah road. Spry (1957) also described the dolomite sequence at Black River as the 'Black River Dolomite' and considered this sequence to be stratigraphically 'rather low in the Rocky Cape Group'. Later (Spry, 1964), he altered this view and described the relationship at the Black River bridge as being: Cowrie Siltstone, unconformably overlain by a sequence of conglomerate, quartz sandstone, chert, and then the 'Black River Dolomite'. The conglomerate, sandstone and chert sequence he called the Forest Conglomerate and Quartzite.

McNeil (1961) and Longman and Matthews (1962), working in the Arthur River area to the south of Smithton, described the dolomite and underlying quartzitic sequence in that area as having a transgressive relationship to the Cowrie Siltstone and suggested an unconformable relationship.

Recent work (Large, 1982; Baillie and Crawford, 1984; D. B. Seymour, pers. comm., 1986) to the west of the Smithton area in the Welcome Quadrangle, indicates that there are two stratigraphically different dolomite successions. The lower one conformably overlies a correlate of the Forest Conglomerate and Quartzite and is lithologically similar to the Black River Dolomite. To the east of the outcrop area of this lower dolomite sequence occurs a zone occupied by similar rocks to those found in the Smithton–Trowutta basalt-sedimentary rock association, which is considered to be a correlate of the Crimson Creek Formation of the Dundas Trough. Further east, underlying the Montagu River plain, is a second carbonate succession which, on preliminary evidence, appears to conformably underlie the fossiliferous Middle–Upper Cambrian successions in the Christmas Hills–Scopus areas. This second carbonate succession is unsilicified and is lithologically similar to the carbonate sequence which underlies the Duck River plain, (D. Seymour, pers. comm., 1986), the original 'Smithton Dolomite'.

The Black River Dolomite contains an upper succession of stromatolite bearing mixtite units with clasts of *Baicalia* cf. *B. burra* in the Forest (Brown, 1985), and Julius River areas (Griffin and Preiss, 1976). Similar sequences are found in the Jims Plain area to the south-west of Montagu on the Welcome Quadrangle (Seymour pers. comm. 1986).

It is recommended that the term Black River Dolomite (after Spry, 1964) be used for the dolomitic sequence conformably overlying the Forest Conglomerate and Quartzite and conformably underlying the Smithton–Trowutta basalt-sedimentary rock association, in the Black River–Forest–Irishtown–Nabageena area and to the south in the Arthur River and Julius River areas on the Trowutta 1:50 000 Map Sheet. Similarly, Smithton Dolomite (Spry in Hughes, 1957, after Nye *at al.*, 1934) be used for that dolomitic succession which underlies the Duck River plains, where the type area occurs, and correlates underlying the Montagu River plains.

Following this recommendation, the late Precambrian – Cambrian stratigraphy of the Smithton Area would be:

Fossiliferous Upper–Middle Cambrian Successions, the Christmas Hills–Scopus association

Unproven relationship, but most probably conformable

Smithton Dolomite

Unknown relationship but possible conformable

Smithton–Trowutta basalt-sedimentary rock association (correlate of the Crimson Creek Formation of the Dundas Trough)

Conformable and gradational contact

Black River Dolomite   ⎰ Correlate of the

Conformable and gradational contact   ⎬ Success Creek Group

Forest Conglomerate and Quartzite   ⎱ of the Dundas Trough

—— *Unconformity* ——

Cowrie Siltstone   ⎰

Detention Quartzite   ⎬ Rocky Cape Group

Irby Siltstone   ⎱

The first description of the (?)Cambrian basalt in the Smithton area was by Twelvetrees and Petterd (1898), followed by Petterd (1910), Ward (1911) and Nye *et al.*, (1934). Other studies, on a wide variety of rocks and not mentioned above include: Nye and Blake (1938); Carey and Scott (1952; 1953) and Foden (1974).

Studies of Tertiary to Quaternary basaltic and sedimentary deposits covered by the Smithton Map sheet have been carried out by Johnson (1888); Twelvetrees (1903); Stephens (1908); Edwards (1941*a–b*; 1950); Gill and Banks (1956); Davies (1961); Cromer (1971) and Colhoun (1977).

PHYSIOGRAPHY

Stanley Peninsula – Port Latta area

P. W. Baillie

For convenience, the physiography of the above areas is described in two parts: the Stanley Peninsula and the Black River–Port Latta area.

STANLEY PENINSULA

Physiographically, the Stanley Peninsula can be described as a ridge of basalt (Green Hills, CQ545850) connected to the mainland by a Y-tombolo (Edwards, 1941). On either side of the tombolo spits have enclosed shallow bodies of sea - East [CQ550810]) and West [CQ520810] Inlets. These spits are lateral extensions of extensive beach ridge systems that are assumed to have a Holocene age on the basis of relative lack of soil development. Truncations of beach ridges in the system immediately west of Green Hills [CQ537845] reflect

Plate 1. Well-developed Late Pleistocene (?) marine terrace on the western side of Green Hills. Prominent lower terrace at right of photograph is probably related to Holocene sea level.

changes in wave pattern caused by wave refraction changes, possibly due to increase of sand volume in West Inlet.

The beach ridges and other dune systems are developed on an older, seaward-sloping sand surface (plate 1) that is probably of Last Interglacial (approximately 125 000 years B.P.) age. This sandy plain reaches a maximum height of approximately 20 m above mean sea level (AMSL).

Stanley [CQ560860] is built on an old cobble/boulder beach 10-15m AMSL (plate 17). Similar deposits form the low surface at the northern end of the Stanley Peninsula between Western Plains [CQ535890] and North Point [CQ530916].

Figure 2 is a west-east profile across the Stanley Peninsula and clearly shows the development of the Last Interglacial surface below the 20 m contour, together with the development of a prominent surface below the 3 m contour. The age of the younger feature is unknown, and can be readily observed from the road at the northern end of Godfreys Beach where the road does a sharp left- hand bend as it begins the climb towards Highfield [CQ561876].

Edwards (1941) cites evidence for the retreat of the spit bounding East Inlet [CQ551823], and the consequent silting-up of Stanley Harbour.

BLACK RIVER – PORT LATTA AREA

This area consists of a dissected plateau of Precambrian and Cambrian rocks with Tertiary basalt at a height of 60-80 m. The plateau has a sharp, scarp-like boundary with the ?Last Interglacial depositional surface. Beach ridges have developed at the seaward extremity of this surface (Gill and Banks, 1956; Davies, 1961).

The Black River is the major river system in the area, and appears to be in a state of rejuvenation, as evidenced by the lack of deposits forming at the present time. Up to 6 m of gravels are exposed in various cuttings and were deposited during times of higher water discharge than the present.

In the valley east of Forest [CQ540755] extensive deposits of alluvium occur on a basement composed of carbonate/chert. The present drainage is by way of a small misfit stream, suggesting either an underground drainage or a former course of the Black River with high water discharge.

A major controlling factor in the development of coastal deposits in the Smithton Quadrangle is the relatively high tidal range. The broad inter-tidal sand flats have been on important sediment source, both during Holocene and Pleistocene times.
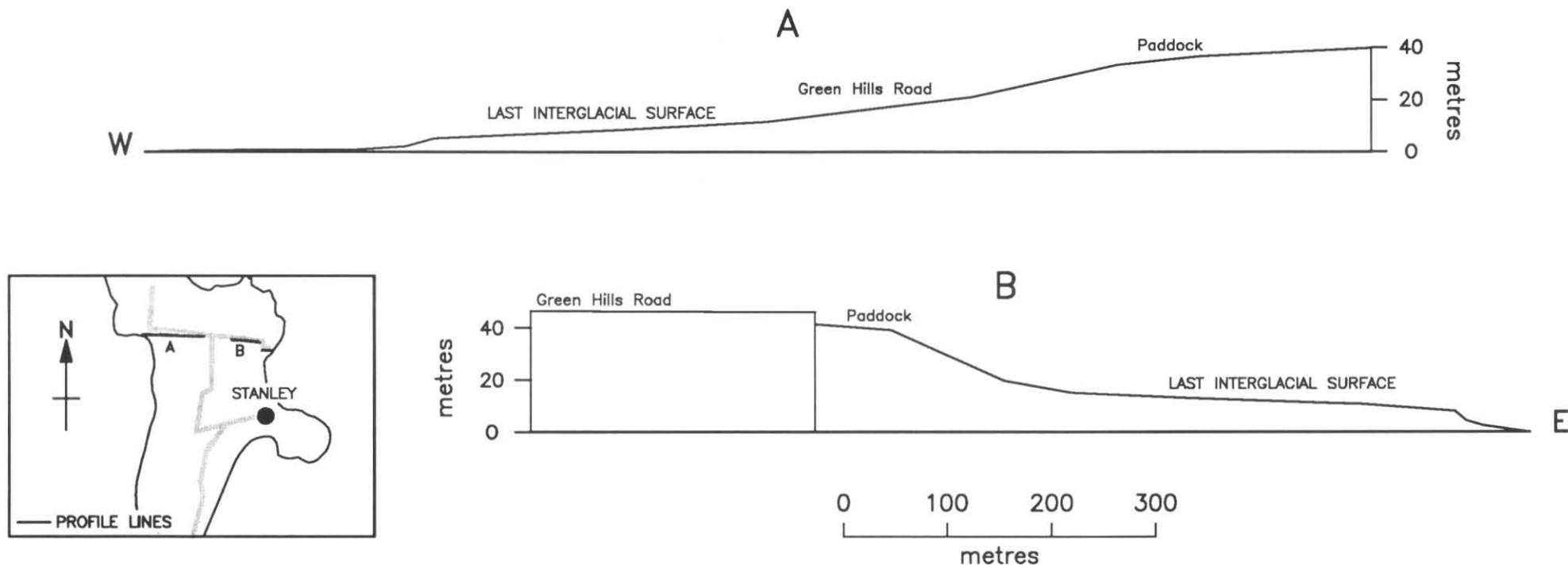
Figure 2. A W–E profile across the Stanley Peninsula showing the development of the Last Interglacial surface below 20 m A.S.L.

Smithton – Forest area

K. D. Corbett
E. B. Corbett

INTRODUCTION

The Smithton-Forest area straddles two major physiographic provinces, *viz.* a coastal, sand-covered plain forming a deep embayment into the older rocks (Anthony Beach, CQ470810 to Tallows Folly, CQ485785), and a dissected plateau, developed on Precambrian and Cambrian rocks and partly covered by a thin veneer of Tertiary basalt, to the south. Farther to the south of this low plateau, which has an average elevation of 60–80 m, is a range of basalt hills forming a high plateau with an average elevation of about 200 m but rising southwards. Outliers of the lower plateau are represented by the hills of Late Precambrian-Cambrian rocks at Smithton and by Briant Hill [CQ450770].

There are strong indications that the Tertiary basalt was poured out onto a more or less flat plain, with an elevation of about 50–60 m, since the base of the main basalt mass in the Forest area closely approximates the (inferred) 50 m contour. The base of the basalt at the foot of the higher plateau occurs near the 80-metre contour to the south-west but comes below 60 m near South Forest [CQ520725], so that continuation of the sub-basalt plain, rising gently south, beneath the high basalt plateau seems likely. The present lower plateau, however, is developed on basalt in the Forest area, and possibly represents a period of post-basalt erosion which has partly exhumed the pre-basalt surface.

COASTAL SAND PLAIN

This has an average elevation of 10–30 m, and is largely covered by wind-blown sand left by the retreating strand line in the later Tertiary and Quaternary. To a large extent it is developed on dolomite, but it also transgresses other rocks. Remnants of old barchan dunes are apparent in many places [eg. CQ470750, CQ455763] and in several areas surround or partially surround circular swamps (lunettes). The thickness of the sand cover varies greatly, from 25 m or more under the old dunes, to zero where patches of bedrock appear. The inland margin of the plain around the main basalt area shows a variable deposit of ironstone gravel and bedrock rubble sitting on shallow bedrock and probably represents a lateritised littoral deposit. A patch of sandy quartz gravel, up to cobble grade, occurs on the sand plain just west of Briant Hill, and may represent an alluvial or beach deposit. Drifts of windblown sand extend from the plain up the flanks of many of the hills (e.g. Marthicks Hill [CQ415745] and Briant Hill) and form isolated patches on higher ground in some areas.

Inland, the sand gives way to alluvial deposits up the major valleys. Although the more recent stream deposits are younger than the sand, and consist largely of reworked sand, it appears that more extensive older alluvium may be largely blanketed by the sand.

Seaward, the edge of the sand is commonly formed by a well-defined terrace, up to 5 m or so high, which may front onto a wave-cut platform of older rocks, as around Duck Bay, or onto a lower terrace, or onto tidal salt marsh. The lower terrace is best seen along the southern shore of West Inlet. It is covered by a thin veneer of sand, with bedrock outcrops in places, and merges laterally into tea-tree swamps. It drops a few metres or less onto the salt marsh. Two similar lower terraces can be seen near the mouth of Duck River. Quaternary beach ridges front the sandplain between Duck Bay and West Inlet.

THE LOWER PLATEAU

Most of the bedrock mapped occurs on this plateau or its remnants, including the Late Precambrian rocks around Smithton, the Precambrian rocks of Briant Hill and Beacom Hills and adjacent areas, and the basalt and underlying rocks of the Forest-South Forest area. The plateau is fairly clearly delineated from the coastal plain by fairly steep slopes, presumably representing old cliff lines. The higher parts of the plateau lie above the 60 m contour, with some areas up to 80 m. The inland margin of the plateau is fairly well defined by the 100-metre contour, while the western margin is a more or less linear scarp falling to the Welcome Swamp between Smithton and Edith Creek. Apart from the extensive basalt cover around Forest, there are isolated patches of basalt in other areas, and the present of deep brown soils in places where there is no present basalt rock suggests a more extensive basalt cover.

DRAINAGE

The major creek systems are those of Coventry Creek, a tributary of the Duck River in the west and Deep Creek and its tributary Sedgy Creek, draining into Duck Bay. The present courses of the creeks are somewhat unusual, and may be different from the earlier (Tertiary) courses. Coventry Creek cuts through the ridge of Late Precambrian-Cambrian rocks to join the Duck River, yet it could follow the sand plain north to Duck Bay parallel to Deep Creek, and may have done so originally, although no blocking structure is apparent. The head of this creek is a low flat divide just north of Irishtown, and the presence of knolls of coarse alluvial gravel near the isolated basalt outcrop [CQ437718] in this area suggests the possibility of an originally larger stream draining north from the Irishtown valley.

The upper reaches of Deep Creek and Sedgy Creek both have tributaries draining the flat dolomite valley at South Forest. Large areas of coarse alluvial gravel occur in this valley, but are not related to the present drainage. The natural outlet for this valley is into an adjacent dolomite valley just north of South Forest, and thence north-east into the Black River. Extensive alluvium is known to occur in the latter valley, which at present has only a small creek. The two valleys are separated now by a low ridge of basalt, but in pre-basalt times the drainage may well have been through this gap.

STRATIGRAPHY

Precambrian

ROCKY CAPE GROUP

Introduction

P. G. Lennox

Gee (1968) defined the 5000 m thick Rocky Cape Group in the general area around Rocky Cape, Sisters Hills, Dip Range and Mawbanna. He subdivided it into the Cowrie Siltstone (base), Detention Subgroup, Irby Siltstone and Jacobs Quartzite (top). It is unconformably overlain by the transgressive Forest Conglomerate and Quartzite.

The drainage basins of the Black and Detention Rivers are underlain by all of the units of the Rocky Cape Group, except for the Jacobs Quartzite.

The stratigraphy, folding and faulting within the Rocky Cape Group observed by Gee (1971) on the Table Cape sheet can be traced into the eastern half of the Smithton Map Sheet.

The base of the Rocky Cape Group is not exposed on the Smithton Map Sheet. Underneath the bridge on the Bass

Highway over the Black River [CQ572767] an unconformity is exposed, between underlying folded Cowrie Siltstone of the Rocky Cape Group and the overlying Forest Conglomerate and Quartzite. This surface is also exposed at CQ556759 and in a quarry off Tierneys Road [CQ504680].

COWRIE SILTSTONE

Dip Range – Shakespeare Hills area

P. G. Lennox

The Cowrie Siltstone is the lowermost formation of the Rocky Cape Group. The base of this formation is not exposed on the Smithton Map Sheet, but the top outcrops on the Dip Range [CQ733612] and in extensive exposures on the western margin of Shakespeare Hills [CQ636682–CQ664667–CQ678619]. This formation covers about 84% of the Black River to Detention River drainage basin. It has been folded, intruded by dolerite dykes and faulted. The mineralogy of this succession indicates regional metamorphism to lower greenschist facies.

The Cowrie Siltstone consists of distinct or faint laminae (2 mm) or layers (10–20 mm) of siltstone in a commonly highly siliceous mudstone matrix (Mawbanna), or usually pyritic black mudstone with spaced layering (Hellyer). Spry (1964, table II, p. 31) reports the Cowrie Siltstone from Crayfish Creek [CQ653759] as having 74% silica, which is high compared with the average shale at 58% (Pettijohn, 1975, pp. 274).

A characteristic rock type within the Cowrie Siltstone occurs at the three main exposures; Knife Edge [CQ651676], Hook Creek [CQ667666] and 'Burma Trail' [CQ674653]. In hand specimen (77/766) the greenish-pale grey (when fresh), highly siliceous mudstone exhibits rough disjunctive cleavage (Powell, 1979) with 0.5–1 mm spacing, at a low angle to bedding. In thin section it consists of abundant detrital quartz grains (18 μm to 40 μm across, 40–45%) and minor chlorite-sheathed acicular muscovite (up to 180 μm × μm, 5%) in a fine quartz and sericite groundmass. As only three good outcrops with these lithologically distinct characteristics exist, a separate formation cannot be justified.

As Gee (1967, p. 28) pointed out, the grain size of the Cowrie Siltstone decreases to the west between Rocky Cape Hamlet [CQ724705] and the Black River [CQ573767].

Petrography

The Cowrie Siltstone is usually weathered to either a pale brown, crimson and grey (77/793) or commonly light to dark grey or buff, and is commonly laminated and bedded on a scale of 20–150 mm. One dominant cleavage is usually present, which may give hand specimens a distinctive sheen (77/708, 78/62).

In most thin sections, opaque to translucent zones define the cleavage. The opaque mineral grains form wavy stringers parallel to the cleavage (80/121), cf. rough disjunctive cleavage of Powell (1979), or a continuous stringer fabric (77/708). Alternatively, a spaced discontinuous opaque stringer (77/789, 78/809, 80/107), or straight discontinuous opaque fabric may be present (78/814). The opaque mineral grains in specimen 77/793 form a skeletal anastomosing fabric whereas those in sample 80/106 form an anastomosing mesh. Only in rare cases, such as in specimen 80/110, does a lepidoblastic sericite fabric dominate.

Acicular muscovite is a minor to rare component. Rare acicular muscovite parallel to the cleavage occurs in sample 77/665 whilst occasional parallel blades occur in specimens 77/791 and 78/62.

Quartz-grains and sericite form 50–60% of most samples, usually in a very fine-grained groundmass which is not microscopically resolvable. Those quartz grains which have be examined under the microscope display undulose extinction (*contra* Spry, 1964, p. 47), may be composite grains (80/109), may show scalloping and elongation (77/668), and in rare cases have sericite beards (77/708).

In some thin sections sedimentary structures are clearly discernible, e.g. flame structures (77/715, 77/719), cross-lamination (77/795), mud-pellets (77/791, 80/133) and grading (77/795).An outcrop in a tributary of Gibson Creek, well removed from visible igneous bodies, appear to show chert-spotting (80/107). Minor chlorite and sericite (~3%) as 0.8 mm diameter blobs of secondary origin are present in sample 80/108. These are surrounded by intensely developed, converging, opaque stringers.

Sample 80/112 exhibits calcareous patches surrounded by a dominantly quartz-sericite matrix. These may be vug fillings. In some samples (especially 80/114, 78/809) iron-staining is abundant.

Sedimentary structures

The Cowrie Siltstone cropping out along the coast displays abundant depositional features, including iron oxide-iron hydroxide(s) bodies, pseudo-nodules of various morph- ologies (plates 2–3), slump structures, cone-in-cone structures (E. Williams, pers.comm.) of differing sizes, and possible evaporite deposits in some beds near Port Latta. Graded bedding and current ripples are common in the foreshore outcrops between Port Latta and Rocky Cape. Disrupted bedding and

Plate 2. Examples of pseudonodules and load cast structures from the Cowrie Siltstone, western end of Hellyer Beach [CQ667751].

Plate 3. Close-up of pseudnodules in Cowrie Siltstone, Edgcumbe Beach [CQ663753] – c.f Gee (1971, fig. 5a).

Plate 4. Festoon cross-lamination from a highly siliceous mudstone bed within the Cowrie Siltstone near Edgcumbe Beach [CQ665752]. The vertical jointing is related to the dominant regional cleavage.

Plate 5. Cone-in-cone structures from the Cowrie Siltstone outcrop on the foreshore platform near the Port Latta conveyor [CQ635765]. Lens cap is 50 mm in diameter.

Plate 6. Iron oxide-hydroxide impregnated box-work weathering pattern in Cowrie Siltstone from the western end of Hellyer Beach (adjacent to C. J. Adam's dated dolerite dyke) [CQ667751]. The lens cap is 50 mm in diameter.

sedimentary de-watering structures are present near Rocky Cape Hamlet. Oxidised crystalline pyrite, reworked beds and cross-lamination (plate 4) are common in the finer-grained beds to the west.

The discoid to spherical iron oxide bodies are up to 150–200 mm across and commonly consist of concentric layers, 5–10 mm thick, about a core. The bodies appear to be elongated in the bedding plane which suggests probable growth after lithification and formation of the bedding surfaces. Liesegang diffusion of iron oxides/hydroxides from a point source followed by differential weathering after exposure has left these more resistant bodies projecting above the outcrop [CQ667751].

The cone-in-cone structures range in size from 50 × 30 mm to 170 × 70 mm and in shape from ellipsoidal to disc-shaped (plate 5). The bodies weather out usually with a pock-marked well rounded upper surface, if this is preserved, or radiating vesiculated pattern, if the core is exposed (e.g. at CQ636766). They are sometimes associated with disseminated crystalline pyrite crystals, and displace the cleavage-bedding intersection lineation. When the bodies are sliced across their long axis the distinctive cone-in-cone structure appears as a series of parallel 1–1.5 mm wide zones running at right angles to the body wall. These cones consist of cones-within-cones with their peaks alternatively facing outward and inward.

Near the Port Latta conveyor-wharf [CQ636765], evaporite-like brown crystalline deposits occur covering bedding surfaces. The 2–3 mm diameter, translucent, intergrown crystals display surface twinning and appear to be deposited upon a 5 mm thick iron-rich layer.

Along the foreshore, outcrops of Cowrie Siltstone exhibit box-like skeletal weathering with 3–4 mm thick

iron oxide/hydroxide impregnated layers forming a resistant framework (plate 6). In some cases this surface weathers to elongated, rounded, or polygonal, 10–20 mm diameter, platelets (e.g. at CQ634764).

Current ripples of various types: simple, planar (Hellyer Beach, CQ667751) and trough (Brickmakers Bay, CQ635766) occur throughout the Peggs Beach to Hellyer Beach foreshore outcrop. Load cast structures of various sizes and forms also occur.

The Cowrie Siltstone outcrops adjacent to the Detention Subgroup west of Rocky Cape-Hamlet, exhibits possible slump structures, sedimentary de-watering structures and block-slides (fig. 3). The sedimentary de-watering structures resemble those from the younger Precambrian siltstone sequence at Bluff Hill Point south-west of Marrawah. The disrupted bedding (illustrated in the upper part of fig. 3) may be related at least in part to sedimentary de-watering.

The presence of black mudstone pellets in a dark grey mudstone from Edgcumbe Beach [CQ661755] indicates probable reworking of the sequence.

In the black mudstone parts of the foreshore outcrops, scattered, usually oxidised ensheathed pyrite crystals up to 2 mm in diameter occur. The pyrite nodules are circular to ellipsoidal in shape (Crayfish Creek, CQ651759).

BLACK RIVER – PORT LATTA AREA

P. W. Baillie

Mapping in the Black River–Port Latta area is in agreement with that of Gee (1971).

At the mouth of the Black River the Cowrie Siltstone consists of thinly-bedded laminated siltstone and mudstone of various colours. Nodular pyrite and cone-in-cone structure occur in beds of black, massive mudstone.

5 cm

5 – 10mm thick beds

1 metre

Disrupted zone

10 metres
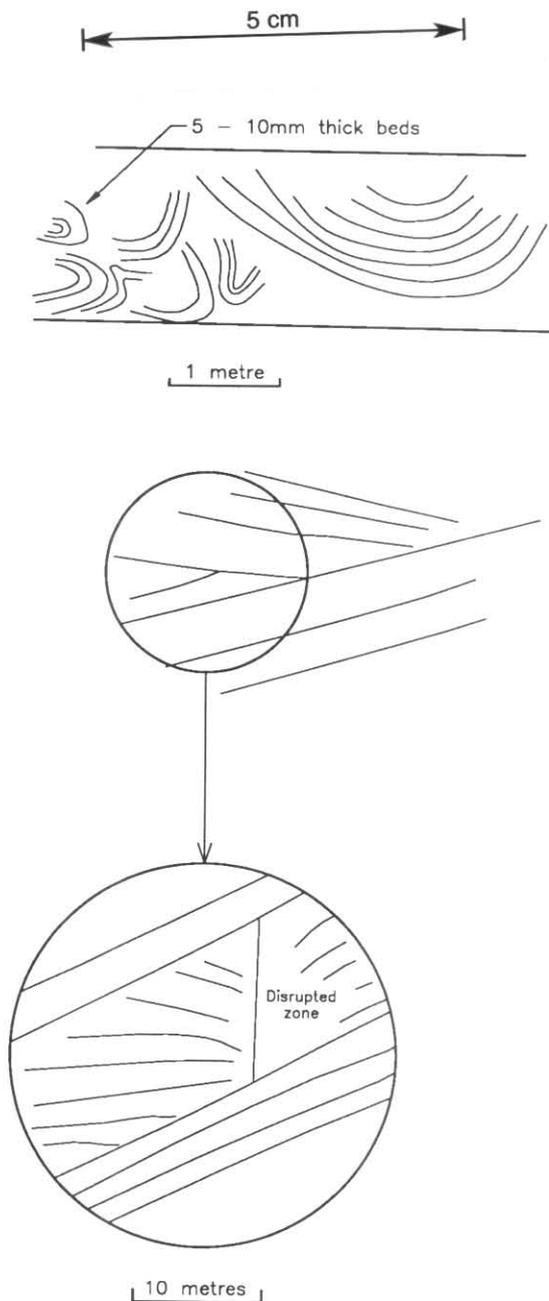
Figure 3. Probable disrupted bedding structure from the Cowrie Siltstone, Rocky Cape. Upper figure may be related to a sedimentary de-watering structure [CQ727751], whilst the lower structure appears to be a block slide [CQ724747] – c.f. Gee (1971, fig. 9a).

Between the western end of Peggs Beach [CQ610763] and Port Latta [CQ641763] the formation consists of interbedded siltstone and very-fine grained sandstone in beds ranging in thickness from 10 to 500 mm, though generally 100–300 mm (plates 7–9). The rock shows a characteristic dark grey/light grey banding due to fluctuations in grain size. Individual beds may show development of planar laminae, with individual laminae ranging in thickness from less than one millimetre up to 20 mm. Other beds display cross-laminae, usually as isolated small-to medium-scale troughs. Occasionally, an upward change from planar-laminated to cross-laminated to structureless silt is present, and these beds are interpreted as having being deposits under conditions of waning flow.

Tops and bottoms of individual beds are usually sharp, and some scour surfaces are present. Pseudonodules are often developed in thinner beds and secondary pyrite is common, both as nodules and on joint surfaces.

The sharp bedding contacts, laminated thin bedding and consistent fine grain size, together with the abundance of pyrite and the overall lack of features characteristic of

Plate 7. Cross-bedded very fine-grained sandstone or siltstone with prominent load casts, interbedded with mudstone, Cowrie Siltstone (Prc), Brickmakers Bay [CP625763].

Plate 8. Close-up of load casts developed in siltstone deposited in overall muddy succession, Cowrie Siltstone (Prc), Brickmakers Bay [CP625763].

Plate 9. Thin-bedded succession of mudstone (dark) and siltstone (light) – Cowrie Siltstone (Prc), Brickmakers Bay [CP625763]. The siltstone layers, which are often cross-bedded and display load casts may represent distal storm deposits.

turbidite sequences suggest that the Cowrie Siltstone (in this area) was deposited on a continental slope (cf. Cook et al., 1982). This interpretation is consistent with the large block slide described from the Rocky Cape area by Gee (1971).

BRIANT HILL – SOUTH FOREST AREA

K. D. Corbett
E. B. Corbett

Introduction

Two Precambrian sequences are recognised in the Briant Hill-South Forest area, viz. an earlier sequence of laminated siltstone and quartzite, which is correlated with the Cowrie Siltstone of the Rocky Cape area (Gee,

1971), and a younger sequence consisting of Black River Dolomite and an underlying quartzite-conglomerate formation, the Forest Conglomerate and Quartzite. The relationship between the two sequences is problematical in the area. At South Forest [CQ515721] and in the headwaters of Deep Creek [CQ500710], there is a basal conglomerate with a sharp contact on the underlying rocks, which are laminated siltstone or slate, but in the Beacom Hills [CQ460740] area the underlying rocks are laminated quartzite and there may be conformity and even transition.

At Briant Hill the rocks consists of laminated pink and green quartzite, very similar to the laminated quartzite which forms the lower sequence in the Beacom Hills area, but unlike the thick-bedded pure white quartzite which normally underlies the dolomite. At the southern end of Briant Hill a sequence of interbedded chert, white quartzite and quartz conglomerate is exposed, and it is likely that these rocks represent the basal part of the Forest Conglomerate and Quartzite sequence.

A problematic sequence of cherty slates is exposed along Deep Creek north-east of Briant Hill. At present it is not known if these rocks belong to the Black River Dolomite or to the Cowrie Siltstone correlate.

Rocks belonging to the Cowrie Siltstone are exposed in four main areas:

(1) north of South Forest township;

(2) headwaters of Deep Creek (south-west of South Forest);

(3) east and west of Lake Mikany in the Beacom Hills area; and

(4) Briant Hill.

South Forest Area

Road cuttings just north of South Forest show a puzzling series of rocks. At the southern end [CQ423727] is a deeply weathered doleritic rock (?dyke), followed by a south- dipping sequence, about 27 m thick, of conglomerate, quartzite and shale correlated with the Forest Conglomerate and Quartzite. At the corner of a branch road to the east this conglomerate is in contact with laminated purple to red shales dipping south-west. The contact could be slightly unconformable. These shales are correlated with the Cowrie Siltstone. They continue north for about 30 m, then there is a long gap to a sequence of south-dipping quartz-sandstones and shales intruded by two basic dykes. This sequence is about 75 m thick as exposed down the north slope of the hill. Towards the lower part of this slope, a small quarry just east of the road reveals north-dipping massive quartzite and white conglomerate, which is correlated with the Forest Conglomerate and Quartzite and is, by extrapolation, unconformable on the south-dipping quartzite-shale sequence.

Headwaters of Deep Creek

About 3 km south-west of South Forest, the Forest Conglomerate and Quartzite is well exposed in Deep Creek, and overlies laminated grey to black slate which is almost horizontal except near the contact, where it dips 50° west. The contact is not exposed, but the abrupt change from slate to coarse siliceous conglomerate suggests unconformity.

Lake Mikany – Beacom Hills area

Good exposures of the older sequence occur along the Irishtown-South Forest railway line at the southern end of Lake Mikany. Here the rocks are mainly laminated grey slates, and are intruded by a sub-conformable gabbro body. The slates are folded, as evidenced by the many changes in dip direction. One minor fold axis

plunges 75° towards 012°. Near the base of the Forest Conglomerate and Quartzite, which is well exposed, the slates dip steeply east, and although somewhat fractured and sheared to be conformable with the base of the conglomerate.

Between Lake Mikany and Faheys Lane [CQ460705], the few outcrops of the sequence consist mainly of laminated grey siltstone or shale, but to the north there is a change to laminated cherty siltstone and fine quartzite. These are exposed at the western end of the Lake Mikany dam, and in the bush-covered areas east and west of the dam. They are distinctively banded purple, green and brown to pink rocks, and show small-scale ripple marks and cross-lamination in places. Deeply-weathered basic dykes occur within the sequence at either end of the dam and in other areas. The contact with the Forest Conglomerate and Quartzite is nowhere exposed in this area, and is mapped only by the first appearance of thick-bedded white quartzite or conglomerate, or of float of these rocks.

Briant Hill

The few outcrops on Briant Hill show laminated pink and green fine-grained quartzite with variable dips up to 70°.

DETENTION SUBGROUP [Detention Quartzite]

ROCKY CAPE – SHAKESPEARE HILLS AREA

P. G. Lennox

Introduction

The Detention Subgroup comprises the 1400 m thick orthoquartzite and slate (Gee, 1968) between the Cowrie Siltstone and Irby Siltstone. It is exposed in the higher relief areas on Shakespeare Hills [CQ680660] and the Dip Ranges [CQ730610]. The base outcrops on the western edge of Shakespeare Hills and on the Dip Range. The upper boundary between the Detention Subgroup and Irby Siltstone is exposed in the upper Detention River [CQ708655] and in a tributary of the Alarm River [CQ713624]. The boundary at the latter locality is marked by a change over 100 m in the proportion of black well cleaved siltstone to ripple-marked and cross-bedded quartzite. The nature of the contact will be further discussed below.

The Detention Subgroup was defined by Gee (1968) to include Spry's (1957) Cave Quartzite, Port Slate and Bluff Quartzite which were only mappable in the Rocky Cape area [CQ740760] and not regionally.

Lower and upper boundaries

Three samples (77/706, 77/707 and 77/708) from the boundary on the Dip Ranges [CQ723611] between basal Cowrie Siltstone and overlying Detention Subgroup are pale grey, extremely well cleaved, apparently highly siliceous siltstone. In sample 77/707, 1.5–8 mm spaced anastomosing joints related to the cleavage planes exhibit a dull-sheen and 0.1 mm diameter white mica plates are visible. Thin sections consist of either a skeletal or complete sericite-fabric surrounding usually elongated, sometimes tapered quartz grains. Quartz-grains vary from 20–60 μm across (77/706) to 90-180 μm across (77/08) and are almost invariably single grains. Rare composite quartz grains (77/706) have indistinct intragrain boundaries which may be sutured or have aligned en echelon sericite blades between grains. Quartz-grains in samples 77/707 and 77/708 are more elongated (up to 4:1) compared with sample 77/706 and are predominantly single grains with straight to gently curved and rarely scalloped margins.

The quartz grains may be tapered at both ends and may possess a sericite beard. The dominant sericite fabric appears transected by one or two other surfaces; one at least must be the bedding as this is aligned at a low angle to the dominant cleavage. A late disturbance causing splitting of some of the quartz-grains may be a reflection of late stage kinking which has been observed in adjoining areas. In sample 77/707 chert grains contain large acicular muscovite needles (7-14 μm × 100 μm) at a high angle to the pervasive sericite fabric.

Lithology and sedimentary structures

The Detention Subgroup consists of a white, well bedded (50-100 mm), commonly cross bedded and occasionally ripple-marked saccharoidal quartzite sequence with a 10% siltstone component. The siltstone beds are not evenly distributed throughout but appear more frequently in some parts of the section.

The orthoquartzite is mesoscopically folded on the foreshore near Rocky Cape Hamlet [CQ730755] whilst elsewhere, such as on Shakespeare Hills, folding is of a more regional nature with individual outcrops having a consistent bedding orientation. The finer-grained lithologies are visibly cleaved whilst the unweathered, thickly bedded, medium sand grade lithologies are not obviously cleaved. Where the finer-grained component predominates, sigmoidal lozenges of quartzite within enveloping cleaved micaceous siltstone may occur.

A network pattern of 5-10 mm wide rounded tubes on an angular boulder within a creek draining the Shakespeare Hills [CQ686664] (fig. 4) may be due to worm burrows or clastic dyke development. Cross-lamination of various morphologies occurs throughout the sequence, eg. festoon cross-lamination and more commonly simple cross- lamination or planar cross-lamination. In rare cases contorted bedding laminae may indicate slump folding. Because of the presence of isolated folds in the sequence it may be difficult to distinguish soft-sediment folds from those of tectonic origin.

The orthoquartzite may be boudinaged, especially where thinner, or platey, less competent beds are more common, e.g. on the Dip Ranges [CQ702606, CQ734625]; Detention River [CQ737758]; or near Rocky Cape hamlet. Rarely, lenticular quartzite beds, up to a few centimetres in length, occur. Quartzite layers may be laminated down to 2 mm thickness [CQ693658] or up to 20 mm thickness forming cross-bedding [CQ694637] Planar cross-bedding is common throughout the sequence, at Rocky Cape, Shakespeare Hills and the Dip Ranges [CQ733755, CQ701610]. Simple cross-bedding and trough or festoon cross-bedding are less common although prevalent, e.g. at Rocky Cape Hamlet [CQ735757].
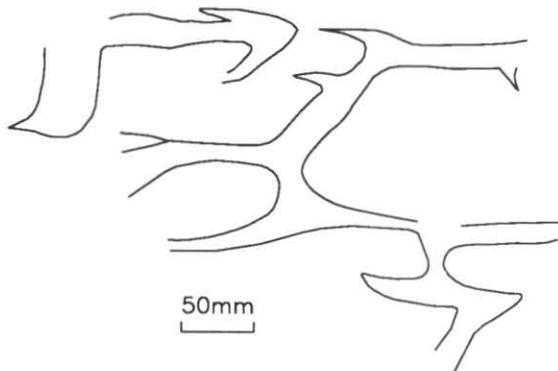
Figure 4. Clastic dykes or worm burrow-like rounded tubes (5–10 mm thick) weathering out on a boulder. Detention Subgroup [CQ68664].
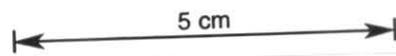
Petrography

Specimens of the Port Slate and Quartzite (from Spry, 1957 and samples 77/650, CQ720747 and 77/648, CQ740760) are light grey or greenish-grey, highly siliceous laminated siltstone, while the Buff Quartzite (Spry, *ibid.*) which is a more typical Detention Subgroup formation consists of white, saccharoidal quartzite (77/649, CQ734738; 77/705, CQ727628). The former exhibit interbedded 5 mm siltstone and mudstone beds, whereas the latter may be laminated in thin units (77/654, CQ730754) or in 50 to 200 mm thick beds.

Opaque mineral grains form a continuous cleavage fabric (spacing 0.1 mm) in sample 77/648 [CQ740760] which corresponds to Powell's (1979) continuous fine cleavage. The opaque mineral grains may form a 'chicken-wire' mesh defining the cleavage (77/649, CQ734738), or a fabric corresponding to the disjunctive rough cleavage of Powell (1979); or wavy opaque-rich zones spaced 2–3 mm apart in a dominantly disjunctive rough cleavage (77/654, CQ730754). Samples 77/703 [CQ737635] and 77/704 [CQ738627] are unusual in having a continuous sericite fabric, anastomosing around quartz grains, which define the cleavage. In most Detention Sub-Group samples (eg. 77/705, CQ727628 and 77/654, CQ730754) sericite in discrete acicular grains comprises less than 3% of the rock. Commonly two cleavages are present, especially in samples 77/654, 77/704 and 77/705.

Quartz clasts are well sorted with a size range (70-140 μm), and are usually well rounded with occasional scalloped margins (77/654) and elongation (up to 2:1 in 77/703). In sample 77/703 the elongate quartz grains have sericite beards. In sample 77/705 quartz triple junctions with 120° angles occur. The grains commonly display undulose extinction. Rare composite grains have indistinct probably sutured intragrain boundaries, eg. in sample 77/649. Rare acicular metamorphic muscovite grains in sample 77/654 are aligned parallel to the wavy opaque-rich zones defining the cleavage.

Samples from the more slatey outcrops of Detention Sub-Group at Rocky Cape Hamlet display a resinous sheen on cleavage surfaces. The white mica plates in the quartzite of sample 77/663 [CQ682658] give it a similar appearance. Flame structures and cross-laminated silt lenses in black mudstone are clearly visible in sample 77/648 [CQ740760].

IRBY SILTSTONE

ALARM RIVER AREA

P. G. Lennox

The Irby Siltstone (Gee, 1971) outcrops in the core of a regional syncline in the upper Detention River and one of its tributaries, the Alarm River [CQ714623]. This is its only exposure on the Smithton sheet. To the east, on the area covered by the Table Cape Quadrangle, the Irby Siltstone lies above the Detention Subgroup and below the Jacob Quartzite. The top of this formation is not exposed in the Smithton Quadrangle.

The Irby Siltstone is defined by Gee (1968) as 'that formation of black siltstone and minor dolomite and sandstone, lying conformably below the Jacob Quartzite. Its type locality is at Sisters Beach [CQ780697]. It is named after Irby Flats behind Sisters Beach'. No outcrops of dolomite, sub-greywacke or cream argillite occur in the Smithton Quadrangle. Interbedded sandstone, siltstone and (more commonly) mudstone outcrops are ubiquitous.

The best exposed upper boundary between Detention Subgroup and Irby Siltstone outcrops in a tributary of the Alarm River [CQ713624]. The black, well cleaved,

mudstone containing clastic dykes (Irby Siltstone, 77/661) outcropping in the lower part of the creek [CQ713624], gradually passes into interbedded 100-200 mm thick bedded saccharoidal-quartzite and siltstone, and finally into cross-bedded quartzite [CQ720618] with no siltstone. The boundary [CQ714623] is drawn where the quartzite beds first dominate the outcrop.

The disseminated pyrite-bearing, well cleaved black mudstone usually is interbedded with silt horizons of variable thickness and abundance. The cleavage is similar to the continuous fine type of Powell (1979) with a spacing of less than 0.1 mm, and is a classical slatey cleavage (77/667). Disseminated crystalline pyrite occurs in samples 77/661 and 77/666 but has weathered out in numerous outcrops (e.g. CQ705654).

Silt laminae of 0.5-1 mm thickness are commonly grouped together in 2-3 mm thick beds spaced about 10mm apart, forming what will hereafter be called spaced-laminated bedding. In many cases the black mudstone appears to be graphitic, and in such cases it is invariably associated with disseminated pyrite (77/667).

In sample 77/667, cross-lamination and a flame structure are visible in the silty-mudstone. In sample 77/666, from the Irby Siltstone at Detention River [CQ709658], clastic dykes (up to 4 mm long by 0.5-1mm wide) of arenite intrude mudstone and are transected by the cleavage. In sample 77/661, a bulbous clastic dyke (?) of siltstone occurs near the termination of a siltstone lens within black mudstone. The dyke is 10 mm wide by 13–15 mm long, and the specimen comes from the Irby Siltstone outcrop in the Alarm River tributary [CQ713624]. At this locality abundant clastic dykes of either mud crack or lithification origin occur (fig. 5), and flaser bedding of siltstone lenses in black mudstone is also present.

In thin section, sample 77/661 [CQ713626] consists of 25–30% angular, mono-crystalline quartz grains with undulose extinction, 30% opaque mineral grains, 50%

sericite and approximately 10% acicular muscovite. The muscovite varies from 8–10 μm wide by 35–140 μm long and is of metamorphic or of metamorphic origin. There are two cleavages, defined by anastomosing opaque zones ensheathing the quartz grains. The first cleavage is at a low angle to bedding and the second cleavage is at a low angle to the first cleavage (fig. 5).

Quartz-arenite (77/666, CQ708657), consists of 60-70% well sorted quartz-grains, 35–70 μm in size, with undulose extinction; 5–10% disseminated opaque mineral grains and 3–5% acicular muscovite, up to 5 × 70 μm, in an altered sericitic matrix.

One sample of ?graphitic black mudstone (77/667) revealed in thin section abundant wispy stringers of siltstone with faint cross-lamination and a possible flame structure. This lithology is common in the Irby Siltstone on the Smithton Map Sheet. It exhibits a pervasive, tenths of a millimetre spaced, continuous cleavage cross-cutting the 1–2 mm spaced laminae defining the bedding. Only in one sample which has 3–7 mm spaced, wavy 0.1 mm thick cleavage planes, is a less penetrative cleavage fabric present. This spaced fabric may be due to the rock being a coarse-grained quartzite. The cleavage planes exhibit a phyllitic lustre due to white mica concentrations.

Late Precambrian(?) – Cambrian

FOREST CONGLOMERATE AND QUARTZITE (₽lf)

BLACK RIVER AREA

P. W. Baillie

The contact between the Forest Conglomerate and Quartzite and the underlying Cowrie Siltstone is exposed on either side of the river, just downstream of the Bass Highway bridge on the Black River [CQ573767]. In another exposure, some 2.5 km upstream [CQ557760], the angular unconformity has an angular discordance of 22°, and the base of the conglomerate transgresses across one metre of siltstone in a width of exposure of 4.6 m (Gee, 1968). The angular discordance, resulting in the unconformity, is attributed to the Penguin Orogeny.

The basal part of the formation consists of a siliceous boulder conglomerate containing often-angular clasts of laminated or massive quartzite up to 500 mm in diameter. The succession fines upwards and cobbles 20–100 mm in diameter predominate 3 m above the base of the formation. Bedding thickness varies from 200 mm to one metre and a coarse to very coarse sandy matrix makes up about 20% by volume of the rock.

The upper half of the formation in the Black River area consists of ortho-quartzite which is often cross-bedded, and minor conglomerate. Beds are generally less than one metre in thickness.

SOUTH FOREST – BEACOM HILLS - BRIANT HILL AREA

K. D. Corbett
E. B. Corbett

The Forest Conglomerate and Quartzite in this area usually consists of basal conglomerate overlain by white quartzite. In some areas the basal conglomerate units are missing, while in other areas there appear to be several conglomerate horizons. Outcrops are present in the South Forest area, and in the Beacom Hills-Lake Mikany area. At the southern end of Briant Hill, a sequence of conglomerate and quartzite interbedded
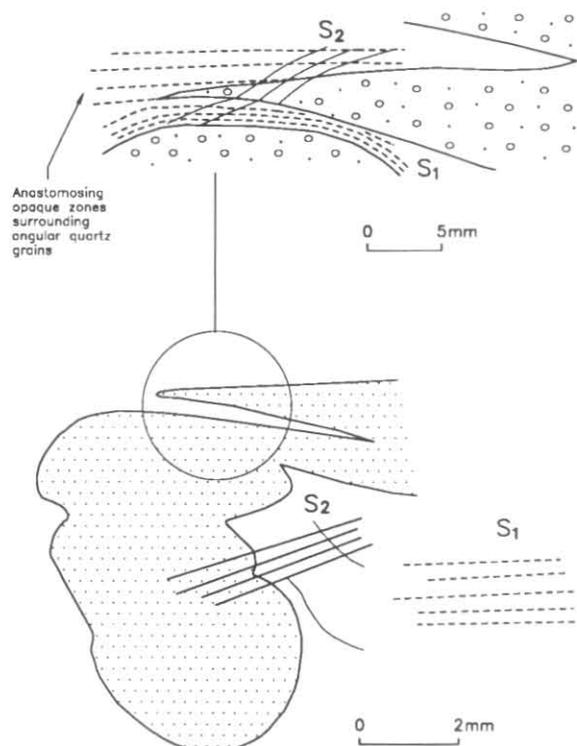
Figure 5. Enlargement of part of thin section 77/661 showing a clastic dyke in a dominantly black mudstone sequence, and the nature of the cleavages developed. Irby Siltstone, Alarm River tributary [CQ713624].
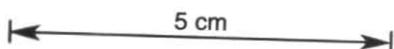
with chert occurs. This sequence has been included in the Black River Dolomite.

South Forest area

The road cutting 500 m north of South Forest [CQ523727] shows the following sequence through the Forest Conglomerate and Quartzite: base - 9 m siliceous conglomerate, mainly pebble to cobble grade but with a few boulders, clasts mainly cherty quartzite but a few of shale; fault zone 150 mm; one metre of conglomerate; 4.5 m white quartzite; 1.5 m grey to pink shale; 0.5 m quartzite bed; 9 m fawn to pink shale, laminated in places, a few cherty bands; 2.4 m coarse conglomerate, with boulders up to 340 mm long, mainly of quartzite; gap-?fault.

The small quarry just east of the road one kilometre north of South Forest [CQ523736] shows thick-bedded white quartzite underlain by poorly-exposed siliceous roundstone conglomerate, the total exposed thickness being about 6 m.

South of South Forest, the Forest Conglomerate and Quartzite forms a prominent scarp above the dolomite valley, but outcrops are rare. Typical white quartzite and siliceous conglomerate are exposed in several places, and at CQ510720 at least 15 m of conglomerate is exposed in a small gravel pit. Best outcrops in this area are in Deep Creek [at CQ500711], where the basal conglomerate is about 15 m thick and passes gradationally up into white quartzite.

Lake Mikany - Beacom Hills area

An excellent exposure of the Forest Conglomerate and Quartzite occurs on the railway line east of the southern end of Lake Mikany. Here the basal conglomerate is 9 m thick, consisting mainly of rounded pebbles and cobbles in a sandy matrix. It is overlain abruptly by 15 m of white, poorly bedded quartzite, which passes into laminated cherty shale representing the base of the Black River Dolomite.

East of Lake Mikany, the formation is poorly exposed, but typical white conglomerate and quartzite occur in a few areas.

In the Beacom Hills area, the formation is represented by at least 120 m of white quartzite which is extensively quarried for road metal. The quartzite is a pure, saccharoidal rock and is generally thick-bedded and poorly cross-bedded. Thin platey bedding also occurs, and ripple marks are preserved on a few bedding planes. The basal conglomerate has not been seen in this area. Extensive faulting and minor folding makes accurate thickness measurement impossible.

Briant Hill area

Two large gravel pits at the southern end of Briant Hill expose a folded sequence of grey chert, laminated shale, thin-bedded white quartzite, and white siliceous conglomerate. These rocks have previously been mapped as the 'cherts, slates, etc. substage', of the dolomite formation by Nye et al. (1934), and as part of the 'Smithton Dolomite' by Carey and Scott (1952) and Gulline (1959). However, they probably represent the upper part of the Forest Conglomerate and Quartzite as well as the lower cherty part of the Black River Dolomite in this area.

In the main quarry [CQ437760], an anticlinal structure trending SSE exposes soft laminated shale overlain by interbedded white quartzite and sandy fine conglomerate with rounded quartzite pebbles, overlain by laminated and irregularly bedded grey chert and chert breccia with horizons of soft clayey material, which may originally have been dolomitic. It is not possible to map

a contact between quartzite-conglomerate and chert, and since chert is the predominant rock type the area is mapped as the chert phase of the dolomite formation.

The contact with the laminated quartzite, which form the bulk of Briant Hill, is not exposed but a strong linear across the hill suggests it is probably a fault. This would explain the apparent great thinning of the Black River Formation between here and Beacom Hills, only 2 km to the south-east.

DEEP CREEK – WILLIS HILL AREA

P. G. Lennox

Small exposures of Forest Conglomerate and Quartzite occur in Deep Creek [CQ498687, CQ488664] whilst two large exposures occur on Tierneys Road [CQ504675] and adjacent to Willis Hill [CQ479638]. The small exposures consist of well bedded, sometimes planar cross-bedded saccharoidal quartzite, with minor quartz-pebble conglomerate horizons at the second locality listed.

A quarry on Tierneys Road [CQ503678] exposes laminated, 5–10 mm thick bedded dark purple mudstone (equivalent to Cowrie Siltstone) overlain with angular unconformity by quartz-pebble conglomerate (plate 10). The conglomerate contains 25 mm diameter well rounded quartz-pebbles and is overlain by fine grained lithic-arenite and pebble-bearing coarse-grained lithic-arenite which may contain planar cross-bedding. Outcrops adjacent to Willis Hill consist of beds 5–180 mm thick of white saccharoidal quartzite, interbedded with sometimes opalised conglomerate (340-400 mm thick beds).

Plate 10. Forest Conglomerate overlying bedded Cowrie Siltstone (Prc). The geological pick is 0.3 m long. Tierneys Road quarries [CQ504675]

BLACK RIVER DOLOMITE (Pld)

INTRODUCTION

Outcrops of dolomitic or silicified dolomitic rocks in the Black River-South Forest–Irishtown–Nabageena area, depicted with the symbol Pld on the Smithton Map Sheet, belong to the Black River Dolomite (after Spry 1964). Those in the Duck River plains belong to the Smithton Dolomite (after Spry, 1957 and Nye et al., 1934).

WILTSHIRE AREA

P. W. Baillie

The contact between the Black River Dolomite and the underlying Forest Formation is exposed in a disused gravel pit near the Wiltshire timber loading facility

[CQ567768] where cross-bedded orthoquartzite is conformably overlain by thinly-bedded fine sandstone which is in turn conformably overlain by chert. In the Black River area [CQ565767] the formation consists of massive dolomite with nodular chert, cryptalgal-laminated dolomite, and stromatolitic cherty dolomite. Elsewhere, in the area mapped (P.W.B.) laminated chert is the only rock type exposed.

NORTH FOREST AREA

A. V. Brown

In areas covered by the Smithton Map Sheet now assigned to the Black River Dolomite (i.e. to the west of the Scotchtown-Nabageena ridge), only laminated chert crops out, however, in a stratigraphic diamond drill hole near Forest (Brown, 1985), only 150 mm of chert were intersected in over 295 m of section belonging to the Black River Dolomite drilled beneath rocks belonging to the Smithton-Trowutta basalt-sedimentary rock association, indicating that silicification is most probably a near surface-groundwater effect.

A detailed log of the drill hole is included as Appendix C. The rocks within the lower 295 m of the drill hole are considered to belong to the Black River Dolomite. The contact with the overlying Smithton–Trowutta basalt-sedimentary rock association is conformable and gradational, over 10 m of section (between 780.8 and 790.5 m), with the change between the sequences being represented by the incoming of basaltic lithic wacke/greywacke and the outgoing of carbonate beds, but with the continuation of black mudstone interbeds. However, carbonate continues to permeate rocks up to 550 m where the last carbonate bed occurs.

From 790 m to 840 m the sequence consists of black mudstone, pyritic black mudstone and minor conglomerate beds interbedded with carbonate and calcareous siltstone. Between 840 m and 960 m irregularly alternating mass flow units of stromatolite clast bearing mixtite, breccias, calcareous pebbly mudstone and limestone. The stromatolite clast mixtite units occupy 50 m of this 120 m section. The largest intersection of a stromatolite clast was 350 mm.

Below the mass flow units, from 960 m to 1015 m, the sequence consists of mudstone, calcareous mudstone, and zones of alternating green and grey or red and white mudstone and carbonate, interbedded with dolomitic limestone, laminated white limestone, muddy limestone. From 1015 m to 1033 m the sequence consists of interbedded black mudstone and grey limestone beds. It is within this section, at 1032 m, that the 150 mm chert unit was intersected. In the lower part of this section, between 1020 m and 1030 m expanding clays were encountered and core loss occurred. The composition of the 'mudstone', from X-ray diffraction analyses, was talc, dolomite, montmorillonite and quartz.

Between 1030 m and the abandonment of the hole at 1076 m due to problems associated with the swelling clays between 1020 m and 1030 m, a sequence of interbedded carbonate, black mudstone and muddy limestone occurs.

NORTH-EAST OF SOUTH FOREST

P. G. Lennox

Outcrops of the Black River Dolomite are usually either dolomite or chert (chert lag in soils near South Forest) in a number of isolated outcrops (table 1). The quarry north-east of South Forest [CQ532740] contains folded black and white lenticularly-laminated chert with abundant, 5–20 mm spaced fractures. Fracturing of the outcrops is very common (e.g. at CQ527736) and in part

causes the distinctive weathering surface associated with this lithology. Specimen 80/139 [CQ420608] has a pock-marked appearance criss-crossed with weathered out planar joints up to 0.5 mm wide and spaced up to 10–20 mm apart. This feature is also influenced in part by the nature of the dissolution process associated with carbonate rocks.

Table 1
SMITHTON DOLOMITE LOCALITIES

Outcrop	AMG Ref
Quarry north-east of South Forest	CQ532740
South-west of South Forest	CQ493707
Gravel pits on Faheys Lane	CQ462705
Hillock off Faheys Lane	CQ443709
East and north-east of Irishtown	CQ439691
Adjacent to McLachlans Road	CQ427667
Within the Duck River drainage basin	
contact with Cambrian sediments	CQ407769
Blackwood Bridge	CQ407755
adjacent to Pokes Hill	CQ412728
Huetts Road quarry	CQ397638
Nabageena	CQ420608

These are the main outcrops and are commonly associated with numerous scattered isolated outcrops. See the accompanying geological maps.

SOUTH FOREST – BRIANT HILL AREA

K. D. Corbett
E. B. Corbett

In the South Forest–Lake Mikany are the Black River Dolomite consists of interbedded dolomite, chert and slate, of which only the chert and a small amount of slate outcrop in the mapped area. The formation forms pronounced negative areas, usually covered with alluvium or sand, through which project ridges or hills of chert. The chert is extensively quarried for road metal.

The stratigraphy of the formation is difficult to determine because of the lack of outcrop, but there is some suggestion that the chert forms a basal unit and another unit in the central part of the formation, and a third, less well-developed unit near the top. It may be, however, that in some areas the formation consists almost wholly of chert.

The thickness of the formation is of the order of 600–750 m in the valley west of South Forest.

The basal chert sequence is well exposed east of Lake Mikany, where the beds dip gently east to north. They consist of thin bedded to laminated grey to black chert and cherty slate, with horizons of chert breccia and nodular chert The rocks are similar to those interbedded with quartzite and conglomerate at Briant Hill.

Chert outcrops in the middle part of the formation occur in the valley west of South Forest; to the north of South Forest; and in the Pulbeena area. A quarry north of South Forest reveals very fractured black chert in beds up to 250 mm interbedded with laminated light to dark grey shale.

Oolitic chert occurs on the western side of a small knob north-east of the Pulbeena limestone quarry. The rock is pale coloured, distinctly bedded in units about 200 mm and consists wholly of oolites, averaging 4–8 mm diameter, in a silica matrix. Large boulders show thicknesses of at least 1.5 m of the pure oolite rock.

The upper part of the dolomite sequence and the contact with the overlying Late Precambrian-Cambrian sequence, is generally not exposed. However, rocks near the contact are exposed on the western side of the dolomite valley about 4 km south-west of South Forest

5 cm

[CQ491705], and consist of grey slate and cherty slate. The contact in this area appears to be conformable.

NABAGEENA – IRISHTOWN AREA

P. G. Lennox

In only a minority of outcrops is the bedding distinctive (eg. specimen 80/139, CQ420608) because of fracturing and the unusual weathering process. Other specimens (e.g. 80/130, CQ438692) exhibit well developed bedding laminae up to 1.5 mm thick, of different shades of grey and black (plate 11).

Some specimens have a subconchoidal fracture (e.g. 80/128, CQ452695; and 80/129, CQ448694). White, usually crystalline calcite or dolomite-filled vugs, up to 4 × 5 mm across, occur in sample 80/128. The carbonate vugs in sample 80/128 are up to 2 mm across with a well rounded, elongated wisp or stringer shape. They consist of equigranular dolomite crystals up to 100 μm across with their distinctive curved concentric growth zones and bladed or sawtooth-shaped calcite crystals (width 70–210 μm, length 210–630 μm). Some of these stringers have a distinct break down their centre and exhibit a definite compositional zonation parallel to this break. Thus the equigranular crystalline carbonate (35 μm across) gives way to zoned blocky dolomite and finally bladed calcite, adjacent to the break. The long axes of the blades are invariably aligned at a high angle to the vein length.

Crystal size ranges, from occasionally very fine-grained (80/139, CQ420608; optically unresolvable); commonly medium-grained (80/128, CQ452695 and 80/129, CQ448694; 21–35 μm); to occasionally coarse-grained
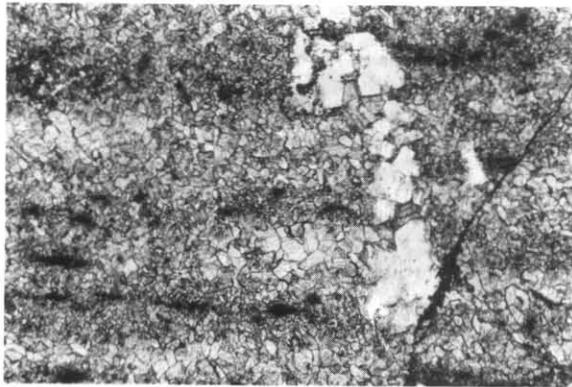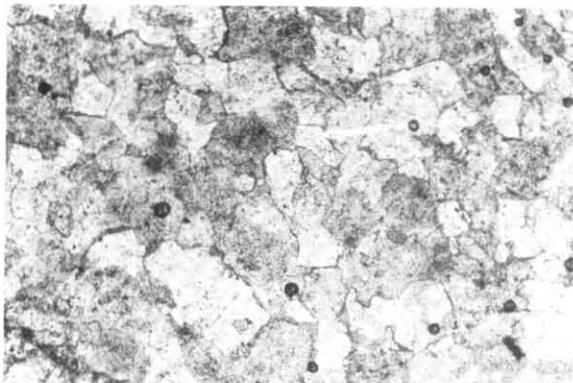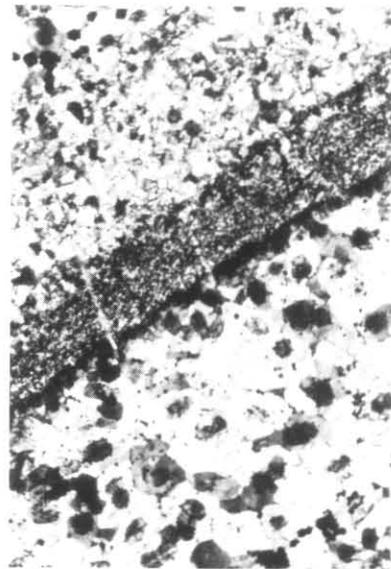
Plate 13. Abundant crystalline ?pyrite withtin and around quartz grains after carbonate in a layered specimen. Photomicrograph of sample from CQ444613 (off South Road). Magnification ×20, crossed polars.

(80/130, CQ438692, 90 μm; 80/142, CQ444617 see plate 12).

Hand specimen 80/129 contains black specks or lines of specks up to one millimetre across but usually less than 0.25 mm across whilst in the thin section of sample 80/142, areas of concentration of fine-grained opaque mineral grains form distinct bodies. One sample (from CQ444613) contains disseminated, crystalline, chalcopyrite-pyrite occurring as mm grains covering numerous bedding laminae. The quartz grains are after carbonate in this specimen and sulphides are more abundant in some laminae than others. They may form marginal deposits outlining the quartz-grains or deposits near the core of the quartz-grains. In each case they consist of concentrations of fine-grained crystalline sulphides (plate 13).

Quartz occurs as isolated scalloped grains (up to 150 μm diameter) forming 5% of sample 80/129 [CQ448694]. This sample consists predominantly of medium-grained equi- granular crystalline dolomite (grain size 25 μm) with up to 10% of blocky, spherical or sausage-shaped bodies up to 450 μm × 2500 μm of very much finer-grained carbonate. Quartz occurs in a patchy vein in sample 80/130 [CQ438692] which appears truncated and displaced. It is difficult to determine whether the quartz is replacing the carbonate or vice versa. The quartz vein consists of equigranular quartz with undulose extinction (70–140 μm across) which is sometimes elongated at a high angle to the vein wall. The quartz grains have straight grain boundaries and are optically continuous in plane polarised light.

A one millimetre wide calcite vein in sample 80/139, [CQ420608] consists of very coarse crystalline calcite (1300 μm grain size) and transects the generally optically unresolvable highly ?siliceous groundmass.

The prevalence of fracturing makes detection of any cleavage development difficult. Sample 80/134 [CQ432594] which is very fine-grained has opaque seams up to 35 μm thick spaced 900–1200 μm apart, and which may subdivide into a number of stringers. As well as these seams some parts of the thin section contain discontinuous straight opaque stringers. Both these surfaces may represent a cleavage.

Plate 11. Laminated dolomite from Irishtown (80/130). Laminae are 0.25–0.5 mm wide and lie E–W in the photomicrograph. The vertical quartz vein is displaced by the fracture. Magnification ×20, plane polarised light.

Plate 12. Equigranular coarse-grained dolomite (?)-calcite from Smithton Dolomite, Poilinna Road. Magnification ×20, plane polarised light.

SMITHTON – TROWUTTA BASALT-SEDIMENTARY ROCK ASSOCIATION (Єs)

SMITHTON AREA

K. D. Corbett
E. B. Corbett

The basaltic-sedimentary rock succession is exposed around the Smithton township, on the hills to the south and around the margins of the basalt plateau between North Forest and South Forest. Outcrops in general are poor, the best exposures being around the foreshore of Duck Bay. Elsewhere, outcrops consist mainly of small weathered sections artificially exposed on tracks or in dams, and mapping of individual units is virtually impossible.

Three major units can be identified in this area: a basal sedimentary unit; a spilite unit; and an upper sedimentary unit. The sequence in general strikes north-south and dips west.

Basal sequence

The basal sequences forms the western part of the range of hills extending from Smithton southwards, but outcrops are very rare because of the deep soil cover. The rocks consist of interbedded siltstone, mudstone and greywacke, and the sequence is of the order of 420 m thick.

Rocks correlated with the basal sequence are well exposed around the shore of Deep Creek Bay towards Copper Mine Point [CQ423795], where they appear to be overlain by the spilite unit. The rocks are somewhat folded and faulted, so that a succession is difficult to establish, and an erosional disconformity occurs in the central part of the outcrop belt. At the eastern end are interbedded greywacke turbidite, siltstone and tuffaceous breccia, dipping and facing west. These are followed to the west by a thick sequence of laminated grey, green and red siltstone, mudstone and fine-grained greywacke sandstone, and the disconformity occurs within this sequence. The disconformity consists of laminated siltstone draped over a sequence of similar siltstone in which a series of broad, shallow channels have been eroded to depths of up to several metres. Angular discordance is only very slight, and the contact probably represents a period of sub-marine erosion, possible by turbidity currents.

Above the disconformity, the siltstone beds dip uniformly south-west at 30–40°, before becoming complexly interbedded with irregular spilite flows and breccias. This complex zone, which appears to be the base of the central spilite unit, is impossible to map except on the most detailed scale, since the lava flows and sedimentary rocks change attitude every few metres and there are no marker horizons. Breccias with isolated lava pillows and pillow fragments occur in this area, and have previously been described by Carey and Scott (1952).

Spilite sequence

The central spilite unit has been mapped over a strike length of about 11 km and is of the order of 300–450 m thick. For the most part it consists of massive amygdaloidal spilite showing no evidence of flow structure or of intercalated sediments except near the top and base. It was originally described as a Devonian dolerite dyke by Nye *et al.* (1934), but was re-interpreted as Cambrian spilite by Carey and Scott (1952).

The petrology of the rock is described in detail by Carey and Scott (1952) and Nye et al (1934). Small flecks of native copper occur throughout the rock (hence 'Copper Mine Point').

Upper sedimentary rock sequence

The basal part of this unit has been mapped on the east bank of the Duck River at Smithton, and again in the Duck River about 3 km south of Smithton. The rocks consist of interbedded greywacke sandstone and green to red siltstone, with intercalated spilite flows. In general the rocks dip and face west, but there are some reversals over gentle flat folds.

NABAGEENA – STUCHBERRYS HILL AND DUCK BAY AREAS

P. G. Lennox

Greywacke, from within the Cs succession, crops out around Nabageena [CQ419609]. They are extremely weathered, speckled pale purple and iron-stained-brown, and usually occur in association with laminated mudstone. The mm thick laminae are spaced 2–3 mm apart in mudstone beds 8–10 mm thick. Tabular mud pellets at the tapering terminations of mudstone beds range in size from 1×3 mm to 1×25 μm and form 1–2% of the rock. Angular quartz grains, mica plates and a medium-grained texture are present in the greywacke. Gently curved joints are coated with a shiny black iron oxide/ hydroxide film.

Fresh greywacke from the quarry on Stuchberrys Hill (80/168, CQ538793) consists of a 4 mm thick dark grey mudstone bed in a pale greenish-grey silt-size groundmass. Whilst two cleavages are distinguishable in hand specimen, in thin section some of the grains are aligned parallel to the bedding but no other grain alignment has been identified. In thin section, specimen 80/168 consists of minor large polycrystalline clasts (up to 50 μm in diameter) and abundant smaller mostly monocrystalline clasts (up to 140 μm in diameter) in a translucent brown anisotropic matrix (?Fe-oxide impregnated quartz). The polycrystalline clasts consist of composite quartz, or intergrown twinned plagioclase laths, or plagioclase and chlorite and apatite and clinopyroxene; more rarely they consists of chlorite or chert. The smaller clasts consist of quartz (single or composite grains) with undulose extinction, plagioclase, or clino- pyroxene (? augite).

Pyroclastic samples consists of reworked tuff (from Duck Bay, 80/165, CQ438796 and Nabageena, 80/135, CQ400595); coarse volcanic agglomerate (from 80/136, Nabageena, 80/136, CQ399595 and Duck Bay, 80/166 CQ443796); and tuff (from Edith Creek, 80/137, CQ394609).

Clasts in the reworked tuff (80/135 and 80/165) are rounded and range from 90×180 μm to 400×1800 μm in size (plate 14). Uniform grain size and lack of fine matrix (glass) suggests that 80/165 is a reworked tuff. In thin section, the clasts are commonly fringed with opaque mineral grains and are comprised of plagioclase (up to 21×105 μm) and clinopyroxene (10–14 μm, ?augite) in a glassy matrix. Sample 80/135 contains disseminated ?pyrrhotite-?pyrite. In thin section the equigranular (120–180 μm diameter) grains are enclosed in an opaque to transluscent iron oxide / hydroxide-enriched groundmass. The clasts in specimen 80/135 have a similar composition to those in specimen 80/165.

Sample 80/136 is a coarse agglomeratic tuff. Sample 80/166 is a finer agglomerate containing vesiculated clasts. Cuspate boundaries of clasts in sample 80/166 are probably a reflection of original vesicles. Plate 15 shows flattened chlorite-filled vesicles in one clast. The clasts range from 1×2 mm to 4×10 mm in size (average 2

mm diameter) and are comprised of albite laths (6×12 µm to 28×140 µm), feathery- chlorite opaque mineral grains and sometimes carbonate selvage. Specimen 80/136 contains dolomite grains up to 1800u across, in addition to the volcanic clasts (1080×1800 µm) consisting of 50–70% plagioclase, 20–40% clinopyroxene, 10% chlorite and opaque mineral grains.

Two specimens, one from the Deep Creek Bay foreshore (80/167, CQ443796), the other from between Stuchberrys Hill and the Stanley turnoff (80/168, CQ538793) are dolomitic. In hand-specimen, sample 80/167 is a black, very fine-grained rock with a sub-conchoidal fracture, containing embayed clasts of paler-coloured material ranging from one millimetre across to 8×28 mm. The clasts are sometimes truncated by the black, wavy cleavage seams which are less than one millimetre thick and spaced up to 7 mm apart. Vugs are filled with crystalline carbonate or crystalline quartz. Hand-specimen 80/169 is a very fine-grained dark greenish-black rock containing disseminated crystalline pyrite bodies, up to one millimetre in size. The well cleaved specimen contains vugs up to 10 mm in diameter which are filled with a white opaline mineral.
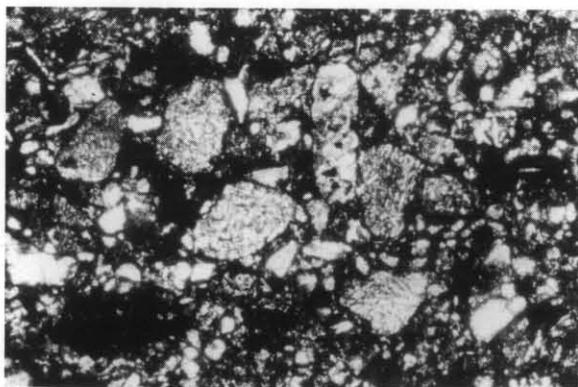
Plate 14. Rounded clasts (sometimes containing laths of twinned plagioclase with flow texture) within an opaque framework and finer grained groundmass. Tuffaceous sandstone, sample 80/135, Nabageena. Magnification ×30, plane polarised light.
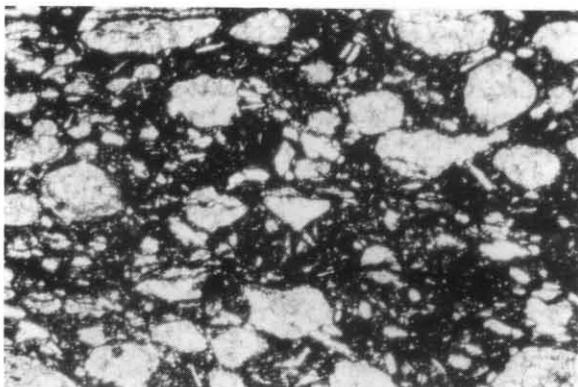
Plate 15. Deformed chlorite-filled vesicles in a clast from a volcanic agglomerate. Note cross-cutting opaque seams and feldspar laths, sample 80/166, Duck Bay [CQ443796]. Magnification ×30, plane polarised light.

FOREST AREA

K. D. Corbett
E. B. Corbett

Basalt and associated sedimentary rocks are exposed along the lower slopes of the hills around North Forest, and in the area of Sedgy Creek and west of South Forest.

At North Forest the sequence appears to dip steeply north, but facings have not been obtained. The lower part of the sequence is a sedimentary unit of siltstone, mudstone, greywacke sandstone and minor greywacke conglomerate poorly exposed in creek sections. The top of this sequence is formed by a massive unit of greywacke conglomerate or mixtite, at least 45 m thick. This conglomerate contains dispersed rounded clasts up to 300 mm long of various rock types, particularly coarse and fine grained basic igneous rocks and laminated shale.

Apparently overlying the conglomerate is a unit of massive spilite which in most places is amygdaloidal. 'Outliers' of similar spilite occur near the foreshore of West Inlet [CQ511800], to the north, and also at two creek localities to the west.

Another belt of this succession occurs in tributaries of Sedgy Creek [CQ480760]. This belt runs south-east, and the majority of dips and facings are to the north-east. The rocks are mainly interbedded greywacke and siltstone, but are overlain by spilite at the northern end. This belt merges with another belt of similar rocks trending SSW and extending south-east of Lake Mikany. The latter belt appears to be essentially synclinal, faulted against Black River Dolomite to the west and underlain conformably by it to the east.

The rocks of the synclinal belt are fairly well exposed along railway and road cuttings which follow the banks of Deep Creek. The sequence is dominantly sedimentary, with the typical siltstone, mudstone and greywacke turbidite, but also includes tuffaceous horizons, spilite units, and several gabbroic bodies. The largest gabbro is well exposed south of Deep Creek, and appears to intrude near the base of the sequence. The lack of outcrop makes it impossible to accurately map the limits of the igneous bodies, and hence they are mostly shown as sub-circular bodies around the known outcrops. The typical massive spilite unit does not appear to be present in this area.

WILTSHIRE AREA

P. W. Baillie

Correlates of the Crimson Creek Formation of western Tasmania are exposed in the area to the north and west of Wiltshire [CQ547780] and consist of mafic volcanics and associated epiclastic sedimentary rocks.

The lower most part of the sequence is exposed at the southern end of East Inlet [CQ548788], where thinly-bedded black shale is interbedded with sometimes-laminated siltstone and greywacke. The greywacke beds beds show features which indicate deposition from tubidity currents and range in thickness from 50–400 mm.

Overlying these beds are massive, fresh, grey/green greywacke beds that are best exposed in a disused quarry at [CQ539797]. The beds often contain rip-up clasts of purple siltstone and are graded. Thickness of individual beds may exceed 6 m. Thin section examination shows that these rocks are almost entirely composed of relatively fresh basaltic fragments with abundant laths of plagioclase. Sedimentary rock fragments are a minor component of the rock. North of Ghost Creek [CQ530800] a unit of mixtite (Csm) was mapped. This rock forms low rounded outcrops in the paddocks and consists of matrix-supported conglomerate containing often well-rounded clasts of fine- to coarse- grained basalt, and other rock types including mudstone and laminated siltstone. The deposit is interpreted as having been deposited predominantly subaqueous debris flows.

NORTH FOREST AREA

A. V. Brown

A stratigraphic diamond-drill hole was sited on a basalt flow at CQ528802, south of the Stanley-Forest turn-off from the Bass Highway. The purpose of the hole was to:

(1) obtain a section through the basalt-sedimentary rocks association;

(2) observe the contact between the basalt-sedimentary rocks association and the underlying Black River Dolomite; and

(3) obtain a section through the Black River Dolomite.

A log of the drill hole is included as Appendix B.

The contact between the basalt-sedimentary rock association and the Black River Dolomite is conformable and gradational over 10 m of section (between 780 m and 790 m). It is defined by the incoming of basaltic lithic wacke/ greywacke units and the outgoing of carbonate beds. However, the first indication of volcanic activity in the area occurs at 802.9 m, where a 10 mm bed of devitrified glass fragments occurs interbedded with the carbonate/mudstone sequence, and carbonate continues to permeate the volcaniclastic sequence up to 550 m where a 50 mm white carbonate bed occurs within the volcaniclastic sequence.

The lower 290 m of the basalt-sedimentary rock association (496-785), in this area, consists of volcaniclastic lithic wacke/greywacke with interbedded laminated black mudstone and volcaniclastic siltstone, pebble conglomerate and agglomerate. The sand grade units are usually graded. Some beds, up to 50 mm thick, are dominated by red mudstone rip-up clasts. Within this zone only one, 500 mm thick unit of amygdaloidal basalt occurs (between 543.0 m and 543.5 m).

Between 495.0 m and 496.2 m a basaltic breccia containing abundant glass fragments occurs. Over the next 219 m of section (495 m to 276 m) the sequence alternates between zones of laminated grey siltstone and black mudstone with minor thin greywacke units and dominantly grey-green greywacke with minor mudstone and siltstone. This is followed by a 32 m intersection (276 to 244 m) of interbedded basalt flows, often chilled and brecciated, with thin greywacke units.

From 244 m to 231 m the sequence is composed of grey-green greywacke interbedded with laminated black mudstone, the mudstone units comprising approximately 25% of the sequence. The overlying 31 m (231–200 m) is composed of laminated siltstone and mudstone with interbedded greywacke in approximately equal proportions. This is followed by 34 m (200–166 m) of well-bedded green-grey greywacke with subordinate, interbedded, red-purple mudstone.

Massive greenish-grey, open-framework agglomerate, with mainly basalt and minor sedimentary rock clasts, dominate the next 79 m (166–87 m) of the sequence. This section is followed by 39 m (87–44 m) of brown pebbly mudstone with subangular clasts of basalt detritus, overlain by greywacke with rip-up clasts of mudstone, then closed framework pebble conglomerate, with mainly basaltic clasts, and finally finely laminated red-brown mudstone and minor greywacke.

The top 44 m of the drill hole consists of 42 m of massive, grey-green, sometimes amygdaloidal basalt overlain by 2 m of basalt boulders and derived soil.

An interesting aspect of the lower basaltic lithic wacke/greywacke units is the presence and preservation of fresh, broken, clinopyroxene grains and intermixed grains of fine-grained basalt which consists of fresh plagioclase and black glass. The deposition and preservation of the angular grains indicate rapid deposition and compaction of the units.

SMITHTON DOLOMITE

A. V. Brown

As recommended in the Introduction (p. 11), the Smithton Dolomite is taken as the carbonate succession which stratigraphically overlies the Smithton–Trowutta basalt-sedimentary rock association and underlies the fossiliferous, Middle–Late Cambrian, Christmas Hills–Scopus sedimentary rock association.

On the Smithton Map Sheet this limits the outcrops of this succession to the areas designated Pld which crop out in the Duck River drainage basin to the west of the Smithton-Edith Creek road.

Spry (in Hughes 1957) defined the succession, in part, as ' ... being approximately 3000 feet [900 m] in thickness with its type locality being immediately west of the Duck River just north of the Smithton–Marrawah Road.' and that the ' ... dolomite varies in colour from light grey to creamish and there are both coarse and fine-grained varieties. The coarse-grained varieties tend to be thickly bedded and the finer grained types have thin bedding, according to Nye *et al.* (1934).' Hosking and Hueber (1954) record a 40 foot [12 m] thick oolitic limestone in the type area which Spry (*op. cit.*) considered to be related to the Smithton dolomite.

Middle – Late Cambrian

FOSSILIFEROUS SEDIMENTARY ROCK SUCCESSIONS (€s)

INTRODUCTION

P. W. Baillie

Fossiliferous rocks of Middle Cambrian age crop out on the western margin of the map sheet. Late–Middle Cambrian faunas are found in the Christmas Hills area [CQ312679], some 400 m west of the western boundary of the Smithton Sheet (Jago and Buckley, 1971; Jago 1976); early–Late Cambrian trilobites and graptolites occur in a road metal quarry near Scopus [CQ335806] (Baillie, 1981; Rickards *et al.*, in press); and a fauna of indeterminate fragmentary fossils were found in float in the headwaters of Geales Creek [CQ322724].

MIDDLE CAMBRIAN

Christmas Hills area

P. W. Baillie

The oldest fossils are found near Christmas Hills in strata dominated by siltstone. Jago and Buckley (1971) reported an abrupt faunal change between older and younger faunas which both indicate the late-Middle Cambrian '*Lejopyge laevigata* Zone'. In the lower fauna '*Proampyx*' and '*Nepea*' are common, together with other polymerids and the agnostids '*Peronopsis*', '*Valenagnostus*', '*Tasagnostus*' and '*Utagnostus*' (Jago, 1976).

Polymerids from the upper fauna at Christmas Hills include *Centropleura, Pianapsis* and *Amphoton*; agnostids include *Peronopsis, Hypagnostus, Grandagnostus, Ptychagnostus, Diplagnostus* and *Clavagnostus* (Jago, 1976). Both faunas also contain inarticulate brachiopods and dendroid graptolites (Quilty, 1971; Jago, 1976).

LATE CAMBRIAN

Scopus area

P. W. Baillie

Late Cambrian faunas are present in a road-metal quarry some six kilometres west of Smithton Aerodrome on the Montagu Road [CQ335806]. The fauna occurs in a succession of thin-bedded, often calcareous, quartz sandstone and interbedded mudstone. The most common faunal elements are dendroid graptolites, including *Dendrograptus*, *Dictyonema*, *Aspidograptus*, *Desmograptus*, *Callograptus*, *Polygonograptus*, *Palaeodictyota*, *Thallograptus*, *Mastiograptus*, *Archaeolofoea* and *Aellograptus* (Rickards *et al.*, in press). Polymerids present include *Corynexochus*, cf. *Alenus*, cf. *Stigmatoa*. Agnostids include *Pseudagnostus* and *?Connagnostus*. Inarticulate brachiopods and the sponge spicule *Protospongia* also occur. The age of the fauna is Idamean (Rickards *et al.*, in press).

In an attempt to see if a relationship could be established between the two fossiliferous successions and the Smithton Dolomite a fully-cored diamond drill hole was drilled some 378 m into the succession from the Scopus locality [CQ335806]. A detailed log of the hole is presented as Appendix C.

The relationship between the faunas remains unresolved after the drilling but stratigraphic continuity is most probable.

Tertiary

STANLEY BEDS OF AGGLOMERATE, TUFFS AND TUFFACEOUS SEDIMENTARY ROCKS (Ts); COARSE-GRAINED ANALCIME-BEARING BASALT (To).

STANLEY PENINSULA

P. W. Baillie

The Stanley beds are here defined as that sequence of massive and bedded, light brown to green, poorly-lithified tuff, tuffaceous breccia, lapilli tuff and tuffaceous sandstone at least 15 m in thickness exposed around the Nut and at the northern end of Godfreys Beach, Stanley. This definition is essentially the same as that proposed by Cromer (1971).

At the northern end of Godfreys Beach [CQ560873] beds have an average thickness of 80 mm and are composed of weathered volcanic (?tuffaceous) material. The beds are poorly-sorted and may show a rough grading, with very angular particles at the base of the beds. Grains range in size from 5 mm to clay grade. Dips are irregular and 25–30° to the east.

A shore platform has developed in the Stanley Beds immediately to the north of Stanley Cemetery [CQ563854]. There appears to be a general upwards-fining of the succession from agglomerate, through volcanic breccia to siltstone. All units are fairly well-bedded; the siltstone showing the best development. Rare large-scale cross-bedding is present.

Gill and Banks (1956) describe the rocks from this outcrop as 'volcanic ejectamata of all sizes from fine tuff to breccia, most being coarse tuff ... there can be no doubt that the rocks are tuffs and breccias of pyroclastic origin'.

Agglomerate crops out in the outcrop 150 m west of the cemetery [CQ565854] where volcanic fragments 20–250 mm in diameter are supported by a clayey matrix which occupies about 50% of the rock. Quartzite xenoliths 50–100 mm are common throughout the agglomerate. Thin section 73-344 contains sub-angular

to sub-rounded basaltic fragments 1–10 mm in a clay matrix. The basalt is very-fine grained and has olivine phenocrysts in a black, glassy groundmass. Zeolites are common in both the basalt and the groundmass.

Behind the timber yards on the southern side of Circular Head [CQ567856] unbedded, baked tuff crops out. They are dark brown in colour and consist (73-350) of rounded to sub-angular basaltic grains up to 5 mm in diameter in a fine-grained matrix. Once again zeolites are abundant.

In the other localities the Stanley Beds appear to be tuffaceous sandstones, consisting largely of epiclastic deposits although some material is almost certainly of primary pyroclastic origins.

SUB-BASALT CONGLOMERATE, QUARTZSTONE OR CLAYSTONE (Tc)

ROCKY CAPE - DETENTION RIVER AREA

P. G. Lennox

Introduction

Gill and Banks (1956) report on a sub-basalt Tertiary deposit from a 60 metre long tunnel east of Irishtown on the northern flank of Johns Hill (CQ437689). One metre of lignite was observed covered by carbonaceous sand then clayey sand. Pollens from the carbonaceous sand indicate a Tertiary flora which disappeared from south-eastern Australia by the end of the Pliocene. Gill and Banks (*ibid.*) also report lignite covered by a partly silicified ferruginous sandstone from a creek near Lileah (upper Edith Creek, CQ467613). This is from the same creek as the intrabasalt deposit reported by Nye *et al.*, (1934) and described below.

In the Rocky Cape–Detention River Area the sub-basalt deposits (Tc) can be divided into two types, quartz-pebble conglomerate and quartzite, and sandstone, siltstone and pebbly claystone.

Quartz-pebble conglomerate and quartzite

Sub-basalt quartz-pebble conglomerate or quartzite crops out in numerous isolated localities around the margin of the basalt flow near Rocky Cape hamlet [CQ724705], as shown in Table 2.

The majority of these 'outcrops' are only groups of boulders or very large boulders which cannot be regarded as definitely *in situ*. Examples of this type occur at Hellyer Siding, Western Line and Detention River 0.75 km upstream of the Alarm River Tributary. The 350 m long ridge crest outcrop adjacent to the Detention River [CQ737637] is continuous, well-bedded and probably *in situ*.

The rock ranges from a quartz-pebble conglomerate to a (occasionally) medium-grained to (commonly) coarse-grained quartzite. At the Detention River, well-rounded boulders (1–7 m) consist of pebble (20–70 mm diameter) conglomerate with 200 mm thick, partly graded, coarse-grained quartzite horizons. The locality near the Newhaven Creek/Newhaven Road junction is similar to that above although the conglomerate contains rare cobble-sized clasts. The outcrop on the northern flank of the Dip Ranges [CQ737637] consists of 100–180 mm thick beds of pebble- conglomerate and quartzite. The pebbles, which are usually rounded but of low sphericity, may vary consistently in size between different layers (plate 16). The dip of the bedding varies up to 42° which seems unlikely for a Tertiary deposit.

One 800 mm thick bed consists mainly of angular quartz-pebbles (40%), laminated quartzite pebbles (10%) and angular boulders of fine-grained (some cross-laminated) quartzite (10%), a coarse sand-sized

Table 2
SMITHTON SUB-BASALT AND INTRA-BASALT DEPOSIT LOCALITIES

Sub-basalt claystone, siltstone and pebbly claystone

Mawbanna West	CQ547724	off Spion Kop Road
	CQ546719	off Spion Kop Road

Sub-basalt quartz-pebble conglomerate or quartzite

Mawbanne East	CQ694715	near Hellyer Siding
	CQ718682	Western Line near Montumana Road
	CQ725678	near Montumana Road/ Western Line crossing
	CQ718648	Detention River 750 m upstream of the Alarm River confluence
	CQ729647	Detention River 2 km upstream of the Alarm River confluence
	CQ737637	Detention River southern side 2.5 km upstream of Alarm River confluence
	CQ697602	near Newhaven Creek/ Newhaven Road confluence
	CQ712708	Western Line near Wilsons Siding

Intra-basalt deposit

Friable sandstone

Mawbanna East	CQ721707	Rocky Cape hamlet

Quartzite, clay and lignite

Irishtown East	CQ459614	Upper Edith Creek near Lovetts Road

Clay and river gravel (borehole)

Irishtown East	CQ472664	Alcomie

Plate 16. Part of a ~5 m high cliff outcrop of well-bedded quartz-pebble conglomerate and quartzite. North Dip Range [CQ737637]. Lens cap is 50 mm in diameter.

quartzite matrix (40%). The boulders range from 130 × 230mm to 450 × 500mm, and are chaotically arranged. The pebbles range up to 20 × 50 mm in size, and are dominantly angular and sometimes imbricated.

The pebble-sized quartzite float outcropping at the boundary between basalt and folded Cowrie Siltstone on the Western Line near Wilsons Siding No. 2 is quite clearly sub-basalt. The quartzite float is recrystallised, angular and usually less than pebble-sized, and may rarely be sufficiently concentrated to form a deposit up to 200 mm thick.

A hand specimen (77/758) of the quartz-pebble conglomerate at the Western Line locality consists of layers containing well rounded granules to pebbles of recrystallised (some laminated) quartzite (~80%) in a partly iron oxide/hydroxide cemented coarse sand matrix (~20%), interbedded with layers of granule to coarse sand-sized saccharoidal quartzite. In thin section the quartzite consists of occasional millimetre sized grains (10%) and abundant 150–900μm diameter quartz

grains (40%) in a matrix of fine cherty subgrains up to 72 μm across but commonly less than 20 μm across (50–55%). One grain 800 × 2800 μm consists of bladed optically homogeneous zones 120–225 μm wide which run the whole length of the grain. This grain contains inclusion trails and opaque minerals at a high angle to these zones and its long axis. The grains of the most common size (150–900 μm) exhibit undulose extinction, well rounded (in some cases cuspate) margins, and sometimes contain aligned sericite needles. The rock is a poorly sorted, mature, quartz-arenite.

A drill hole* about one kilometre north-west of the Rocky Cape Store [CQ717709] revealed the following section:

0 – 0.2 m	top soil
0.2 – 4 m	clay
4 – 10 m	sand
10 – 23 m	sand, clay and gravel
23 – 24 m	basalt
24 – 26 m	clay
26 – 29 m	conglomerate
29 – 31 m	basalt

* Water Bore Index: Landowner: Mr Blake, completed: 27 August 1971. No card number.

This intrabasalt conglomerate may be the equivalent of the conglomerate cropping out on the Western Line [CQ718682] and hence indicate it is not everywhere sub-basalt, although this cannot be proved.

Sandstone, siltstone and pebbly claystone

The exposures off Spion Kop Road [CQ547724, CQ546719] are generally only partially lithified and may display (reverse) grading and possible cross-bedding. Iron-pans and subhorizontal planar cracks (? due to relief of lithostatic load) are a distinctive feature of the gravel pit at the locality. There are significant changes in the lateral continuity of the sandy white units, which are less than 20 m apart, around the edge of a 100 m long gravel pit.

The deposits in the Spion Kop Road area are sheets of clay and silt overlain by a channel deposit of well rounded pebbly claystone with iron-pans and gritty angular claystone. Imbricated pebbles in the two lower lithological units indicate a current direction to the SSW.

SOUTH FOREST AREA

K. D. Corbett
E. B. Corbett

West of South Forest are large patches of quartzose gravel and coarse sand. Some of these occur adjacent to the small areas of basalt, and the local physiography suggests they may pass beneath the basalt. A basalt boulder was noted near boulder deposits in one area. Similar patches occur near the basalt body south of Pulbeena. Drilling would probably be necessary to prove the relationship.

In the Pulbeena area, small hills of this gravel are overlapped by more recent alluvium and also apparently by the Pleistocene Pulbeena Limestone. Quarries in the gravel just south of the Pulbeena quarry show it to be at least 4 m deep and to continue below plain level. It consists of white sandy gravel, with rounded pebbles of quartzite, quartz and chert up to 100 mm long, with a few horizons of puggy clay.

In the South Forest area, this gravel forms a terrace rising about 15 m above the adjacent valley and includes boulder beds as well as finer gravel and sand. Some of

the material is cemented with limonite. Smaller patches of similar gravel occur near Lake Mikany, and also near Smithton (boulder beds) and Briant Hill (sandy fine gravel).

INTRABASALT DEPOSITS (Td) OF SANDSTONE, CLAY, LIGNITE AND QUARTZ-STONE (SILCRETE OR GREYBILLY)

ROCKY CAPE AREA

P. G. Lennox

Friable sandstone

A 0.5–2-metre thick massive, friable, partly iron oxide / hydroxide cemented medium-grained sandstone within olivine-basalt on the Bass Highway near Rocky Cape township [CQ721707] probably represents a lake deposit. The individual quartz grains in the deposit are well rounded, highly spherical and are packed in a loose framework without finer grained material as a matrix.

IRISHTOWN – LILEAH AREA

P. G. Lennox

Nye *et al.* (1934) mapped three main Tertiary intrabasalt deposits south of Smithton:

Upper Series – Hursts Road below Mt Lileah and between Youngs Road and Blizzard Creek, 220–230 m contour

Lignite Series (Quartzite, clay and lignite) – Off Lovetts Road/Upper Edith Creek, 170–200 m contour Johns Hill

Lower Series (quartzite) – South Road below Beatties Hill, 140 m contour.

Unfortunately agricultural activities connected with pasture development have caused loss of outcrop of the Lower and Upper Series. Being situated in a steep-sided valley the Lignite Series has been left undisturbed.

Figure 6 shows the section as determined by Nye *et al.*, (1934) and as recently measured. The main difference lies in the position of the 'lignite' within the sequence, i.e. above the distinctive clay bed or below it. A sample from wavy black lignite beds within a saccharoidal quartzite bed is a carbonaceous-sandstone. In hand-specimen it consists of equigranular, medium to coarse grained, well rounded, quartz grains with variable sphericity, loosely packed in a carbonaceous matrix. The one metre thick lignite horizon that Nye *et al.*, (*ibid.*) observed at the top of the main section may have since been eroded or may be obscured by the abundant basalt float within the creek bed.

A borehole at Alcomie [CQ472664]* contains the following sequence from top to bottom:

23 m	soil, sandy clay and clay
1 m	basalt
21 m	clay and river wash
3 m	basalt

* Water Bore Index Card 995. Landowner: M. G. Kay, completed: 9 December 1966.

SILICEOUS GRAVEL AND COARSE-GRAINED SAND DEPOSITS (Tg?)

BLACK RIVER AREA

P. W. Baillie

Deposits of unconsolidated siliceous gravels (Tg?), apparently overlying basalt were mapped some 3 km south of Black River [CQ573743]. On lithological

grounds and stratigraphic position the deposits are inferred to have a Tertiary age.

Quaternary

PULBEENA LIMESTONE OF FRESHWATER ORIGIN (Qp); CONCEALED BY DERIVED SOIL (Qp')

PULBEENA AREA

K. D. Corbett
E. B. Corbett

Freshwater limestone consisting of interbedded shelly layers and peat layers, has been mined for lime at Pulbeena. Soil derived from this deposit occurs over a wide surrounding area and several small outcrops in drains suggest the limestone is quite widespread. It appears to be overlapped by shallow sandy alluvium
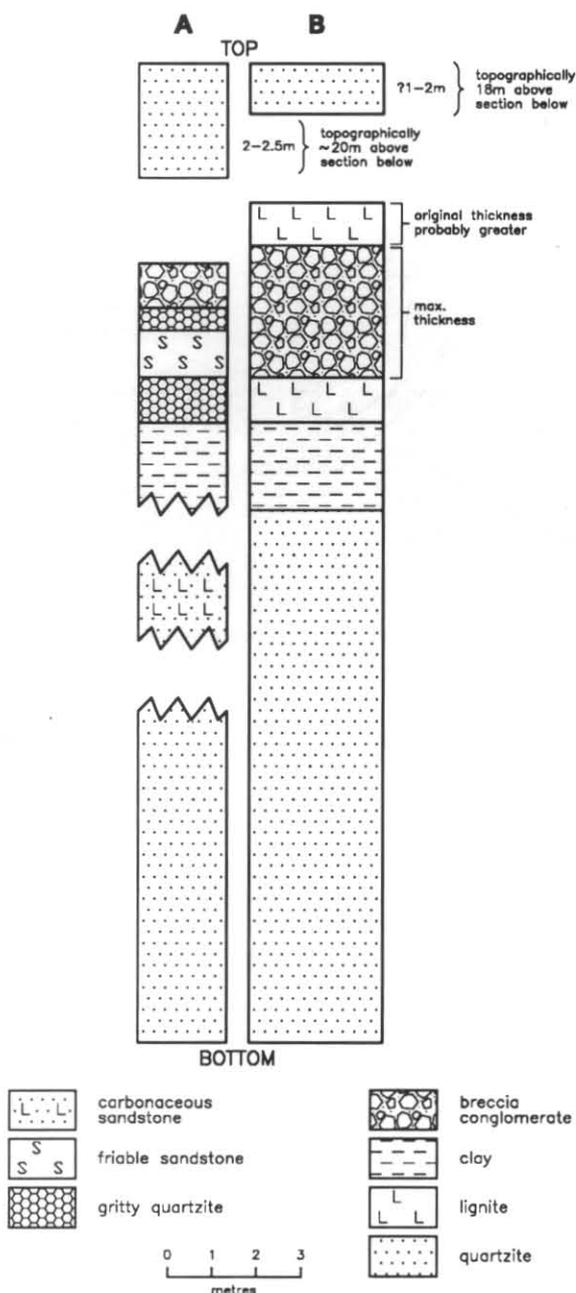
Figure 6. Intrabasalt deposit, upper Edith Creek, off Lovetts Road [CQ459614]. (Section B after Nye, *et al.*, 1934; section B, this report).

along the eastern side and by windblown sand along the northern side. The limestone soil-alluvium contact is not well defined and it is possible that some of the soil is actually alluvium. The exposed depth of limestone in the quarry is about 4 m. The stratigraphy and age of this deposit are discussed by Gill and Banks (1956).

CONGLOMERATE OF LOCAL DERIVATION OF PROBABLE STRANDLINE ORIGIN (Qc), WITH ASSOCIATED IRONSTONE GRAVEL IN SOME AREAS (Qci).

STANLEY PENINSULA

P. W. Baillie

Cobble to boulder conglomerate, composed dominantly of basalt clasts, occurs extensively on the Stanley Peninsula (plate 17), from West Inlet [CQ531818] to North Point [CQ529914]. The deposits are found at heights up to about 20 m AMSL. Individual clasts are usually well-rounded and long axes are sub-horizontal, no strongly imbricate fabric is present such as is often observed in fluvial sediments. The deposits often have a sandy matrix which may be podsolised (e.g. West Inlet). The beds, identical with modern strandline deposits, which may be observed in this area, are interpreted as also being strandline deposits.

Plate 17. Locally-derived Late Pleistocene beach deposits (Qc) at Stanley.

NORTH FOREST

K. D. Corbett
E. B. Corbett

The inland edge of the coastal plain, where it abuts against the basalt hills west of North Forest, shows areas underlain by a variable deposit characterised by brown-soil, fragments of ironstone or limonitised gravel, rounded to angular pebbles and boulders of bedrock and Tertiary basalt (Qci). The thickness of the deposits is not known, but they appear to be shallow (a few metres or less) and in places surround low flat outcrops of bedrock. They possibly represent shore-face deposits left as the sea retreated from the plain.

BASALT TALUS (Qtb); QUARTZITE TALUS (Qtq)

STANLEY PENINSULA

P. W. Baillie

Extensive slope deposits, of locally-derived basalt, occur south-west of Green Hills [CQ540835] and as a

Plate 18. Talus deposits (Qtb) overlying Stanley Beds (Ts) at the southern end of Godfreys Beach [CQ563864].

fringing deposit around Circular Head [CQ562853] (plate 18). They consist of poorly-sorted clasts, often up to several metres in diameter. Weathering skins are thick where present.

WINDBLOWN SAND OF PREDOMIN-ANTLY COASTAL PLAIN WITH TERRACE, LUNETTE AND ASSOCIATED SWAMP MARGINS INDICATED (Qs). UNDERLYING MARINE SANDS INDICATED WHERE KNOWN IN BOREHOLES (Qs/Qsm)

WILTSHIRE AREA

P. W. Baillie

Windblown sand occurs as a veneer, mantling coastal deposit over extensive portions of the Smithton Sheet. Because both aeolian or dune sand (Qs) and older sands and clays (Qsm) are usually seen on the ground as grey clayey sand they have been grouped on the map as Qs, but shown separately where this has been demonstrated by drilling.

The most common soil type developed on the sand is a mature podsol, which consists of a dark, humic-rich, A1 horizon, a bleached A2 and an orange-yellow coloured iron-enriched B2 horizon. The profile may be up to 2 m thick.

In areas where internal drainage is poor a groundwater podsol may develop. This has a thicker A1 horizon than the normal podsol, a thinner A2 horizon and a very thick B2 horizon, usually dark brown in colour due to enrichment by humates and iron oxides. The B2 horizon or 'coffee rock' may exceed 3 m in thickness.

The aeolian sands locally form small terrestial dunes e.g. Wiltshire [CQ556771]. Circular deflation hollows and associated lunettes are found between Smokers Bank [CQ433753] and Sedgy Creek [CQ470748]. Lunette formation in south-eastern Australia is usually attributed to the later part of the last glacial stage, between 10000 and 26000 years B.P. (e.g. Bowler 1971, 1976).

Drilling program

P. W. Baillie

In an attempt to prove stratigraphic relationships between various Quaternary units, and in particular to see if the sand forming the extensive sand plains (Qs) was of marine origin a programme of shallow drilling was undertaken. The location of the holes is shown on Figure 7 and the results of the drilling are tabulated as Table 3.

The drilling clearly highlights the last two marine transgressions which have affected the area:
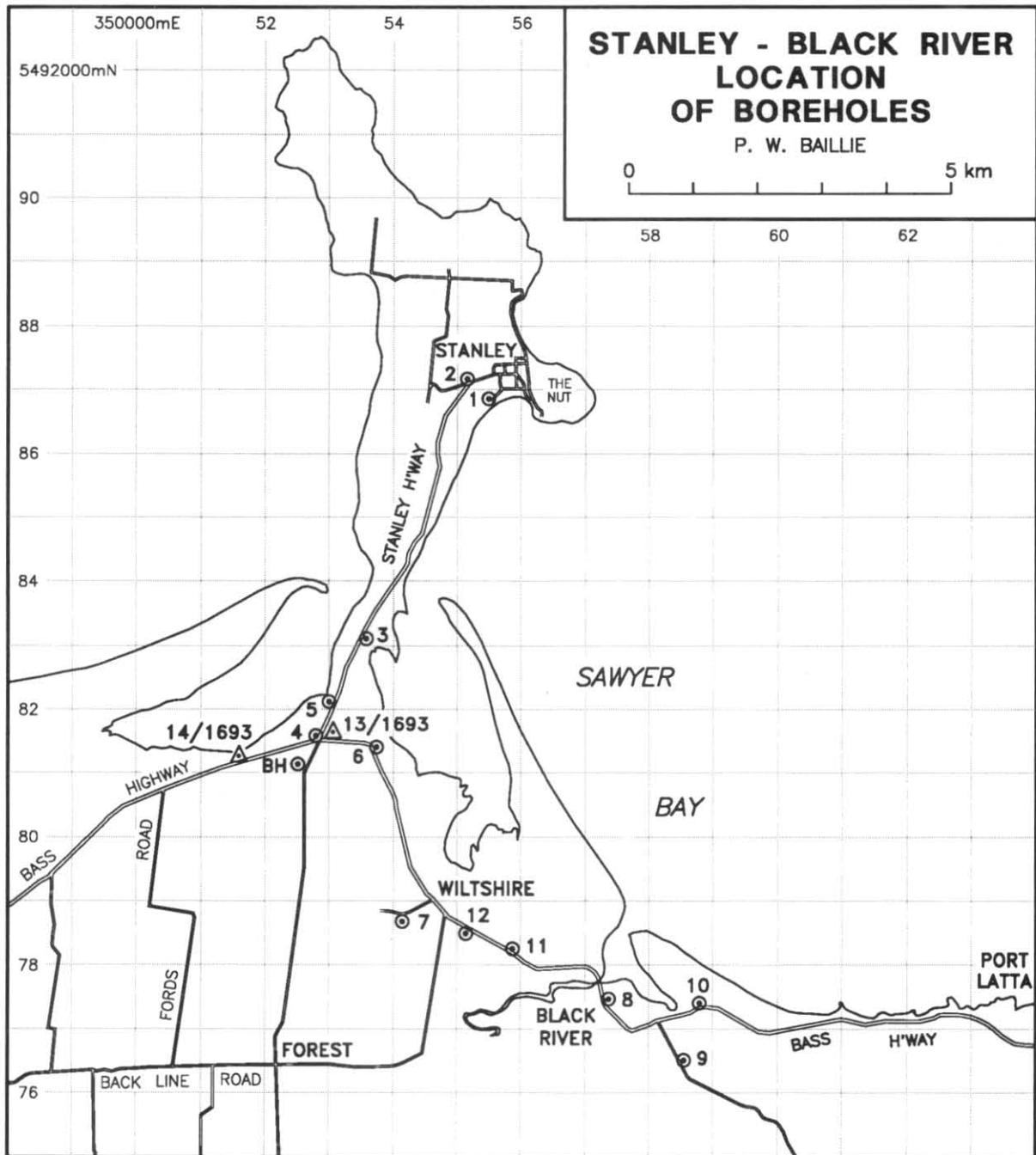
Figure 7. Location of shallow boreholes in the Stanley – Black River area.

(1) the Holocene (approx. 8000–6000 years B.P.) transgression when sea level reached its present level following deglaciation is preserved in Hole 1.

(2) the Last Interglacial transgression (approximately 125 000 years B.P.) when sea level may have been up to 20 m higher than the present, is preserved in Hole 7 and probably also in Hole 10.

Further aspects of the Quaternary geology of the region are discussed by Colhoun *et al.* 1982 and Banks *et al.*, 1976. Those studies, together with the present study, have permitted the determination of a stratigraphic framework for the Pleistocene and Holocene deposits (table 4).

DETENTION RIVER – CRAYFISH CREEK AREA

P. G. Lennox

The main tidally affected areas of the coastline north-west of Smithton Township extend from Morgans Bay [CQ408785] in the east to Cades Bay [CQ320842] in the west. The most extensive areas consist of swampy marshlands adjacent to the mouth of creeks.

There are extensive areas of grey loamy sand with occasional quartz-gravel horizons in the Detention River drainage basin, behind the older stabilised dunes of Hellyer Beach and Forwards Beach and behind the beach between Port Latta [CQ640763] and Crayfish Creek [CQ660758].

Table 3
RESULTS OF DRILLING IN THE WILTSHIRE AREA

Hole No.	R.L.(m)	AMG Ref.	Depth (m)	Stratigraphy
SQ1	5.13	CQ55458582	0 – 2.4	Clean very well-sorted dune sand (Qo)
			2.4 – 6.1	Well-sorted marine sand (Qo)
			6.1 – 8.8	Clayey marine sand (Qo)
			>8.8	Weathered ?tuff (Ts)
SQ2	8.09	CQ55188611	0 – 2.4	Iron-rich clayey sand (Qs)
			2.4 – 6.1	Clay or sand clay with decomposed basalt (?Qs)
			6.1 – 7.0	Green volcanic clay (?Tb)
			>7.0	Weathered basalt (Tb)
SQ3	2.87	CQ53558211	0 – 1.8	Leached white sand (Qs)
			1.8 – 5.2	Marine clay (Qsm)
			>5.2	Basement (Єs)
SQ6	2.17	CQ53768032	0 – 2.4	Foul smelling iron-rich sand (Qs)
			2.4 – 5.2	Well-sorted sand (Qs)
			5.2 – 6.1	Shell-bearing sand (Qsm)
			>6.1	Basement (Єs)
SQ7	20.00	CQ54127770	0 – 2.4	Leached very well-sorted dune sand (Qs)
			2.4 – 3.4	Iron-rich sand as above (Qs)
			3.4 – 8.2	Clayey sand with shells (Qsm)
			8.2 – 8.5	Clay with pebbles, wood, ?shells (Qsm)
			>8.5	Greywacke (Єs)
SQ9	8.62	CQ58527550	0 – 1.5	Clayey sand (Qs)
			>1.5	Weathered siltstone (Ɛrc)
SQ10	3.97	CQ58807640	0 – 1.2	White leached sand (Qs)
			1.2 – 3.4	Iron-rich sand (Qs)
			3.4 – 5.2	Marine sand (Qsm)
			5.2 – 8.8	Clean shelly sand (Qsm)
			8.8 – 9.8	Clayey sand
			>9.8	Weathered siltstone (Ɛrc)

Table 4
STRATIGRAPHIC FRAMEWORK FOR THE PLEISTOCENE AND HOLOCENE DEPOSITS

Years B.P.	Series	Stage	Marine and related deposits	Aeolian deposits	Talus and slope deposits	Fluviatile / alluvial deposits	Lacustrine deposits	Soils
			Beach sands, gravels (Qhy, Qm)	Blowout dunes, beach ridges (Qhy, Qo)	Landslips	Alluvium (Qha)		Minor leaching
Present	Holocene			↑				
10 000				?				
20 000		Last Glacial		Lunettes, cover sands (Qs)	Talus (Qt)			
30 000								
40 000				?		?		
50 000	Pleistocene					Peat at Mella		Strong podsolisation
60 000							Pulbeena Limestone (Qp)	
70 000								
80 000							?	?
90 000								
100 000								
110 000						?		
120 000		Last Interglacial	Marine sands, conglomerate (Qsm, Qc)			?		
130 000						?		

DEEP CREEK AREA

K. D. Corbett
E. B. Corbett

Coastal sand extends inland for some 7 km in the Deep Creek area, east of Smithton, and forms broad plains partly covered by grassland and partly by scrub. Patches of the sand, obviously windblown, also occur on higher areas and slopes. For the most part the deposit consists of loose friable sand showing little or no structure, but the few deeper sections show some limonitic cement up to a metre or so below the surface. A sand pit on a hill side on Williamson's property, near Copper Mine Point, shows a recent sandy layer up to one metre thick overlying an earlier brown talus deposit with bedrock fragments, also about a metre thick, which in turn overlies older, limonite-cemented sand. The superficial
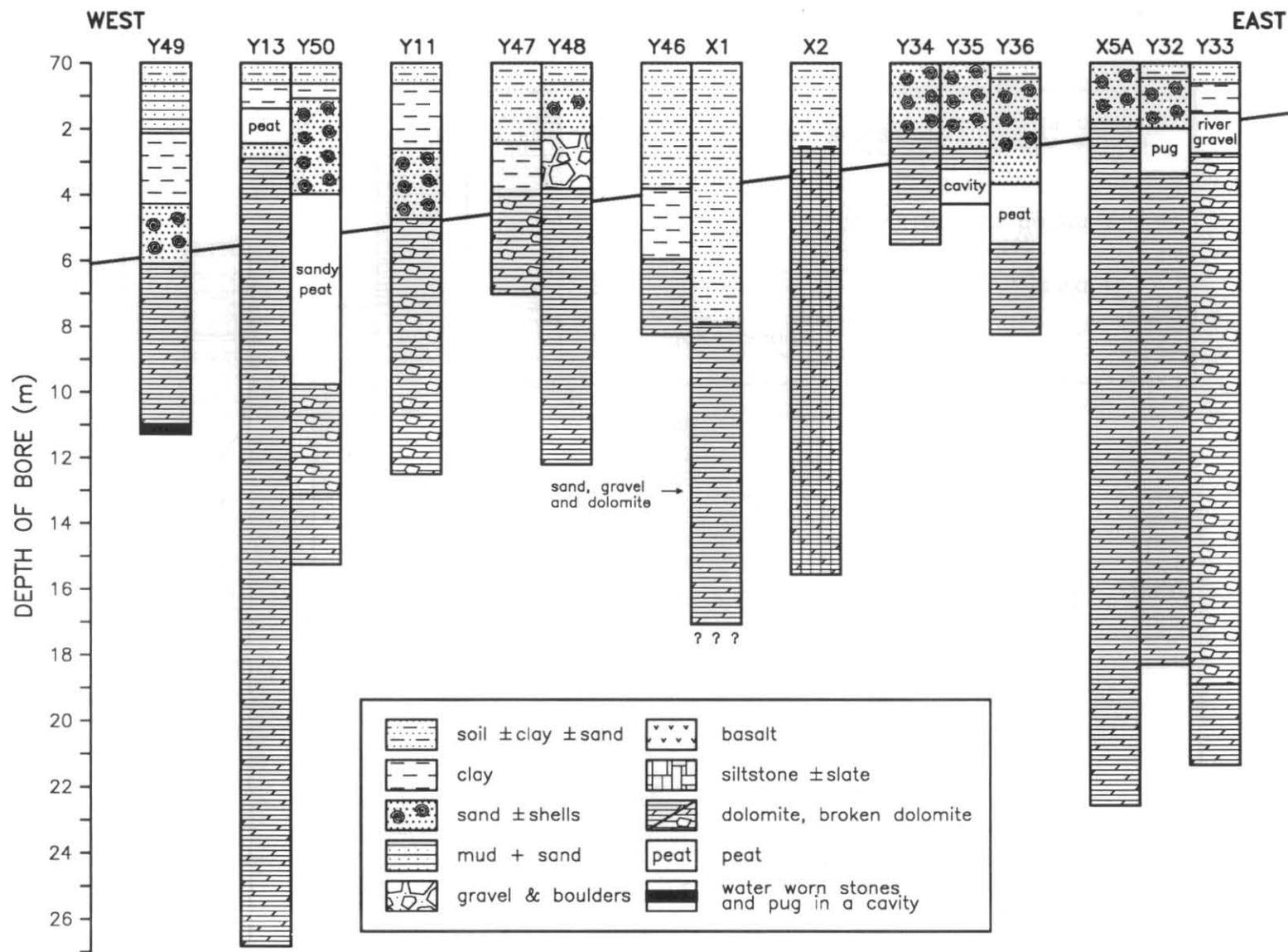
Figure 8. Drill hole data from Gulline (1959). See Figure 10 for locations of drill holes.
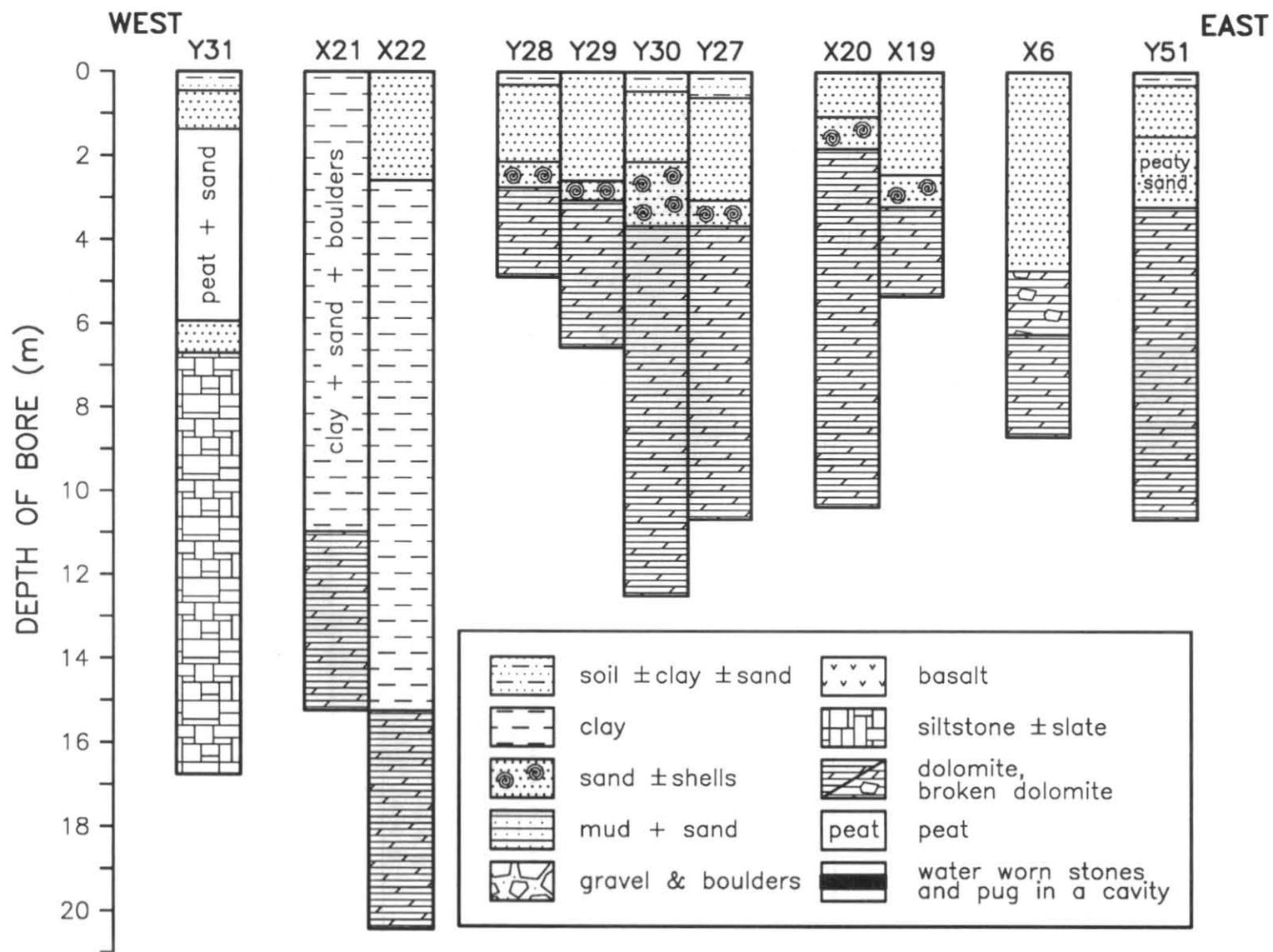
Figure 9. Drill hole data from Gulline (1959). See Figure 10 for locations of drill holes.
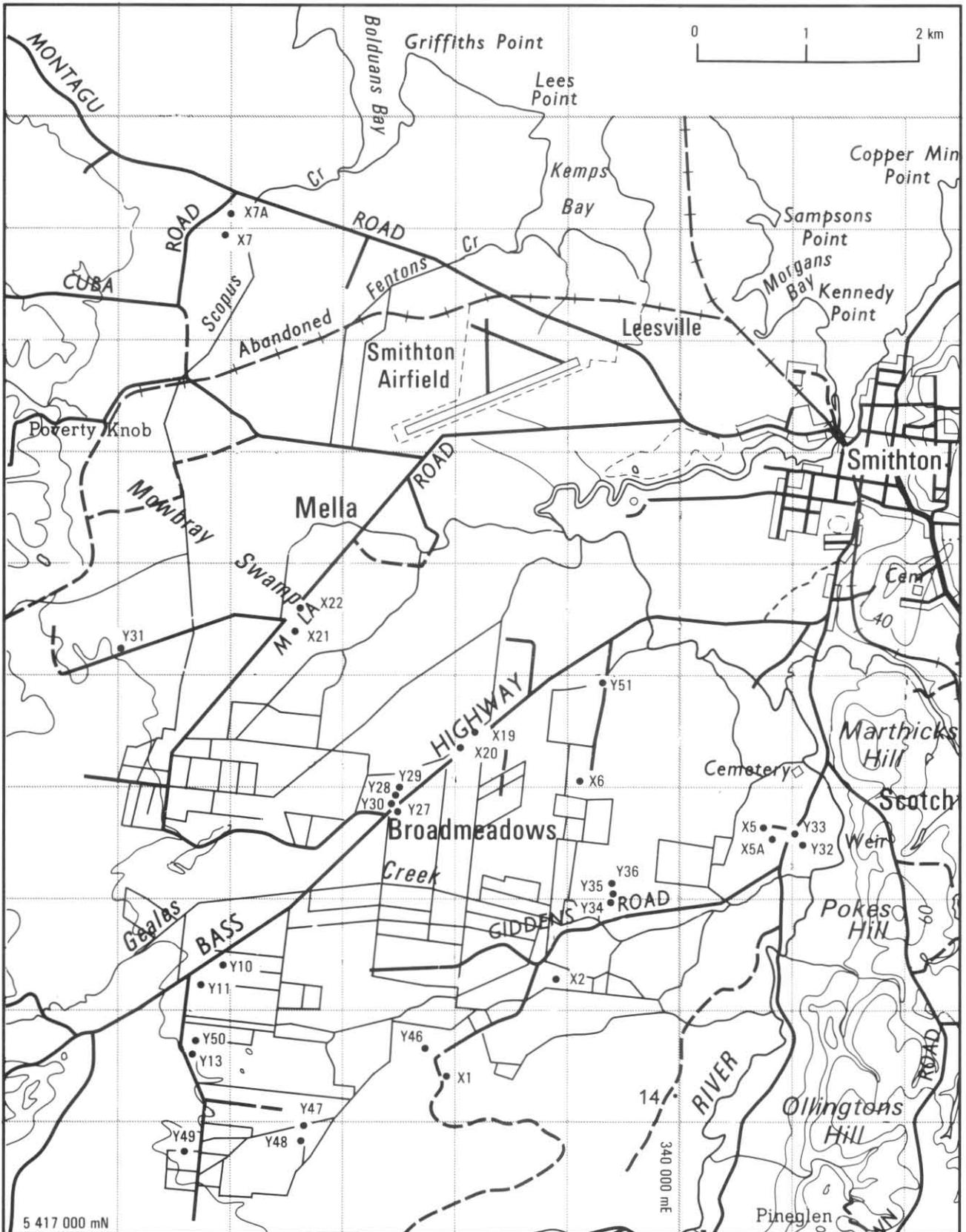
Figure 10. Locations of drill holes (from Gulline, 1959).

sand has been derived by weathering of the older sand, and has migrated over the earlier talus-soil.

Remnants of old dunes are apparent in many areas, and in some places stand up to 15 m above the surrounding plain. They can be seen as far inland as the sand occurs, but are generally too irregular to be mapped in detail. The highest dunes are barchan type and associated with circular lakes or swamps (lunettes) underlain by peaty deposits. The lunettes are surrounded by dunes except for an opening on the south-east side. In two of them, the surrounding dune is almost continuous and is steeper towards the central swamp, suggesting a wind direction from the north-west.

DUCK RIVER PLAIN

P. G. Lennox

The Duck River drainage basin and the area between Montagu Road and the coast is all covered with windblown sand. The Bass Highway to Montagu Road section of the Duck River drainage basin has been extensively drilled, as reported by Gulline (1959). Simplified geological drill logs are shown in Figures 8–9. The localities for these drill holes are shown in Figure 10. It can be seen from Figure 8 that the depth to basement generally increases to the west within this part of the Duck River drainage basin. This may indicate that the Duck River once flowed further west of its present course, at least within the Bass Highway region.

OLDER STABILISED BEACH AND DUNE SAND (Qo); BEACH RIDGE TRENDS INDICATED

PERKINS ISLAND

P. W. Baillie

Extensive and spectacular beach ridge systems are found in coastal areas covered by the Smithton Map Sheet. These occur from Perkins Island [CQ360840] to Forwards Beach [CQ705741]. This systems have been described by Gill and Banks (1956). Lack of soil development and immaturity of topography indicate a Holocene age and the deposits must have formed since sea level reached its present height about 6000 years B.P.

WEST INLET – DUCK BAY AREA

K. D. Corbett
E. B. Corbett

A series of Holocene sand ridges forms the broad spit between West Inlet and Duck Bay. The ridges are mainly 3–6 m high, and two major series can be recognised. The older series forms the inland part of the spit, fronting the coastal sand plain. These ridges are truncated by the tea-tree swamp and salt marsh deposits to the east, and by the younger series to the north. The younger series forms the bulk of the spit and is essentially parallel to Anthony Beach. Representatives trends of the ridges are shown on the map. Similar sand ridges are described by Gill and Banks (1956).

PORT LATTA – FORWARDS BEACH AREA

P. G. Lennox

To the east and west of the areas discussed above, three further areas are backed by dune sand ridges: Forward Beach [CQ700740]; Hellyer Beach [CQ680744]; and Perkins Island [CQ360850].

The spit-sand near the mouth of the Detention River on Hellyer Beach [CQ690743] may not be stabilised and if the river should change its course it may be altered in shape.

The parallel beach ridges behind Forwards Beach and Hellyer Beach are similar to those surveyed by Gill and Banks (1956) behind Peggs Beach [CQ590760]. They recognise three phases of sand ridge building which indicate a fall of sea-level of the order of three metres.

YOUNGER DUNE, BEACH SAND (Qhy); BEACH BASALT GRAVEL (Qhy').

BLACK RIVER – STANLEY PENINSULA

P. W. Baillie

Deposits of sand are currently being formed on present beaches and some remobilisation of older dunes has occurred, in particular, in the vicinity of Black River Beach [CQ563800], where parabolic blow-out dunes have begun to form.

Modern deposits of basalt boulders (Qhy'), that may be either reworked from older deposits or primary deposits, are grouped within this mapping category. The deposits are confined to the Stanley Peninsula.

ANTHONY BEACH AREA

K. D. Corbett
E. B. Corbett

Fronting the sand ridges at either end of Anthony Beach are a series of partly mobile recent (?) dunes developed behind the beach. These tend to be irregular in form, and reach heights of over 20 m in places.

PORT LATTA – ROCKY CAPE AREA

P. G. Lennox

The beaches between Port Latta and Rocky Cape in front of the stabilised dunes, consist of beach sand. The spit at the mouth of the Detention River may also be of this sand type.

MUD, SANDY CLAY AND SAND OF TIDAL MARSHES (Qhm); AND COASTAL TEA-TREE SWAMP (Qhmt)

WILTSHIRE – STANLEY PENINSULA AREA

P. W. Baillie

Muddy tidal flats sometimes occur on the landward side of beach ridge systems, in particular in areas where drainage of the sand plains (Qs) reaches the sea. Encroachment by vegetation has allowed the formation of tea-tree swamps, and these have been differentiated on the map (Qhmt).

DEEP CREEK BAY – WEST INLET AREA

K. D. Corbett
E. B. Corbett

Tidal salt marshes (Qhm), laced with tidal channels and creeks, occur around Deep Creek Bay and West Inlet. The deposits consist mainly of mud and sandy clay trapped by the roots of the marsh vegetation. Towards the eastern end of West Inlet the marsh is underlain by coarse gravel and shell debris.

Areas of dense tea-tree swamp (Qhmt) occur just inland from the salt marshes at Deep Creek Bay and West Inlet. They appear to be underlain by sand and recent peaty material, and possibly represent earlier, higher level salt marshes.

SPRING MOUND DEPOSITS (Qhs); CALCAREOUS (Qhsc) OR SILICEOUS (Qhss)

DEEP CREEK – BRIANT HILL AREA

K. D. Corbett
E. B. Corbett

Spring mounds occur mainly in areas underlain by Smithton Dolomite. The majority are calcareous and limonitic, but a few are dominantly siliceous. A large calcareous mound occurs near Deep Creek Bay at CQ450787, and has been mined for lime. Limestone derived from a coalesced series of springs forms an extensive deposit in the valley of Coventry Creek [~CQ427745].

A large body of banded, massive and brecciated silica or chert occurs near the foreshore of Deep Creek Bay at CQ445792. The origin of this rock is problematical. It was mapped as bedrock chert by Nye *et al.* (1934), and included in the Smithton Dolomite by Carey and Scott (1952) and Gulline (1959). However, the rock does not show the typical bedding of chert but resembles more a concretionary deposit and at this stage is thought to be a large siliceous spring deposit. A smaller deposit of this type occurs west of Briant Hill.

MELLA – HUETTS ROAD AREA

P. G. Lennox

Gill and Banks (1956) recorded thirteen spring mound deposits (Qhs) from the Mella area, whilst Colhoun (1979) has also described the same mounds.

Two spring mound deposits (Qhsc) off Huetts Road [CQ365643, CQ366648] are 30–60 m in diameter and 0.5–1 m high, and consist of dark, chocolate-brown, porous iron-oxide/hydroxide boulders ranging up to 1× 2 m in size.

ALLUVIUM – DOMINANTLY SANDY LOAM (Qhas); DERIVED WITH ASSOCIATED SOIL FROM SMITHTON DOLOMITE AND OFTEN WITH CHERT LAG (Qhad); RIVER TERRACE GRAVEL DEPOSITS (Qhat); MAN-MADE DEPOSITS (Qham) AT CIRCULAR HEAD [CQ568855]

COVENTRY CREEK – DEEP CREEK AREA

K. D. Corbett
E. B. Corbett

Sandy alluvium occurs along most of Coventry Creek and Deep Creek and the upper part of Sedgy Creek. The more extensive alluvial plains occur inland of the coastal sand deposits, and it is apparent that this sand has overlapped the alluvium to a large extent. However, in the lower reaches of the major creeks (particularly Deep Creek), the sand deposits have been eroded and redeposited on narrow alluvial plains which are flanked by high banks of sand. In most places the alluvium consists of brown sandy loam covered by pasture or, in a few places, by dense tea-tree stands.

In the dolomite valley which runs west from South Forest, modern alluvium overlies deep soil (which may consist partly of older alluvium) developed on the dolomite, and forms plains cut in coarse gravel deposits (Qhat).

SOILS (Qhad)

SOUTH FOREST

K. D. Corbett
E. B. Corbett

There are some areas, particularly on the dolomite, where it has not been possible to determine on the type of bedrock because of the depth of soil cover. These areas are mapped as soil. A deep ditch west of South Forest in this material [CQ509723] shows at least 4 m of yellow-brown soil, of which the upper 2 m may be partly transported and the lower 2 m largely *in situ* decomposed dolomite or shale.

DETENTION RIVER – DUCK RIVER AREA

P. G. Lennox

Alluvium is common within the creeks and rivers draining the area covered by the Smithton Map sheet. The Wilsons Creek drainage basin contains alluvial mud banks up to 2 m high, especially near the Rocky Cape Road turnoff [CQ708720].

Embankments on the Detention River are up to 8 m high at one point [CQ679720]. The section consists of 100 mm of black soil overlying 4–6 m of colour banded grey sand, which in turn overlies 1–2 m of pebbly indurated sand. The angular, imbricate pebbles in the lowest unit range from 10–20 mm diameter up to 60 mm diameter (rare), and are predominantly quartzite (with some ?dolerite/?basalt) and form a decreasing percentage of the rock from bottom (40%) to top (20%). There is a sharp planar contact between the lowest unit and the grey sand, and pebbles near this contact commonly have their long axes aligned parallel to the contact.

The meandering section of the Black River [CQ645614] contains up to 1.5 m high alluvial mud banks. The Black River river flats south west of Doughboy Hill [CQ632603] consist of alluvial mud. A one metre high embankment on Mawbanna Road in this area consists of 120 mm of river gravel (bottom) overlain by 70 mm of rootlet-bearing black loam, 80 mm of river gravel and up to 560 mm of alluvium (top).

The Dip River and Gibson Creek [CQ523642], which are both tributaries of the Black River, have extensive alluvial mud areas in their lower reaches.

The extensive alluvial mud flats surrounding Amos Hill [CQ452708] may reflect a different drainage pattern to that now present.

The Duck River throughout its traverse across the plains from Edith Creek [CQ396628] to Smithton has alluvial mud banks up to 2.0–2.5 m high.

TERRACE GRAVEL DEPOSITS (Qhat)

MAWBANNA AREA

P. G. Lennox

Two gravel deposits cropping out 200 m apart on the Western Line, 4 km east of Mawbanna Siding [CQ643704] are shown in Figure 11. Both deposits overlie a very weathered mudstone within the Cowrie Siltstone. One section exhibits two separate gravel deposits with a soil profile between (fig. 11). The other deposit shows grading and imbrication which indicate the river which formed the deposit flowed to the west.
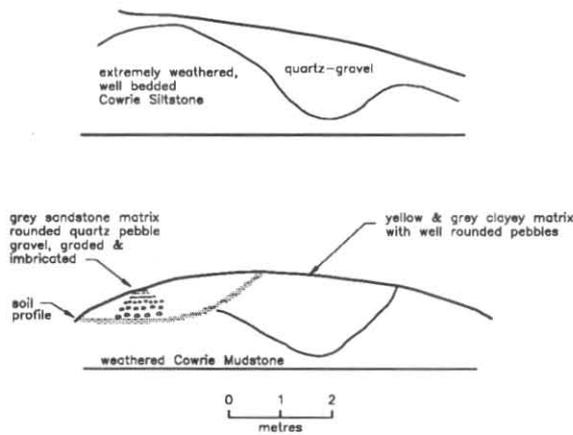
Figure 11. Quaternary (?)gravel deposits along railway embankments on the Western Line [CQ643704].

ROCKY CAPE AREA

P. G. Lennox)

The two sections shown in Figure 12 correspond to gravel pit embankments near the Rocky Cape Store [CQ727707]. These partly imbricated, graded gravel deposits occur near the mouth of a creek [CQ730709] draining the Rocky Cape National Park and may possibly be fan deposits (*cf.* Colhoun 1977).
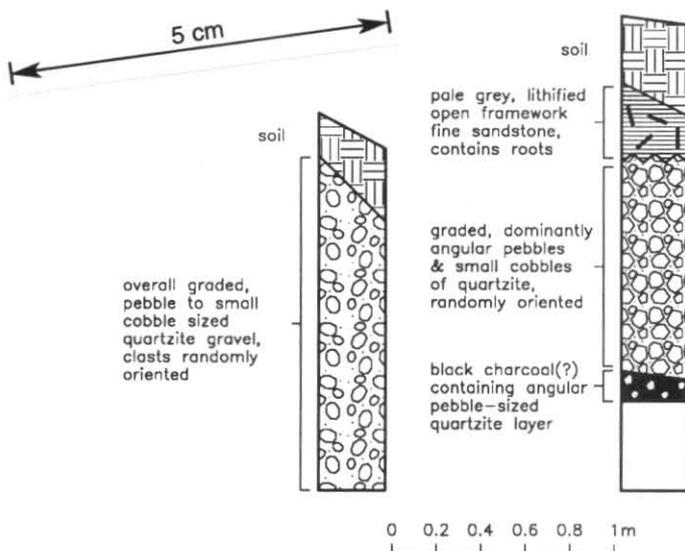
Figure 12. Quaternary gravel deposit, Rocky Cape township area [CQ727707].

BLACK RIVER AREA

P. G. Lennox

Three deposits on the Black River [CQ624602, CQ617614, CQ611631] may correspond to river terrace deposits. The deposit, about 750 m downstream of the Mawbanna Road – Black River crossing [CQ624602], consists of a 0.8 m thickness of well-rounded pebbly-gravel underlying 1.6 m of clayey alluvium with rate gritty layers. The poorly sorted, extremely well rounded pebbles of medium sphericity do not display imbrication although they appear graded in parts of the exposure. In a river bend at CQ617614, a 1.5 m thick deposit of quartz-pebble to cobble conglomerate overlies Cowrie siltstone. The well rounded, low sphericity, mostly flat lying quartzite pebbles and small cobbles (80%, maximum size 50 × 80 mm) lie in a gritty

clay matrix (20%). Tabular mudstone cobbles occur in the bottom 0.5-metre section directly above the Cowrie Siltstone. Whereas the two deposits above occur adjacent to the river, the Skippers Creek road deposit [CQ611631] is exposed in a quarry face about 50 m from the river. The three metre high quarry cliff consists of well rounded, well sorted, small pebble to small cobble sized quartzite and basalt gravel in a fine sand-size matrix. The clasts are imbricated in places, and the deposit is overlain by weathered basalt and soil.

HELLYER – TURNERS PLAINS AREA

P. G. Lennox

Terrace gravel deposits are exposed at the following three localities:

Loosemore Road gravel pit [CQ668726]; Mathers Road gravel pits [CQ583719] and Turners Plain gravel pits [CQ555633]. The Loosemore Road gravel pit is excavated in angular to well rounded, white, recrystallised, pebble-sized quartzite float overlying a coffee-coloured ferruginous friable sand. P. W. Baillie (pers.comm.) has identified a distinctive coffee-coloured friable indurated sand from drill holes and roadside exposures near the Stanley turnoff on the Bass Highway [CQ528805]. The coffee-coloured indurated sand overlies clay with wood and underlies the leached zone which is itself overlain by humus-rich soil. The gravel at Loosemore Road pit may overlie equivalent 'coffee rock', in which case the age of the deposit may by Holocene rather than Tertiary (?) – Late Quaternary (?).

The Turners Plain gravel pits expose angular, pebble to small-cobble sized, white recrystallised quartzite float sometimes overlying Cowrie Siltstone, but usually the underlying rocks are not exposed and are unknown.

The Mathers Road gravel pits are similar to the quartzite gravel pits described above, although no underlying rock type is exposed, and the gravel only ranges up to small pebble-size at the most.

STRUCTURAL GEOLOGY

P. G. Lennox

Rocky Cape Group (Black River to Rocky Cape region)

INTRODUCTION

This region extends from the edge of the basalt cover in the west (Bass Highway/Black River CQ572767 – Spion Kop Lookout CQ547703 – Peppermint Hill CQ504674 – Willis Hill CQ479638), to a north-south line through Rocky Cape hamlet [CQ735755] in the east. The southern boundary of the region is the latitude 41°00′ approximately corresponding to an east-west line through Nabageena [CQ420610].

Gee (1971) reported NE–SW trending folds with shallow to moderate plunges to the north-east from the Rocky Cape Group on the Table Cape Quadrangle). The folds are regularly faulted by a series of high-angle oblique-slip thrusts. Gee *(ibid.)* observed slaty cleavage in a lutite bed in the Detention Subgroup as well as isolated outcrops containing a later crenulation cleavage. The crenulation cleavage is not related to any known periods of folding and appears to have a more or less constant sub-horizontal attitude throughout the area.

The major E–W trending transcurrent fault passing through Jacobs Boat Harbour (J.B.H., CQ840690) is a prominent feature on the Smithton Quadrangle and can be shown to effect folds within the Rocky Cape Group north and north-west of Mawbanna [CQ627650] before
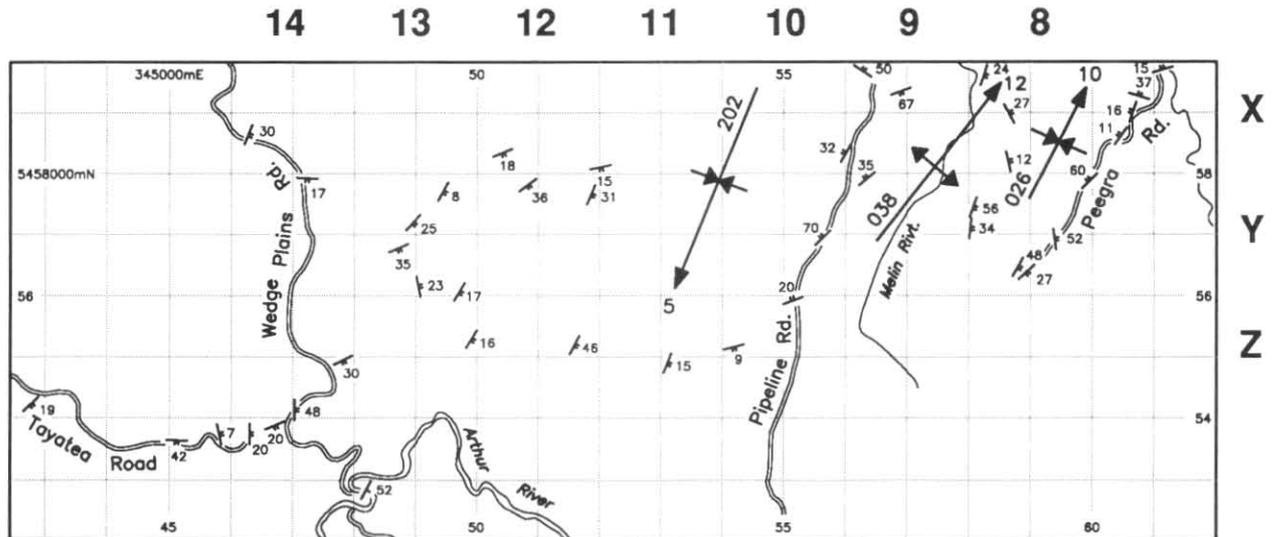
Figure 14. Geological map of the folding in the Cowrie Siltstone south of the southern boundary of the Smithton Quadrangle. Contoured stereoplots of the poles to bedding on which these fold hingelines are based are shown in Figure 27. The numbering of the 2 km × 2 km squares is as shown.

Table 5
ROCKY CAPE GROUP – CLEAVAGE ANALYSIS

The localities at which two or three cleavages are well developed. S_0 is equivalent to bedding, S_1 is equivalent to the dominant or first cleavage whilst S_2 and S_3 are equivalent to later, crenulation cleavages

Locality	AMG Ref	Formation	S_0	S_1	S_2	S_3	Comments
Alarm River tributary	CQ714624	Irby Siltstone	050-060/ 35-45	062/56	080/86	-	S_2 equivalent to cleavage seams consisting of discontinuous
		Altered dolerite	050-060/ 35-45	045/70-73	028/60		opaque stringers space 1-2 mm apart
Shakespeare Hills	CQ693637	Detention Subgroup	159/33	074/77	135/53	-	Shakespeare Hills anticline has a hingeline plunging 35° to 048°
Shakespeare Hills	CQ674653	Detention Subgroup	141/38	074/81 074/47	061/72 057/67		
Hook Creek Upper reaches	CQ661664	Cowrie Siltstone	127/40	104/74	084/84	-	The later cleavage is related to a local fold
Middle reaches	CQ668665	Cowrie Siltstone	113/34	037–040/65	350/60(?)	072/77(?)	There appear to be two directions of fracture which interfere to give the overall cleavage
Pine Corner Road quarry	CQ584683	Cowrie Siltstone	variable	076/40–50	041.70/80	-	S_1 local cleavage S_2 regional cleavage – see figures
Melin Rivulet	CQ577613	Cowrie Siltstone	178/23	080/75	047/73	-	Cleavage consists of an extremely-fine-grained sericite fabric cross-cutting authigenic muscovite laths
Brickmakers Bay	CQ621763	Cowrie Siltstone	- 095/33 095/47	075/90 085/87 085/90	320/80 130/90 130/77	-	Folded Cowrie siltstone with hinge-lines plunging 5–20° to 250–260°
Mathers Road–Pine Corner Road	CQ570711	Cowrie Siltstone	048/74(?)	233/59	174/79,198/62	-	

disappearing beneath the Tertiary basalt cover near the Gibson Creek junction with the Black River [CQ545682].

The structural features of the Black River to Rocky Cape region were analysed systematically in 2 km × 2 km squares (or parts thereof), shown in Figures 13 and 14.

CLEAVAGE

Introduction

Gee (1971) observed a slaty cleavage and rarely a crenulation cleavage in lutite beds within the Detention Subgroup on the Table Cape Quadrangle. The slaty cleavage on this sheet varies in trend from 018° to 85° dips NW to WNW at between 42° and 85°, which is approximately axial planar to the NE-plunging folds which dominate the region. There may be two distinct cleavages (trending 020–040°, 070–080°) present on the Table Cape Quadrangle, which are of similar orientation to the two main cleavages observed within the Rocky Cape Group on the Smithton Quadrangle.

One cleavage and frequently two cleavages were observed in all the formations of the Rocky Cape Group on the Smithton Quadrangle. Table 5 lists localities where two (or three) cleavages were observed in the Irby Siltstone, Detention Subgroup and Cowrie Siltstone.

The Cowrie Siltstone is the areally dominant formation of the Rocky Cape Group cropping out on this quadrangle. The highly siliceous nature of the formation means that although two cleavages are commonly observed in hand-specimen they cannot necessarily be confidently identified in thin section. Where two cleavages can be identified in thin section they may be defined by two dominant directions of lepidoblastic-sericite fabric. Commonly one direction of aligned sericite predominates and is overprinted by a minority of aligned sericite needles in another direction.

Cowrie Siltstone

The dominant cleavage observed in forty thin sections of Cowrie Siltstone is defined by either discontinuous anastomosing opaque to semi-opaque stringers, or a lepidoblastic-sericite fabric, or both, depending on the composition of the rock, degree of iron oxide/hydroxide staining and the relative proportion of opaque mineral grains. In 77/718, 77/764, 80/107, 80/120 and 80/121, the anastomosing opaque stringers are predominant (plate 19). In 80/107 the discontinuous opaque stringers are commonly only 6-10 μm wide and spaced 35-56 μm apart. In 77/718 some mica blades are aligned at an angle to the opaque stringers and may define another weakly developed cleavage.
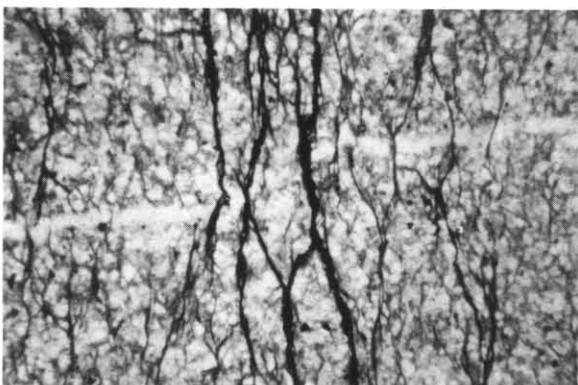
Plate 19. Concentration of opaque stringers defining the cleavage into a cleavage seam. Note the truncated and displaced quartz vein. Cowrie siltstone, Rocky Cape township [CQ725747], 77/651. Magnification ×2, plane polarised light.

In 77/655, 77/795, 78/814, 80/105 and many others, both opaque stringers and a lepidoblastic-sericite fabric are present. The continuity, straightness, thickness and spacing of the opaque stringers varies within each sample and between samples. The thickness of the opaque stringers varies from commonly 7–21 μm (77/659, 77/795, 80/106) to rarely 210 μm (77/655). The spacing of the opaque stringers is usually between 35 and 70 μm (80/107, 80/122, 77/795) but may rarely be up to 450 μm (80/106).

In 77/719, 80/109 and 110, 80/171, 78/62 and 78/63, lepidoblastic-sericite fabric alone defines the dominant cleavage. The sericite needles where resolvable range from 1 to 7 μm thick (80/114) by 21 to 40 μm long, and may form aggregates up to 450 μm long (80/109). the lepidoblastic- sericite fabric consists of an almost continuous mesh of individual aligned sericite needles, or aggregates of optically continuous aligned sericite needles (77/670). In 77/670 the 35–350 μm spaced sericite aggregates are from 1–70 μm thick and may form seams spaced up to 2.25 mm apart and of 180–270 μm thickness. Similar sericite - ?muscovite seams define both cleavages in 77/668.

The lepidoblastic-sericite fabric may sometimes be resolvable into two directions about 30 μm apart. A large proportion of the aligned sericite needles define one cleavage which is weakly ?overprinted by a minority of sericite needles and rare mica (?muscovite) blades in the secondary cleavage direction. Thin sections 77/659, 77/670, 78/63, 80/172 and 80/111 have a weakly developed cross-cutting sericite fabric. In 80/109 there may be two directions of lepidoblastic-sericite fabric development in addition to the dominant direction.

77/665, 77/764 and 80/121 exhibit a weakly developed crenulation cleavage crosscutting the dominant cleavage, while 77/714 and 78/827 have a well developed cross-cutting crenulation cleavage. In 77/668 and 80/106 the lepidoblastic-sericite fabric displays distinct disrupted zones consisting of a gap in the continuity of the sericite fabric. This may be due to incipient development of a crenulation fabric.

The dominant cleavage may be at a very low angle to bedding (77/655, 77/714, 78/63) or a high angle to bedding (77/665, 78/817, 80/107, 80/121, 80/109 and 110). In 77/764, 77/795 and 80/114, the crenulation cleavage is at a high angle to the dominant cleavage.

Where resolvable quartz grains are present they range from 7–14 × 35–79 μm (78/817, 77/795 and 77/668) up to 70 × 140-350 μm (77/662, 77/670) across. The quartz grains may be elongated (77/662, 77/668, 80/105), may have sericite beards (77/670), and may exhibit gently curved to scalloped margins (77/662, 78/817, 80/105) or sutured intragrain boundaries (80/109). Bladed ?muscovite which may be ensheathed in fine sericite needles (e.g. in 77/718, 78/817, 80/114, 80/109 and 80/105) is usually less than 7 μm thick (rarely up to 21 μm thick) by 35–70 μm long (rarely up to 160-210 μm long, 80/121 and 80/103). Rarely are individual sericite needles resolvable, but in 78/814 authigenic sericite needles have been identified, while in most thin section metamorphic sericite needles ranging from 7 μm thick by 21-40 μm long are common.

Pyrite in 80/108 consists of relict aggregates of fine crystalline grains from 140 × 200 – 350 μm × 500 μm in size, sometimes with bent, elongated quartz beards from 7 × 35 μm to 28 × 140 μm in size. Pyrite also occurs in 80/112 and 80/114.

Quartz veins cut by the cleavage in 78/63, 80/172, 77/659, 80/111 and 80/105 indicate that most quartz-veining was pre-cleavage. In some cases sigmoidal to parallelogram- shaped remnants are all that remain of a quartz vein.

|← 5 cm →|
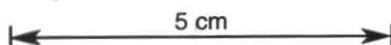
Plate 20. Photomicrograph of spotting in a spotted, laminated mudstone, specimen 80/107 of Cowrie Siltstone from a tributary of Gibson Creek [CQ725747]. The composition of the spots differs only in respect of the proportion of opaque minerals compared with the remainder of the rock. Magnification ×30, plane polarised light.

Plate 21. Photomicrograph showing microfolded laminae and axial plane crenulation cleavage. Detention Subgoup, specimen 77/669, Shakespeare Hills [CQ693673]. Magnification ×2, plane polarised light.

Thin sections 80/106 and 80/107 contain elongate spots which are enhanced by bunching together of opaque mineral grains stringers along their margins. The spots range from 140×350 μm to 595×1120 μm in size (plate 20).

In three samples, 77/659, 77/665 and 80/112, clasts with a finer-grained, more sericite-rich composition form up to 25% of the rock and are aligned parallel to the dominant fabric. They range in size from 90×1440 μm (80/112) to 4mm $\times$ 30 mm (77/659) and vary in shape from wispy to tabular.

Detention Subgroup

Hand specimens and thin sections from the three main Detention Subgroup outcrops (Shakespeare Hills CQ680660, Dip Range CQ730610 and Rocky Cape Hamlet CQ730755) reveal similar cleavage development to that in the Cowrie Siltstone.

In the quartz-arenite specimens the dominant cleavage is a dissolution cleavage (77/669) consisting of discontinuous, widely spaced, semi-opaque to opaque seams alongside which scalloped, sometimes parallel fractured quartz grains occur (77/673). Any lutite units or intergrain sericite-rich matrix invariably exhibits a lepidoblastic-sericite fabric (77/673) or a crenulation cleavage (77/669, 77/654).

The crenulation cleavage in 77/669 is axial planar to microfolding of the 220-600 μm thick sericite-rich mudstone laminae (plate 21). The crenulation cleavage in 77/654 is expressed by isolated aligned needles of metamorphic mica (up to 28×100 μm in size) and pinching and disturbance of the main sericite fabric. Semi-opaque, wavy cleavage seams in 77/673 lie adjacent to quartz grains truncated by pressure solution (plate 22) and are parallel to the lepidoblastic-sericite fabric within the matrix.

In hand specimen the quartz-grains may form lozenge-shaped bodies (e.g. 77/673, bodies 3–4 $\times$ 15 mm in size) within a finer-grained mudstone matrix. The lozenge-shaped quartz-rich ?clasts in 77/654 range from 105×210 μm up to 0.5mm across, and consist of quartz grains up to 9×11 μm across. The well-sorted, equigranular quartz grains in 77/704 and 77/705 display undulose extinction and occasionally sutured intragrain

Plate 22. Photomicrograph showing scalloped, elongate and fractured quartz grains adjacent to the opaque cleavage seams. Detention Subgroup, specimen 77/673 from Shakespeare Hills [CQ691669]. Magnification ×3, plane polarised light.

boundaries. Quartz grain boundaries in 77/654 and 77/703 are gently curved to scalloped, indicating probable pressure dissolution. The quartz grains in 77/703, 77/705 and 77/654 may be elongate – up to 2:1. The quartz grains range in size from 14–35 μm across (77/669, 77/704) to 70–140 μm across (77/703, 77/654). In 77/703 some quartz grains have sericite beards, and between adjacent quartz grains lines of en echelon sericite needles may form.

The sericite where resolvable ranges from 1–3 μm wide (usually less than one micrometre) by up to 14 μm long (77/703, 77/707). Rare aligned mica (?muscovite) laths up to 28×100 μm in size, together with crenulated sericite needles, define a secondary cleavage. Minor aligned sericite needles and ?muscovite delineate the first cleavage in 77/704, while segregations of aligned aggregates of sericite ?muscovite spaced 70-100 μm apart and of 7–14 μm thickness define the second cleavage. This may represent incipient development of a crenulation cleavage.

Irby Siltstone

The Irby Siltstone crops out in only one area, within the core of the Newhaven Syncline [CQ720650], and up to
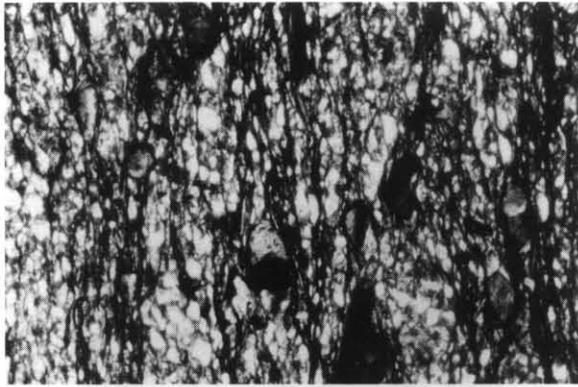
Plate 23. Photomicrograph of well-developed anastomosing stringers in concentrated bunches forming cleavage seams. Irby Siltstone, specimen 77/786 from core of Newhaven syncline [CQ720650]. Note the metamorphic mica aligned parallel to the cleavage, scalloped and elongate quartz grains and the small size of quartz grains between closely-spaced opaque stringers. Magnification ×25, plane polarised light.

two cleavages have been observed in outcrops in this area.

The predominant cleavage consists of bunches of anastomosing opaque stringers in cleavage seams, as in samples 77/786, 77/660, 77/661 and 80/104 (plate 23). The seams are spaced from 360–480 μm (77/661) to 3 mm (77/786) apart. In 77/661 the opaque-rich muddy beds do not contain cleavage seams, but rather 7–70 μm wide layers containing quartz grains and aggregates of sericite needles plus semi-opaque mineral grains interlayered with 14–70 μm wide opaque layers, both of which are parallel to the cleavage. The anastomosing, discontinuous stringers which form these seams are spaced 14–35 μm (77/661, 80/104 to 70–84 μm apart (77/660) and are 7–14 μm thick. In 77/786 and 77/660 there are two discernible trends about 20° apart within the opaque stringers.

A lepidoblastic-sericite fabric is recognisable in only one thin section (80/104) and this does not have two trends in it. In 77/666 a minor number of sericite needles define a secondary cleavage at 20° to the dominant sericite alignment.

The quartz-grains where resolvable range from usually 14–35 μm across, commonly display undulose extinction, may be tapered (77/786), elongated (77/661, up to 2:1), exhibit gently-curved to scalloped margins (77/660) or truncation. The quartz grains in 77/660 may have sericite beards as well as in some instances lines of en echelon sericite needles in the boundary zone between quartz-grains (? incipient sericite beards).

The sericite needles where resolvable range from less then one micrometre thick by up to 14 μm long (77/666) to 2 μm thick by 35 μm long (77/786 and are the dominant mineral component defining the cleavage fabric, apart from the opaque stringers. Rare ?muscovite laths up to 2–10 μm thick by 80–105 μm long are aligned subparallel to the cleavage in 77/661 and 77/786. They form less than 2% of the rock and may be ensheathed in sericite.

Quartz veins about 14 thick in 77/661 and 77/786 are cross-cut by the cleavage at a high angle, and are dissected into relict sigmoidal patches, or in some parts of the rock (e.g. in the middle of the cleavage seams in 77/786) are almost completely obliterated (pressure solution?).

|←————— 5 cm —————→|
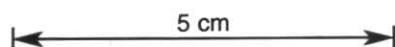
Table Cape area

Ten thin sections were made of samples of the Rocky Cape Group from Jacobs Boat Harbour [CQ840680], Sister Beach [CQ780698], Cathedral Rocks [CQ752735] to Anniversary Point [CQ769721], and Burgess Cove [CQ744752] on the Table Cape Quadrangle. This enabled petrographic comparison of the cleavage fabric in the Rocky Cape Group from the Table Cape and Smithton Quadrangles.

The seven Irby Siltstone hand specimens all exhibit one dominant, penetrative cleavage (e.g. 77/644, 77/652). In some instances lineations on the handspecimens indicate the present of another cleavage at a low angle to the first cleavage (77/644). In both thin sections from the Cathedral Rocks to Anniversary Point Area (77/646 and 77/647) the lepidoblastic-sericite fabric exhibits one dominant trend ?overprinted by a poorly developed secondary fabric. Thin sections 77/645 (Sisters Beach) and 77/653 (Burgess Cove) display a weakly developed crenulation of the dominant sericite fabric. In 77/645 there may be three cleavages: a primary cleavage (?slaty) at a low angle to bedding, a secondary cleavage (seam cleavage) and finally a crenulation cleavage.

The single quartz-arenite sample of the Jacobs Quartzite (77/642) shows incipient recrystallisation of the quartz grains and some alignment of the minor sericite needles in one dominant direction. The one sample of the Detention Subgroup (77/648) exhibits a cleavage consisting of closely spaced opaque seams which are almost parallel to the bedding. this has given the rock an appearance similar to flaser-bedding.

A thin section of the unassigned siltstone near Jacobs Boat Harbour (77/641) displays two cleavages; a lepidoblastic-sericite fabric cross-cut at a high angle by a crenulation cleavage. The crenulation cleavage is weakly developed and affects only a minor part of the dominant lepidoblastic-sericite fabric. A small number of isolated sericite needles are aligned parallel to the crenulation cleavage.

Summary and conclusions

(1) A cleavage and frequently two cleavages are generally visible in every hand specimen. The cleavage expression in various lithologies is either penetrative down to microscope scale (80/109, 80/105, 77/714, 77/659, 80/122), or alternatively spaced and crenulating the bedding laminae (80/121, 80/112, 80/120).

(2) In the Rocky Cape Group formations exposed on both the Smithton and Table Cape Quadrangles (Gee 1971 and this report) the primary cleavage is defined by discontinuous anastomosing opaque stringers and/or lepidoblastic-sericite fabric.

(3) In hand specimen (commonly) and in thin section (ubiquitously) at least two foliations apart from the foliation due to bedding can be recognised. The predominant secondary foliation is either a second, more weakly developed fabric at a low angle (20 μm – 30 μm) to the dominant lepidoblastic-sericite fabric (77/659, 78/63, 80/172) or a weak to well developed crenulation of the lepidoblastic-sericite fabric (77/665, 80/121, 78/817). The other secondary foliations consist of disruptions of the lepidoblastic- sericite fabric (77/654), or formation of millimetre-spaced cleavage seams as a result either of bunching together of opaque stringers (77/786, 77/661) or of aggregation of sericite (77/704). The disruption foliation may in part represent incipient crenulation of the lepidoblastic-sericite fabric.
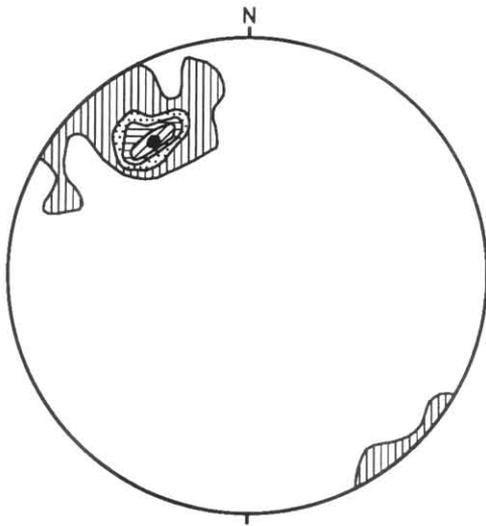
Block D (7–12)*. **46 readings**, contours 4, 11, 13, 15, 17% per 1% area. Plane corresponding to plot maximum 235˚SE58˚
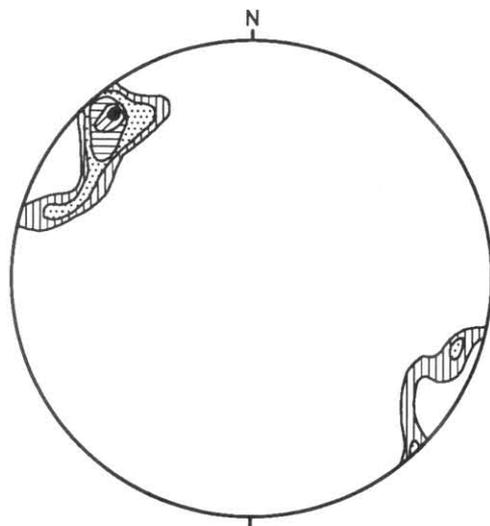
Block C (7–12). 33 readings, contours 6, 9, 12, 15, 18% per 1% area. Plane corresponding to plot maximum 230˚SE78˚
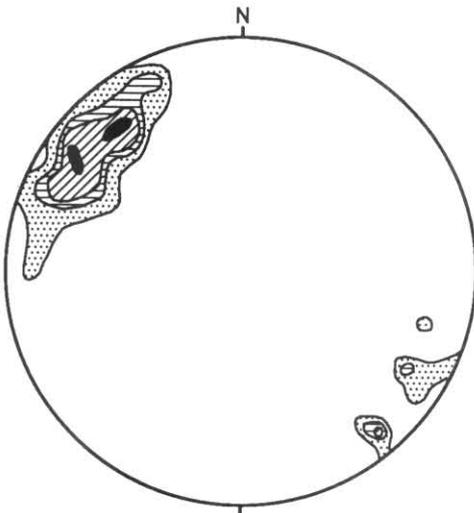
Block B (7–12). 53 readings, contours 4, 6, 7.5, 11% per 1% area. Planes corresponding to plot maxima 230˚SE73˚, 228SE68˚
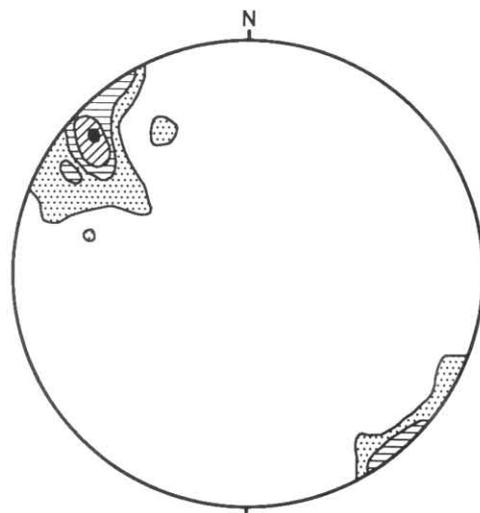
Block A (7–12). 40 readings, contours 5, 10, 13, 18% per 1% area. Plane corresponding to plot maximum 222˚SE78˚

5 cm
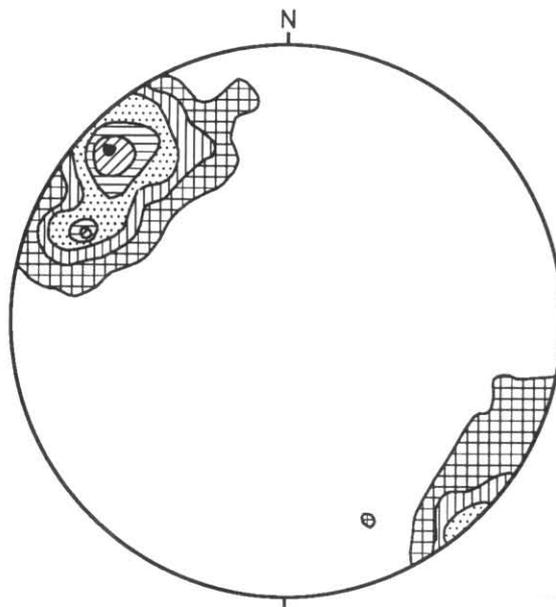
Blocks A–D (7–12). 172 readings, contours 2, 4, 6, 8, 9, 12% per 1% area. Planes corresponding to plot maxima 223˚SE78˚, 200˚SE68˚

Figure 16. Cowrie Siltstone. Contoured steroplots of poles to cleavage(s) from Blocks A–D. All steroplots are equal area, lower hemisphere projections. For location of Blocks see Figure 13.   * e.g. Block D (7–12) = Block D7 + D8 + D9 + D10 + D11 + D12.
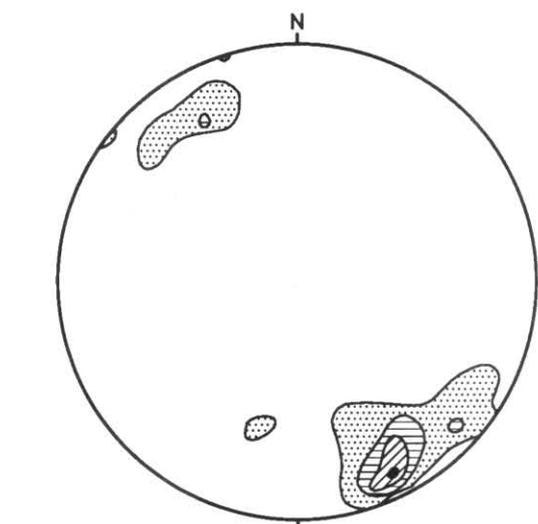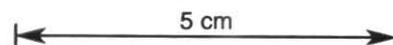
Mudstone. 53 cleavage readings, contours 4, 7.5, 11, 15% per 1% area. Planes corresponding to plot maxima 043°NW79°, 064°NW79°, 239SE67°
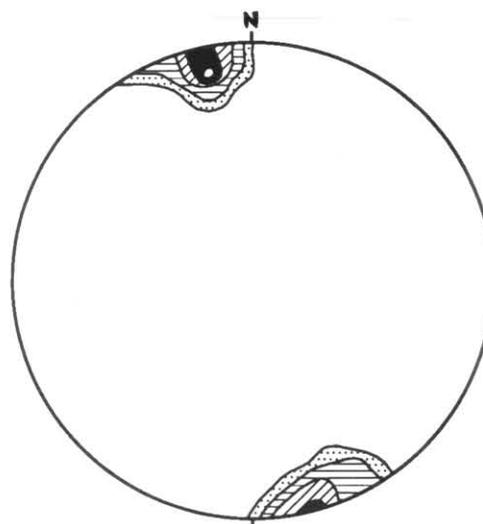
Siltstone. 40 cleavage readings, contours, 5, 7.5, 12.5, 17.5, 22% per 1% area. Plane corresponding to plot maximum 257°SE79°
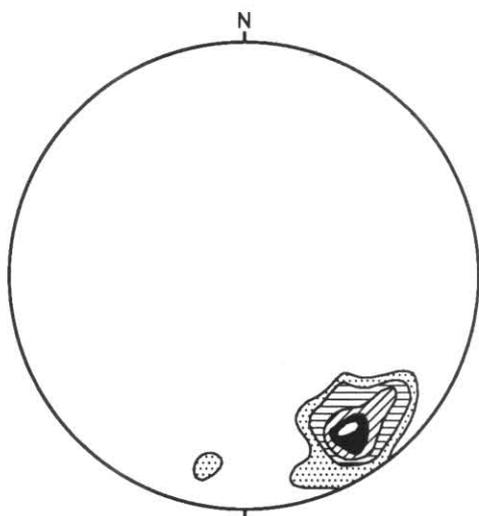
Quartzite. 41 cleavage readings, contours 5, 7.5, 15, 20, 25% per 1% area. Plane corresponding to plot maximum 055°NW68°
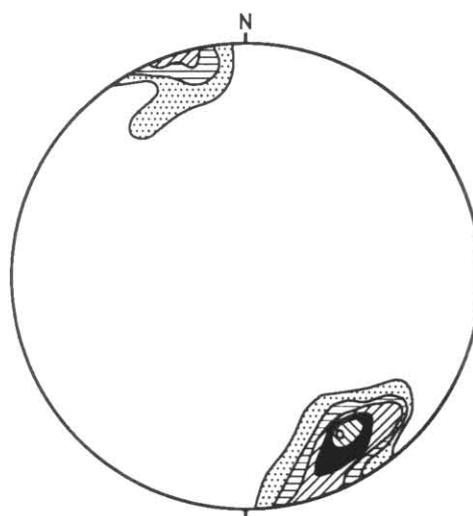
Combined. 134 readings, contours 3, 6, 7.5, 10.5, 13.5% per 1% area. Plane corresponding to plot maximum 059°NW67°

Figure 17. Rocky Cape Group. Contoured steroplots of poles to cleavage in diferent lithologies. All steroplots are equal area, lower hemisphere projections.

(4) The occasionally elongate quartz-grains usually exhibit undulose extinction and straight to gently curved or scalloped grain boundaries (rarely sutured), and some are tapered parallel to the dominant cleavage. They may occasionally show incipient recrystallisation or parallel fracturing adjacent to an opaque cleavage seam, and some contain interstitial sericite needles. Elongate quartz-grains commonly exhibit sericite beards or *en echelon* sericite needles between adjacent grains. The mineralogy and the quartz-grain characteristics described above indicate that the Rocky Cape Group underwent low grade regional metamorphism (probably lower greenschist facies) during the Penguin Orogeny.

Regional cleavage pattern

The basement geology between Black River and Rocky Cape, with cleavage(s) emphasised, is shown in Figure 15. Most of the localities where two or three cleavages occur (table 5) are shown alongside dots indicating the field station. Generally the crenulation cleavage trends more northerly compared with the early or dominant cleavage. The Alarm River Tributary (Irby Siltstone, CQ714624) outcrop and the Melin Rivulet (Cowrie Siltstone, CQ577613) outcrop exhibit crenulation cleavages striking more easterly than the dominant cleavage strike.

The trend of the dominant cleavage gradually changes from the southern margin of the Smithton Quadrangle where it is just east of north, to the Bass Strait foreshore outcrops 14–15 km to the north where it is almost east-west. It appears that movement on the Jacobs Boat Harbour transcurrent fault has caused rotation of cleavages (and regional folds) adjacent to the fault. These trends are discernible in spite of the fact that the Cowrie Siltstone sometimes contains two cleavages (apart from the crenulation cleavage), 20–30 μm apart in strike orientation and equivalent to the two distinct lepidoblastic-sericite fabric trends discussed above.

Structural elements including the cleavage(s) have been analysed on the basis of the 2 × 2 km squares shown in Figure 13. Figure 16 shows contoured stereoplots of poles to cleavage from Blocks A (south) to D (north), south of the Jacobs Boat Harbour Fault. As shown the
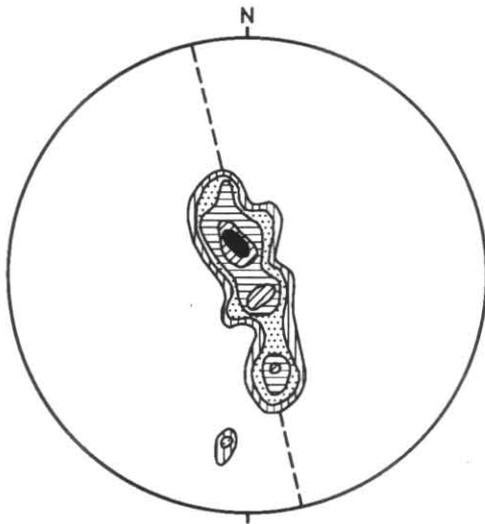
Black River – Bass Highway syncline. 43 cleavage readings, based on the mapping of Gee (1967, p. 188, fig. 17) and Baillie (1978, map of Stanley west). Contours 4.5, 7, 9, 14, 18.5% per 1% area. Best fit great circle corresponds to a fold with a hingeline which does not plunge but trends 077°/257°.
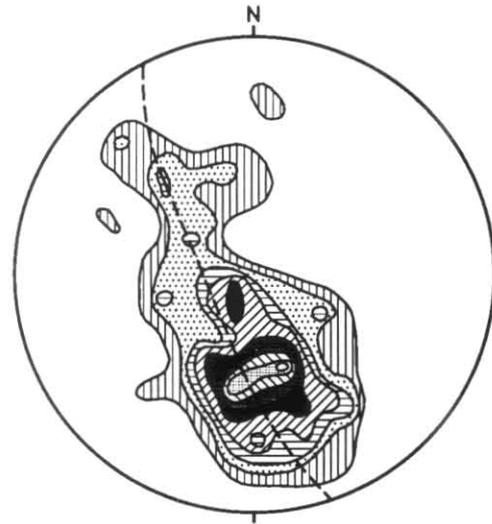
Crayfish Creek anticline. 206 readings, based on analysis of bedding from 2 km × 2 km blocks 3–7E–G, 4–7H and 5–7I, contours 1, 2, 4, 5, 6, 7, 8, 9% per 1% area. Best fit great circle corresponds to a fold with a hingeline plunging 14° to 060°, as shown.
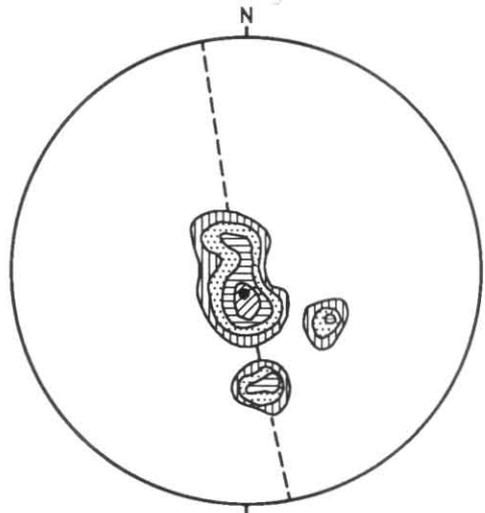
Jacobs Boat Harbour Fault – Black River antiform. 47 readings from blocks 11E and part of 10E, contours 4, 6, 8, 16% per 1% area. The possible best fit great circle, as shown, corresponds to a fold with hingeline plunging 2° to 079°.
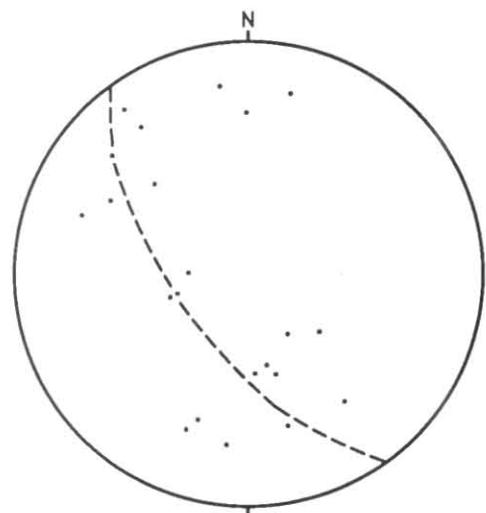
Mawbanna Sidling antiform. 22 readings from blocks 7E and 8F, The best fit great circle, as shown, coresponds to a fold with hingeline plunging 25° to 054°.

Figure 19. Major and minor folds in the Cowrie Siltstone (–Forest Conglomerate and Quartzite, Smithton Dolomite) from north of the Jacobs Boat Harbour Fault. Contoured steroplots of poles to bedding. (see fig. 13 for block numbers).

* Analysis of Gee's data (11 readings) alone, indicates that the syncline upstream of the bridge is best approximated by a conical fold with a half-apical angle of 60°, inclined at 50° to 252°. Not much reliance can be placed on this analysis because of the small

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dominant cleavage trend ranges from 222 μm in the south to 235 μm in the north.

In an attempt to determine whether the dominant cleavage orientation in the Black River to Rocky Cape region outcrops is directly related to the type of lithology in which it occurs, stereoplots of poles to cleavage in mudstone units, siltstone units and quartzite units were prepared (fig. 17). It can be seen that there are not any great differences between the strike trends shown in stereoplots of poles to cleavage from the mudstone and quartzite units, although the siltstone stereoplot yields a slightly rotated cleavage strike trend relative to the other stereoplots.

FOLDING

Introduction

The folding on the Smithton Quadrangle and an area adjacent to it on the Trowutta Quadrangle were analysed using the 2 × 2 km squares shown in Figure 14. the position of these squares are designated using a numeral and letter of the alphabet.

Three scales of folding are designated: major (half-wavelength 500 m), minor (half-wavelength 100 m maximum) and mesoscopic (half-wavelength less than 20 m). The inferred fold trends and plunges shown
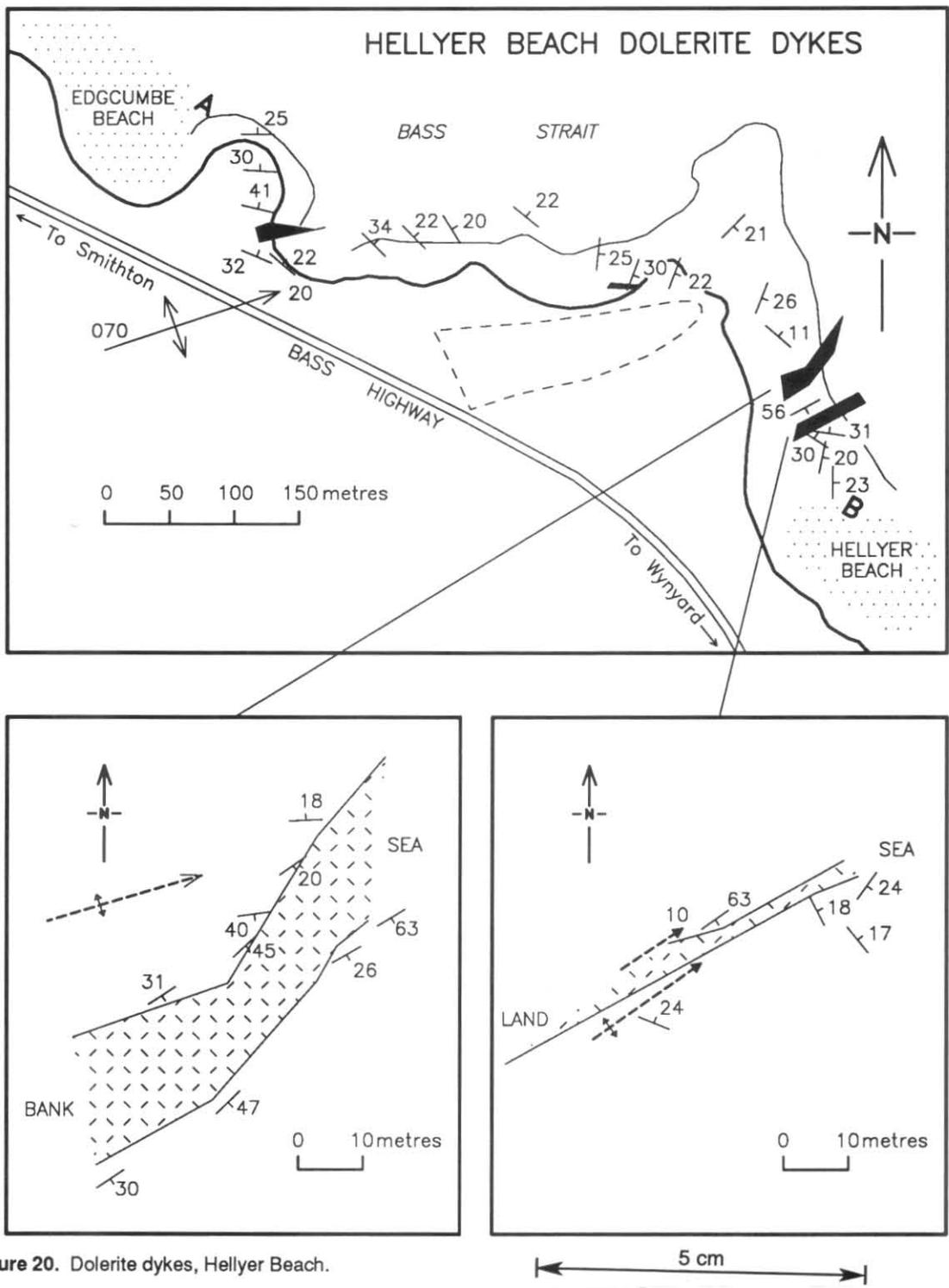
Figure 20. Dolerite dykes, Hellyer Beach.

on the maps are stereographically determined from an appropriate number of bedding readings.

It is apparent from Figure 15 that the dominant cleavage is generally trending (sub)-parallel to the inferred hingelines of the major and minor folding. It will be shown from an examination of the mesoscopic folding in the Cowrie Siltstone between Peggs Beach [CQ610754] and Rocky Cape that the dominant cleavage is also parallel to the inferred and measured hingelines of these mesoscopic folds.

North of the Jacobs Boat Harbour (J.B.H.) Fault

Figure 18 shows the inferred hingelines of major folds in the Black River to Rocky Cape region. There are four folds (three minor folds and one major fold) north of the J.B.H. Fault. Contoured stereoplots of poles to bedding for these folds are shown in Figure 19.

The hingeline of the Black River - Bass Highway Syncline [CQ570766] was determined on the basis of data from P. W. Baillie, and Gee (1967). This fold probably has a bent hingeline as suggested by Gee (*ibid*).

The major Crayfish Creek Anticline [CQ660755] is probably continuous onto the foreshore platform near Hellyer Beach where a minor anticline occurs (fig. 18, 20). The inferred hingeline trend of the Crayfish Creek Anticline was determined using two sub-areas (fig. 21–22). It appears from this analysis that the plunge of the anticline steepens from 062/12° to 062/20° towards
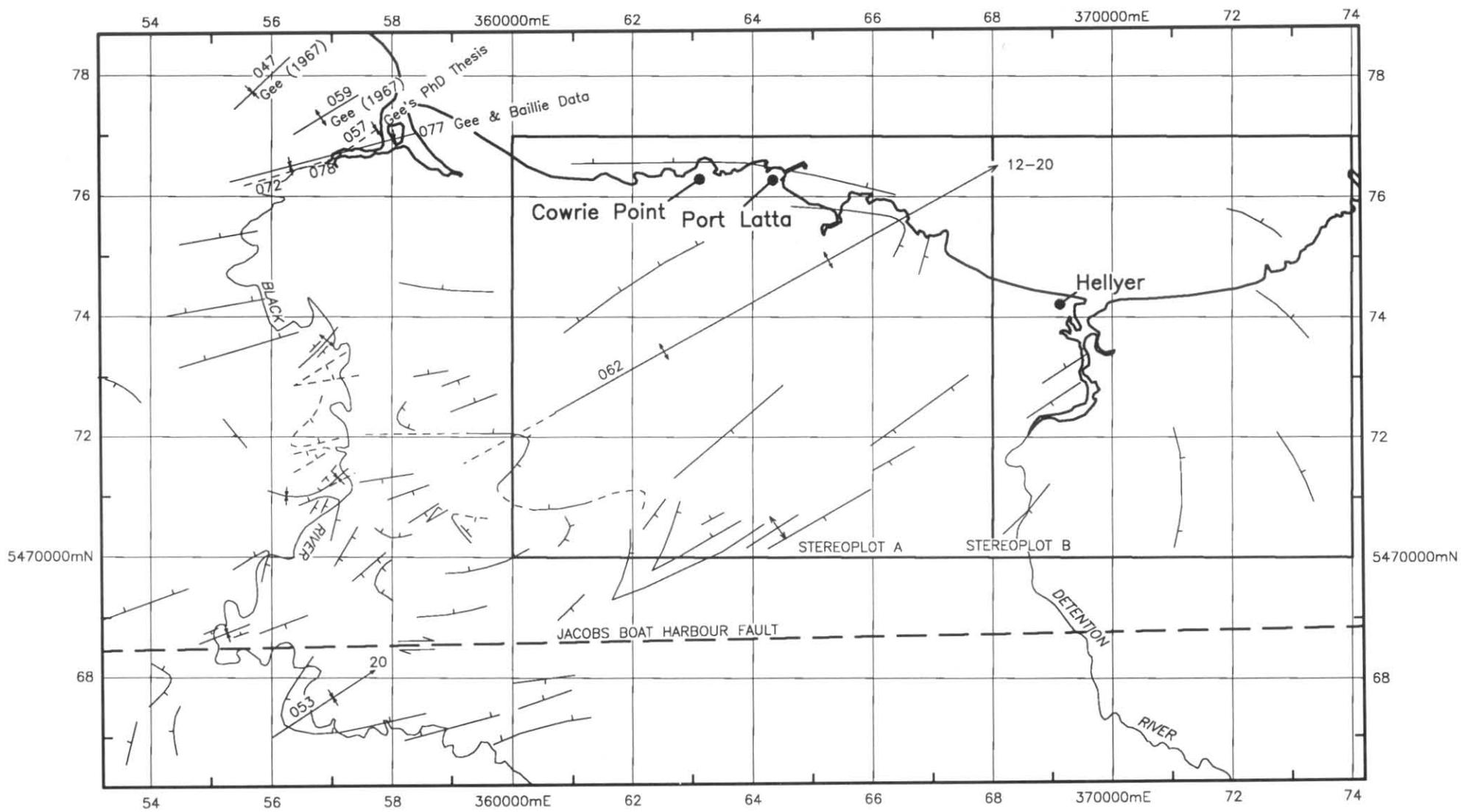
Figure 21. Folding in the Cowrie Siltstone, north and north-east of the Jacobs Boat Harbour Fault.
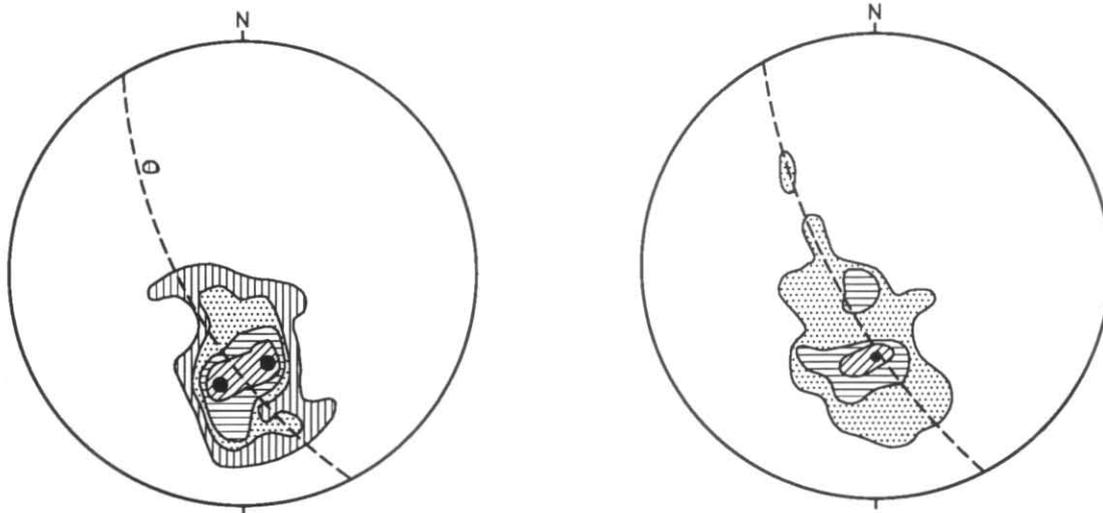
A (see Figure 21). 142 readings, 3, 4, 5.5, 7, 10% per 1% area. The hingeline of the fold on the basis of the great circle (broken line) plunges 20° to 062°

B (see Figure 21). 208 readings, 3, 5, 7, 10% per 1% area. The hingeline of the fold on the basis of the great circle (broken line) plunges at 12° to 062°

Figure 22. Stereoplots of poles to bedding, Crayfish Creeek Anticline [CQ660755].
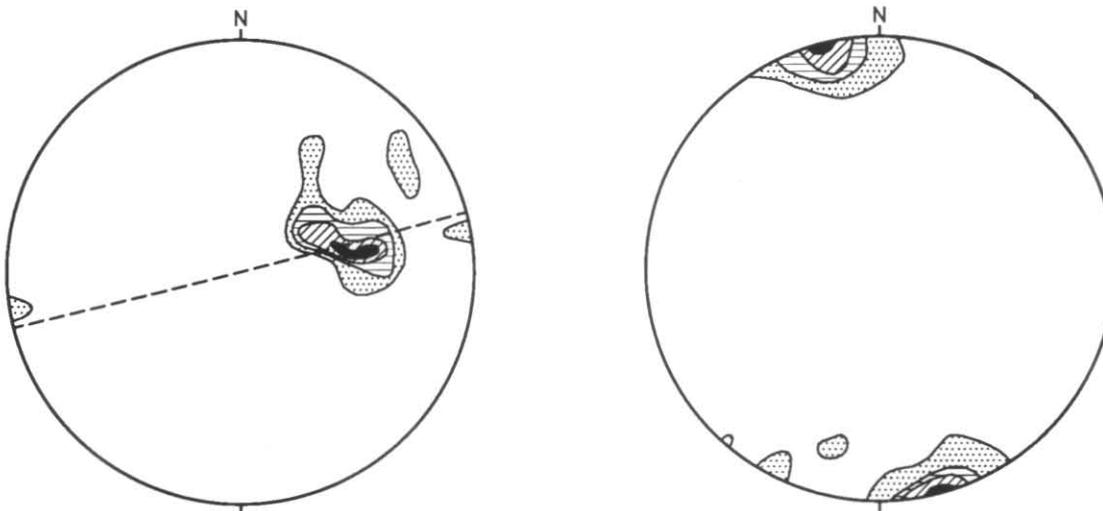
A Contoured steroplot of mesoscopic fold hingelines from the foreshore outcrop. Half-wavelength ranges from 0.1–0.15 m to 5 m. 48 readings, contours 5, 14, 19, 28% per 1% area. The broken line corresponds to the dominant cleavage orientation (075°/90°) from this same foreshore outcrop (see. fig. B).

B Contoured steroplot of poles to bedding for the same outcrop as plot A. Contours 5, 14, 19, 28% per 1% area. The dominant cleavage corresponds to a plane oriented 075°/vertical.

Figure 23. Stereoplots of structural data, Cowrie Siltstone (Detention Subgroup).
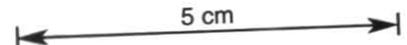
the coast. Gee (1971) noted a similar steepening of hingelines in the major folds on the Table Cape Quadrangle. Contoured stereoplots of hingelines of mesoscopic folds and associated cleavage on the foreshore platform between Peggs Beach [CQ610763] and Rocky Cape Hamlet [CQ734756] are shown in Figure 23. Comparison of the two contoured stereoplots indicates that the cleavage is almost axial planar to the mesoscopic folds. The dominant cleavage is ENE–WSW and usually dipping to the south-east in areas of the hingeline trace of the Crayfish Creek Anticline [CQ660755], and to the north-west in areas west of the hingeline trace of this major anticline. Some examples of mesoscopic folding in the Rocky Cape Group are shown in Plates 22–24.

The two possible minor folds adjacent to the Jacobs Boat Harbour Fault are poorly delineated: J.B.H. Fault –

Plate 24. Tight folding in flaggy quartzite, Detention Subgroup, Rocky Cape township foreshore[CQ734756].

5 cm
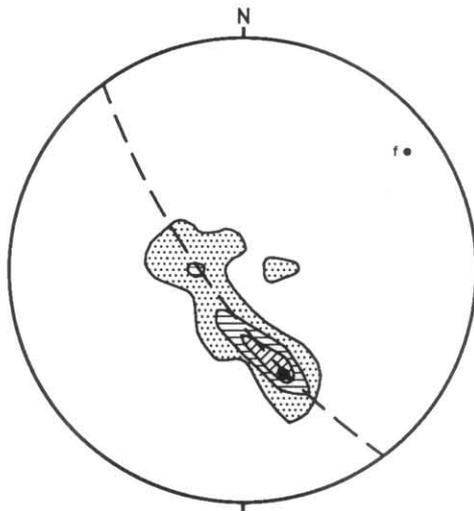
A Gibson Creek – Gibson Creek Road antiform. 46 readings, 4, 9, 13, 15% per 1% area. The best for great circle corresponds to a fold with a hingeline plunging 12˚ to 053˚, as shown. The bedding data are from parts of squares 10D, 11C and 11D as shown on Figure 13.
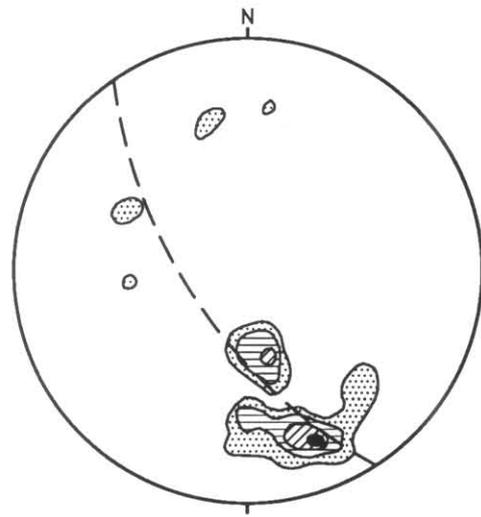
B Pine Corner Road - Black River synform. 50 bedding readings, contours 4, 6, 12, 20% per 1% area. One possible best fit is shown which corresponds to a fold with a hingeline plunging 20˚ to 056˚. The data are from parts of squares 9D and 9E.
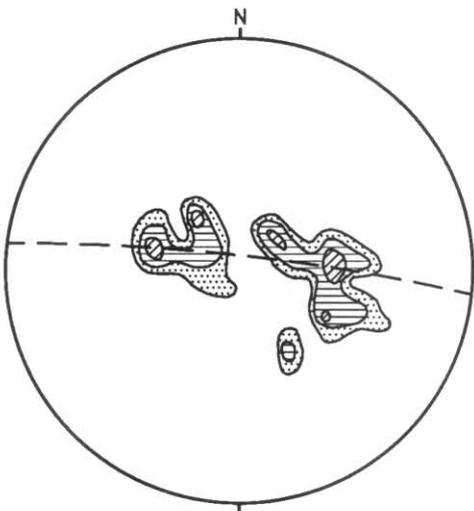
E Tipunah Road antiform. 140 bedding readings, contours 3.5, 4, 5.5% per 1% area. The great circle of best fit is shown and corresponds to a fold plunging at 6˚ to 186˚. The data for this fold are from squares 11A–C, 12A–C and 13A–C.
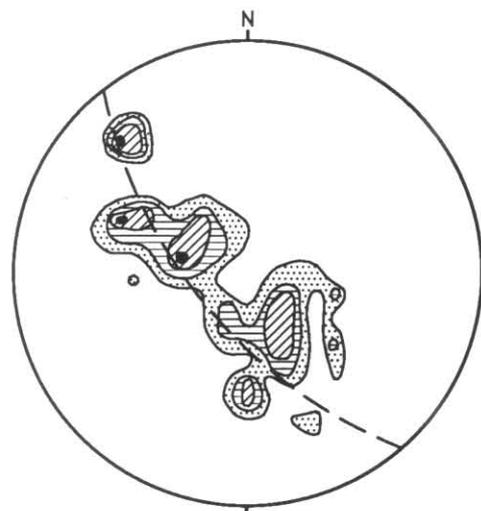
F Turners Plain antiform. 100 bedding readings, contours 2, 3, 4, 5% per 1% area. The best fit great circle corresponds to a fold plunging at 20˚ to 052˚ as shown. The data for this fold are from squares 9B, 9C, 10B and 10C.

Figure 25. Contoured stereoplots of poles to bedding for the folds south of the Jacobs Boat Harbour Fault. For plots C, D, G, H see Figure 26.
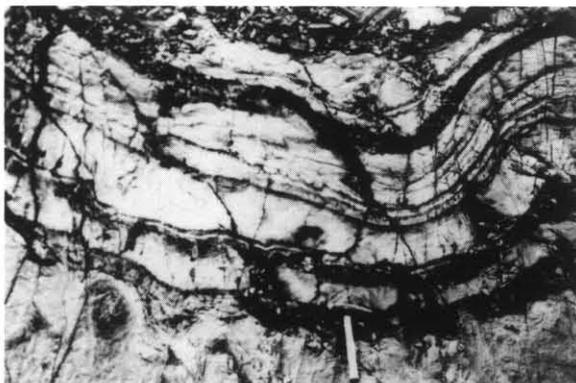
Plate 25. Asymmetric fold in an embankment outcrop at the junction of the Western Line and the Savage River Pipeline Road [CQ601710]. Load cast structures are discernible at the base of a white layer in the centre of the photograph. The geological pick is 300 mm long.

Black River Antiform [CQ547691] and Mawbanna Sidling Antiform [CQ6077704].

South of the Jacobs Boat Harbour (J.B.H.) Fault

There are three major folds (Shakespeare Hills Anticline CQ690660, Newhaven Syncline CQ710630 and Dip Range Anticline CQ730610) and at least eight minor folds in the Rocky Cape Group south of the J.B.H. fault on the Smithton Quadrangle (fig. 18). Three possible minor folds have been delineated on the Trowutta Quadrangle adjacent to the southern boundary of the Smithton Quadrangle.

The folds have been alphabetically designated on Figure 24 to correspond to the similarly assigned contoured stereoplots of poles to bedding shown in Figures 25–26.

Disregarding the Tipunah Road Antiform [CQ530630] and the three folds on the Trowutta sheet all the other
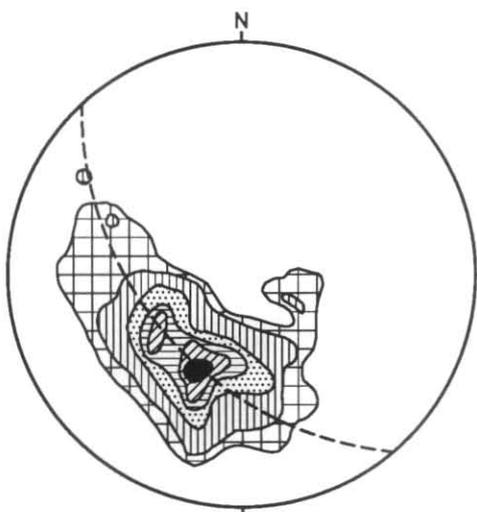
C Shakespeare Hills anticline. 195 readings, contours 1, 2, 5, 8, 10, 13% per 1% area. The best fit great circle corresponds to a fold with a hingeline plunging 35° to 048°, as shown. The bedding data are from parts of squares 3A–D, 4A–D and 5A–D.
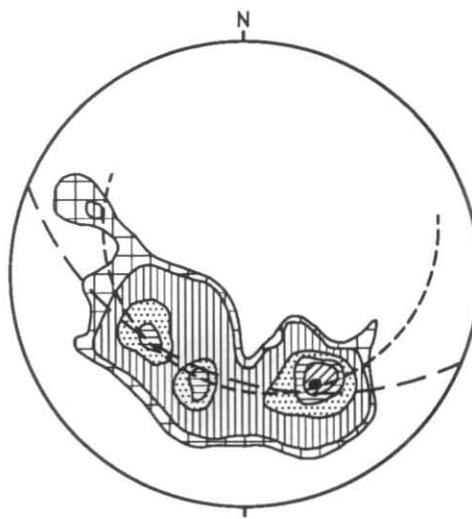
D Newhave Road syncline. 210 readings, contours 2, 5, 7, 11, 13% per 1% area. The great circle of best fit for a cylindrical fold is shown by the long-dashed line and corresponds to a fold plunging 38° to 022°. The best fit great circle for a conical fold with a half-apical angle of 40°, inclined at 70° to 038° is shown. The data are from parts of squares 1A–D, 2A–D and 3A–D.
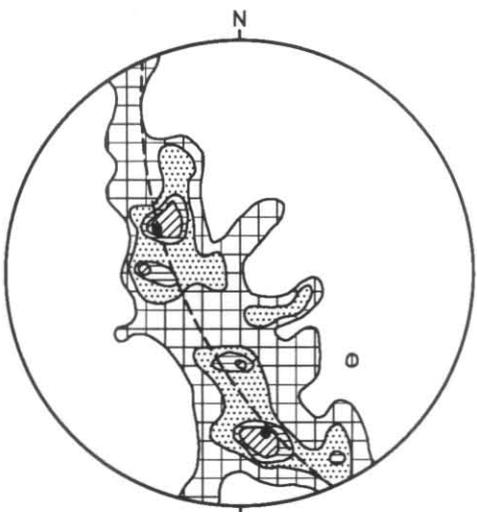
G Black River to Mawbanna Road antiform. 138 readings, contours 1.5, 3, 5, 6.5% per 1% area. The great circle of best fit is shown and corresponds to a fold plunging at 20° to 065°. The data are from squares 7C, 7D, 8C and 8D.
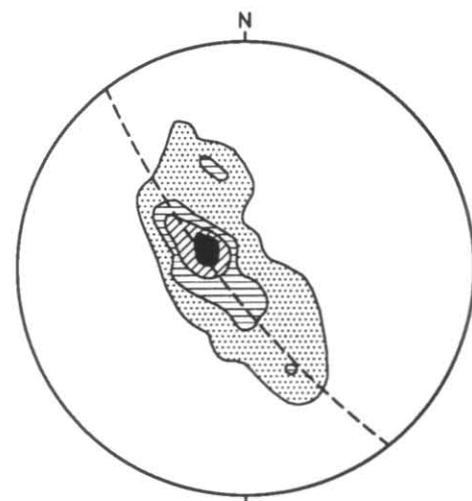
H Dip River to Black River antiform. 110 readings, contours 2, 5.5, 8, 10% per 1% area. The best fit great circle corresponds to a cylindrical fold plunging at 20° to 051° as shown. The data are from squares 7A, 7B, 8A and 8B.

5 cm
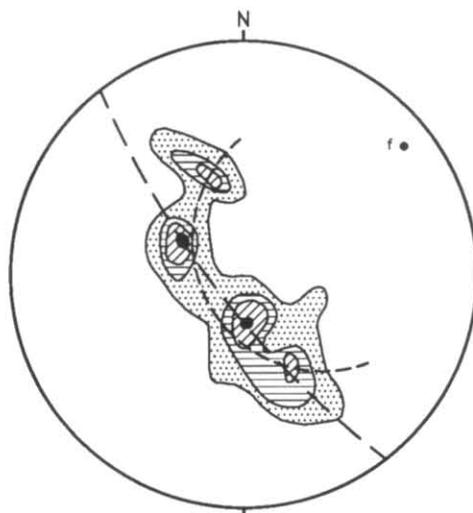
I Cowrie Siltstone – Dip Road – Black River synform. 71 readings, contours 3, 6, 7, 11% per 1% area. The best fit great circle for a cylindrical fold corresponds to a fold with a hingeline plunging at 10° to 052° (long-dashed line). The best fit for a conical fold is shown by a short-dashed line. The data for this fold are from squares 7B and 8B, 10B and 10C.

Figure 26. Contoured stereoplots of poles to bedding for the folds south of the Jacobs Boat Harbour Fault. For plots A, B, E, F see Figure 25.

5 cm
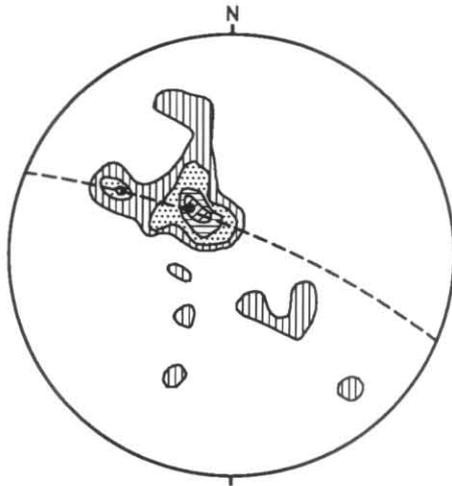
Tipunah Road – Apiary Road synform [CQ540570]. 27 bedding readings, 4, 8, 12.5, 15% per 1% area. The best fit great circle corresponds to a fold with a hingeline plunging 5˚ to 202˚, as shown. The bedding data are from parts of squares 11–13Z, 11–14X, 13Y and 14Y.
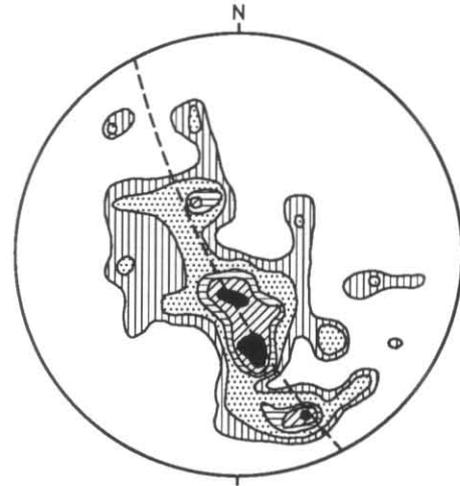
North-western quadrant. 150 bedding readings, contours 1, 2, 3, 4, 5% per 1% area. The best fit great circle corresponds to a fold hingeline plunging 10˚ to 063˚, as shown. The bedding data are from squares 9C–D, 10C–D, 11C–D and 12C–D.
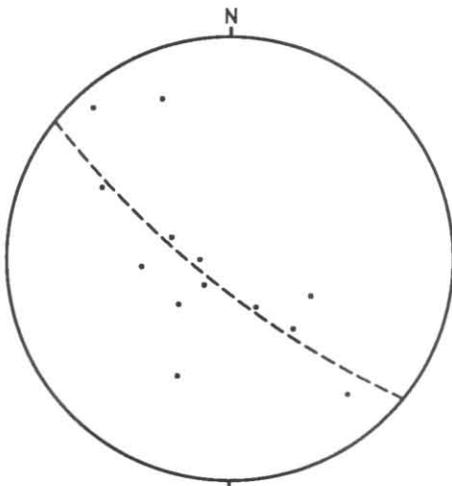
Upper Melin Rivulet antiform [CQ570580]. 12 bedding readings. The best fitting great circle is shown and corresponds to a fold with a hingeline plunging 12˚ to 038˚. The data are from parts of squares 8X, 8Z, 9X, 9Z, 10X and 10Y.
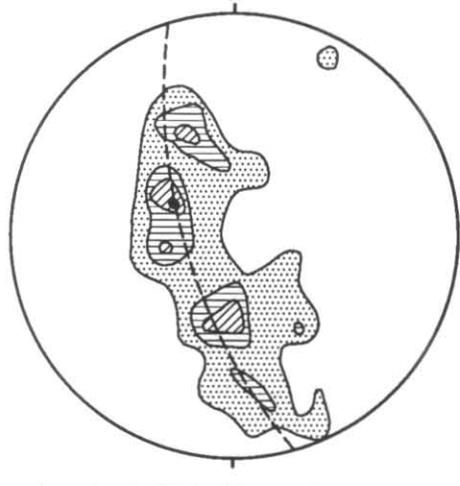
North-east quadrant. 153 bedding readings, contours 2, 4, 6, 8% per 1% area. The best fitting great circle is shown and corresponds to a fold with a hingeline plunging 16˚ to 074˚. The data are from squares 6C–D, 7C–D and 8C–D. See Figure 30 for contoured stereoplot of poles to cleavage.
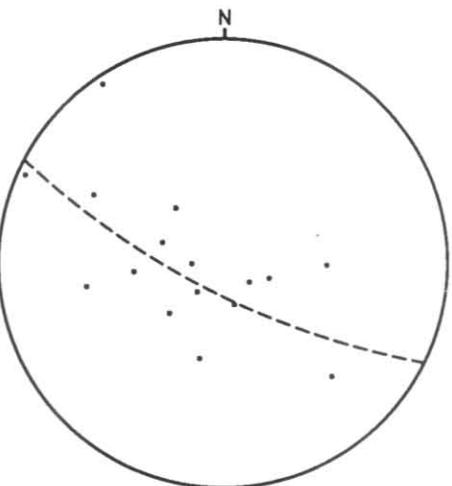
Peegra Road synform. 14 bedding readings. The great circle of best fit is shown and corresponds to a fold hingeline plunging at 10˚ to 026˚. The data for this fold are from squares 7Z, 8Z and 8X.
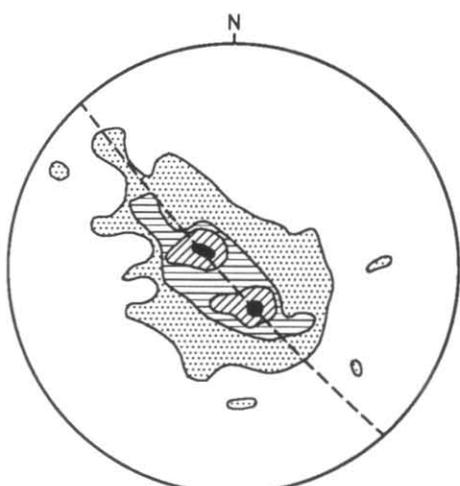
Southern region. 124 bedding readings, contours 1.6, 4, 5, 7, 8% per 1% area. The best fit great circle is shown and corresponds to a fold hingeline plunging at 3˚ to 049˚. The data for this fold are from squares 6–12A and 6–12B.

Figure 27. Stereoplots of poles to bedding for the minor folds from west (top) to east (bottom), Cowrie Siltstone, near the boundary of the Smithton and Trowutta Quadrangles. Grid squares are shown on Figure 14.

Figure 28. Contoured stereoplots of bedding for the north-western, north-eastern and southern regions, south of the Jacobs Boat Harbour Fault. Cowrie Siltstone. Grid squares are shown on Figure 13.
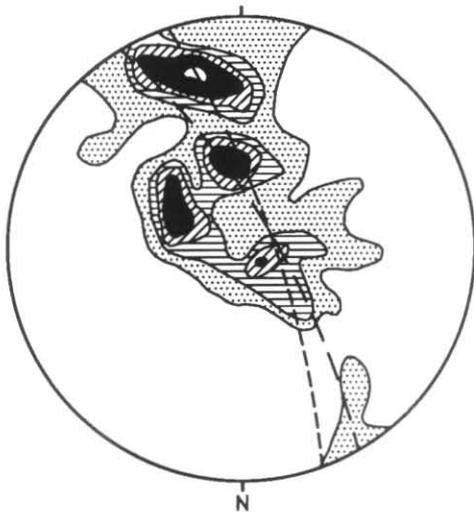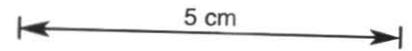
181 readings, contours 1, 3, 4, 5, 7% per 1% area. The long-dashed line corresponds to a fold with a hingeline plunging 10° to 060°, whilst the short-dashed great circle corresponds to a fold with a hingeline plunging 10° to 070°, as shown. The bedding data are from squares 7–12D.
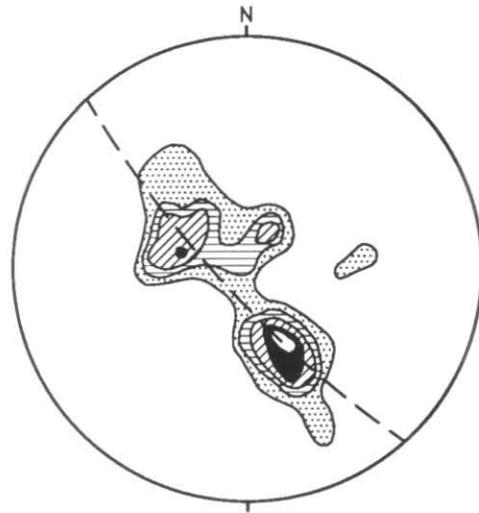
146 readings, contours 3, 4, 5, 7, 8% per 1% area. The best fit great circle corresponds to a fold with a hingeline plunging 8° to 048°. The data are from squares 7–12C.
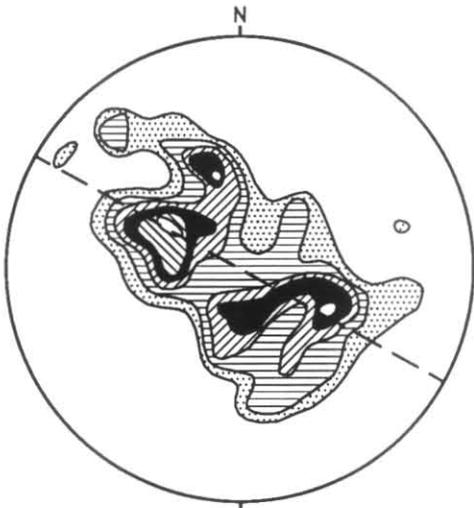
158 readings, contours 1.3, 2, 3, 4, 5, 6% per 1% area. The best fit great circle corresponds to a fold with a hingeline plunging 0° to 030°. The data are from squares 7–12B.
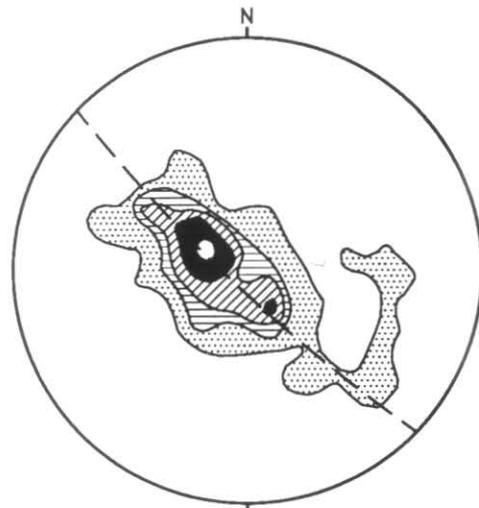
129 readings, contours 1.5, 4.6, 8, 15% per 1% area. The best fit great circle corresponds to a cylindrical fold with a hingeline plunging 8° to 048° as shown. The data are from squares 7–12A.

Figure 29. Contoured stereoplots of poles to bedding for blocks A–D, Cowrie Siltstone, south of the Jacobs Boat Harbour Fault.
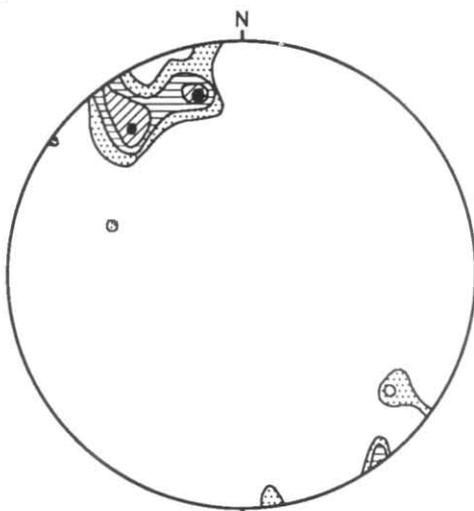
North-eastern quadrant. 42 cleavage readings, contours 5, 7, 9.5, 12% per 1% area. The maximum concentrations of poles correspond to cleavage planes 232°SE68° and 256°SE69°. See Figure 28 for steroplot of poles to bedding.
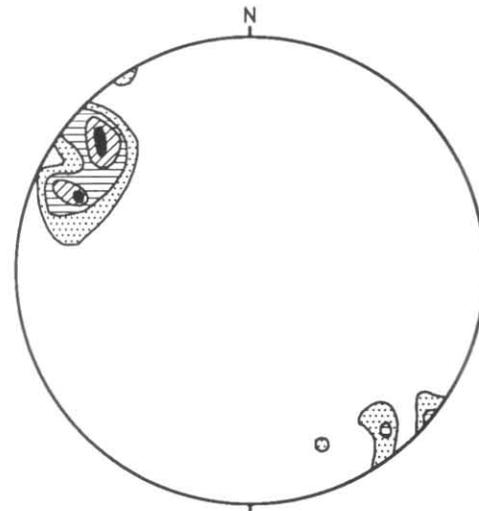
Southern region. 38 cleavage readings, contours 5, 8, 10.5, 13% per 1% area. The maximum concentrations of poles correspond to cleavage planes 203°SE68° and 221°SE73°.

Figure 30. Contoured stereoplots of poles to cleavage for north-eastern and southern regions, south of the Jacobs Boat Harbour Fault. For plots A, B, E, F see Figure 25.
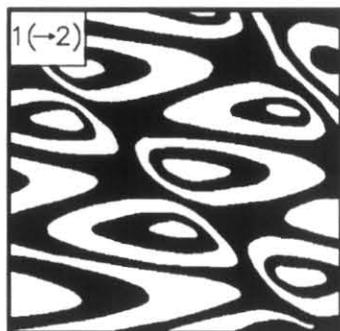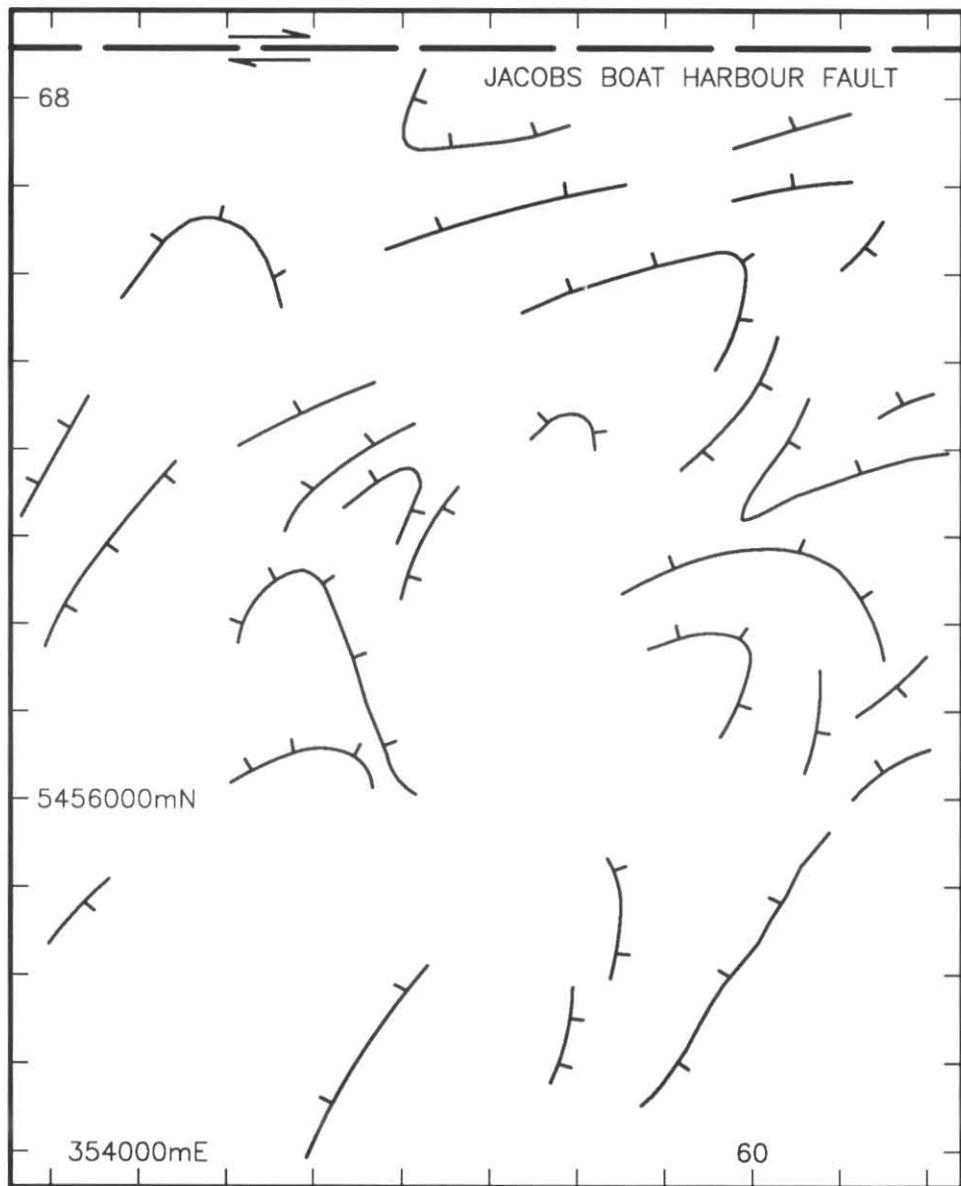
Figure 31. Cowrie Siltstone – bedding strike pattern in the 10 km × 14 km area west and south-west of Mawbanna. The basin and dome pattern most rembles the 2D pattern (above) which is a variation between Types 1 and 2 interference patterns (Ramsay (1967, fig. 60b). In Type 1 interference patterns the flow direction of the second movement is close to the axial surfaces of the first folds, whereas in Type 2 interference patterns the flow direction of the second movement is at a high angle to the first folds (see text for further explanation).

Plate 26. Microscopic fold within well-bedded, highly siliceous mudstone, from near the Lissanthe Link – Harris Creek crossing [CQ630717]. Note the axial-plane fault which displaces some of the folded beds in the lower part of the slide. Magnification ×10.

folds have inferred hingelines plunging NNE–ENE. The hingeline trends range from a little east of north on the Trowutta Quadrangle (fig. 27) to east of north-east near the J.B.H. Fault, reflecting a similar rotation to that noted for the dominant cleavage. Using blocks of the 2 × 2 km squares south of the J.B.H. Fault (fig. 13, Blocks A south to D north), contoured stereoplots of poles to bedding (fig. 28) show the extent of rotation of the grain of the country rock west of Mawbanna. Thus, the most southern block yields a hingeline plunging 4° to 42° whereas the most northerly block yields a hingeline plunging 10 to 070° area west of Mawbanna was subdivided into quadrants (NW, NE, SE and SW) and contoured stereoplots made of poles to bedding and cleavage (fig. 29–30). Shortage of readings meant that the contoured stereoplots of poles to bedding for the SE and SW quadrants had to be combined, while no contoured stereoplots of poles to cleavage for the NW quadrant could be constructed. The bedding stereoplots indicate that the inferred hingeline in the NE quadrant trends more east of north than that in the NW quadrant. The cleavage stereoplots show that there has been a rotation of cleavage trends between the southern half and NE quadrant.

Examination of the minor folds west of Mawbanna (fig. 19, 25) shows that the folds are not persistent laterally, reflecting the dome and basin style of folding that the area has undergone.

The Tipunah Road Antiform [CQ530630] reflects the minor fold hingeline trends further to the south, and is itself reflected in the mesoscopic folding in Harbour Creek [CQ510642] and in the general north-south strike

← 5 cm →

Table 6
MESOSCOPIC FOLD LOCALITIES

Sub-sheet	Locality	AMG Ref	Fold Style
Stanley East	near Rocky Cape hamlet	CQ730755	$\lambda/2$ from 0.2 – 20 m. Generally open asymmetric vergence to south-east(?) moderately plunging upright axial surfaces
Stanley East	Peggs Beach to Hellyer Beach	CQ610764–CQ667750	$\lambda/2$ from 5 – 15 m. Open, asymmetric with vergence generally to south-east, sub-horizontally plunging upright axial surfaces well rounded closures
Mawbanna East	Detention River near Bass Highway bridge	CQ689735	$\lambda/2$ from 0.5 – 5 m. Open to close, asymmetric gently to moderately plunging, steeply inclined to upright axial surface, well rounded closures
	Hook Creek	CQ670672	Broad synforms and tight antiforms, ?incipient tectonic dewatering structure
Mawbanna West	Dip Road-Black River (five localities)	CQ591665 CQ601681 CQ622656	$\lambda/2$ from 150 mm – 50 m. Open (to sometimes closed) asymmetric usually, moderate to subvertical axial surface
	Bauera Spur	CQ565631	Sub-horizontal to gently plunging, ± sub-angular to well rounded, generally verges to west
	Daisies Road	CQ570646	
	Dip Road (two localities)	CQ586623, CQ583608	
	Savage River pipeline Road (at least four localities)	CQ568612–CQ601711	
	Western Line	CQ588736	
	Lissanthe Link	CQ630718	
	Gibson Creek area	CQ542670	
	Black River	CQ613635	
	Dip River off Kurrle Road	CQ611602	
Mawbanna West	Dip Road	CQ588621	Recumbent conjugate folds
	Daisies Road	CQ547623	
	Dip River	CQ611602	
	Mawbanna Road	CQ623654	monoclinal folds
	Savage River Pipeline Road	CQ582667	
	Dip River	CQ576663	
Irishtown East	Harbour Creek	CQ510642	$\lambda/2$ 0.8 m to 50 m. Sub-horizontal to gently plunging, upright folds, asymmetric
	Gentle Annie Creek	CQ514621	Similar fold style

Tertiary basalt

Alluvium

Cambrian sedimentary sequence

Smithton Dolomite

Forest Conglomerate and Quartzite

unconformity

Cowrie Siltstone and correlates

geological boundary
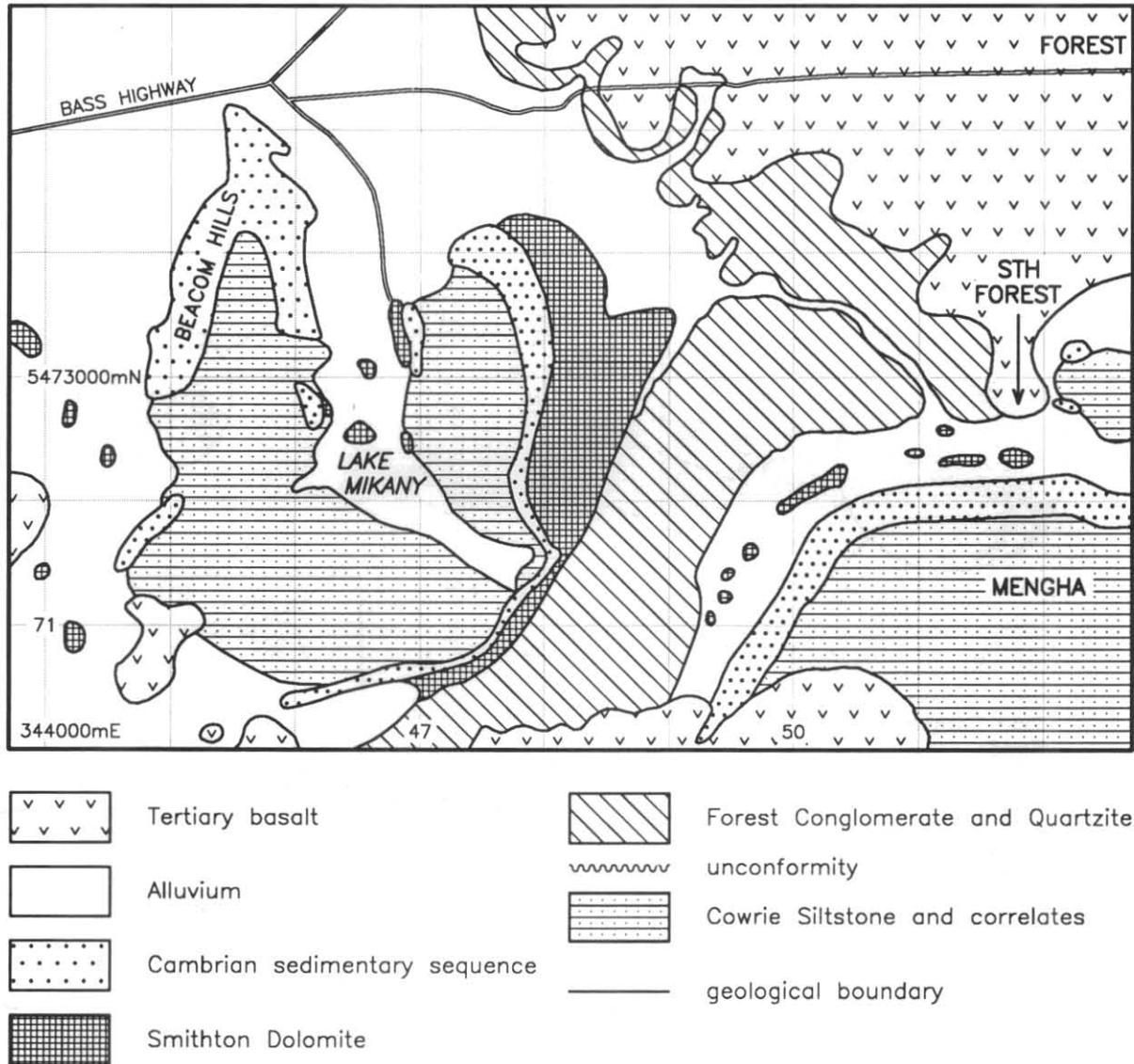
Figure 32. Lake Mikany [CQ465721] – Beacom Hills [CQ455740] area, showing the outcrop pattern of the Forest Conglomerate and Quartzite, which lies on the unconformity between rocks folded during the Penguin Orogeny and those above. Note two domes, with part of an intevening basin filled with Cambrian sediments.

of the Cowrie Siltstone west of Tipunah Road. The Newhaven Road Syncline has an inferred axial plane thrust fault (on the basis of outcrop pattern) associated with it. This fold may be conical rather than cylindrical, as indicated in Figure 26. The shortage of bedding readings on both limbs of the Dip Range Anticline precludes determination of its inferred hingeline, although Gee's map of the Table Cape Quadrangle (1966) shows it trending to the north-east and associated in part with an axial plane thrust fault.

Folding-cleavage relationships – summary and conclusions

(1) The trend of the regionally dominant cleavage shows a similar rotation to that shown in fold hingeline trends, from the southern edge of the Smithton Quadrangle where both trend east of north, to the Bass Strait shoreline where both trend north of east. Both structural elements appear to have been rotated during the 8 km transcurrent displacement on the Jacobs Boat Harbour Fault (Gee, 1971).

(2) The basin-and-dome folding observed on a mesoscopic scale on the foreshore between Black

River and Rocky Cape hamlet, is reflected in the larger scale minor folding in the Cowrie Siltstone west of Mawbanna. This may indicate superposed folding, producing an interference pattern transitional between a Type 1 pattern and Type 2 pattern of Ramsay (1967) (fig. 31). In a Type 1 interference pattern the flow direction of the second movement is close to the axial surfaces of the first folds, whereas in a Type 2 interference pattern the flow direction of the second movement is at a high angle to the axial surfaces of the first folds (Ramsay, 1967). The lack of two distinct cleavage trends likely with superposed deformations, suggest that another mechanism produced the basin and dome folding with only one dominant cleavage direction. Williams, E. (pers. comm.) proposed a stress field in one orientation which may initiate a dome at a point in a block of country rock. This dome formation causes a local quantative change in the stress field resulting in initiation of other domes surrounding the initially formed dome. In such a way a basin and dome pattern is formed with only one cleavage orientation.

5 cm
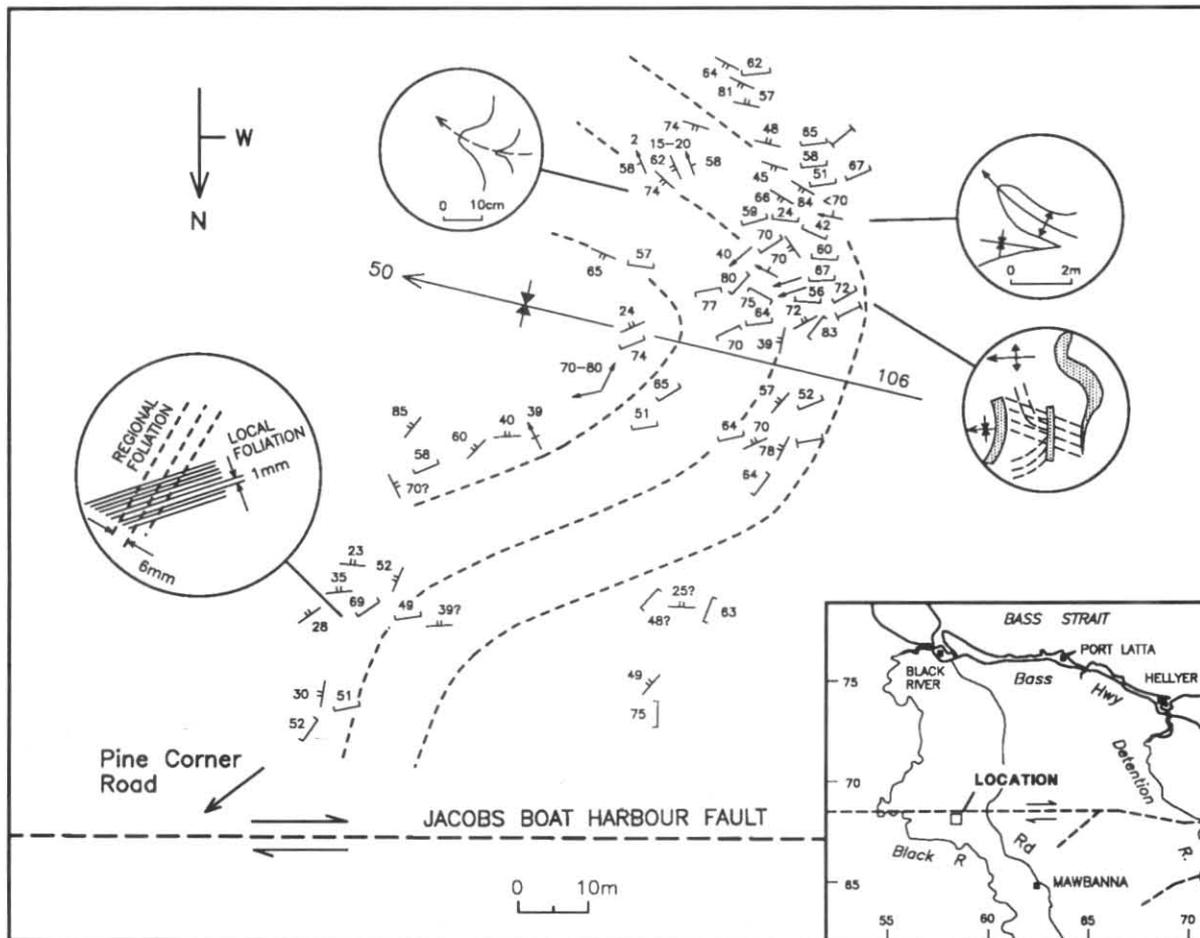
Figure 33. Pine Corner Road quarry [CQ584683]. Structural map showing bedding, cleavages and diagrammatic sketches of the folding (cleavages) style in the quarry, which is adjacent to the Jacobs Boat Harbour transcurrent fault.
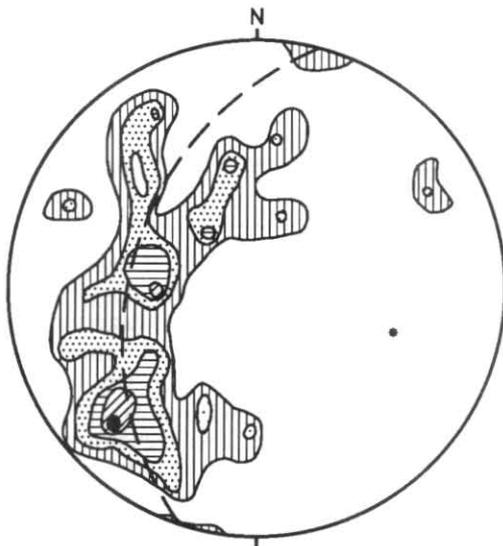
Figure 34. Pine Corner Road quarry, contoured stereoplot of poles to bedding (lower hemisphere, equal area projection. 62 readings, contours 1, 3, 5, 8, 10% per 1% area. The great circle of best fit is shown and * is the corresponding hingeline (plunge 50° to 106°).
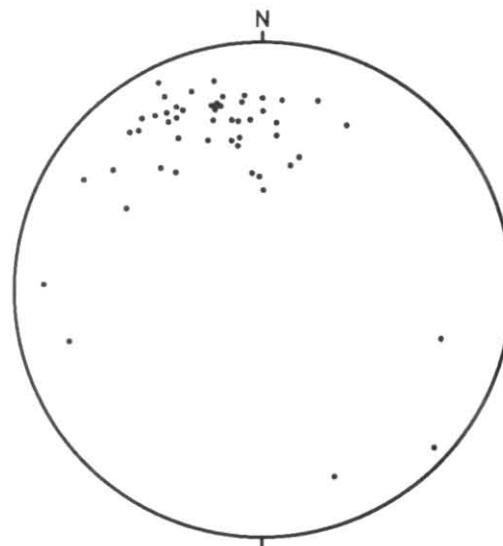
Figure 35. Pine Corner Road quarry. Steroplot of poles to cleavage for 52 readings.

(3) The outcrop distribution pattern of the Forest Conglomerate and Quartzite, especially in the Lake Mikany-Beacon Hill area (fig. 32) indicates a larger scale basin-and-dome structure in the Cowrie Siltstone west of South Forest. The 3 × 4 km dome in this area contrasts with less than 2 km diameter domes and basins in the area west of Mawbanna.

Mesoscopic fold style

Summary

In summary the mesoscopic fold style within the Rocky Cape Group is characteristically (see table 6):

(1) generally open to sometimes close,

Table 7
KINKS – LOCALITY AND STYLE

Formation	Locality	AMG Ref	Comments
Cowrie Siltstone			
	Dip Range (southern end)	CQ702581	5-10 mm spacing between axial surfaces positive and negative kinks Dewey (1965)
	Dip Road-Black River	CQ591665	Bent simple kinks with associated foliation
	Mawbanna Road near Pine Corner Road junction	CQ601681	simple kinks
	Tributary of Mosquito Creek	CQ583685	?microfolds
Detention Sub-group			
	Dip Range	CQ735634	Conjugate and simple kinks, associated with a foliation
Irby Siltstone			
	Hogarths gravel quarry (adjacent to Dip Range)	CQ717644	Simple kinks
	Alarm River Tributary (Dip Range)	CQ724617	Simple kinks

(2) usually asymmetric although symmetric folding is also present,

(3) sub-horizontal to gently or moderately plunging,

(4) with steeply-dipping to upright axial surfaces,

(5) with usually well-rounded fold closures at all scales (half-wavelength from one centimetre to one metre) but sometimes sub-angular (especially where half-wavelength is less than 0.2 m, or in the case of conjugate folding).

The mesoscopic folding of half-wavelength 5-20 m on the foreshore near Rocky Cape hamlet indicates vergence towards the south-east. The basement structure indicates a major anticline to the south-east of Rocky Cape hamlet, in agreement with the vergence of these mesoscopic folds.

A group of tight antiforms and broad synforms (half-wavelength ~0.75 m, amplitude ~0.3 m) is exposed in Hook Creek [CQ670672] with quartzite of the Detention Subgroup. These may be incipient tectonic dewatering features rather than folds The recumbent fold (half-wavelength ~0.2 m, amplitude ~0.2 m) exposed on Dip Road [CQ588621] within the Cowrie Siltstone is the only example of this style of fold.

A number of conjugate folds consisting of either an open antiform-close synform or open synform-close antiform occur on Daisies Road and the Dip River (table 6).

The monoclinal folds exposed on Mawbanna Road, Savage River pipeline road, and on the banks of the Dip River and the Black River (table 6) range in half-wavelength from 2–20 m and may merely correspond to a warping in the bedding orientation within the Cowrie Siltstone.

The dominant foliation is generally axial-planar to the mesoscopic folds. In the case of an antiform in the upper reaches of Hook Creek (half-wavelength 2 m, amplitude 0.75 m) a local foliation axial planar to the fold is exposed [CQ661665]. The drag fold exposed in the Pine Corner Road quarry (CQ584683, fig. 32–35) exhibits a local axial planar foliation and two cross-cutting regional foliations.

Conclusions

The Rocky Cape Group exhibits dome-and-basin folding both as mesoscopic folds on the foreshore between Peggs Beach and Rocky Cape hamlet, and as minor folding west and south-west of Mawbanna. The axes of the minor folds have been rotated from the southern border of the sheet (axes trending approximately N–S) to the northern coastal exposures (axes trending approximately E–W). The Jacobs Boat Harbour transcurrent fault has also superimposed further rotation of the fold axes. The mesoscopic folds are generally open, usually asymmetric, gently plunging, and upright with well-rounded closures. They usually exhibit one dominant axial plane cleavage. The axes of the minor folds delineated west and south-west of Mawbanna are subparallel to one dominant cleavage. The Cowrie Siltstone correlate and Forest Conglomerate and Quartzite west of South Forest exhibit a larger scale dome-and-basin pattern compared with that present west of Mawbanna.

FAULTING

Introduction

The dominant fault is the major east-west transcurrent fault stretching from Jacobs Boat Harbour [CQ840680] to East Creek [CQ527687], a tributary of the Black River about 30 km to the west.

Because of the difficulty in identifying definite stratigraphic horizons in the Cowrie Siltstone outcrops inland, no faulting has been proven in exposures other than the coast outcrops during mapping of this formation. The outcrop pattern in the Newhaven Road region [CQ700620] indicates that the Newhaven Syncline is associated with an axial-plane thrust fault in a similar manner to axial-plane faults identified by Gee (1971) on the adjacent Table Cape Quadrangle.

The extensive NE–SW trending normal faulting identified by Gee (1971) in the Rocky Cape Group within the Rocky Cape National Park is identifiable in an adjacent area on the Smithton Quadrangle.

The outcrop pattern on the periphery of the Shakespeare Hills enables a number of normal faults trending about NE-SW to be inferred, some of which are truncated by the Jacobs Boat Harbour Fault.

Jacobs Boat Harbour Fault

Gee (1971) proved from the extent of structural mismatch that the J.B.H. Fault had undergone approximately 8 km of dextral transcurrent movement.

The Newhaven Syncline and Shakespeare Hills Anticline have been truncated by this fault (fig. 36). Although the fault is obscured by Tertiary basalt in the former case, a sharp change in relief and a better developed fabric delineate the fault in the latter case. There is no continuity in minor folding across the J.B.H. Fault in the Pine Corner Road area [CQ570687], reflecting the transcurrent displacement the Cowrie Siltstone on either side has undergone.
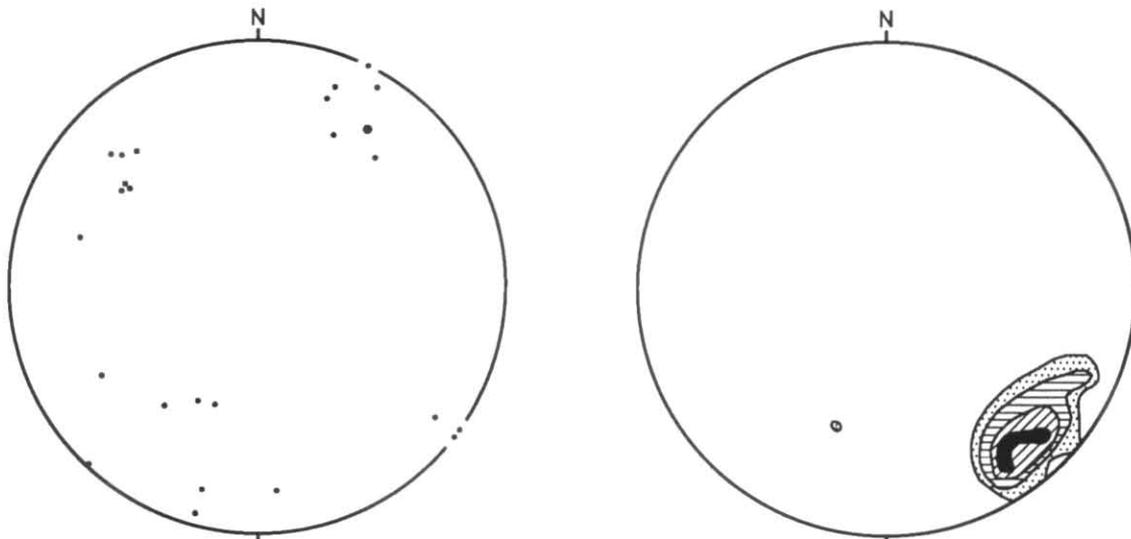
A. Stereoplot of poles to the axial surfaces of kinks. 25 readings from the Dip Range localities listed in Table 7. The point marked ● corresponds to the major fold hingeline for this area.

B. Contoured stereoplot of poles to cleavages for the Rocky Cape Group. 41 readings, contours 5, 10, 15, 20% per 1% area.
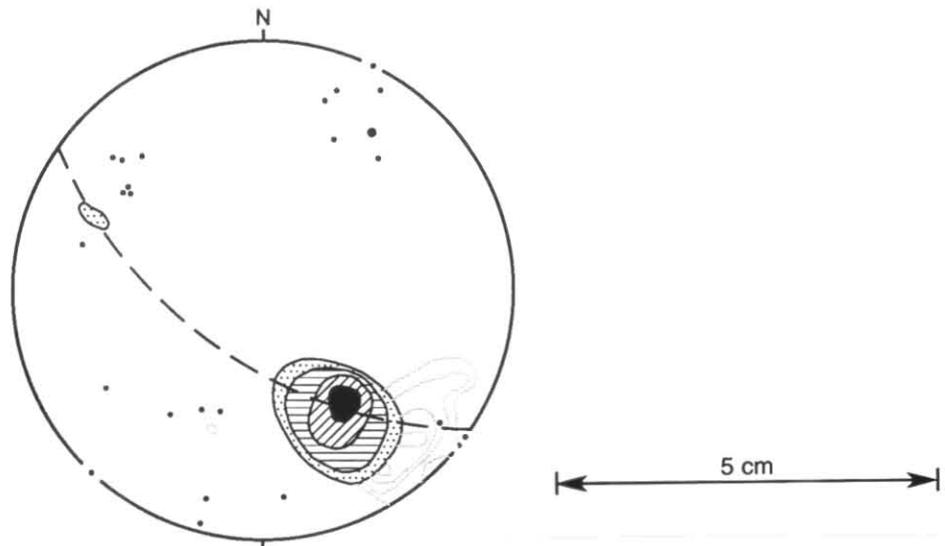
C. Compilation of the contoured steroplot of poles to bedding (solid contour lines, 86 readings 5, 7, 12, 23% per 1% area), contoured steroplot of poles to cleavage (screened contour lines) and poles to the axial surfaces of kinks. The point marked f corresponds to the major fold (Dip Range anticline) hingeline determined from the best fit great circle as shown (broken line).

Figure 37. Dip Range. Stereoplots of poles to the axial surfaces of kinks (A), poles to the cleavage(s) (B) and a compilation of poles to bedding planes and A + B (C). Squares 1A, 1B, part of 3A and most of 2B (see fig. 13).

Detailed mapping of the Cowrie Siltstone in the Pine Corner Road quarry [CQ584683] immediately south of the J.B.H. Fault indicates there has been formation of a mesoscopic drag fold as a result of the dextral transcurrent displacement along the fault (fig. 33–35). This fold is transected by two foliations and is associated with a rare and poorly developed axial plane foliation. The dominant foliation is a lepidoblastic-sericite fabric (samples 80/109, and 80/110; regional foliation on Figure 33), which is cross-cut by a spaced, differentiated sericite fabric (local foliation).

Other faults

The Newhaven Syncline [CQ710630] and Dip Range Anticline [CQ730610] have associated axial-plane thrust faults, on the basis of outcrop distribution in the latter case and Gee's (1971) mapping on the Table Cape Quadrangle in the former case (fig. 36).

The Detention Subgroup orthoquartzite outcropping on Shakespeare Hills has been affected by a number of NE–SW trending normal faults (fig. 36). A probable dolerite dyke is associated with the normal fault in Blackfish Creek [CQ650683]. the displacement of the Detention Subgroup–Irby Siltstone boundary adjacent to the Detention River [CQ702663] probably reflects the presence of a normal fault, although there is no obvious continuing fault line other than adjacent to the displacement.

One of the transcurrent faults [CQ732722] mapped by Gee (1971) can be inferred to occur on the Smithton Quadrangle from displacement of the boundary between the Cowrie Siltstone and Detention Subgroup (fig. 36).

A large number of local faults have been identified in the foreshore Cowrie Siltstone (Detention Subgroup) outcrop between Peggs Beach [CQ610764] and Rocky Cape hamlet [CQ735756]. These faults may be

associated with planar quartz-veining or warping in the bedding orientation. The faults in some cases form a zone (up to 2 m wide) between two subparallel fault planes which range up to 100 m long. One 0.3 m wide fault zone near Rocky Cape hamlet [CQ731756] is associated with a dolerite dyke.

Some axial-plane faults are exposed in the Cowrie Siltstone at the eastern end of Forwards Beach [CQ724748].

KINK BANDS

A limited number of examples of simple kinks and conjugate kinks have been mapped. The Dip Range [CQ730610] in the far south-eastern corner of the Smithton Quadrangle exhibits the largest number of outcrops with kinks (table 7).

In two localities, Dip Road–Black River [CQ5914665] and Dip Range [CQ735634], the kinking appears to be associated with a foliation. This foliation parallels the axial surface of the kinks.

Figure 37 shows contoured stereoplots of poles to the axial surface of kinks, poles to bedding and cleavage for the Dip Ranges. Since a geometrical relationship between the kinking and earlier formed bedding surface is likely, it is not surprising that some of the kink axial surfaces are at a high angle to the major fold hingeline.

THE BLACK RIVER TO ROCKY CAPE REGION AS AN INTEGRAL PART OF THE ROCKY CAPE GEANTICLINE

The north-western part of the Rocky Cape Geanticline consists of the unmetamorphosed Rocky Cape Group. This group is separated by an 8 to 15 km wide belt of metamorphic rocks (Keith Metamorphics) from a different unmetamorph- osed rock succession (the Burnie Formation) at the eastern margin of the geanticline (Williams, 1976).

Gee (1967, 1977) identified five phases of deformation which involved the repeated development of mesoscopic, co-axial, flattened flexural folds in the Burnie Formation on the eastern margin of the Rocky Cape Geanticline. Gee (1971) identified north-easterly plunging, asymmetric folds of 1.5 km half-wavelength associated with north-westerly dipping high-angle thrusts in the Rocky Cape Group adjacent to The Keith Metamorphics. The folding becomes more symmetrical and broad further away from the Keith Metamorphics belt.

Lennox (1980) identified two phases of folding which resulted in the development of gently plunging, open, upright, mesoscopic to major folds in the Bluff Hill Point region at the far western margin of the Rocky Cape Geanticline. These folds are related to two foliations; a lepidoblastic-sericite fabric (?slaty cleavage) and a crenulation of this fabric.

In the Black River to Rocky Cape region the Rocky Cape Group exhibits two foliations; a NE- to ENE-trending foliation generally overprinted by a more northerly-trending foliation. Folds associated with these foliations are commonly gently-plunging, usually open and upright. The primary foliation is a lepidoblastic-sericite fabric and/or discontinuous anastomosing, opaque stringers and corresponds to a slaty cleavage. The secondary foliation is usually a less well developed sericite fabric or a crenulation cleavage.

Thus the Bluff Hill Point region and Black River to Rocky Cape region both exhibit a slaty cleavage overprinted by a crenulation cleavage, and folding is similar in style in both regions. The trends of folds and associated foliations in both regions are:

	F1	F2
Bluff Hill Point region	NW - SE	NE - SW
Black River to Rocky Cape region	ENE - WSW	NE - SW

Williams (1983) has shown by considering the unstraining of Tabberabberan deformation that the angular difference between the foliations in the latter case may be altered by around 10°.

Summary and conclusions

The Rocky Cape Group on the Smithton Quadrangle has undergone three phases of deformation during the Penguin Orogeny. Cleavages were formed during each phase; the primary and dominant cleavage is a slaty cleavage whilst the secondary cleavages are crenulation cleavages. Folding was associated with the first two phases of deformation but not the last phase of deformation. Dolerite dykes were intruded before the first phase of deformation, after the first phase of deformation and after the second phases of deformation.

The fold hingeline trends in the Black River to Rocky Cape region (F1 ENE–WSW, F2 NE–SW) differ significantly from those in the Bluff Hill Point region (F1 NW–SE, F2 NE-SW) to the west. The fold style and nature of cleavage development are similar with open, asymmetric, upright folds associated with a well developed cleavage.

An additional rotation due to the Jacobs Boat Harbour Fault, has been superimposed on the regional rotation of fold hingeline trends and cleavage trends which is apparent between the southern margin of the Smithton Quadrangle and the northern coastal exposures.

PRECAMBRIAN(?) – CAMBRIAN(?) BASIN

Introduction

The Penguin Orogeny resulted in deformation of the Rocky Cape Group below the Forest Conglomerate and Quartzite, whereas the Tabberabberan Orogeny may have resulted in deformation (with cleavage formation) of the sedimentary rocks above the Rocky Cape Group. The Rocky Cape Group may have been flattened without cleavage development during the Tabberabberan Orogeny.

Gee (1968) and Griffin (1976) outline the sequence overlying the Rocky Cape Group as being:

Top

Greywackes, volcaniclastics and basic volcanics	750 m
Smithton Dolomite	600 m
Forest Conglomerate and Quartzite	32 m

Bottom

and it is this sequence of sedimentary and volcanic rocks which has primarily undergone deformation due to the Tabberabberan Orogeny.

Folding

The bedding orientations in the Cambrian sedimentary sequence both within the area mapped by E. B. and K. D. Corbett and the area covered by this report, are presented in a contoured stereoplot of poles to bedding in Figure 38. There are two possible girdles on this stereoplot with the most likely indicating a fold with a hingeline plunging 10° to 180°.

Faulting

Gulline (1959) proposed an approximately north-south orientated normal fault on the eastern margin of the Duck River drainage basin at the boundary between the Smithton Dolomite (west) and Cambrian sedimentary

rocks/spilite (east). There is undoubtedly a marked change in relief at the eastern margin of the Duck River drainage basin. The best exposures of a possible fault, near Smithton Primary School [CQ411771] on the banks of the Duck River, shows no discernible indication of the deformation associated with a normal fault of this magnitude. The bedding orientation in the Cambrian sedimentary rocks has not been rotated adjacent to the proposed fault.

BEACOM HILLS AREA

K. D. Corbett

PRECAMBRIAN ROCKS

Detailed structural analysis has not been attempted on the Precambrian rocks, and in the area mapped there is a lack of outcrops suitable for such purpose. Bedding in the older sequence is clearly recognisable in most cases, and dips range from flat to vertical although most are less than 60°. A poorly-defined cleavage has been seen in only two places – north-east of South Forest it trends 157° and is vertical, while at the western end of Lake Mikany Dam closely spaced fractures trend 122° N 85°.

The younger sequence tends to occur as a series of large open folds on which are superimposed smaller folds. The 'Forest Conglomerate and Quartzite', in particular, can be used as a marker horizon to outline the major fold structures in the area. To the east it appears to form a complex faulted anticline just north of South Forest, but this structure will need further careful mapping on the adjacent sheet. South of South Forest it forms a broad curving strike ridge dipping north-west at up to 85°. The dips around this structure are variable, however, and there appear to be some areas of flat dip where the formation extends well inland over the older sequence, as evidenced by the occurrence of boulders weathering out of the conglomerate.

In the Lake Mikany area, the Forest Conglomerate and Quartzite forms a complex anticlinal structure to the west (Beacom Hills), and a broad, gentle anticline to the east. Between these two structures, at Lake Mikany

Figure 38. Contoured poles to bedding, Cambrian sedimentary sequence. 95 bedding readings derived from the Cambrian outcrops mapped by Corbett (1978) and Lennox (1980) on the Duck River East and West and Irishtown East and West areas – squares 16–AF, 17A–F and 18A–B. Contours 3, 6, 8, 10% per 1% area and the two most likely best fir great circles are shown. The related folds have hingelines plunging 10° to 180° and 10° to 079°.

itself, the geology is complex but poorly exposed and difficult to interpret. Chert similar to that of the Black River Dolomite formation occurs on the 'islands', and on the west bank, where it is underlain by white quartzite. On the east bank, a small patch of conglomerate occurs halfway along the lake. As well as this, dolomite is reported in a borehole in the bottom of the lake (W. L. Matthews, 1973). These facts point to there being a tight, faulted syncline under Lake Mikany, although the rocks at either end of the dam belong to the older sequence (with basic dykes). This interpretation differs from that of Gulline (1959), who included much of the laminated quartzite, now mapped as older sequence, in the younger sequence but did not show the medial syncline.

The structure at Beacon Hills is assumed to be a broad anticline, although this is not obvious from the measured dips. Laminated quartzite of the older sequence occurs in the core of the structure, and dolomite occurs on either side. The variable dips and strikes suggest cross-folding and/or faulting. Several faults are apparent in the major quarries, and a minor fold plunging 10° to the north-east occurs near the northern end.

Structures in the chert exposures of the Smithton Dolomite vary from consistent dips, as in the area east of Lake Mikany, to complex folds and faults, as at the southern end of Briant Hill. A minor anticlinal structure trending ESE-WNW appears to be present in the large quarry at Briant Hill.

CAMBRIAN ROCKS

Structures in the Cambrian rocks are also difficult to determine because of the poor outcrops. Mapping to date shows no evidence of unconformity between the Precambrian and Cambrian sequences. There is no apparent cleavage in the Cambrian rocks.

Exposures around the foreshore of Deep Creek Bay show low to moderate dips in most cases, but there is possible overturning in one area. Small faults cut the sequence in this area, some of them with pronounced drag dips on either side. Several small gentle folds trend SSE and have low variable plunges. The disconformity mentioned previously can be traced for about 130 m. The beds above and below are essentially concordant except on the edges of the eroded channels in the older sequence.

IGNEOUS ROCKS

Precambrian (?) – Cambrian

DOLERITE - GABBRO DYKES (€Pd)

FIELD DESCRIPTIONS

Black River - Detention River area

P. G. Lennox

Introduction

In the Black River to Rocky Cape area abundant dolerite-gabbro dykes outcrop within the Proterozoic Rocky Cape Group. The dykes are either folded with the Cowrie Siltstone, lie along faults parallel to the axial planes of folds, or are intruded along joints related to the cleavage.

Whilst most of the dykes do not contain a foliation, others have a well developed foliation (Brickmakers Bay), or two foliations (Alarm River Tributary, CQ714622) which are related to the foliation(s) in the enclosing Cowrie Siltstone. The >110 m wide dyke on the Western line [CQ630708] and the ~250 m wide Hellyer quarry dyke [CQ682735] exhibit fabrics related

to the alignment of ferromagnesian blebs within the dykes.

Where a dolerite dyke can be traced for any length it is invariably aligned (sub-) parallel to the structural grain of the country rock. The succession of isolated but aligned leucocratic coarse-grained dolerite dykes exposed north-west of Mawbanna may be a reflection of a continuation of the NE-trending fault which truncates Shakespeare Hills [CQ643673–CQ654687].

Age dating

Adams (pers.comm., 1980; Adams et al.,1985) dated an unfoliated dyke at the Edgcumbe Beach end of Hellyer Beach [CQ66775] and a foliated dyke at Brickmakers Bay [CQ622763]. Two samples from the unfoliated dyke were dated at 584±8 Ma and 600±8 Ma and sample from the foliated dyke at 588±8 Ma.

Petrography

Almost forty thin sections and a greater number of hand-specimens of dolerite-gabbro were examined from the Smithton sheet. Hand-specimens are predominantly equigranular, holocrystalline (unless obscured by weathering), fine-grained (samples from CQ560604 and CQ583698), medium-grained (samples from CQ578612 and 77/658), to coarse-grained or gabbroic (samples from CQ525618 and 77/792). The dykes are commonly altered so that the feldspar is tinted pale green, and the samples overall are greenish-grey to steel bluish-grey in colour. One particular type distinguished in the Black River-Detention River area have a distinctive leucocratic appearance and appear to contain two feldspars.

Specimens from the Hellyer Quarry (80/164, CQ682735), Western Line (77/792, CQ630708) and Melin Rivulet/Dip Road (80/161, CQ581613; 80/162, CQ578611) areas have fine-grained segregations (~30 × 12 mm) within the coarse-grained equigranular leucocratic groundmass. A number of dykes contain an asbestiform mineral associated with acicular quartz in vugs, veins and fracture-filling, and which is probably an amphibole. Samples of such dykes were collected from: Hellyer Quarry Alarm River Tributary (77/796, CQ719619); Dip River [CQ57366]; Black River [CQ566718] and Mathers Road [CQ582734].

A number of dykes contain pyrrhotite(?) as a disseminated trace component; e.g. those at Knife Edge Road [CQ635670], Tipunah Road [CQ525618] and Mosquito Creek Tributary [CQ583698].

In the medium to coarse-grained varieties blocky aggregates of ferromagnesian minerals may be up to 2 mm × 1 m (e.g. samples from CQ678637 and CQ583698) and more rarely up to 5 mm × 2 mm. Needles of ?clinopyroxene in a sample from CQ525618 are up to 4 mm × 0.25 mm. The ferromagnesian component ranges from about 40% (leucocratic varieties, 77/792) to about 60%. The feldspar occurs in laths (77/796) or blocky crystals, either intergrown with the ferromagnesia component or as a groundmass surrounding isolated aggregates or individual crystals of ferromagnesians.

In thin section the predominate texture is (relict) subophitic to ophitic (77/794, 80/163, 77/767, 77/722 and 77/658), sometimes graphic (77/792, 80/162, 77/709) and rarely poikilitic (80/159). Sample 77/792 has hypidiomorphic granular texture, and sample 77/709 has allotriomorphic granular texture. The samples are invariably deuterically altered, with saussuritisation, partial or complete replacement of clinopyroxene by amphibole or chlorite, and recrystallisation of albite.

Feldspar laths commonly are completely sericitised (e.g. 80/169, 77/656). in sample 77/766 the feldspar laths are

Plate 27. Intergrown relict, tabular crystals whose cleavage planes in one direction have been partly filled with opaque minerals. The groundmass surrounding these crystals consists of completely sericitised feldspar and altered pyroxene. Specimen MW54, magnification ×30,
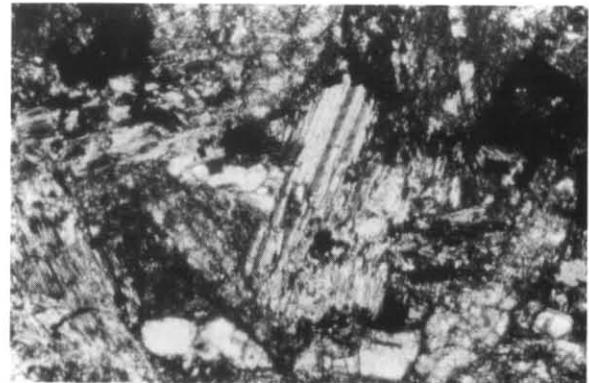
Plate 28. Dolerite dyke from a tributary of Black River at the Gibson Creek Road crossing [CQ560663]. Photomicrograph shows albite-twinned plagioclase lath surrounded by cracked, altered relict pyroxene crystals within fringing skeletal opaque minerals. Magnification ×30,
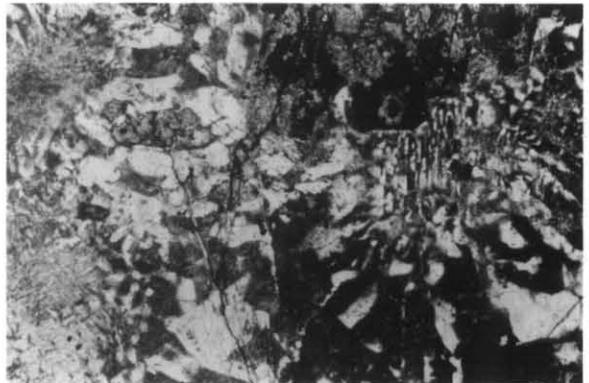
Plate 29. Graphic intergrowth of quartz and feldspar (albite?) from leucocratic coarse-grained dolerite from Melin Rivulet. Note the appearance of an exsolution texture at the bottom left. Specimen 78/64 from CQ758612. Magnification ×20, plane polarised light.

aligned. Plagioclase may show simple or multiple twinning (77/794, 77/792).

Clinopyroxene (commonly augite) occurs as phenocrysts and also as a major component of the groundmass. It is commonly cracked and overgrown by fibrous amphibole or more rarely chlorite (plate 25). Pyroxene phenocrysts in sample 80/159 (Tipunah Road) are augite up to 5 mm in diameter. Intergrowths of sometimes twinned pyroxene up to 2 mm occur in the dolerite dyke near the Bass Highway bridge over the Black River. Similar intergrown clinopyroxene (77/794) may by overgrown by fibrous amphibole. In sample 80/169 (Western Line, CQ492713) clinopyroxene forms a glomeroporphyritic mass up to 5 mm across consisting of 0.25 mm diameter grains. Minor orthopyroxene was identified in a sample from Tipunah Road [CQ525654] and subcalcic augite in sample 77/722 (Dip Road). In sample 80/163 (Detention River) clinopyroxene has been replaced by both chlorite and tremolite/actinolite. In a sample from Blackfish Creek [CQ654685] clinopyroxene has been probably replaced by tremolite/actinolite. Hornblende is also present in some samples from the Western Line (77/792), Black River (77/794), Dip Road/Melin Rivulet (80/161) and in samples from CQ607648 and CQ654685. The groundmass usually consists of microphenocrysts of twinned feldspar laths (commonly completely sericitised), blocky to tabular clinopyroxene (cracked and marginally to wholly replaced) and abundant skeletal opaque mineral grains.

Chlorite may display anomalous blue interference colours (e.g. 77/792, 77/722) and is a common accessory mineral. Apatite needles in recrystallised albite grains occur in samples 77/792, 80/162 and 77/709. Specimen 77/709 contains ?calcite. Opaque mineral grains are ubiquitous, either disseminated (sample from CQ607648) or forming opaque haloes around relict feldspar crystals (77/767, 77/658, samples from CQ607648 and CQ654685) (plates 27–28). Skeletal magnetite in specimen 77/722 shows ilmenite exsolution along its cleavage planes.

Albite is common as a secondary mineral (e.g. 77/722). It may occur in graphic intergrowths with quartz (80/162) or as isolated grains (plate 29). Graphic textures may involve intergrowth of quartz-orthoclase (77/792, CQ607648), or quartz-(?)albite (77/709, CQ654685).

Black River area

P. W. Baillie

Dolerite bodies have been mapped within the Cowrie Siltstone. Contacts with the country rock, where observed, are discordant and contact zones up to 6 m in width were observed (e.g. the dyke on the railway line at CQ591739 is 25 m in width and has a 6 m contact zone).

South Forest Area – Lake Mikany area

K D. Corbett
E. B. Corbett

A number of gabbroic bodies intrude both the (?)Cambrian and Precambrian rocks. The largest of these occur in the (?)Cambrian sequence west of South Forest [CQ492711], but smaller bodies intrude the Precambrian rocks around Lake Mikany and there are also two small bodies in the undifferentiated sequence north-east of Briant Hill. Contacts with the country rocks are generally not exposed, but hornfels occurs adjacent to the contact of the northernmost of the bodies west of South Forest [CQ493732], and also against the second largest of the bodies [CQ491721] shown in this

area. It is possible that the series of separate bodies shown in this area represent a single dyke.

At the southern end of Lake Mikany, a dolerite sill intrudes laminated siltstone of the older Precambrian sequence. The contact is essentially conformable except for short perpendicular steps which could be small faults.

Deeply-weathered basic igneous dykes occur at either end of the dam at Lake Mikany, trending approximately E-W. They are decomposed almost completely to clay, although retaining the igneous texture in patches. They appear to be associated with cross-faults.

Two outcrops of poorly exposed weathered doleritic rock occurs in the lower reaches [CQ463785] of Deep Creek.

Chemistry

A. V. Brown

Introduction

In the past it has been assumed that all 'dolerite' dykes which crop out along the Noth West Coast between Sulphur Creek and Smithton were correlates of the Cooee Dolerite (Spry, 1957; Gee, 1971; Lennox, 1978). During the compilation of this report, it became obvious that at least four different phases of dyke formation occur in the Smithton Quadrangle and that none of these dykes could, on chemical grounds, be correlated with the Cooee Dolerite.

As four groups of dykes could be recognised in the field and petrographic and chemical evidence was available from the Smithton Quadrangle, a re-sampling program was under- taken in November 1988 to obtain a uniform chemical data set from the main dyke locations between Heybridge and Black River, which, when combined with field and petrographic evidence, may solve the question of how many phases of volcanic activity are represented by dykes in this area.

Plots of preliminary chemical data (fig. 39–40) show how easily the two most common varieties of dykes in the Smithton Quadrangle may be distinguished by both major and trace elements, as well as how chemically different these two groups of dykes are to samples of Cooee Dolerite from the Burnie–Cooee area.

When the chemistry of the samples of the Cooee Dolerite are compared with three samples of lava from the Oonah Formation in the Zeehan area (analyses from Brown, 1986), it is seen, that although there are differences, these two rock types were most probably related and belonged to the same phase of volcanism.

The main conclusions from the work in progress are that there is a volcanic asymmetry across the Arthur lineament and that the traditional view that all the dykes were related to the Cooee Dolerite is invalid.

Smithton Quadrangle

Using a combination of chemical data, petrography, and structural and stratigraphic constraints, four groups of dykes have been recognised in the Smithton Quadrangle.

Only one of the four groups can definitely be classed as Precambrian. This group has a tholeiitic chemistry and samples contain a crenulation cleavage, which can be shown in the field to be consistent with similar cleavages found within the surrounding Cowrie Siltstone. In hand specimen samples have a schistose appearance. This phase of volcanic activity may be coeval with the Bernafai Volcanics of the Savage River area. In Figures 39–40 samples from this group are represented by (∗)
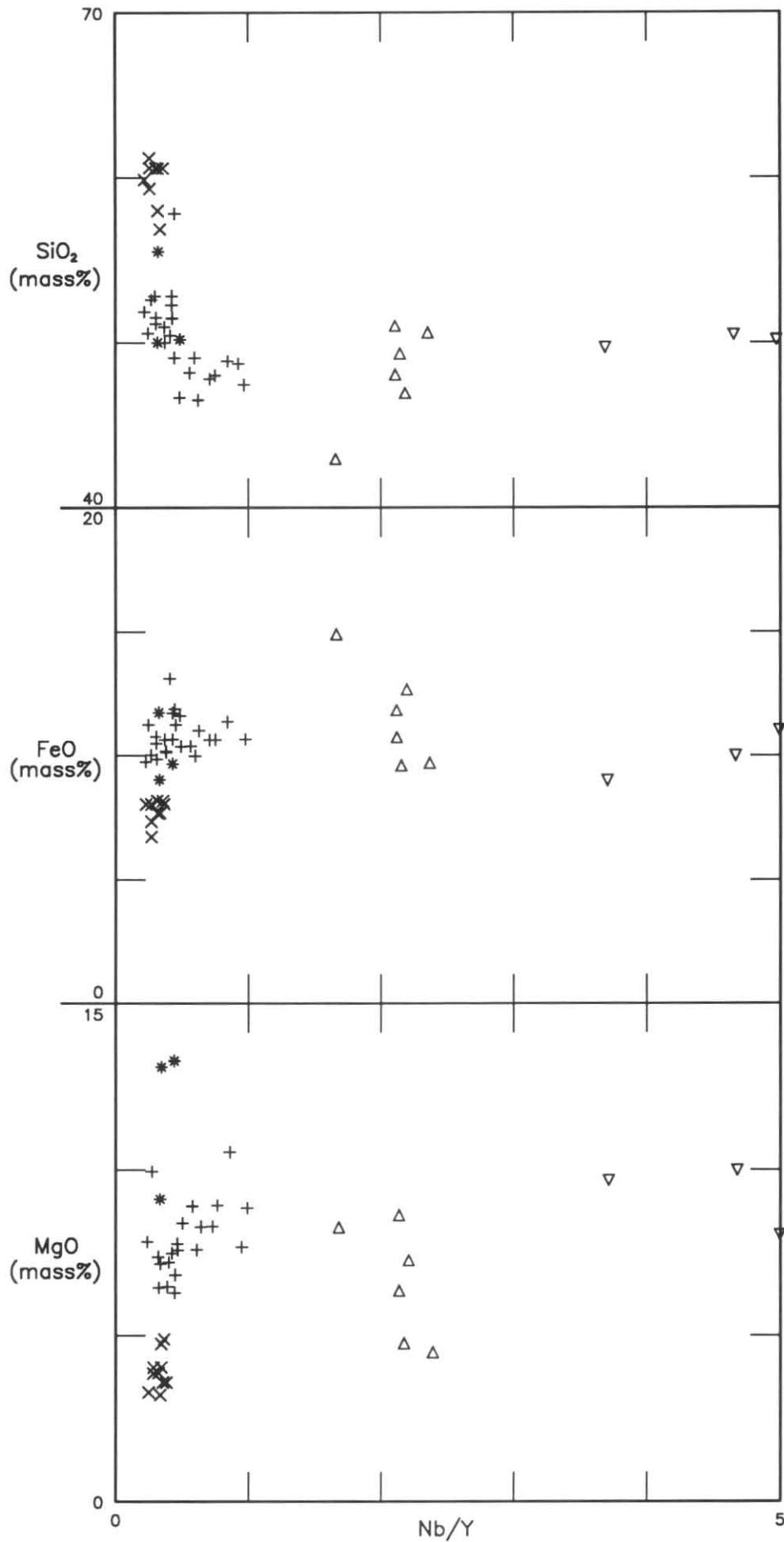
Figure 39. Chemical variation diagram for dolerite dyke samples from the Smithton Quadrangle – foliated tholeiite (✳); massive tholeiite (+); calc-alkaline (×); Burnie–Cooee area area (Δ); and lavas from the Oonah Formation (∇).
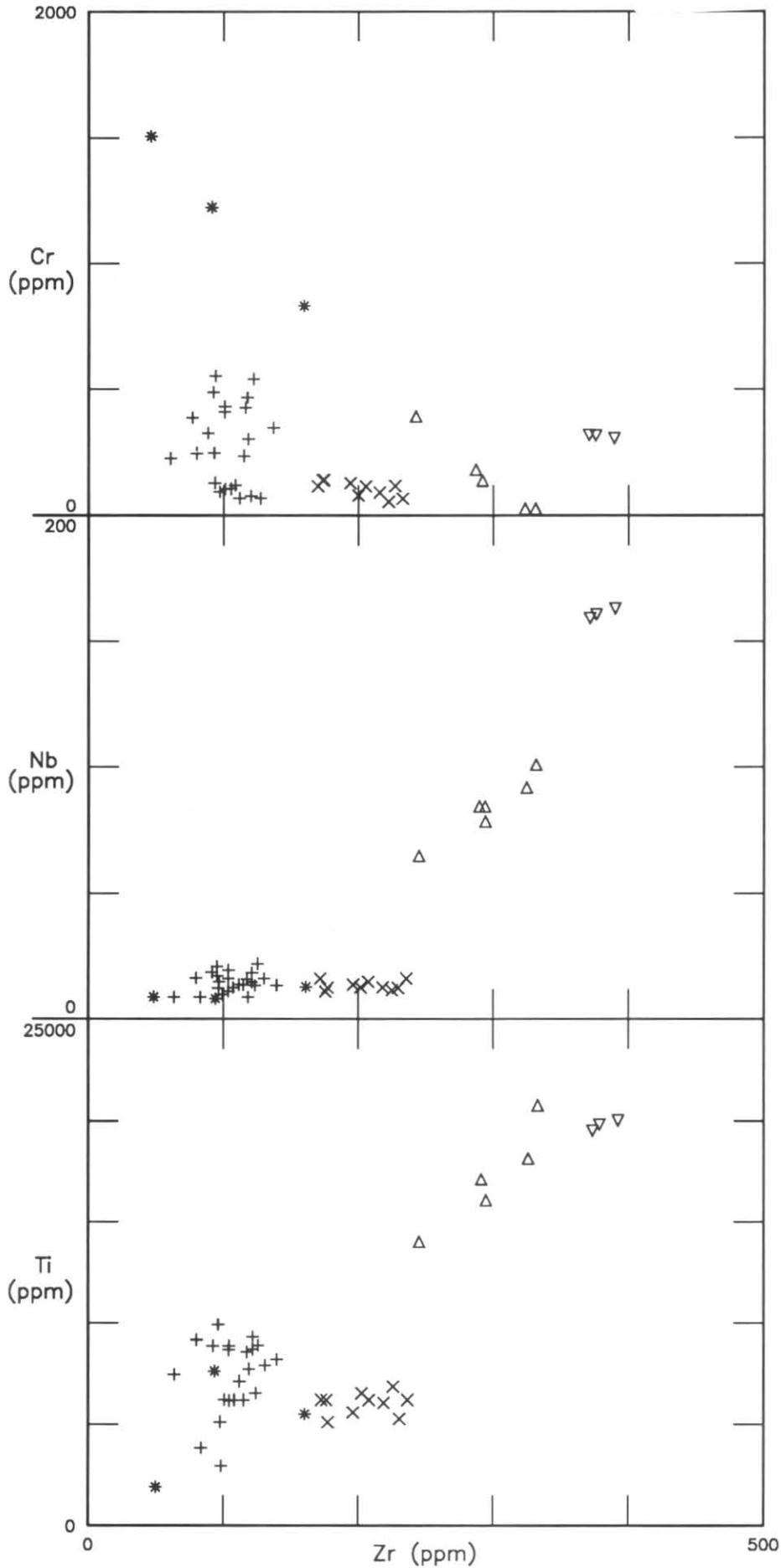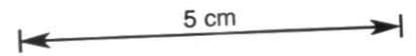
Figure 40. Chemical variation diagram for dolerite dyke samples from the Smithton Quadrangle – foliated tholeiite (✱);
massive tholeiite (+); calc-alkaline (×); Burnie–Cooee area area (Δ); and lavas from the Oonah Formation (∇).

Table 8 a

CHEMICAL ANALYSES OF WHOLE ROCK AND MINERAL
CONSTITUENTS OF SAMPLES FROM GROUP FOUR
PRECAMBRIAN(?) – CAMBRIAN DYKES

Field No.	SB10				Mineral Phases		
Anal. No.	813131						
Reg. No.	850791			Ol	Opx	Cpx	Sp
SiO_2	41.65	SiO_2	39.62	55.70	52.80	-	
TiO_2	0.10	TiO_2	-	-	0.40	1.04	
Al_2O_3	8.26	Al_2O_3	-	1.18	1.88	15.16	
Fe_2O_3	2.48	Cr_2O_3	-	0.44	0.98	45.40	
FeO	8.63	FeO	16.19	10.30	5.17	28.82	
MnO	0.17	MnO	-	-	-	-	
MgO	25.79	MgO	44.55	30.23	18.13	9.29	
CaO	5.74	CaO	-	2.00	19.93	-	
Na_2O	0.28	Na_2O	-	-	-	-	
K_2O	0.20	K_2O	-	-	-	-	
P_2O_5	0.03	P_2O_5	-	-	-	-	
CO_2	0.23						
H_2O^-	0.50	Total	100.36	99.85	99.29	99.60	
H_2O^+	5.24						
		Mg*	83.1	83.9	86.2	44.9	
Total							
		Ca	-	3.8	40.5	-	
Mg#		Mg	-	80.7	51.3	-	
		Fe	-	15.4	8.2	-	
Cr	4213						
Ni	851	Cr*	-	-	-	66.9	
Co	358						
Sc	-						
V	-						
Rb	8						
Ba	67						
Sr	24						
Nb	-						
Zr	10						
Y	4						

Table 8 b

CHEMICAL ANALYSES OF WHOLE ROCK AND MINERAL CONSTITUENTS OF
SAMPLES FROM GROUP FOUR PRECAMBRIAN(?) – CAMBRIAN DYKES
(continued)

Field No.	K5B				Mineral Phases			
Anal. No.	813139							
Reg. No.	850792			Ol	Opx	Cpx	Sp-1	Sp-2
SiO_2	41.77	SiO_2	39.50	55.36	53.07	-	-
TiO_2	0.10	TiO_2	-	0.48	0.33	6.49	0.65
Al_2O_3	8.23	Al_2O_3	-	1.26	2.10	8.62	16.75
Fe_2O_3	2.32	Cr_2O_3	-	0.35	1.08	36.58	43.42
FeO	8.40	FeO	17.56	10.55	5.59	42.16	30.86
MnO	0.17	MnO	-	0.24	-	-	-
MgO	26.04	MgO	43.64	30.32	18.63	6.01	8.20
CaO	5.77	CaO	-	1.81	18.38	-	-
Na_2O	0.27	Na_2O	-	-	-	-	-
K_2O	0.20	K_2O	-	-	-	-	-
P_2O_5	0.04	P_2O_5	-	-	-	-	-
CO_2	0.25							
H_2O^-	0.45	Total	100.70	100.37	100.15	99.86	99.88
H_2O^+	5.22							
		Mg*	81.6	83.7	85.6	30.5	39.6
Total		Ca	-	3.5	39.0	-	-
Mg#	-	Mg	-	80.8	52.2	-	-
		Fe	-	15.8	8.8	-	-
Cr	4213							
Ni	851	Cr*	-	-	-	74.0	63.5
Co	358							
Sc	-							
V	-							
Rb	8							
Ba	67							
Sr	24							
Nb	-							
Zr	10							
Y	4							

Table 8 c

CHEMICAL ANALYSES OF WHOLE ROCK AND MINERAL CONSTITUENTS OF SAMPLES FROM GROUP FOUR PRECAMBRIAN(?) – CAMBRIAN DYKES (continued)

| Field No. | ABS33 | | | | | Mineral Phases | | | |
| Anal. No. | 814097 | | | | | | | | |
Reg. No.	850793		Ol	Opx	Cpx	Sp-1	Sp-2	Plag
SiO_2	42.44	SiO_2	39.42	55.43	52.71	-	-	45.75
TiO_2	0.10	TiO_2	-	-	0.29	1.13	5.28	-
Al_2O_3	8.95	Al_2O_3	-	1.19	2.11	15.59	9.48	33.42
Fe_2O_3	1.70	Cr_2O_3	-	0.46	1.12	44.70	38.14	-
FeO	8.92	FeO	17.18	10.12	5.39	29.53	40.75	0.74
MnO	0.18	MnO	0.26	-	-	-	-	-
MgO	25.34	MgO	43.81	30.13	17.82	8.85	5.64	-
CaO	6.25	CaO	-	2.08	20.01	-	-	17.67
Na_2O	0.42	Na_2O	-	-	-	-	-	1.22
K_2O	0.24	K_2O	-	-	-	-	-	0.78
P_2O_5	0.03	P_2O_5	-	-	-	-	-	-
CO_2	0.11							
H_2O^-	0.15	Total	100.67	99.41	99.45	99.80	99.29	99.58
H_2O^+	4.61							
		Mg*	82.0	84.1	85.5	42.8	28.7	-
Total								
		Ca	-	4.0	40.8	-	-	-
Mg#	-	Mg	-	80.8	50.6	-	-	-
		Fe	-	-	-	-	-	-
Cr	3956							
Ni	899	Cr*	-	-	-	65.8	73.0	
Co	-							
Sc	-	Ab	-	-	-	-	-	10.6
V	-	An	-	-	-	-	-	84.9
		Or	-	-	-	-	-	4.5
Rb	10							
Ba	-							
Sr	27							
Nb	-							
Zr	10							
Y	<4							

Table 8 d

CHEMICAL ANALYSES OF WHOLE ROCK AND MINERAL CONSTITUENTS OF SAMPLES FROM GROUP FOUR PRECAMBRIAN(?) – CAMBRIAN DYKES (continued)

| Field No. | ABS34 | | | | Mineral Phases | | |
| Anal. No. | 814098 | | | | | | |
Reg. No.	850794		Ol	Opx	Cpx	Sp-1	Sp-2
SiO_2	41.57	SiO_2	39.55	55.71	52.95	-	-
TiO_2	0.10	TiO_2	-	-	-	5.68	0.84
Al_2O_3	9.54	Al_2O_3	-	1.17	2.24	9.28	16.64
Fe_2O_3	2.76	Cr_2O_3	-	0.55	1.18	38.34	45.08
FeO	7.41	FeO	16.73	10.01	5.24	39.94	29.03
MnO	0.18	MnO	-	-	-	-	-
MgO	23.96	MgO	43.88	29.97	18.62	6.32	8.84
CaO	6.44	CaO	-	2.15	19.41	-	-
Na_2O	0.21	Na_2O	-	-	-	-	-
K_2O	0.41	K_2O	-	-	-	-	-
P_2O_5	0.03	P_2O_5	-	-	-	-	-
CO_2	0.06						
H_2O^-	0.16	Total	100.16	99.56	99.64	99.56	100.43
H_2O^+	6.33						
		Mg*	82.4	84.2	86.4	32.0	42.3
Total							
		Ca	-	4.2	39.3	-	-
Mg#	-	Mg	-	80.7	52.4	-	-
		Fe	-	15.1	8.3	-	-
Cr	3855						
Ni	793	Cr*	-	-	-	73.5	64.5
Co	-						
Sc	-						
V	-						
Rb	16						
Ba	-						
Sr	32						
Nb	-						
Zr	12						
Y	<4						

Table 8 e

CHEMICAL ANALYSES OF WHOLE ROCK AND MINERAL CONSTITUENTS OF SAMPLES FROM GROUP FOUR PRECAMBRIAN(?) – CAMBRIAN DYKES
(continued)

Field No.	ABS35				Mineral Phases		
Anal. No.	814099		Ol	Opx	Cpx	Sp	Plag
Reg. No.	850795						
SiO_2	43.71	SiO_2	38.61	55.59	52.90	-	46.37
TiO_2	0.13	TiO_2	-	-	-	1.09	-
Al_2O_3	14.00	Al_2O_3	-	1.25	1.95	12.16	-
Fe_2O_3	1.64	Cr_2O_3	-	0.54	0.99	44.86	-
FeO	7.11	FeO	19.48	10.96	6.09	35.74	1.12
MnO	0.14	MnO	0.28	-	-	-	-
MgO	17.18	MgO	41.80	29.46	18.76	5.90	-
CaO	9.01	CaO	-	2.50	18.58	18.66	-
Na_2O	0.61	Na_2O	-	-	-	-	1.57
K_2O	0.40	K_2O	-	-	-	-	-
P_2O_5	0.05	P_2O_5	-	-	-	-	-
CO_2	0.05						
H_2O^-	0.16	Total	100.17	100.30	99.27	99.75	99.50
H_2O^+	5.28						
		Mg*	79.3	82.7	84.6	29.5	-
Total							
		Ca	-	4.8	37.6	-	-
Mg#	-	Mg	-	78.8	52.8	-	-
		Fe	-	16.4	9.6	-	-
Cr	1706						
Ni	405	Cr*	-	-	-	71.2	-
Co	-						
Sc	-	Ab	-	-	-	-	13.2
V	-	An	-	-	-	-	86.8
		Or	-	-	-	-	0.0
Rb	19						
Ba	-						
Sr	56						
Nb	-						
Zr	16						
Y	8						

Table 8 f

CHEMICAL ANALYSES OF HOLE ROCK AND MINERAL CONSTITUENTS OF SAMPLES FROM GROUP FOUR PRECAMBRIAN(?) – CAMBRIAN DYKES
(continued)

Field No.	ABS15				Mineral Phases		
Anal. No.	-		Ol	Opx	Cpx	Sp-1	Sp-2
Reg. No.	850796						
SiO_2	-	SiO_2	39.17	55.83	53.30	-	-
TiO_2	-	TiO_2	-	0.24	0.32	0.97	6.90
Al_2O_3	-	Al_2O_3	-	1.20	1.94	15.11	8.53
Fe_2O_3	-	Cr_2O_3	-	0.45	1.02	45.59	34.54
FeO	-	FeO	17.78	10.72	5.54	29.70	44.18
MnO	-	MnO	0.25	-	-	-	-
MgO	-	MgO	43.26	30.11	18.06	8.63	5.44
CaO	-	CaO	-	1.94	19.92	-	-
Na_2O	-	Na_2O	-	-	-	-	-
P_2O_5	-	K_2O	-	-	-	-	-
CO_2	-	P_2O_5	-	-	-	-	-
H_2O^-	-						
H_2O^+	-	Total	100.46	100.49	100.10	100.27	99.59
Total	-	Mg*	81.3	83.3	85.3	41.8	27.8
Mg#	-	Ca	-	3.7	40.4	-	-
		Mg	-	80.2	50.7	-	-
Cr	-	Fe	-	16.2	8.8	-	-
Ni	-						
Co	-	Cr*	-	-	-	66.9	73.1
Sc	-						
V	-	An	-	-	-	-	-
		Ab	-	-	-	-	-
Rb	-	Or	-	-	-	-	-
Ba	-						
Sr	-						
Nb	-						
Zr	-						
Y	-						

The second group of dykes also has a tholeiitic chemistry but are massive and exhibit no cleavage, either in field outcrop or in thin section. In hand specimen, samples are fine- to medium-grained mafic (basaltic) dolerite with a number of samples containing a distinct black clinopyroxene. Two samples from one of the dykes within this group gave K/Ar ages of 600 ± 8 Ma and 588 ± 8 Ma. This group of dykes is interpreted as being feeders for the basalt within the Smithton–Trowutta basalt-sedimentary rock association. In Figures 39–40 samples from this group are represented by (+).

The third group of dykes has a calc-alkaline chemistry and the dykes are massive and unfoliated. In hand specimen, samples from this group are medium- to coarse-grained leucrocratic 'dolerite' with recognisable free quartz, allowing samples of this group to be separated from the other unfoliated dykes in the field. In thin section, samples display graphitic intergrowth of quartz and feldspar. The age of this group of dykes and the nature of the associated volcanic rocks are unknown. In Figures 39–40 samples of this group are represented by (×)

The fourth group intrudes an area of the Late Precambrian – (?)Cambrian Smithton–Trowutta basalt-sedimentary rock association in the South Forest area. These dykes have a distinctive chemistry and are interpreted as being remnant feeders for a phase of picritic volcanism. In hand specimen the samples consist of olivine, two pyroxenes and interstitial feldspar, which allows them to be readily identifed in the field. The age of these dykes is unknown. Picritic lavas from south-east King Island have been considered to be 'Cambrian' in age, but this is purely an assumption. The dykes in the South Forest area intrude a tholeiitic basalt - sedimentary rocks association and are overlain by Tertiary basalt. This very broad stratigraphic position is similar to that exhibited by dykes with a similar petrography and chemistry, in the Cleveland–Waratah area, (Williams and Brown, 1983; Brown, 1985; Brown *in* Seymour 1989). Whole rock major and trace element chemistry and electron probe analyses of constituent mineral phases of samples from this group are listed in Table 8*a–f*.

Eocambrian – Cambrian

SMITHTON–TROWUTTA BASALT-SEDIMENTARY ROCK ASSOCIATION (€sp – AMYGDALOIDAL SPILITE, COMMONLY WITH PILLOWS)

INTRODUCTION

A. V. Brown

Based on a combination of outcrop and aeromagnetic data, the basalt - sedimentary rock association extends across the Smithton Quadrangle from Perkins Bay in the north to Nabageena in the south. Outcrop extends from Shell Pit Point [CQ431804] south, past Smithton to east of Nabageena [CQ420610] onto the Trowutta map sheet. On outcrop, aeromagnetic and gravity data (Appendix D) a second zone of the association extends in a north-easterly direction from Nabageena, under the Lileah–Irishtown Tertiary basalt, to east of South Forest, then into the Forest-Tallows Folly area, past North Forest, and then to the north under the Tertiary basalt on the Stanley Peninsula, with an intense aeromagnetic high centered around CQ545860, and then to the west of the peninsula underlying approximately 50 km² of the eastern part of Perkins Bay.

Due to a folding-fault arrangement a Precambrian, basement rock dome stucture occurs between these two

arms in the Lake Mikany, Beacon Hills, Briant Hill area with an extention under the Anthony Beach area. The formation of this structure tilted the western of the two arms to the west, allowing a section through the succession to be obtained along the southern shore of Deep Creek Bay to Copper Point.

Geochemically, the oldest basalts associated with this association occur along the southern foreshore of Deep Creek Bay (around CQ433795) then young up sequence, to the west, with the most evolved basaltic rocks, in this part of the sequence, occurring at Copper Point. An erosional disconformity mapped in this area (see p. 23, this publication), is geochemically of little significance, as similar basaltic rocks to those found in this area occurs in a section exposed by the Arthur River (Griffin, 1974) where basalt flows follow each other, without interlayered sedimentary rocks or any other evidence of an erosional disconformity.

SMITHTON AREA

P. G. Lennox

Petrology

Four spilite samples from the Smithton area were examined. They are either very altered (Copper Mine Point Road quarry, 80/170, CQ427785 and Drive Creek, 80/140, CQ401613) or saussuritised (Drive Creek area, 80/138, CQ397606; 80/141, CQ401613).

In hand-specimen the spilite is a very fine-grained, very tough, subconchoidally fractured greenish-black coloured rock containing millimetre size amygdules and gabbroic segregations. Thin sections of samples usually show abundant amygdules and gabbroic segregations and an overall pale green colour, except for sample 80/140 whose groundmass has been extensively replaced by magnetite and hematite.

In thin section 80/141, the gabbroic segregations range up to 4 × 7mm, and contain albitised and chloritised plagioclase phenocrysts (2 × 4mm) with peripheral microphenocrysts of clinopyroxene (up to 140×455 μm) in a groundmass of saussuritised interlocking plagioclase laths (35×72 μm) clinopyroxene, chlorite and opaque mineral grains. Clinopyroxene (augite) microphenocrysts are scattered throughout. Other coarse granular parts of the thin section consist of chlorite (up to 1260 μm across), associated with amphibol (?tremolite/actinolite), clinopyroxene and plagioclase. Some rounded amygdules (up to 2 mm) filled with a radiating opaline mineral are present (plate 30).

The very altered, greenish-black hand specimen, 80/170, contains numerous vugs up to 5 mm cross filled with a translucent black, coarsely crystalline, ?calcareous
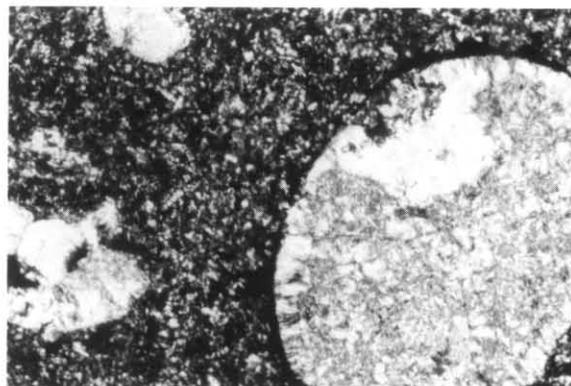
Plate 30. Photomicrograph of a radiating opaline mineral in a vug filling, with a 144 μm-wide selvage of similar material. Specimen 80/141 from CQ401613. Magnification ×20, crossed polars.

Table 9

CHEMICAL ANALYSES OF CAMBRIAN BASALT SAMPLES FROM THE SMITHTON-TROWUTTA BASALT-SEDIMENTARY ROCK ASSOCIATION

	1	2	3	4	5	6	7	8	9	10
Reg.No.	850081	850083	850082	850084	850779	850780	850781	850782	850783	850079
Field No.	ABS36	ABS38	ABS37	ABS40	ABS28	ABS20	ABS21	SB11	SB18	SB16
Anal. No.	814100	814102	814101	814104	814094	814087	814088	813132	813134	813133
SiO_2	45.87	47.03	46.69	47.74	48.58	47.41	48.29	49.72	46.78	47.23
TiO_2	0.66	0.67	0.68	1.56	1.68	1.69	1.74	1.57	1.63	1.67
Al_2O_3	14.44	14.76	14.48	13.96	14.32	13.81	13.83	14.12	13.87	14.27
Fe_2O_3	3.68	2.71	3.18	4.70	4.50	5.54	5.01	7.60	7.80	5.23
FeO	6.04	6.72	6.27	7.94	7.94	7.63	7.33	4.68	5.28	7.18
MnO	0.19	0.16	0.17	0.20	0.25	0.17	0.20	0.15	0.17	0.18
MgO	10.67	10.11	10.04	6.66	6.88	6.49	6.60	4.65	5.64	6.51
CaO	9.95	9.87	10.30	10.46	10.58	10.01	8.32	7.73	7.79	11.24
Na_2O	2.61	2.13	2.70	2.45	2.12	2.67	2.87	0.21	3.71	2.28
K_2O	0.14	0.63	0.15	0.56	0.13	0.35	0.16	0.15	0.20	0.22
P_2O_5	0.16	0.17	0.16	0.20	0.21	0.19	0.19	0.16	0.19	0.20
CO_2	0.08	0.07	0.04	0.28	0.05	0.05	0.05	0.85	0.23	0.15
H_2O^+	4.62	4.20	4.32	2.77	2.37	3.29	4.36	6.79	3.24	2.79
H_2O^-	0.23	0.26	0.22	0.10	0.15	0.04	0.06	1.18	0.48	0.29
Total	99.34	99.49	99.40	99.58	99.76	99.34	99.01	99.56	99.01	99.44
Mg#	67	66	66	49	51	48	50	42	45	49
Cr	952	767	777	169	249	161	161	227	150	260
Ni	297	230	226	87	95	81	83	84	82	92
Co	nd	nd	nd	nd	nd	nd	nd	-	47	45
Sc	50	46	48	44	39	41	44	-	42	40
V	210	220	220	350	350	370	370	-	370	350
Rb	<4	9	<4	4	<4	5	<4	4	5	<4
Ba	420	830	490	290	200	200	260	-	350	240
Sr	566	140	532	210	176	225	243	24	142	290
Nb	15	13	13	5	7	6	7	8	9	7
Zr	72	65	71	93	100	95	98	84	98	97
Y	15	18	15	20	20	20	22	29	22	23
Th		-	-	-	-	-	-	<8	<8	<8

Table 9

CHEMICAL ANALYSES OF CAMBRIAN BASALT SAMPLES FROM THE SMITHTON-TROWUTTA BASALT-SEDIMENTARY ROCK ASSOCIATION
(continued)

	11	12	13		14	15	16	17
Reg. No.	850784	850785	850785		850787	850788	850789	850790
Field No.	ABS6	ABS44	ABS26		ABS49	ABS52	ABS55	ABS56
Anal. No.	814081	830782	814093		830783	830784	830785	830786
SiO_2	49.44	50.99	48.44		48.11	45.22	53.33	38.79
TiO_2	1.63	1.75	2.32		3.19	3.59	2.28	4.16
Al_2O_3	12.67	11.40	13.25		11.99	12.30	10.46	15.01
Fe_2O_3	5.60	4.70	5.57		5.97	1.93	5.09	4.38
FeO	11.28	11.87	7.71		8.86	13.06	6.13	12.32
MnO	0.24	0.27	0.21		0.16	0.20	0.15	0.24
MgO	4.53	4.17	6.43		6.48	5.81	7.16	7.76
CaO	7.91	7.15	8.08		5.72	8.21	8.08	6.03
Na_2O	2.73	2.80	3.27		2.38	2.96	2.07	1.69
K_2O	0.80	0.77	0.12		0.36	0.19	0.39	0.66
P_2O_5	0.32	0.40	0.25		0.44	0.44	0.29	0.53
CO_2	0.08	0.11	0.08		0.93	0.42	0.78	1.05
H_2O^+	2.68	2.86	3.57		4.27	4.09	3.48	5.84
H_2O^-	0.00	0.14	0.26		0.19	0.19	0.24	0.27
				SO_3	-	0.51	-	0.27
Total	99.91	99.38	99.54		99.05	99.12	99.94	99.00
Mg#	33	32	47		45	41	54	46
Cr	84	50	161		590	30	530	98
Ni	42	34	85		270	54	250	74
Co	-	42	-		49	45	42	47
Sc	51	53	35		33	26	24	36
V	410	420	380		350	410	250	440
Rb	18	25	4		9	10	10	18
Ba	720	290	250		115	75	145	320
Sr	177	110	293		81	145	670	200
Nb	29	27	15		28	28	23	37
Zr	119	130	139		230	230	190	300
Y	43	49	22		31	33	26	40
Th	-	7	-		4	5	7	6

Mg# = recalculated anhydrous (MgO/FeO total)
FeO total = $(0.8998 \times Fe_2O_3 + FeO)$

Table 10
LOCALITIES OF SAMPLES LISTED IN TABLES 8 – 9

Field No.	Analysis No.	AMG Ref.	Rock type
Localities for samples listed in Tables 8a–f			
SB10	813131	CQ492712	Plagioclase-bearing poikolitic lherzolite
KB5	813139	CQ492712	Plagioclase-bearing poikolitic lherzolite
ABS33	814097	CQ492712	Plagioclase-bearing poikolitic lherzolite
ABS34	814098	CQ490708	Plagioclase-bearing poikolitic lherzolite
ABS35	–	CQ479707	Plagioclase-bearing poikolitic lherzolite
Localities for samples listed in Table 9			
ABS36	814100	CQ43207935	Olivine phyric basalt
ABS38	814102	CQ43207960	Olivine phyric basalt
ABS37	814101	CQ43207945	Olivine phyric basalt
ABS40	814104	CQ41907245	Cpx and/or plagioclase phyric basalt
ABS28	814094	CQ42607850	Cpx and/or plagioclase phyric basalt
ABS20	814087	CQ40906240	Cpx and/or plagioclase phyric basalt
ABS21	814088	CQ40806845	Cpx and/or plagioclase phyric basalt
SB11	813132	CQ49207125	Cpx and/or plagioclase phyric basalt
SB18	813134	CQ48807165	Cpx and/or plagioclase phyric basalt
SB16	813133	CQ48757140	Cpx and/or plagioclase phyric basalt
ABS6	814081	CQ52757985	Cpx and/or plagioclase phyric basalt
ABS44	830782	Forest DDH 12.3m	Cpx and/or plagioclase phyric basalt
ABS26	814093	CQ42307940	Cpx and/or plagioclase phyric basalt
ABS49	830783	Forest DDH 178.0 m	Basaltic lithic wacke
ABS52	830784	Forest DDH 270.5m	Cpx and/or plagioclas phyric basalt
ABS55	830785	Forest DDH 39.9 m	Basaltic lithic wacke
ABS56	830786	Forest DDH 495.4 m	Basaltic breccia
Localities for samples from the Montagu area			
ABS22	814089	CQ24308360	Cpx and/or plagioclase phyric basalt
ABS23	814090	CQ24108355	Cpx and/or plagioclase phyric basalt
ABS24	814091	CQ20858605	Cpx and/or plagioclase phyric basalt
ABS25	814092	CQ21158515	Cpx and/or plagioclase phyric basalt

mineral. In thin section, under plane polarised light, the translucent brown glassy matrix contains concentrically-lined amygdules (up to 350 μm diameter) consisting of an opaque outer layer (14-28 μm thick), a radial chlorite layer (40–60 μm thick), and core of opaque mineral grains, quartz and chlorite. The matrix also contains scattered albitised non-aligned feldspar laths ranging from 18×90 μm to 36×360 μm. In cross-polarised light the thin section appears completely altered by chloritisation, sericitisation and saussuritisation. Other amygdules are filled by dolomite (calcite), wedge-shaped aggregates (1.12mm diameter) of twinned albite (72×280 μm to 210×560 μm) and minor quartz.

In thin section, the saussuritised sample 80/138 consists of vugs from 1to 4mm across filled with relict blocky to tabular clinopyroxene (175×560 μm, partly altered to amphibole + chlorite and phenocrysts of albite (180×360 μm) and amphibole (tremolite/actinolite) after clinopyroxene (14 μm to 35 μm across), abundant angular opaque mineral grains (21 μm to 28 μm across) and sericitised bladed, twinned feldspar (14×60 μm to 28×210 μm). In thin section 80/140, the clinopyroxene phenocrysts and microphenocrysts are remarkably unaltered, while a large proportion of the feldspar groundmass has been replaced by opaque mineral grains.

WILTSHIRE AREA

P. W. Baillie

Basalt or 'spilite' was mapped in the tract of country south of the Stanley turnoff [CQ525800]. In hand specimen it is a dense grey-green, fine-grained rock that generally contains blebs (1–2 mm) of pyrrhotite. Agate has been observed within the rock. Other amygdules, where they have been observed, are composed of chlorite.

Altered zones occur and the rock typically has a chlorite/epidote/quartz mineral assemblage.

No pillows were observed in the mapped area.

Chemistry

A. V. Brown

Thirteen basalt samples from the Smithton–Nabageena and Forest areas were obtained for whole rock analyses (table 9, analyses 1–12). Four further analyses, of sedimentary rocks dominantly derived from the basaltic rocks (table 9, analyses 13–17), were also obtained from different depths within the stratigraphic drill hole at North Forest (Appendix B). Chemical analyses obtained during earlier work in the Smithton area (e.g. Foden 1973) and used in Varne and Foden (1987), are not be discussed in this report due to their lack of trace element data. Analyses of basalt samples from south of the map sheet, in the Trowutta area (Griffin, 1974), are consistent with the samples discussed below. Four analyses, from samples obtained from the Montagu area to the west – table 10, ABS22–25 – (Brown, 1985) are used in conjunction with the samples from the Smithton Quadrangle to demonstrate the nature of the lavas and their stratigraphic association (table 10).

Using the normative classification of Green (1970), all of the (?)Cambrian lavas are tholeiitic basalt (normative hypersthene). The lavas from the lowest part of the

5 cm
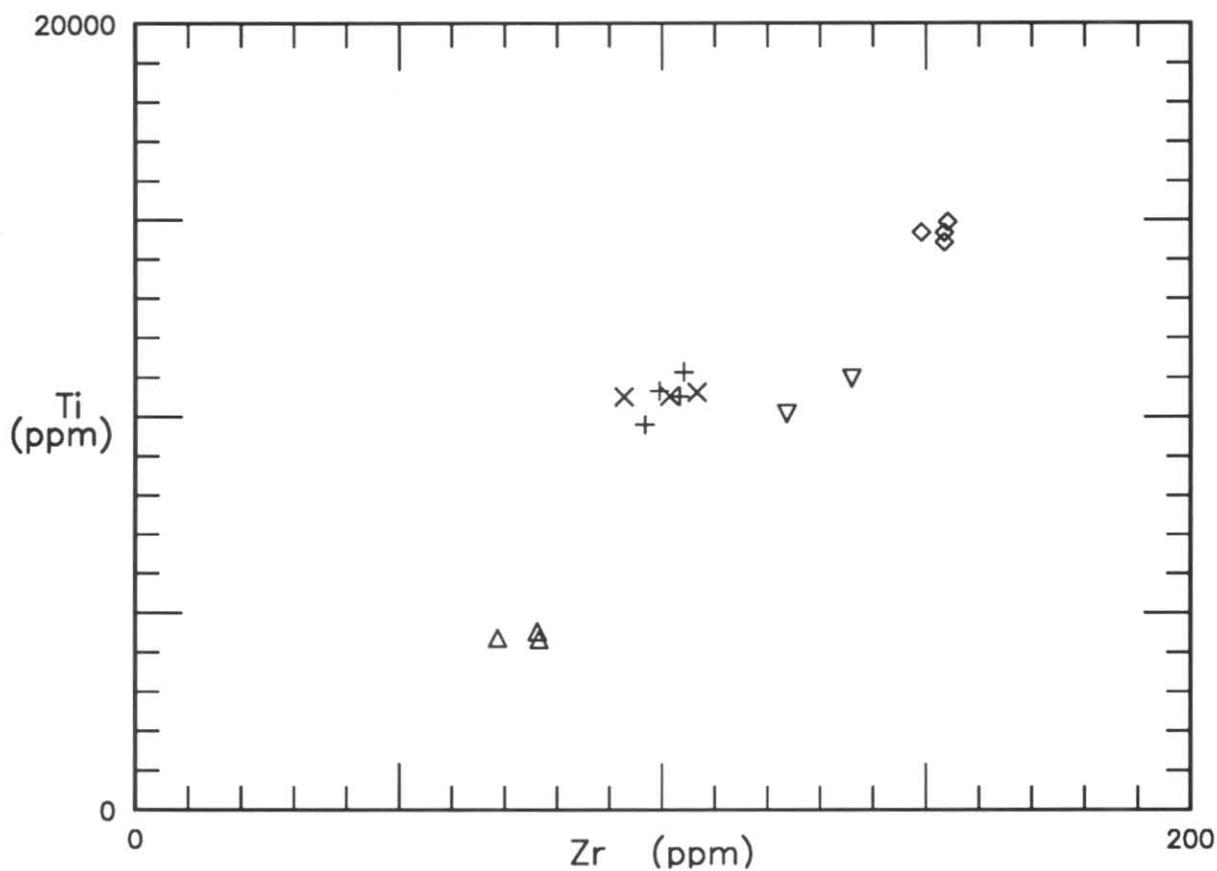
Figure 41. Chemical variation diagram for Ti *v* Zr in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊).
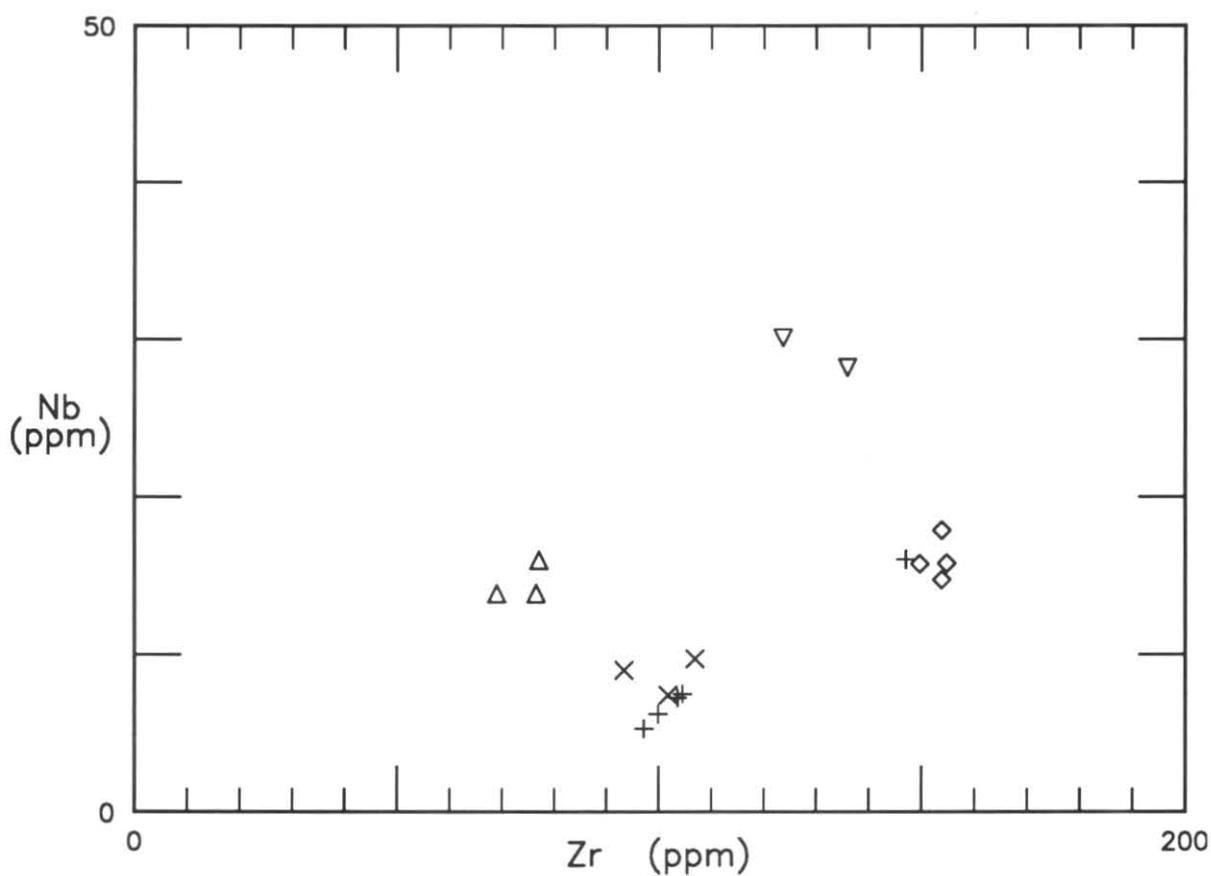
Figure 42. Chemical variation diagram for Nb *v* Zr in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊).

5 cm
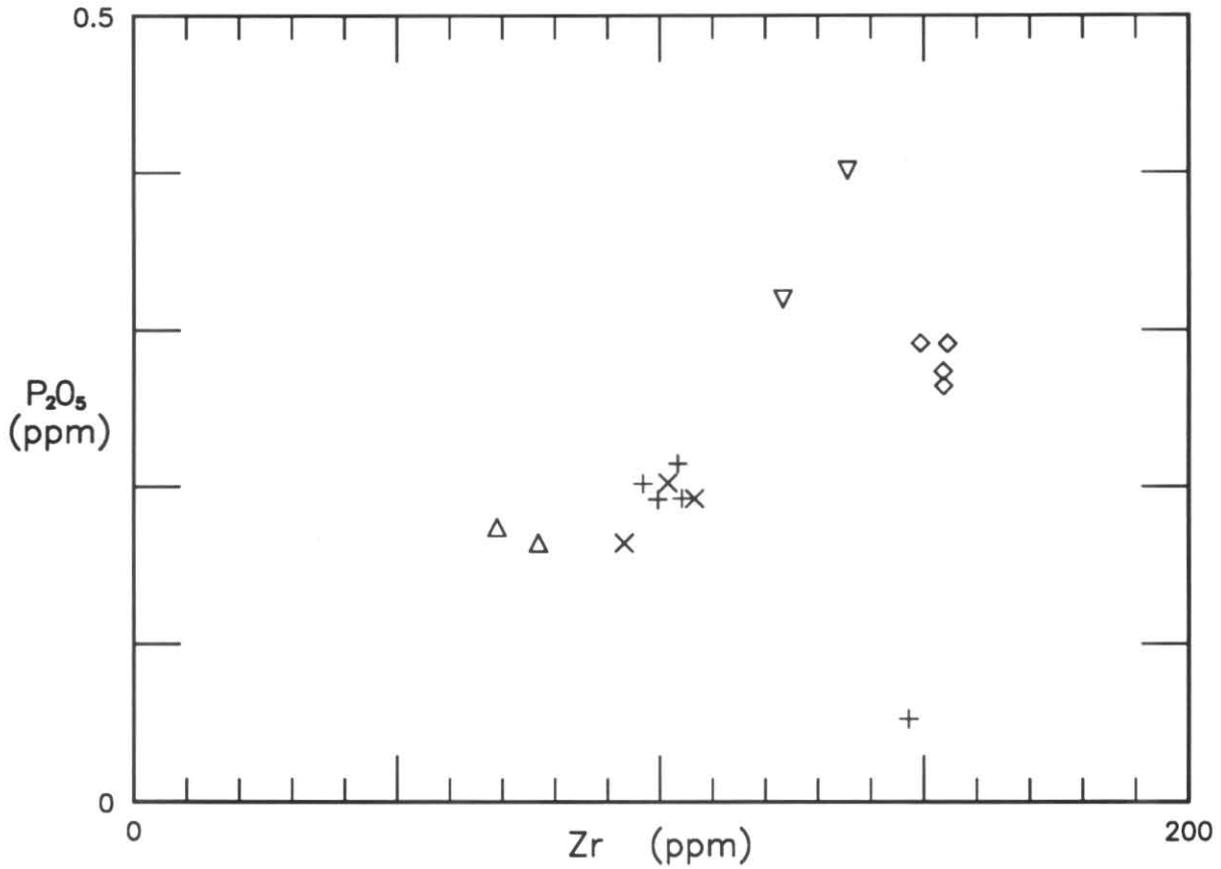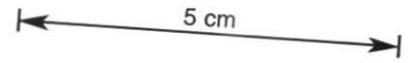
Figure 43. Chemical variation diagram for P_2O_5 v Zr in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊).
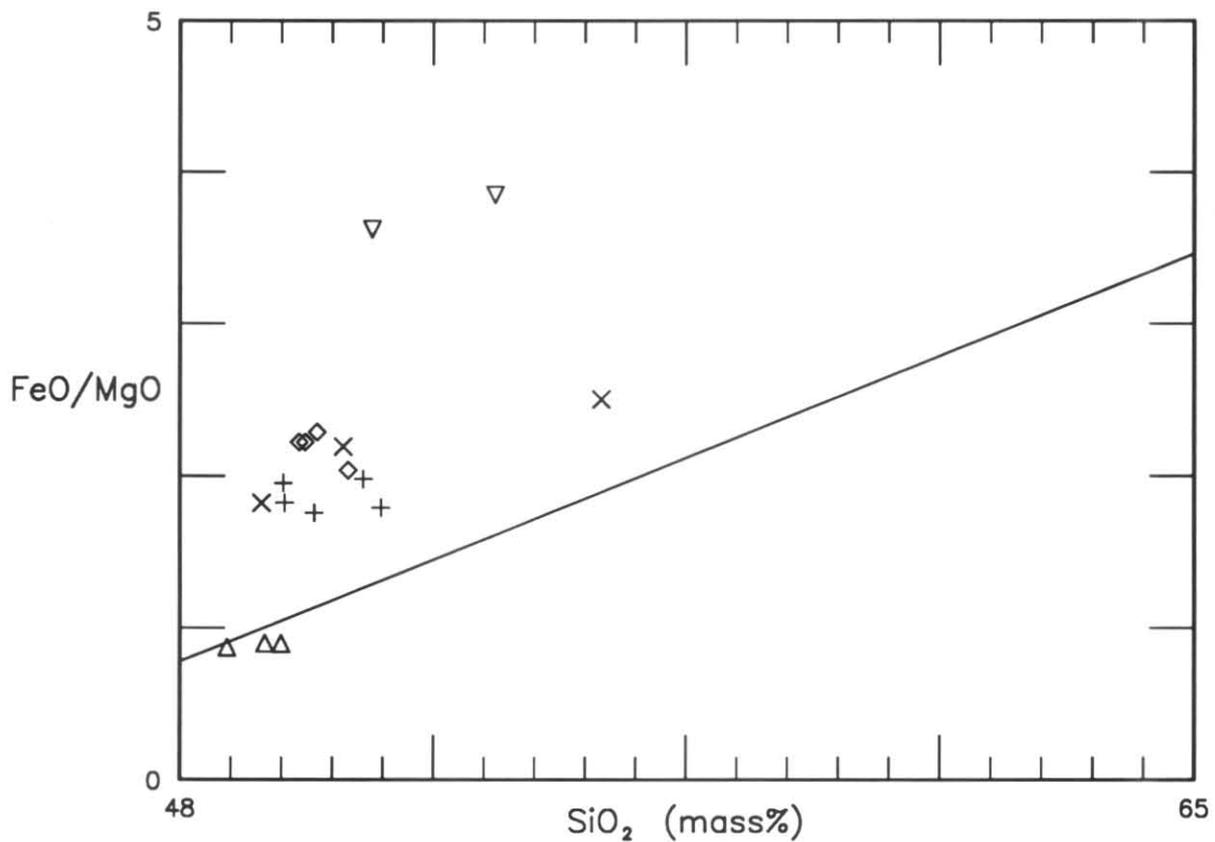
Figure 44. Chemical variation diagram for FeO/SiO_2 v SiO_2 in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊). Dividing line from Miyashiro, 1974.
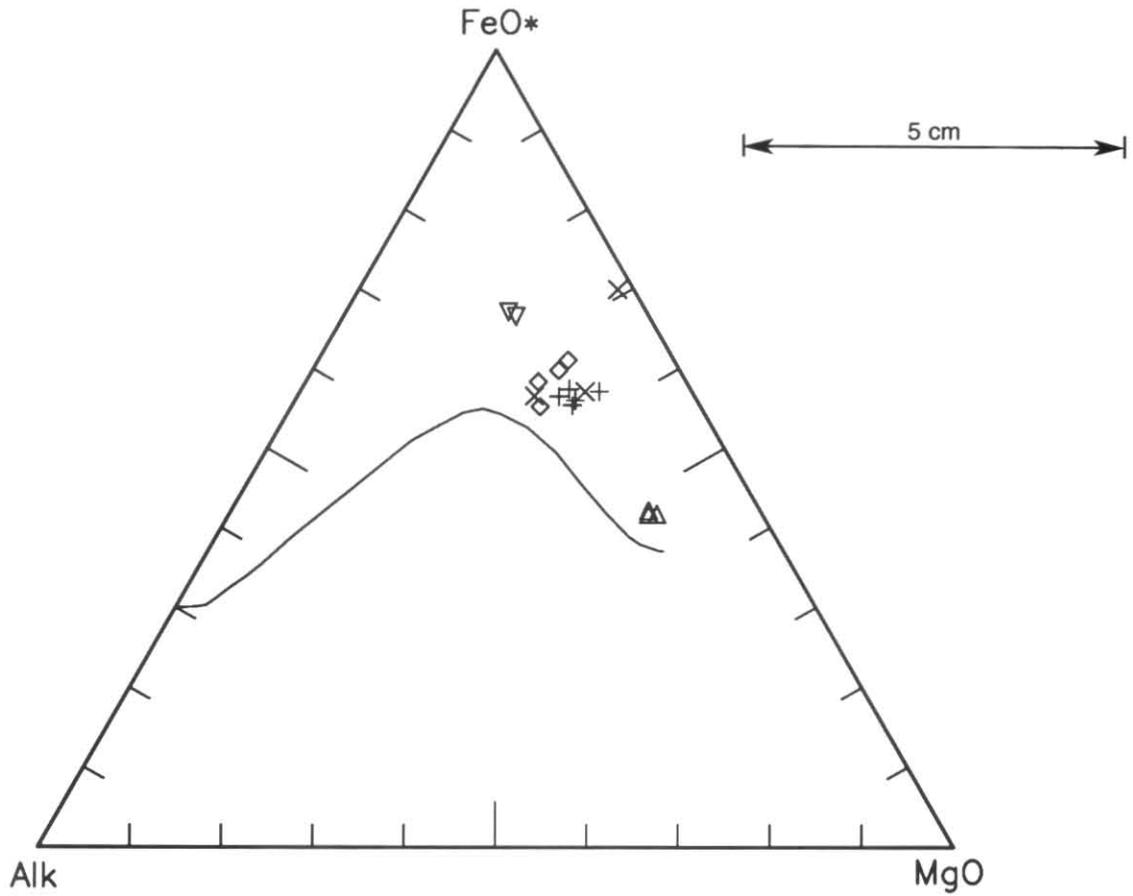
Figure 45. Chemical variation diagram for FeO* v Alk v MgO in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊). Dividing line after Irvine and Baragar, 1971.
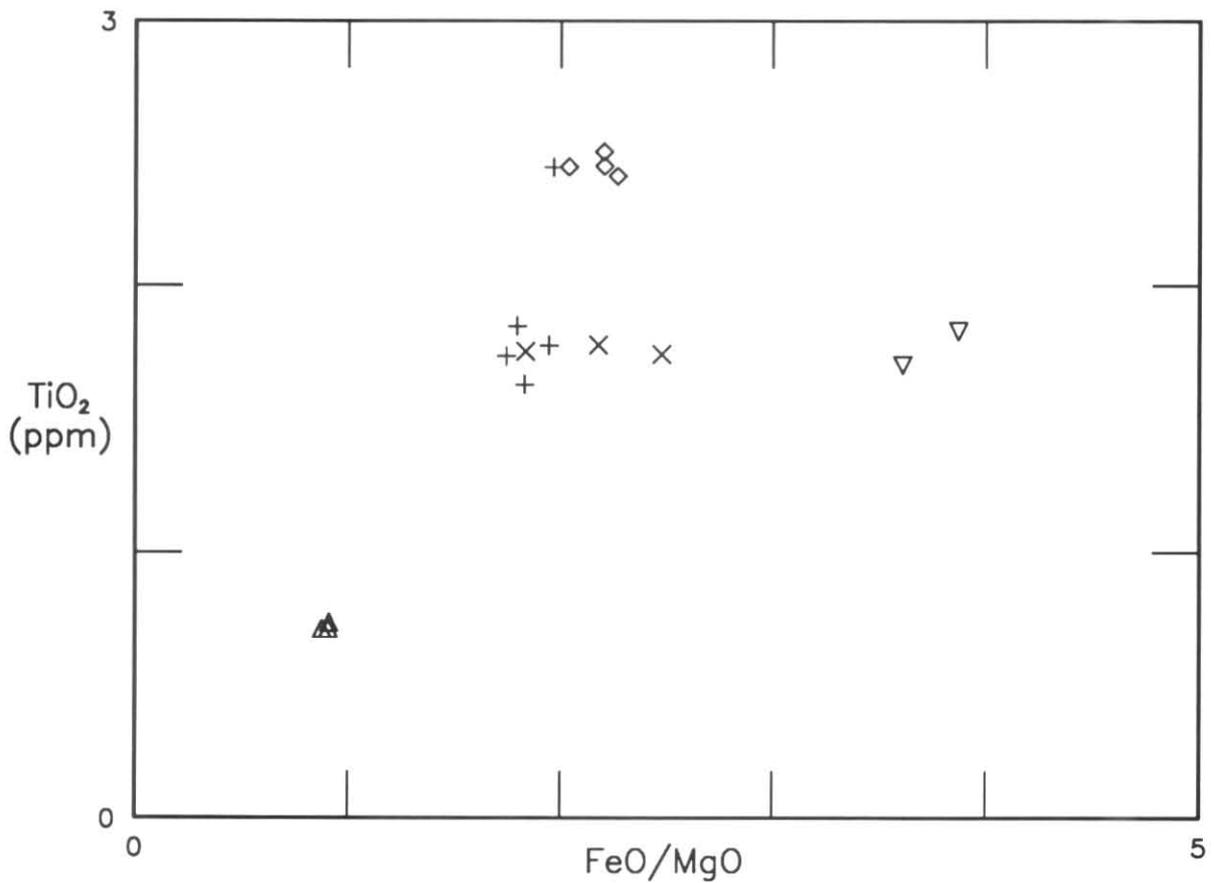
Figure 46. Chemical variation diagram for TiO_2 v FeO/MgO in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊).

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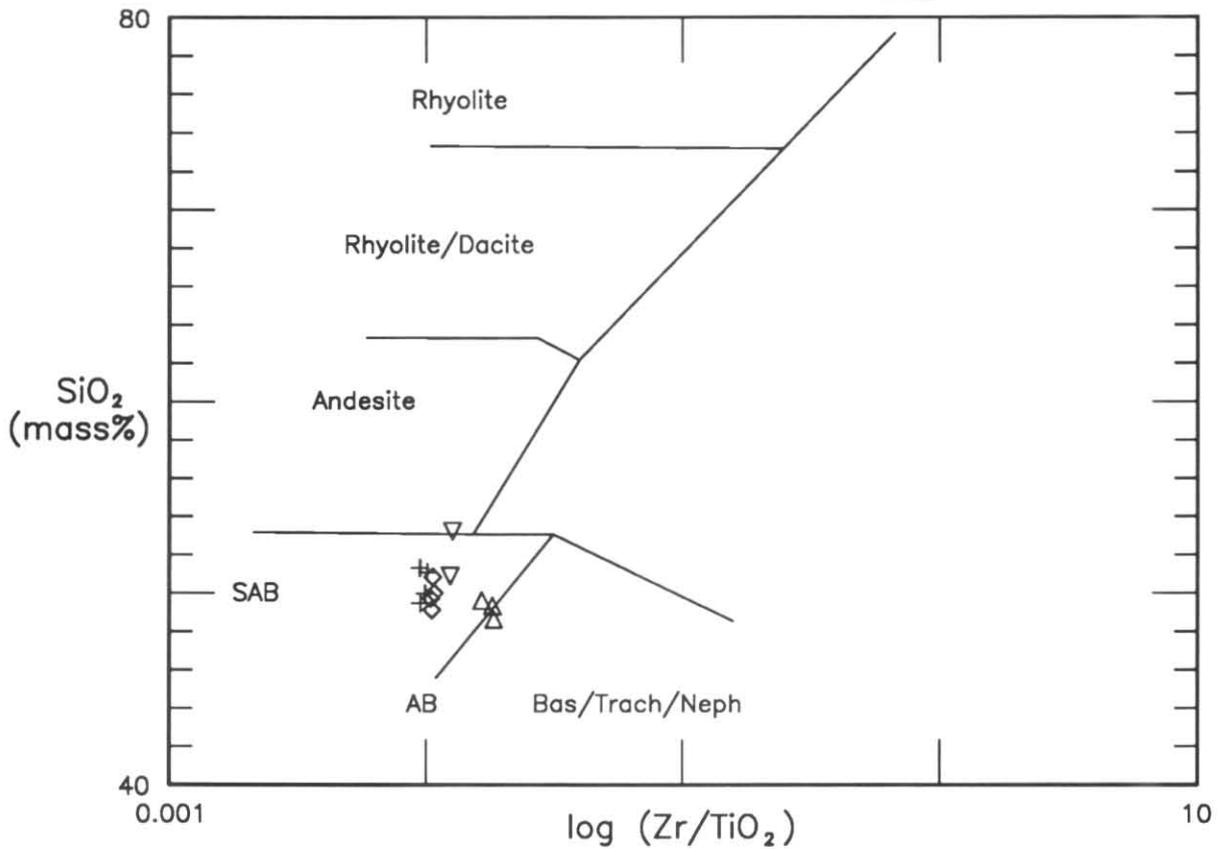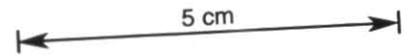
Figure 47. Chemical variation diagram for SiO2 v log (Zr/TiO₂) in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊). Dividing lines after Winchester and Floyd, 1977.
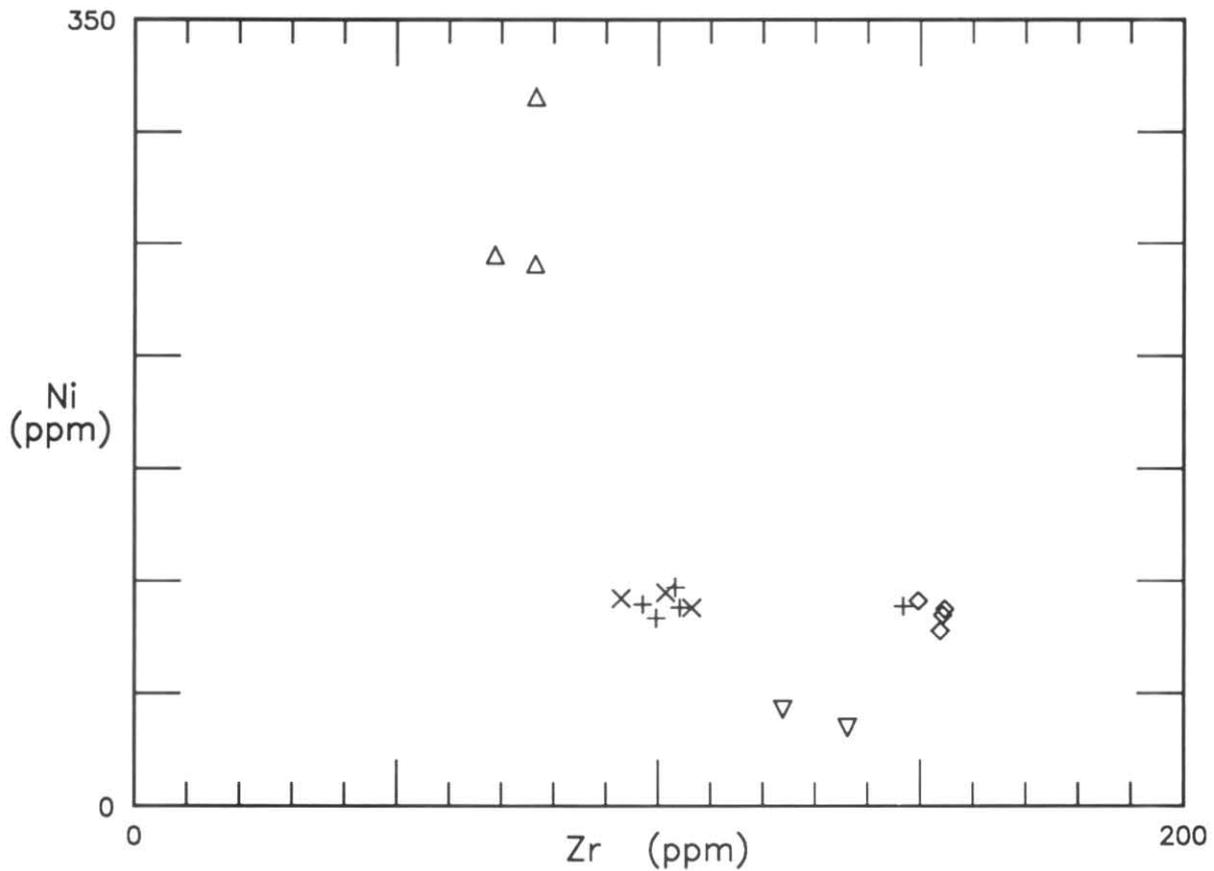
Figure 48. Chemical variation diagram for Ni v Zr in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊).

5 cm
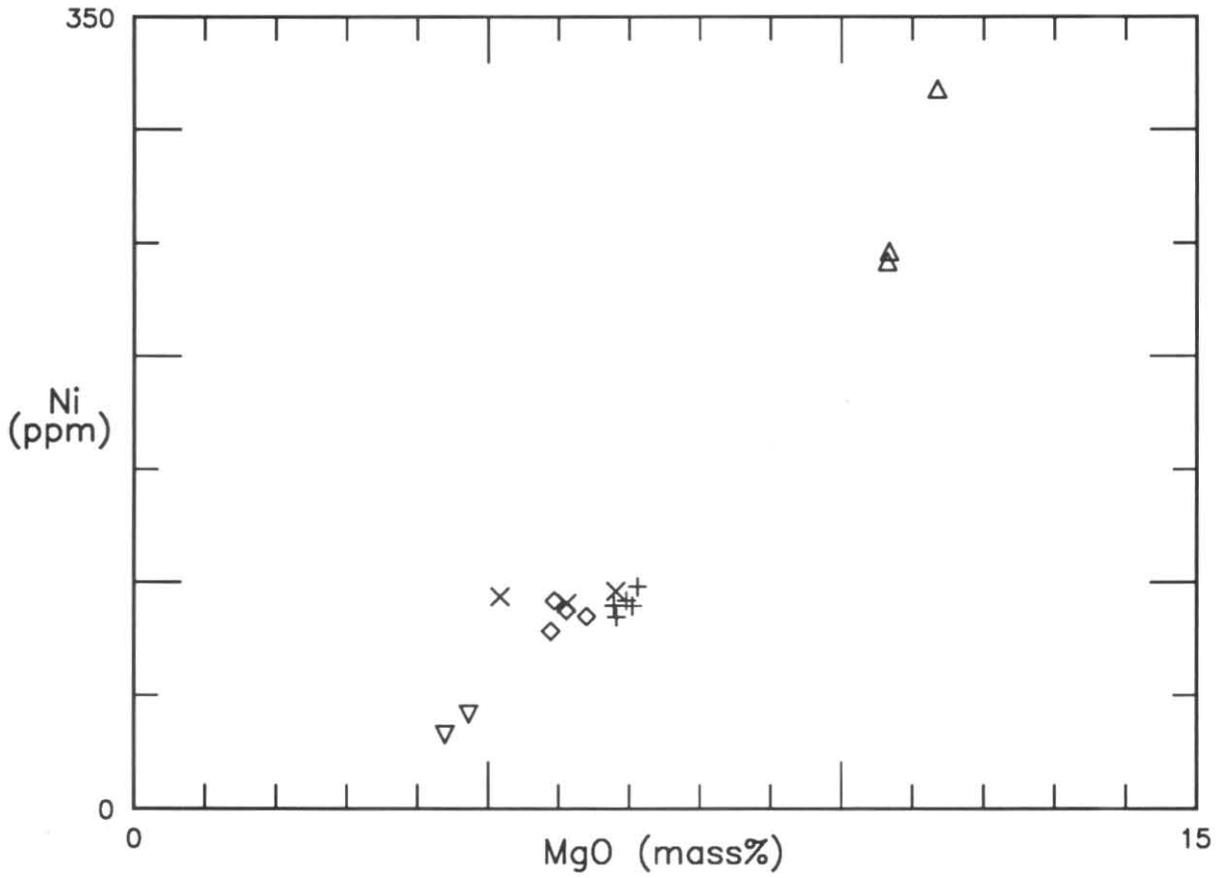
Figure 49. Chemical variation diagram for Ni v MgO in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊).
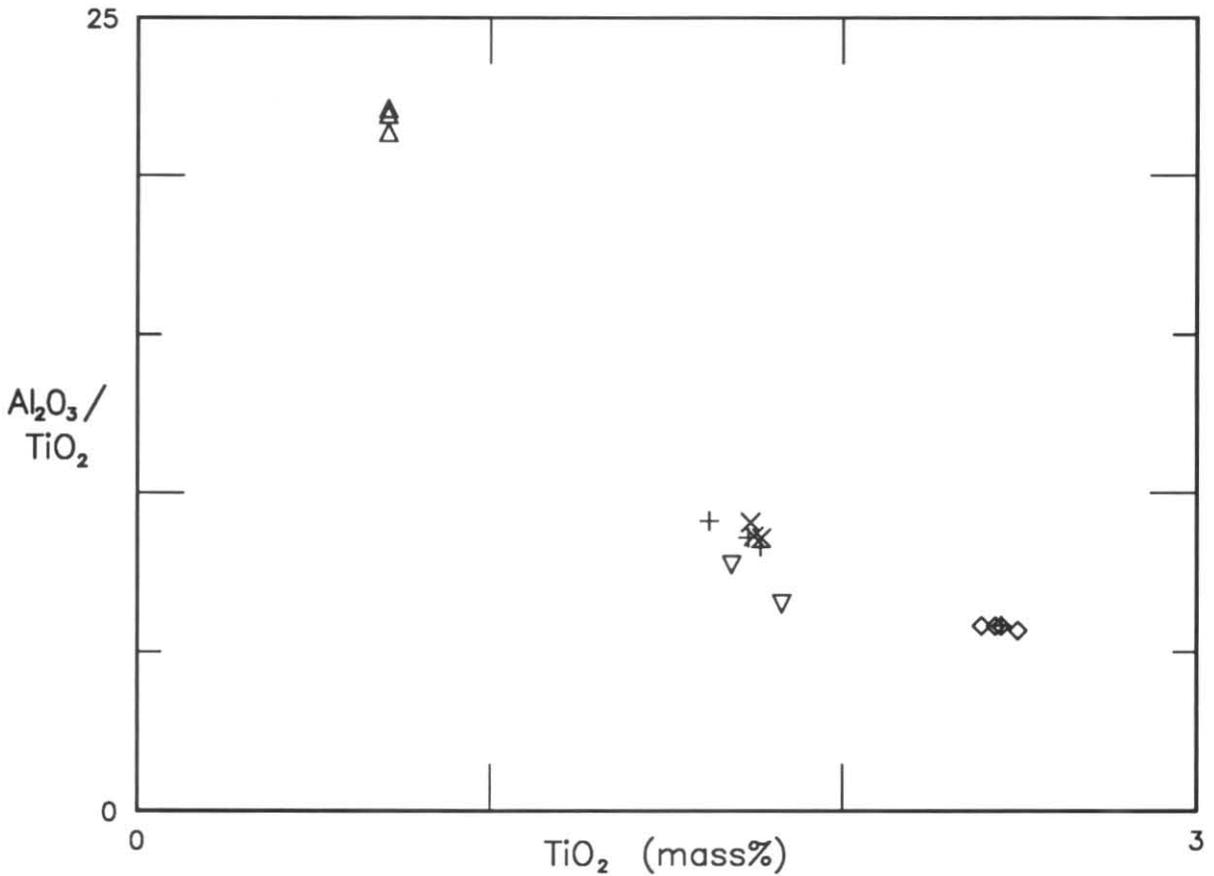
Figure 50. Chemical variation diagram for Al₂O₃/TiO₂ v TiO₂ in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊).
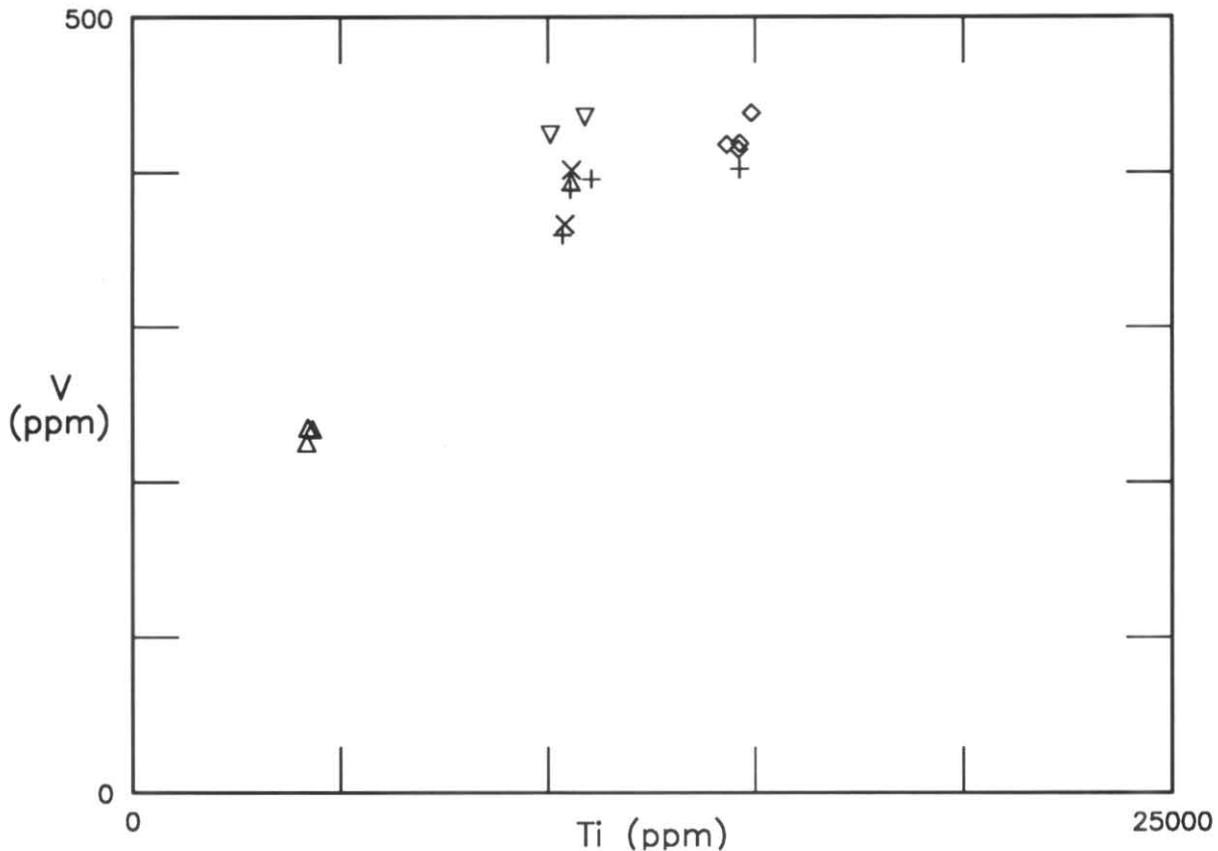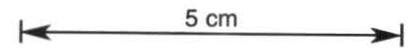
Figure 51. Chemical variation diagram for V v Ti in (?)Cambrian basalt samples. Group 1 samples (Δ), Table 9, 1–3; Group 2 samples (+), Table 9, 4–7; South Forest area (×), Table 9, 8–10; North Forest area (∇), Table 9, 11–12; Group 3 samples: Smithton area (+), Table 9, 13; Montagu area (◊).

sequence, on the southern shore of Deep Creek Bay, are olivine tholeiites (normative olivine and hypersthene), with the rest of the samples, from the Smithton–Nabageena and Forest areas, being quartz tholeiites (normative quartz and hypersthene).

The chemistry of the samples defines three distinct groups of lavas, with the second group having a subgroup of two samples. The production of the different magma types is considered to have been controlled by variations in partial melting and fractional crystallisation. The most primitive lavas, the olivine tholeiite samples (table 9, analyses 1–3), occur just above the base of the succession. These lavas are either aphyric or olivine-phyric. Lavas with a similar chemistry have been reported from near the base of the sequence in the Arthur River area to the south of Trowutta (Griffin 1974). The second chemical group of lavas crop out along the prominent ridge running south from Smithton to Nabageena (table 9, analyses 4–7), and in the South Forest area (table 9, analyses 8–10). Two iron rich variants of this group (table 9, analyses 11–12) occur in the North Forest area. Lavas with a similar chemistry to those in Group 2 are also reported from the Trowutta–Arthur River area (Griffin 1974). Only one sample of a third chemical group was obtained from the Smithton Map Sheet, at Copper Mine Point (table 9, analysis 13). Other samples belonging to this group occur further west at Montagu on the Woolnorth Map Sheet (Brown 1985) as well as one sample from the Trowutta area (Griffin 1974). Samples of both the second and third groups are clino- pyroxene and/or plagioclase phyric.

The whole rock chemistry of the four samples taken from the stratigraphic drill hole at North Forest (appendix B), and included in Table 9 as analyses 14–17. These samples consist of: a volcanic lithic wacke

(analysis 14), which consists of angular grains of fine-grained basalt and fragments of fresh plagioclase and clinopyroxene phenocrysts within a mud matrix; a brecciated coarse-grained basalt with a finer grained, vesicular, basalt matrix (analysis 15); a volcanic wacke (analysis 16) with a minor amount of carbonate clasts and quartz fragments; and a volcanic conglomerate (tuff?) (analysis 17), which is composed dominantly of fine-grained basalt clasts with a minor amount of carbonate clasts.

Whole-rock major and trace element data

Samples were obtained up through the section from the south- western shore of Deep Creek Bay to Copper Mine Point near Smithton, as well as samples from along strike, between Smithton and Nabageena, and across strike, in the South and North Forest areas. Sample localities are listed in Table 10.

The basalt samples can be split into three groups on the basis of numerous major and trace element values and ratios. On a Ti-Zr diagram (fig. 41) the samples show the distinctive groups, each with an extremely narrow range of TiO_2 values but each with increasing Zr content with a group. The first group of samples have a average TiO_2 content of 0.67 mass% with a range of 0.66–0.68 mass%; the second group have an average TiO_2 content of 1.66 mass% with a range of 1.5–1.8 mass% and the third group (including the four samples from Montagu) have an average of TiO_2 content of 2.33 mass% with a range of 2.3–2.39 mass%. This grouping, with increasing TiO_2 content, corresponds to the samples having been obtained from gradually higher stratigraphic levels within the succession, indicates a batch melting process with periodic eruptions of chemically similar lavas, each with a tholeiitic trend.

The two samples from North Forest (table 11, analyses 11–12) show a difference in chemistry from other Group 2 lavas being extremely iron rich differentiates. Generally, they have higher values of total iron, Nb, Rb, Sc, V, Y, and Zr and lower values of MgO, Cr and Ni than other Group 2 lavas.

Using the continuingly increasing nature of Zr (fig. 41) as a basis of comparison, a Nb-Zr plot (fig. 42) indicated that, with the exception of the two iron rich samples from North Forest, Group 2 lavas have lower Nb values than Group 1 and 3 lavas. A plot of P_2O_5-Zr (fig. 43) shows the increasing value of P_2O_5 with increasing differentiation and batch melting.

The tholeiitic nature of all of the lavas can also be seen by other chemical parameters, including the iron enrichment trend on SiO_2~FeO^*/MgO and alkali~ FeO^*~MgO plots (fig. 44–45) and the overall lowering of the Mg# number (MgO/FeO^*) from group 1 (average 66) to Group 2 (average 48) to Group 3 (average 46) samples. The iron enrichment trend is not only evident between groups but also within each of the groups. (fig. 46, TiO_2 - FeO^*/MgO,

On the basis of their High Field Strength Element (HFSE) ratios the lavas from the Smithton Map Sheet have an alkali nature. On a SiO_2-Zr-TiO_2 plot (after Winchester and Floyd 1977) (fig. 47) the samples fall within the sub-alkaline field. The subalkaline nature of the lavas is also evident on a SiO_2-alkali plot.

Crystal fractionation of olivine played a role in the formation of Group 2 and three magmas from the group 1 magma composition, but not between Groups 2 and 3 (fig. 48–49, Ni-Zr and Ni-Mg plots).

Plagioclase and probably clinopyroxene fractionation occurred between the extrusion of Group 2 and Group 3 lavas (fig. 50, Al_2O_3/TiO_2-TiO_2). Due to the large amount of titanomagnetite in the lavas and the lack of negative TiO_2 and V trends, magnetite fractionation is not considered to have played a part in the formation of the different magma variants.

On the V-Ti diagram (fig. 51) (after Shervais 1982) the tholeiitic trend of increasing V with increasing Ti is evident. This diagram also shows the batch melting effect and the similarity of lava composition with stratigraphic level, irrespective of the present physical location of the samples. For example, Group 2 lavas were obtained along an 18 km strike length (Smithton-Nabageena) and an 8 km wide strike width (South-North Forest) and group three lava samples from Copper Mine Point and Montagu.

Summary

The lavas from the Smithton–Trowutta basalt-sedimentary rock association are composed of three chemically different magma groups. The groups are related to each other by different degrees of partial melting and fractional crystallisation.

The first group of lavas, samples of which are from near the base of the stratigraphic succession, are characterised by TiO_2 contents of between 0.65 and 0.7 mass%, an FeO^*/MgO ratios of approximately 1 and an average Mg# of 66. The HFSE ratios of these lavas define the maga as alkaline, but with tholeiitic characteristics. The lavas from this group also have a low Ti/V ratio and High Cr and Ni values.

The second group of lavas occur stratigraphically higher in the succession than the group 1 lavas, and are clinopyroxene and/or plagioclase phyric and have an average TiO_2 content of 1.66 mass% (range of 1.5–1.8 mass%). The samples from group 2 are subalkaline, and relatively fractionated in comparison to group 1 lavas, having an average Mg# of 48.

Group 3 lavas have a transitional alkaline-subalkaline character and contain an average TiO_2 content of 2.33 mass% (range 2.31–2.39 mass%). These lavas are stratigraphically the highest in the sequence and mainly occur in the Montagu area to the west of the Smithton map sheet.

Tertiary

ANALCIME-BEARING BASALT (To)

STANLEY PENINSULA

P. W. Baillie

Circular Head or The Nut [CQ568861], was first sighted by Bass and Flinders in 1798. Edwards (1941a), quotes Flinders (1814) as describing it as 'a cliffy lump, much resembling in form a Christmas cake, joined to the mainland by a sandy isthmus'.

It is a rounded steep-sided monolith rising from sea level to a maximum height of 143 m. Although its igneous origin is clear its precise manner of formation has not been clearly understood. Edwards (1941a) described it as the remains of a small steep-sided basaltic laccolith intruded into Permo-Carboniferous sediments.

Gill and Banks (1956) recognised the pyroclastic nature of the Stanley Beds and suggested that The Nut was the remnant of a volcanic neck intruded into tuff, probably of Tertiary age. Cromer (1971) studied the petrology of The Nut, and with the interpretation of a limited gravity survey concluded that the Nut was a remnant of a ponded lava flow, and that no significant feeder system was present.

A detailed gravity survey (appendix D) was conducted on and around the Nut and after defining a positive anomaly some 250 m in diameter, near the northern edge of The Nut, it was concluded that The Nut was the remnant of a volcanic feeder, as first suggested by Gill and Banks (1956). Contacts between the main body of The Nut (To) and the older Stanley Beds (Ts) are exposed at three localities:

(1) At the southern side of The Nut behind the timber yard [CQ568856] where the contact is very sharp. Prominent cooling joints parallel to the contact trend (065NW62). Baking of the country rock, which appears to be massive tuff, has occurred, suggesting that the contact is intrusive.

(2) In the base of the cliff one hundred metres north east of the wharves on the south-eastern side of The Nut [CQ570856], where the contact is very irregular and sub-horizontal. Very vesicular basalt overlies reddish, weathered, or altered tuff. The vesicular basalt rapidly grades into massive basalt.

(3) In an old quarry on the northern side of Circular Head, some 400 m east of Stanley Cemetery [CQ567863] where vesicular basalt that rapidly increases in grain size overlies weathered tuff. This contact is regular and dip south-east.

An outcrop of critical important in understanding the origin of The Nut is exposed on the shore platform some 150 m east of Stanley Cemetery [CQ565864]. The country rock consists of agglomerate that dips to the east at 45°. It is intruded by an amygdaloidal basalt dyke (180° W 83°). The basalt has been broken and veined by red tuffaceous material (plate 31). On the same outcrop, but more seaward, irregular, rounded 'pods' of massive basalt intrude the agglomerate. The 'pods' are up to one metre in length and about 400 mm in width. These intrusions are clearly non-dilational and presumably intruded unconsolidated sediments.

Plate 31. Brecciated basalt (To), southern end of Godfreys Beach [CP565863]

The relationship between this basalt and the brecciated dyke basalt is not clear but they probably represent two intrusions. The brecciation of a pre-existing dyke is probably the result of hydro-phreatic activity. These features are consistent with a volcanic origin for The Nut and also for the Stanley Beds (at least in part).

Petrologically, Circular Head has been studied in detail by Edwards (1941a) and Cromer (1971). Because of the detail of this work, little further petrographic work was carried out. The rock forming the bulk of The Nut is a coarse-grained undersaturated crinanite or teschenite. In thin section (73-333, 83-341, 73-342), the rock is seen to consist of loose aggregates of olivine along with subhedral titaniferous augite, laths of labradorite, analcite, magnetite and K-feldspar. The titanaugite is often glomeroporphyritic (e.g. 73-343). Analcite occurs both as a primary mineral and as a replacement of plagioclase.

At the southern contact the basal rock (73-348) contains subhedral phenocrysts of olivine with some clinopyroxene in a groundmass of augite, magnetite and glass. Very small vesicles may be present.

Half a metre above the contact the rock (73-349) contains iddingsitised olivine, sometimes stellate titaniferous augite and laths of labradorite in a felted groundmass of magnetite, olivine, analcite and glass.

Petrology

A. V. Brown

Introduction

The following section on the petrology and mineralogy of the basaltic rocks which constitute The Nut has been edited from Cromer (1971).

From the base upwards, the Tertiary Circular Head teschenite (160 m thick) consists of a narrow, glassy porphyritic basanoid zone grading rapidly into non-porphyritic alkali-olivine basalt; this in turn blends into teschenite with a prominent 'glomeroporphyritic' texture, forming the major part of the body. Progressive decrease of olivine, pyroxene and opaque oxides, and increasing analcite, with increasing height, constitute the principal modal variations in the teschenite.

Olivine show only a small compositional range of Fo_{61} .. Fo_{68} with differentiation, with the most fayalitic specimens occurring in the upper-middle levels of the mass. The clinopyroxene is a titaniferous salite which exhibits a range in composition of $Ca_{45} Mg_{43} Fe_{12}$ – $Ca_{44} Mg_{35} Fe_{21}$ with differentiation. Plagioclase ranges from An_{50} in the lower basaltic zone to An_{33} in the upper levels.

The basal zones are petrologically and chemically very similar to adjacent basalt on the Stanley Peninsula, and also to lavas from Forest, 10 km to the south.

The mineralogical constitution of the teschenite remains relatively constant throughout, although there is notable variation in grain size and fabric. The most obvious differences occur in the relative percentages of different mineral species, but the variations are insufficient to carry the rocks outside the definition of teschenite. Wilkinson (1955) discussed the various usages of rock names such as 'teschenite', 'crinanite' and 'analcime-olivine dolerite', and has suggested that the term 'crinanite' is virtually synonomous with 'teschenite', and should be discarded since the latter has priority of usage.

Based on modal and textural variations within the body the following petrological classification of the Circular Head teschenite (from the base upwards) is made:

(1) A basal alkali olivine basalt zone overlying a narrow chilled glassy contact, and varying in thickness from about one metres to at least 16 m.

(2) A medium-grained teschenite zone, forming the bulk of the body, and grading vertically into,

(3) a coarser grained teschenite zone of unknown thickness, becoming increasingly enriched in analcite and other alkaline minerals,

(4) isolated coarse-grained pegmatitic schlieren (not observed *in situ*).

It is emphasised that nowhere in the field are distinct boundaries between rock types observed, rather, each zone blends gradually into the other. The only exceptions are the pegmatitic schlieren, which exhibit sharp boundaries with the host rocks.

Chilled basal rocks

The basal chilled rocks of the teschenite are all porphyritic and fine-grained. They contain subhedral phenocrysts of olivine and rare pink clinopyroxene in an even-grained 'patchy' groundmass of clinopyroxene, opaque oxides, feldspathoids(?), zeolites(?) and colourless glass. Plagioclase becomes increasing prominent at heights greater than 200 mm above the contact and the rocks grade rapidly into typical alkali olivine basalt.

Olivine phenocrysts in the glassy contact constitute approximately 10% of the rock. They are generally subhedral but are occasionally grouped in small aggregates. The olivine grains are invariably partly or wholly iddingsitised and/or chloritised along fractures and crystal margins. Compositional zoning is evident in most of the phenocrystic olivine. Pale pink titaniferous clinopyroxene is occasionally present as anhedral phenocrysts which are rimmed by a border of granular opaque oxides. In some samples pyroxene has crystallised into a stellate arrangements of crystals.

Pink titaniferous clinopyroxene (40%) is abundant in the groundmass where is occurs as small (0.01 mm) subhedral grains (and incipient laths) frequently grouped in loose irregular aggregates. The opaque oxide (15–20%) occurs as two generations: as small octahedral plates, and as minute skeletal acicular forms, in many cases producing elongate herringbone structures. The remainder of the groundmass (40%) consists of faint incipient feldspathoid and zeolite(?) minerals set in a glassy base. K-feldspar may also be present. Slender laths of plagioclase are extremely rare. Natrolite(?), crystallising in vesicles, forms patches of radiating fibrous needles.

Alkali olivine basalt

With increasing height, the glassy basal rocks grads rapidly into typical alkali olivine basalt. The porphyritic nature of the former is replaced by prominent intergranular texture, and the rocks partake of a pronounced increase in grain size. Olivine can constitute up to about 15% of the rock, and occurs as anhedral-subhedral strongly iddingsitised crystals. Some grains are surrounded by an irregular halo of smaller granular olivine, suggesting the partial resorption of larger crystals. Olivine grains are commonly grouped in loose aggregates, and this habit becomes an increasingly prominent feature of the teschenite in the higher levels. Clinopyroxene (35–40%), is evenly distributed throughout the rock, occurring as small subhedral crystals between the feldspar laths.

The plagioclase (40%), with a composition approaching An_{50} (andesine/labradorite) occurs as subhedral laths up to 0.4 mm in length, exhibiting albite and combined Carlsbad-albite twinning. Where K-feldspar is present, the irregular, blocky crystals are commonly analcitised. The remainder of the rock consists of an alkaline base of feldspathoid(?) and isotropic analcite. The amount of opaque oxides has decreased markedly from 15–20% in the chilled base, to 5–7%; individual grains have increased in size and are generally associated with olivine. Analcite, occurring both as a primary interstitial phase and as a deuteric feldspar alteration product, is relatively common in the basalt.

From thin section studies, it is apparent that the alkali olivine basalt zone is of irregular thickness and that this basalt and its porphyritic chilled contacts are almost identical to the sequence of basaltic rocks at Green Hills.

Teschenite

The lower alkali olivine basalt zone grades with increasing height into teschenite varieties. The intergranular texture is replaced by 'glomeroporphyritic' patches of ferromagnesian minerals, and the grain size steadily increases. The mineral assemblage present in lower basalt is retained, and only the relative percentages, and habits, have changed.

Olivine (Fo_{61}–Fo_{68}) occurs mainly in loose 'glomeroporphyritic' aggregates, or less commonly as smaller individual crystals intergranular to feldspar. In the former, clinopyroxene is almost always present.

Generally, olivine shows a thin dark fringe of opaque and light red-brown iron oxides, and other alteration products include chlorite, bowlingite, serpentine and less commonly, iddingsite. The areas between the olivine/pyroxene aggregates are occupied mainly by elongate sub-parallel plagioclase, together with occasional late crystals of K-feldspar, and irregular analcite patches. With increasing height in the body, the size and amount of feldspar (K-feldspar + plagioclase) and primary analcite increases. Analcitisation of the feldspar becomes more common. Opaque oxide occurs throughout the rock, but is more commonly associated with the ferromagnesian minerals.

Coarse-grained pegmatitic schlieren

Pegmatitic schlieren have so far only been found in scree slopes on the northern side of Circular Head. In thin section, the rock consists essentially of large mauve clinopyroxene and plagioclase crystals set in an altered, often fine-grained mesostasis of feldspar microlites, feldspathoids, zeolites, aegirine-augite, apatite, opaque oxides, minor olivine, biotite(?), carbonates and other dusty alteration products.

The larger (5 mm) clinopyroxene grains are elongate skeletal crystals, many are subhedral. Twinning and zoning are generally present. Where the mineral is in contact with the more alkaline parts of the mesostasis, a thin irregular border of pale-green pleochroic aegirine-augite has developed.

Plagioclase forms large (5 mm) subhedral crystals which are generally extensively analcitised. Twinning after the albite, Carlsbad and pericline laws is present. The mineral is commonly strongly zoned, becoming increasingly richer in soda towards the margins, and is usually bordered by a well-developed rim of nepheline. A second generation of feldspar, possible K-feldspar, occurs as small curved microlites in the mesostasis. Olivine, when present, forms individual anhedral grains occasionally poikilitically included within feldspar crystals. It is invariable highly altered, showing conspicuous mantles of iddingsite and opaque and red-brown oxides. The alkaline mesostasis of the pegmatite consists of curved K-feldspar(?) microlites, occasional euhedral nepheline, irregular analcite patches, natrolite and aegirine-augite, together in an indeterminate, altered alkaline base. Large acicular apatite needles are present, and biotite(?) occurs as small elongate or irregular crystals.

Dyke rocks

A number of small irregular and discontinuous basaltic dykes intrude the Stanley Beds on the northern side of Circular Head. The dykes trend roughly at right angles to inferred contacts with the teschenite. A chemical analysis of the dyke rock shows it to be relatively unsaturated with respect to the teschenite, and in fact shows closer affinities with the basal basaltic rocks on Green Hills.

In thin section the dyke-rock is very fine-grained porphyritic and amygdaloidal, with abundant olivine phenocrysts, occasional olivine xenocrysts and clinopyroxene set in a dark 'patchy' groundmass of clinopyroxene, opaque oxides, feldspathoid(?) and rare corroded feldspar laths.

Mineralogy

Plagioclase, clinopyroxene, olivine and opaque oxides occur in all the thin sections studies. Analcite is present in all but the lower parts of the chilled basalt zone. Biotite and aegirine-augite are rare and minor constituents. Typical secondary minerals include bowlingite, iddingsite, chlorite serpentine and less commonly, carbonates.

The clinopyroxene (pink-mauve titaniferous salite) occurs as well-formed generally subhedral-euhedral elongate prisms, with average dimensions of 0.9 × 0.45 mm. Occasionally it is present as individual crystals interspersed between feldspar laths, producing an intergranular texture. More typically, it occurs in loose crystal aggregates almost invariably associated with olivine. This 'glomeroporphyritic' texture, is responsible for the characteristically spotted appearance of the rock in the field. A feature of pyroxene within basalt from Circular Head is the presence of well-developed twinning. Simple twins are predominant, but multiple twins are occasionally present. Many pyroxene grains exhibit strong compositional zoning. In the simplest type, only two zones (core and margin) are present. Oscillatory zoning, often on a very delicate scale, is occasionally present, and hour-glass and sector zoning were observed.

Olivine is a colourless variety occurring mainly in loose aggregates of subhedral - anhedral crystals, usually with pyroxene. The average composition for the whole body is Fo_{64}, with a range from Fo_{61} to Fo_{68}. It is commonly

Plate 32. Pillow lava (Tbp), west of Green Hills [CP538865]

altered to iddingsite, especially in the lower chilled zone, and other alteration products include bowlingite(?), chlorite, serpentine and opaque oxide grains. Later pyroxene crystals, themselves occasionally sub-ophitic towards plagioclase, are often moulded against olivine, suggesting that the crystallisation sequence was olivine; plagioclase/clinopyroxene. Some olivine grains exhibit euhedral grain boundaries, but generally they are subhedral. Rounded crystals give the appearance of having been partly resorbed.

Olivine from the pegmatitic schlieren are much more extensively altered (to opaque and red-brown iron oxides) than elsewhere in the body, and occasionally the alteration products pseudomorph the olivine.

There is a marked increase in the grain size of olivine in the basal few metres of the body. Initially much large then the clinopyroxene, the size of the olivine grains remain relatively constant in the upper levels whereas that of pyroxene gradually increases to a maximum in the pegmatites.

Zoning is observed in most olivine grains, the crystal rims being more fayalite-rich than the cores.

Plagioclase occurs as elongate subhedral laths filling areas between the glomeroporphyritic aggregates of olivine and pyroxene. There is a strong tendency towards sub-parallel alignment and in some samples, larger pyroxene and olivine grains are partly wrapped by adjacent feldspar.

In the lower levels of the teschenite, plagioclase generally does not exhibit sub-ophitic relationships with the pyroxene, but this habit is developed with height, especially in the more differentiated rocks, representing a change in the sequence of crystallisation in the higher levels, with plagioclase precipitating earlier with respect to the pyroxene.

The plagioclase is andesine, with a compositional range (estimated on symmetrical extinction angles on Carlsbad-albite twins) of An_{33}–An_{50}, Plagioclase becomes more sodic with height.

The grain size of the plagioclase increases with increasing height in the teschenite, reaching a maximum in the pegmatites. Twinning on the Carlsbad-albite and albite laws is present throughout the body, as well as well-developed pericline twins occurring in the pegmatite. Zoning of plagioclase laths is very evident in the later differentiates, although it is commonly present in all thin sections studies.

Plagioclase is generally fresh in the lower rocks, but becomes increasingly more analcitised in the higher levels. some grains in the pegmatite and completely pseudomorphed by analcite. An interesting feature of the plagioclase from the pegmatite is their well-developed mantling by nepheline.

BASALT (Tb) – (Tbp – PILLOW LAVA; Tba – ALKALI OLIVINE BASALT; Tbu – UNDER-SATURATED BASALT AS NEPHELINITE, BASANITE)

GREEN HILLS – NORTH POINT AREA

P. W. Baillie

Massive (Tb) and pillowed (Tbp) basalt of presumed Tertiary age crops out extensively on the Stanley Peninsular from Green Hills [CQ543841] to North Point [CQ530915].

The contact between basalt and the underlying Stanley Beds is exposed at the northern end of Godfreys Beach [CCQ560874] where scoriaceous basalt unconformably overlies ?tuff and mudstone. The contact is irregular and dips very shallowly to the east. Immediate overlying the scoriaceous basalt are ropey lavas, in turn overlain by massive columnar basalt with curved collonades. These are overlain by massive basalt. The ropey lava was observed as three concentric, broad, flat lobes that flowed from 070 degrees. Scoriaceous material is abundant in the frontal part of the lobes. The massive columnar basaltic rock (73-336, 73-337, 73-338) are undersaturated. In thin section, sample 73-336 consists of phenocrysts of olivine, labradorite and smaller titaniferous augite in a groundmass of labradorite, rare nepheline, magnetite, augite and late-stage feldspar. Samples 73-337 and 73-338 are olivine nephelinite and contain phenocrysts of olivine and titaniferous augite in a groundmass of magnetite, nepheline, augite, some glass, zeolite and late-stage feldspar. Pillow lavas are exposed on the tidal flats on the western side of the Green Hills in West Inlet [CQ537867] (plate 32). Some pillows show flattening and may be up to one metre in diameter. They have chilled margins that are highly jointed whereas cores are relatively massive. The joints radiate from the centre of the pillows but are hexagonal (approx. 100 mm diameter) in plan. The basalt gets darker towards the edge of the pillows. In thin section (73-353) the rock is seen to consist of phenocrysts of augite and rare olivine in a groundmass of augite, magnetite, glass, rare plagioclase and zeolites.

Pillowed basalt form the bulk of the bedrock northwards from the last described locality to North Point [CQ530916].

Alkali olivine basalt appears to constitute the bulk of the remainder of the basalt sequence (e.g. 73-339, 73-351, PS100). Phenocrysts of partly iddingsitised olivine and titaniferous augite (may be stellate) occur in a groundmass of labradorite laths, magnetite, augite and zeolite.

BLACK RIVER AREA

P. W. Baillie

Three small intrusive bodies of presumed Tertiary age were mapped near the Black River bridge [CQ570767]. Immediately west of the bridge two bodies intrude chert. The margins of the westernmost body are exposed, and it is seen to be a dyke trending 120°. Form of the other body is not proven, but it is probably also a dyke. In thin section (73-334) the basalt consists of partly serpentinised phenocrysts of olivine in a groundmass of strongly-oriented laths of plagioclase (andesine), magnetite, olivine, and glass. Some olivine phenocrysts appear to have broken by abrasion.

SOUTH FOREST AREA

K. D. Corbett, E. B. Corbett.

Tertiary basalt forms an extensive humpy plateau in the Forest area, with several small outliers west of South Forest, and two small occurrences near the foreshore of West Inlet. Over most of the area the basalt is represented only by deep red soil with scattered blocks, and boundary mapping is difficult. However, the boundary can be accurately located in a few spots, and suggests that extensive downslope movement of talus has not occurred. Extensive slope deposits occur near the isolated basalt hill south of Pulbeena.

The basaltic rocks have not been examined in detail. Descriptions can be found in Nye *et al.* (1934) and Edwards (1941).

ROCKY CAPE – MAWBANNA – IRISHTOWN AREAS

P. G. Lennox

Introduction

As well as the areas described above, three further large areas of Tertiary basalt occur on the Smithton map sheet. These are: to the north, east and south of the Rocky Cape township [CQ724704], around Mawbanna [CQ627649] and east and south of Irishtown [CQ436688].

Nye *et al.*, (1934) distinguished four flows in the basalt near Irishtown:

maximum thickness *(m)*

top flow	15
upper flow	13
middle flow	43
bottom flow	37

They reported a maximum thickness near Mt Lileah [CQ440636] of 160 m. After petrographic and chemical analysis they recorded the rock as an olivine-basalt which varies between flows and is slightly amygdaloidal in places.

Edwards (1950) uses the analyses of Nye *et al.*, (1934) and an examination of appropriate thin sections to show that the olivine-basalt from the lowest of the three flows is unusual. It contains an extremely high alumina content with a correspondingly high content of lime and alkalis and a low magnesia content. According to Edwards *(ibid.)* it is a differentiated variety whose composition resembles crinanite from The Nut at Stanley, although the latter rock contains more magnesia and less alumina.

Edwards *(ibid.)* subdivides basaltic rocks on the basis of the type of pyroxene predominating, texture of the groundmass and nature of the glass (green/black) plus the nature and relative proportion of phenocrysts, olivine, plagioclase and pyroxene.

In Edwards' classification the three main basalt areas on the Smithton sheet consist of:

Rocky Cape township: Burnie, Deloraine and Branxholm type

Mawbanna: Mersey type

Irishtown area: dominantly Burnie, Deloraine and Branxholm type, some Mersey type, some Ouse and Bridgewater types

In Sutherland's (1969) review of Tasmanian Cainozoic volcanic provinces these basaltic rocks lie in the undersaturated olivine basalt province.

Petrography

Rocky Cape Township area

In fresh handspecimen, Tertiary basalt samples from the north, west and south of the Rocky Cape Township are greenish-black, fine-grained, partly crystalline rocks which usually contains millimetre-size phenocrysts of olivine (77/757) and occasionally exhibits a subconchoidal fracture (77/757).

The texture varies from intersertal (most thin sections), to subtrachytic (77/664) and trachytic (77/757, 77/759, 77/763), and very coarse grained (77/787, 77/664).

In the twelve thin sections examined, from this region, cracked, blocky olivine phenocrysts are ubiquitous, varying in size from 180×296 μm (77/763) to 900×2800 μm (77/787). The olivine occurs as isolated grains or in aggregates. It is usually altered along cracks to sericite (77/664) or carbonate (77/787).

Two coarse-grained basaltic rocks (77/787, Shakespeare Hills, CQ688607) (77/664, Newhaven Road) contain twinned plagioclase phenocrysts from 180×900 μm to 360×2800 μm in the former case and from 160×350 μm to 225×900 μm in the latter case. The plagioclase in sample 77/664 exhibits albite, Carlsbad-albite and microcline twins in thin section whilst albite twins predominate in the thin section of sample 77/787. On the basis of the Michel-Levy method the plagioclase is andesine-labradorite (77/664) and andesine (77/787).

Plagioclase crystallites which from 30–45% of all samples are partly aligned and vary from usually less than 14×100 μm (77/664) to 36×360 μm (77/763). They are commonly albite twinned and are andesine to labradorite in composition (77/763).

Granular clinopyroxene from 10 μm to 140 μm diameter is always present and forms 10-30% of the rock. Clinopyroxene phenocrysts (probably augite, 77/763 and 77/787), up to 1200×1600 μm, may form 2–3% of the rock. They may be marginally altered to a semi-opaque brown mineral (77/787).

Angular, usually skeletal opaque mineral grains (up to 140 μm), are prevalent and may sometimes encase the olivine phenocrysts (77/756). The interstices are filled with semi-opaque glass (77/763), apatite needles (77/756, 77/763), serpentine alteration (77/761) and K-feldspar.

Edwards (1950, p. 108) considered that the distinctive feature of this group of rocks (Burnie, Deloraine and Branxholm type) is the characteristic occurrence of titanaugite as isolated, more or less lens-shaped patches, which are in intimate ophitic intergrowth with sheaves of narrow subparallel plagioclase laths.

Mawbanna area

In hand specimen, olivine-basalt from the region around Mawbanna hamlet [CQ627649] are greenish-black, fine-grained, holocrystalline rocks, in contrast to the more glassy basalt from the Rocky Cape township region. They contain abundant olivine phenocrysts.

In thin section, the twelve samples obtained usually display trachytic texture (77/712, 77/790, 78/59, 78/61, 80/117) sometimes intergranular texture (77/712, 80/115), and rarely sub-ophitic or subtrachytic texture (80/116; plate 33).

The twinned, aligned plagioclase laths vary from 14×35 μm (78/60) to 90×450 μm (80/117). The plagioclase is either albite twinned (80/116) or Carlsbad-albite twinned (78/60). In two samples (77/712 and 80/115) the plagioclase laths and K-feldspar form 60% of the slide. The altered plagioclase (77/790) sometimes contains radiating bunches of apatite needles. The

5 cm
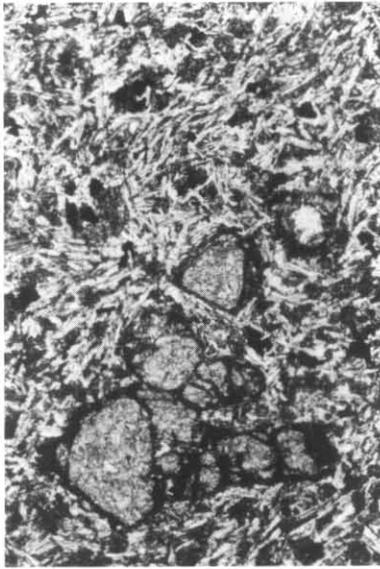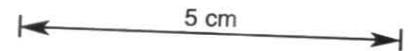
Plate 33. Sub-trachitic and intergranular rock from 2.5 km NNE of Mawbanna [CQ626673], showing twinned plagioclase laths partly aligned around blocky olivine phenocrysts (with marginal opaque minerals). Granular clinopyroxene and angular to skeletal opaque minerals in the groundmass are completely enclosed by the feldspar. Magnification ×20, plane polarised light.
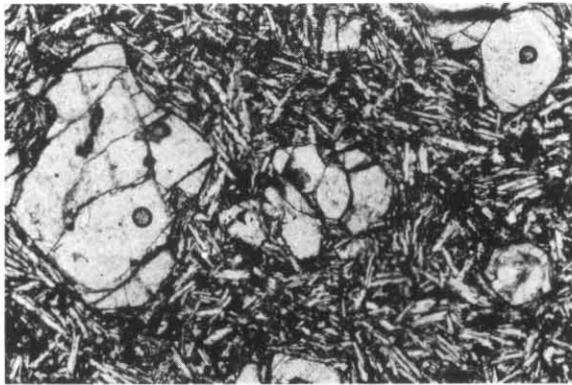
Plate 34. Cracked polygonal olivine phenocrysts enclosed in a subtrachytic mass of twinned plagioclase laths, semi-opaque clinopyroxene, glass and K-feldspar. Specimen 80/116, Skippers Creek Road [CQ613628]. Magnification ×20, plane polarised light.

plagioclase is labradorite-andesine in composition (80/116) or andesine-minor oligoclase (80/117) on the basis of the Michel-Lévy method. Some areas of K-feldspar in 77/790 show quartz exsolution features consisting of equally spaced parallel strips.

Granular clinopyroxene forms a 20% (80/115) to 30% (80/116, 80/113) component and occurs as either individual grains or in aggregates. The individual grains range from 7×14 μm (77/790) to 90×90–180 μm across (80/115) whilst aggregates range up to 70×210 μm (77/790). The clinopyroxene shows alteration to chlorite in 77/712. Clinopyroxene (augite?) occurs as phenocrysts in 77/716, 78/61 and 80/116.

Cracked olivine phenocrysts with round, rectangular or polygonal shape may form 10% (80/113), 10–15% (77/790, 80/115, 80/116) or 30% (77/712) of the rock (plate 34). The sizes range up to 270×360 μm (78/60) and the phenocrysts are usually peripherally altered to serpentine (77/712, 77/790) and opaline quartz-serpentine-chlorite (78/60). THe olivine in sample 80/146 occurs equally as individual grains and as aggregates. Scattered, skeletal angular opaque mineral

grains 18–36 μm across are ubiquitous and form 2–3% of most samples (eg. 80/113).

Edwards (1950) considers the Mawbanna region basalt to be of the Mersey Type, that is it contain green intersertal glass. Edwards *(ibid.)* also notes the common partial alteration of the olivine phenocrysts to serpentine.

Irishtown area

The basalt outcropping south and south-east of Irishtown is the most areally extensive on the Smithton sheet. On the basis of Nye, Finucane and Blakes' (1934) three intrabasalt deposits (the basalt can be subdivided into at least three flows, corresponding to contour intervals of 60–120 m, 140–170 m, >220 m. Examination of the sixteen thin sections from this region reveals no discernible petrographic difference between the flows.

Texturally, samples collected at contour heights greater than 220 m (80/118, 80/126, 80/131 and 80/132) are trachytic and contain more glass and less crystalline component than samples collected below this height.

Textures vary from intersertal (80/127), subtrachytic (80/124, 80/125) to trachytic (80/123, 80/132), to partly intergranular (80/119. In thin section, of a sample from CQ503693 is holocrystalline and contains phenocrysts of plagioclase and titanaugite, in contrast with samples dominated by semi-opaque glassy mesostasis (e.g. 80/118).

Olivine is common in all of the thin sections as either individual phenocrysts or in aggregates of phenocrysts forming 5% (80/127) to 17% (80/118) of the rock. It is usually partly idiomorphic in rectangular, polygonal (sometimes hexagonal) grains, and ranges in size from 70 μm to 140 μm across (80/118) to 1700×2250 μm (80/127). It is occasionally altered along cracks or around margins to an alteration product which is greenish-brown and semi-opaque in plan polarised light. This alteration product appears to consist of a core of opaline quartz fringed with a feathery serpentine-relate mineral (80/124, D. C. Green, pers. comm.).

The plagioclase occurs rarely as phenocrysts (80/118, 80/119, 80/132) and more commonly as usually partly aligned, twinned laths of microphenocryst to crystallite size (80/127, 80/124, 80/123). The phenocrysts form 1% (80/132) to 4–5% (80/118) of the rock and range in size from 35–84×350 μm to 670×2700 μm (80/119), varying in composition from andesine (common) to andesine-oligoclase (80/119). The twinning is either albite type (80/118, 80/119), carlsbad-albite type (80/132) or rarely microcline type. The plagioclase crystallites are a 20% (80/132) to 40–45% (common, 80/127, 80/123 component and range in size from 14×100 μm (80/124) to 90×504 μm (80/127). Twinning is usually of albite and Carlsbad-albite type, and composition is andesine (80/127 Michel-Lévy method). Plagioclase laths in sample 80/127 contain abundant inclusions.

Clinopyroxene is a 5% (80/119) to 40% (80/125) component and is commonly granular and sometimes bladed, tabular or idiomorphic. It varies in grain size from 14 μm (80/131) to 135 μm (80/119) and is usually titanaugite in composition.

A basalt sample from CQ503693 contains large zoned titanaugite(?) xenocrysts, which have clear, unaltered, inclusion-bearing cores and milky, altered, purplish-tinged margins. The olivine phenocrysts in this rock have embayed margins.

Opaque mineral grains form a continuous network in sample 80/127, whereas in most thin sections they form scattered, isolated, angular to skeletal grains. They form

Table 11
ANALYSES OF TERTIARY BASALT SAMPLES

	1	2	3	4	5	6	7	8	9
Reg. No.	850800	850801	850802	850803	850804	880001	880002	880003	880004
Field No.	ABS1	ABS16	ABS2	ABS11	ABS39	101611	101610	101612	101613
Analysis No.	814077	814085	814078	814083	814103	861457	861456	861458	861459
AMG Ref. [CQ]	694614	454650	728651	625651	322708	568855	568855	561876	561876
SiO_2	51.09	45.60	47.27	46.75	39.88	45.12	45.09	43.92	44.07
TiO_2	1.71	2.13	2.30	2.36	3.11	2.09	2.12	2.23	2.26
Al_2O_3	14.53	13.91	14.83	14.07	12.42	14.48	13.95	13.96	14.05
Fe_2O_3	1.76	3.00	3.63	3.36	4.56	1.90	2.97	2.58	2.70
FeO	8.92	8.70	7.18	7.94	9.53	9.40	9.21	9.40	9.31
MnO	0.17	0.17	0.17	0.14	0.10	0.16	0.17	0.16	0.17
MgO	7.98	10.19	8.12	8.80	8.72	8.97	9.42	8.50	8.62
CaO	8.16	8.60	8.39	7.39	8.07	8.23	8.29	8.14	8.28
Na_2O	2.89	2.64	2.69	3.05	5.44	5.11	5.07	4.73	4.89
K_2O	0.85	1.37	1.63	1.78	1.40	1.77	1.57	2.38	1.89
P_2O_5	0.24	0.43	0.48	0.59	1.31	0.90	0.86	0.95	1.03
CO_2	0.11	0.11	0.08	0.10	0.12	0.07	0.18	0.12	0.12
H_2O^-	0.21	0.27	0.32	0.24	0.68	-	-	-	-
H_2O^+	1.23	2.62	3.00	2.87	3.10	1.94	1.73	2.49	2.79
Total									
Mg#	58	61	58	59	53	59	59	56	57
Cr	345	324	336	286	240	330	320	250	250
Ni	178	228	139	182	166	195	160	170	165
Co	-	-	-	-	-	44	47	38	50
Sc	-	-	-	-	-	20	21	15	20
V	-	-	-	-	-	170	230	150	190
Ba	-	-	-	-	-	350	380	360	175
Rb	23	19	20	36	12	41	45	45	24
Sr	284	490	485	760	1190	930	810	1200	1150
Nb	15	29	32	36	96	45	43	61	61
Zr	120	174	204	240	416	270	260	330	270
Y	21	21	18	16	18	18	16	13	18

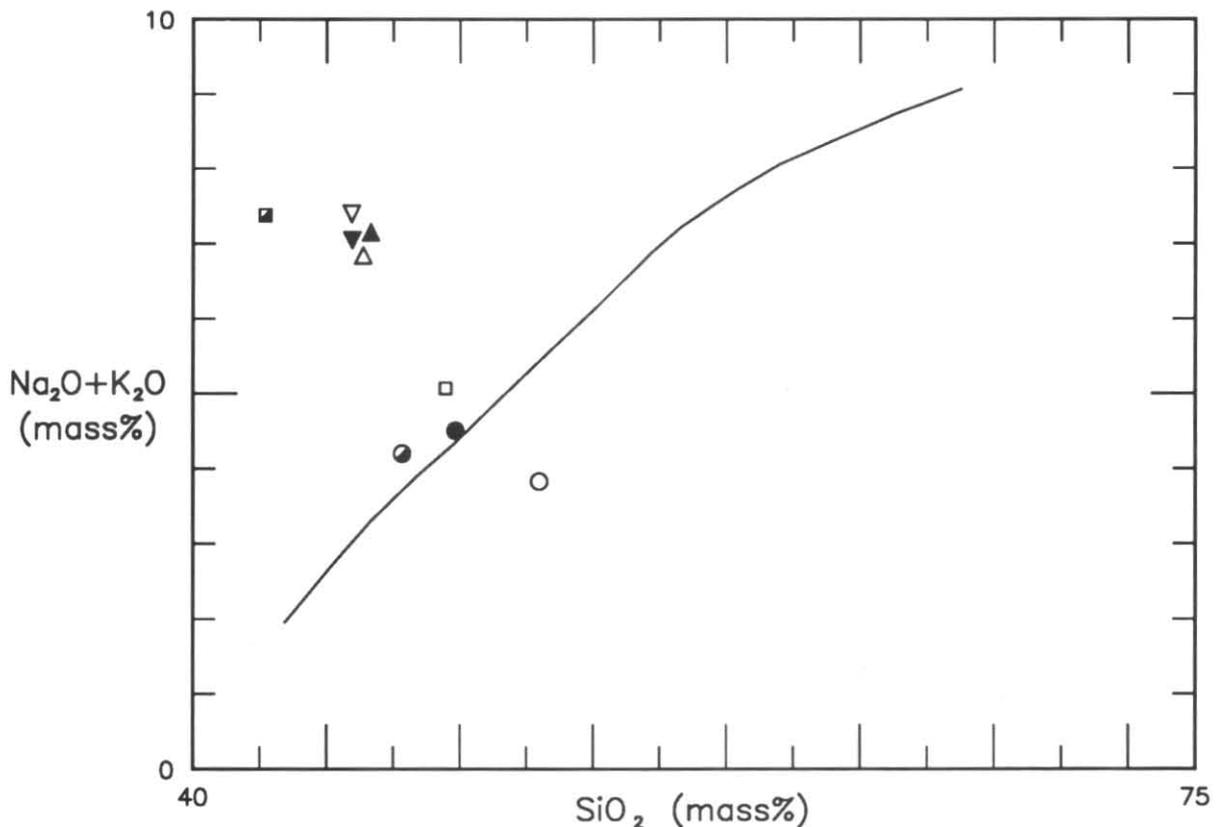**Figure 52.** Chemical variation diagram for Na_2O+K_2O v SiO_2 in Tertiary basalt samples. Analyses are listed in Table 11. Analysis 1 (O); 2 (◨); 3 (◆); 4 (□); 5 (◪); 6 (△); 7 (▲); 8 (▽); 9 (▼). Dividing line after Irvine and Baragar, 1971.

a 5% (80/119) to 30% (80/127) component and range in size from 8 μm (80/131) to 126 × 162 μm (80/124).

A 1800 × 1980 μm vug in sample 80/124 contains a core of cryptocrystalline quartz surrounded by an 18u wide zone of ?serpentine alteration and a further alteration rim 540-720 μm wide.

The groundmass in sample 80/118 (60/70%) and 80/132 (50-55%) is semi-opaque in plane polarised light and black to multicoloured in crossed nicols. Edwards (1950) grouped the Irishtown region basaltic rocks dominantly in the same group as those from the Rocky Cape store region; that is in the Burnie, Deloraine and Branxholm type (titanaugite basalt).

CHEMISTRY

A. V. Brown

During the mapping of the Smithton Quadrangle five samples of Tertiary basalt, from widely spaced areas, were obtained for major and trace element analyses (table 11, analyses 1–5). Subsequently, four further samples were obtained, two from The Nut and two from Godfreys Beach (table 11, analyses 6–9), for K-Ar age dating (appendix E). Previous studies of The Nut (Edwards, 1941; Cromer, 1972) yield a further 21 analyses of major elements (5 and 16 respectively) and Nye *et al.*, obtained two sets of major element data from samples collected in the Irishtown–Lileah area.

Due to variations in analytical techniques and the 50 year time span between the first and last analysis, they cannot be used to define specific trends, but when the analyses were reviewed using CIPW Norm calculations, calculated from anhydrous values for each sample, they give consistent results.

Based on the chemically derived norms the samples progressively become more alkaline, from east to west across the map sheet. Using the normative classification of basaltic rocks proposed by Green (1970), the samples collected from south of the Rocky Cape Township [~CQ728651] and along the Newhaven Road [~CQ693614] (table 11, analyses 1-2) are olivine tholeiite basalt (normative hypersthene and olivine, hypersthene >3%). The sample from Mawbanna (table 11, analysis 3) is an olivine basalt (normative olivine and 0-3% hypersthene but no normative nepheline), while the two samples obtained by Nye *et al.*, from Irishtown and Lileah and the new sample from Lileah (table 11, analysis 4) are alkali olivine basalt (normative olivine and nepheline, with nepheline <5%).

The samples from The Nut and Godfreys Beach (table 11, analyses 6-9) and those collected by Edwards (1941) and Cromer (1972) are dominantly basanite (normative olivine, nepheline and albite with nepheline >5% and albite >2%) with the more differentiated samples from the upper parts of The Nut being alkali olivine basalt. Some coarse-grained feldspathoid rich samples obtained from scree deposits are considered to have come found around the top of The Nut.

Plotting the major element geochemistry on a total alkalis ($Na_2O + K_2O$) against silica (SiO_2)diagram (fig. 51), shows that only one sample (table 11, analysis 1) falls within the tholeiitic field of MacDonald and Katsura (1964), the remaining thirty-one all fall within the alkaline field. Of the alkaline samples twenty-four fall into the mildly alkaline field of Saggerson and Williams (1964) with the remaining seven samples being classed as strongly alkaline.

Overall, the major element geochemistry exhibits a general alkaline trend, with decreasing SiO_2, total iron (as FeO), MgO, Cr, Ni and Y; and increasing total alkalis ($Na_2O + K_2O$), Al_2O_3, P_2O_5, TiO_2, Nb, Zr, and Sr with differentiation. The most undersaturated and highly alkaline sample comes from the small area around Christmas Hills (table 11, analysis 5).

Cromer (1972) analysed fourteen basaltic rocks from various heights within the teschenite zone of The Nut as well as two extremely differentiated rocks. In general, the chemical composition of the rocks he selected for analysis reflects the modal variation of major mineral species, and the trend in major oxides shows no significant differences from other differentiated alkali-rock series.

Although he found that were only minor differences in chemistry between the samples selected, a small trend is evident which coincides with increasing height in the teschenite. Cromer (1971) states that 'silica shows generally an irregular variation although there is a slight increase in the later stages of differentiation. The high values of SiO_2 in the middle and late stages is due to the increase in modal plagioclase, K-feldspar and zeolites at the expense of the ferromagnesians. Ferric iron increases steadily, with the later teschenite being relatively enriched in the oxide with respect to earlier rocks. Total iron (as FeO) increases slightly in the middle stages of differentiation, but decreases steadily to a minimum in the more differentiated rocks. A very slight enrichment occurs in the pegmatite. Magnesia decreases progressively with differentiation and the FeO/MgO ratio of the bulk rock increases slowly in the lower levels and then increases rapidly with further differentiation. The trend in lime in the middle stages of differentiation reflects the increasing amount of modal plagioclase in the middle levels, its increasing sodic nature and degree of analcitisation results in a consequent decrease in lime. Overall the Circular Head basalt shows a definite trend of alkali enrichment with differentiation. When alkalis are plotted against silica an average curve drawn through the points is concave upwards, illustrating a general feature of alkali-olivine basalt, i.e. increasing alkalis with increasing silica'.

RADIOMETRIC AGE DATING

One sample from the southern side of The Nut and one sample from the flows at the northern end of Godfreys Beach were dated using the whole rock K-Ar method (appendix E). The sample from The Nut gave an age of 12.5 ± 0.2 Ma and that from the flow at Godfreys Beach 8.5 ± 0.1 Ma. The age for The Nut is very close to that obtained for a sample from the chemically and petrographically very similar lava at Table Cape, 13.2 ± 0.2 Ma (Sutherland and Wellman, 1986).

These dates represent the youngest ages yet obtained from Tertiary basaltic rocks from Tasmania, but due to the chemical differentiation of the lavas from west to east it is considered probable that the flow around Christmas Hills as well as the flows further east on the Woolnorth Quadrangle may be even younger.

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Appendix A

ECONOMIC GEOLOGY

C. A. Bacon

Resources of interest within the Smithton Quadrangle include silica, dolomite, gravel, limestone and ochre. Minor occurrences of native copper and galena have also been recorded.

SILICA

Sources, and potential sources of silica in the Smithton area include outcrops of the Forest and Detention Quartzites (*q.v.* this volume). The Forest Quartzite is currently quarried to provide raw material used in the manufacture of silicon metal.

SMITHTON (BEACOM HILLS)

LOCATION

An area five kilometres south-east of Smithton, known as Beacom or White Hills, contains a number of small pits which have been quarried to produce road construction materials.

GENERAL GEOLOGY

The material quarried is the Forest Quartzite, of Precambrian age, which overlies the Rocky Cape Group and is overlain by the Smithton Dolomite. The geology of the Smithton area is given in Lennox *et al.* (1982). The quartzite is well jointed and cleaved, and is also weathered and friable and is easily broken into fist-sized lumps. However blasting is required to extract some of the more resistant quartzite horizons.

Iron staining and other brown stains by peaty or iron-laden percolating groundwater have discoloured part of the quartzite. The outcrop area covers about 4 km^2.

MINING AND EXPLORATION HISTORY

The workings in the Beacom Hills area were visited by V. M. Threader in 1984. At that time, quartzite was being quarried from Mining Lease 879P/M by the Department of Main Roads for use as a road base. A bulk sample of 2000 t was being removed by Brambles Holdings Ltd from ML 917P/M. T. Ling was working ML 1082P/M on a small scale, and an unleased pit on Odgers' property was similarly being worked intermittently. The bulk sample was crushed and screened to produce a 500 t sample of −125 mm to +38 mm material (a 25% recovery) for use by Pioneer Concrete Pty Ltd.

The unleased pit on Odgers' property was examined by AMDEL in 1982 on behalf of a Kaiser Aluminium - Mineral Holdings Australia Pty Ltd joint venture (Ware, 1982). Eight shallow airtrack holes were drilled, and AMDEL concluded that the quartzite had been subject to secondary silicification, and leaching had resulted in surface enrichment. Reserves would depend on the chemical specifications and size distribution required for the final product.

The area of these pits was closely examined in 1985 by Pioneer Concrete. Some of the material currently used in their silicon smelter at Electrona is obtained from this source.

CURRENT TENURE

Several leases are currently held over the quartzite in the Beacom Hills area. These are:

ML 879P/M Circular Head Council
ML 1085P/M M. K. and G. J. Francome and P. McBain
ML 13M/87 Pioneer Silicon Industries Pty Ltd
  (previously part of Ballast Reserve)
ML 14M/87 Pioneer Silicon Industries Pty Ltd
ML 1179P/M K. C. & D. M. Odgers
ML 1279P/M Pioneer Silicon Industries Pty Ltd
  (formerly ML 917P/M held by T. J. and M. J. Leis)
DMR Ballast Reserve (currently not worked).

In addition an area owned by K. Odgers is not under lease but the ground is worked intermittently. Leases (1257P/M, 1265P/M) were also held in the area by Mineral Holdings Pty Ltd until recently, when they were relinquished.

QUALITY

Samples from pits in the Faheys Lane (samples 1, 2) and Beacom Hills areas (Samples 3-9) were collected by V. M. Threader in 1984. The results of testing are:

	1	2	3	4	5	6	7	8	9
SiO$_2$ (%)	96.1	81.3	98.5	98.9	98.8	95.9	96.9	96.2	94.1
Al$_2$O$_3$ (%)	0.90	7.24	0.15	0.11	0.11	1.63	0.42	0.76	0.80
Fe$_2$O$_3$ (%)	1.26	5.72	0.92	0.74	0.74	0.92	1.66	2.06	1.37
K$_2$O (%)	0.12	1.56	0.03	0.02	0.02	0.28	0.07	0.12	0.12
Na$_2$O (%)	0.04	0.13	0.09	0.09	0.08	0.10	0.07	0.09	0.06
CaO (%)	0.07	0.17	0.01	0.14	0.18	1.01	0.06	0.96	0.03
LOI (%)	1.31	3.20	0.24	0.03	0.03	0.06	0.72	0.70	3.46

One pit was examined in 1982 by AMDEL on behalf of a Kaiser Aluminium and Chemical Corporation Pty Ltd and Mineral Holdings Australia Pty Ltd Joint Venture (Ware, 1982).

RESERVES

The Beacom Hills outcrop occupies an area of about one square kilometre. Reserves of in situ quartzite, regardless of particle size or quality, are one million cubic metres per metre of depth. Assuming recoverable quartzite to two metres depth, the reserves of the deposit are two million cubic metres. Calculations by V. M. Threader suggest that the recovery of the +38 mm fraction is around 20% and the reserves of this fraction are in the order of one million tonnes.

DIP RANGE – DETENTION RIVER AREA

Two areas in the Dip Range south of Rocky Cape have been examined with a view to using the quartzite as a source of silica. These are:

(1) an area at the northern end of the Dip Range, along the banks of Hogarth Creek [around CQ720630], and

(2) an area in the southern part of the Dip Range, 2 km north of Detention Peak [around CQ715598].

DIP RANGE - HOGARTH CREEK - QUARTZITE PEAK AREA

This area, 35 km west of Burnie, is reached via a track from Newhaven Road.

General geology

The quartzite is part of the Detention Quartzite of Precambrian age, and is usually thinly bedded and dips at steep angles.Good exposures of quartzite are found in Hogarth Creek and other creeks which have cut fault-controlled gullies across the strike of the quartzite forming the Dip Range.

The geology of the area is shown on the Table Cape 1:63360 sheet (Gee, 1966).

Mining and exploration history

An exploration licence (EL43/70) was taken out in 1970 over a large area, including the Dip Range. Some prospecting activity and chip sampling was done and exploration for silica continued on a small scale for some years. Recent interest in Tasmania for a source of silica to supply the Electrona silicon smelter resulted in an upswing in exploration for this commodity.

An extensive programme of percussion drilling and costeaning was carried out in 1981 by Longworth and McKenzie, for the Kaiser Aluminium – Mineral Holdings Joint Venture partnership. The quartzite in the Hogarth Creek prospect was found to vary laterally and vertically in the degree of silicification and quality. The deposit was considered to be sufficient in quantity but was not of the quality required by Kaiser Aluminium, and the joint venture partnership ended. Since then (1985) Monier Pty Ltd has investigated this area and has indicated that some high quality silica sand does exist.

Quality

	1	2	3	4	5
Fe_2O_3 (%)	0.23	0.068	0.017	0.21	0.018
Al_2O_3 (%)	0.08	0.68	0.05	4.2	0.16
TiO_2 (%)	0.082	0.60	0.087	0.11	0.029
Cr_2O_3 (%)	<0.001	<0.001	<0.001	0.002	<0.001
CaO (%)	0.01	0.01	<0.01	0.01	<0.01
MgO (%)	<0.01	0.02	<0.01	0.48	0.01
Na_2O (%)	0.01	0.01	<0.01	0.02	<0.01
K_2O (%)	0.02	0.20	0.01	1.0	0.04
LOI (%)	0.11	0.12	0.05	0.68	0.07
SiO_2 (%)	99.6	98.8	99.7	93.2	99.6

1. Dip Range No. 1 North Prospect Costean - four hand samples.
2. Dip Range No. 1 North Prospect Costean - bulk sample 17117
3. Dip Range No. 1 North Prospect Costean - bulk sample 17118
4. Quartzite (Shakespeare) Peak - blister blasted sample 17123
5. Quartzite (Shakespeare) Peak - blister blasted sample 17120

Current tenure

Mining Leases 33M/86 and 36M/86 are held over the area of interest, with an area adjoining both these two currently under mining lease application.

Reserves

Reserve figures are not available.

DIP RANGE SOUTH

The area around CQ715598 was named 'Dip Range No. 2 Prospect' by the explorer and briefly examined during the 1981 exploration, although no drilling or sampling was done in this area, which is currently not held under any form of mineral tenement.

MAYNES CREEK

An outcrop of the Jacob Quartzite near Maynes Creek [CQ755585] was examined in 1981 by BHP. Two percussion holes were drilled and a bulk sample taken. The quality in the drill holes was reported by Longworth and McKenzie (1987) as:

DDH		SiO_2	Fe_2O_3	$Al2O_3$
		(%)	(%)	(%)
SC 11	0-6 m	98.9	0.45	0.10
	9-15 m	99.0	0.25	0.10
SC 12	0-6 m	98.7	0.30	0.05
	6-12 m	98.5	0.35	0.10

This prospect is not currently under any mineral tenement, being in the relinquished portion of EL43/70.

POKES ROAD

Two quarries in the Jacob Quartzite at CQ711520, used to provide road materials for the Wynyard Council, were examined around 1980–1981 by BHP.

No analyses have been reported from the area and the prospect is currently not held under any mineral tenement, being in the relinquished portion of EL43/70.

DOLOMITE

Dolomite (as part of the Smithton Dolomite qv this volume) occurs extensively throughout the Smithton area. Various outcrops have been examined and sampled by Nye, Finucane and Blake (1934), Hughes (1957) and Bacon and Jennings (1987).

In 1971 two drill holes were drilled close together, abount one kilometre north-east of Irishtown [CQ440696], by the Marble Cliff Quarries Company. Numerous analyses were made of the dolomite intersected in these holes.

One hole was drilled north of Edith Creek [CQ395636]. A number of holes were drilled around the town of Smithton in 1945 by the BHP Company. Logs, but no analyses, exist for these holes.

Nye (1934) described two types of dolomite: a fine grained, thinly bedded, light grey type with numerous points at right angles to the bedding planes, producing rectangular blocks, and a coarser grained, grey-white thickly bedded type with crystals 1/16" (mm) in size, evidently derivedc from the finer grained material.

The dolomite has been quarried at Edith Creek and Duck River for use in road making. Currently the dolomite is quarried at Smithton and at the Roger River for agricultural purposes.

QUALITY

Dolomite is a mineral composed of approximately equal quantities of the carbonates of magnesium (Mg) and calcium (Ca) in equal molecular proportions, the formula for dolomite being $(Ca.Mg)(CO_3)_2$. Pure magnesium carbonate ($MgCO_3$) is called magnesite and pure calcium carbonate ($CaCO_3$) is calcite. The rock dolomite is a sedimentary rock containing 50% or more by weight of the mineral dolomite. Limestone is a sedimentary rock containing 50% or more by mass of the mineral calcite.

For comparative purposes, rock samples can be analysed using XRF analysis which gives the composition of a sample in terms of various oxides. Pure dolomite is composed of:

54.35 mass%	$CaCO_3$
45.65 mass%	$MgCO_3$

In an XRF or 'whole rock' analysis, the calcium and magnesium are reported as oxides, and so pure dolomite would have the analysis:

30.4%	CaO
21.7%	MgO
and 47.9%	CO_2 (from the carbonates)

The proportion of magnesium given as MgO in the whole rock analyses can be converted back to %dolomite by the following conversion:

MgO (mass%)	Equiv. $MgCO_3$ (mass%)	Equiv. dolomite (mass%)
5	10.5	23.0
10	20.9	45.7
20	41.7	91.6
21	44.0	96.2
21.5	45.0	98.5

Analyses of known dolomite occurrences in the Smithton area are as follows:

Good quality dolomite is known from near Blackwood Bridge, from near Irishtown and from Watsons Bend on the Duck River. The Circular Head Dolomite Trading Company currently operate a quarry near the latter locality. The crushed dolomite from House's quarry is also good quality.

CURRENT WORKINGS

Smithton

The largest currently operating quarry is owned by Circular Head Dolomite Trading Company and is located near to the town of Smithton. The Company hold a mining lease ML 101M/87 of 35 ha over the dolomite deposit, and produces around 60 000 tonnes of dolomite annually for the agricultural market.

Sample	CaO	MgO	CO_2 by ignition loss	SiO_2	Al_2O_3	P_2O_5	C	FeO/Fe_2O_3	
1*	31.12	21.48	46.73	0.08	0.36	trace	0.02		0.24
2*	31.22	21.64	46.14	0.20	0.48	trace	0.156		0.24
3*	31.32	21.50	46.68	0.12	0.36	trace	0.032		0.12
4*	31.22	21.56	46.64	0.08	0.48	trace	0.028		0.12
5*	31.60	22.22	46.84	0.08	0.40	trace	0.03	n.d.	0.08
6*	28.70	19.72	43.60	4.60	3.18	0.029	0.20	0.84	0.37
7*	28.30	19.76	43.31	4.88	3.06	0.03	0.25	0.78	0.44
8*	28.64	19.32	43.35	4.80	3.56	0.03	0.25	0.87	0.47
9*	28.40	20.36	43.73	3.80	3.38	0.028	0.35	0.74	0.29
10*	28.00	19.20	43.63	5.08	3.86	0.035	0.25	0.71	0.35
11*	28.20	14.62	40.75	6.64	8.24	0.054	0.65	1.26	0.76
12*	29.80	19.40	44.73	2.12	3.54	0.04	0.35	1.03	0.71
13*	28.00	19.98	42.48	5.52	3.68	0.03	0.40	0.94	0.40
14*	30.40	21.56	44.83	3.28	0.42	0.06	0.05	0.38	0.15
15*	31.20	21.36	46.46	0.52	0.56	0.10	0.14	0.71	0.65
16	20.27	22.88	46.16	1.76					
17	20.58	21.38	45.62	3.36					
18	19.99	22.48	46.70	1.48					
19	29.04	23.15	46.17	2.02					
20	30.3	21.3	-	<0.10	0.20	0.06	-	0.24	0.09
21	30.4	23.0	-	0.20	0.15	0.16	-	0.17	0.09
22	28.9	20.7	-	2.1	1.2	0.13	-	0.23	0.99
23	28.0	19.5	-	4.8	1.7	0.80	-	0.25	1.7

Samples localities:

1-5 Near Blackwood Bridge
6-10 Near Irishtown
11-13 Near Scotchtown
14 Near Irishtown
15 from Watsons Bend (near quarry currently worked by Smithton Dolomite Pty Ltd).
16 Sample 1/1A DDH1, 1971 drilling near Irishtown
17 Sample 1/2 DDH1, 1971 drilling near Irishtown
18 Sample 1/3, DDH1, 1971 drilling near Irishtown
19 Sample 2/1, DDH2, 1971 drilling near Irishtown
20 Boulder of dolomite, base of House's quarry
21 Crushed dolomite, sale product, House's quarry
22 Powdered dolomite, sale product, House's quarry
23 Dolomite sand, sale product, House's quarry

* analyses from Nye, Finucane and Blake, 1934

Table A1
CONSTRUCTION MATERIALS IN THE SMITHTON AREA

Ref.	Grid. Ref.	Locality	Occupier	Rock type	Lease	Land		Res.	Ops.	Ex.	USCS	Uses	Qty
01	CQ426784	Coppermine Point	PWD	basalt	-	CL	QP	MED	ABN	BL	GP	CA,RS,RU	M
02	CQ385612	Trowutta Road	-	gravel	-	FH	QP	NIL	ABN	BH	CL	RS,RB,RU	S
03	CQ376595	Trowutta Road	-	gravel	-	FH	QP	NIL	ABN	BH	ML	RS,PB,RW	S
04	CQ355599	Roger R.	DMR	siltstone	-	FH	QP	NIL	ABN	DZ	SMD	RS,RW	S
05	CQ432690	Irishtown	Lavelle	siltstone	-	FH	-	NIL	FOP	DZ	SC	RS,RU	M
06	CQ471704	Faheys Lane	Reid, D.	dolomite	-	FH	-	MED	OCC	-	SC	RS,RB,RU	S
07	CQ470706	Faheys Lane	PWD	dolomite	-	CL	QP	MED	FOP	DZ	SM-SC	RS,RB,RW	S
08	CQ471708	Faheys Lane	Circular Head Council	dolomite	-	CL	QP	MED	FOP	DZ	SC-SM	RS,RB,RW	M
09	CQ446615	Nabageena	Beattie	dolomite	-	FH	QP	NIL	ABN	DZ	SC	RG,RB,RU	M
10	CQ438613	Nabageena	Circular Head Council	dolomite	936P/M	FH	QP	MED	FOP	DZ	SC	RS,RB,RU	S
11	CQ504678	Tierneys Road	Tuxworth	conglom-erate	-	FH	QP	NIL	ABN	DZ	GMD	RS,RB,RW	S
12	CQ505678	Tierneys Road	Tuxworth	conglom-erate	-	FH	QP	NIL	ABN	DZ	SMD	RS,RB,RW	S
13	CQ584683	Mengha	Forestry Commission	gravel	-	CL	QP	NIL	ABN	DZ	SM	RS,RU	M
14	CQ484739	Boys Road	Circular Head Council	gravel	-	CL	QP	NIL	-	DZ	CH	RS,RU	M
15	CQ523736	South Forest	Medwin	dolomite	-	FH	QP	NIL	OCC	DZ	SC	RS,RB,RU	M
16	CQ407629	Edith Creek	-	siltstone	-	FH	QP	MED	OCC	DZ	SC	RS,RB,RU	S
17	CQ435762	Briant Hill	DMR	dolomite	-	CL	QP	NIL	ABN	DZ	SM-SC	RS,RB,RU	S
18	CQ441758	Smithton	-	dolomite	-	CL	QP	NIL	-	DZ	SM-SC	RS,RB,RW	S
19	CQ438734	Irishtown Road	DMR	siltstone	-	CL	-	NIL	ABN	DZ	SC-SM	RS,RU	S
20	CQ450730	Beacom Hills	Reid, D.	quartzite	-	FH	AP	MED	FOP	DZ	GM-SM	RS,RB,RW	S
21	CQ450734	Beacom Hills	DMR	quartzite	-	CL	QP	MED	OCC	DZ	SMD	RS,RB,RW	S
22	CQ452740	Beacom Hills	Lee	quartzite	-	FH	QP	MED	FOP	DZ	SMD	RS,RB,RW	S
23	CQ456747	Beacom Hills	Circular Head Council	quartzite	879P/M	FH	QP	MED	FOP	DZ	SP-SM	RS,RB,RW	S
24	CQ457748	Beacom Hills	Circular Head Council	quartzite	879P/M	CL	QP	MED	ABN	DZ	SMD	RS,RB,RW	S
25	CQ604674	Mawbanna Road	Circular Head Council	quartzite	-	CL	QP	NIL	ABN	DZ	GMD	RS,RU	M
26	CQ642609	Newhaven Road	Circular Head Council	gravel	-	CL	QP	SML	OCC	BH	SMD	RS,RB,RU	S
27	CQ628761	Cowrie Point	Savage River Mines	siltstone	-	FH	QP	SML	OCC	DZ	CL-GC	RS,RU	M
28	CQ644757	Port Latta	Savage River Mines	quartzite	-	FH	QP	SML	ABN	DZ	GMD	RS,RB,RW	S
29	CQ396765	Smithton	Circular Head Council	dolomite	13M/50	FH	QP	MED	OCC	BL	GP-GM	CA,RS,RB, RW	S
30	CQ684735	Speedwell Road	Circular Head Council	dolerite	-	CL	QP	NOT	OCC	BL	SC	RS,RB,RU	S
31	CQ726707	Rocky Cape	Burns	quartzite	-	FH	QP	NIL	OCC	DZ	GP-GM	RS,RB,RW	S
32	CQ733740	Rocky Cape Road	DMR	quartzite	-	CL	QP	NIL	ABN	DZ	GP-GM	RS,RB,RW	S
33	CQ555635	Daisies Road	Forestry Commission	quartzite	-	CL	QP	NIL	ABN	DZ	GC	RS,RB,RU	M
34	CQ726742	Rocky Cape Road	Circular Head Council	quartzite	-	CL	QP	SML	OCC	DZ	GP	RS,RB,RU	S
35	CQ325807	Montagu Road	Parsons	basalt	-	FH	QP	MED	OCC	DZ	GP	RS,RU	M
36	CQ340713	Christmas Hills	DMR	sand	-	FH	QP	SML	OCC	BH	SP	RH,SD	S
37	CQ452747	Deep Creek	Leis, T.J. & M.J.	quartzite	917P/M	FH	QP	-	-	-	-	-	-
38	CQ453737	Beacom Hills	Francombe & McBain	quarzite	1085P/M	FH	QP	-	OCC	DZ	SMD	RS,RB,RW	S
39	CQ450725	Beacom Hills	Odgers, K.C. & D.M.	quartzite	1179P/M	FH	QP	-	-	-	-	-	-

Roger River

A smaller quarry, within mining lease 1275P/M held by J.H. & M.F. House, is located 12 km south west of Edith Creek, at CQ335523. This small quarry is worked intermittently to produce dolomite which, after crushing, is sold as an agricultural product.

LIMESTONE

Freshwater, Quaternary limestone occurs around Pulbeena. This is described by Nye (1934) as 'tuffaceous and marly', and has been worked intermittently to provide lime for agricultural purposes.

High quality limestone is found bedded with the Smithton dolomite in places. At Scotchtown, this limestone has been quarried and used by APPM at the Burnie paper manufacturing plant. Leases over the Scotchtown deposit have since lapsed.

OCHRE

A small ochre deposit, known as Sampson's, occurs north-east of Smithton near the mouth of Deep Creek. The ochre has been formed from the precipitation of sediments from mineral springs (bog iron ore), and is of Pleistocene age. The ochre is interbedded with sand and peat. A complete description of the mine (two quarries) and the geology is given in Thomas and Henderson (1943).

Small quantities of this ochre, which was yellow in colour, were mined during the 1940s and sold to a Melbourne market for paint manufacture.

COAL

Small lenses of lignite and peat occur within the Tertiary and Quaternary unconsolidated sands and gravels, although no deposits of this material have been worked. A lease 39P/M was taken out by a Mr McGillivray on land owned by Mr A. Wood (at 458/682, Lileah 1:25 000 sheet), in 1919; the lease was allowed to lapse and in 1921 a Reward Lease (79P/M) was issued over the same ground to the discoverer, McGillivray.

At the time of Nye's 1934 visit three small adits were still visible, but had collapsed. A sample was taken from a seam one metre thick in a small creek on Johns Hill:

Moisture (%)	9.90
Volatiles (%)	51.00
Fixed Carbon (%)	29.90
Ash (%)	9.20
Sulphur (%)	3.61

Two thin seams (0.3-0.6 m thick) of lignite exposed in Edith Creek [CQ460614] are also described by Nye (1934). No leases have been taken out over this occurrence.

CONSTRUCTION MATERIALS

Basalt, dolerite, quartzite and dolomite are all quarried within the Smithton district for use as road making materials; as road base and road wearing (surfacing). Basalt is also crushed for use as an aggregate in concrete manufacture. Sand from one pit is used to manufacture road hotmix sand. A list of quarries used for the production of construction materials is given in Table A1.

METALLIC MINERALS

Native copper

Small flakes of native copper are known to occur within the Cambrian basalts in the Smithton area. (Blake, 1936, Scott,1954).

Silver–lead

A very small pocket of silver-lead ore occurs to the east of Lileah. Now obscured, the deposit was seen in the 1950s and has been described as a large vein of quartz, 0.6-1.0 m wide, containing smaller pods and lenses of galena.

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Appendix B

PRELIMINARY REPORT ON THE FOREST No. 1 DIAMOND DRILL HOLE, AND CHEMICAL ANALYSES OF ASSOCIATED THOLEIITIC BASALTS IN THE SMITHTON AND WOOLNORTH QUADRANGLES

A. V. Brown

Abstract

A stratigraphic diamond drill hole, sited in the Eocambrian succcession to the north of the township of Forest confirmns that the correlate of the Crimson Creek Formation in the Smithton Basin conformably and gradationally overlies a carbonate / mudstone succession which includes stromatolitic breccia units. The later succession is a correlate of the Success Creek Group and a lateral continuation of the Black River Dolomite. Analyses of other basaltic units intercepted by the hole, as well as analyses of other basalt samples from surface outcrop localities withtin the Smithton and Welcome Quadrangles are given.

INTRODUCTION

A stratigraphic diamond drill hole was drilled into the Eocambrian succession to the north of the township of Forest. The hole was drilled in two stages: 0–500.3 m between 30 October 1981 and 25 June 1982; and 500.3–1076 m between 11 July and 14 October 1983.

Hole name:	Forest 1
DH Collar co-ordinates:	352738.00 mE, 5480111.00 mN (±5 m)
Elevation:	10.000 m (±0.1 m)
Depth of hole:	1076 m

Down-hole survey details*:

Depth (m)	Bearing (°M)	Inclination (°)
0.00	0.00	0.00
407.70	316.50	2.50
605.70	316.50	10.00
803.70	316.50	11.50
1001.70	316.50	10.50

* Results of a down-the-hole survey using an Eastman single shot camera or equivalent. Inclination measured from the vertical.

Space co-ordinates† used for plotting:

Depth (m)	Grid co-ordinates (metres E)	(metres N)	Elevation (m)	
0.00	352738.000	5480111.000	10.000	Collar
203.85	352738.000	5480111.000	−193.850	
506.70	352731.295	5480122.382	−496.412	
704.70	352713.845	5480152.007	−691.404	
902.70	352693.810	5480186.019	−885.429	
1073.00	352678.058	5480212.760	−1052.877	EOH

† The calculated space co-ordinates listed above refer to the Australian Metric Grid (AMG).
The magnetic/grid north angle = 13.00°.

The objectiver of the hole was to determine whether a correlate of the Success Creek Group, the Black River Dolomite and Forest Conglomerate, underlay the correlate of the Crimson Creek Formation in the Smithton Basin, and if so, what was the boundary relationship.

Before the first 500 m of the hole was drilled, the existence of deep gully infillings by volcaniclastic sedimentary rocks and associated basaltic rocks was unknown. The hole was deepened in order to obtain information on the nature of the basement for the Eocambrian successions in this area and to act as a seismic anchor point for the proposed ACORP seismic profile along north-western Tasmania. Due to the thickness of the successions, basement was not reached before the hole was abandoned because of drilling difficulties. These difficulties related to the presence of expansive clay (montmorillonite) and talc in the laminated mudstone units between 1020 and 1030 m.

The lithological log is given as Table B1.

Table B1
LITHOLOGICAL LOG OF DRILL CORE

Depth (m)	Description
.0-2.0	Basalt boulders.
2.0-44.2	Dominantly massive, green-grey, sometimes amygdaloidal basalt from 26.3-26.8 m. Sample ABS44 from 12.3 m, basalt. ABS45 from 15.3 m, basalt.
44.2-52.2	Finely laminated, with the laminations often wispy, red-brown mudstone with interbedded greywacke with clasts of basic volcanic and subordinate quartz. Greywacke interbeds generally less than 100 mm. Laminae 1-2 mm. Sample ABS46 from 47.2 m, greywacke.
52.2-52.8	Pebble conglomerate, closed framework, clasts dominantly volcanic.
52.8-68.3	Dominantly greywacke, some rip-up clasts of mudstone present, in beds up to 2 m thick. Sample ABS47 from 65.6 m, greywacke.
68.3-68.7	Pebble conglomerate.
68.7-87.3	Brown pebbly mudstone containing rounded to subangular clasts of basic volcanic detritus. Clasts make up less than 10% of the rock and range in size from 2-80 mm. Crudely laminated thinly bedded coarse sand layers define bedding.
87.3-124.0	Massive greenish-grey, open-framework agglomerate; clasts dominantly of basalt, angular to subrounded; maximum size 180 mm. Minor sedimentary clasts. Sample ABS48 from 91.3 m, agglomerate.
124.0-165.7	Agglomerate, basalt clasts. Sample ABS95 from 141.7 m, basaltic clast. ABS96 from 151.7, basaltic clast. ABS97 from 165.8 m, basaltic clast.
165.7-166.4	Basalt.
166.4-200.0	Well-bedded green-grey greywacke with subordinate interbedded reddish-purple mudstone. Greywacke units, up to one metre thick, may be graded and often contain mudstone rip-up clasts. Zone of strong epidotisation with veins of quartz and calcite from 181.3-181.9 m. Sample ABS49 from 178.0 m, greywacke.
200.0-231.2	Laminated siltstone/mudstone and greywacke in about equal proportions. Greywacke beds may reach 500 mm in thickness, but usually are less than 150 mm. Mudstone beds are less than 50 mm. Sample ABS50 from 206.6 m, siltstone.
231.2-240.5	Green-grey greywacke (30-100 mm thick) and interbedded black mudstone (3-30 mm thick). Mudstone comprises about 25% of the sequence. Sample ABS51 from 235 m, siltstone.
240.5-242.0	Dominantly greywacke.
242.0-244.0	Interbedded greywacke and mudstone.
244.0-244.2	Volcanic breccia.
244.2-244.3	Greywacke.
244.3-275.8	Basalt flows, often chilled and brecciated; thin greywacke units present. Sample ABS52 from 270.5 m, basalt.
275.8-322.2	Laminated grey siltstone and black mudstone with minor thin greywacke units. Sample ABS53 from 281.3 m, laminated mudstone.
322.2-377.1	Dominantly grey-green greywacke with minor mudstone. Sample ABS54 from 323.3 m, laminated mudstone.
337.1-367.9	Massive green-grey greywacke with purple mudstone. Sample ABS55 from 339.9 m, laminated siltstone.
367.9-371.2	Laminated black mudstone interbedded with grey-green siltstone.
371.2-495.0	Well-bedded grey greywacke, often thickly bedded with interbedded purple mudstone.
495.0-496.2	Basaltic breccia containing abundant glass fragments. Sample ABS56 from 495.4 m, basaltic breccia.
496.2-500.2	Interbedded greywacke and mudstone. Sample ABS57 from 499.0 m, greywacke.
500.2-501.8	Interbedded greywacke and agglomerate.
501.8-505.1	Pebble conglomerate with angular basalt clasts.
505.1-506.9	Greywacke.
506.9-508.2	Pebble conglomerate.
508.2-509.5	Brecciated zone.
509.5-518.0	Basaltic agglomerate, pebble conglomerate and mudstone.
518.0-529.1	Fine-grained basalt. Zone of quartz and epidote with sulphide minerals. Sample ABS98 from 523.0 m.
529.1-543.0	Agglomerate and interbedded, basaltic clast. Zones of brecciation.
543.0-543.5	Amygdaloidal basalt.
543.5-550.2	Laminated green-grey siltstone and mudstone with greywacke units. Red mudstone rip-up clasts dominate some units up to 500 mm thick. Sample ABS58 from 550.0 m, carbonate unit.

550.2-551.1   Red siltstone with carbonate horizon.

551.1-558.5   Dominantly greywacke with laminated red mudstone units.

558.5-586.0   Dominantly green-grey greywacke with lenses of mudstone. Some units rich in carbonate.

586.0-615.5   Laminated black mudstone and green-grey siltstone with minor greywacke and zones of brecciation.

615.5-632.6   Dominantly greywacke with minor laminated mudstone and siltstone. Sample ABS59 from 632.5 m, greywacke. ABS60 from 632.6 m, greywacke.

632.6-658.0   Interbedded laminated mudstone/siltstone and greywacke. Sample ABS61 from 645.0 m, greywacke.

658.0-667.5   Dominantly greywacke with laminated mudstone/siltstone. Sample ABS62 from 666.9 m, greywacke.

667.5-681.0   Laminated black mudstone and siltstone with minor greywacke units.

681.0-739.5   Dominantly greywacke with lenses of black mudstone/siltstone. Good grading and scour bases of greywacke units. Sample ABS63 from 688.1 m, greywacke. ABS64 from 723.0 m, greywacke. ABS65 from 733.9 m, greywacke.

739.5-743.4   Laminated black mudstone and minor greywacke.

743.4-763.5   Dominantly greywacke with lenses of black mudstone. Mudstone 10-20 mm thick, but at times up to 50 mm thick. Sample ABS66 from 757.75 m, greywacke.

763.5-766.6   Zone of brecciation in laminated mudstone/siltstone.

766.6-780.8   Dominantly greywacke with black mudstone units. Sample ABS67 from 771.0 m, greywacke. ABS68 from 772.0 m, greywacke. ABS69 from 773.5 m, greywacke.

780.8-790.5   Interbedded laminated black mudstone, siltstone and carbonate units, some with a high sulphide mineral content. Minor greywacke (the amount of carbonate in the sequence is increasing down sequence). Sample ABS70 from 782.7 m, bedded carbonate-mudstone.

790.5-804.4   Bedded carbonate units with minor black mudstone. Sample ABS71 from 793.0 m, bedded carbonate-siltstone. ABS72 from 800.5 m, bedded carbonate-siltstone. ABS73 from 802.9 m, bedded greywacke-siltstone.

804.4-809.0   Laminated carbonate - black mudstone -siltstone.

809.0-810.5   Laminated black mudstone.

810.5-816.4   Interbedded laminated carbonate and mudstone.

816.4-821.8   Interbedded carbonate units. Sample ABS74 from 813.3 m, calcareous siltstone.

821.8-823.3   Interbedded carbonate and black mudstone.

823.3-837.3   Pyritic black mudstone.

821.8-823.3   Interbedded carbonate and black mudstone.

823.3-837.3   Pyritic black mudstone. Sample ABS75 from 826.65 m, pyritic mudstone. ABS76 from 833.2 m, bedded carbonate-mudstone.

837.3-846.5   Pyritic pebbly black mudstone. Sample ABS77 from 842.0 m, conglomerate.

846.5-847.1   Bedded carbonate.

847.1-848.2   Black mudstone.

848.2-854.1   Pebbly black mudstone with minor carbonate units. Sample ABS78 from 850.0 m, calcareous conglomerate.

854.1-854.5   Calcareous pebbly mudstone.

854.5-857.9   Carbonate.

857.9-869.5   Calcareous pebbly conglomerate. Sample ABS79 from 858.0 m, mixtite. ABS80 from 866.5 m, fine-grained conglomerate.

869.5-873.5   Bedded carbonate with minor mudstone.

873.5-874.5   Calcareous pebble conglomerate. Sample ABS81 from 874.0 m, dolomite.

874.5-876.0   Bedded carbonate units.

876.0-877.0   Pyritic pebbly mudstone.

877.0-880.5   Bedded carbonate. Sample ABS82 from 877.75 m, stromatolitic breccia.

880.5-881.0   Laminated pyritic black mudstone.

881.0-884.4   Calcareous pebble mudstone. Sample ABS83 from 883.5 m, stromatolitic breccia.

884.4-886.5   Brecciated interbedded carbonate and mudstone.

886.5-926.7   Mixtite (calcareous pebble conglomerate), with stromatolite clasts and minor interbedded carbonate units. Sample ABS84 from 890.0 m, conglomerate. ABS85 from 904.4 m, stromatolitic conglomerate. ABS86 from 910.0 m, stromatolitic conglomerate.

926.7-934.0   Pyritic and calcareous, black, pebble mudstone. Sample ABS57 from 927.0 m, stromatolitic conglomerate.

934.0-941.2 Calcareous to muddy mixtite with stromatolite clasts, and minor mudstone units.

941.2-955.8 Pebble-bearing muddy carbonate.

955.8-961.6 Brecciated pebbly carbonate.

961.6-964.1 Calcareous mudstone.

964.1-970.1 Bedded carbonate.

970.0-973.4 Calcareous mudstone.

973.4-994.4 Bedded carbonate units.

994.4-1002.5 Bedded green and grey mudstone and carbonate. Sample ABS88 from 990.0 m, dolomitic limestone. ABS89 from 1002.5 m, laminated limestone/mudstone. ABS90 from 1002.5 m, laminated limestone/mudstone.

1002.5-1005.5
                Interbedded red mudstone and carbonate.

1005.5-1008.8
                Interbedded green and grey mudstone and carbonate.

1008.8-1015.0
                Bedded carbonate.

1015.0-1032.8
                Brecciated, bedded calcareous mudstone, with thin chert unit. Sample ABS91 from 1032.0 m, chert.

1032.8-1034.5
                Bedded carbonate.

1034.5-1046.8
                Black mudstone and minor carbonate. Sample ABS92 from 1042.0 m, muddy limestone.

1046.8-1048.9
                Bedded carbonate.

1048.9-1076+ Muddy carbonate. Sample ABS93 from 1062 m, muddy limestone. ABS94 from 1073 m, muddy limestone.

Appendix C

LOG OF SMITHTON DDH No. 2 SCOPUS AREA [CQ335806]

P. W. Baillie

Depth (m)	Description
0-6	Weathered siltstone; fossil horizon at 3.0 m.
6-32	Thin-bedded succession consisting of interbedded dark-grey mudstone (1–25 mm) and lighter grey fine-very-fine sandstone beds (2-60 mm), often with sharp bases and displaying ripple cross-lamination. Sand/shale ratio greater than 1.
32-88	Interbedded mudstone and fine to medium-grained sandstone beds (20–500 mm). Sandstone beds thicken noticeably down this section of the hole. Some of the thicker sandstones are graded and have cross-laminations, often with mudstone partings in the upper part of individual beds. Sand/shale ratio ~1. Broken zones 67.0–72.5 m; 83.5–85.3 m.
88-108	Dominantly black mudstone with subordinate laminated fine sandstone containing wispy mudstone laminae. Soft-sediment breccia zone 95.5–96.2 m. Abundant bedded and disseminated pyrite. Sand/shale ratio less than 1.
108-115.5	Interbedded dark grey mudstone (1–30 mm) and well-laminated and cross-laminated sandstone (1–90 mm) often with wispy mudstone laminae, sharp bases and diffuse tops.
115.5-159	Thin, rhythmically layered and interbedded dark grey mudstone, light grey siltstone and light grey fine to very-fine grained sandstone. Sandstone units often show cross-lamination. Individual all less than 30 mm. Some slumping present. Sand/shale ratio less than 1.
159-215.2	Thinning-upward succession of dominantly graded quartzwacke and subordinate mudstone. Tops of sandstone beds may show cross-laminations often with wispy mudstone laminae. Around 160 m maximum sandstone thickness is 70 mm but usually between 20–40 mm. Interbedded mudstone has a maximum thickness of 30 mm. Around 175 m thickness of sandstone beds ranges from 5–150 mm and mudstone is less than 100 mm. Around 190 m graded sandstone beds reach 350 mm in thickness. 600 mm bed of sandstone present at 202.5 m. Sand/shale ratio greater than 1.
215.2-280.3	Interbedded succession of mudstone, siltstone, sandstone and conglomerate. Conglomerate beds reach a maximum thickness of 3 m, are always clast-supported, and show a variety of grading including normal, inverse and normal-to-inverse. Disorganised units also occur. Clast grain size is generally of the order of 1–10 mm although in thicker conglomerates well-rounded clasts up to 25 mm in diameter are present. Clast composition is dominantly of chert with lesser quartzite and minor volcanics and conglomerate. Individual clast shape varies from sub-angular to well-rounded with the larger clasts displaying the highest degree of rounding. The non-congomeratic units within this section are well-bedded and generally less than 100 mm in thickness.
280.3-333	Finely laminated, interbedded dark grey mudstone, light grey siltstone, light grey fine-grained sandstone. Thickness of beds less than 130 mm.
333-358.5	Finely laminated green-grey mudstone and siltstone with minor sandstone; bed thickness less than 20 mm. Sand/shale ratio less than 1.
358.5-365.9	Interbedded green-grey mudstone and siltstone with jasper-bearing conglomerate. Conglomerate clasts consist of jasper, volcanics and quartzite ranging in size from 1–5 mm. The conglomerates are clast supported and the majority of the clasts are sub-angular.
365.9-378.4	Finely laminated green-grey mudstone and siltstone with occasional sandstone units (less than 30 mm).

Appendix D

INTERPRETATION OF A GRAVITY SURVEY IN THE SMITHTON AREA, NORTH-WESTERN TASMANIA

R. G. Richardson

Abstract

An interpretation of a gravity survey conducted in the Smithton-Forest area of north-western Tasmania indicates that the late Precambrian to Cambrian Smithton Basin contains a basal siliceous clastic dolomite succession (density = 2.79 t/m^3), followed by a volcanosedimentary succession (2.70 t/m^3), a second dolomite succession (2.79 t/m^3), and a fossiliferous Cambrian succession (2.67 t/m^3).

INTRODUCTION

The Smithton area has been covered by a number of geophysical surveys. The first comprehensive coverage was the 1973 Bureau of Mineral Resources gravity survey with a survey density of one station per 49 km^2. At the request of A. V. Brown, a survey at a station density of one per square kilometre was undertaken in 1984/85 over the area shown in Figure D1. In 1984 the B.M.R. flew a combined aeromagnetic and radiometric survey over north-west Tasmania using a 500 m line spacing.

INTERPRETATION

Within the area of interest the radiometric data show the Cowrie Siltstone to be an area of high total counts, the Cambrian volcanic rocks to be an area of low total counts, and the fossiliferous Cambrian rocks to be an area of high counts. Much of the upper dolomite has a much rougher radiometric topography than the lower dolomite.

A full discussion of, and a set of processed images for, the north-west Tasmania aeromagnetic survey is presented in Bishop (1987). Within the Smithton and Woolnorth Quadrangles the main magnetic anomalies are related to the Cambrian volcanic rocks, with a lesser effect from the Tertiary basalts. Steeply-dipping Cambrian volcanic rocks mark the eastern side of the Smithton Trough with a strong magnetic anomaly, but the more gently dipping western margin is marked by only a weak anomaly. The interpreted depth of burial

and thickness of the Cambrian volcanic rocks (fig. D2) is such that the continuity of the volcanic rocks across the trough cannot be proven either magnetically or gravimetrically. The edges of other synclines on the two sheets also show magnetically, implying the presence of Cambrian volcanic rocks.

The detailed gravity survey (fig. D1) shows strong gradients at the eastern edge of the Smithton Trough and at the margin of the small syncline immediately to the east of the main trough. These gradients join approximately five kilometres south of Irishtown and continue to the south as one gradient. A positive ridge running north towards Circular Head marks an area of thick Cambrian volcanic rocks. A profile along grid line 5480 kmN between the west coast and grid line 360 kmE was interpreted by two-dimensional modelling of the residual field after removal of a linear regional. The final model (fig. D2) had drill control at 353 kmE and used the following densities:

Fossiliferous Cambrian rocks	2.67 t/m^3
Dolomite / conglomerate	2.79 t/m^3
Cambrian volcanic rocks	2.70 t/m^3
Precambrian basement	2.67 t/m^3

The model shows the central trough to be up to 3.9 km thick with approximately 1.6 km of fossiliferous Cambrian rocks. A second profile along grid line 5465 kmN was not modelled because of the low station density but showed the synclines to have decreased in depth to the south. A small anticline has developed on the western limb of the main trough.

REFERENCE

BISHOP, J. R. 1986. Interpretation of the north-west Tasmania aeromagnetic survey. *Geophys. Rep. Mt Read Volc. Proj. Tasm.* 4.
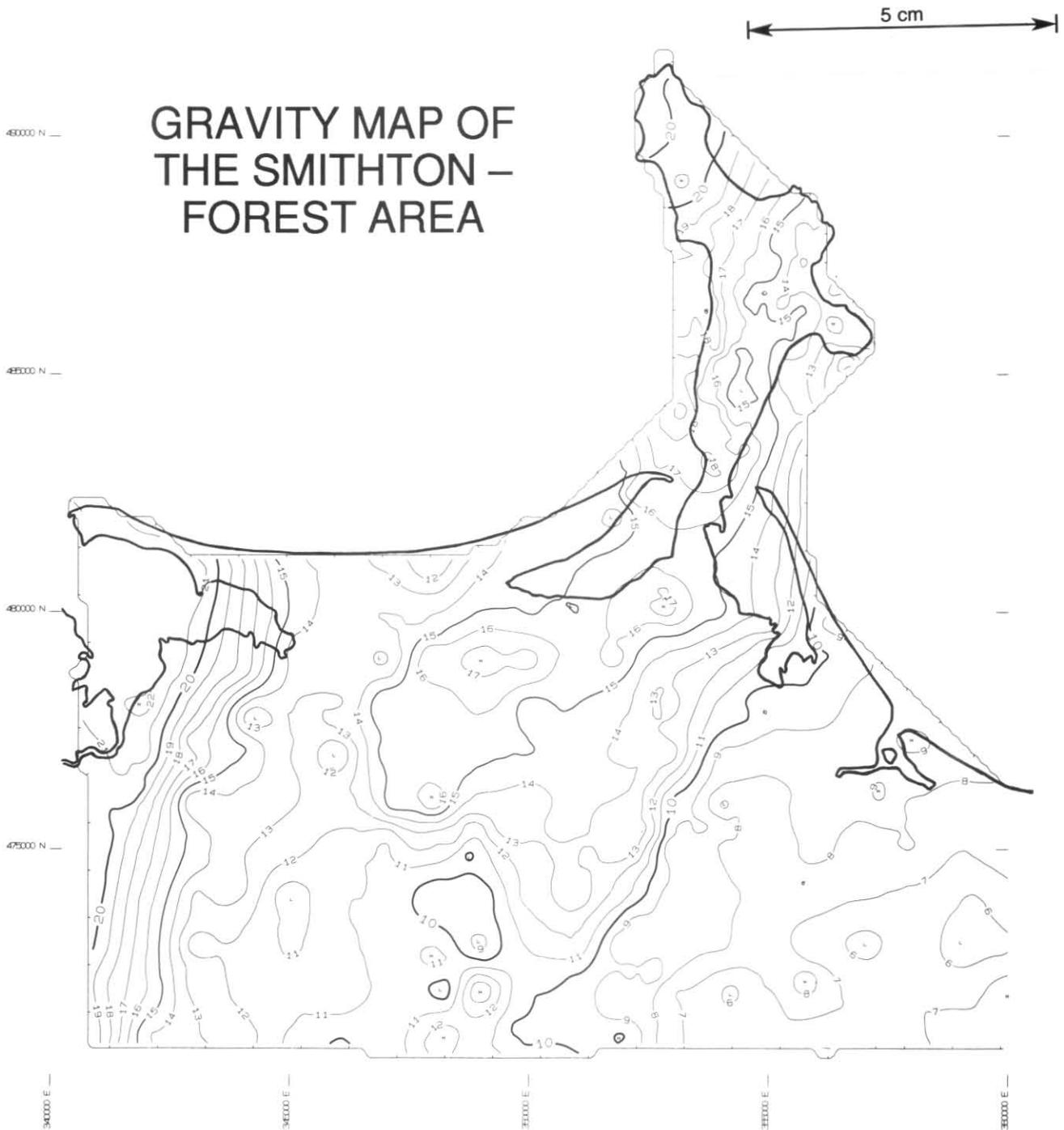
Figure D1. Gravity map of the Smithton–Forest area.
Contour interval 1 mgal. Correction density 2.67 t/m^3. Nominal station density one station per km^2.
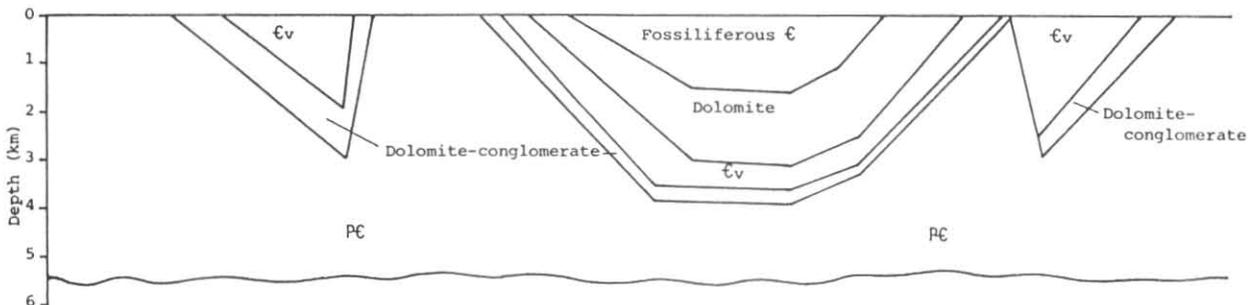

Figure D2. Interpretative cross-section of gravity data along AMG line 5480000mN, between 300000mE and 360000mE.
Density: Precambrian basement – 2.67 t/m^3; dolomite-conglomerate succession 2.798 t/m^3;
volcano-sedimentary succession 2.70 t/m^3; upper dolomite succession 2.79 t/m^3;
fossiliferous siltstone-mudstone succession 2.67 t/m^3.

APPENDIX E

Radiometric ages for the Circular Head and Green Hills basalts, north-western Tasmania

P. W. Baillie

Abstract

Whole-rock K/Ar ages have been obtained for samples obtained from Circular Head (12.5 ± 0.2 Ma) and the basalt at the northern end of Godfreys Beach (8.5 ± 0.1 Ma), in the Stanley area of north-western Tasmania. The Green Hills basalt is the youngest known volcanic rock in Tasmania.

INTRODUCTION

Although the igneous origin of The Nut (or Circular Head) is clear, its precise age and mode of formation has not been clearly understood. Baillie and Leaman (1978) conducted a detailed gravity survey on and around The Nut, and after defining a positive anomaly some 250 m in diameter near the northern edge, concluded that The Nut was the remnant of a volcanic feeder, as first suggested by Gill and Banks (1956).

As part of a regional study of Miocene volcanism in the Bass Basin and its environs, samples were obtained from Circular Head and also from the Green Hills area for radiometric analysis.

The sample from Circular Head was obtained from a very large block immediately behind the timber yards on the southern side of the monolith [CQ569856]; the Green Hills sample came from the curved colonnades near the base of the pile at the northern end of Godfreys beach [CQ561875].

The dating was carried out by AMDEL, Frewville, South Australia.

RESULTS

The Circular Head sample was a medium-grained glomeroporphyritic rock consisting of olivine and titaniferous augite in a matrix of calcic plagioclase, iron oxides and zeolite.

The Green Hills sample was a fine-grained porphyritic basalt, consisting of olivine, titaniferous augite, feldspar, zeolites and ?nepheline.

The analyses and calculated ages are:

	%K	^{40}Ar (× 10^{-11} moles/g)	^{40}Ar/^{40}Ar total	Age (± 10^6 years)
1.	1.441 1.435	3.1302	0.800	12.5 ± 0.2
2.	2.103 2.101	3.0926	0.765	8.5 ± 0.1

1. Circular Head
2. Green Hills

Ar* denotes radiogenic argon

Constants:

$$^{40}K = 0.01167 \text{ atom\%}$$
$$\lambda_\beta = 4.962 \times 1^{-10} \text{ y}^{-1}$$
$$\lambda_\epsilon = 0.581 \times 1^{-10} \text{ y}^{-1}$$
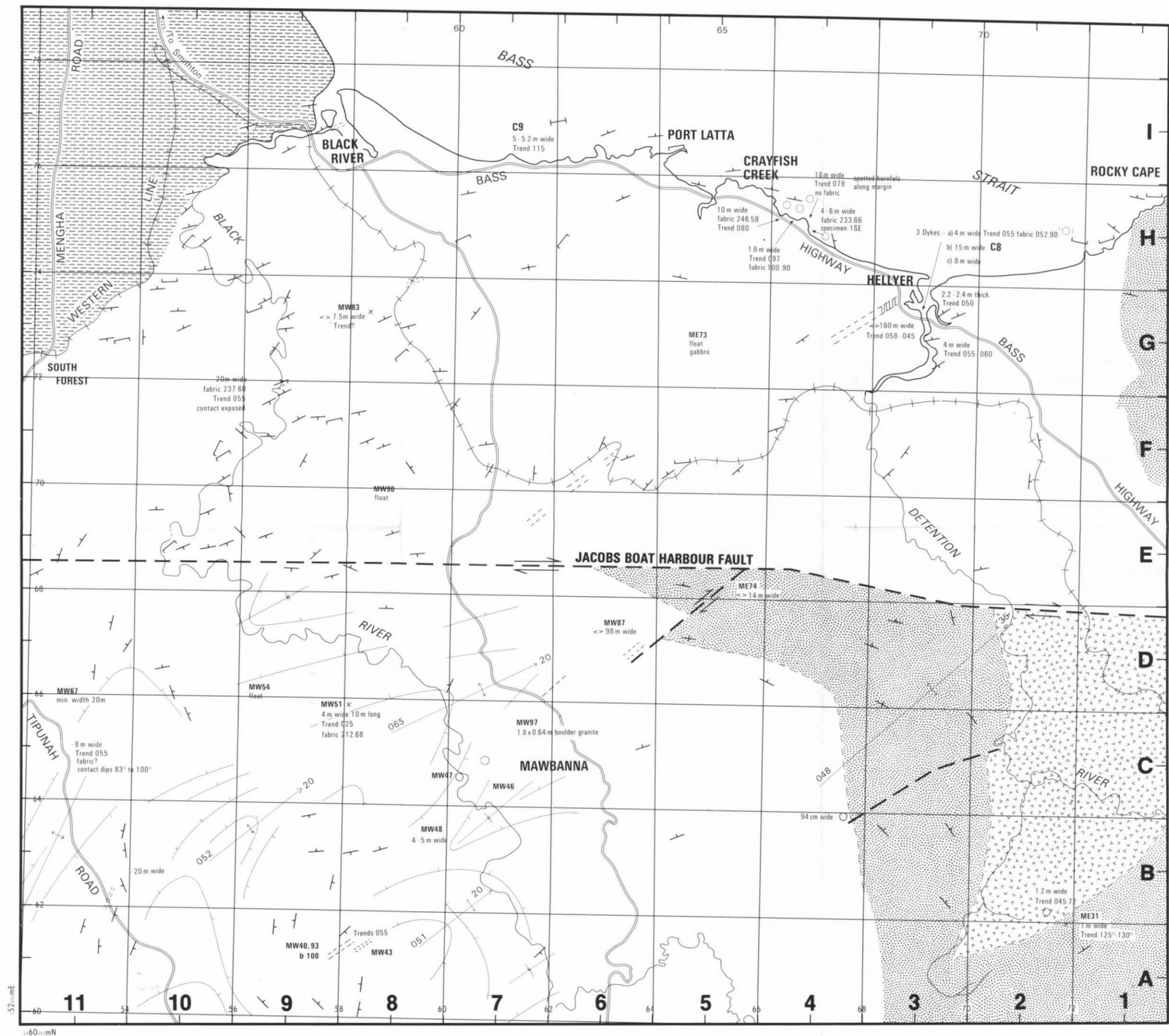
DISCUSSION

The ages are in agreement with observed stratigraphic relationships in the area, and are Late Miocene, using the time scale of Harland *et al.* (1982).

The dates are the youngest known from the Tasmanian Tertiary and provide a new upper limit for Miocene volcanism in the region.

REFERENCES

BAILLIE, P. W.; LEAMAN, D. E. 1978. Gravity survey at Stanley. *Unpubl. Rep. Dep. Mines Tasm.* 1978/17.

GILL, E. D.; BANKS, M. R. 1956. Cainozoic history of the Mowbray Swamp and other areas of northwestern Tasmania. *Rec. Qn Vict. Mus.* 6:1–41.

HARLAND, W. B.; COX, A. V.; LLEWELLYN, P. G.; PICKTON, C. A. G.; WALTERS, R. 1982. *A geologic time scale.* Cambridge University Press.

Figure 13.

Smithton Explanatory Report

Figure 15.

Figure 18.

BASEMENT GEOLOGY
BLACK RIVER TO ROCKY CAPE
FOLDING EMPHASISED

Geologist:- P. Lennox

GEOLOGY SYMBOLS

strike and dip direction of bedding plane

strike of early or dominant cleavage, vertical

strike of crenulation cleavage, vertical

dominant strike direction of bedding planes

probable trend and plunge of hingeline of
synform and antiform

observed fault with relative displacement as shown

observed geological boundary

MW74, ME63   specimen field numbers

DYKES LESS THAN 10m WIDE

fine to medium grained and cleaved

fine to medium grained and cleaved
and containing asbestos-form mineral

undifferentiated

DYKES GREATER THAN 10m WIDE

leucocratic medium to coarse grained
with mafic segregations and sometimes
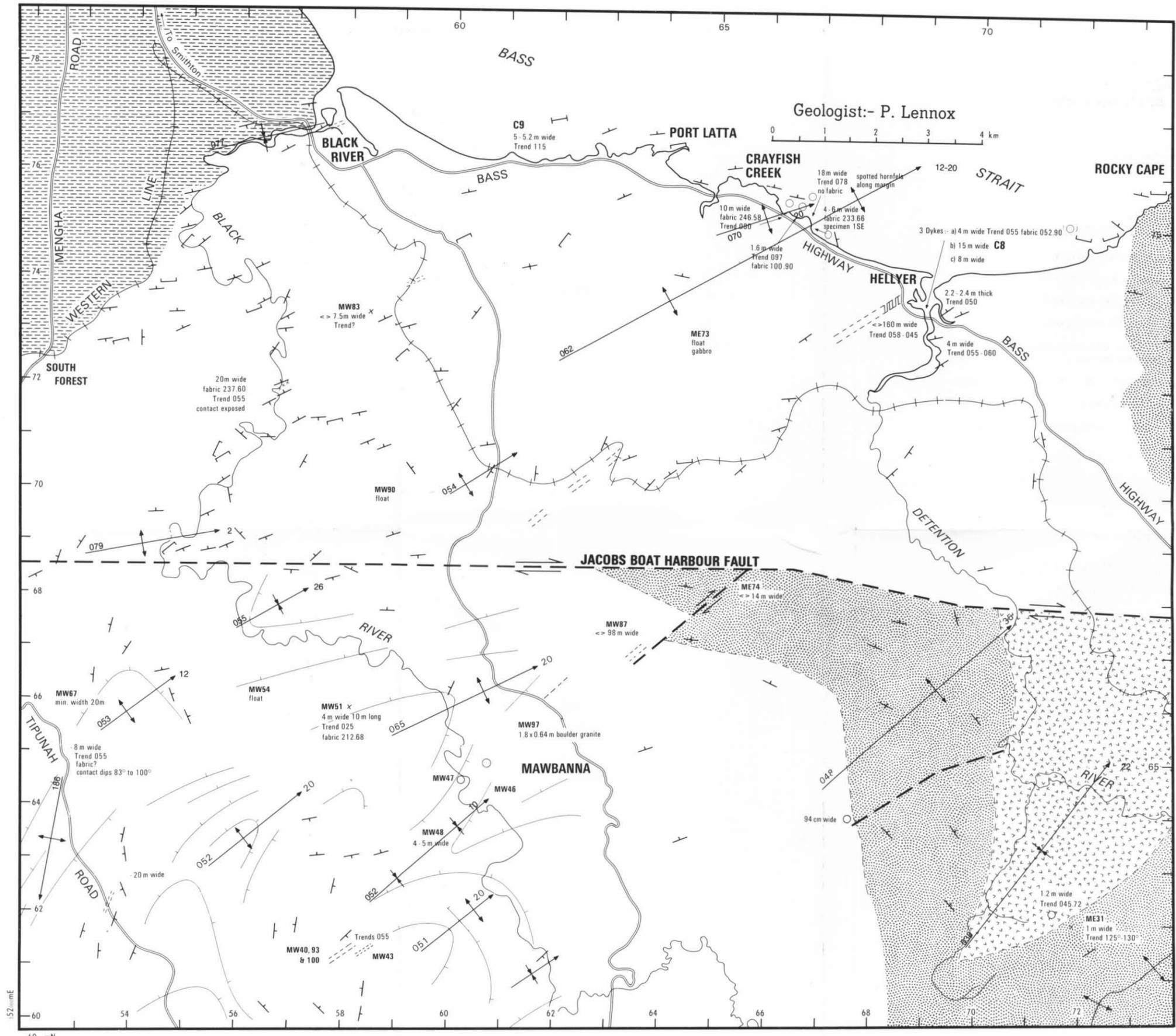an asbestos-form mineral (dotted over print)

GEOLOGY

unspecified geology
(EoC to recent)

Irby Siltstone

Detention Sub-group

Cowrie Siltstone

5 cm

Smithton Explanatory Report

Figure 24.

Smithton Explanatory Report

INDEX DIAGRAM OF MAJOR
AND MINOR FOLDS SOUTH OF
THE JACOBS BOAT HARBOUR FAULT

Geologist:- P. Lennox

GEOLOGY SYMBOLS

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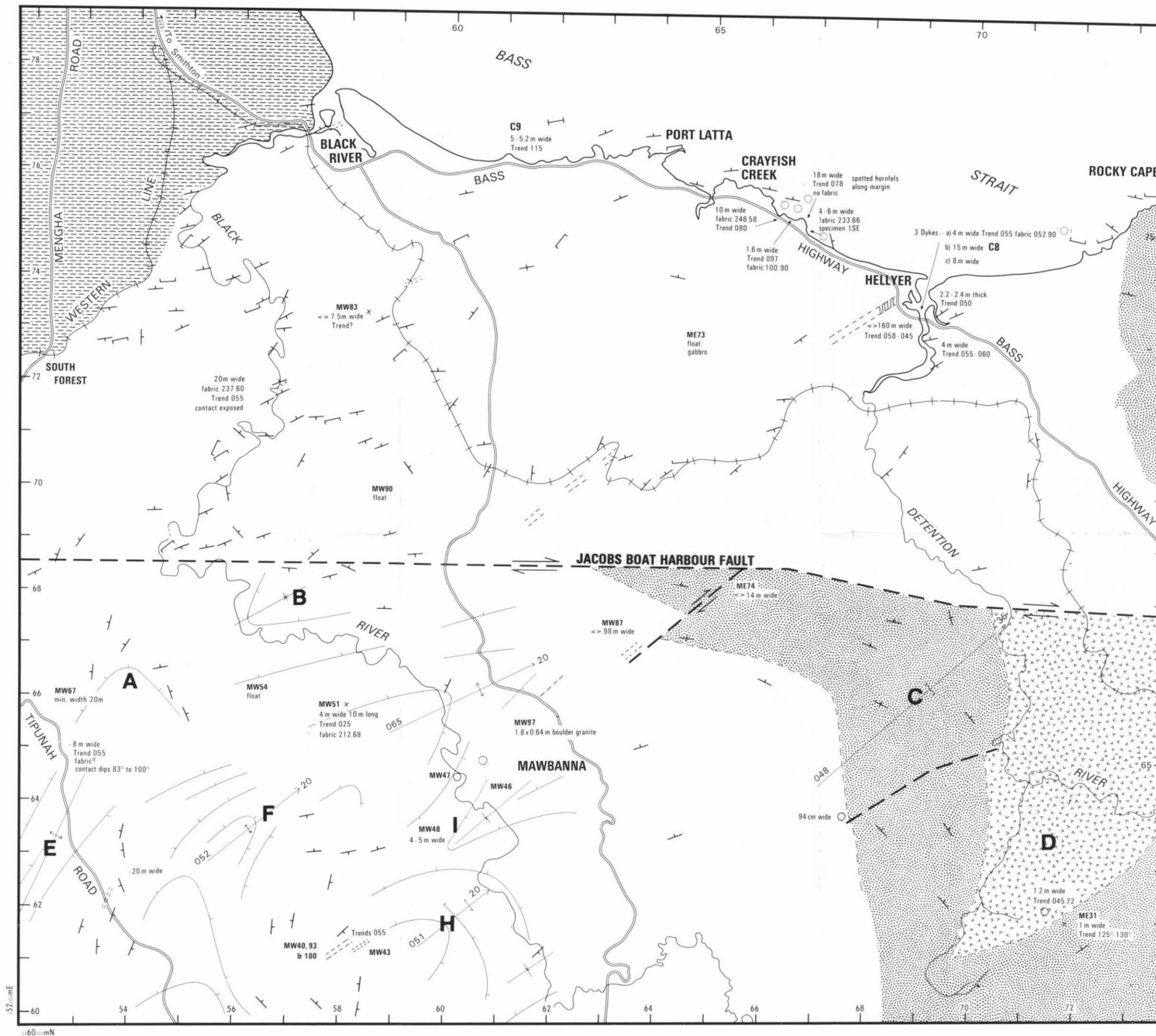an asbestos-form mineral (dotted over print)

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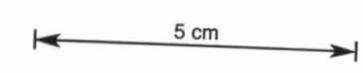
Irby Siltstone

Detention Sub-group

Cowrie Siltstone

0   1   2   3   4 km

5 cm

Figure 36.

Geologist:- P. Lennox

Map labels and annotations

BASS

ROAD

To Smithton

C9
5 - 5.2 m wide
Trend 115

PORT LATTA

BLACK RIVER

BASS

CRAYFISH CREEK

18 m wide
Trend 078
no fabric

spotted hornfels
along margin

12-20

STRAIT

ROCKY CAPE

10 m wide
fabric 246.58
Trend 060

4 - 6 m wide
fabric 233.66
specimen 1SE

3 Dykes a) 4 m wide Trend 055 fabric 052.90
b) 15 m wide   C8
c) 8 m wide

070

1.6 m wide
Trend 097
fabric 100.90

HIGHWAY

HELLYER

2.2 - 2.4 m thick
Trend 050

MENGHA

BLACK

WESTERN LINE

MW83
< > 7.5 m wide
Trend?

062

ME73
float
gabbro

< >160 m wide
Trend 058 - 045

4 m wide
Trend 055 - 060

ROCKY CAPE
NATIONAL PARK

SOUTH FOREST

20 m wide
fabric 237.60
Trend 055
contact exposed

MW90
float

054

DETENTION

HIGHWAY

079   2

JACOBS BOAT HARBOUR FAULT

ME74
< > 14 m wide

68

26

095

MW87
< > 98 m wide

RIVER

20

SHAKESPEARE
HILLS ANTICLINE

66   12

MW67
min. width 20m

053

MW54
float

MW51 ×
4 m wide 10 m long
Trend 025
fabric 212.68

065

MW97
1.8 x 0.64 m boulder granite

MAWBANNA

04P

NEWHAVEN
SYNCLINE

RIVER   22   65

TIPUNAH

186

8 m wide
Trend 055
fabric?
contact dips 83° to 100°

64

MW47

MW46

94 cm wide

62

052

20 m wide

MW48
4 - 5 m wide

052

20

1.2 m wide
Trend 045.72

ME31
1 m wide
Trend 125° 130°

ROAD

051

Trends 055

MW40, 93
& 100

MW43

DIP RANGE
ANTICLINE

Legend

**FAULTING WITHIN THE
ROCKY CAPE GROUP
IN THE BLACK RIVER
TO ROCKY CAPE REGION**

Geologist:- P. Lennox

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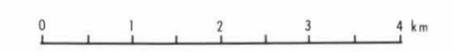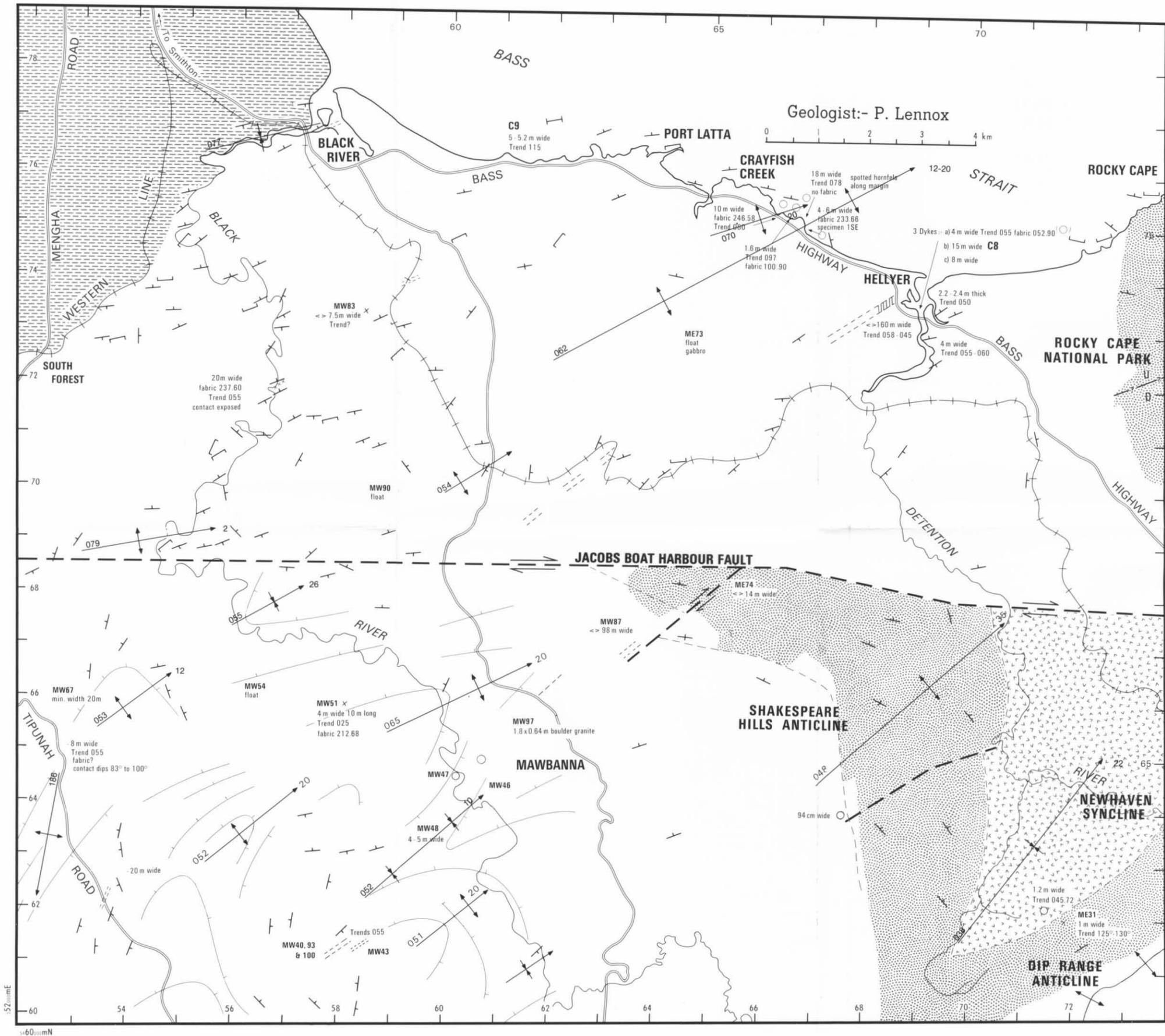
Irby Siltstone

Detention Sub-group

Cowrie Siltstone

0   1   2   3   4 km

5 cm

ER19165