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QUAMBY

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ISSUED UNDER THE AUTHORITY OF THE HONOURABLE
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PREFACE

This explanatory report outlines the geology and mineral resources of the Quamby Quadrangle, which extends from the Great Western Tiers to the Longford Basin and includes the townships of Deloraine, Westbury and Bracknell. The Quamby geological atlas 1-mile sheet was published in 1969.

Agriculture and forestry provide the principal employment in the area, which lacks significant metallic mineral deposits. Lower Palaeozoic conglomerates and Tertiary ironstone gravels are used extensively for road construction.

Particular attention has been given to the well-exposed Permo-Triassic sequences which have been used as a reference in the determination of the stratigraphy of these Systems throughout northern Tasmania in recent years.

J.G. SYMONS, Director of Mines

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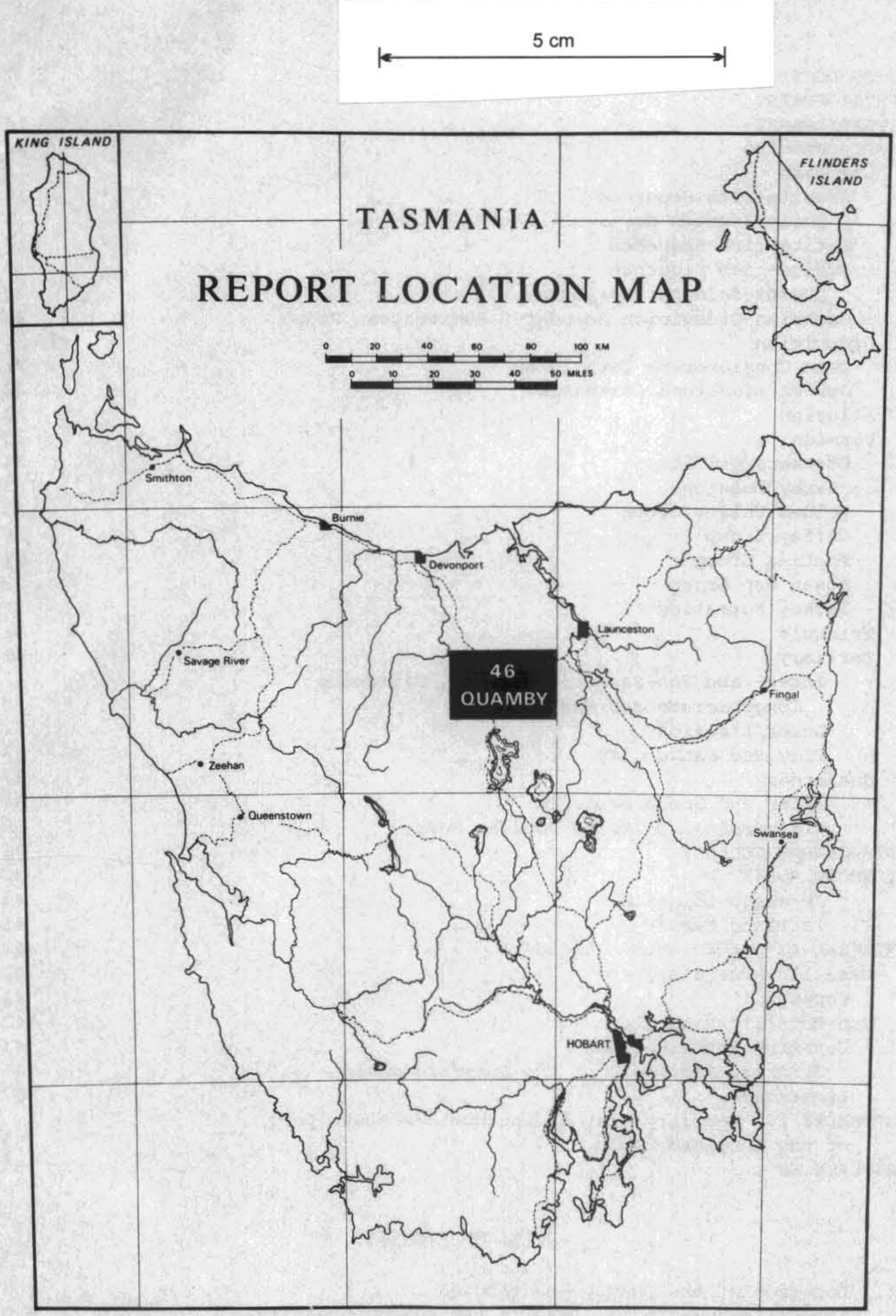


Figure 1. *Location of the Quamby Quadrangle.*

INTRODUCTION

The Quamby Quadrangle (fig. 1) lies in the central north of Tasmania between latitude 41°30' and 41°45'S and longitude 146°30' and 147,00'E. The base map for the geological map was prepared by the Lands and Surveys Department, Hobart, at a scale of 1:63,360. Mapping was carried out between March 1966 and September 1968 using air photographs (1:53,100 and 1:15,840) and topographical maps (1:31,680 and 1:15,840, contour interval 25 ft).

Geologists of the Department of Mines who have taken part in the regional mapping of this Quadrangle are Dr C.M. Barton, A.P. Bravo, A.B. Gulline, M.J. Longman, W.R. Moore, Dr B. Marshall, W.L. Matthews, I.H. Naqvi and G.P. Pike. The degree of responsibility of the geologists for the work done in the various areas is indicated on the map sheet. The author was principally responsible for the compilation of both the map and explanatory report. The regional mapping was supervised by Dr E. Williams.

Geological mapping by Wells (1957) and McKellar (1957) of the areas around Deloraine, Golden Valley and the north-eastern portion of the Western Tiers provided the main sources of published information on the region.

Road access in rural areas of the region is very good and more rugged areas on and around the Tiers are well served with logging tracks, which, however, may be impassable during the winter months.

The relief controls the degree of exposure of the rocks, which is good in road and creek sections on the face of the Tiers but poor on the low hills and plains which constitute much of the central, northern and eastern sections of the Quadrangle.

Deloraine, Westbury, Bracknell and Meander are the main population centres in an area which derives most of its income from agricultural and timber industries.

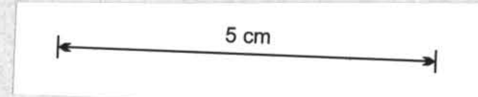
The author acknowledges the information received in the form of unpublished notes or personal communication from the various geologists engaged in mapping the Quadrangle and also acknowledges the advice received from G. Everard, Mineralogist and Petrologist, on the petrography of many of the rocks.

All specimens and thin sections referred to in the text are catalogued in the Department of Mines, Hobart.

PHYSIOGRAPHY

The southern and south-western parts of the Quamby Quadrangle are characterised by a high plateau and precipitous concave escarpments, which is in striking but picturesque contrast to the broad plains, low rolling hills and well defined ridges of the central, northern and eastern sectors of the region.

The high plateau, which is a north-eastern extension of the Central Plateau has an average height of 1220 m above mean sea level. The plateau has developed on thick erosion-resistant dolerite and characteristically has a gently south-sloping, sparsely vegetated boulder-strewn surface with numerous joint(?) or fault(?) orientated shallow depressions containing high moor peats and marshes. Rocky ridges and bluffs such as Bastion, Projection and Drys Bluff stand as erosional remnants above this surface.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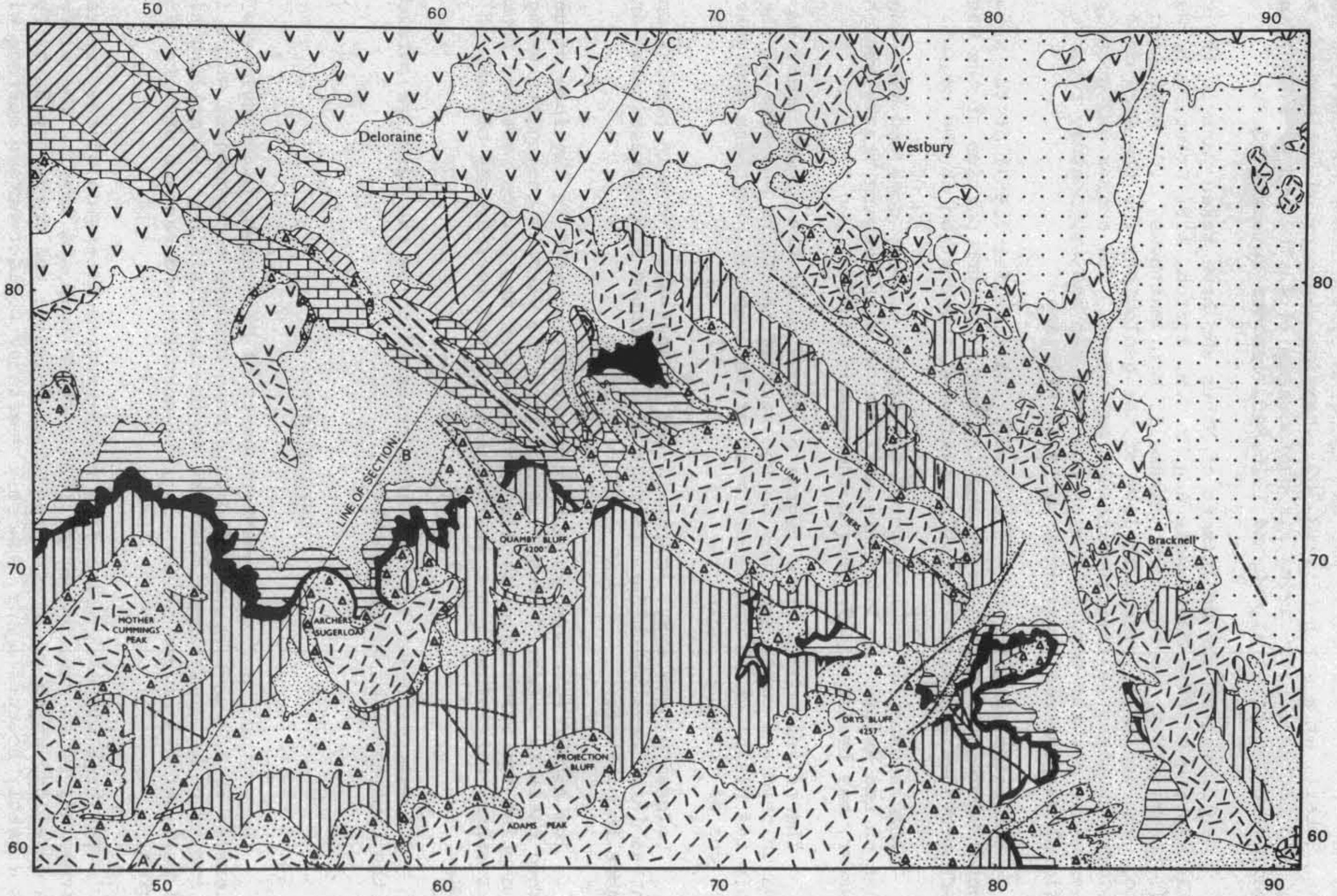
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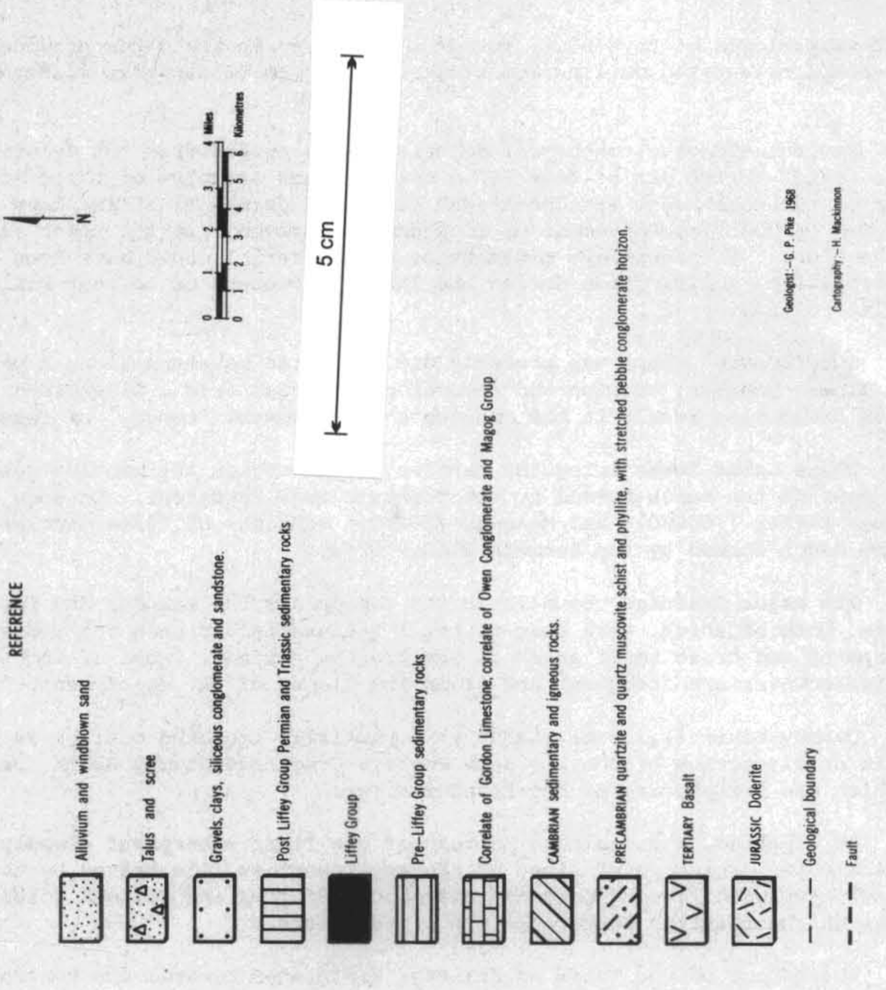

Figure 2. *Generalised geological map of the Quamby Quadrangle.*

The escarpment of the Great Western Tiers* and related escarpments typically have steep sides with locally developed cliffs and benches. This stepped appearance is due to differential erosion of the flat-lying Permo-Triassic beds which crop out beneath the dolerite capping. Where the dolerite has been eroded away, mesaform hills capped by massive resistant Triassic sandstone remain.

The upper levels of the plateau margins are bounded by dolerite cliffs. These cliffs are up to 150 m in height in some areas and have cast thick scree and talus mantles over underlying rocks thus obscuring the stepped profile of the escarpment in these areas.

The scree deposits are concentrated at the base of the dolerite cliffs and consist of angular joint blocks averaging 0.6-1.5 m but up to 6 m across. The screes are bare of vegetation and have an irregular surface which dips generally at about 30°, which is the angle of repose of the blocks. On the

* Henceforward referred to as the Tiers.

north-west slopes of Drys Bluff movement of the scree field has produced down-slope orientated gullies and ridges which form distinctive linear features.

Several elongate tongues of dolerite talus extend from the dolerite scree fields to the plains some 600 m below. Good examples of these 'tongues' occur on the north-west and north-east flanks of Quamby Bluff and have been produced by downslope movement of rock debris derived from the upper slopes of the Bluff. The downslope movement of this material could have been due to periglacial solifluction during the late Pleistocene or to post-Pleistocene gravity rolling.

The 'tongue' shape was probably due to debris movement along a particular line. However, erosion and removal of material from a widespread talus mantle could also result in the emergence of a remnant 'tongue' of talus.

Where talus forms irregular mantles in the region the mantles generally rest on the bench formed by the Triassic Ross Sandstone. In some areas, as near Liffey [760660]* and Meander [580695] remnants of talus mantles rest on the bench formed by the Permian Liffey Group.

The major drainage channels in the region are the Meander and Liffey Rivers, both of which, with some of their tributaries, breach the Tiers escarpment and drain small areas of the plateau surface. Most of the tributaries however are insequent and drain the slopes of the escarpment.

Quamby Bluff (1,226 m) stands as a partially isolated outlier as a result of dissection of the Tiers by Jackeys Creek and Quamby Brook, both of which are tributaries of the Meander River.

As expected, the drainage pattern of the Tiers escarpment closely parallels the direction of slope of the escarpment as illustrated by the strongly eastward flowing Garcias, Blackwood, Brumbys and Bullock Holes Creeks which drain the eastern margin of the Tiers.

The effect of the Tiers on drainage diminishes towards the central and eastern sectors of the region and structural and other controls begin to dictate the drainage pattern. Structural control of drainage is apparent through the McRaes Hills and several hills to the NNW of this area. Creeks flowing eastward from the Tiers swing through 90° to follow a NW-SE trend which corresponds in direction to large scale faults. On both the Central Plateau and the Cluan Tiers elongate depressions occupied by marshes and rivulets such as Breton, Eden and Westons Rivulets have a strong NW-SW orientation and are probably also controlled by the rock fracture pattern.

In the central and northern areas folded Lower Palaeozoic rocks form erosion resistant, fairly sharp E-W trending hog-backs and cuestas. The rocks composing ridges such as Gardners, Needles and Long Ridges are Ordovician sandstones and conglomerates whereas smaller more rounded E-W trending hills are of Cambrian greywackes, conglomerates, slates and shales. These ridges have surprisingly little effect on the present drainage pattern in which most of the rivers flow N-S through them. This absence of major control of the drainage by the E-W ridges suggests that either the N-S trend has been superimposed on the Lower Palaeozoic rocks or that the present drainage pattern has resulted from a major interruption to the normal development of the drainage system.

The Lower Palaeozoic strata may at one time have been overlain by flat-

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* 100 yard grid reference; all locations lie within 100 kiloyard grid square 48, zone 7.

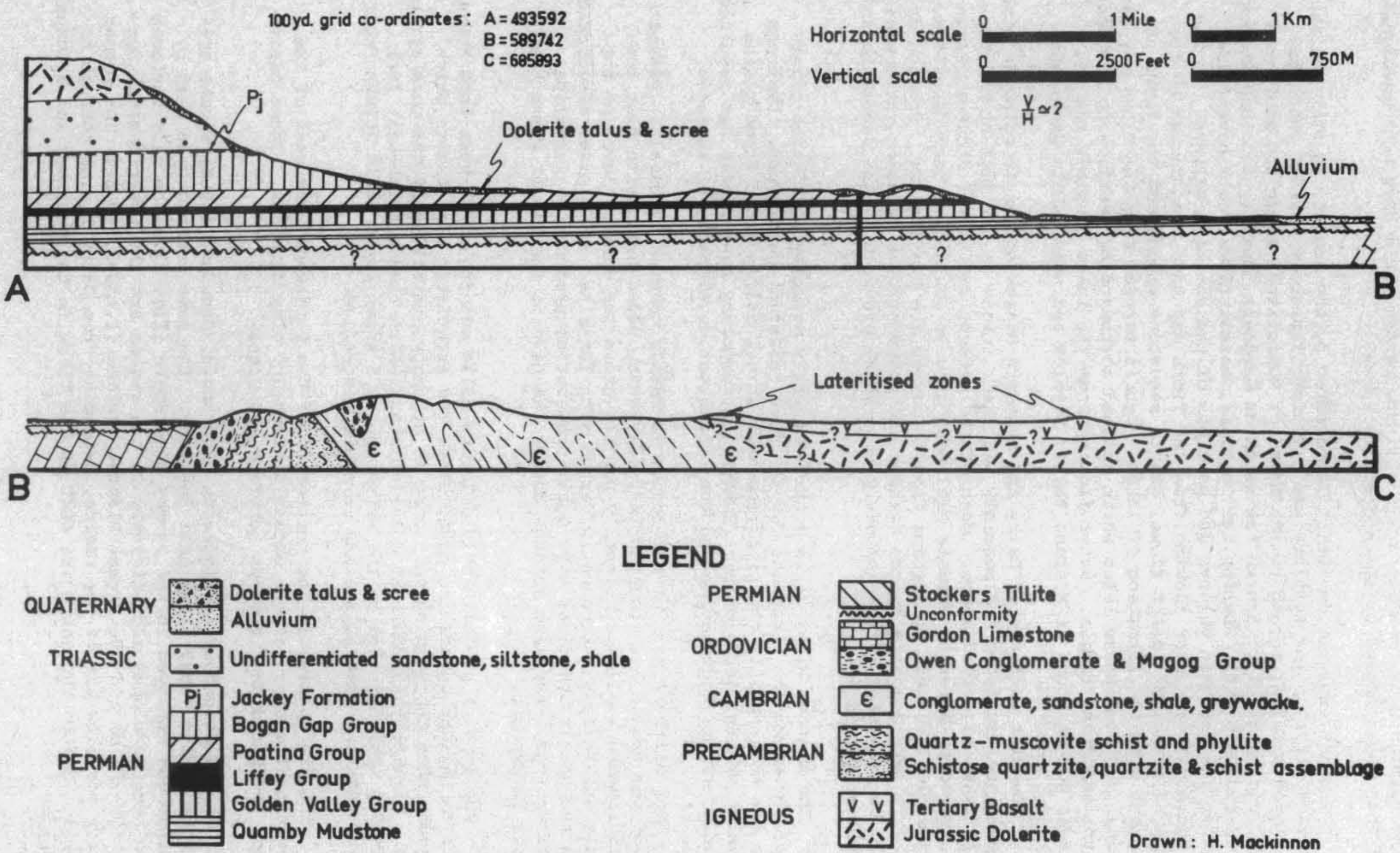

Figure 3. *Geological sections across the Quamby Quadrangle.*

lying Permian beds on which a N-S drainage system could have been developed; and then superimposed on the underlying rocks.

Another explanation, which is favoured by the author, is that the main drainage prior to the Tertiary was E-W along limestone valleys which had developed parallel to and to the north of Pumicestone Ridge and Beefeater Hill, and parallel to and to the south of Gardners, Needles and Long Ridges and Native Hop Hill. During the Tertiary, basalt flows could have filled most of the northern valleys and portions of the southern valleys. In the southern valleys water flowing from the Tiers may have been dammed by the combined effect of basalt flows, quartz sandstone ridges and the Tiers escarpment with the formation of lakes. Debris carried from the Tiers may have gradually filled these lakes which drained northward by overflowing portions of the sandstone ridges. Water flowing from the lakes possibly cut the present gorges found at Montana Falls, Needles and near Cubits Sugarloaf.

The flat surfaces of Dairy and Stockers Plains appear to coincide with depositional surfaces and possibly had their origin as the beds of the Tertiary lakes suggested above. Much of the present surface of Stockers Plain is covered by dolerite gravels but these gravels could have been deposited on the old lake beds by streams flowing during the Pleistocene. Erosion of the soft lake deposits by the Meander and other streams crossing these plains would be prevented by the temporary base level provided by the sandstone and conglomerate ridges.

The Meander River is in a stage of early maturity with knick points at places where the river has cut the more resistant rock types. Upstream from the knick points the river meanders across fairly broad flood plains on which several lakes occur. Removal of temporary base levels has resulted in local river rejuvenation and the consequent development of terraces.

The northern part of the region is mainly covered by basalt. Dissection of the basalt has resulted in fairly steep sided hills with flat tops. Small rounded knolls occasionally project above the general level of the basalt and these are frequently capped with laterite. Hill sides associated with the basalt sometimes show small concavities produced by landslips. Small springs, seeps and marshes border the base of the basalt where the latter is exposed.

The line of predominantly dolerite hills running north-west from McRaes Hills to Lawsons Corner are parallel to and associated with faults which suggests that the physiography here is strongly controlled by the rock structure. Similarly a prominant dolerite scarp which trends north-west from Bogan Gap [687706] lies on the extension of a known large fault (Cluan Fault) thus suggesting that this scarp is fault controlled.

The flat plains in the north-east of the Quadrangle are part of the depositional surface of the extensive Tertiary clay deposits. These plains extend south and east towards Longford and Cressy.

In the neighbouring Middlesex Quadrangle, Jennings (1963) sought evidence of Davies (1959) erosional surfaces. The same technique as used by Jennings was employed in the Quamby Quadrangle (fig. 4). The only surfaces which have developed significantly in the region are the Lower Coastal Surface (90-270 m) and the Higher Plateau Surface (1,130-1,340 m). The former surface occupies 45% of the region, extending from Dairy Plains through to Deloraine and to the north and east of the Tiers in the Westbury and Bracknell districts.

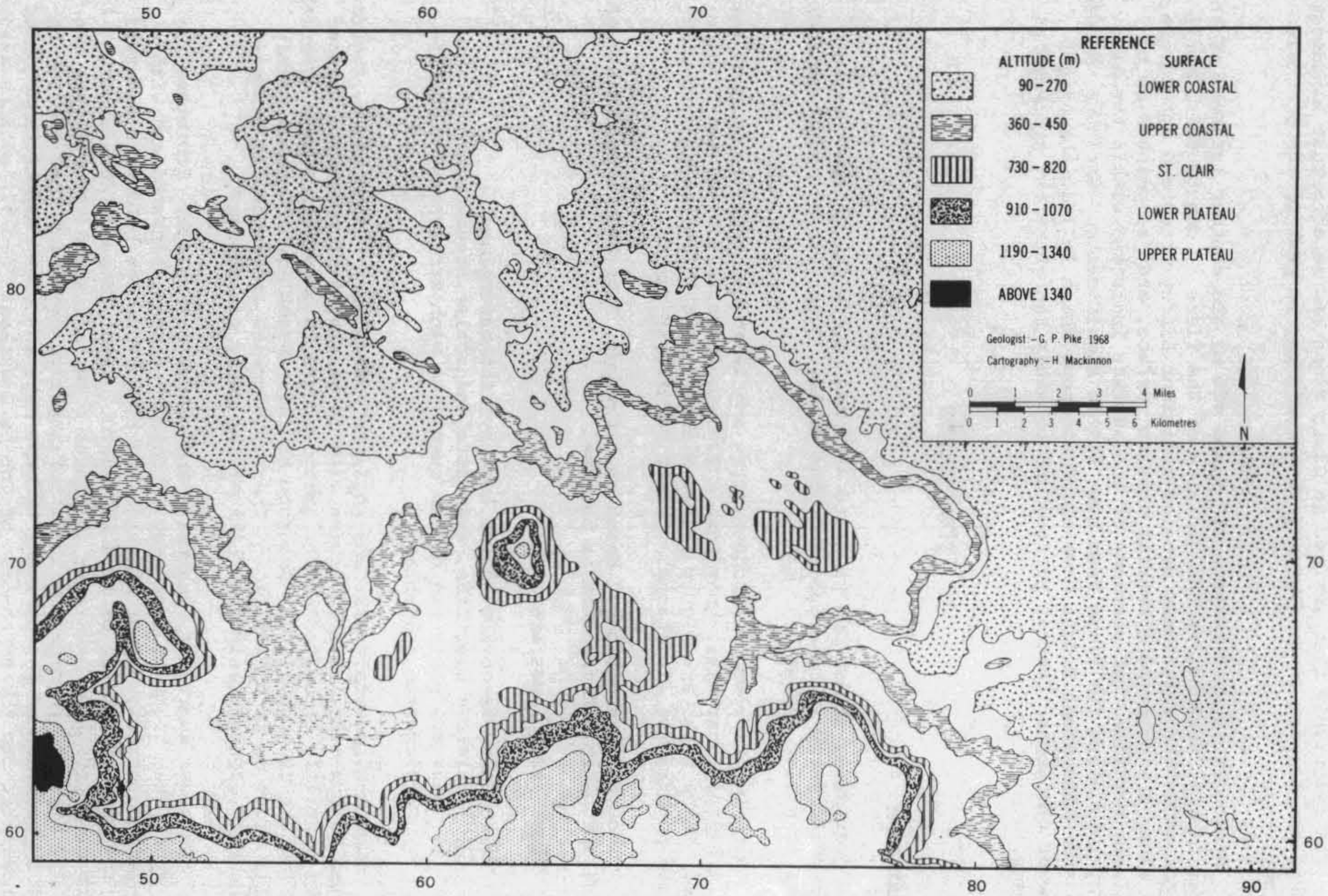

Figure 4. *High-level erosional surfaces.*

The Higher Plateau Surface (1,130-1,340 m) is represented by the surface of the Central Plateau.

The relatively flat surface of Cluan Tiers and an accordant monadnock east of the Meander River (Warners Sugarloaf) may be part of the St Clair Surface.

Bench development between 360 m and 460 m, the contour interval of the Higher Coastal Surface, in the vicinity of the Tiers is due to the removal of beds above the relatively erosion-resistant Liffey Group and not to erosion along a widespread subaerial erosion surface, and, as pointed as by Jennings, verifies that portions of the surface indicated within the main valleys and along the Tiers face have little significance. Gardners, Needles, Long and Pumicestone Ridges have accordant tops which fall in the height range of the Higher Coastal Surface and possibly represent the pre-Permian Surface.

STRATIGRAPHY

Precambrian

Quartzite, schist and phyllite assigned to the Precambrian System occur principally in outcrops at Golden Valley, Quamby Brook and at various points on Native Hop Hill.

Rock types present include massive and laminated white to grey quartzite, schistose quartzite, quartz-mica schist, chlorite schist, and conglomerate. These rocks are highly folded with a strong foliation and two well-defined penetrative lineations. Quartz veining is common.

Three main assemblages, based on lithology, have been mapped although the relationship between them is obscure.

These assemblages are:

(1) Quartz-muscovite schist and phyllite assemblage.
(2) Schistose quartzite, quartzite and schist assemblage.
(3) Massive, platy and banded quartzite with stretched-pebble conglomerate assemblage.

Quartz-muscovite schist and phyllite assemblage. Light brown, coarse-grained quartz-mica and mica schist with large plates of muscovite wrapped around partially elongated quartz grains occurs in association with greenish grey to dark grey phyllite. Outcrops of this assemblage are found mainly on hill sides or in the gullie The ridge crests are generally occupied by the more erosion-resistant rocks of the other assemblages.

Schistose quartzite, quartzite and schist assemblage. Schistose impure quartzite, light to dark grey in colour, banded, lineated and with a well-defined schistosity or micaceous parting crops out boldly on several hill crests to the north of Stockers Plain. Fairly massive (50-225 mm) layers of crystalline dark grey quartzite occur and where these layers are thin (50 mm) and are embedded in either phyllite or schist they are represented by boudins and the elongate tectons make the rock resemble a deformed conglomerate. To the north-east of Cubits Sugarloaf [590787] schists associated with impure sandstones have been brecciated.

Massive, platy and banded quartzite with stretched-pebble conglomerate *assemblage*. The massive quartzite assemblages consist predominantly of white to light grey massive quartzite but also includes platy metaquartzite, laminated quartzite, stretched-pebble conglomerate and minor bands of schist. Sutherland (1965) described a specimen of schist from this assemblage as consisting of 'muscovite 40%, quartz 35%, biotite 20% and garnet 5% with zircon, epidote, rutile and andalusite(?) as accessories'. Three foliations within the rock are delineated by muscovite and sericite and one foliation is characterised by the presence of large brown biotite crystals. Sutherland recognised snowball structure in some of the porphyroblastic garnets which range in size up to approximately 3 mm in diameter.

The Precambrian rocks are overlain with sharp angular unconformity by Palaeozoic and younger rocks. At Golden Valley horizontal basal Permian beds of the Quamby Mudstone rest on highly folded Precambrian quartzites and schists. To the north-west [600791] sandstone and conglomerate correlated with the Ordovician Owen Conglomerate rest with angular discordance on the underlying Precambrian and Cambrian rocks.

The relationship between Precambrian and Cambrian rocks is obscure but in most areas observed the Cambrian beds have rock boundaries which transect those of the underlying Precambrian, thus suggesting an angular unconformity between them.

Cambrian

Rocks assigned to the Cambrian System rest unconformably on Precambrian basement rocks and are unconformably overlain by siliceous sandstone and conglomerate horizons which are correlates of the Ordovician Owen Conglomerate formation.

The main outcrops occur in a belt which strikes ENE and is bounded by Gardners, Needles and Long Ridges to the south and Pumicestone Ridge, Beefeater Hill and Dunorlan to the north.

The Cambrian strata consist of a variable sequence of clastic and pyroclastic rocks in association with both intrusive and extrusive igneous rocks.

The presence of thick sequences of graded-bedded units of greywacke and conglomerate and the occurrence of associated volcanic rocks suggests that rapid deposition occurred in a deepening trough in an unstable environment.

No fossils have been found here to confirm the Cambrian age for these rocks. However, their stratigraphic position and lithologies are consistently similar to beds assigned to the Cambrian System elsewhere in Tasmania.

Wells (1957) considered these rocks to be correlates of the Dundas Group (Elliston, 1954) and defined several formations. However, Marshall (unpublished Department of Mines maps) who re-mapped most of the Cambrian rocks of the area, could not substantiate Wells' stratigraphy. As the stratigraphic succession is still in doubt, this report consists mainly of a summary of the characteristic lithologies of the mappable units.

The Cambrian System has been subdivided into lutite-rich, arenite-rich and rudite-rich sequences. Each sequence contains rock types of variable grain size and lithology as well as some volcanic rocks, but these rock types are subordinate to the rocks of the grain size characteristic of the sequence. Although the relationships between the sequences are uncertain, it should be noted that south of Pumicestone Ridge, conglomerates and graded-bedded sandstone of the rudaceous sequence appears to overlie slate, phyllite and shale of the lutite sequence.

ARENITE-RICH SEQUENCE

Although greywacke beds are ubiquitous through the Cambrian of the area, a sequence of fairly massive greywacke beds forms a distinct mappable unit (€ss)* which generally crops out as either a low, rounded ridge or a linear series of flat-topped hills.

Associated with the greywacke layers are minor beds of puddingstone conglomerate, lithic greywacke conglomerate, lithic-wackes, phyllite, coarse siltstone, slate and volcanic rocks.

The greywacke varies from a light grey to pink colour and consists of well sorted, rounded and angular fragments of rock, vein quartz and feldspar. Dark grey slate, schist, phyllite, quartzite and occasionally chert comprise the predominant rock fragments, and give the impression that the clasts are locally derived. The matrix consists of quartz, feldspar and mica. Alignment of clasts and micaceous minerals gives these rocks a well defined grain which represents a poorly developed cleavage.

The rocks on a flat-topped ridge immediately north of Gardners Ridge are typical of the ubiquitous greywacke sequences. Here, beds of brown, purple and grey greywacke with flakes of phyllite up to 10 mm in diameter in a feldspathic matrix, lie adjacent to beds of laminated, convoluted siltstone, sandstone and shale from 6-12.5 mm thick. To the east at [517840] highly weathered rusty brown sandstone and horizons of quartz granule conglomerate mark the eastern continuation of the sequence. Westwards along the ridge, the greywacke beds become flaggy and conglomerate horizons appear.

Conglomerates, which usually comprise massive beds of rounded to sub-angular fragments of quartzite and schist, are associated with the greywacke sequence. An outcrop of approximately 20 m of coarse breccia conglomerate with minor greywacke beds 0.9-1.2 m thick occur at Lobster Rivulet [475887]. The breccia conglomerate is massive bedded with many angular to sub-rounded blocks of quartzite, 0.6 m in diameter. This bed is overlain by approximately 180 m of dark grey to light tan greywacke layers. Typical lithic greywacke conglomerate of the sequence crop out on a small ridge north of Long Ridge [566810]. Here the rock consists of pebbles and granules of vein quartz with fragments of phyllite in a quartz, feldspar and sericite matrix.

The volcanic rocks associated with the greywacke sequence form two distinct units, one unit is rich in basic material (€vb) the other is an acid unit (€sm). This latter unit forms a good marker horizon.

Basic Igneous Rocks

A belt of greyish green basic lava and pyroclastic rocks (€vb) crop out at Quamby Brook [654752]. These rocks correspond to the Kentish Volcanics of Wells (1957) and are typically chlorite and epidote rich and slightly sheared.

The basic lava is hard, massive, medium-to fine-grained and porphyritic. Crystals of white feldspar, black ferromagnesian mineral and occasional patches of green chlorite bespeckle a grey-green microcrystalline groundmass which consists of very fine grains with similar composition to that of the phenocrysts. The ferromagnesian mineral of the groundmass has been rendered

* Symbol used on Quamby geological map.

semi-opaque by alteration. Scattered large phenocrysts and crystal aggregates of white plagioclase (oligoclase) constitute 15% of the rock. These crystals exhibit zonation and generally are highly altered. Euhedral crystals of augite comprise approximately 8% of the phenocrysts and are often associated with chlorite (8%), and a little epidote. Epidote and quartz occur commonly as veins through the rock.

Associated with the lava are beds of volcanic breccia and tuff consisting of elongate red to green fragments of volcanic ejectamenta in a chlorite, epidote and calcite matrix. The fragments range up to 20 mm in size and consist of fine-grained lavas rich in microcrystalline ferromagnesian minerals and sericite, and sheared lavas rich in chlorite. Some of the fragments show spherulitic growths and have abundant iron oxide. Many of the fragments show sub-rounded borders developed partly by attenuation during rock deformation and partly by reaction with the matrix. The sphericity of the fragments is low. A weak cleavage is present through the rock due to both clast alignment and the strong cleavage developed in the individual clast fragments. The matrix does not reflect this cleavage to a noticeable degree.

Scattered veins of malachite through the volcanic rocks indicate that some copper mineralisation has occurred.

In the far north-west of the Quadrangle a fine- to medium-grained massive crystalline altered dolerite crops out on the northern slopes of the Gog Range. This rock occurs in association with Cambrian phyllite and greywacke and unconformably underlies Owen type sandstone.

In thin section the dolerite shows a marked ophitic texture with sericitised feldspar laths penetrating larger crystals of tremolite-actinolite or uralite (Specimen 68-68). Crystals, crystal aggregates and skeletal masses of magnetite-ilmenite are disseminated through the rock. Masses and veins of epidote and small spherical masses of microcrystalline quartz also occur sporadically.

Within the greywacke sequence a brownish grey, dense, hard bed of acid crystal tuff (€sm) forms a distinct marker horizon. In hand specimen the rock is porphyritic with white crystals of quartz and feldspar approximately 1 mm diameter embedded in a hard, siliceous, dark grey groundmass. These crystals constitute about 50% of the rock. This bed crops out on a hill about 1 km south of Beefeater Hill [555828] and can be traced several miles westwards to Lobster Rivulet.

In thin section (Specimen 69-102) the phenocrysts of quartz appear as euhedral to subhedral crystals with embayed margins. The feldspar crystals are lath-like and have multiple twinning and have been altered to sericite.

Diffuse masses and granules of deeply coloured biotite are scattered through the tuff and no doubt contribute largely to its colour. The groundmass consists of an uneven felty mass of fine quartz, feldspar and sericite with some scattered opaque grains.

The overall fragmental texture of this rock suggests that it is a pyroclastic rather than a lava hence it is considered to be a recrystallised acid tuff.

LUTITE-RICH SEQUENCE

A phyllite and slate sequence (€sp) containing minor beds of tuffaceous, feldspathic and greywacke sandstone and occasionally siltstone and volcanic rocks underlies the rudite-rich sequence.

The siltstone of this unit is pink to yellow in colour and generally soft, laminated and micaceous. Thin sections of these rocks reveal rhythmic alternation of bands of coarse and fine silt. Some of the siltstone beds contain convolute laminae, and north of Needles [505845] layers of fine, thinly laminated sandstone show internal convolutions. The siltstone and fine sandstone beds lie within bands of grey-green phyllite and hard black slate.

The phyllite and slate have generally been tightly folded and form sharp synclines and anticlines with a strong cleavage parallel to the axial surface. Strain slip cleavage occurs fairly frequently in the slate horizons.

Near Lobster Rivulet [465888] layers of slate and fine-grained greywacke of this lutite-rich sequence are interbedded with a fine-grained, pale grey rock which, in thin section (Specimen 68-67), consists of angular and embayed fragments and crystals of quartz, orthoclase and oligoclase-andesine in a structureless microcrystalline groundmass containing glass shards. This fine-grained rock is either a lava or recrystallised pyroclastic rock, which indicates unstable conditions existing during deposition of the sequence.

An intra-formational conglomerate of unsorted (2-20 mm) ellipsoidal pebbles of orange to yellow-brown argillite in a grey-green silty matrix crops out at [616786]. This bed is associated with greywacke and siltstone of the lutite sequence.

Two distinctive mappable units, a grey-green greywacke rich sequence (€sg) and a coarse feldspathic to arkosic sandstone bed (€sf), are also associated with the lutite sequence.

The grey-green greywacke sequence (€sg) which consists of conglomerate, slate, siltstone and greywacke sandstone beds forms a good marker horizon. The greywacke is characteristically micaceous and well cleaved and in thin section (Specimen 68-168) shows medium- to fine-grained muscovite flakes and sometimes biotite flakes wrapped around angular detrital grains of quartz, rock fragments, amphibole and feldspar. The matrix is cloudy and consists of fine grains of quartz feldspar, muscovite, chlorite and tourmaline. The green colour of this specimen is probably due to the relative abundance of amphibole, however, in general the green colour of the foliated and well cleaved micaceous sandstone and siltstone is due to a thin greenish skin which develops on these rocks during weathering.

Wells (1957) described grey-green greywacke sequences from the region and included them in his Thompson Formation.

A coarse feldspathic to arkosic sandstone (€sf) is found associated with greywacke, conglomerate and phyllite of the grey-green successions south of Deloraine [614822]. The sandstone is notably compact and leucocratic and consists of 2-3 mm grains of pink feldspar and white quartz and sporadic larger (10 mm) patches of dark green to black basic material. In thin section (Specimen 68-169) the sandstone is a mosaic of sub-angular grains of feldspar and quartz with a minimum of interstitial material which although largely chloritic contains fine-grained siliceous, ferruginous and epidotic material. The feldspar grains are oligoclase in composition and constitute about 60% of the rock as cloudy, angular to sub-rounded crystals showing both simple and lamellar twinning. Quartz constitutes approximately 30% of the rock and occurs as clear sub-angular grains with peripheral fritting and signs of incipient recrystallisation. Detrital lava fragments and fine chlorite, iron oxides and epidote constitute the remainder of the rock.

RUDITE-RICH SEQUENCE

A rudaceous succession (Єsc) of massive-bedded polymict conglomerate, of varying median grain-size, and greywacke sandstone is well exposed on the south face of Pumicestone Ridge and in a gravel pit about 2.5 km south of Deloraine [613833].

The conglomerate varies in colour from blue-grey to reddish-brown and forms small flat-topped hills with bold rounded outcrops. The pebbles are well rounded to sub-angular and composed predominantly of quartzite, quartz schist and mica schist. Fragments of slate, argillite and porphyry(?) are also fairly common. Coarse conglomerate with clasts with an average diameter of 50 mm have a sand grade matrix similar in composition to the clasts.

Thin sections of granule conglomerate (Specimen 68-40) showed 60-70% of the rock to consist of fairly well sorted fragments of quartzite, quartz schist and mica schist averaging 15 mm in diameter. The remaining 20-30% of the rock consists of smaller well rounded quartz grains. The fragments of schist are usually elongate with angular to sub-rounded form and many have had their extremities drawn out to merge with the matrix. Most of the clasts are closely appressed along their boundaries. Any matrix present is micaceous to sericitic. A hematitic cement has permeated much of the conglomerate sequence and as such has effectively bound the fragments together and given an overall red coloration to the rock.

Most of the conglomerate beds are lenticular. At Pumicestone Ridge a 450 mm thick bed thins to 80 mm over a distance of 0.6 m. Pebbles in the conglomerates have been crudely orientated parallel to an incipient cleavage direction. At [613833] weathering of the conglomerate matrix and schistose pebbles to clay has resulted in the rock becoming weak and easily disaggregated. The disaggregated rock is used as road gravel.

Greywackes and lithic sandstones interbedded with conglomerates are frequently graded. The sandstone is light grey to buff in colour and fairly soft, friable and well sorted and clusters of mica flakes are common. A thin section of sandstone shows it to be composed of sand grade fragments of quartz (50%), quartzite (15%), chert, quartz schist, muscovite schist and argillite, which are angular to sub-rounded and well sorted. The matrix is of clay and sericite and constitutes about 10% of the rock.

At Pumicestone Ridge the upper beds of the conglomeratic sequence are overlain by quartz sandstone and grit containing a variable percentage of porphyry fragments. The character and relationship of the sandstone succession to the conglomerate succession will be discussed in detail later. The beds of both successions have been intruded by quartz-feldspar porphyry. Some of the porphyry probably reached the surface and spread as lava and ash flow over the sediments.

Quartz-Feldspar Porphyry

The rudite-rich sequence is associated with a porphyry (Єva), the Scott Quartz Keratophyre of Wells (1957), (Specimen 68-34), which is flesh pink to deep red in colour with numerous large (5 mm) phenocrysts of feldspar (oligoclase) and colourless quartz in a groundmass composed of intergrown microlites of feldspar (medium labradorite), quartz and interstitial magnetite, glass and possibly pyroxene. Alteration and recrystallisation have affected this rock to the extent that in many samples the broken and embayed, euhedral quartz crystals lie in a felty indistinct quartz-sericite groundmass. The feldspar phenocrysts remain only as lath-shaped patches of sericite.

CAMBRIAN-ORDOVICIAN BOUNDARY, PUMICESTONE RIDGE

At the eastern end of Pumicestone Ridge a sequence of beds of polymict pebble conglomerate, granule conglomerate and greywacke sandstone underlie beds of massive quartz sandstone. The two formations appear to be unconformable.

Evidence for an unconformity is shown by the discordance between the units. The greywacke and conglomerate sequences which are conformable with phyllites and slates of Cambrian age, have both strikes and dips consistently at considerable variance with the overlying quartz sandstone sequence. Ten measurements of bedding orientation in the greywacke and conglomerate beds taken over a strike length of 2.4 km and within 18 m of the quartz sandstone boundary showed a mean strike of 86° (maximum variation 10°) and a dip of between 70°N and 80°S (mean 90°). Measurements of bedding orientation in the adjacent and apparently overlying quartz sandstones consistently showed a strike of 68° and a dip of 47°N.

The boundary between the quartz sandstone unit and conglomerate sequence is exposed at several points on Pumicestone Ridge. At [600835] pink quartz sandstone overlies a conglomerate consisting of rounded pebbles of quartzite, vein quartz and schist. The sand-grade matrix and pebble-grade material of the conglomerate are poorly sorted, and its boundary with the overlying quartz sandstone is irregular, with some of the irregularities varying up to 75 mm from the mean conglomerate-sandstone interface. At [595835] similar layers of conglomerate are rich in porphyry pebbles and the rock sequence contains thin greywacke beds in which sporadic porphyry fragments occur. These fragments are many centimetres in length, have tapered ends and show no obvious signs of water transport. Some of the porphyry in the conglomerate appears to form part of the matrix and wrap around the quartzite clasts.

Discordantly overlying the Cambrian conglomerate beds is a sequence of quartz sandstone, grit and fine quartz pebble conglomerate, over 10 m thick. This succession contains sandy beds rich in worm casts and beds with some clastic grains of quartz porphyry.

The relationship between the two sequences becomes complex towards the western end of Pumicestone Ridge. Here the Cambrian beds at polymict conglomerate are unconformably overlain by quartz sandstone which has been intruded by quartz porphyry. The intruded sandstone is pink to white in colour, fine- to very fine-grained with faintly visible colour banding. In thin section (Specimen 68-37) the overlying sandstone consists of interlocking quartz grains averaging 0.7 mm in diameter which are angular and show some strain but only traces of incipient recrystallisation. The sandstone contains a little interstitial material which consists of wisps of sericite and occasional small patches of pink microcrystalline quartz. The porphyry conglomerate contact exposed at [588834] is an uneven surface parallel to the dip of the overlying sandstone beds which appear to have been disrupted by the porphyry. The cross-cutting relationship of porphyry and sandstone; the dismembered sandstone beds and the occasional concordant porphyry-sandstone boundary suggest that intrusion and possibly extrusion took place in this zone. On a regional basis the rock distribution of the porphyry is such that it appears to cut across the strike of the conglomerate. At [603828] a traverse down the quartzite ridge along a small southward flowing creek with headwaters at the break in the quartzite ridge shows Cambrian conglomerate on the west bank of the creek at the same level as porphyry on the east bank. The conglomerate on this latter bank occurs at a much lower level than that on the other which suggests that either the porphyry is bounded on the east and west by faults or alternatively that it is transgressively intrusive. This latter concept is supported by the local and regional distribution of the porphyry.

Another relationship between the porphyry and the quartz sandstone succession has been noted on Pumicestone Ridge. Porphyry is overlain by quartz sandstone which contains small clastic fragments of the underlying porphyry. Thus erosion of the porphyry is indicated before and/or during part of the upper quartz sandstone deposition. A thin section (Specimen 68-166) cut across the porphyry / quartz sandstone interface shows the sandstone to consist of angular to sub-rounded clasts of porphyry embedded with well rounded quartzite and quartz grains. Heavy minerals such as zircon and magnetite(?) show an increased concentration along the porphyry surface. The percentage of porphyry fragments in the quartz sandstone beds decreases upwards until the sandstone is free of unstable grains about 9 m from the upper surface of the porphyry.

As the porphyries are typical of Cambrian types and some evidence shows that quartz sandstone layers which rest unconformably on polymict conglomerate beds of probable Cambrian age have been intruded by a porphyry, the quartz sandstone may also be taken as being Cambrian in age. The possible sequence of geological events which may explain the relationships noted in this area is:

(1) Deposition of beds of greywacke and polymict conglomerate. Volcanic activity with extrusion and intrusion of porphyry.

(2) Uplift and folding.

(3) Erosion and deposition of pink quartz sandstone.

(4) Intrusion and extrusion of porphyry.

The quartz sandstone succession which unconformably overlies the polymict conglomerate at Pumicestone Ridge has been mapped as a correlate of Ordovician horizons mainly on lithological grounds. However, in view of the evidence obtained in further studies and discussed above the quartz sandstone sequence of Pumicestone Ridge must be considered Cambrian in age.

Ordovician

Correlates of the Owen Conglomerate and the Gordon Limestone represent the Junee Group in the Quamby Quadrangle.

OWEN CONGLOMERATE CORRELATES

Siliceous conglomerate and sandstone of this formation crop out as elongate narrow ridges which trend E-W across the central and western parts of the region.

In most of the region thick white quartz sandstone of this formation is the predominant rock type. The sandstone is generally well-bedded, sometimes cross-bedded and has zones rich in worm casts.

At a number of localities sandstone forms bedding units which vary in thickness from 50-600 mm. Occasionally the beds are laminated. Worm casts generally lie normal to bedding. Cleavage is usually absent but where the beds are more argillaceous, a rudimentary cleavage is developed.

Jointing is widespread in the sandstone layers which are usually very resistant to weathering. However, it has been noted that where joints are spaced at less than 6 mm intervals the resistance of the rock to erosion is considerably reduced. At Pumicestone Ridge white quartz sandstone forms distinctive cliffs 24 m high. The sandstone at Pumicestone Ridge is well sorted, unfossiliferous and forms beds 300-600 mm thick. The beds have numerous quartz stringers and gash veins. A thin section of the sandstone shows polycyclically rounded quartz grains with secondary quartz overgrowths.

In the neighbouring Middlesex and Sheffield Quadrangles, Jennings (1963) named a similar sandstone horizon the Moina Sandstone.

Typical of the conglomerate beds of this unit are those cropping out on Cubits Sugarloaf. Here, impersistent beds of dense, unfossiliferous, white to pinkish, silicified, quartz-conglomerate 1.5-3 m thick are interbedded with massive quartz sandstone. The conglomerate consists of subrounded to well rounded pebbles composed predominantly of quartz and quartzite and rarely slate and quartz schist. The pebbles average 40 mm in diameter and are embedded with a closed framework in a sparse sandy matrix which has become recemented with silica.

The impersistent nature of the conglomerate horizons is also demonstrated on Pumicestone Ridge [585835] where a bed of granule conglomerate 0.9 m thick, lying within massive tubicolar sandstone, is found to thin and eventually disappears along the strike.

Coarse cobble conglomerate associated with granule conglomerate and sandstone of this unit is found unconformably overlying Precambrian rocks on a ridge north of Native Hop Hill [600790].

The Owen Conglomerate correlate attains a maximum thickness of 490 m in the region at the eastern end of the Gog Range and thins to the east and north. In the absence of good type sections the thickness given must be regarded as tentative only.

The unconformity between the conglomerate and sandstone succession of the Junee Group and the underlying rocks is exposed to the north of the Lake Highway [600790] where the Owen Conglomerate correlate rests with sharp angular discordance on Precambrian quartzite and schist. Further north, at Pumicestone Ridge, quartz sandstone of probable Ordovician age (see p. 21) unconformably overlies Cambrian conglomerates. The unconformity between Ordovician and Precambrian rocks is also exposed in a gravel quarry west of Montana Falls. Flaggy, white, shallowly-dipping quartzite beds of the Owen Formation rest on highly folded and lineated quartzite and schist at this locality. The basal bed of the Ordovician sandstone is marked by a thin 0.3 m bed of quartzite breccia consisting of angular quartzite fragments presumed to have been derived from the underlying rocks.

GORDON LIMESTONE CORRELATE

Small outcrops of Gordon Limestone occur on the northern flanks of Gibsons Sugarload and on Stockers Plain near Golden Valley. In both places the fresh rock is blue-grey when fresh and weathers to a light grey or cream colour. It is stylolitic and has a well developed cleavage. Bedding in the limestone is not distinct but where noted at Gibsons Sugarloaf dips 65° NE and strikes 135°. No fossils were found in the beds examined although Wells (1954) reported indefinite forms on etched surfaces and in thin sections. He considered these forms to represent fossil remains.

Wells (1957) reported a limestone quarry south of Deloraine in the Quamby Brook area and this report has been confirmed by the farmer on whose property the quarry occurs. Examination of the region by the author failed to find any evidence of limestone and the 'quarry' can now best be described as a muddy, water-filled depression. At this locality the foundations of old lime kilns can be seen. Substantial faulting would be required to explain the distribution of Gordon Limestone if it occurred in this area, and it may be noted that at least one large fault is known which trends towards the quarry from Spear Hill to the south.

Silurian

A buff to yellow-brown quartz sandstone bed which crops out on the western margin of the Quadrangle [456790] is considered to be Silurian in age. The sandstone bed dips fairly steeply to the west and forms a distinct strike ridge. The rock is fine- to medium-grained, well sorted, unfossiliferous and has an incipient cleavage. This unit is considered to be of Silurian age because in the adjoining Middlesex Quadrangle it is conformable to underlying Gordon Limestone and is unconformably covered by flat-lying Permian beds.

Permian

A succession of Permian sedimentary beds, approximately 600 m thick, is best exposed along the face of the Western Tiers and on Quamby Bluff. Permian rocks have long been recognised in the area and been mapped and subdivided by McKellar (1957) and Wells (1957). More recent revisions of portions of the succession have been made by Clarke (1968) and Bravo and Pike (1969), however, the basic groupings of McKellar have been retained.

The Permian succession is relatively undisturbed with dips averaging 3-5° SW. Between Quamby Bluff and Adams Peak, 10 km to the south, the Blackwood Conglomerate has declined from 790 m above sea level to 640 m and the dip appears to be fairly constant throughout the area giving a regional southerly dip of 15 m per kilometre. MacLeod *et al.* (1961) found the Permian in the Du Cane area to have a regional dip to the south of 10.4 m per kilometre. The apparent anomaly between measured dips and regional dips is probably due to small undetected faults.

Rocks of the Permian System rest unconformably on folded Precambrian and Lower Palaeozoic strata. Clarke (1968) has demonstrated that at Golden Valley the pre-Permian land surface had a high relief and this is probably also true of most of the pre-Permian basement in the region.

Overlying Permian rocks are thick sandstone and shale sequences of the Triassic System. Although the boundary between these two systems is not well defined in the area the relationship appears to be conformable. For mapping purposes the Permo-Triassic boundary is placed at the base of the first massive quartz sandstone unit devoid of carbonaceous fragments and known to overlie the Bogan Gap Group. Massive sandstone and shale beds overlying the Bogan Gap Group which contain abundant carbonaceous particles have been included in the Permian Jackey Formation.

The Permian succession in the Quamby Quadrangle is outlined in the following table.

	Formation	*Rock Type*	*Thickness (m)*
	Jackey Formation	Sandstone and shale	43
BOGAN GAP GROUP	Eden Mudstone	Grey to black micaceous mudstone	6-9
	Blackwood Conglomerate	Granule or pebble conglomerate	1
	Drys Mudstone	Dark grey to black massive mudstone with some sandy beds	100
	Palmer Sandstone	Unfossiliferous sandstone	3-5
	Springmount Mudstone	Hard dark grey mudstone with occasional pebbles	69
POATINA GROUP	Garcia Sandstone	Pebbly to conglomeratic sandstone	9-14
	Weston Mudstone	Micaceous mudstone with bryozoa	9
	Dabool Sandstone	Highly fossiliferous sandstone with erratics	7
	Meander Mudstone	Sandy siltstone, micaceous mudstone and thin sandstone beds	62
LIFFEY GROUP		Sandstone and subordinate shale and thin beds of conglomerate. Mottled quartz-mica sandstone towards top (Creekton Formation)	33-35
GOLDEN VALLEY GROUP	Macrae Mudstone	Siltstone and mudstone	48
	Billop Sandstone	Micaceous sandstone with erratics	8
	Glencoe Formation	Calcareous shale and limestone with erratics	27
	Quamby Mudstone	Pyritic and carbonaceous mudstone with a few pebbles. Tasmanite oil shale.	88-172
	Stockers Tillite	Tillitic conglomerate	0-100

STOCKERS TILLITE

Stockers Tillite crops out on the south-eastern extension of Stockers Plain [626745]. In this area coarse, unsorted, unfossiliferous, tillitic conglomerate consisting of sub-rounded to angular, and faceted pebbles of limestone, quartzite, slate and schist, unconformably overlies folded and cleaved Gordon Limestone. The pebbles range in size up to 250 mm but are commonly 20-50 mm in diameter, and are embedded in a pale grey-brown matrix of quartz, clay and calcite. At Dairy Plains [470764] the basal beds of this formation are exposed where they overlie a sink hole developed in Gordon Limestone. Large (150 mm) angular blocks of the underlying limestone are embedded with rock fragments of a variety of compositions and varying degrees of roundness. At Golden Valley (Clarke, 1968) found that only the lower 3.65 m of the formation consisted of true tillite, the remainder being crudely bedded and sorted suggesting probable water deposition.

Immediately to the south-east of the Quadrangle tillite overlying Precambrian(?) dolomite is exposed in a quarry. The tillite has been traced from this outcrop into the south-east corner of the map sheet by noting the occurrence of boulders.

The thickness of the formation at Stockers Plain is 14 m while at nearby Golden Valley (Clarke, 1968) and several miles south at Poatina (McKellar, 1957) thicknesses of 6.5 m and 103.5 m respectively were recorded in borehole sections. These large variations in thickness can be expected when it is considered that deposition probably occurred in irregular depressions on the pre-Permian surface.

QUAMBY MUDSTONE

The Quamby Mudstone occurs as rather indistinct outcrops in the Golden Valley region and in road cuttings at Creekton at the south end of McRaes Hills. The formation is characteristically a monotonous sequence of dark grey, pyritic and carbonaceous mudstone containing sporadic pebbles of quartzite, slate and schist up to 30 mm in diameter. Fossils are fragmentary and rare, however those found include *Grantonia* sp., *Merismopteria* and *Keeneia*. Scattered glendonites and disseminated pyrite also occur. On weathering the rock disintegrates into small angular pellets.

Approximately 1.5 m of 'Tasmanite' oil shale has been recorded by Wells (1957) and Clarke (1968) 96 m below the base of the Golden Valley Group. This shale unit crops out in the bed of Quamby Brook not far from Golden Valley [657737]. Oil shale has also been reported to have been quarried at Gibsons Sugarloaf. An extensive search by the author failed to find this shale locality, however the geology of the region suggests that oil shale probably occurs.

Clarke (1968) recorded 88.25 m of Quamby Mudstone in a borehole at Golden Valley. At Poatina McKellar (1957) found that this formation varied in thickness between 75 m and 100 m.

GOLDEN VALLEY GROUP

The Golden Valley Group occurs extensively throughout the southern part of the region. It is characteristically a fossiliferous marine sandstone and mudstone unit which lies conformably between the Quamby Mudstone below and the Liffey Sandstone above. It has a thickness at Golden Valley of 83 m which is maintained fairly constantly throughout the area mapped. Outcrops of the Group are generally poor, and in several regions the Group has been mapped on the occurrence of scattered fossiliferous boulders in areas of low relief below the Liffey sandstones.

In a re-appraisal of the Lower Permian at Golden Valley, Clarke (1968) subdivided the group into the Glencoe Formation (at the base), Billop Sandstone and Macrae Mudstone (at the top). The Glencoe Formation consists of richly fossiliferous calcareous shale and limestone with abundant variable sized erratics of wide compositional range. The rich shelly fauna contains *Eurydesma, Grantonia, Keeneia, Strophalosia, Martiniopsis, Deltopecten* and *Aviculopecten,* bryozoan fragments such as *Stenopora,* and crinoid debris.

Overlying the Glencoe Formation is the Billop Sandstone, a thin buff-coloured poorly sorted fossiliferous micaceous sandstone in which erratics are common. Fossils include *Peruvispira, Spiriferella, Grantonia, Myonia, Strophalosia* and fragmental spiriferids, fenestellids, crinoids and rarely *Eurydesma.* This formation has a distinct base and a gradational top; the upper limit is taken as the occurrence of the uppermost large erratic.

The Billop Sandstone is more resistant to erosion than its adjacent formations and although thin, frequently crops out as a fairly narrow but persistent sandstone bench and associated scarp. The formation is well exposed on the northern slopes of Mother Cummings Peak and also east of Bogan Road near Quamby Brook [665740].

The Macrae Mudstone which rests on the Billop Sandstone is characteristically 'a monotonous sequence of poorly-fossiliferous, dark, ill-sorted siltstone and mudstone' (Clarke, 1968). This unit looks somewhat like the Quamby Mudstone and some beds contain abundant disseminated pyrite. Hydroplastic structures and evidence of worm activity are found in beds close to the top of this formation. Good ourcrops of the Macrae Mudstone are rare because the rock readily disintegrates on exposure to the atmosphere to form lenticular fragments.

LIFFEY GROUP

Perhaps the most distinctive mappable unit in the Quamby region is the Liffey Group, which consists of pale brown carbonaceous quartz and quartz mica sandstone and minor carbonaceous shale, 33-35 m thick. These rocks crop out as persistent cliffs, benches and waterfalls along the face of the Western Tiers and in the Liffey Valley.

Thin flaggy beds of fine-grained quartz sandstone, 66-150 mm thick and massive beds, 300-900 mm thick, of soft creamy white, medium-grained, micaceous, quartz sandstone and some beds of coarse, gritty, quartz granule and pebble conglomerate are representative of much of the sequence. In a cliff section in the Liffey Group in the valley of the Meander River just north of Warners Sugarloaf [578695] a layer of pebbly sandstone, 0.9 m thick, is exposed which contains well rounded quartzite and sandstone pebbles in a sandy matrix, interbedded with quartz mica sandstone and subordinate dark grey, carbonaceous, micaceous shale and laminated siltstone. Carbonaceous shale also crops out in the Liffey River, south-west of Bracknell [840670], where the beds have been deformed by dolerite intrusion. The more micaceous and fissile siltstone is often rich in plant fragments. Sandstone and siltstone beds containing abundant worm casts occur as impersistent horizons.

On the northern face of Quamby Bluff [630737] excellent outcrops of both current-bedded Liffey sandstone and lenticular beds of quartz conglomerate occur. The conglomerate beds are approximately 0.6 m thick and consist of well rounded, milky, vein-quartz pebbles, between 50 mm and 100 mm in diameter in a quartz sand matrix.

A mottled quartz-mica sandstone unit considered to be equivalent to McKellar's (1957) Creekton Formation is found towards the top of the Liffey Group. This bed is underlain by a more massive quartz-mica sandstone and overlain by grey mudstone of the Poatina Group. The mottled sandstone varies transitionally from a tough, fairly micaceous, medium-grained sandstone at the base to a slightly more micaceous, silty sandstone rich in worm casts at the top. Thin sections of the sandstone (Specimens 68-221C, 68-222A, 68-222C) examined by Bravo (1969) are of mainly fine- to medium-grain and are composed predominantly of quartzose grains with some mica, feldspar and mudstone fragments.

The sandstone of the topmost unit of the Liffey Group is moderately well-sorted and differs from the sandstone of the lower beds only in the amount of altered muddy matrix contained and in the percentage of sandy siliceous cement which has developed around the margins of the framework grains. The mottled appearance of the sandstone is due to cylindrical worm casts, 5 mm in diameter, which contain silt, mud and sporadic lithic fragments.

The absence of marine fossils and the presence of abundant carbonaceous material in beds rich in current induced sedimentary structures suggests that deposition of the Liffey Group occurred in a fresh water environment.

POATINA GROUP

The Poatina Group consists of 87 m of fossiliferous and erratic-rich marine mudstone and sandstone which conformably overlies the Liffey Group. Excellent outcrops of the Group occur around the margins of the Western Tiers and also just beyond the Quamby Quadrangle boundary at Poatina, the location of the type section for the Group.

The Poatina Group has recently been defined (Bravo and Pike, 1969) as consisting of four formations, Meander Mudstone (at the base), Dabool Sandstone, Weston Mudstone and Garcia Sandstone.

The Meander Mudstone has a thickness of approximately 62 m and consists of alternations of tough, non-fissile sandy siltstone rich in angular to rounded rock fragments, soft micaceous mudstone and thin (150-300 mm) fossiliferous sandstone beds. The mudstone is well bedded and contains sporadic brachiopod fragments. Erratics are fairly common and range in size up to 150 mm across and vary in both shape and composition. Bravo (1969) observed that at Poatina erratics with bladed, disc or roller shapes had their longest axis in haphazard orientation with respect to the bedding.

The mudstone of this formation weathers readily to phacoidal flakes in contrast to the associated siltstone which forms joint-controlled blocky fragments. As a result of the ready breakdown of the mudstone good natural outcrops of this formation are rare. However, exposures occur in road cuttings along Bogan Road [680705] and at the foot of Mother Cummings Bluff [480720].

McKellar (1957) recorded limestone beds from the Meander formation at Poatina. However, no limestone has been found in the Quamby Quadrangle.

The Dabool Sandstone which overlies the Meander Mudstone is a brown to grey, medium-grained, highly fossiliferous sandstone consisting of angular to sub-angular grains of quartz, rock fragments and sometimes feldspar in a muddy matrix. Erratics are common throughout the formation and sometimes form pebbly beds. A rich shelly fauna which frequently forms bands in association with pebbly horizons includes *Wyndhamia jukesi* (Etheridge), *Martiniopsis profunda* (Campbell), *Martiniopsis denmeadi* (Campbell), *Martiniopsis ovata* (Campbell), *Paraconularia derwentensis* (Johnston) and *Grantonia hobartensis* Brown.

The thickness of the Dabool Formation as recorded in bore-hole sections at Poatina (McKellar, 1957) varies from 7.6 m to 12.2 m. However, most field exposures observed appear to have a thickness which is more consistent with the lower limits of this range.

The Dabool Sandstone is fairly resistant to erosion and sometimes crops out as a small scarp with an associated bench. The formation is difficult to distinguish from the Garcia Sandstone which occurs some 9 m above it.

The Dabool Sandstone grades through sandy siltstone and fissile, thinly laminated mudstone and silty mudstone to the overlying bryozoan mudstone of the Weston Mudstone formation.

The Weston Mudstone consists of 9 m of soft, fine, micaceous mudstone which is extremely rich in fenestrate and stenoporid bryozoa. This formation is essentially free of erratics, has a uniform texture and serves as a convenient marker horizon.

At Jackeys Marsh [605674] the Weston Mudstone has such a high concentration of fenestrate skeletons that some of the original calcareous skeletons remain to give the rock a lime-rich appearance.

The upper 1.2 m of the Weston Mudstone contains thin beds of fine brachiopod-rich sandstone, 150 mm thick, which act as passage beds into the overlying Garcia Sandstone.

The Garcia Sandstone is a fairly hard, resistant pebbly to conglomeratic sandstone, 9.1-13.7 m thick, which overlies the Weston Mudstone and underlies the mudstones of the Bogan Gap Group. The top of this formation is marked by a distinctive bench which is persistent over much of the southern portion of the region. Good outcrops of Garcia Sandstone occur at Bogan Gap [680702] near Liffey, the northern slopes of Quamby Bluff and near Meander [518693].

Near Meander, a section through the Garcia Sandstone shows the bottom bed to be 2.1 m thick and to consist of non-pebbly, fossiliferous, sandstone which is medium-grained at the base and fine-grained at the top. It is overlain by 6.1 m of sandstone which becomes progressively richer in pebbles and poorer in fossils towards the top. The grain size increases towards the top of the bed and the sediment becomes muddier and less well sorted. These sandstones are in turn overlain by 1.5 m of fairly well sorted, hard, siliceous, lithic sandstone devoid of fossils. Scattered and fairly large (50-75 mm) pebbles occur. This bed is capped by 1.8 m of fine, soft sandstone and fissile mudstone containing scattered pebbles, which is in turn overlain by a hard, siliceous muddy, poorly sorted sandstone 0.6 m thick on which a topographic bench has developed.

Bravo (1969) states that 'in the type area sandy mudstone, considered to be the top of the Weston Mudstone, is overlain by pebbly to gritty sandstone which contains a few brachiopods, some bryozoa and occasional boulders. This basal unit of the Garcia Sandstone becomes unfossiliferous higher in the sequence where sandy siltstone is interbedded with medium-grained to gritty sandstone. The sandstone contains mainly quartz together with some altered feldspar grains, mudstone fragments and other lithic material, rounded to angular and only moderately sorted. The grain size varies from an average of 0.2 mm to 6 mm. This sandstone is overlain by tough, grey siltstone.'

The top of the Garcia Sandstone at Poatina is a conglomeratic sandstone consisting mainly of poorly sorted, coarse to granular sandstone with a siliceous cement. In places this bed contains well rounded, isolated boulders and cobbles of schist, slate and quartzite which are up to 120 mm in diameter.

The fossiliferous lower beds of the Garcia Sandstone and the Dabool Sandstone contain the same shelly fauna and can only be reliably distinguished from each other when the Weston Mudstone is found between them. For this reason the Dabool-Weston-Garcia Formations generally have not been separated during mapping, although where determined, the Dabool Sandstone has been shown on the geological map.

BOGAN GAP GROUP

The Bogan Gap Group was defined by Bravo and Pike (1969) as 'that group of rocks consisting of the Springmount Mudstone (at the base), Palmer Sandstone, Drys Mudstone, Blackwood Conglomerate and Eden Mudstone (at the top), which has a thickness of 178.4 m and lies conformably between the Poatina Group below and the Jackey Formation above.

The predominant rock type is sparsely fossiliferous medium to dark grey, quartz and mica mudstone (Springmount, Drys and Eden Mudstones) containing a thin unfossiliferous, conglomeratic sandstone (Palmer Sandstone) and a thin, unfossiliferous quartz conglomerate (Blackwood Conglomerate)'.

This Group is well exposed along much of the face of the Tiers and the type area is in the vicinity of a track which climbs from Bogan Gap [682700] in a SSW direction to the Lake Highway.

The Springmount Mudstone is a hard, dark grey mudstone which on weathering changes to a light cream colour. It is a very fine grained, well sorted rock and although essentially unfossiliferous several brachiopods have been found in beds 6.1-9.1 m from the top of the formation near Bogan Gap [703675]. A leaf impression of *Glossopteris* has been found towards the base of the sequence near Huntsman Rivulet [516644].

Pebbles occur sporadically throughout the sequence but are not common. The mudstone varies slightly in the relative abundance of quartz and mica and this variation produces weak bedding.

The Palmer Sandstone, which overlies the Springmount Mudstone is a 3.04-4.6 m thick, unfossiliferous sandstone bed, which crops out as well defined cliffs and benches.

The rock is buff to brown in colour, fairly hard and resistant to weathering. Usually well sorted sand-grade grains of quartz, rock fragments and feldspar predominate particularly at the base of the formation, and is a matrix to numerous well rounded pebbles and boulders of slate, schist, chert, granite, mudstone, quartzite and vein quartz. The percentage of pebbles near the base of the formation is frequently sufficiently high for the rock to be described as a conglomerate. Many of the pebbles range up to 200 mm diameter but generally their size lies between 6.2 and 76 mm. Several boulders of granite, at least 0.6 m diameter, which occur near the foot of a hill below an outcrop of Palmer Sandstone near Bogan Gap [683696] have probably weathered out of this horizon. The percentage of pebbles decreases upwards such that the upper portion of the Palmer Sandstone forms a relatively pebble-free medium-grained sandstone. On weathering, the sandstone becomes light grey to cream coloured and speckled with clay from the breakdown of argillaceous rock fragments and feldspar grains.

A thin section (Specimen 68-220A) of a typical medium-grained sandstone from the Palmer Sandstone west of Blackwood Creek township [800590] was described by Bravo (1969) as consisting of 'moderately well-sorted quartz grains, 5% feldspar, altered mudstone fragments and 2% fine matrix. Discernible overgrowths of secondary silica give the well rounded quartz grains an angular outline'.

Although the Palmer Sandstone is a distinct lithological unit there is some lateral variation in the percentage of pebbles to matrix, the degree of sorting and the thickness.

The Drys Mudstone (99.7 m) rests on the Palmer Sandstone and consists mainly of dark grey to black, massive-bedded, unfossiliferous quartz mudstone. The mudstone is hard and contains angular fragments of clear quartz. On weathering, the rock becomes light buff in colour. Spheroidal weathering is common where the beds are well jointed. These joints are generally iron stained.

The basal beds of the Drys Mudstone are of hard, dense, very fine, dark grey to black quartz mudstone in which weathered fragments of clear glossy quartz occur. These fragments are usually 1-1.5 mm diameter but range up to 3 mm diameter. The basal mudstone is sufficiently hard to be used as road gravel and has been quarried near the Huntsman Rivulet [506638] and at Jackeys Marsh [615660].

Approximately 30 m below the base of the overlying Blackwood Conglomerate the mudstone becomes sandy and in several localities forms a distinct bench. This horizon which is rich in worm casts, is well exposed near Cluan Tiers [710795]. Coarse silt to fine sand occurs in some of the beds and in parts has given rise to a mottled streaky texture formed by convoluted and drawn out wisps of dark coloured mudstone in the siltstone. Pods, knots and nodules of coarse sand also occur in the silty mudstone. The nodules are up to 60 mm in diameter and have irregular boundaries. They contain aggregates of rounded, granular rock fragments 2-3 mm in diameter and angular to sub-rounded quartz in a grey, fine sandy matrix. These structures may be due to hydroplastic deformation.

Towards the top of this formation thin beds of sandy mudstone and fine sandstone occur interbedded with the more typical featureless mudstone. Near Jackeys Marsh [620655] a 1.5 m thick bed of medium to coarse sandstone is overlain by a sequence of interbedded layers of fine sandstone and mudstone, 6.1 m thick. These beds appear to be transitional into the 0.9 m thick coarse grit and conglomerate of the overlying Blackwood Conglomerate. Elsewhere the Drys Mudstone appears to retain its characteristic muddy nature right to the base of the conglomerate.

The Blackwood Conglomerate is a hard siliceous granule to pebble conglomerate formation which underlies the Eden Mudstone and overlies the Drys Mudstone. It consists mainly of well rounded pebbles of vein quartz, with minor quartzite, slate and chert fragments in a sparse sand to silt grade quartz matrix which frequently has been cemented with silica. The cement is generally red-brown in colour due probably to the presence of very fine iron oxides. The rudite particles generally have an average grain size of 5 mm but range up to 40 mm in diameter.

This formation varies in thickness from 0.9-1.5 m and forms a distinct topographic bench. This bench in combination with the distinctive lithology of the rock makes the Blackwood Conglomerate an excellent marker horizon. The formation is well exposed in a small creek bed [662662] where the river has cut a waterfall into the conglomerate bench.

The uppermost formation of the Bogan Gap Group is the Eden Mudstone which is well exposed on the northern slopes of Projection Bluff [657678]. The mudstone is grey to black, micaceous, and contains brown to white patches of fine sandy material and worm casts. The sandy patches were probably formed by worms reworking thin sandy beds.

The mudstone is hard, unfossiliferous, devoid of erratics and weathers characteristically to cuboidal fragments bounded by conchoidal fracture surfaces.

This unit is 6.1-9.1 m thick and is generally poorly exposed. The boundary between the Eden mudstone and the overlying Jackey Formation has not been observed in the area.

JACKEY FORMATION

The Jackey Formation consists of a series of beds of sandstone and shale which lie between the Bogan Gap Group and the Triassic System. Exposures of this formation are poor, the best observed being in the headwaters of one of the tributaries of Jackeys Creek [663660]. In this region, yellow brown quartz and mica sandstone, grit and feldspathic sandstone which weather to a creamy white, are interbedded with dark grey carbonaceous shale.

The siliceous sandstone is well sorted and frequently cross-bedded and south of Stella Glen [656675] forms small benches. The feldspathic sandstone is well sorted and contains abundant mica, plant fragments, carbonaceous material and occasionally mud pellets. The shale is dark grey to brown in colour, thinly laminated and is rich in mica and carbonaceous material. No coal seams were found in this formation in the Quamby region. The proportion of sand to shale and the thickness of this formation appears to vary along strike. In the type area McKellar (1957) estimated the thickness of the Jackey Formation to be 43 m.

Some difficulty was experienced by the writer in determining the upper boundary of this formation because some beds in the overlying Triassic System are similar to those of the Jackey Formation. The boundary is placed at the change of slope at the base of the first cliffs of massive quartz sandstone found above carbonaceous beds.

Triassic

Rocks assigned to the Triassic System outcrop extensively along the face of the Western Tiers, and on Quamby Bluff and Cluan Tier. The outcrops are generally in the form of massive cliffs which are a distinctive part of the topography. Although outcrop and exposure of the Triassic System are excellent for practical convenience this System has been mapped as a single unit. McKellar (1957) on the basis of bore holes and mapping established four major units in the System and these have been summarised as follows:

Formation	*Rock Type*	*Thickness (m)*
Brady Formation	Feldspathic sandstone and dark grey shale in approximately equal proportions. Carbonaceous shale and coal bands are common.	165

Formation	*Rock Type*	*Thickness (m)*
Tiers Formation	Alternations of grey-green shale and non-carbonaceous feldspathic sandstone.	85
Cluan Formation	Fine- to medium-grained quartzose sandstone interbedded with dark grey shale and occasional siltstone, the ratio of arenite to lutite being 1 : 1 with gradation from sand-rich at the base to shale-rich at the top.	140
Ross Formation	Impure, medium-grained quartz sandstone which crops out as persistent cliffs.	198

All the rock types of the above formations occur in the Quamby region.

Near Quamby Brook [663763] the basal Triassic rock unit is a brown to pinkish, well sorted, impure, medium-grained quartz sandstone which is cross-bedded. On weathering the rock becomes friable and white speckled due to the breakdown of feldspar and argillaceous rock fragments. No conglomeratic beds occur here.

On Cluan Tiers south of Fern Bank, cross-bedded, impure micaceous quartz sandstone of the basal Triassic beds is overlain by coarse to fine granule-grade, quartz and mica sandstone consisting of rounded quartzite and other rock fragments up to 5 mm diameter in a quartz and mica matrix. These beds are rich in clay pellets up to 20 mm diameter. Mud pellet conglomerate also crops out south of Bracknell [853694] and occurs as boulders at Cluan [765777].

On the Lake Highway [670676] the basal Triassic units consist of massive, well sorted quartz sandstone overlain by alternating beds of massive cross-bedded sandstone and flaggy micaceous sandstone and siltstone. The massive quartz sandstone beds are generally light grey when fresh and weather to a cream or brown colour. The sandstone rock types are typical of those found as persistent cliffs throughout most of the area.

The Triassic rocks which form much of the southern portion of Cluan Tiers are characteristically fine- to medium-grained, cross-bedded quartz sandstone in which brown to grey shale containing numerous plant fragments occur. The shale bands are impersistent in outcrop and appear to have been stripped away to leave the more resistant sandstone beds as benches.

Tertiary

Inter- and Sub-Basalt Gravels, Siliceous Conglomerate and Sandstone

Gravel beds (Tg) consisting of well sorted quartzose pebbles in a quartz-rich grey brown sandy matrix, and sandstone occur both beneath and between the Tertiary basalt flows.

In the McRaes Hills, Black Hills and Tea Hills districts quartzose gravel occur beneath basalt outcrops. Several isolated patches of pebbles which occur near to and on the same level as the known sub-basalt gravel have also been mapped as such. These pebble patches contain fragments of quartz, quartzite, silicified wood, agate and occasionally ironstone pellets.

A lithic sandstone (Ts) which crops out as small rounded hills at Fern Bank consists of well sorted, medium-grained rock fragments in a sparse clay matrix. This sandstone is fawn to brown in colour and fairly friable. Although no fossils have been found to confirm the age of the rock it is similar to sandstone from nearby areas which have been identified as Tertiary. These rocks disintegrate on weathering to form a white to light grey sandy soil. A good example of sub-basalt sandstone occurs beneath basalt in a road cutting [860889]. This rock is poorly compacted and shows good cross bedding.

A 0.9 m thick bed of inter-basalt fine tuffaceous(?) sandstone containing angiosperm leaf impressions crops out near Dairy Plains [475803].

Recrystallisation and silification of Tertiary gravel and sand by hydrothermal solutions introduced by the basalt has occasionally resulted in the formation of hard quartzite or quartz conglomerate (Tc) of the 'grey-billy' type. These rocks are well exposed near Exton [662862] where large blocks, collected by farmers from their paddocks, have been dumped on the hill top. A small patch of rock consisting of pebble, granule and cobble conglomerate and vein quartz in a grey 'fused' quartzite matrix, and siliceous conglomerate boulders up to 0.9 m diameter which occur at [910861], have also been included in this unit.

Lateritisation

Evidence of lateritisation is widespread through the northern and eastern parts of the region and has affected Tertiary basalt, Jurassic dolerite and Tertiary gravel and sand.

Laterites which have developed on the basalt are fairly massive and usually bauxitic. Thick dark red pisolitic laterite caps a small hill at Exton [664862] and also several hills to the south-west.

Massive laterite also occurs on dolerite but is more frequently found as gravel consisting of rounded limonitic pebbles approximately 12 mm in diameter. These gravels have been excavated and used as road material.

Iron cementation of gravel and sand at Exton is probably directly or indirectly related to lateritisation. Pieces of iron-cemented pisolite containing quartzite pebbles and cobbles are also found as sparse fragments lying in paddocks near Needles [514820].

Clay and Sandy Clay

Most of the extensive plain which lies to the east and north-east of McRaes Hills is underlain by thick Tertiary beds composed of clay, sandy clay, sand and lignite (Tcl).

A gravity survey over the northern and eastern sectors of the Quamby region (Longman; Leaman, 1971) showed the existence of a deep NE-trending basement trough covered by Tertiary clay. Recent deep drilling in this trough east of Bracknell confirmed that the Tertiary beds extended to a depth of approximately 520 m (W.L. Matthews, pers. comm.).

The Tertiary deposits of the northern and north-eastern parts of the Quamby region have been drilled extensively as part of a detailed survey of the Longford Basin by W.L. Matthews and W.R. Moore (Appendix 1).

Quaternary

The Quaternary rocks of the Quamby region consists principally of alluvial deposits on riverine plains and deposits due to mass movements associated with escarpments.

Talus and Scree deposits

Mass wasting of the dolerite cliffs of the escarpments of the Great Western Tiers, Cluan Tiers and Quamby Bluff has produced extensive deposits of dolerite talus (Qtd). This talus, which consists of weathered and unweathered, usually joint-bounded dolerite blocks and yellow-brown to red-brown clay, may extend downslope from the cliff bases as tongues or mantles.

The talus of Quamby Bluff consists of a mass of variable sized blocks of dolerite, many up to 6 m across and sporadic quartz sandstone blocks of similar size, in a clay matrix. The sandstone blocks have been derived from the Triassic sandstone cliffs which occur downslope from the dolerite scarps. On the margins of Stockers Plains [601733] several disorientated sandstone and dolerite blocks rest erratic-like on the Permian basement and attest the transporting potential of the talus slide.

Most of the lower slopes of dolerite capped scarps have a predominantly dolerite talus but sometimes the percentage of fragments derived from beds lower than the dolerite can be a significant proportion of the talus as illustrated by the sandy dolerite talus cropping out along the road at Liffey. Some of the non-dolerite fragments probably became incorporated in the talus by hill wash.

South of Westbury and in the west Bracknell district talus consisting of angular blocks of dolerite in clay are thought to overlie solid dolerite. Small areas of recent sand and lateritised zones which could not be mapped separately, have been included in this talus.

Scree found immediately at the foot of the dolerite cliffs consists of an unvegetated accumulation of unweathered dolerite fragments derived mainly by frost wedging from the scarp face. The scree fields have not been differentiated on the map.

McKellar (1957) reports that drilling in some dolerite scree and talus in the vicinity of Poatina proved the deposits to be over 152 m in thickness.

Talus consisting of angular blocks of quartz sandstone in a light grey sandy soil is usually found close to the base of Triassic sandstone scarps. Where these deposits are significant they have been indicated on the map (Qts). Near Liffey [755672] a large sandstone talus mantle contains zones of crudely bedded and poorly sorted lenses of sand and gravel (Qtst). These beds show evidence of limited water transport and have probably been derived by sheet erosion of higher levels of the talus deposit.

Sharp ridges of quartzose Ordovician and Precambrian rocks have portions of their slopes covered by fairly fine (averaging 50 mm across) fragments of quartzite, sandstone and vein quartz. On the northern slope of Needles Ridge talus deposits of this type are of sufficient depth to be excavated for road gravel and rail ballast.

The landslip masses and talus associated with the basalt margins consist of sporadic rounded and weathered boulders of basalt in a fertile red soil and have been differentiated on the map as Qtb.

Material eroded from the face of the Western Tiers has been spread as an alluvial sheet on the scarp pediment. The deposits consist of dolerite boulder beds (?Qd), dolerite gravel (Qag) and sand, silt and clay (Qa).

Pleistocene? Dolerite Boulder Beds

Areas covered with scattered, large (up to 0.6 m in diameter) dolerite boulders in the vicinity of Blackwood Creek township have been mapped separately (?Qd). The deposit consists of large dolerite boulders, cobbles and gravel in a golden-yellow, gritty clay matrix which has largely resulted from decomposition of dolerite. The matrix contains some pisolitic ironstone and occasionally larger fragments of lateritic ironstone. Most of the coarser boulders have a clean unweathered skin whereas the smaller fragments are usually deeply weathered. A drainage trench on the Iveridge property [840602] shows the boulder beds to consist of a closed framework of boulders of deeply weathered dolerite in a matrix of pisolitic ironstone gravel, and clay formed from dolerite disintegration. This deposit rests as a thin sheet on Permian mudstone and sandstone.

The origin of this deposit is perplexing. Nicolls (1959), in a soil survey, referred to soils in the area as resting on stony alluvial fans. The presence of three large creeks, Blackwood, Garcias and Brumbys Creek, flowing eastwards from the Tiers, through the deposits support an alluvial fan origin. However, there is no evidence that the deposit thickens as a wedge back towards the foot of the Tiers. Air photo interpretation of the morphology of the region suggests that topographic modification has been caused by sheet-flooding associated with the above creeks.

The origin of unweathered boulders in the deposits in conjectural but might be explained as due to reworking of the talus material during sheet flood activity.

Longman (1966) interpreted a similar dolerite pebble conglomerate cropping out in the Launceston Quadrangle as a Tertiary mudflow deposit. The limonitic material contained therein was considered to have been derived from hills adjacent to the depositional site.

Bravo (1969) considered that the deposits in the Garcias Creek area are essentially Pleistocene mudflow deposits which gained the mixed fresh and weathered boulders, limonitic pisolites and laterite fragments from streams which reworked Tertiary material during mudflow development.

On both Stockers and Dairy Plains significant areas are covered by a thin sheet of silt and sand which is underlain by rounded water-deposited dolerite gravel. The gravel must have been deposited by streams of greater competence than those flowing at present and it is suggested that most of the transport and deposition occurred during the pluvial stage which followed Pleistocene glaciation. Entrenchment of a rivulet east of Gibsons Sugarloaf [475764] has exposed approximately 3 m of gravel resting on flat-lying Permian mudstone and overlain by 0.9 m of grey brown silt.

Alluvial and Other Deposits

Sand and silt occur on the flood plains of the Meander and other rivers, and river terraces of quartz gravel and sand (Qat) have been identified at several points along Lobster Rivulet.

Semi-consolidated Quaternary clay, silt and sand (Qa) cover many of the flat-lying areas of the Quamby region thus obscuring the underlying rocks. The flat-floored valley between the McRaes Hills and the Western Tiers was drilled with a proline drill to find whether Quaternary alluvium was obscuring Tertiary clay. The drilling showed that Permian and Triassic beds occurred at shallow depths beneath the alluvial sheet.

Ironstone lag (Qal) occurs at several localities in the region. East of Montana [545775] blocks of massive, precipitated iron oxide, 150 mm across are found lying scattered on the soil surface suggesting that the soil has been washed or blown away to leave the ironstone as a residual. Rounded limonite pebbles, derived possibly from the erosion of an old lateritised surface are found frequently as lag on the surface of the Tertiary clay (Tcl).

Windblown sand and sand derived from nearby Triassic and Tertiary sandstone (Qs) form a thin blanket over several small areas in the region. One such deposit near Carrick [860889] appears to have been derived by wind transport and deposition of sand weathered from nearby sub-basalt Tertiary sandstone.

A friable limestone (Qml) surrounds freshwater springs at Stinking Springs [831644]. The limestone is limited to a small area surrounding the spring and was examined by Dr. P.G. Quilty who concluded that the calcium carbonate was organically deposited and noted amongst the numberous organic remains the occurrence of a gastropod, *Lenameria*, known from recent non-marine sediment in Tasmania, and a freshwater ostracod, *Eucandona*.

A chemical analysis of the limestone was made at the Department of Mines Laboratories, Launceston:

	%		%
SiO_2	1.9	CaO	52.8
Fe_2O_3	0.49	CO_2	42.7
Al_2O_3	0.24	H_2O	0.29
MgO	0.83		

As the name implies Stinking Springs has a rather unpleasant odour and this is due to the release of appreciable quantities of hydrogen sulphide gas from the water. The water probably becomes charged with sulphides and carbonate as it moves as groundwater through pyritic and calcareous beds of the Lower Permian succession which crop out nearby.

The dolerite surfaces of the Central Plateau, Cluan Tiers and Drys Bluff are covered with small water filled depressions in which sphagnum moss and other vegetation has accumulated. Decaying vegetation and inwashed clay and fine silt form marsh deposits (Qm) in these depressions.

STRUCTURAL GEOLOGY

The pre-Permian rocks of the Quamby region are folded mainly along WNW-ESE trending hinges. Permian and younger beds are flay-lying to gently dipping.

The Precambrian rocks are tightly folded and have a well developed foliation and show penetrative lineations. The schistosity and lithological trends are broadly similar in trend to those of the folded Palaeozoic strata and of Tabberabberan age but generally trend about 10° more towards E-W. The first order structures in the Precambrian rocks are difficult to determine because outcrops are confined to a number of small inliers. However, small scale folds approximately 0.3 m in wavelength are fairly numerous. At Golden Valley [647734] these minor folds vary from 0° to 90° in their plunge towards the south-east. One fold in quartzite with a wavelength of 150 mm plunges 70° at 130°, and in nearby crenulated phyllites, the minor folds have axes which are vertical. Thin quartzite beds in phyllitic schists have been deformed to produce boudins such that the resulting tectons have become surrounded by a schistose matrix.

North of Native Hop Hill [607774] fairly argillaceous schistose quartzite with horizons of schistose light grey quartzite show strong herringbone kink bands which parallel the schistosity as a strain slip movement.

Beside the Lake Highway [640743] a platy metaquartzite is folded along a nearby horizontal axis trending 325°. Two lineations exposed in these rocks trend parallel to and normal to this axis. Further to the north [630752] NW-plunging folds show variation in plunge from 0° to 45°.

West of Barretts Bridge [597789] deformed Precambrian quartzite pebbles and cobbles define a distinctive lineation trending north-east. The Precambrian lineations and most of the structures in the Precambrian rocks do not appear to be closely related to the folds of Tabberabberan age.

The Cambrian rocks exposed in the region are generally tightly folded and have been slightly altered through low grade regional metamorphism. The fold style is similar with slaty cleavage being well developed in the more pelitic horizons. The fold limbs generally dip at high angles and in several areas overturning has occurred.

Strain slip cleavage has developed in some of the slate horizons and at Lobster Rivulet trends 190° and dips 80° NW. a small tight anticline at this locality has a hinge line striking 110° and plunging 25°E.

The more competent Cambrian greywacke beds form broader folds and the cleavage throughout these rocks is generally weak. On a small ridge east of Lobster Rivulet [475865] folds in flaggy greywacke and interbedded sandstone, siltstone and argillite are asymmetrical, have nearly vertical axial surfaces, wavelengths of approximately 1.5 m and a weak cleavage parallel to the axial surface.

The angular unconformity between Cambrian and Ordovician strata indicates a period of deformation prior to the commencement of Ordovician deposition. This tectonic activity may be responsible for some of the regional schistosity in the Cambrian rocks even though the schistosity is parallel to the Devonian Tabberabberan fold trends.

The Junee and Eldon Group beds were strongly folded during the Tabberabberan Orogeny with the result that the competent Owen type sandstone now forms broad concentric folds accompanied by break thrusts. Several orders of folding are represented varying from first order structures with wavelengths of many kilometres to mesoscopic folds with wavelengths of a few metres.

A syncline which lies south of the easterly extension of the Gog Range has a wavelength of approximately 10 km and is probably an eastern extension of the Mole Creek Syncline (Jennings, 1963) which is more fully exposed in the adjoining Middlesex Quadrangle. The beds of the Gog Range area represent the northern limb of this syncline and have dips which average 55°S. The core of the syncline is represented by occasional outcrops of Gordon Limestone and undifferentiated Silurian(?) beds in the Dairy Plains region. At Gibsons Sugarloaf [466770] the limestone beds dip east at from 10° to 65° and have a well developed nearly vertical slaty cleavage which strikes at 120°. The southern limb of this fold is obscured by the Permian and younger overlying rocks of the Tiers.

A complementary anticline with a wavelength of 2.4 km lies to the north of the Mole Creek Syncline between Gardners Ridge and Beefeater Hill. Folded Cambrian greywacke, slate and lava lie in the core of this fold. In the Lobster Rivulet region a thrust fault at the base of the correlate of the

Owen Conglomerate is needed to explain the anomaly in dips between the Cambriwn and Ordovician beds. The movement along the thrust plate would have been to the north.

The ridge to the north of Native Hop Hill [600790] is structurally a small, fairly symmetrical syncline in Owen type sandstone and conglomerate. It plunges shallowly to the east and dies out towards the west.

The more massive competent beds of the region are highly jointed. At a point on Needles Ridge [826520] the joints are closely spaced with a 6 mm parting. Many joints are quartz filled and sigmoidal gash veins are common.

The relationship between the Cambrian and Precambrian rocks at Golden Valley [653744] is a faulted one. The faults here are pre-Permian in age and lie sub-parallel to the major fold trends.

About 3 km south of Deloraine [602830] a well defined N-trending vertical fault cuts the Cambrian and Ordovician beds. The fault does not cut the Tertiary basalt.

Several previous workers have reported Gordon Limestone from a quarry at Quamby Brook [644804] although the writer found no positive evidence of it. If this limestone does occur where reported then several faults of considerable magnitude must be inferred to explain its structural setting. Evidence for large faults in the region is not strong although a fault with a throw of about 243 m recognised at Spear Hill trends towards the limestone(?) area and may be effective there.

Block faulting along NW and NE trends has displaced Permian and Triassic beds in the eastern part of the region.

The NW-trending faults generally downthrow to the east and are larger and more persistent than the NE-trending faults and have given the easterly region a NW-SE physiographic grain.

Photo linears produced by ridges and elongate marsh-filled depressions occur in association with the dolerite of the Central Plateau, Cluan Tiers and the McRaes Hills. These linears lie parallel to the major fault directions and hence are probably related to the faulting.

The Tiers Fault is one of the largest and most significant of the NW-trending faults. The fault zone can be traced north from McRaes Hills to the Osmaston Road, a distance of 25 km and both Triassic and Permian beds have been displaced to the order of 365 m. Matthews (pers. comm.), has found no evidence of significant dolerite displacement and suggests that considerable amount of movement took place along the fault prior to or concomitantly with Jurassic dolerite intrusion.

Recent drilling 4 km east of Bracknell found Triassic sediment about 520 m below the surface. This infers a fault of approximately 520 m throw between the drill site and Triassic rocks cropping out on the eastern margin of McRaes Hills. This fault is presumed to have a NW-SE trend and forms part of the margin of the Longford Basin in which thick Tertiary clay has been deposited.

Several faults with large displacements occur to the west of the Tiers Fault and are parallel or sub-parallel to it. On the south-eastern end of Cluan Tiers a talus tongue obscures a fault with a throw of at least 60 m; several miles to the west the WNW-trending Cluan Fault (McKellar, 1957), with a throw of approximately 245 m, has faulted the Poatina Group beds against Middle Triassic sandstone and shale. A dolerite scarp at the south end of Cluan Tier [684710] lies along this fault line which suggests that this scarp is fault produced and that the faulting is post-Jurassic. A fault on the lower slopes of Drys Bluff has a swing in trend from NW-SE to NNW-SSE and a downthrow to the east of about 75 m.

At Spear Hill [652786] a steep NW-trending fault has brought dolerite and Liffey Group sandstone against Cambrian greywacke and volcanic(?) rocks. This fault has a downthrow to the east of at least 245 m and is post-dolerite.

On the western flank of Quamby Bluff a concealed fault with NW-trend has a downthrow to the west of approximately 76 m.

Approximately vertical faults with a NNE trend cut part of the eastern sector of the region. A large fault with this trend at Liffey [790668] has a throw which varies from 45 m to 200 m along its length and acts as the surface against which several NW-trending faults die out. The pattern of block faulting in the Liffey area is shown in Figure 5.

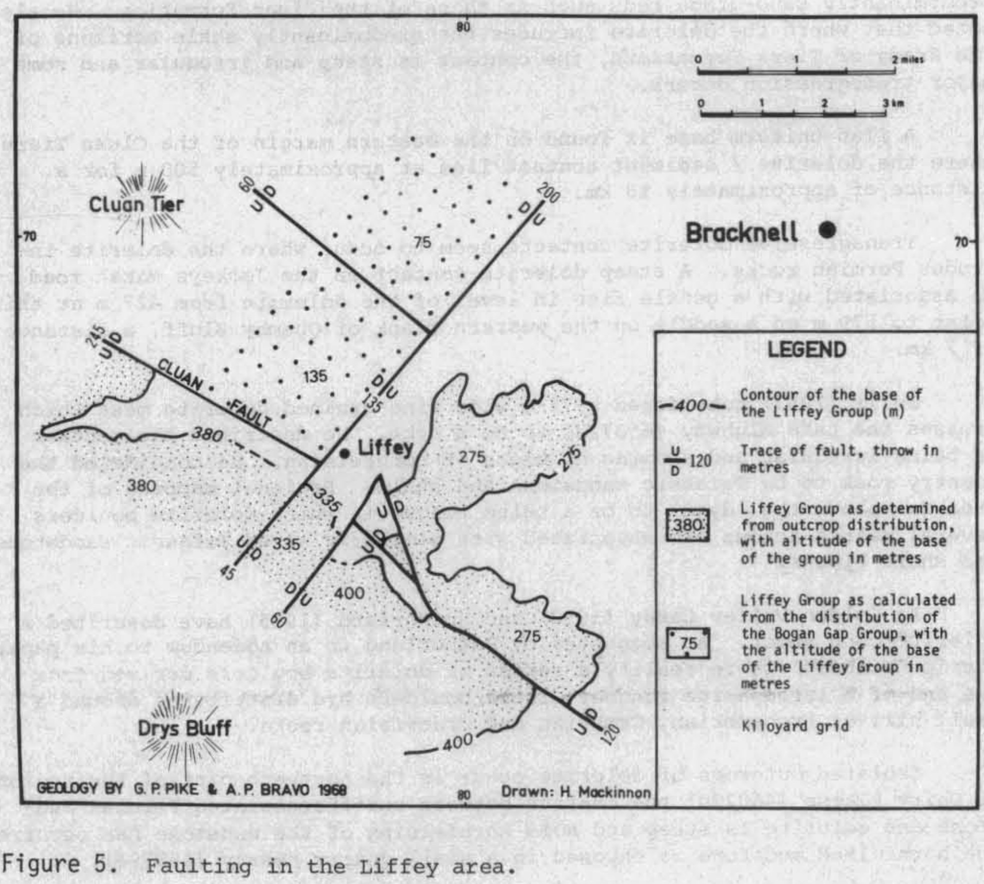

Figure 5. Faulting in the Liffey area.

Most of the block faulting in the region was probably associated with Tertiary epeirogenesis with some movements possibly occurring along pre-existing Jurassic fault lines.

IGNEOUS ROCKS

Jurassic Dolerite

Dolerite occurs as thick, fairly flat-lying sill-like sheets which have intruded both Permian and Triassic strata. The upper surface of the dolerite has been exposed by erosion of the overlying beds and is itself eroded. Although the lower contacts of the dolerite are generally covered by a thick accumulation of scree and talus reasonable interpretations of the position of this base can be made from the physiography and from isolated zones where the base is exposed.

Along the Tiers excarpment the dolerite base shows a general uniformity in level. On Mother Cummings, Projection and Drys Bluffs the dolerite base lies between 1,005 m and 1,127 m above sea level and this level is maintained at 1,005 m on Quamby Bluff, a northerly remnant of the escarpment.

McKellar (1957) noted that the dolerite / sediment contact extends without a major transgression from Drys Bluff southward to the Palmer track. He considered that the uniformity in contact is related to the rock type intruded; the dolerite generally being non-transgressive where it intrudes predominantly sand-grade beds such as those of the Cluan Formation. He also noted that where the dolerite intrudes the predominantly shale horizons of the Brady or Tiers Formations, the contact is steep and irregular and some major transgression occurs.

A flat uniform base is found on the eastern margin of the Cluan Tiers where the dolerite / sediment contact lies at approximately 500 m for a distance of approximately 13 km.

Transgressive dolerite contacts seem to occur where the dolerite intrudes Permian rocks. A steep dolerite contact on the Jackeys Marsh road is associated with a gentle rise in level of the dolerite from 427 m at this point to 579 m on a saddle on the western flank of Quamby Bluff, a distance of 2 km.

Wells (1957) considered a 75 m wide fine-grained dolerite mass which crosses the Lake Highway [653722] to be a dyke. He described the contact as being irregular and showing no signs of hornfelsing. He considered the country rock to be Triassic sandstone and shale. Regional mapping of the area has shown the 'dyke' to be a talus tongue in which dolerite boulders several metres across are associated with similarly sized Triassic sandstone and shale blocks.

At Golden Valley Carey (1958) and Sutherland (1965) have described a dolerite cone sheet. As suggested by Sutherland in an addendum to his paper, the 'cone sheet' is in reality a series of dolerite boulders derived from the end of a large talus tongue. These boulders are distributed around a small hill of Precambrian, Cambrian and Ordovician rocks.

Isolated outcrops of dolerite occur in the northern part of the region. At Dairy Plains [460790] the contact between undifferentiated Permian mudstone and dolerite is steep and some hornfelsing of the mudstone has occurred. The hornfelsed mudstone is exposed in a small quarry nearby [468794].

Generally the dolerite has had little metamorphic effect on the country rocks apart from hornfelsing mudstone along the contact zones.

The thickness of dolerite exposed in the region is approximately 120 m on Cluan Tier and 210 m on Quamby Bluff and the face of the Western Tiers.

The dolerite appears to be normal tholeiite, which is common elsewhere in Tasmania. As the petrological characteristics of Tasmanian Jurassic dolerite has been described previously by many workers, principally by Edwards (1942), no further petrological study has been made by the writer of these rocks from the Quamby region.

Tertiary Basalt

Basalt is widely distributed throughout the northern and eastern parts of the Quamby region and has contributed much to the agricultural potential of the area. Many small low-level hills have a basalt capping, for basalt, when fresh, is hard and erosion resistant. Basalt reaches a thickness of approximately 100 m in the area, this thickness being attributable to several flows separated by inter-basalt gravel and sandstone.

Gibsons Sugarloaf, a fairly sharp crested hill which projects conspicuously above Dairy Plains, has a capping of basalt overlying Jurassic dolerite. Basalt also overlaps dolerite at Dairy Plains [477804] and Ashley. South of Deloraine basalt laps onto Owen type sandstone and Cambrian beds.

Wells (1957) described the petrology of the Deloraine basalts. He differentiated two major basalt types; the Ashley Basalt, a widespread, dense, fine-grained, olivine poor, amygdaloidal, blue-grey rock; and the Exton Member, a dark, blue-grey basalt with large olivine crystals as phenocrysts and smaller ones in the groundmass.

No further studies have been made by the writer of the petrology of the basalts of the region.

Basalt has had little metamorphic effect in the area except for the formation of isolated patches of siliceous 'grey billy' as found near Exton.

Lateritisation of the basalt during the Tertiary Period has given rise to fairly thick layers of pisolitic laterite which are now found sporadically throughout the basalt areas.

MINERAL RESOURCES

V.M. Threader

No metallic minerals have been exploited in the area, although a low grade copper orebody was prospected in 1923 and in 1971.

The non-metallic mineral resources are discussed under the physiographic unit in which they occur, *viz.*: Central Highlands, Great Western Tiers, Conglomerate Ridges, Longford Basin, Meander Valley.

Metallic Minerals

COPPER

Some secondary copper minerals with associated gold and silver were discovered in basic igneous rocks of Cambrian age near Quamby Brook [639762] in 1921. A report by Reid (1923) stated that the ore was not high grade but the orebody could be of large size and was worthy of attention. A syndicate was formed to prospect the deposit in that year but little progress was made. Recent prospecting and drilling operations (1971) by a private company were unsuccessful.

Non-metallic Minerals

Table 1. SUMMARY OF NON-METALLIC MINERALS RESOURCES

Rock type	Use	Potential use
Central Plateau		
Dolerite	Weathered zones are used for construction materials on unsealed roads.	Fresh dolerite is plentiful and when crushed is suitable for concrete aggregate and road sealing but is too remote for any but local use.
Great Western Tiers		
Triassic sediments	Sandstone has been quarried in the McRaes Hill area for use as building stone. Indurated zones near dolerite contacts in the Cluan area have been used to a limited extent as road making aggregate. Both uses have been discontinued.	With the exception of conglomerate bands and indurated zones at igneous contacts most of the Permian and Triassic sediments have too much clay and too little coarse particles for use as aggregates.
Permian sediments	Forestry Commission uses Bogan Gap Group mudstone for the construction of logging roads. The material is highly plastic and its use is not recommended.	
Oil shale		A 1.4 m seam indicated on the geological map near Golden Valley was investigated by Hills in 1921. It was estimated to occupy an area of about 4 km^2, but there have been no detailed prospecting operations carried out to establish grade or extent of the deposit.
Scree (predominantly weathered dolerite but containing weathered Permian and Triassic sediments)	These materials have too wide a size range (boulders to clay) to be of much use as construction materials.	

Table 1 - continued

Rock type	Use	Potential use
Lower Palaeozoic Conglomerate Ridges in the north-west of the Quadrangle		
Cambrian Conglomerate (Pumicestone Ridge area)	Used extensively for road construction. (Table 2)	
Ordovician Conglomerate (Needles Ridge area)	Used extensively for road construction. (Table 2)	
Longford Tertiary Basin		
Ironstone gravel	Used extensively for road construction. (Table 2)	
Tertiary sediments		The material is predominantly fine-grained and is similar to sandy clays used for brick manufacture in the Launceston area.
Meander Valley		
Dolerite and basalt	Unweathered zoned yield suitable material for crushing for road sealing and concrete aggregate.	
Ordovician limestone on Gibsons Sugarloaf	Crushed and formerly used for agricultural purposes.	

CONSTRUCTION MATERIALS

The results of some testing work by the P.W.D. laboratory in Ulverstone are summarised in Table 2. The actual analytical results are not included in this report but will be included in a subsequent publication on construction materials.

Table 2 includes results from both the Cambrian and Ordovician conglomerates and from the Tertiary ironstone gravel. All of these materials are suitable for road construction but the Cambrian conglomerate yields a better graded aggregate than the Ordovician conglomerate and is therefore of wider application and is used for both surface course and base course construction. The two conglomerates are restricted to a ridge or series of ridges in the north-west of the quadrangle. The ironstone gravel is more widespread and occurs throughout the Longford and Launceston basins. Its origin is attributed to the deposition of iron oxide from meteoric water within the *B* horizon of the soil profile in an arid or semi-arid climate. It may have originally been continuous or nearly so near the Tiers. Known localities of ironstone gravel are indicated on Figure 6. The presence of this material in the bore

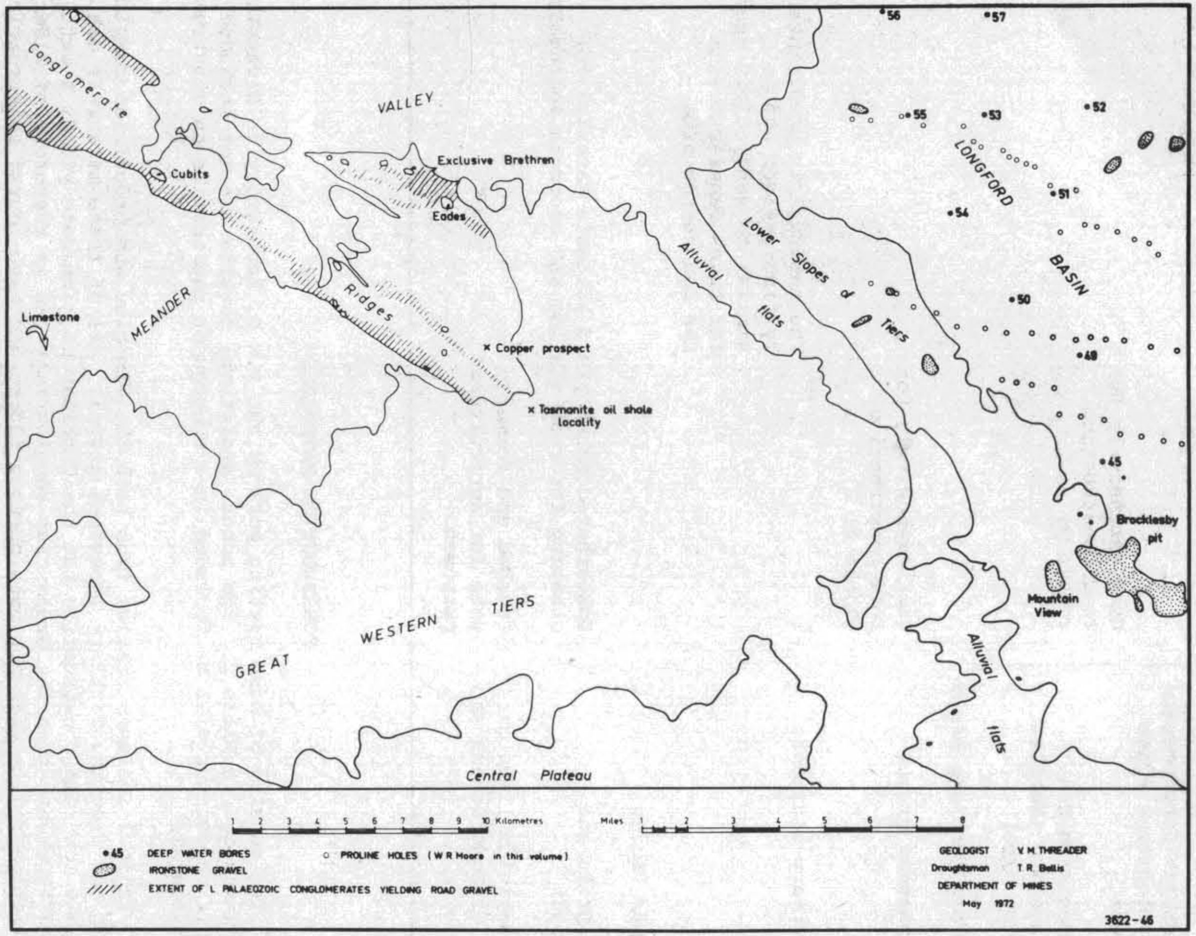

Figure 6. *Physiographic units and mineral localities.*

Table 2. RESULTS OF P.W.D. TESTS ON CONSTRUCTION MATERIALS

Name of Pit	Sample	PI	DR	Aggregate Coarse	Aggregate Fine	Binder	Grading	Use
Cambrian Conglomerate								
Exclusive Brethren	1228	nil	0.59	S	S	S	D	BC,SC
	1D	nil	0.45	M	S	S	B	BC
	2D	nil	0.59	M	S	S	D	BC
	1W	nil	0.49	M	S	S	B	BC
	2W	2.9	0.51	M	S	S	E,F	BC,SC
Dunham		nil	0.59	M	S	S	B	BC
Eade's	Face	10.9	0.42	S	S	S	B	bc
	1 (3 ft)	23.2	-	S	S	S	B	-
	2 (3.5 ft)	24.0	0.48	S	S	S	B	-
	2 (6 ft)	21.3	0.78	S	S	S	B	-
	2 (8 ft)	25.3	0.76	S	S	M	B	-
	3 (2 ft)	11.3	0.40	S	S	M	B	bc
Ordovician Conglomerate								
Cubit's	1211	nil	0.40	S	S	M	B	bc
	1212	nil	0.40	S	S	M	B	bc
	1213	nil	0.36	X	S	M	B	bc
	1214	nil	0.43	X	S	M	B	bc
	1215	nil	0.42	X	X	X	A	bc
	1216	nil	0.41	S	X	X	A	bc
	1217	nil	0.42	S	X	X	A	bc
	1218	nil	0.33	M	S	X	A	bc
	1219	nil	0.37	X	S	X	A	bc
	1220	nil	0.49	S	X	X	A	bc
	1221	nil	0.41	X	S	S	A	bc
Atkin's	1222	nil	0.43	M	S	X	B	bc
	1223	1.7	0.53	M	S	S	B	BC
	1224	nil	0.47	M	S	S	B	BC
	1225	8.0	0.57	X	S	S	B	bc
Tertiary Ironstone								
Brocklesby	712007	-	-	S	S	S	C	BC,SC

S - satisfactory, M - slightly excessive, X - excessive proportions relative to nearest grading.
BC - base course, bc - marginal suitability for base course, SC - surface course.

holes (Table 3) suggests that it is widespread although of variable thickness and distribution in depth.

PI (Plasticity Index). This is the numerical difference between the liquid and plastic limits of a material expressed as percentages of dry weight. The allowable limits are 0-6% for sealed roads and 4-9% for unsealed roads.

DR (Dust Ratio). This is the ratio of the weight percentage passing 200# (0.075 mm) to that passing 36# (0.42 mm).

Aggregate for pavement construction is included in three size ranges:

Coarse aggregate	>2.4 mm
Fine aggregate	2.4 mm-0.42 mm
Binder	<0.42 mm

Grading. There are six standard gradings recognised by NAASRA (National Association of Australian State Road Authorities).

	Maximum particle size	*Suitability*
A, B	50.8 mm (2 in)	Base course
C, D	25.4 mm (1 in)	Base course and surface course
E, F	9.5 mm (0.375 in)	Base course and surface course

In Table 2, the terms satisfactory and excessive are comparisons with the standard grading listed. The use column refers to conformity with the specifications of plasticity and grading.

Tertiary sediments of the Longford Basin

A series of proline auger holes was drilled in the Longford Basin under the direction of W.R. Moore as part of a regional mapping programme. The samples were not tested for ceramic properties but the logs of these holes (see Appendix 1) indicate a high clay content.

A similar series of holes was drilled in the Launceston basin for clay resource investigations. The samples from these holes were tested and the results of the investigation were given by Threader and Clements (1972).

A series of deep rotary holes was drilled in the Longford-Launceston-Lake River area for underground water resource investigations. Eleven of these were drilled in the Quamby quadrangle. The holes were logged by W.L. Matthews and the samples were determined for silt/clay content by Clements using a sedimentation method. In the accompanying table the log is compared with the sand content. The actual cut off figure used was 20 μm and therefore the sand content in the table also includes coarse silt. The test is employed as a rough guide to ceramic properties, it is assumed that if the sand/coarse silt content exceeds 50% the material is not an economic brick clay deposit. It has been shown that where the material is uniform and fine-grained, much higher percentages of sand (up to 75%) can be tolerated (Threader and Clements, 1972).

A considerable discrepancy exists between the written log and the sand content determined by sedimentation which would suggest that visual inspection is inadequate for distinguishing small particles, particularly when wet.

It is proposed at some later date, to carry out X-ray diffraction analysis of these samples as a check on the sedimentation tests and to determine the clay mineralogy. The Tertiary sediments are generally mixtures of silt and clay and would have little economic value. It is unlikely that economic quarrying would extend any deeper than 15 m. The sedimentation results determined on material at depths of 0-15 m from holes 49-58 show considerable variation.

Bore Hole No.	*Depth (ft)*	*(m)*	*Average content of >20 µm particles (%)*	*Remarks*
49	0-50	0-15	75.9	Some ironstone fragments near surface.
50	0-15	0-4.5	88.3	Sandy clay.
	15-25	4.5-7.5		Gravel.
	25-50	7.5-15		Basalt fragments.
51	0-50	0-15	60.1	Ironstone fragments, 10-12 m.
52*	0-50	0-15	46.6	
53	0-50	0-15	73.4	Ironstone fragments, 1.5-6 m.
54*	0-50	0-15	56.2	Ironstone fragments, 0-1.5 m.
55	0-50	0-15	73.9	Few ironstone fragments, 1.5-9 m.
56*	0-35	0-10.5	55.0	Basalt below 10 m.
57	-		-	All in basalt
58*	0-5	0-1.5		Ironstone gravel.
	5-30	1.5-9	54.7	

*Only material from these holes is considered suitable for the manufacture of bricks.

LIMESTONE

Ordovician limestone crops out over a small area on the northern flank of Gibsons Sugarloaf in Dairy Plains. The limestone was once quarried and used locally for agricultural purposes. The analysis indicates a composition typical of Ordovician limestones (Hughes, 1957), except for a slightly higher than average SiO_2 content.

Analysis of limestone from Gibsons Sugarloaf (Reg. No. 710027, Dept. of Mines 5 May 1971).

	%		%
SiO_2	7.7	MgO	0.96
CaO	50.2	P_2O_5	Trace
P_2O_5	2.0	Loss on Ignition	33.4

Table 3. PERCENTAGES OF >20 μm MATERIAL IN SAMPLES FROM DEEP BOREHOLES IN THE NORTH-WESTERN PART OF THE QUAMBY QUADRANGLE.*

Borehole No.	Depth *ft*	*m*	% >20 μm Material	Lithology
49	0-6	0-1.5	84 (1;0)†	Soil and brown clay.
	5-40	1.5-12	67-87 (7;0)	Light brown clay with few ironstone fragments.
	40-100	12-30	54-80 (12;2)	Dark brown to grey clay.
	100-160	30-49	81-90 (12;0)	Dark brown to grey plastic clay.
	160-170	49-52	89-90 (2;0)	Sand and clay.
	170-200	52-61	63-88 (6;0)	Dark brown grey plastic clay.
	200-220	61-67	70-75 (4;0)	Clay with some wood fragments.
	220-240	67-73	75-82 (4;0)	Black to brown plastic clay, a little sand.
	240-270	73-82	52-83 (6;2)	Grey, brown plastic clay, a little sand.
	270-320	82-98	45-62 (10;8)	Grey clay. Sand becoming more abundant.
	320-335	98-102	70-87 (3;0)	Sand. Some clay.
	335-375	102-114	46-70 (8;6)	Grey clay.
	375-425	114-130	65-81 (10;0)	Sand and clay (some sandstone fragments).
	425-460	130-140	60-85 (7;0)	Clay, a little sand. Some wood fragments.
	460-475	140-145	70 (1;0)	Sand and clay.
	475-502	145-153	54-80 (6;2)	Grey clay, a little sand. Some wood fragments.
50	0-5	0-1.5	79 (1;0)	Clayey sand.
	5-15	1.5-4.6	60-87 (3;0)	Sandy clay.
	15-25	4.6-7.6	90-97 (2;0)	Rounded gravel up to 6 mm.
	25-260	7.6-80	92-99 (44;0)	Basalt fragments.
51	0-5	0-1.5	68 (1;0)	Brown clay.
	5-25	1.5-7.6	32-59 (4;4)	Light brown clay.
	25-35	7.6-11	59-79 (2;1)	Light brown clayey sand.
	35-40	11-12	67 (1;0)	Light brown sandy clay with large angular iron oxide fragments.
	40-65	12-20	59-76 (5;1)	Dark grey clay in part plastic.
	65-110	20-34	63-73 (9;0)	Light grey-brown sandy to very sandy clay.
	110-120	34-37	86-87 (2;0)	Coarse sand.

* For location of boreholes see Figure 5, page 44.

† Figures in parentheses are the number of samples tested, followed by the number of samples containing less than 60% >20 μm material.

Table 3 - continued

Borehole No.	Depth ft	Depth m	% >20 µm Material	Lithology
	120-160	37-49	66-83 (8;0)	Light grey sand and clay.
	160-175	49-53	64-68 (3;0)	Light brown clay.
	175-250	53-76	33-76 (14;8)	Brown clay with variable amounts of wood fragments.
	250-280	76-85	50-70 (4;2)	Mainly wood fragments.
	280-360	85-110	51-72 (16;4)	Brown clay, varying amounts of wood fragments and a little sand.
	360-365	110-111	68 (1;0)	Brown clay and wood fragments.
	365-375	111-114	73-76 (2;0)	Clay and sand.
	375-480	114-146	53-87 (21;2)	Clay and wood fragments and very little sand.
	480-490	146-149	83-89 (2;0)	Clay and sand.
	490-600	149-183	61-92 (22;0)	Clay and wood fragments and very little sand.
	600-655	183-200	68-88 (11;0)	Clay and wood fragments.
	655-730	200-223	76-98 (15;0)	Mainly wood fragments, some clay.
	730-745	223-227	77-87 (3;0)	Clay, wood fragments and a little sand.
	745-800	227-244	87-92 (11;0)	Mainly wood. Some clay.
	800-855	244-261	84-93 (11;0)	Mainly wood fragments. Some clay and very little sand.
	855-890	261-271	70-87 (7;0)	Clay and wood fragments and a little sand.
	890-920	271-280	88-93 (6;0)	Mainly wood fragments.
	920-925	280-282	85 (1;0)	Clay and wood fragments.
	925-1012	282-308	73-89 (17;0)	Mainly wood fragments and a little clay.
52	0-5	0-1.5	67 (1;0)	Brown to grey sand.
	5-10	1.5-3	58 (1;1)	Clayey sand.
	10-50	3-15	34-52 (8;8)	Light brown sandy clay.
	50-60	15-18	42-74 (2;1)	Black to dark grey clay (dark colouration due to presence of wood fragments).
	60-160	18-49	15-58 (20;20)	Grey clay and sandy clay with wood fragments.
	160-175	49-53	53-83 (3;1)	Wood fragments.
	175-180	53-55	76 (1;0)	Grey clay and wood.
	180-205	55-62	50-64 (5;1)	Grey sandy clay with wood fragments.
	205-215	62-66	69-75 (2;0)	Sandy clay and abundant wood fragments.

Table 3 - continued

Borehole No.	Depth ft	Depth m	% >20 µm Material	Lithology
	215-225	66-69	73-81 (2;0)	Sand and wood fragments (some clay).
	225-320	69-98	36-88 (19;8)	
	320-360	98-110	47-59 (8;8)	Grey sandy clay with some wood.
	360-430	110-131	50-68 (14;9)	
	430-460	131-140	63 (1;0)	Wood fragments.
	460-500	140-152	41-65 (9;6)	Sandy clay with abundant wood fragments. Grey sandy clay with wood fragments.
53	0-5	0-1.5	88 (1;0)	Brown soil.
	5-20	1.5-6	62 (2;0)	Iron stained grey clay with a few iron oxide nodules.
	20-35	6-11	51-83 (4;1)	Grey and light brown clay.
	35-50	11-15	83-86 (3;0)	Dark grey plastic clay.
	50-60	15-18	52-80 (2;1)	Brown clay with a few iron oxide nodules.
	60-110	18-34	70-86 (10;0)	Grey-brown clay, green and brown clay.
	110-150	34-46	65-80 (8;0)	Grey sandy clay, some solid blue clay, wood fragments towards bottom.
	150-170	46-52	76-85 (4;0)	Very sandy grey clay.
	170-215	52-66	79-85 (9;0)	Sandy clay.
	215-280	66-85	65-92 (13;0)	Grey sandy clay.
	280-290	85-88	76-80 (2;0)	Clay, sand and wood fragments.
	290-350	88-107	65-87 (12;0)	Grey clay with a little sand and variable amounts of wood fragments.
	350-390	107-119	61-83 (8;0)	Mainly clay a little sand and some wood fragments.
	390-470	119-143	69-78 (16;0)	Grey clay, some sand and wood.
	470-480	143-146	64-66 (2;0)	Grey clay with a little wood.
54	0-5	0-1.5	83 (1;0)	Brown clay with iron oxide and quartz.
	5-10	1.5-3	74 (1;0)	Dark brown clay soil.
	10-35	3-11	31-71 (5;4)	Brown to grey plastic clay.
	35-40	11-12	50 (1;1)	Dark grey and brown plastic clay.
	40-135	12-41	57-86 (19;3)	Clay pellets and weathered basalt fragments.

Table 3 - continued

Borehole No.	Depth ft	Depth m	% >20 µm Material	Lithology
	135-170	41-52	86-91 (7;0)	Grey and dark brown clay pellets and fragments of weathered basalt.
	170-176	52-54	83 (1;0)	Solid basalt.
55	0-5	0-1.5	94 (1;0)	Brown soil.
	5-30	1.5-9	65-78 (5;0)	Light brown to grey clay, a few iron oxide nodules
	30-45	9-14	53-89 (3;1)	Medium grey to brown clay.
	45-95	14-29	82-96 (10;0)	Dark grey to brown plastic clay.
	95-134	29-41	82-97 (7;0)	Solid basalt (bottom 4 ft [1.2 m] unweathered).
56	0-5	0-1.5	64 (1;0)	Red clay soil.
	5-10	1.5-3	73 (1;0)	Red brown clay.
	10-35	3-11	35-77 (5;4)	Light brey-brown clay.
	35-40	11-12	92 (1;0)	Dark grey clay.
	40-112	12-34	90-100 (12;0)	Solid basalt (bottom 2 ft [0.6 m] unweathered).
57	0-5	1-1.5	91 (1;0)	Dark brown clay soil.
	5-57	1.5-17	97-100 (8;0)	Basalt (bottom 4 ft [1.2 m] unweathered).
58	0-5	0-1.5	92 (1;0)	Ironstone gravel.
	5-50	1.5-15	42-66 (9;6)	Brown and grey clay with red oxide staining.
	50-140	15-43	52-94 (18;1)	Dark grey, brown plastic clay.
	140-180	43-55	59-72 (8;1)	Light brown and cream clay pellets.
	180-240	55-73	40-82 (12;5)	Red and dark brown clay pallets becoming more plastic towards bottom.
	240-250	73-76	83-89 (2;0)	Brown clay some sand and abundant wood fragments.
	250-270	76-82	63-82 (4;0)	Wood fragments with a little clay.
	270-275	82-84	89 (1;0)	Sand and wood fragments.
	275-305	84-93	70-76 (6;0)	Wood fragments with some sand horizons.
	305-502	93-153		Clay and wood fragments.

APPENDIX 1

Tertiary Clay of the North-western part of the Longford Basin

W.R. Moore

A program of subsurface mapping in the Longford Tertiary Basin between Longford, Cressy, Bracknell, Westbury and Carrick was carried out during 1965 and 1966, as an aid to underground water supply investigations. This area lies in the eastern part of the Quamby geological map sheet and the western part of the Longford Sheet.

SUBSURFACE MAPPING PROGRAM 1965-1966

Following a preliminary geological reconnaissance drilling was commenced using hand augers. Sixty holes were drilled to depths varying from 1.5-4.5 m but averaging 3 m. The hand augering recovered only clay with very little lithological variation either in depth or in lateral extent and showed that clay was widespread in the area.

Hand augering was abandoned in favour of a Proline power auger which was mounted on a four wheel drive vehicle. The Proline drill was found to be not only more economical in use but enabled deeper holes to be drilled. One hundred and four holes were drilled to average depth of 15 m using this machine. Ninety-four of these drill holes were located on three E-W survey lines 16-23 km long across the basin with drill hole spaced approximately 800 m apart. Holes were also drilled at sites located on two shorter survey lines. One short survey line is near Carrick from the river terrace near the Bass Highway to the present flood plain near the confluence of the Liffey and Meander Rivers. The other short survey line of drill holes is situated along Green Rises Road 1.5 km north of Cressy township. The locations of these proline holes and the lithologies of the sediments recovered from the holes are shown in Figure 7.

CLAY DEPOSITS

Ninety of the 104 holes drilled encountered Tertiary clay and of these 57 were drilled in clay of varying colours but showing no lithological variation. Even where lithological changes occurred in the clay recovered from some of the drill holes, the variations were of little help in the compilation of a subsurface geological map. The lithological variations encountered occasionally within the clay included the admixture of small amounts of fine sand forming a sandy clay, or a small amount of concretionary ironstone pellets forming a gravel band. Ironstone bands of cemented concretionary pellets were rarely encountered in the clay.

The colour of the clay varied considerably and the colour shown in Figure 7 approximates that of the clay when drilled. Colours varied from white through light grey and dark grey to black, from light brown and orange-brown to dark brown, and from a pinkish red to dark red. The colour of the clay recovered gradually darkened with depth in each drill hole but changes from one group of colours to another was abrupt (*e.g.* brown to red). The actual factors determining the particular colour of a clay are unknown, but changes within a colour group may often either appear associated with changes in organic content or the leaching and deposition of iron with fluctuations of the ground water level. Other factors such as the depositional environment, the distance the clays have been transported and palaeoclimatic changes may also have influenced the colour of the clay.

The only clays which showed any textural variation were the residual deposits derived from igneous rocks which crop out around the periphery of the basin. These clays have a textural variation which gives them a mottled appearance and which reflects the original igneous texture of the parent rock. This remanent igneous texture is particularly characteristic where the parent rock is dolerite. The *in situ* clay was present only in 15 holes all of which are located near the Cluan Tiers on the western margin and the Pateena Hills on the north-eastern margin of the Basin.

The clay recovered from the remaining 71 drill holes has an even and uniform texture. The lack of textural variation in the clay is believed to reflect uniform transportation and deposition in a shallow water environment. Similar conditions existed over a wide area of the Longford Basin for a long period of geologic time.

Many small shallow stock water holes have been dug in the Longford Basin. The clay found on the spoil heaps of these water holes is lithologically similar to the transported clay recovered from many of the drill holes. From the evidence obtained from water holes and the drill holes it is apparent that clay underlies most of the Basin.

The 14 holes drilled in which no Tertiary clay was encountered were located near the margins at the Longford Basin. Eight of these holes were drilled into Quaternary gravel which is mainly terrace gravel of the Meander and South Esk Rivers. Of the remaining 6 drill holes 2 were in Pleistocene or Tertiary windblown sand which is believed to be from buried lunettes, two in Tertiary clayey sand associated with the buried lunettes, one in Tertiary sand derived from underlying Triassic sandstone, and one in Quaternary alluvial sand, gravel, clay and silt.

The presence of the comparatively coarse grained Quaternary river terrace gravel overlying fine-grained Tertiary clay, in which the lunettes are buried, indicates that much Tertiary clay has been removed by erosion. Substantial erosion of clay is also shown by the variation in the levels of the surface of the clay deposits in the Longford Basin. Erosion to the present level of the basin can be accounted for by the present drainage system.

Table 4. TERTIARY CLAYS ENCOUNTERED IN PROLINE DRILLING

Proline drill line no.	No. of drill holes	With Tertiary clays	With only Tertiary clays	With Tertiary clays and gravels			With sandy clays	With sands and clayey sands	With silts	Thought to be transported	Thought to be derived in situ
				Total	Ironstone gravels	Mixed gravels					
1	5	2	0	0	0	0	2	0	1	2	0
2	40	35	25	2	0	2	8	1	1	32	3
3	32	27	10	9	8	1	8	1	1	20	7
4	22	21	17	2	1	1	0	1	0	19	2
5	5	5	5	0	0	0	0	0	0	5	0
Total	104	90	57	13	9	4	18	5	3	71	15

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PROLINE DRILLING LONGFORD BASIN

W.R.Moore
1964

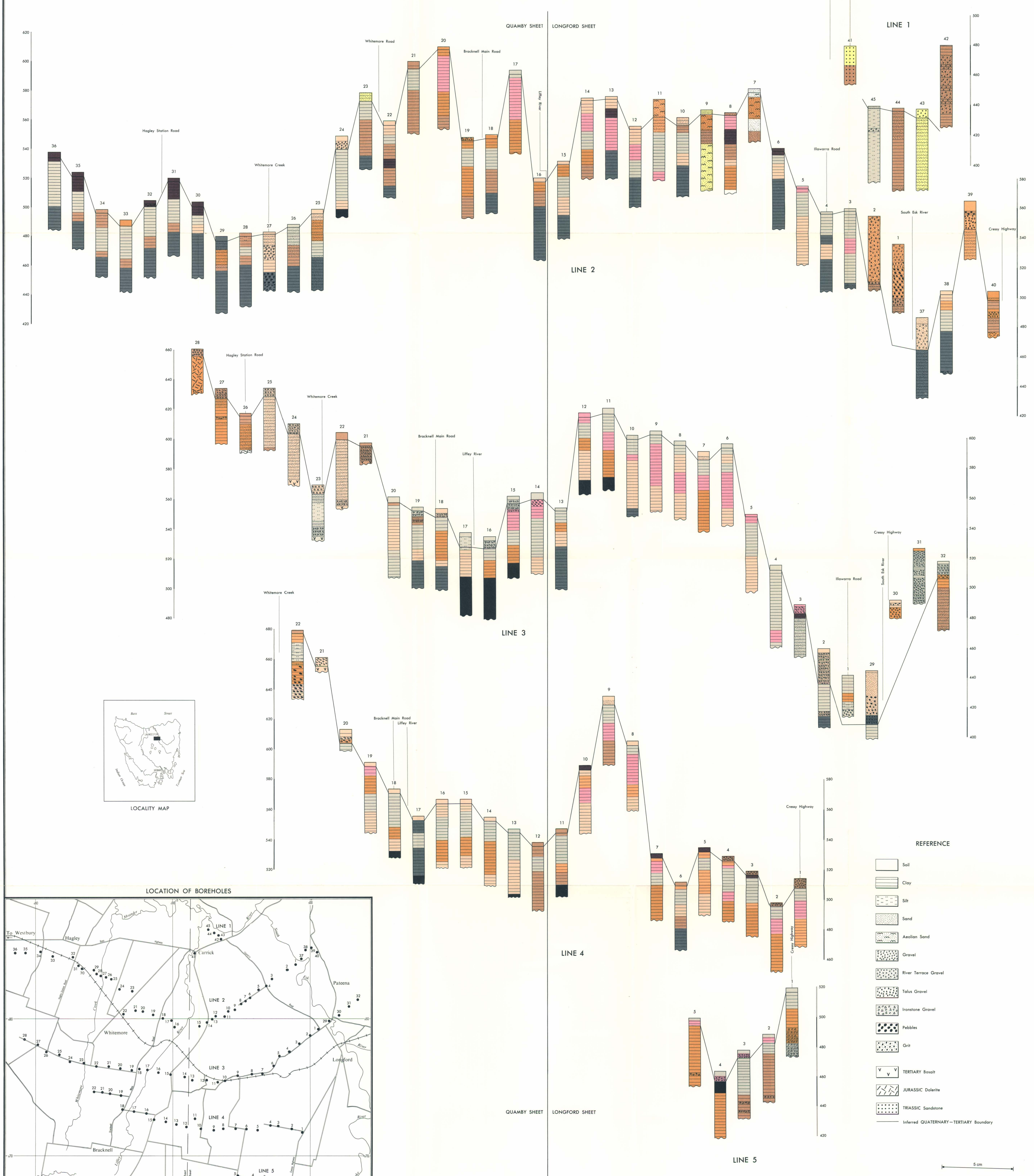

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Figure 7 Explan. Rep. Dept. of Mines Tasmania – Quamby

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