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DEPARTMENT OF MINES

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EXPLANATORY REPORT

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PIPERS RIVER

by

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APPENDICES by

by

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Issued under the authority of
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Preface

The discovery in 1860-61 of gold at the Den goldfield in the Pipers River district was an important event in the economic development of the region. Gold was found at Back Creek in 1870 and in 1878 the main gold deposit in the district, the Lisle goldfield, was discovered. The other goldfields in the Pipers River district, at Golconda, Lone Star, Panama and Denison were discovered and in 1879 it was reported that 2,500 were employed on the Lisle field.

By the end of the century much of the gold-bearing ground in the district had been worked out. However the access and transport facilities built to service the mining settlement remained, so that agricultural and forestry developments began and these have since formed the basis of the permanent settlement in the district.

These explanatory notes describe the geology of the area in detail. New data is presented on the complex geological structure and history of the area. The conclusions presented here will form a basis for the better understanding of the geological problems encountered over a large part of NE Tasmania. It is perhaps fitting to note that at the time this publication goes to press there is a new interest emerging in the abandoned goldfields in this portion of the State.

J. G. SYMONS, Director of Mines.

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(Photos: P. J. Legge)

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In pocket
at back
of book

EXPLANATORY REPORT ON PIPERS RIVER QUADRANGLE

Introduction

This report is an account of the geology of the Pipers River Quadrangle (fig. 1), and is to supplement the 1 inch:1 mile Geological Map Sheet No. 31 (Marshall, *et al.*, 1965).

Mild winters, warm summers, and a rainfall of approximately 30 inches have favoured agricultural development. The Mathinna Beds, however, produce a barren soil and the farming properties are consequently concentrated on the Permian of the Lilydale-Lower Turners Marsh district, on the Devonian and Tertiary rocks along the E margin of the Quadrangle, and on the strips of Tertiary rocks which tend to parallel the Back Creek-Pipers River-Pipers Brook and the Little Forester drainage systems. The Forestry Department has established pine plantations in the Lisle Basin, over a large NNW trending tract of country centred on Retreat, and on the lowermost talus and granite slopes of the Sideling Range.

Appreciation of the excellent beaches at Noland, Anderson and to a lesser extent, Tam O'Shanter Bays, is evidenced by the increasing number of 'weekend cottages'. However in contrast with Lulworth and Weymouth, which have few permanent residents, Bridport is more firmly established, being a venue for tourists and the home of a small fishing industry.

Numerous abandoned prospecting trenches, shafts, and open-cast alluvial workings, particularly in the Lisle-Golconda and Lefroy-Back Creek districts, witness the once-flourishing gold mining industry. Another dead industry is evidenced, in the Bangor region and N of the Back Creek gold workings, by disused slate quarries. In contrast, with new roads being constructed and old roads being re-surfaced, road materials are very much in demand, and many of the old gravel workings have been reopened.

Most of the area is within 30 minutes of a hotel by car, camping therefore being unnecessary. The Bridport Hotel was suitably placed in the NE quadrant, access to the central and SE districts was facilitated by staying at Scottsdale, the NW quadrant was easily reached from George Town, and the remaining area was mapped from Launceston.

Mapping was executed on 1 inch:20 chain dyelines, supplemented by 1 inch:30 chain and 1 inch:45 chain aerial photographs. Boundaries were finally draughted on sixteen 1 inch:20 chain sheets, production of the composite 1 inch:1 mile map being effected by pantographic reduction.

Dr. B. Marshall and Mr. I. H. Naqvi commenced the present survey early in the winter of 1963, and by December of the same year had completed a strip S of an irregular line passing through Lebrina, the Golconda Goldfield and West Scottsdale. Following the 1963-64 summer field season, mapping of the Pipers River area was recommenced in May and completed by late November

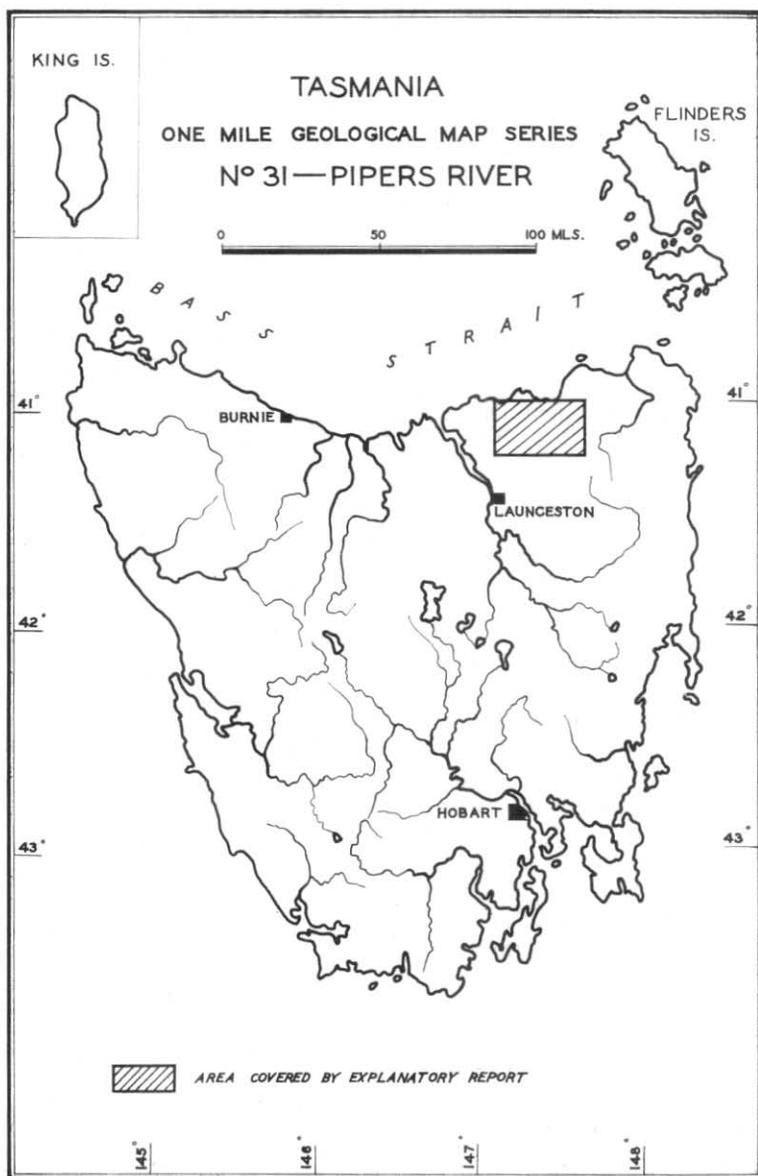


FIGURE 1

5 cm

1964. During this period Marshall mapped W of a line running from Lower Turners Marsh N towards Weymouth, Mr. D. J. Jennings completed an irregular wedge N of a line from Lulworth through Duncraggen Hill to Jetsonville, whilst Naqvi and Dr. C. M. Barton covered the remaining area. Marshall re-examined sections through the Mathinna Beds in railway cuttings between Lebrina and Greta, and along the Little Forester River N of its confluence with the Denison River and, resulting from work by Jennings, re-interpreted the strip of sedimentary rocks running S from Lietinna. A limited preliminary reconnaissance was carried out by Mr. M. J. Longman in the NE of the area and by Mr. A. B. Gulline in the extreme SW. The regional mapping was supervised by Dr. E. Williams.

Before the present regional survey, previous workers had mainly confined their interest to areas of economic importance. Further reference to their reports will be found in the section on economic geology, it being sufficient at this stage to acknowledge the invaluable record that they provide of early exploration in mining areas long since fallen into decay. Much useful discussion with Longman, who mapped that part of the Launceston Quadrangle which abuts against the S boundary of the Pipers River Sheet, facilitated the interpretation of the Permian rocks.

Physiography

Contrasting with much of Tasmania the Pipers River Quadrangle is of moderate to low relief. From heights of a little over 2000 feet in the S the topography falls away to sea-level on the N margin of the sheet, the average gradient being approximately 1 in 45 (fig. 2).

Mt. Arthur (3900 feet) is situated on the pre-Permian surface of 2000 to 2400 feet near the N boundary of the Launceston Quadrangle. This surface, as the foothills of Mt. Arthur, projects N into ridges adjacent to Shepherds Rivulet, and is also represented by Bessell's Ridge, the Blumont, and the Sideling Range. Continuing N and NNW the ridges rapidly decrease in altitude to 1000 feet in the Lilydale North-Retreat district, and to 600-800 feet between the Den Ranges and Ryans Hill, in the tract of country S of the headwaters of the Pipers River, and between Blumont Siding and Duncraggen Hill. Running out towards the coast, particularly N of Duncraggen Hill, a 300-400 foot surface is possibly present.

The regional topographic step-down from S to N is superimposed in the Lower Palaeozoic areas on NW to NNW trending ridges. This trend may be attributed to tectonic control, the dominant planar structures in the Mathinna Beds (bedding and/or cleavage) dipping steeply and striking approximately NW-SE.

The Permo-Triassic rocks scarcely modify this NW trend because their limited extent prevents the assertion of a regional pattern. There are, however, two other contributory factors: the strikes of the Permo-Triassic and the Mathinna Beds are similar; the pre-Permian topography preserved under a thin veneer of basal Permian, influences the weathering and drainage pattern.

5 cm

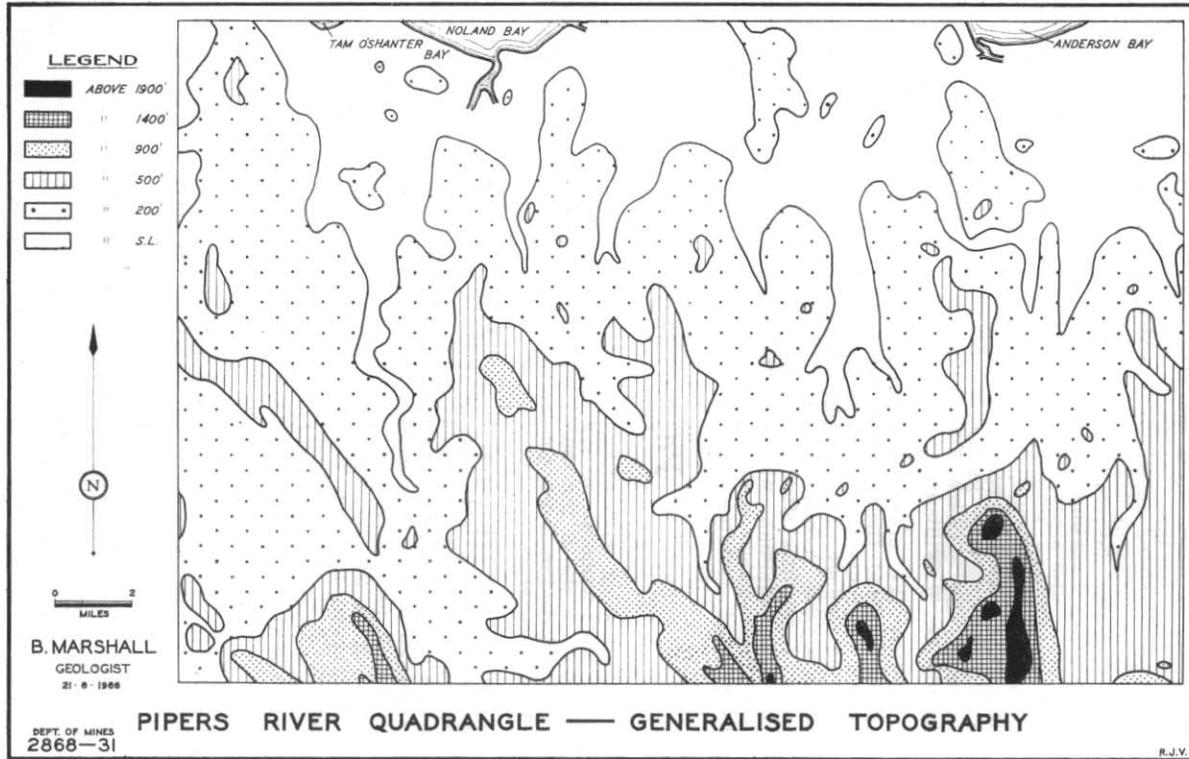


FIGURE 2

Further to the SW, the Dismal Range rises to over 1500 feet and is the N continuation of a dolerite sheet which, passing through Holloways Hill, the Dido Hills, and Mt. Edgecombe in the Launceston area, is of similar elevation. Were the sheet flat-lying, the joint system would produce symmetrical hills, but coupled with the SW inclination it results in asymmetrical hills elongated in a NW direction, a trend further enhanced by the strong NW-SE faulting. The topographic fall from the Dismal Range towards Mt. Direction is also related to the regional tilt.

Granite, cropping out in the E of the sheet and in the Lisle-Golconda district, and contrasting with the resistant rims of contact metamorphosed Mathinna Beds, forms areas of negative relief in which the joint-controlled landforms are generally symmetrical. Moving N through West Scottsdale, the granite passes under Tertiary sedimentary rocks which lack a strongly developed joint-system and thereby permit an initially radial drainage from the basalt-capped hills.

Along the N coastal strip the topography takes two forms. Where Mathinna inliers rise above the Quaternary deposits the regional NW trend is preserved. In the remaining area the advancing dunes and wind-blown sand impart an E-W trend to the topography.

The drainage pattern is dominated by NW and NE trending streams, the latter exploiting a strongly developed joint direction in the Mathinna rocks. Of the main water courses Pipers Brook illustrates the NW trend, but the Little Forester and Pipers River drain N, the compound trend comprising NE and NW orientated sections.

Joints in the granite have little modified the insequent, somewhat dendritic, drainage pattern; nor is there any marked control, other than initial slope, as these streams and those initiated on the Tertiary deposits move seaward. However, the W course of the Brid River around Duncraggen Hill, and the E sweep of the Great Forester between its headwaters at Springfield and its mouth near Bridport, suggest damming effects which will be discussed under 'Cainzoic Deposits: Gravels'. This influence is further expressed in the passage of Fourteen Mile Creek, through resistant dolerite hills, to the Tamar.

Pseudo-twinning due to modification of drainage by Tertiary basalt flows, is evidenced by the Little Brid and Brid Rivers near West Scottsdale, whereas the Little Forester River and Lisle Creek N of Greta provide an example of true twinning.

Stratigraphy

SUMMARY

The basement rocks or Mathinna Beds comprise a sandstone and siltstone sequence, which exhibits turbidite structures, with intercalated slate and phyllite; they are ascribed an Ordovician-Devonian age.

Devonian granodiorite is emplaced in the E portion of the sheet, being a continuation of the masses which dominate NE Tasmania. Removal of the Mathinna roof has exposed subsidiary bodies in the Lisle-Golconda district, whilst the Bridport mass is separated from the main body by Tertiary deposits.

A Permian sequence, disconformably overlain by Triassic sandstone, occurs in the SW of the sheet where hills of Permo-Triassic rocks are capped by a Jurassic transgressive dolerite sill.

From a SW locus Tertiary and Quaternary deposits with Tertiary basalt become increasingly important until they dominate the N and NE portions of the area.

SEDIMENTARY ROCKS

Lower Ordovician-Devonian Systems

MATHINNA BEDS

These rocks have been subdivided into an argillaceous and an arenaceous sequence, the former being autochthonous, and the latter allochthonous with respect to the basin of deposition. The boundary, indifferently exposed to the E of Shepherds Rivulet (5166/9237.5) and in railway cuttings SE of Lebrina, is placed below the first major development of laminated siltstone, or siltstone and sandstone, in the transitional sequence from slate with infrequent siltstone laminae through laminated siltstone to more thickly bedded siltstone and sandstone. Although the relative age of the two subdivisions is not clearly demonstrable, relationships in the Lebrina-Wyena district suggest that the arenaceous sequence is stratigraphically younger, thereby supporting earlier conclusions for NE Tasmania (Banks, 1962; Longman, 1966).

Recently graptolites of the Lower Ordovician have been recovered from Mathinna Beds at W Turquoise Bluff in the Back Creek area (M. R. Banks, pers. comm.). Fossil plants described from the Mathinna Beds at Warrentinna in the Ringarooma Quadrangle suggest that the rock sequences there are of the Upper Silurian-Lower Devonian (Cookson, 1937; Banks, 1962).

Should the argillaceous belt W of the Pipers River be equivalent to that of the Lebrina district, as seems reasonable, the narrower argillaceous/arenaceous alternations would probably be largely of tectonic origin. This cannot, however, be proved.

(a) ARGILLACEOUS SEQUENCE

These rocks occur in two main NNW trending belts. Owing to lack of exposure the thickness of the sequence was not obtainable, nor may any sensible estimate be given.

In the E belt sparse laminae of fine to medium grained, slightly feldspathic siltstone interrupt an otherwise monotonous sequence of slate and subordinate phyllite. In the W belt slate and phyllite again predominate, and are associated with fine grained quartz siltstone and quartzite laminae.

The slate, dark grey when fresh but weathering through lighter shades of grey to a pale brownish-yellow, generally occurs in beds ranging between 3 cm. and 25 cm. in thickness. Cleavage is well developed, and the cleavage face, except where crossed by strain-slip cleavage or kink-banding, has a smooth matte or weakly lustrous appearance. Lineation due to the trace of bedding on cleavage is either weak or absent, whereas the trace of cleavage is strongly imposed on the bedding surface.

In thin section sericite and quartz are seen to predominate. Other common minerals are chlorite and clastic mica, whilst tourmaline, zircon, rutile and opaque iron ore occur in accessory proportions.

Sericite and quartz flakes range up to 0.05 mm., but are generally less than 0.02 mm. in size. Clastic muscovite attains lengths of up to 0.70 mm. and clastic fragments of tourmaline exceptionally have a greatest dimension of 0.10 mm. More commonly as with zircon and rutile, tourmaline occurs as well rounded grains less than 0.02 mm. in diameter.

The fabric exhibits a strong planar preferred orientation arising from parallelism of quartz flakes and micaceous minerals. Co-planar with this cleavage are matrix lenticles (longest axis up to 0.15 mm.) of clastic muscovite, chlorite, sericite and quartz; (001) of the layer lattice minerals generally forms a high angle with the cleavage. The mass extinction of strongly orientated micaceous minerals (predominantly sericite) is interrupted therefore by lenses in which stacks of chlorite and sericite show birefringence colours due to their differing orientation.

Opaque iron ore is more common in the fresh rock than in weathered material from which, following oxidation, it has presumably been leached.

The more phyllitic rocks differ from slate in that the foliation surface possesses a marked sheen, attributable to the increased grain size of the mica, and that slight metamorphic differentiation has taken place.

Quartz siltstone varies in colour from dark grey when fresh to pale whitish-grey on the weathered surface. It is a surprisingly hard, often well cleaved rock with a lustreless cleavage face. Strain-slip cleavage (S_2) is frequently present and may dominate the primary cleavage (S_1), their intersection producing a strong lineation. Except as units delimited by thin quartzite horizons, when thicknesses from several mm. to 20 cm. were encountered, bedding is ill-defined.

In thin section quartz predominates. Also present are sericite, clastic muscovite, opaque iron ore, tourmaline, a little chlorite, and rare grains of rutile and zircon.

Quartz exhibits undulose extinction and comprises a sutured, granulose, partly recrystallised aggregate in which coarser grained microlithons (greatest dimension up to 0.15 mm. in *ac* section) denote original bedding laminae. Sparse residual grains up to 0.10 mm. in diameter, may be found within the fine grained matrix quartz which is usually less than 0.01 in size. Sericite and chlorite vary up to 0.01 mm in length, clastic muscovite attains

lengths of 0.01 mm., tourmaline fragments rarely exceed 0.05 mm. in size, and zircon and tourmaline form rounded grains of less than 0.01 mm. diameter. Specks (less than 0.005 mm.) of iron ore disseminated along the cleavage have partially oxidised to limonite.

The rock in *ac* section consists of discontinuous layers of quartz separated by films of sericite which parallel the cleavage and, depending upon the excess of quartz over sericite, exhibit a varying degree of aggregate polarisation. Matrix lenticles, less common than in slate, frequently have a nucleus of clastic mica.

The quartzite horizons, varying in thickness from a few millimetres to approximately 3 centimetres, are generally associated with quartz siltstone, and consist of a hard, fine grained rock in which cleavage is poorly defined or absent. A colour variation from greyish-white to dark grey characterises the fresh specimen and is little affected by weathering.

Under the microscope this rock is seen as an equigranular, recrystallised quartz mosaic, individual dimensions varying within the strict limits of 0.03 mm to 0.05 mm. Sutured margins occur where the more typical recrystallisation texture, as evidenced by polygonal grainshape, has suffered later deformation. Limonitic films and discrete sericite flecks have a planar preferred orientation, which is reflected in the hand specimen as a rudimentary bedding fissility.

Compositionally and texturally the slightly feldspathic siltstone laminae are akin to the siltstone of the arenaceous sequence under which they will be described.

(b) ARENACEOUS SEQUENCE

The arenaceous sequence, largely comprising siltstone, impure sandstone with quartzite, and minor intercalations of slate, crops out over more than half the Quadrangle. A well-developed cleavage which fans about the axial planes of folds, is common to most horizons; where absent as in more massive quartzite beds, tectonism is expressed as a bedding fissility. Sedimentary structures within these poorly sorted deposits include graded units, sole markings (plate 1), small scale slumping, convolute folding and crossed laminae, and suggest deposition by the turbidity current mechanism and provide way-up criteria. Despite this, poor exposure prohibits a comprehensive structural interpretation of the sequence, the thickness of which cannot, therefore, be given.

Composition differences between successive sedimentation units (as used by Bouma, 1962, p. 48-51) and grain size and textural variations within a sedimentation unit, make description of these rocks difficult. Nevertheless, there are certain pervading features: in that all are poorly sorted and include a notable proportion of dominantly argillaceous or siliceous matrix.

The commonly encountered rock is an impure quartz sandstone or quartz greywacke (unless stated to the contrary the terminology is that of Williams, Turner and Gilbert, 1954). When deeply weathered it is friable and yellowish-brown in colour; where fresh it varies from dark grey in the highly indurated rock to pale grey. A reasonably well developed axial-plane cleavage may be

found, especially in the finer grained sandstone, but tectonism is often expressed as a poorly developed parting at a high angle to the bedding, or as an incipient bedding fissility.

The following minerals are seen under the microscope: quartz, sericite, feldspar, clastic muscovite and occasionally chlorite. Present in accessory proportions are iron ore (often limonitised), zircon, apatite, rutile and tourmaline. Some specimens contain lithic fragments of quartz mosaic; others contain clay pellets. A small quantity of granular carbonate cement is infrequently encountered.

Poorly sorted sub-angular to angular quartz, ranging in diameter from less than 0.05 mm. (in the matrix) up to 1.0 mm., exhibits undulose extinction, marginal corrosion by the argillaceous matrix, and pressure solution effects at uncommon intergrain contacts. When present, lithic grains vary in diameter between 0.3 mm. and 1.0 mm. Feldspar, both plagioclase and subordinate orthoclase, is of similar distribution and grain size to quartz, limiting values generally lying between 0.1 mm. and 0.75 mm. Sericitisation, particularly of potash feldspar, and marginal corrosion are common. Clastic muscovite flakes attain 0.75 mm. in length, and are often disoriented, bent, and moulded against adjacent quartz grains. Sericitic mica less than 0.03 mm. in length, is usually a major constituent of the groundmass and, associated with chlorite, possesses a strongly preferred planar orientation in well cleaved rock. More typically, other than immediately adjacent to poor cleavage partings which are spaced down to approximately 1.0 mm., sericite is disoriented. Tourmaline, is irregularly shaped and sub-hedral pieces, attain 0.75 mm. in size. Zircon, apatite and rutile form well rounded grains of high sphericity up to 0.2 mm. in diameter.

Textural heterogeneity has two forms: planar anisotropism arising from the development of widely spaced cleavage partings, and irregular variation in packing density probably due to pressure solution during diagenesis. The classification of this rock as an impure quartz sandstone or quartz greywacke depends on the low feldspar content (<10%), on there being greater than 10% matrix, and on the poor degree of sorting. In terms of Pettijohn's classification (1957) it would be a subgreywacke verging towards a quartzose subgreywacke. Some specimens which have considerably more matrix, and greater than 10% feldspar may be termed feldspathic greywackes in the sense of both Pettijohn and Williams, Turner and Gilbert. Others having a very low feldspar content and highly siliceous matrix, are protoquartzites (after Pettijohn, *op. cit.*).

The siltstone is yellowish-brown and friable when strongly weathered. Fresher specimens are pale to medium grey with a greyish-brown oxidised skin. Cleavage is strongly developed, but when the siltstone is laminated, bedding may be the dominant planar surface. Crossed lamination is not uncommon.

Under the microscope the poorly sorted rock is seen to consist of sericite, quartz, clastic mica, feldspar, hydrous iron oxides, tourmaline, zircon and rutile.

Quartz ranging from 0.01 mm. to 0.05 mm. in diameter, is seen in the more argillaceous siltstone, as angular irregularly shaped pieces and lenticular flakes embedded in a matrix of strongly orientated sericite and fine grained silica. The more arenaceous siltstone is characterised by a higher ratio of quartz to matrix, the quartz either forming a closely packed interlocking mosaic, or comprising discrete grains or grain aggregates spaced by sericite films. The small proportion of plagioclase feldspar is similar to quartz in distribution and grain size. Sericitic mica flakes, rarely exceeding 0.05 mm in length, vie with quartz for dominance and possesses a strong planar orientation parallel to the cleavage. A contrast is provided by the clastic muscovite flakes, which range up to 0.20 mm. in length and are co-planar with the bedding or form the nucleus to matrix lenticles. Hydrous iron oxides frequently coat the grains and stain the cleavage surfaces, as well as forming diffuse specks in the ground mass possibly resulting from oxidation of pyrite spherules. Tourmaline, rutile and zircon occur as well rounded grains, less than 0.02 mm. in diameter.

The fabric is characterised by a planar preferred orientation, most strongly developed in the more argillaceous siltstone, and exhibits a marked mass extinction effect. The framework is semi-disrupted except in quartzose horizons of laminated siltstones where partly recrystallised mosaics may be encountered. Corrosion of grain boundaries is common, as also is undulose extinction in the larger quartz grains and clastic mica.

Depending upon the predominance of either quartz or sericite these rocks may be termed arenaceous or argillaceous siltstones. Where feldspar exceeds 10% the adjective feldspathic may be applied.

Permian System

The Permian rocks crop out in the SW of the sheet, where they form the lower slopes of the Dismal Range and continue E towards Lilydale North as a series of low hills. They have a shallow SW dip of 5-18°, are about 1450 feet thick, and unconformably overlie the folded Mathinna Beds.

The lithology varies from boulder, cobble and pebble conglomerate, through conglomeratic sandstone, and siltstone, to sandstone, siltstone and mudstone, with pebbles and granules either rare or absent (fig. 3). No simple correlation exists between the height of rocks above the base of the Permian and their rudaceous content, but there are fewer pebbles and cobbles ('erratics') in the upper part of the sequence.

Over parts of the area the Permian strata and pre-Permian surface dip conformably. However, NW trending basement highs occurring at 5148E/9203N and 5060E/9256N, rudimentary terrace formation visible in the region of 5115E/9207N, and shallow possibly NE trending depressions located at 5110E/9235N and 5077.5E/9267.5N, indicate that the lower Permian was deposited on an undulating surface. In all probability total relief did not exceed 300 feet, and gradients were less steep than 1 in 5; the SW slopes of basement ridges at 5143E/9203N and 5080E/9221N are approximately 1 in 5 and 1 in 10 having been corrected for post-Permian tilting.

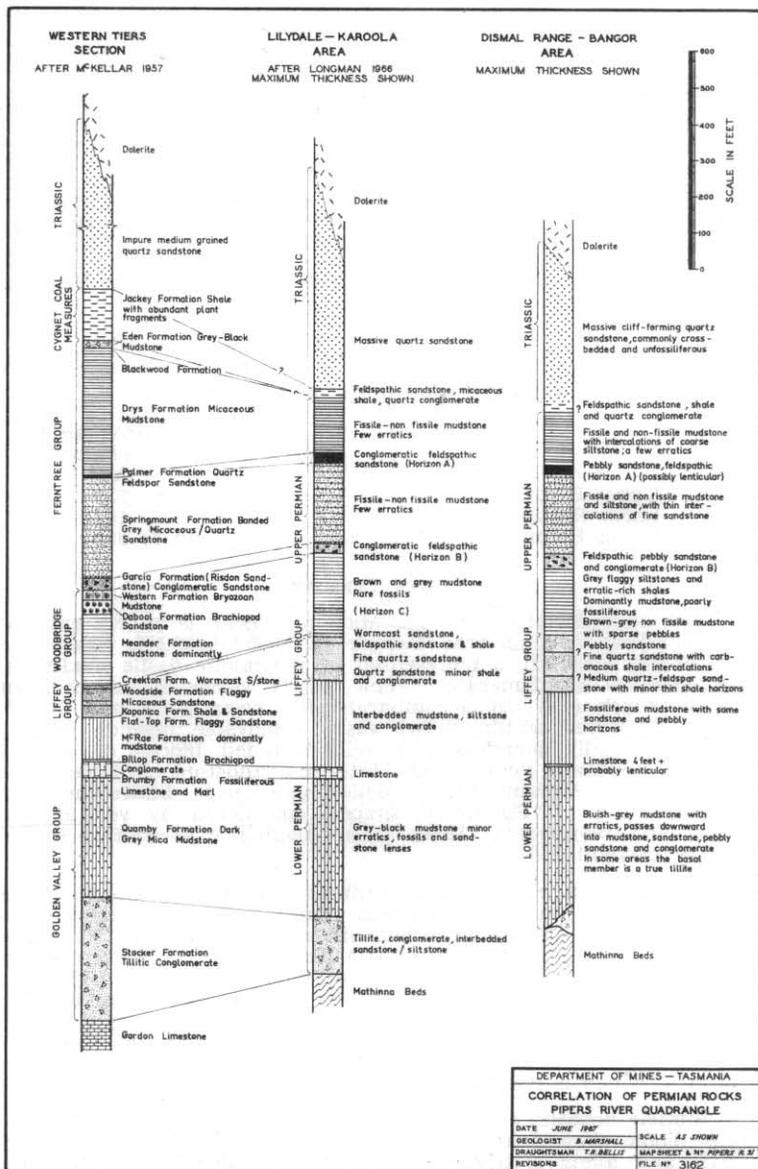
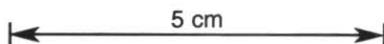


FIGURE 3



Nowhere within the area was the Permo-Triassic boundary actually seen. Generally, in ascending sequence, Upper Permian mudstone float gives way to float of a friable feldspathic sandstone, the boundary being placed just above the highest mudstone fragment encountered. In the Launceston Quadrangle Longman (1966, p. 13) commences the Triassic at the base of the first thick well-sorted sandstone above the Liffey Group and records that at 5033.3E/9170N on the Pipers River Road the boundary is just below a 2 inch quartz conglomerate band which was on an undulating surface. Since this locality lies but a short distance S of the Permo-Triassic rocks in the Pipers River Sheet a similarly disconformable relationship may be anticipated.

In the Pipers River Quadrangle the subdivision of the Permian is given in Table 1.

TABLE 1
Main Subdivision of the Permian Rocks

	<i>Approximate thickness feet</i>
Upper Permian	630
Liffey Group	150
Lower Permian	up to 650

LOWER PERMIAN

The unconformity with the Mathinna Beds is poorly exposed in a roadside cutting near Bangor at 5042E/9230.5N, where the base of the Permian is represented by polymictic fissile mudstone, and siltstone conglomerate. The matrix varies in colour from pale brownish grey, to a comparatively unweathered pale bluish grey. Scattered within it are easily removable pebbles, cobbles and occasionally boulders and joint-bounded blocks of diverse coloured quartzites, vein quartz, Mathinna sandstone, Ordovician(?) conglomerate, Precambrian(?) schist, Gordon(?) Limestone, and rarely granite. 'Flat-iron' shapes, considered by von Engel (1930) and Wentworth (1936) to be diagnostic of glacial action, may be encountered.

Thin section examination confirms the tillitic aspect of the outcrop, in that rounded to angular grains and rock fragments are embedded in an abundance of fine silt and clay-sized matrix. The fragments, which vary from a little larger than the matrix up to granules in size, mirror the range of rock type in the rudaceous fraction; however, there is a higher relative percentage of vein quartz and quartzite in the smaller size range. Limonitic matter has clouded the matrix, but it would appear to consist of quartz and sericite and is in no way inconsistent with a glacial origin for the rock, which is considered to be a true tillite.

Similar deposits occur in railway cuttings between the Lilydale Falls picnic ground and Bacala Sdg., in road-cuttings at 5111E/9237N and along a track at 5138E/9202N (plate 2). However, rudimentary bedding is apparent at the first locality, and inter-bedded sandstone horizons occur at the latter two thereby indicating

that either fluvial or marine waters were increasingly active within the environment of accumulation. The polymictic pebble and cobble mudstones are therefore considered to have been deposited directly from glaciers, possibly within a marine environment (Carey and Ahmad, 1961), whereas the poorly to moderately sorted fine to medium grained pebbly sandstone is thought to have arisen from localised rewashing of glacial material, perhaps accompanied by slumping and redeposition by a high density current mechanism.

With diminution in the number of sandstone horizons, the basal rocks pass upward into dark bluish-grey, pale buff to fawn weathering mudstone, in which are sparsely distributed pebbles and small cobbles of vein quartz and quartzite. These 'erratics' are often faceted and may be concentrated along specific horizons designating bedding. Minor pebble- and cobble-sandstone, and occasional beds of conglomerate, appear in the higher part of the sequence. The fossils which include foraminiferids, polyzoans, brachiopods, pelecypods and gastropods, are not abundant.

The weathered mudstone is extremely friable, characteristically breaking down into a rubble of concavo-convex fragments, less than 5.0 mm. in size. Accompanying this expression of the conchoidal fracture pattern is colour variation from pale bluish-grey to buff or fawn.

In the upper portion of the Lower Permian, limestone and calcareous mudstone are encountered. Fossiliferous mudstone crops out in a small quarry at 5054E/9200N, and in the bed of the Pipers River in the vicinity of 5049E/9207N. Limestone is exposed approximately 175 feet above the river flat at 5056E/9195N. Nye (1924) reported a similar limestone from the N bank of the Second River in the region of 5059E/9216N, and from ' . . . along the Pipers River between Bangor and Karoola. The northern end of this outcrop is a few hundred yards south of Cassidy's corner and it extends for almost a mile to the south where the bed probably dips below river level.' According to Nye the limestone is bluish grey and compact with abundant fossils and numerous polymictic pebbles, cobbles and occasional boulders, including quartz, quartzite, granite schist and gneiss. Longman (1966, p. 17) has identified *Calcitornella stephensi*, *Stenopora tasmaniensis* and *Eurydesma cordatum* from the probable correlate of this limestone in the Launceston Quadrangle. The limestone is at least 4 feet thick since this is the exposed thickness at 5056E/9195N, and Nye (1924) found an included boulder of this diameter. However, the lenticularity of limestone at this stratigraphic level has been noted by Banks (1962, p. 197), and it is reasonable that this limestone either inosculates or is discontinuous.

Polyzoal mudstone overlies the limestone and passes upwards into a less fossiliferous sequence of mudstone, siltstone and conglomeratic sandstone. Nevertheless fossils, which include foraminiferids, brachiopods, pelecypods and gastropods, as well as polyzoans, are more common than in the rocks underlying the limestone. Polyzoal mudstone is well exposed at 5062E/9195N in a recently excavated water hole, whereas the molluscan fauna may be seen at 5054E/9200N and, as float, at 5082E/9200N.

Banks (1962, p. 193), in a figure partly based on work by Nye, indicates that up to 200 feet of sedimentary rock separate the limestone from the younger Liffey Group (the Mersey Group of

Nye), and this appears to be so in the Cassidy's Corner and Second River districts. However, mainly from observations in the vicinity of 5055E/9196N, Nye (1924) stated that limestone is found '... a short distance below the sandstone of the Greeta Coal Measures, and it is significant that in many cases when the sandstones are exposed in cliff faces, the limestone occurs below. This association is due to the fact that surface and underground waters containing carbon dioxide dissolve the limestone and carry it away in solution. Cavities are thus formed under the sandstones and large bodies of these rocks fall under the action of gravity, leaving vertical cliff faces at the line of rupture.' Irrespective of the merit of this mechanism, it is apparent that Nye thought the Liffey Group was closely underlain by limestone, and in consequence, part of the Pipers River Sheet 2½ miles SSE of Bangor was mapped on this premise. Since publication of the map, further investigation has necessitated the modification shown in figure 4. The area no longer supports the stratigraphy envisaged by Nye, and although displacements on the previously unmapped faults cannot be determined with certainty, there seems little doubt that the area conforms with the common stratigraphy in that up to 200 feet of rock lie between the limestone and the Liffey Group.

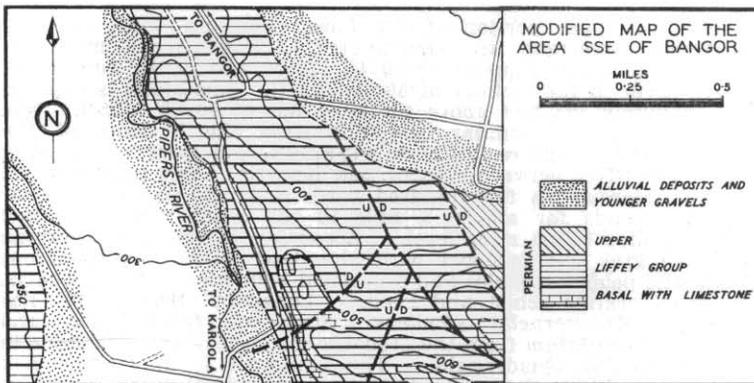


FIGURE 4

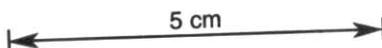
LIFFEY GROUP

This group is better exposed in the Launceston Quadrangle where Longman (1966) established the sequence shown in Table 2.

TABLE 2

Top not exposed.

	Feet
5. Grey feldspathic sandstone with worm-casts and abundant pebbles	5+
4. Interbedded feldspathic sandstone and carbonaceous shale with abundant plant fragments	20+



- | | |
|--|-----|
| 3. Fine grained quartz sandstone with minor micaceous and carbonaceous shale bands | 70+ |
| 2. Quartz sandstone with minor shale and quartz conglomerate | 30 |
| 1. Quartz conglomerate (not always present) | 0.5 |
| Lower Permian | |

In the Pipers River area poor exposure prohibited confirmation of this sequence, but a probable thickness of up to 150 feet is indicated by the distribution of float and sandy soil on the lower slopes of the Dismal Range. Basal quartz conglomerate (unit 1) is not encountered, but a correlate of Longman's unit 2 forms substantial cliffs at 5055E/9196.5N, where a massive sandstone is associated with large scale cross-bedded units (plate 3), in which the current direction appears to be from the WNW. Thin shale bands, and vein quartz and granite pebble horizons are infrequently encountered, whereas ferruginous concretions are less common.

In the hand specimen the friable rock often exhibits Liesegang diffusion phenomena, varying in colour from pale fawn to orange-brown. Discrete white mica flakes glisten on the bedding face and in bright sunlight individual quartz grains flash.

Under the microscope the main minerals identified were quartz, plagioclase, potash feldspar (microcline), clastic muscovite, and grains of sericite-quartz slate or phyllite. The rock is moderately well-sorted, closely packed angular to sub-rounded grains forming a continuous framework in which is enclosed quartz, sericite, and chlorite matrix. This fraction is generally less than 0.01 mm. in size whereas the clastic fraction occupies the 0.30 mm. to 0.40 mm. size range. Quartz grains with rounded secondary silica overgrowths are thought to have been recycled.

Matrix comprises approximately 10% of the rock, which, therefore, falls on the boundary between wacke and arenite (Williams, Turner and Gilbert, 1954) and cannot be considered clean. However, substantial textural condensation has been effected by pressure solution, and in consequence the original matrix content, expressed as a percentage of total volume including void space, must have been somewhat less than 10%. Thus, in view of the approximately equal proportions of feldspar and lithic fragments, this rock may suitably be termed a feldspathic lithic sandstone or arenite.

Towards the crest of the ridge above the sandstone cliffs (5056E/9196.5N) is an occurrence of oil shale (Twelvetrees, 1918a; Nye, 1924). The horizon, which apparently comprises an alternation of shale with oil shale, is probably between 18 and 36 inches thick.

Little is known of the overlying units, but on the lower slopes of the Dismal Range (5021E/9213N) Naqvi established the intermittent sequence in Table 3.

TABLE 3

<i>Rock type</i>	<i>Possible correlation with Longman's units</i>
Medium to coarse grained pebbly sandstone.	Unit 5
Fine grained quartz sandstone with subordinate carbonaceous shale bands.	
Carbonaceous shale alternating with thin fine grained sandstone horizons.	Unit 3
Medium grained quartz-feldspar sandstone with thin shale horizons.	
	Unit 1

The top of the Liffey Group consists of sub-angular to rounded pebbles of vein quartz, quartzite, and occasionally schist, embedded in a medium to coarse grained feldspathic sandstone. Occasionally the pebbles are sufficiently abundant for the rock to be called a conglomerate.

UPPER PERMIAN

This sequence, which consists of mudstone, siltstone, fine sandstone and pebbly sandstone, approaches 650 feet thick on the slopes of the Dismal Range. Of the lower 200 feet, even float is scarce, but above this two separate sandstone horizons (*a* and *b*) often crop out on prominent benches, whilst the intervening finer grained rocks are represented by a great deal of float.

The base of the Upper Permian is nowhere exposed in the Quadrangle, the stratigraphically lowest outcrop being found approximately 25 feet above the base at 5018E/9213N, and consisting of brownish-grey non-fissile poorly bedded mudstone, with quartz and quartzite pebbles up to an inch in diameter. At 5024E/9197.5N a similar rock passed upward into yellowish-brown shale with sparse erratics, approximately 60 feet above the Liffey group, whereas 210 feet above the Liffey immediately underlying sandstone horizon *b*, at 5025E/9198N, brown and grey erratic-rich flaggy siltstone and shale occur. Nothing is known of the intervening strata in the Pipers River Quadrangle.

Horizon *b* is the principal marker in the Upper Permian sequence. The full thickness of 35 feet is exposed to the W of Lower Turners Marsh in the vicinity of 5006E/9233N, but occasional outcrops and abundant float are found all along the Dismal Range. The rock is a brownish-grey, well indurated, coarse grained, impure feldspathic sandstone with abundant pebbles and cobbles of quartz, quartzite, slate and schist. In thin section the constituent minerals are seen to be quartz, orthoclase(?), microcline, perthite, myrmekite (one grain only) and quartzitic rock fragments in a very fine matrix, less than 0.01 mm. average diameter, of quartz, sericite and ferruginous matter. The poorly sorted angular to sub-rounded grains of the clastic fraction range from 0.05 mm. to 1.5 mm. in diameter, and, being entirely embedded in matrix

form a disrupted framework. Approximately 40% of the rock is matrix and 10-15% is feldspar, therefore it may be termed a pebble and cobble feldspathic wacke or impure sandstone.

Horizon *a*, an essentially similar sandstone, may be encountered approximately 220 feet above horizon *b*. It consists of several medium to coarse grained pebbly beds, each up to 18 inches thick, in association with finer grained sandstone and siltstone. The total thickness is nowhere exposed but a conservative estimate of 5 to 10 feet may be given. Typical outcrop is seen on a bench at 5066E/9197N about 50 yards E of a small quarry. The limited extent of horizon *a* in the Launceston Quadrangle and its apparent absence from the Dismal Range in this sheet, suggests either that it varies in lithology and, thereby, in resistance to weathering, or that it is lenticular.

Separating horizons *b* and *a* are some 220 feet of fissile and non-fissile mudstone and siltstone with very infrequent intercalations of thinly bedded sandstone. Fossils were not encountered and subangular to rounded pebbles of quartz, quartzite, and rarely, schist, were scarce. Well developed joints normal to bedding impart a tabulate appearance to non-fissile beds. Yellowish cream weathered surfaces and grey and cream mottling on fresher surfaces are characteristic. One of several isolated outcrops on the Dismal Range may be seen at 5004.5E/9232.5N.

Between horizon *a* and the Permo-Triassic unconformity are a further 160 feet of fissile and non-fissile mudstone. Other than containing a few more erratics towards the top, this sequence is indistinguishable from that underlying *a*.

Triassic System

Triassic rocks are restricted to the SW of the Quadrangle where, in the Dismal Range and Mt. Direction, they are protected by dolerite. They dip towards the SW at 5-10° and whilst attaining a thickness of about 400 feet on the N slopes of the Dismal Range, it would appear to thicken to WSW due to the transgressive dolerite sheet (see fig. 8).

According to Longman (1966, p. 18) the disconformable Permo-Triassic relationship consists of a slightly undulating Permian mudstone surface on which is deposited a 2 inch thick layer of quartz pebble conglomerate. This is apparently overlain by 20 feet of alternating feldspathic sandstone and shale, which, in turn, passes upward into massive sandstone.

In the Pipers Quadrangle the disconformity and basal sequence were not exposed, the first outcrop being in massive thickly bedded sandstone.

This pale khaki to purplish-brown, generally unfossiliferous, somewhat friable rock, often forms substantial cliffs in which large scale cross-bedding, ferruginous concretions, and Liesegang diffusion phenomena are prominent; it is surprisingly similar to the cliffs of Liffey Group sandstone at 5055E/9196.5N. At 4982.5E/9225N, just W of the upper reaches of Biddle Creek, natural caves, 8 feet deep, have been excavated in the cliff face.

Under the microscope the rock is seen to be medium grained quartz sandstone or arenite. Well sorted quartz grains of 0.4 to 0.5 mm. diameter constitute more than 90% of the rock, the remainder consisting of microcline, plagioclase and interstitial ferruginous matter. Polygonal grain-shape and low porosity are due to secondary quartz overgrowths, grains originally being sub-angular to sub-rounded. Where secondary quartz development is less pervasive, particularly adjacent to feldspar grains, leaching of the ferruginous cement has resulted in a partially porous and friable rock.

The intrusive dolerite contact was not seen but as far as could be ascertained contact metamorphic effects were insignificant.

Cainozoic Deposits: Tertiary

All rocks ascribed a Tertiary age are demonstrably older than basalt, the latter being the uppermost proved Tertiary horizon, but not necessarily the end of the Tertiary period. The deposits have been divided into (i) sandstone and conglomerate and (ii) gravel and siliceous conglomerate.

SANDSTONE AND CONGLOMERATE

As well as occurring in narrow strips and isolated patches, these rocks cover a substantial portion of the sheet E of a line joining Bridport with the Sideling Range. Regional variation is induced by the provenance of the detritus and, on this basis a threefold division is recognised: those derived from (a) granite, (b) Mathinna, and (c) dolerite terrains. Included within the second group are the auriferous leads at Back Creek.

The ferruginous zones shown in the Bridport-West Scottsdale trough are the result of impregnation of Tertiary sandstone and conglomerate by limonitic iron oxides. They differ from the undifferentiated ferruginous deposits in that the iron oxides lack pisolitic form and only comprise the matrix portion of the rock. Their distribution with respect to basalt residua would suggest that basalt provided the iron oxide.

A small lateritic zone overlies dolerite in the SW corner of the sheet. It is not possible to say whether this and the E ferruginous zones are co-eval.

(a) DERIVED FROM GRANITE TERRAIN

Deposits of this type are largely restricted to the E marginal depression, and even when substantial quantities of Mathinna Beds detritus are involved, granitic quartz granules are the pervading feature. Superficial expression varies with composition: dearth of Mathinna sandstone pebbles and cobbles in the parent rock produces a soil of sub-angular quartz granules, with rare vein quartz pebbles, which is not easily distinguished from soils overlying granodiorite; when sandstone pebbles and cobbles are abundant, the soil reflects this and is easily distinguished from the granite-soils. The very poor natural exposures of these rocks are restricted to areas of ferruginous impregnation, N of Jetsonville. However, by way of compensation, gravel workings and road and rail cuttings are abundant. Neither the stratigraphic sequence

nor total thickness could be established, but considerable lateral variation and a seaward increase in thickness is most probable. Information from specific localities will now be presented.

One and a half miles WNW of Springfield, abundant float of pebbles and small cobbles of quartz and Mathinna sandstone, exhibiting high sphericity, covers the flanks of the valley. A shallow cutting in the track at 5338E/9244N has exposed an abundance of ellipsoidal sandstone pebbles two to four inches in diameter. At 5345E/9279N a conglomerate deposit is being quarried for road fill. Approximately 20 feet of sedimentary rock are exposed in the highest face, which exhibited the following sequence.

	<i>Approximate thickness in feet</i>
Soil profile rich in quartz granules	4
Uniform quartz granule grits with interstitial clay and rare quartz pebbles (approx. 1 inch in diameter)	2
Conglomerate of well rounded Mathinna sand- stone pebbles and small cobbles, averaging 2-4 inches in diameter, with subordinate smaller sub-rounded vein quartz pebbles in a clay matrix	2
Coarse sand and quartz granules in clay, with discontinuous horizons of well rounded pebbles, approx. 1 inch in diameter	3
Large rounded pebbles and cobbles in a matrix of clay and quartz granules	12+

A similar deposit is to be found in a small gravel pit approximately $\frac{1}{4}$ mile to the SSE (5351E/9268N).

Underlying the soil profile in a railway cutting at 5350E/9305N is a deposit, approximately 5 feet in thickness, of sub-angular to well rounded quartz granules in a silty clay matrix with some limonitic impregnation. This passes downward into at least 6 feet of conglomerate, consisting of pebbles and small cobbles ($\frac{1}{2}$ -5 inches in diameter) of Mathinna sandstone and vein quartz, in a matrix of clay, sand and quartz granules.

The next railway cutting immediately E of the level crossing at Lietinna, is also in conglomerate. An irregularly shaped but broadly lenticular horizon, some $2\frac{1}{2}$ feet by 10 feet, consisting of quartz granules in sandy clay, is found a third of the way up a 15 feet section of Mathinna sandstone pebbles, cobbles and small boulders, with some vein quartz pebbles, embedded in a sand, quartz-granule and clay matrix.

Two hundred yards N of the Lietinna level-crossing, a recent road alignment has exposed 6 feet of closely packed, perfectly rounded sandstone pebbles and cobbles, up to 8 inches in diameter, with sparse quartz pebbles and 2-3 inch discs, in a matrix of clay, sand and quartz granules. This passes disconformably upward into at least 6 feet of quartz-granules with interstitial clay, and cross-bedded fine grained sandstone.

Road improvements at 5365E/9301N have exposed a face approximately 50 feet long and 15 feet high, in which the following sequence was established—

	<i>Approximate thickness in feet</i>
Superficial basaltic soil profile	1½
Coarse grained (up to ½ inch) quartz-granule grit with some interstitial clay	2½
Pale sandy clay, with discontinuous clay horizons forming sinuously lenticular bodies up to 2½ feet in length and 8 inches in thickness	4
Uniform quartz-granule grit with rare clay pellets, lenses (6 inches x 4 feet) of slightly coarser sediment, and small sand- stone pebbles	5
Pale sandy clay with abundant embedded quartz granules	2

In this section the undulating interfaces between successive beds is attributed by D. J. Jennings (1966) to 'contortion during compaction of the sediment while still waterlogged, possibly at the time of basalt extrusion.'

Large scale cross-bedding in coarse grained quartz-granule grits, with units up to 8 feet in length picked out by limonitic impregnation, is exposed in a road-materials pit at 5349E/9313N. Similar quartz-granule deposits, with sparse horizons of Mathinna sandstone and vein quartz pebbles may be encountered in cuttings along the Scottsdale-Bridport road. Substantial thicknesses of conglomerate deposits tend not to persist, or are unencountered, N of Jetsonville.

The sediments have apparently been laid down in an elongate depression formed by deep weathering and partial removal of granitic rock in late Mesozoic time. In the ensuing marine transgression a bay probably formed as far S as the Springfield district, and became the depository for Mathinna and granitic detritus from adjacent hills. Subsequent regression resulted in substantial redistribution of introduced detritus and of granitic debris essentially weathered *in situ*.

Much of the foregoing account was abstracted and modified from an unpublished report by D. J. Jennings (1966).

(b) DERIVED FROM MATHINNA TERRAIN

General

These rocks, of restricted distribution, tend to be closely associated with basalt, and are probably fluvial deposits laid down by Tertiary streams. Exposure is very poor and identification is based mainly on well-rounded float and blocks of conglomerate in recently cleared or ploughed fields. Usually the freshly turned surface is strewn with well-rounded pebbles and cobbles of Mathinna sandstone with subordinate amounts of vein quartz and

quartzite (possibly Ordovician), but near the confluence of Back Creek and the Pipers River the soil is very sandy and cobbles are scarce.

N from Greeta, basalt patches overlies a predominantly conglomerate deposit, which is exposed in a road-cutting at 5242E/9298.5N. Well rounded cobbles and pebbles of Mathinna sandstone, frequently ellipsoidal and discoidal in shape, occur with vein quartz pebbles in an ill-sorted matrix of quartz, feldspar and clay. The feldspar is largely decomposed, but this is probably a recent feature since it would hardly have survived much transport in its weathered state. Bedding is denoted by possibly discontinuous horizons of matrix material. This conglomerate rock is of bi-modal derivation since the rudaceous fraction is predominantly Mathinna whereas the matrix is granitic.

Induration of sandstone and conglomerate is often partly due to impregnation by limonite. Examples of this may be found in the Lebrina and Pipers Brook districts, approximately $1\frac{3}{4}$ miles SW of Pipers River, and $1\frac{1}{4}$ miles ESE of the Leura Mine.

A less indurated sandstone consisting of a bedded, medium grained, Mathinna-derived, quartz sand with infrequent traces of vein quartz pebbles, overlies Mathinna Beds at 5026.5E/9439.5N. To the SW at 5022E/9432.5N, the sandstone has given way to a pebble conglomerate in which the rudaceous fraction consists of Mathinna quartzite, vein quartz and an other quartzite, probably derived from the Ordovician via the Permian.

S of Pipers River, at 4985.5E/9353N, a pinkish brown to light brown sandstone underlies the basalt, and carries imprints of dicotyledonous Tertiary leaves (see Appendix 2). This well-indurated, fine to medium grained sandstone which is partly cemented by ferruginous compounds and mainly composed of quartz grains, may be co-eval with the tuff described on page 69 and contain a small proportion of volcanic material.

The Back Creek District

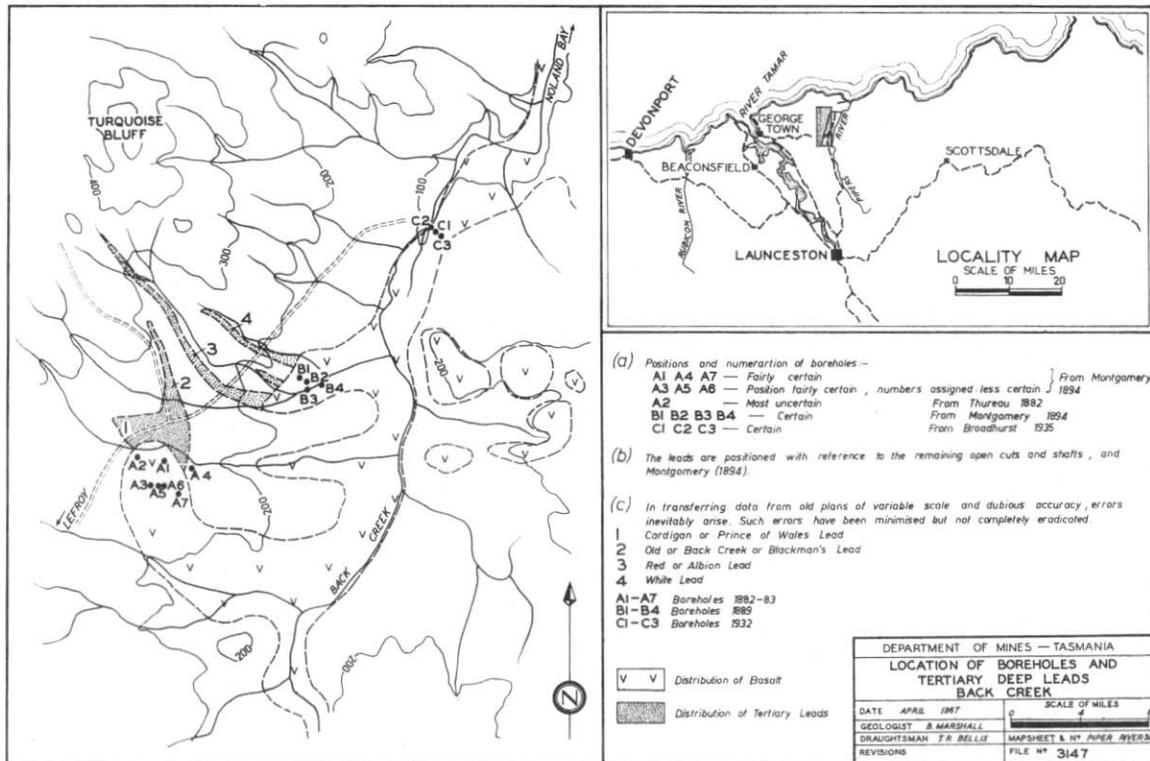
The economic aspects of the Back Creek auriferous leads will be referred to in Appendix 1; present discussions will be confined to stratigraphical considerations. Available data are conveniently divisible into those from open-cast workings and those from bore-holes.

The main workings were the White Lead, the Red Lead, Blackman's Lead, and the Cardigan Lead (fig. 5). In their vicinity the soil contains much fine- to medium-grained sand, with vein quartz and Mathinna pebbles.

According to Montgomery (1894a) the White Lead owed its name to the high content of white clay. He reported that the higher portion of the wash was mostly sandy clay with some sub-angular vein quartz, whereas the gold-bearing layer was probably made up of angular vein quartz. A recent examination of the open-cut, which is up to 20 feet deep, has shown that S of

5 cm

FIGURE 5



the track fine grained blotchy, light brown sandstone overlies a pale grey to white sandy clay with embedded vein quartz fragments. This directly overlies argillaceous Mathinna or passes downward into a boulder conglomerate containing blocks (up to 3 feet) of vein quartz, slate, and silicified slate and vein quartz fragment conglomerate (see p. 44, Siliceous Conglomerate), which in turn overlies Mathinna. N of the track one encounters an increasing proportion of well-indurated fairly clean, medium grained, grey to brown sandstone.

Montgomery (1894a) suggested that the Red Lead was so named because of the reddish colour of iron oxides in the wash, and that the Lead was 10-15 feet deep. Where recently examined the open-cut was 8-10 feet deep, approximately 6 feet of mottled brown and grey silty clay underlying a more indurated fine-medium grained sandstone. The sandstone exhibits weak vertical jointing whereas the silty clay has a poor horizontal fissility.

Blackman's Lead, also known as the Old or Back Creek Lead, was stated by Montgomery (1894a) to have been 18-25 feet deep, and to have comprised a bottom of soft slate overlain by 3 to 7 feet of water-worn boulders of vein quartz, slate and sandstone. These were in turn overlain by sand and clay which was succeeded by 3 to 6 feet of sandy drift with much angular quartz. In the lower part of the excavation the bedrock was reported (Thureau, 1882b; Montgomery, 1894a) to pass underneath a false bottom of quartz, slate and sandstone boulders in a sandy clay matrix. Recent investigation has revealed in the central part of the excavation—

Humic soil profile	10 inches
Fine grained, mottled brown to grey sandy clay containing angular and rounded granules and pebbles of vein quartz. These approach cobble size with depth	5 feet
Poorly indurated fine to medium grained sandstone, of pale brown colour	14+ feet
No bottom.	

A little S of this, in an incomplete sequence a few inches of fine sandstone pass downward into a whitish-grey to light-brown silty clay with blocks of slate, siltstone and vein quartz.

Where examined, the Cardigan Lead was shallow, consisting of a white to grey silty clay with pebbles, cobbles, and small boulders of vein quartz, Mathinna, and siliceous conglomerate. Montgomery (1894a) reported well-rounded blocks of conglomerate, weighing several tons, from the N side of the Lead, and, having noted the occurrence of siliceous conglomerate in the White Lead, drew attention to a report by Thureau (1882b) which stated: 'All these auriferous runs of diluvial gravels demonstrate an immense force of water running in swift torrents in self-eroded channels in prehistoric times, as evidenced by the rounded and

semi-angular boulders of a hard siliceous breccia, one of which was found embedded in a reddish clay, and which measured 15 feet across by a thickness exceeding 4 feet, having evidently travelled over a considerable distance, as I could not discover any similar rock in the district'. Although not doubting that the streams which laid down the gravels were able to transport larger material than the present water courses Montgomery (1894a) questioned the existence of streams sufficiently large to move the boulder noted by Thureau. Montgomery (1894a) considered that they were '... formed *in situ*, not mechanically transported', since they were '... composed of exactly similar material to the surrounding and often underlying loose wash'. He suggested that rounding of the conglomerate boulders was effected by later water-action, perhaps during the erosion of the existing water channels.

The writer has seen neither the boulder referred to by Thureau (1882b) nor the boulders weighing several tons mentioned by Montgomery (1894a), but the small boulders that were encountered in the Cardigan Lead and the blocks of the White Lead had definitely suffered water-transport since—

- i. They showed signs of rounding.
- ii. Rounded vein quartz and Mathinna beds boulders were of comparable dimension.
- iii. All boulders were embedded in a sandy clay matrix.

The possibility that rounding was effected by post-lead water-action (Montgomery, 1894a; Thureau, 1882b) is rejected since more recent streams of depleted transporting power cannot be rounding such large boulders. There is little doubt that the siliceous conglomerate boulders were rounded and carried by water-action into the conglomerate of the Cardigan and White Leads.

Montgomery (1894a) provides the following explanation for the distribution of the leads: 'When the streams that laid down the auriferous gravels were running the present leads were in the bottoms of their valleys; these, during the long period of subsidence which can be shown to have prevailed in Palaeogene times in Tasmania, became filled with drift deposits; later on the streams cut down again through these upper drifts, but not exactly in the old channels, and have now cut fresh beds in what were formerly the sides of the old valleys, leaving the old gravel deposits on the slopes and top of the spurs.'

The leads pass E under a basalt flow and most probably may be correlated with inter-basalt deposits encountered in bore-holes (cf. Broadhurst, 1935, p. 71).

Three series of diamond-drill borings have been sunk in the years 1882-83, 1889, and 1932. Since their positions were not surveyed and the numeration assigned to bores 3, 5, and 6 (first series) is uncertain, their distribution, as shown in figure 5, is tentative. The following records are from Broadhurst (1935).

FIRST SERIES OF BORES IN 1882-83

No. 1 BORE—Commenced 9th September, 1882,
finished 10th October, 1882.

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
	<i>ft. in.</i>	<i>ft. in.</i>
Surface shaft	9 0	9 0
Sandy clay and soft brown rock	11 0	20 0
Bluestone (basalt)	41 0	61 0
Basaltic clay	12 0	73 0
Gravelly wash	7 0	80 0
Brown sandy clay with decayed wood	51 0	131 0
Black sandy clay with wood	10 0	141 0
White clay	6 0	147 0
Black clay with wood	4 0	151 0
Conglomerate	0 6	151 6
Black clay, wood and gravel	5 6	157 0
Gravelly wash	8 0	165 0
Cemented sand and gravel	25 0	190 0
Gravelly drift	5 0	195 0
Cemented sand and gravel	14 0	209 0
Drift	5 6	214 6
Gravel	3 10	218 4

No. 2 BORE—Commenced 27th October, 1882,
finished 6th November, 1882.

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
Surface shaft	8 0	8 0
Clay	8 0	16 0
Soft brown rock	10 0	26 0
Bluestone and honeycombed basalt	36 0	62 0
Basaltic clay	12 0	74 0
Gravel	6 0	80 0
Clay	10 6	90 6
Slate and sandstone, with thin quartz veins	24 6	115 0

No. 3 BORE—Commenced 18th November, 1882,
finished 29th November, 1882.

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
	<i>ft. in.</i>	<i>ft. in.</i>
Surface shaft	8 0	8 0
Sandy clay	3 0	11 0
Gravel	1 0	12 0
Clay	12 0	24 0
Soft brown rock and honeycombed basalt	5 0	29 0
Bluestone (basalt)	47 6	76 6
Honeycombed basalt	5 0	81 6
Basaltic clay	15 0	96 6
Gravel	6 0	102 6
Brown and black sandy clay, with wood	27 9	130 3
Conglomerate	0 6	130 9
Brown and black sandy clay, with wood	35 6	166 3
Conglomerate	3 2	169 5
Bluestone and honeycombed basalt	21 0	190 5
Light-coloured sandy clay	9 10	200 3
Brown sandy clay and gravel	3 0	203 3
Soft slate and sandstone	37 3	240 6

No. 4 BORE—Commenced 11th December, 1882,
finished 12th December, 1882.

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
Clay	16 0	16 0
Sandstone	24 0	40 0

No. 5 BORE—Commenced 27th December, 1882,
finished 16th January, 1883.

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
Clay	12 0	12 0
Soft rock	12 0	24 0
Bluestone (basalt)	54 0	78 0
Honeycombed basalt	5 0	83 0
Basaltic clay	9 0	92 0
Brown and black sand and wood	3 0	95 0
Gravelly wash	3 0	98 0
White clay	2 0	100 0
Brown and black sandy clay, fine gravel and wood	60 0	160 0
Honeycombed basalt	4 0	164 0
Basalt (lower part honeycombed)	28 6	192 6
Black and brown clay and wood	5 0	197 6
Clay, wood, drift, gravel and cement	8 6	206 0
Cement and gravel	2 0	208 0
Sandy clay and gravel	4 0	212 0
Gravel	2 0	214 0
Slate reef and sandstone	24 0	238 0

No. 6 BORE—Commenced 25th January, 1883,
finished 9th February, 1883.

<i>Strata passed through</i>	<i>Thickness</i>		<i>Total depth</i>	
	<i>ft.</i>	<i>in.</i>	<i>ft.</i>	<i>in.</i>
Clay	33	0	33	0
Bluestone (solid basalt)	25	0	58	0
Honeycombed basalt and bluestone	5	6	63	6
Bluestone and honeycombed basalt	19	0	82	6
Basaltic clay	4	2	86	8
Clay and wood	4	6	91	2
Gravelly wash and drift	10	0	101	2
Clay	3	0	104	2
Sandy clay with wood	5	10	110	0
Gravelly drift, sand and wood	18	0	128	0
Brown sandy clay and wood	34	0	162	0
Bluestone and honeycombed basalt	21	0	183	0
Basaltic clay	11	0	194	0
Brown sandy clay, gravel, and cement	16	0	210	0
Red-brown sandy clay	27	0	237	0
Sandy clay and a little gravel	2	0	239	0
Sandstone	15	0	254	0

No. 7 BORE—Commenced 20th February, 1883,
finished 4th May, 1883.

<i>Strata passed through</i>	<i>Thickness</i>		<i>Total depth</i>	
	<i>ft.</i>	<i>in.</i>	<i>ft.</i>	<i>in.</i>
Clay	8	0	8	0
Gravel	1	0	9	0
Clay	7	0	16	0
Soft rock and bluestone (basalt)	45	0	61	0
Basaltic clay	12	0	73	0
Gravelly wash	7	0	80	0
Brown sandy clay and gravel	10	0	90	0
Black sandy clay with wood and gravel	52	0	142	0
Basaltic clay	6	0	148	0
Sandy clay and gravel	4	0	152	0
Clay with wood and gravel	6	0	158	0
Cemented gravel	7	0	165	0
Cemented sand and gravel, and floating reef	25	0	190	0
Cemented sand and gravel	22	0	212	0
Cemented gravel	4	9	216	9
Gravel	4	3	221	0
Sandstone	2	0	223	0

SECOND SERIES OF BORES: 1889

No. 1 BORE—Commenced 2nd February, 1889,
finished 2nd March, 1889.

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
	<i>ft. in.</i>	<i>ft. in.</i>
Surface shaft	6 6	6 6
Basaltic clay	22 6	29 0
Blue and black clays with decayed wood and cemented pebbles	44 6	73 6
Hard basaltic rock	90 9	164 3
Basaltic clay	7 8	171 11
Quartz drift and stones	2 0	173 11
Blue clay	1 11	175 10
Quartz wash	1 0	176 10
Soft slate bottom	15 5	192 3

No. 2 BORE—Commenced 9th March, 1889,
finished 13th April, 1889

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
Surface shaft	6 6	6 6
Yellow clay	3 9	10 3
Quartz gravel	2 6	12 9
Basaltic clay	37 4	50 1
Black clay and decayed wood	10 2	60 3
Basaltic clay	9 4	69 7
Hard basaltic rock	99 1	168 8
Basaltic clay	5 8	174 4
Quartz wash	8 4	182 8
Slate and quartz gravel	8 4	191 1
Black slate bottom	4 0	195 0

No. 3 BORE—Commenced 20th April, 1889,
finished 18th May, 1889.

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
Surface shaft	11 6	11 6
Basaltic clay	14 0	25 6
Soft basaltic rock	21 7	47 1
White sandy clay and decayed wood	8 8	55 9
Black clay and decayed wood	17 6	73 3
Blue clay	3 0	76 3
Hard basaltic rock	91 10	168 1
Basaltic clay	7 9	175 10
Cemented wash	0 6	176 4
Brown and blue slate	8 2	184 6
Quartz leader	0 6	185 0
Blue slate	3 4	188 4

No. 4 BORE—Commenced 24th May, 1889,
finished 5th July, 1889.

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
	<i>ft. in.</i>	<i>ft. in.</i>
Surface Shaft	11 0	11 0
Rotten basalt	24 0	35 0
White, brown, and black clays, and decayed wood	27 0	62 0
Soft basaltic rock	3 0	65 0
Hard basaltic rock	116 5	181 5
Basaltic clay	12 4	193 9
Clay and decayed wood	5 1	198 10
Quartz wash	5 11	204 9
Black slate bottom	6 5	211 2

THIRD SERIES OF BORES: 1932

No. 1 BORE

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
Clay	7 0	7 0
Hard basalt	81 0	88 0
Slate	10 0	98 0

No. 2 BORE

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
Soft basaltic clay	10 0	10 0
Quartz wash	2 0	12 0
Blue slate	2 0	14 0

No. 3 BORE

<i>Strata passed through</i>	<i>Thickness</i>	<i>Total depth</i>
Basalt, most of it hard	171 0	171 0
Quartz	1 0	172 0
Slate	8 0	180 0

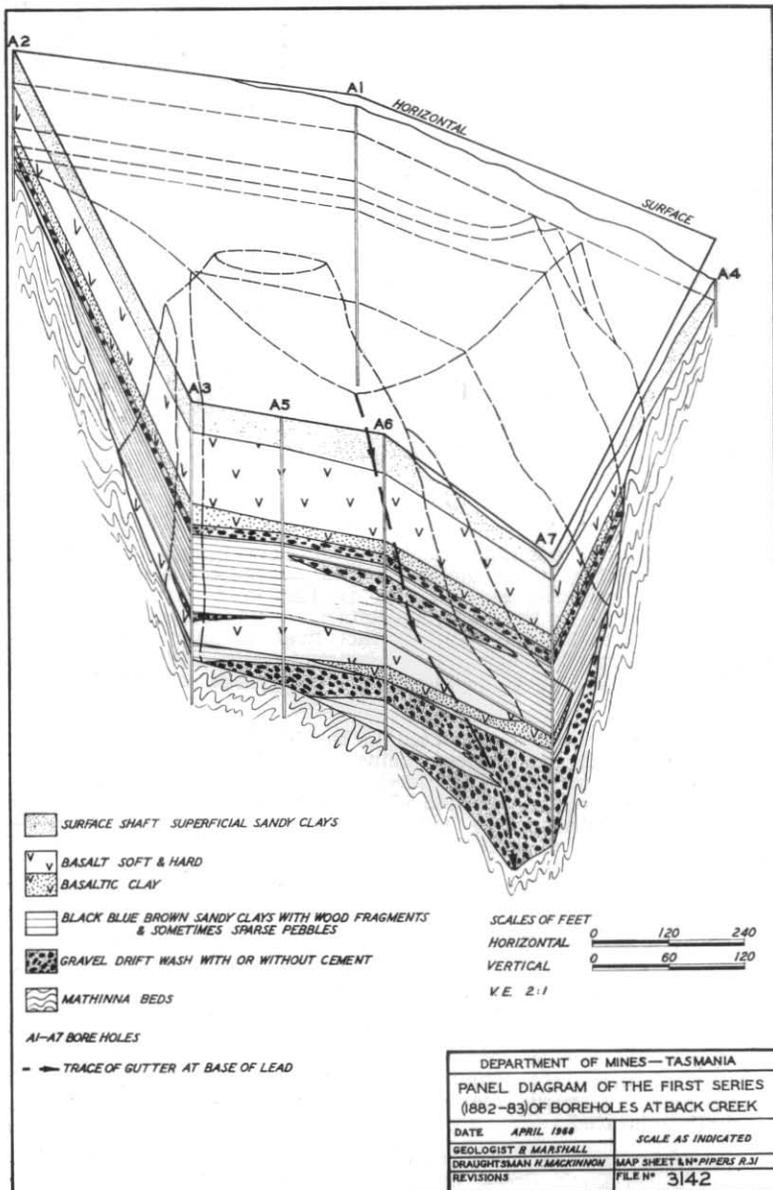


FIGURE 6B

5 cm

A columnar presentation of this data is given in figure 6. Several of the older bores reveal two flows of basalt, separated by a substantial thickness of sedimentary rock. This indicates that a considerable period of time must have elapsed between flows.

The third series of bores was apparently sunk according to the recommendations of Montgomery (1894a). The failure to encounter sedimentary material is attributed to Back Creek having been erosional along this part of its course, during the Tertiary (see p. 64).

(C) DERIVED FROM DOLERITE TERRAIN

This lenticular horizon is restricted to the SW corner of the sheet and is an extension of the Tertiary deposits of the Launceston Quadrangle. It consists of rounded to sub-angular boulders, cobbles and pebbles of dolerite, ranging from 3 feet to 2 inches in diameter, in a brown coloured bedded clay matrix. Rare pebbles of hornfelsed Permian, lenticular mudstone horizons devoid of pebbles, and lenses of clean sandstone may also be encountered. The conglomerate is best exposed in road cuttings to the W of Mt. Direction at 4932E/9200N and 4930.5E/9200.5N.

GRAVEL

The gravel deposits, consisting of vein quartz with minor quantities of Mathinna sandstone and quartzite, have been subdivided into rounded, angular and rounded, and angular types, of which the latter is the most uncommon. Outcrop is restricted to man-made excavations, whilst surface float consists of fragmental angular and rounded vein quartz, ranging up to cobble dimensions but more commonly of pebble size, strewn upon a grey to fawn soil.

Rounded gravel is restricted to the N of the Quadrangle, the most important occurrences being in the Ferny Hill district (5200E/9400N) on the Back Creek-Pipers River interfluvium, and 1½ miles SE of Lulworth. At 5192.5E/9377.5N excavations have exposed 6 feet of predominantly sub-rounded to rounded vein quartz pebbles (average diameter about ½ inch) in a matrix of quartz sand and granules. Stratification and cementation were not conspicuous. Gravel workings 200 yards NNW of the Leura Mine reveal well-rounded vein quartz ranging up to cobble dimensions in association with quartz sand and minor amounts of argillaceous material. These deposits, and others approximately ½ mile to the S, are capped by lag concentrates which possibly formed in the Tertiary on small knolls not covered by basalt (fig. 9). The workings SE of Lulworth are amongst the most extensive known in the Quadrangle. They consist of several feet of lag gravel (well-rounded pebbles, cobbles, and some small boulders) grading downward into a conglomerate in which the matrix is sandy with some clay. Towards the base of the exposed material the rock is quite indurated.

Angular and rounded gravel form notable occurrences in the Pipers River-Back Creek drainage basins where deposits consist of lag concentrates derived from a conglomerate of vein quartz in

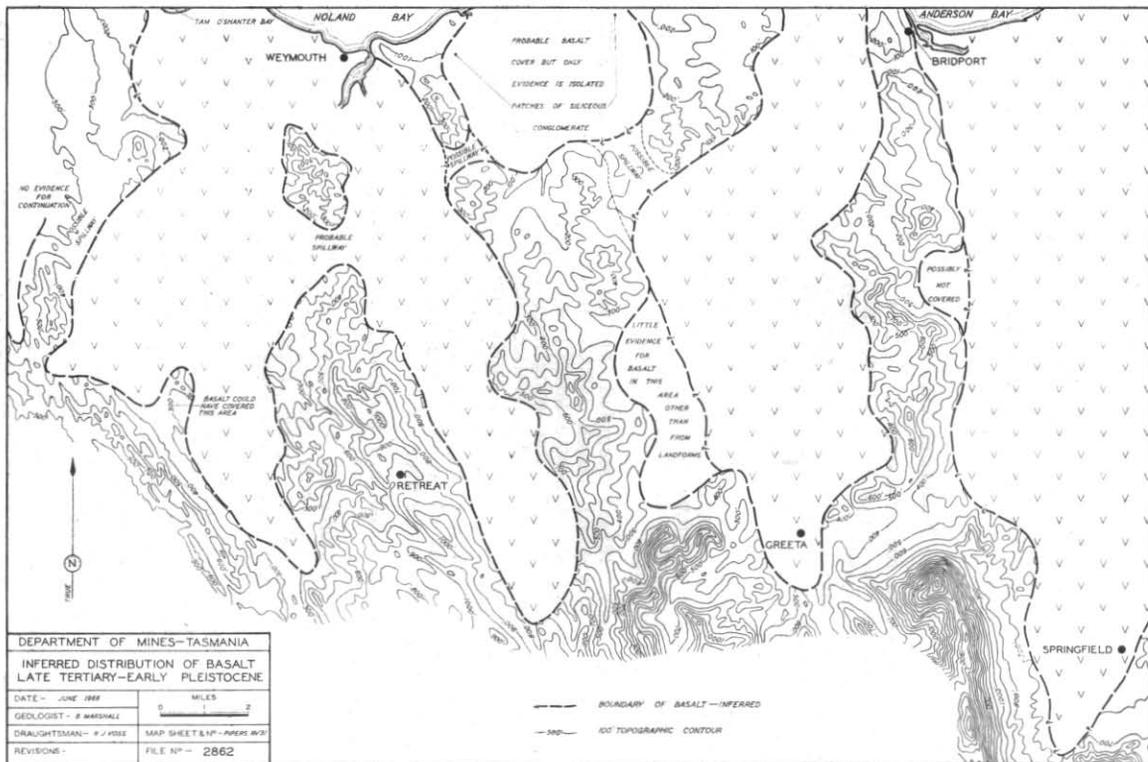


FIGURE 7

5 cm

a matrix of quartz granules, sand, and some clay. Typical exposures may be seen at 4997E/9401N, 5019E/9435N, and 5009E/9449N, where it will be apparent that a gradational relationship exists between these and the rounded gravels.

Angular gravel occurs in several small patches between 1 and 2 miles SE of Weymouth. In two cases the age was proved by the relationship to siliceous conglomerate and basalt; the others were grouped with these two because they were nearby and of similar height.

SILICEOUS CONGLOMERATE

This massive rock consists of angular and rounded fragments and pebbles of vein quartz, and sometimes Mathinna Beds slate, in a pale grey, fused, siliceous matrix (plate 5). The fused matrix and resulting sub-conchoidal fracture permit spheroidal exfoliation during weathering. In Tasmania the rock is often termed 'grey billy' whilst Dury and Langford-Smith (1966) refer to it as 'minyon bole'.

Where the matrix has but partly 'fused', substantial void-space occurs within the quartz-fragment framework. Reduction in silicification often accompanies an increase in iron-content, normal 'grey-billy' giving way to pisoliths in a poorly 'fused', ironstained, quartz-sand matrix.

Montgomery (1894a) recorded the association seen at the W extremity of Weymouth beach (5056E/9479N), where a sheet of siliceous conglomerate separates basalt from the Mathinna (plate 5). He concluded that '... the conglomerate is a quartz gravel cemented together by siliceous matter, the result most probably being brought about by the hot water and steam from the lava flows'. Similarly Broadhurst (1933) considered that the conglomerate was derived from original gravels that '... were cemented together by the siliceous vapours and water coming from the basalt which flowed over them.'

The following items are pertinent to the origin of siliceous conglomerate—

- i. The conglomerate is in contact with or closely related to basalt with the exception of small patches at 5164E/9492N, 5144E/9470N, 5170E/9478N, and 5100E/9478N; even these were probably once overlain by basalt.
- ii. The degree of fusion of the matrix partly reflects the composition of the parent gravel. Conglomerate of high iron-content, or rich in Mathinna fragments, was never observed to be highly fused, massive, or lacking in pore space.
- iii. Conglomerate was associated with the narrow confined flows of the Pipers River, Back Creek, and Pipers Brook drainage systems rather than the broader sheets of the Springfield-Bridport tract of country.
- iv. The conglomerate often occupies 'convex-upward' forms on the base or the flank of a confined basalt flow.

From the preceding items it may be deduced that prerequisites for the formation of typical siliceous conglomerate are—

- i. Vein quartz gravel with a quartz sand and silt matrix; a high clay or iron content would appear to inhibit the process.
- ii. Basalt flows with basal irregularities such as would concentrate siliceous vapours and form local hot spots.
- iii. A supply of water; this could come from the sediment were it saturated or from streams in the valleys down which the basalt flowed.

It is suggested that siliceous conglomerate forms in irregular shallow pockets on the base or flanks of lava flows. Superheated steam, rich in dissolved silica, becomes trapped in the pockets and ultimately deposits silica in the pore spaces of the sediment. It is possible that some fusion occurs, at and close to, the contact with basalt; flow structures at the interface, similar in appearance to flute marks in turbidites (cf. Longman, 1966, p. 13) would seem to support this.

Cainozoic Deposits: Unassigned

These deposits, which are particularly extensive in the Fourteen Mile Creek and Back Creek basins, are similar to some of the Tertiary gravels. They are, however, emplaced in this category for one or more of the following reasons—

- i. They overlie basalt which is the upper stratigraphical limit of provable Tertiary rock in the Quadrangle.
- ii. They overlie and are demonstrably derived from known Tertiary sedimentary deposits.
- iii. They underlie recent alluvial and marsh deposits but cannot be traced into proved Tertiary rocks.

Thus, two categories of rocks are involved: that younger than known Tertiary and older than known Recent; and that older than known Recent. In the former case, since the basalt does not close the Tertiary era, Pleistocene and upper Tertiary rocks are involved; in the latter case, the rocks could be Pleistocene or come from any part of the Tertiary.

SANDSTONE AND CONGLOMERATE

These deposits occur in isolated patches and narrow strips which rise above the present alluvial flood plain. Along the Pipers River and Little Forester-Denison River drainage system, the upper limit is less than 50 feet above water level, but at Lisle and to the W of Springfield they are found up to 125 feet above present drainage. Although this relationship suggests contemporaneity there is no certainty that the patches are co-eval; nor can their stratigraphical relationship with the 'overlying' quartz gravels be assured, even though their more indurated nature and similarity to Tertiary sandstone and conglomerate might suggest that they be placed at the base of the sequence.

Exposures are confined to man-made excavations, the deposits typically being represented by float of well-rounded, frequently disc-like or ellipsoidal pebbles and cobbles of Mathinna siltstone

and sandstone, dispersed on a soil which often possesses a high content of silt-sized grains, but which may largely be clay. Well rounded vein quartz pebbles are generally present in subordinate amounts, whereas Ordovician(?) quartzite and conglomerate cobbles at 5022E/9284.5N, and quartz granules W of Springfield, are respectively local expressions of upstream Lower Permian deposits and adjacent Devonian igneous rock.

In the Lisle-Golconda district where the deposits are auriferous and have been extensively studied, cross-sections are available (Appendix 3). Those other than in the Lisle Basin will be dealt with first. According to Reid (1926, p. 40) the 6 to 8 inch auriferous horizon at Tobacco and Cradle Creeks underlies approximately 7 feet of clay. That it directly overlies Mathinna is not stated, but from an examination of what are now exceedingly poor exposures, this would appear to be so (confirmed pers. comm. Noldart, 1967). The indurated rock consists of well-rounded pebbles and small cobbles of vein quartz and Mathinna sandstone, siltstone, and slate, embedded in a sandy clay matrix.

For Lone Star Valley the information is scanty. Reid (1926, p. 34) reports that the deposits consist of 'water-worn quartz and friable white sandstone and rest on soft decomposed granite.' This was partially confirmed at 5183E/9235N where one finds abundant well rounded pebbles and cobbles, of quartz and hornfelsed Mathinna Beds, in association with sub-angular vein quartz up to 8 inches in diameter. In a small pit W of the track (5181E/9242.5N) a pale bluish-grey sticky clay with occasional quartz granules overlies highly decomposed granite.

The deposits at Lisle fall into two categories: those below 750-800 feet which are wholly alluvial; those above 800 feet which are partly eluvial. The former, typically exposed at 5209E/9220N and 5204.5E/9219.5N, consist of well-rounded, frequently ellipsoidal pebbles and cobbles of Mathinna sandstone and vein quartz which although ranging in size from about $\frac{1}{2}$ to 8 inches, generally have a longest diameter of 3 to 4 inches. Interstitial to the framework, which may be either continuous or slightly disrupted, is a matrix of predominantly silty clay with mica. The overlying pale grey clay with quartz granules is thought to have been derived from granite and to be part of the composite soil profile.

The high-level deposits, exposed at 5211E/9220N on the E side of the valley, and at 5198E/9220N on the W, consist of poorly sorted sub-angular to rounded pebbles and small cobbles of quartz, Mathinna sandstone and slate, and rarely granite, in a matrix of sandy clay or siltstone. The rudaceous fraction either forms a disrupted framework conglomerate, or is sufficiently dispersed for the rock to be termed a pebbly siltstone. Separating the auriferous basal unit from the talus are occasional sandstone lenses and unconsolidated sandy beds which may be water lain.

The genesis of the high-level deposits is uncertain, but Reid's suggestion (*op. cit.*, p. 21) that they mark the surface of a lake-bed is not without merit. Slightly rounded eluvial material sliding off steep slopes into a lake would suffer little further attrition or sorting, and could form a strictly comparable deposit. The low-level accumulation in the shallow portion of the basin, was presumably

laid down at a later date when the lake was contracting, perhaps to a series of shallow pools within a braided stream network, and Lisle Creek was approaching its present base-level. The better sorted well rounded character of the deposit is in keeping with such an origin.

FERRUGINOUS DEPOSITS, SAND, AND GRAVEL

Collectively designated Csg in the legend (Marshall, *et al.*, 1965) these deposits, whose differences frequently reflect their localised derivation, are in part co-eval.

FERRUGINOUS ASSOCIATION

Three subdivisions may be recognised but, owing to the imperceptible gradation of one into another, they are generally not mappable.

Massive ironstone (Csg') was successfully differentiated as a unit in the Pipers Brook-Lebrina district by Barton, where basalt-capped hills have a peripheral ironstone strip which passes rapidly downslope into ferruginous drift. Ironstone outcrop may also be seen at 5009E/9379N $1\frac{1}{4}$ miles E of Pipers River, and at 4991E/9397.5N on the track from Pipers River to the Back Creek Goldfield. Typically the dark brown to orange-brown massive rock is variolitic, since it consists of limonitic pisoliths, with occasional pieces of petrified wood, bound together and cemented by further layers of iron oxide. This results in a poorly developed spongiform appearance, where some of the cavities may contain fine sand and silt; this could not have washed in at a later date since it is often wholly enclosed. Variants such as ironstone largely without cavities, or with incorporated pebbles and angular pieces of vein quartz, are quite common.

Pisolitic gravel and ironstone blocks are characteristically found on poorly drained flats adjacent to remnant caps of basalt, and may be seen both E and W of the Leura Mine (5005E/9423N). Ironstone is patchily scattered in a rubble of pisoliths associated with quartz granules and angular vein quartz. The soil varies from chocolate brown to pale grey depending on the ratio of pisoliths to silt and fine sand.

Ferruginous drift usually forms a down-slope apron around the other types and comprises small pisoliths, quartz granules, silt and dune sand in sufficient concentration to mask the underlying rock.

The genesis of deposits of this type is problematical, but in this instance the association with basalt as a source of iron is inescapable. It is considered that accompanying contraction of the basalt flows due to weathering, pisoliths and soluble iron were transported onto the increasingly more exposed sub-basalt flat. Here in association with minor amounts of locally derived silt, sand, and gravel, possibly originating from sub-basalt alluvial deposits, pisoliths were laid down. As a feature of compaction it is probable that the pisoliths partially fused, whilst a further coating of iron was deposited from trapped interstitial ferruginous

solution. It seems likely that this process of concentration and cementation was restricted to a poorly drained level environment and took place at the water table or within its fluctuating limits. Where these conditions were not satisfied, a loose rubble perhaps with patchy development of ironstone, probably resulted.

Deposits of the first two types are often assigned a Tertiary age in Tasmania (e.g., Longman, 1966); this practice has not been adhered to because, although a late Tertiary age seems probable, the ferruginous association is post-basalt and, therefore, younger than proved Tertiary.

The third type is a drift or wash deposit derived from the other types and, as such, could be considerably younger. Indeed, on steep slopes, it could still be forming.

In the Pipers Brook district, Barton observed a thin ironstone horizon underlying basalt in a small cliff section, and concluded that the first two types were pre-basalt in age. However, basalt need not be completely stripped off before ironstone can form, and it is possible that the silt-deficient type could have formed in just such an environment.

SAND

Extensive deposits of clean, sub-angular to well rounded, fine to medium grained quartz sand, with sparse vein quartz pebbles, occur N of Mt. Direction. At 4941E/9262N they are between 10-30 inches thick, and overlie a pale brown sandy clay, whereas at 4937.5E/9267N, 12 inches of somewhat less clean sand overlies a 10 inch thick ironstone unit which in turn overlies sandy clay with pebble-sized pieces of vein quartz.

Since the deposits only occupy that part of the basin abutting and overlying Triassic sandstone, their ultimate derivation from this rock is not questioned. It is considered, however, that the primary deposit consisted of sand, silt and clay, washed into the basin from Permian, Triassic and Jurassic sources, and that the present concentration of sand is a lag deposit.

Around Nabowla and Springfield are substantial flats strewn with quartz granules, and sparse pebbles of vein quartz and Mathinna sandstone. The well-rounded pebbles of high sphericity have obviously been recycled from older (Tertiary?) gravels, whereas the sub-angular to rounded granules, whose primary source is contiguous granodiorite, are probably bimodal being partly recycled and in part directly derived. Direct derivation is particularly indicated at 5374E/9250N, where, in an exposed thickness of approximately 5 feet, sparse sub-angular feldspar granules occur. Another excavation is to be seen $1\frac{1}{2}$ miles SSW of Springfield on the Ten Mile Track.

GRAVEL

Accumulations of vein quartz occupy substantial tracts of country in the W of the sheet and along the lower reaches of the main drainage systems. They have been subdivided into rounded, angular and rounded, and angular deposits of which the last is most,

and the first is least, common. The superficial expression of all three is similar, being composed of abundant angular vein quartz fragments, commonly about $\frac{3}{8}$ inch in diameter but ranging from granule to large pebble and rarely cobble proportions, strewn upon a pale to dark grey soil. Where rounded material is in the underlying deposit fragments often possess one rounded face, whilst halved and rarely entire pebbles may be seen. Although vein quartz predominates, pieces of quartzose Mathinna Beds (distinct from float of the underlying rock), ironstone, siliceous conglomerate, and Ordovician(?) quartzite (reworked from Permian deposits), may be encountered.

Rounded gravel forms a small patch $2\frac{3}{4}$ miles NW of Jetsonville, which contains a notable quantity of Mathinna sandstone pebbles and has developed *in situ* from underlying Tertiary rock is probably younger than the rounded gravel from elsewhere in the Quadrangle. Lag concentrations in the Little Pipers River drainage basin and approximately 3 miles NNE at 5173E/9467N, are derived from deposits comprising water-worn pebbles and silty clay. Although proof is lacking it seems reasonable that with Tertiary deposits nearby, these also are of Tertiary age. Three patches approximately $2\frac{1}{2}$ miles WSW of Retreat and one at 4953E/9345.5N are essentially similar. Exposed in a gravel working at the latter locality are 18 inches of rounded quartz granules, pebbles and cobbles, overlying approximately 3 feet of silt and fine sandstone with pebble horizons, which in turn overlies a basal unit consisting of angular to sub-rounded blocks of Mathinna rocks (up to 10 inches) in a limonite cemented sand and silt matrix, that varies in thickness, and rests directly upon Mathinna Beds. As the limonitic horizon transgresses bedding and parallels the hillside it is probably related to the modern water table. The river deposit which occurs some 50 to 100 feet above the existing valley floor is probably of Tertiary age.

Angular and rounded gravel deposits flank ridges, and spread over valley floors. The relationship to the Mathinna Beds of extensive gravel accumulations in the N part of the Four Mile Creek basin, is the same as that of quartz sand to Triassic in the S portion (cf. page 48). It is similarly suggested that silt, clay and vein quartz, possibly from high-level angular lag gravels, were washed into the basin where, after suffering varying degrees of attrition, they formed the primary deposit of indifferently sorted angular and rounded vein quartz in a silty clay matrix. Following water and possibly wind winnowing of the matrix, the existing lag deposits were formed. Their thickness in gravel workings at 4932E/9280N and 4943.5E/9299.5N was 10 inches and 24 inches respectively.

Deposits in the Back Creek drainage basin and W of Baker Tier are essentially similar to those just discussed, and are particularly well exposed in gravel excavations at 4940E/9355N and 4942.5E/9369.5N.

Compared with other deposits, a tract of gravel approximately $3\frac{1}{2}$ miles NW of Jetsonville (5317E/9360N), has a higher proportion of Mathinna pebbles and quartz granules. However, this is to be expected of a lag deposit derived *in situ* from Tertiary conglomerate (see page 28 for description of conglomerate).

Should gravel occur high on the side of, or mask a hill, rounded material tends to be confined to the lower slopes. Thus, as at 5037.5E/9407.5N, where rounded pebbles were not found above 630 feet, it would seem that high-level angular gravel is drifting down-slope over lower rounded and angular material.

Should rounded material persist to the top of the deposit, there is a strong probability that it is Tertiary since, wherever age could be established, all high-level rounded deposits have proved to be so.

Angular gravel tends to cap hills (5005E/9325N) and ridges (5270E/9435N), or occupy benches between hill-crest and valley-floor (5190E/9353N). Underlying the cappings which are usually less than 18 inches thick is a silty clay soil with vein quartz fragments which in turn overlies Mathinna bedrock. It is concluded that the sequence has developed *in situ* from deeply weathered Mathinna and that the lag deposit has arisen due to water and wind winnowing of the clay. Transportation of gravel by water is envisaged only as a minimal factor in the formation of bench deposits. Two arguments may be advanced regarding age; firstly, that the angular and rounded gravels were formed when angular deposits, comparable to those now seen, were transported from the hills into the valleys, and that the present cappings have formed since the main transportation period; secondly, that the cappings are remnants of the original substantial angular deposits. Against this second suggestion is the probability that, unless conditions favoured further gravel development when the cappings would be of compound age, residua would have been stripped off since the main transportation period.

SILT AND CLAY

Substantial flats, composed of silt and silty clay with rare small quartz pebbles and fragments are well represented in, but not confined to, the W marginal strip of the sheet. Because of their close association with vein quartz and their relationship with the present drainage, it is suggested that the detritus is mainly the matrix fraction washed from vein quartz lag deposits during their formation.

Cainozoic Deposits: Quaternary

OLDER GRAVELS

This account is largely a modification of a report by Jennings (1966).

The deposit is most extensively developed SE of Bridport, but is also found intermittently between Bridport and the Pipers River estuary. Superficial expression of these gravels, which form seaward dipping, poorly-drained flats, is restricted to sandy soils with sparse vein quartz granules and pebbles.

Exposure is largely confined to man-made excavations. In road cuttings at 5334.5E/9461.5N, the deposit attains a demonstrable thickness of at least 30 feet. The upper portion consists of fine grained sand, with sub-angular to rounded quartz granules,

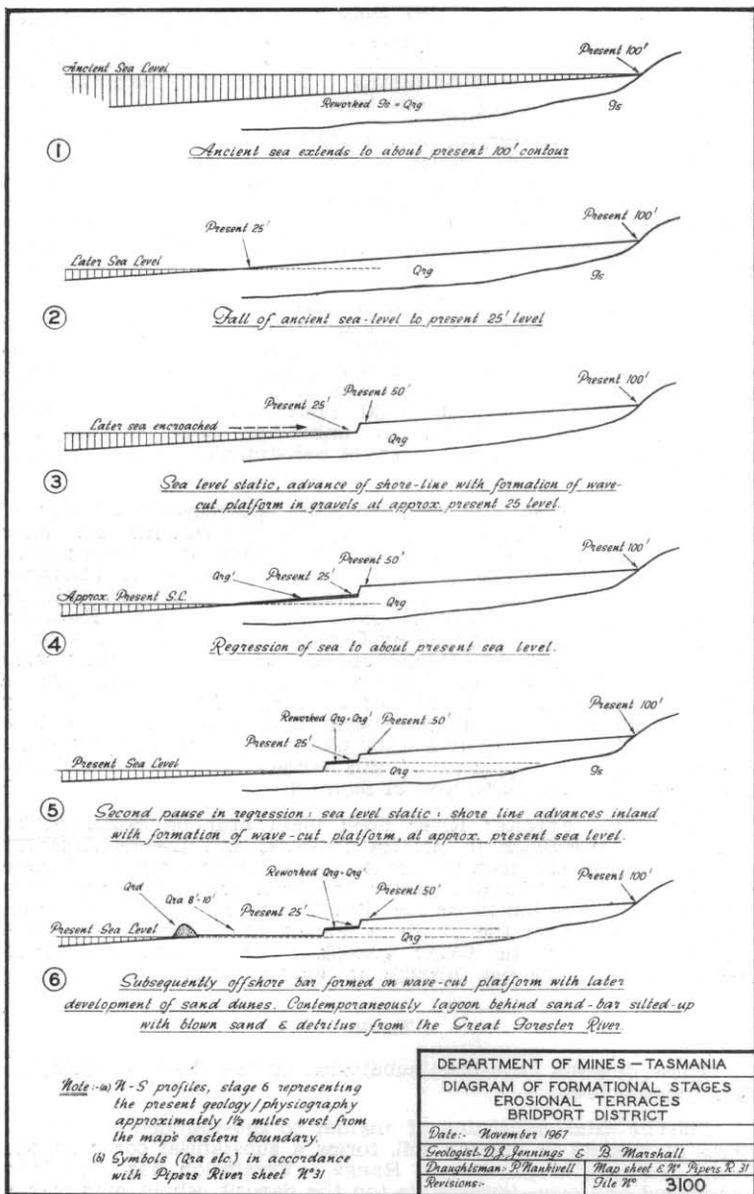
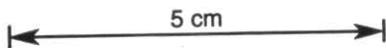


FIGURE 9



and infrequent rounded quartz pebbles up to $\frac{1}{2}$ inch in diameter. Passing downward, one encounters conglomerate horizons, up to 18 inches in thickness, composed of abundant vein quartz pebbles in a medium to coarse sand matrix. The sequence exhibits large scale cross-bedding and generally lacks clay.

A feature of the gravel pits at 5303E/9468N, are the lenticular beds of coarser gravel. These are part of a sequence of 1-2 feet thick beds of grit and sand, with discontinuous horizons of small pebbles. They consist of sub-rounded, discoidal and oblate pebbles and rare small cobbles of vein quartz and, uncommonly, Mathinna sandstone or slate, with a small amount of sandy matrix.

The variation in these deposits may be further illustrated by the gravel pit at 5297.5E/9453N. Fine sand and grit alternate with horizons of well-rounded vein quartz, sand and sparse Mathinna pebbles. These units, ranging from 2 inches to 2 feet in thickness, contrast markedly with massive beds of coarse, gritty sand. In another part of the pit, discoidal quartz and sandstone pebbles overlie a compacted, apparently unbedded, sand, in which a washout gully is infilled with layers of well-rounded, very small, vein quartz pebbles and granules.

The older gravels are most probably the recycled derivate of Tertiary deposits; this is evidenced by low clay content and better sorting. Jennings (1966) considers that they were re-deposited in shallow-water marine conditions on the wave-cut platform. The S limit of the incursion was approximately coincident with the abrupt rise of Tertiary deposits above the gravel plain. However, in the wedge of land bounded by Ockerby Creek and Cox Rivulet, this is ill-defined, and it would appear that these streams were tidal for perhaps two or three miles inland, and that paralic conditions prevailed. The 25 foot erosional terrace was probably formed during the marine regression; a decrease in sea-level to about 20-25 feet, followed by a static phase, would have permitted its incision. The development of this terrace and the coastal flat is diagrammatically illustrated in figure 9.

The Great Forester River flood plain may be explained by slow marine regression to present sea-level and the development of dunes along the seaward limit of the Older gravels. These dunes diverted the Great Forester W across the old marine platform where it was joined by the Brid River and entered Anderson Bay. Deposition on the platform during floods formed extensive alluvial flats over the Older gravels. At present, the Great Forester reaches the sea through an artificial cut.

TALUS

These deposits have been subdivided on the sheet according to their parent rock.

Dolerite talus, consisting of angular to sub-rounded blocks and pieces of dolerite in dolerite soil, forms a substantial cover on the E and N slopes of the Dismal Range. Vegetation has been long established and even towards its top the deposit, which may merge with insignificant amounts of scree, is firmly fixed.

Basalt talus, comprising sub-rounded and rounded boulders and cobbles in rich basalt soil, is found throughout the sheet wherever basalt caps steep-sloped hills. Quite often the underlying rock is not wholly masked, and its boundary with basalt may be adequately established. In these cases the talus deposit has not been shown on the map.

Mathinna Beds talus has been mapped where Mathinna Beds abut granitic rock. This practice has been followed because—

- i. Differentiation between talus and float veneer is impracticable without sections.
- ii. At 5175E/9205.5N, where a section is available, talus is less than 10 feet thick.
- iii. Erosion of the Permian/Mathinna Beds unconformity has removed the Permian but has produced negligible amounts of talus on the hitherto protected pre-Permian surface, even in areas of marked relief (5145E/9203N).
- iv. Substantial thicknesses of talus (see Appendix 3) mask the Mathinna Beds/granodiorite contact in the Lisle Basin, and on the E flank of the Sideling Range.

The talus comprises pieces of Mathinna sandstone which vary in size up to small boulders embedded in clayey soil. Eluvial transport has effected a marked degree of rounding in pieces found towards the bottom of the talus slope although for the greater part the material is angular to sub-angular. The thickness of the deposit has been contributed to by the following factors—

- a. The induration and weathering resistance of the contact metamorphosed Mathinna rocks resulting in steep slopes and substantial relief which has impeded dissolution of detritus.
- b. Intensive jointing in the hornfels which has facilitated production of detritus.
- c. Undermining of the contact by removal of deeply weathered granitic rock.

WINDBLOWN AND LOCALLY DERIVED SAND

Marsh and swamp overlies this deposit in much of that strip between the W margin of the sheet and Bridport, whilst dune sand laps onto it approximately $\frac{1}{2}$ mile S of Pipers Head. In turn, it overlies the Older gravels, as is apparent between Weymouth and Bridport, but is of uncertain age with respect to talus. The deposit, which blankets much of the coastal strip, has been explored by auger and the following data established—

Locality			ft. in.
4920E	9414.5N	Humic soil with sand	7
		Sand with subordinate soil content	2 3
4956E	9460N	Sandy clay	5+
		Humic soil with bracken roots	4
		Sand with decreasing soil content	7 0+

Locality			ft. in.
5006.5E	9489N	Grey sandy soil with pieces of vein quartz	11
		Sand with minor quantities of soil and vein quartz	1 6
		Ironstone with vein quartz	2+
5365.5E	9435N	Sandy soil	8+
		Sand with decreasing soil content	8 0+

From its distribution, the sand would appear to have blown in from slightly W of N and drifted against higher ground, where it became arrested, channelled along valleys, or spilt over the crests. The thickness varies considerably and where sand has banked up SW of Bridport and along the flanks of Ryan's Hill and Turquoise Bluff, it could be very much thicker than the maximum proved value of 8 feet. The deposit, which largely falls within the belt covered by coastal heath (Jackson, map 7, in Davies, 1965) is firmly fixed, and often overlain by a humic soil layer. Small patches of free sand are probably very recent, having either blown down from a higher level or arisen from local soil erosion.

Although the greater part of the deposit consists of sand blown inland from the coast, it could also include redistributed sand derived from underlying Cainozoic deposits. This is particularly possible to the S of Back Creek Goldfield, in the basin S of Lulworth, and approximately 2 miles SW of Bridport. For this reason the deposit is termed 'windblown and locally derived sand.'

DUNE SAND

Substantial sand dunes occur at Lulworth, Pipers Head, and Barnboughe Beach. The rate of advancement to the S is particularly well illustrated at 5071E/9478N where youthful trees and a small cottage will soon be overwhelmed (plate 6).

Age relationships with marsh and swamp deposits are not certain, since some swamp patches appear to have formed in the lee of more stable dunes. Nevertheless, where dunes are rapidly advancing, there is no doubt that they are younger than marsh, swamp and alluvium.

ALLUVIAL DEPOSITS (INCLUDING YOUNGER GRAVELS)

Alluvial silt, clay, and gravel occur parallel to the present streams. S of Bangor the flats of the Pipers and Second Rivers are largely formed of dark loamy silt, which overlies silt and clay with occasional pebble horizons. Similar deposits are found in flats NW and SE of Bacala Sdg., whereas in the bank of the Little Forester River at 5244.5E/9295N, approximately 1 foot of loam overlies a densely packed deposit of platy ellipsoidal Mathinna pebbles and cobbles. E of Bridport, the flat associated with the Great Forester consists of a continuous silt cover overlying vein quartz gravels and horizons of fine sand with occasional vein quartz granules and pebbles.

Deposits on dolerite consist of a sticky, sometimes peaty, clay containing dolerite granules and fragments of highly weathered dolerite.

MARSH AND SWAMP DEPOSITS

Marsh and swamp commonly overlie alluvial flats and occupy poorly drained low lying ground over the greater part of the area. Complex swamp systems, often associated with stagnant pools of water, characterise the distribution of windblown and locally derived sand between Bridport and the W margin of the district.

Igneous Rocks

Devonian

Despite an extensive search the Ordovician dykes of porphyroid rock reported by Reid (1926), were not found.

A tract of granitic rock trending S from Bridport characterises the E portion of the area. It has a S extension to Musselboro in the Launceston Quadrangle and passes E into the Ringarooma and Alberton Quadrangles. Although predominantly granodioritic in composition, more leucocratic phases were recognised and have been designated Dg', as in the area SW of Springfield, where they attained mappable dimensions.

The Lisle, Lone Star, Panama and Golconda Goldfields are located on small granitic emplacements that are probably apophyses of the main Scottsdale Granite. The size of the contact aureoles in relation to the exposed area of granodiorite is notable.

The granodiorite has intruded and contact-metamorphosed the Ordovician-Devonian Mathinna Beds, and is overlain by Tertiary deposits. However, in the Launceston Quadrangle, Lower Permian rocks unconformably overlie the granodiorite which may consequently be assigned to the Devono-Carboniferous. The radiogenic age-determination of the Scottsdale Granite is a minimum of 370 ± 10 m.y. (McDougall and Leggo, 1965).

The granodiorite, which is usually medium to coarse grained and grey in colour, consists of quartz, plagioclase (usually oligoclase), potassium feldspar, biotite and hornblende. However, the components vary considerably in their relative proportions: with reduction in the amount of quartz and/or an increase in the calcium content of the plagioclase, the rock grades into tonalite and quartz diorite. Increase in the percentages of quartz and potassium feldspar, accompanied by a reduction in the amount of hornblende, effects a gradation into adamellite and, less commonly granite.

Spry and Ford (1957) suggested that some of the Tasmanian Devono-Carboniferous adamellite and granitic rocks arose through potash metasomatism of granodiorite, but conclusive support for this was not found in slides of the adamellite Dg'. Knots of quartz, with or without feldspar, up to 3 inches in diameter are possibly metasomatic in origin, and are notably developed along the Little Brid River in the region of 5332E/9263N.

No petrographic examination was made of the extremely decomposed soft yellowish-white to brick-red granitic rock in the Lisle and Lone Star Valleys. However, Twelvetrees (1909, p. 13) and Reid (1926) indicated that the rock consisted of lime-soda

feldspars, biotite, hornblende, subordinate quartz and a little orthoclase. Such an assemblage justifies the name quartz diorite, but there is every reason to suppose that these bodies will range from quartz diorite to granodiorite in composition.

The granitic rock of the Golconda Goldfield was not examined in detail, but in hand-specimen it appeared more acidic than typical granodiorite. This tendency towards an adamellite composition was confirmed by a cursory thin-section examination.

Pegmatitic and aplitic phases of the granodiorite are very uncommon. A weakly pegmatitic phase comprising biotite and feldspar (up to 1 inch in cross-section) was encountered at 5368.5E/9247N whilst at 5322E/9192.5N several aplitic blocks consisting of fine grained quartz and feldspar with some secondary carbonate were observed.

Blocks of quartz-feldspar porphyry were found by a gate at 5369E/9240N. They had obviously been placed there by the farmer, but since one or two were nearly 18 inches in diameter it is improbable that they had been moved very far.

It has been reported that veins of quartz, tourmaline and molybdenite cut the granite where it crops out on the bank of Lone Star Creek near the Enterprise Mine (Reid, 1926, p. 10). Similar veins were found SW of the road in the Mathinna Beds country rock, a few yards from the E boundary of the Golconda intrusive.

Xenoliths are common in the E tract of granodiorite where they often have a poor ellipsoidal form suggesting that they have been shaped by flow. Although variants may be recognised in the hand-specimen the majority of the xenoliths are of dioritic composition and are probably cognate. The more felsic xenoliths are very similar in appearance to feldspathised Mathinna Beds seen in the Noland Bay Quadrangle, NW of Bridport; these are thought to be accidental. The xenoliths have a preferred orientation, the significance of which will be referred to in the section on structure.

The contact between granodiorite and Mathinna Beds is exposed at the W coastal strip of granite passing NNW from Bridport into the Noland Bay Quadrangle. Examination of this wave-washed contact has revealed a sharply defined surface (granodiorite against hornfels) which for the greater part parallels bedding but occasionally, where joint-controlled, trends at 90° to it. The granodiorite is not visibly finer grained but is usually mafic-rich; less commonly it is coarsely foliated for 1 to 2 inches in from the contact, folia ranging from $\frac{1}{8}$ - $\frac{1}{4}$ inches in thickness and comprising alternations of biotite and quartzo-feldspathic material.

Feldspathisation of Mathinna Beds adjacent to the contact takes place on a relatively minor scale. Typically, coarse grained horizons in the cores of minor folds become lighter coloured as the feldspar increases in grain size. Intensification of this process results in the porphyroblastic feldspars tending to become euhedral. The small folds are probably pre-granite in age since they are similar in style and orientation to folds far removed from the contact. However, the three-dimensional irregularity of a minority of the fold-forms suggests that plastic mobilisation has

occasionally taken place. The mobilisation is considered to have modified pre-existing fold-forms rather than to have evolved new ones.

On a regional scale, the contact of the Bridport-Springfield granite generally follows the strike of the Mathinna Beds. However, embayments at Nabowla and S of Duncraggen Hill have the same irregularity of form that characterises the granitic bodies of the Golconda-Lisle belt.

Contact-relationships provide data on the emplacement of the bodies. On a small scale, intrusion by dilation of s-surfaces and particularly jointing may be observed. On a large scale it is suggested that dilation as a prelude to stoping was the major mechanism of emplacement. Bedding and cleavage appear to have been the major planes of weakness, whilst sub-vertical joints striking normal to the bedding seem to have exercised considerable influence. Granitisation is discarded owing to a dearth of evidence; doming is rejected since no deviation of strike was found adjacent to any of the bodies.

McIntosh Reid (1926) recorded two granitic dykes in railway cuttings E and W of Lone Star Creek; Barton could find adequate evidence only for the E one of these. A small body of granodiorite W of the summit of Mt. Wilson, and a dyke in the vicinity of the Bessel Reward Mine, both shown on McIntosh Reid's 1926 Map, were not encountered in the field.

Jurassic

Extensive intrusion of tholeiitic magma, which probably occurred during Middle Jurassic time (McDougall, 1961), is represented in the SW corner of the area by a dolerite sheet that has a minimum thickness of 500 feet. In thin section this medium grained rock does not differ from the published descriptions of Tasmanian dolerite that have been summarised by Spry (1962, p. 266). Coarse grained phases were not encountered, whilst the fine-grained chilled contact, anticipated at the base of the intrusion, was largely masked by talus.

In this district dolerite intrudes only Triassic strata, but from figure 8 it will be apparent that the two are not concordant. This is to be expected since the dolerite is part of an undulating or inosculating sheet which, in the Launceston Quadrangle transgresses the whole Permian sequence (Longman, 1966).

Tertiary

In the Pipers River Quadrangle, as over much of Tasmania, the Tertiary period was one of substantial basalt eruption. At least two phases of extrusion are known in the Launceston area (Longman, 1966, p. 24), and in the Lefroy district (Groves, 1964). Proof of a similar sequence in the present area is provided by bore-hole records from the Back Creek Goldfields, where approximately 80 feet of sedimentary rock separates two flows, and by the presence of water-worn siliceous conglomerate boulders in sub-basalt Tertiary leads (p. 34). Naqvi mapped two flows, apparently separated by a sedimentary sequence of variable thickness (50-75

feet) approximately $1\frac{1}{2}$ miles SSE from Pipers Brook. The inconclusive field evidence may alternatively be interpreted as a window having been excised in a flow that has filled the valley and spilt over onto the adjacent flat.

The duration of intermittent extrusion in the Pipers Quadrangle is unknown. According to Banks (1962, p. 241): 'Tasmanian basalts include some that are older than Upper Oligocene and others that are younger than Middle Miocene'; Longman (1966, p. 24) has found that the earliest basalt flows in his area are interbedded with Palaeocene to Lower Eocene deposits.

From drill-hole data (p. 39) the greatest continuous thickness of basalt is 171 feet; more usually the values range between 21 to 120 feet. Comparable maxima are obtained for hill-cappings, measured vertically* between the hill-top and appropriate stratum contour on the sole of the flow: approximately 165 feet of basalt is present at 5341.5E/9258N, and up to 150 feet at 5371E/9278N. If it may be assumed that basalt filled valleys to the top of cappings on adjacent ridges, composite thicknesses are obtained exclusive of sedimentary intercalation, which substantially exceed the previous maxima. Between A and B, C and D, E and G, and H and L (figs. 12, 13) were, respectively, 400 feet, 375 feet, 275 feet and 280 feet of basalt. However, these values are from the middle and lower portions of the river system. Upstream, although an exception may be found immediately N of Lebrina, values of 250 feet decreasing to 175 feet appear more common. It would seem that the composite thickness increases coastward. An interesting comparison is afforded with the Tamar River where, from the middle reaches, Sutherland (1966) reports a possible thickness of 500 feet.

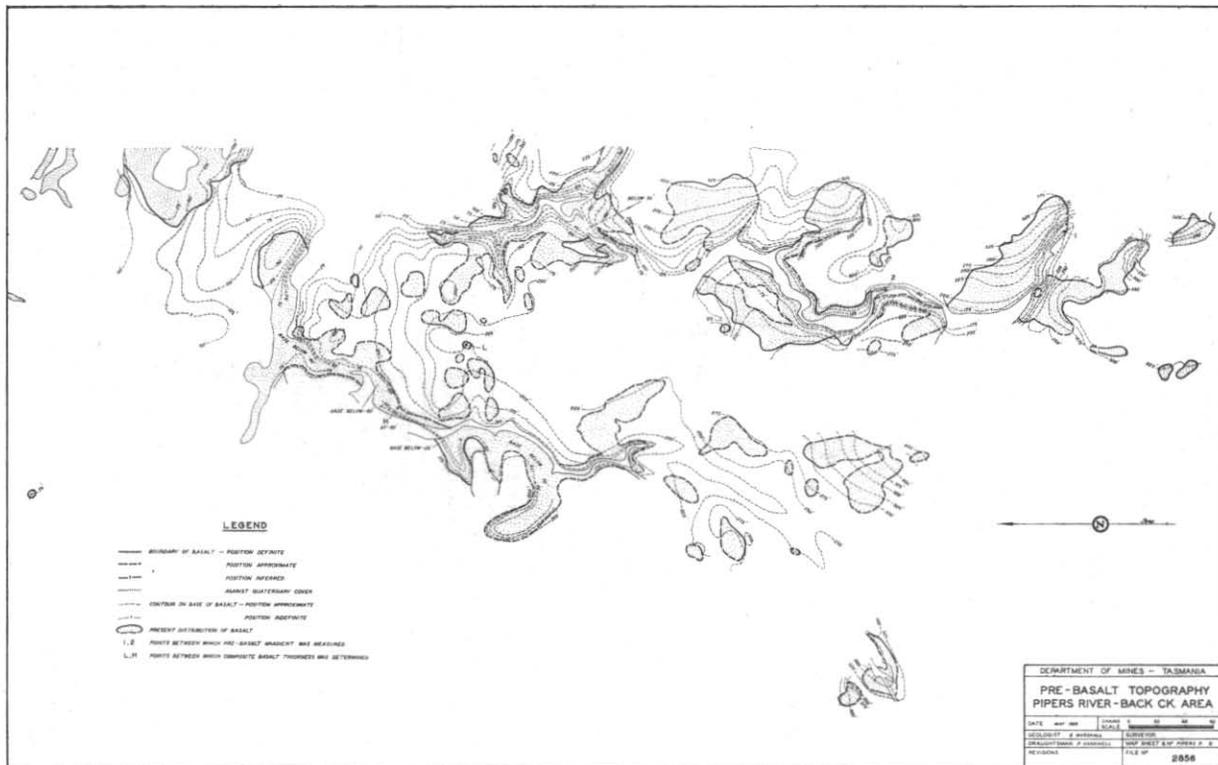
A complete petrological examination has not been undertaken in view of Edwards' classic paper on Tasmanian basalt (1950) and the more recent work of McDougall (1959) and Spry (1955, 1962). Edwards (*op. cit.*) recognised three groups of olivine-basalts, which he subdivided into ten types, and a group of 'differentiated basaltic rocks' (Table 4).

* Owing to the extremely shallow dips involved, the true and 'bore-hole' thicknesses will be approximately equal.

TABLE 4: Classification of Tasmanian Basaltic Rocks
(Edwards, 1950)

<i>Main divisions</i>	<i>Sub-divisions</i>
Olivine-basalts—	
(a) With black glass	Midlands, Ouse and Bridgewater Types
(b) With green glass	Mersey and Waratah Types
(c) With Titan-augite	Hampshire, Deloraine, Burnie, Branxholm and Smithton types
Differentiated basaltic rocks—	
(d) Oligoclase-basalts,	limburgites and limburgite-basalts,
olivine-nephelinites and basanites,	melilitite-fasnites, and
melilite-basalts.	

FIGURE 13



5 cm

He recorded gradational varieties between types and showed that little chemical variation existed within the black glass and within the green glass groups. Partly because of this Spry (1962) effected the following reclassification:—

- i. Saturated olivine basalts: to include types (a) and (b) (Table 4).
- ii. Unsaturated olivine basalt: to include types (c) and (d) (Table 4).

Both classes are present in the Pipers River Quadrangle. Edwards (*op. cit.*, fig. 1) identified basalt with black glass in the Back Creek district, and titan-augite and nephelinite-basanite rocks in the Scottsdale-Springfield area; Barton (Appendix 4) identified basalts with green glass in the Lebrina district. Coarse grained basalt (64-231) collected from 4920E/9373N near Blanket Creek and referred to by Groves (1964, p. 65) is transitional between the Mersey and Branxholm types. It comprises anhedral olivine grains up to 0.5 mm. in diameter, occasional plates and prismatic crystals of pyroxene approaching 2 mm. in length, and decomposed 'ilmenite' plates, associated with feldspar laths up to 0.5 mm. in length, granular olivine and pyroxene, and a small amount of intersertal pale green glass. Labradorite penetrates pyroxene and ilmenite in a sub-ophitic relationship, but this is subordinate to the dominant intergranular texture arising from the relationship of mafic grains to feldspar. In patches mafic constituents, mainly pyroxene, have aggregated to form intergranular clusters. The weakly pleochroic to non-pleochroic pale brown pyroxene is probably slightly titaniferous. Notes on other basalts, particularly the nepheline-bearing rocks from a quarry E of West Scottsdale, may be found in Marshall, *et al.* (1965, p. 49), and in Appendix 5.

Basalts of the Pipers River Quadrangle may be termed even or uneven according to the morphology of their soles. Even flows are planar or gently undulating, horizontal or shallowly dipping, and are usually elevated with respect to the existing drainage; uneven flows are prone to rapid variations in strike and dip, and frequently form a veneer along the existing valley sides. Often, an uneven flow form becomes even as it passes upslope, and so, although a composite flow sequence lacking detrital intercalations cannot be disregarded, there is no reason for ascribing the two expressions different ages. In the Lebrina area, Barton (Appendix 4) noted that specimens from the topographically higher level were petrographically distinguishable by their very fine grained groundmass. One might argue that different periods of extrusion were present, but McDougall (1959) considered that the Ouse, Bridgewater, Midlands, Pontville and Jordan types of his area arose from differential cooling within a single flow, and Spry (1958) showed that textural variations in four basalt-types along the Mersey River did not reflect chemical differences; textural without chemical variation is, therefore, no criterion for different flows.

Centres of extrusion were not found although a sub-basalt tuff SW of Pipers River is indicative of minor explosive activity. It is suggested that the flows were fissure eruptions related to major NNW trending faults. Such a mechanism satisfies the absence of discrete centres, and is in keeping with the tholeiitic affinity of the saturated lava type.

Figure 9, a tentative reconstruction of the original extent of the basalt, is based on the present distribution of ferruginous and vein quartz gravels, basalt, and siliceous conglomerate; the topographic form, whether flat-topped and rounded as opposed to ridges and elongate; and on the behaviour of stratum contours in figures 10, 11, 12, and 13. As is apparent the basalt welled up and mantled substantial tracts of country between confining Mathinna ridges. However, passing N, either decrease in relief or increase in the thickness of basalt has resulted in spillways with the consequent mergence or super-position of adjacent flows, and development of a basalt blanket.

The E sheet of basalt, which seems to consist of a single flow or two flows extruded within the one phase, has a shallow coastward component of dip. The N-S gradients between the numbered points on figure 10 are—

<i>Between</i>	<i>Gradient</i>
1 and 2	1 in 163
1 and 3	1 in 160
1 and 4	1 in 159

These, and the essential continuity of outcrop, negate the possibility within this section of post-basalt faults, other than those lacking a component of throw, or with a N-S trend. Between point 4, and the inferred position of basalt at 5283E/9470N, the N-S gradient is 1 in 80. Provided the notion of a shoreline seaward of its present position is accepted, there is no reason to invoke faulting to explain the steeper gradient. Should the notion be unacceptable the possibility of an E-W fault, perhaps forming a scarp against which the Older gravels were banked, cannot be disregarded.

The inferred sheet paralleling the Little Forester River is one of the least satisfactory aspects of figure 9, due to general lack of controls. Twinning N of Greeta could be indicative of discrete minor valley fillings rather than a broad sheet, whilst the Mickca Rivulet and Little Forester sheets could have been partly separate systems S of 5220E/9400N. N-S gradients between points on figure 11 are—

<i>Between</i>	<i>Gradient</i>
1 and 2	1 in 73
1 and 3	1 in 98
1 and 4	1 in 114
1 and 5	1 in 115

The change in gradient is consistent with a normal stream-profile. There is no indication of the possible fault referred to in the previous paragraph.

The basalt paralleling Pipers Brook could well comprise several flows, since W of Weymouth, three flows may be differentiated on topographic expression (fig. 14). However, in the valley the thickness of the sheet could alternatively be due to its highly confined nature. Even in the Lebrina district (fig. 12) where stratum contours could support two distinct extrusive periods, the

5 cm

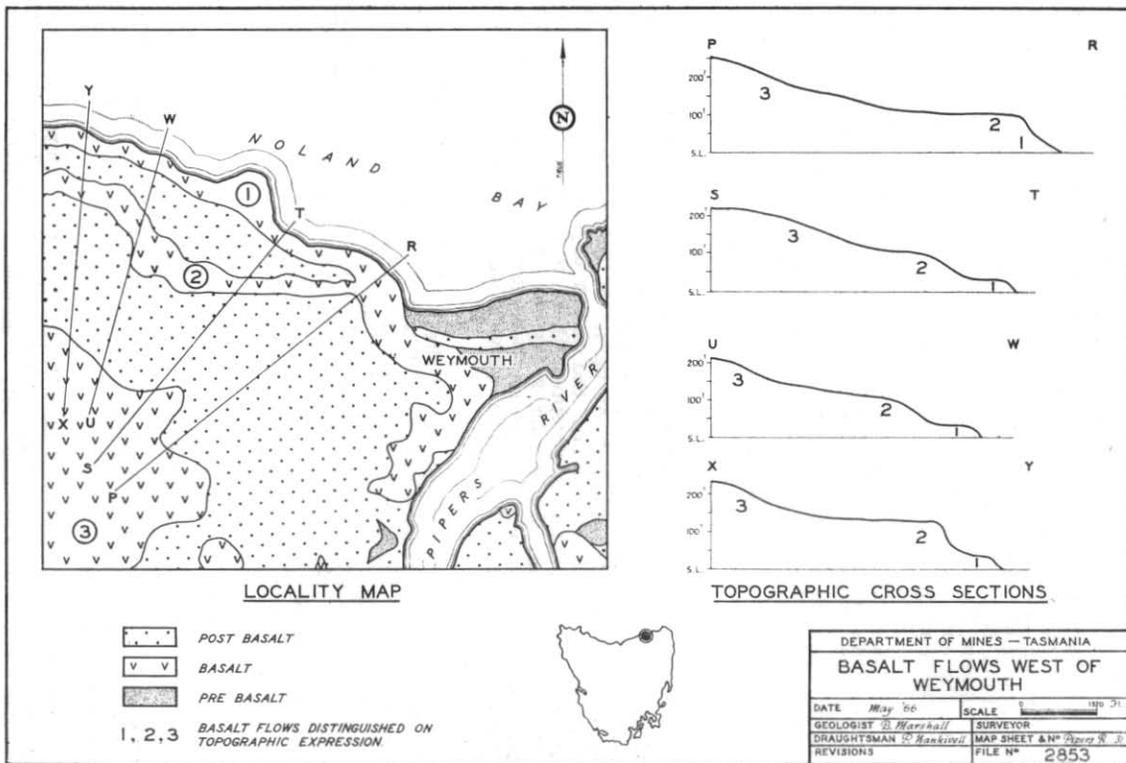


FIGURE 14

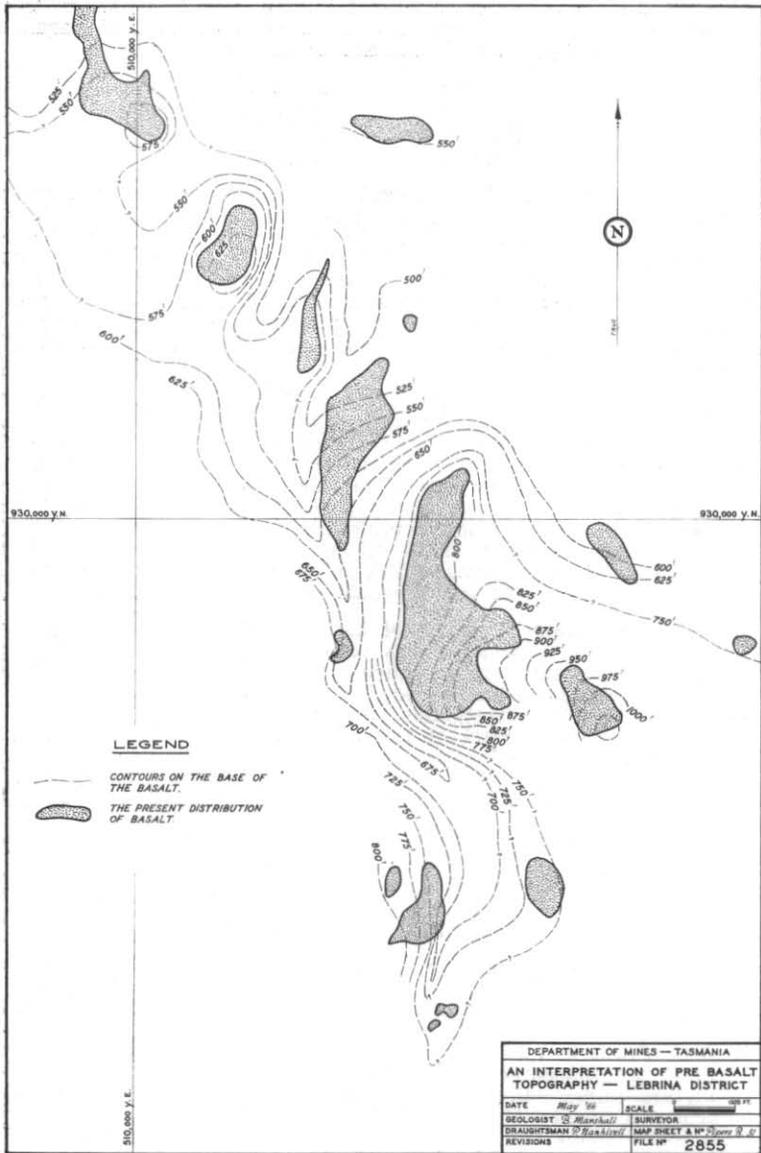


FIGURE 15

5 cm

evidence is inconclusive since lack of control permits an alternative construction (fig. 15). Gradients have been determined parallel to the trend of Pipers Brook and are as follows—

<i>Between</i>	<i>Gradient</i>
1 and 3	1 in 78
2 and 3	1 in 85
1 and 4	1 in 87

At point 4 the base of the basalt was taken to be at sea-level; the bottom of the gutter could be substantially lower than this. The values are comparable with the upper reaches of the Little Forester system, and one may conclude that a considerable part of the river's course lay between point 4 and the Tertiary sea. The present gradient of Pipers Brook (1 in 82 from source to upper tidal limit) is also a juvenile form, in keeping with the lower part of the profile being drowned following post-Tertiary elevation of sea-level.

Since the Pipers River-Back Creek sheet merges with that of Pipers Brook, approximately two miles SSW of Weymouth, a multiple flow may be anticipated. Confirmation is offered by the S group of holes along Back Creek (fig. 5), but, somewhat surprisingly, the N holes reveal no inter-basalt sediments. It is concluded that the first extrusion caused a reduction in grade which resulted in the Creek being depositional in its upper reaches and erosional seaward from 4990E/9430N. The second flow would therefore overlies sediments upstream from this point whereas a continuous thickness of basalt would be found downstream.

Since the great thickness of basalt occupies a slot-like gorge it is possible that the river was dammed following the first flow and that the sedimentary sequence is partly lacustrine. With two flows represented in the bore-holes it is likely that the highest flow at Weymouth corresponds with high level capping S and N of Pipers River and near the Leura Mine. Thus tentative values, presented below, may be calculated for gradients preceding the periods of extrusion. Points between which, and paths along which, gradients have been measured are shown in figure 16—

<i>Between</i>	<i>Gradient</i>	<i>The base of:</i>
1 and 4	1 in 80	1. (the bottom flow)
3 and 7	1 in 260	2. (the middle flow)
2 and 7	1 in 290	
5 and 6	1 in 300	3. (the top flow)

As might be expected the pre-basalt gradient is the same as for the Pipers Brook sheet, whilst inter-basalt gradients become increasingly shallower. Their extreme shallowness (slopes of less than 1 degree) is surprising, particularly since the present gradient of Back Creek is 1 in 127. A possible explanation is that points 6 and 7 are inaccurate and that the values, whilst illustrating a trend, are numerically incorrect; alternatively, should the values be accepted the top of the first flow and each successive flow must have been nearly flat. Knowledge of pre-basalt gradients along the Pipers River would assist the interpretation but, owing to insufficient control, data is only available between points 1 and 2 (fig. 13) where the grade is approximately 1 in 264.

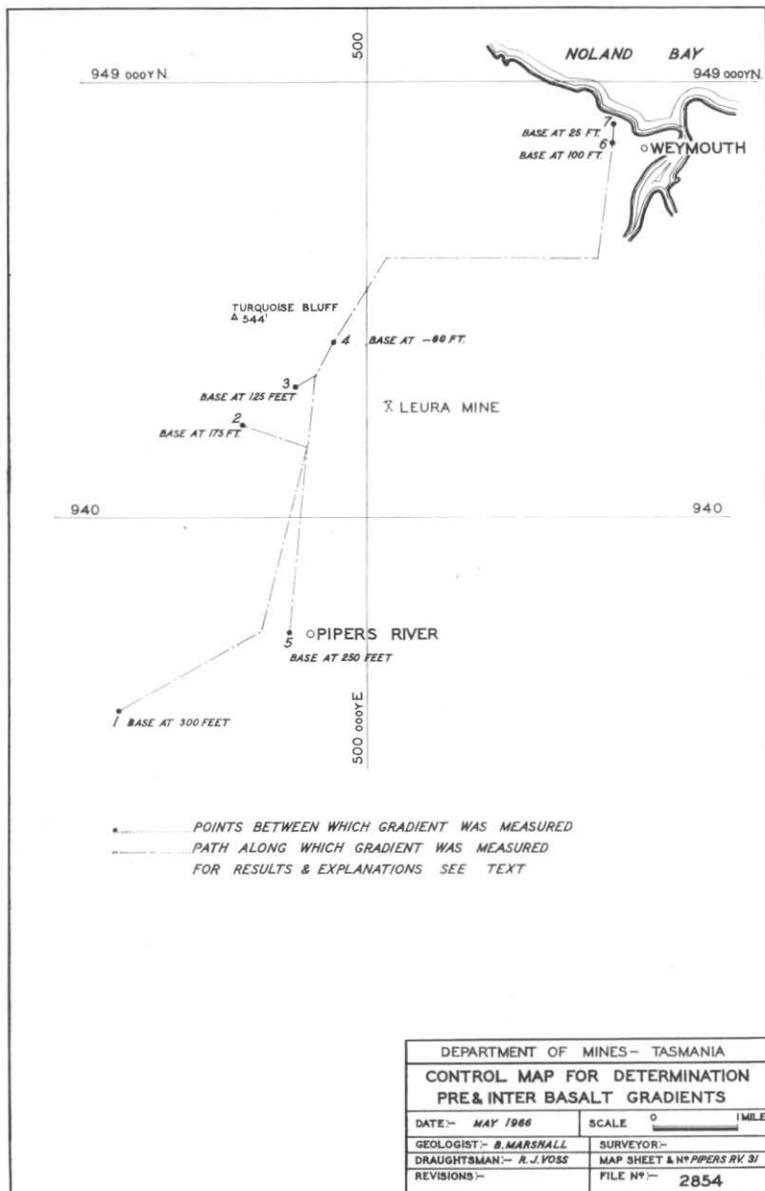


FIGURE 16

5 cm

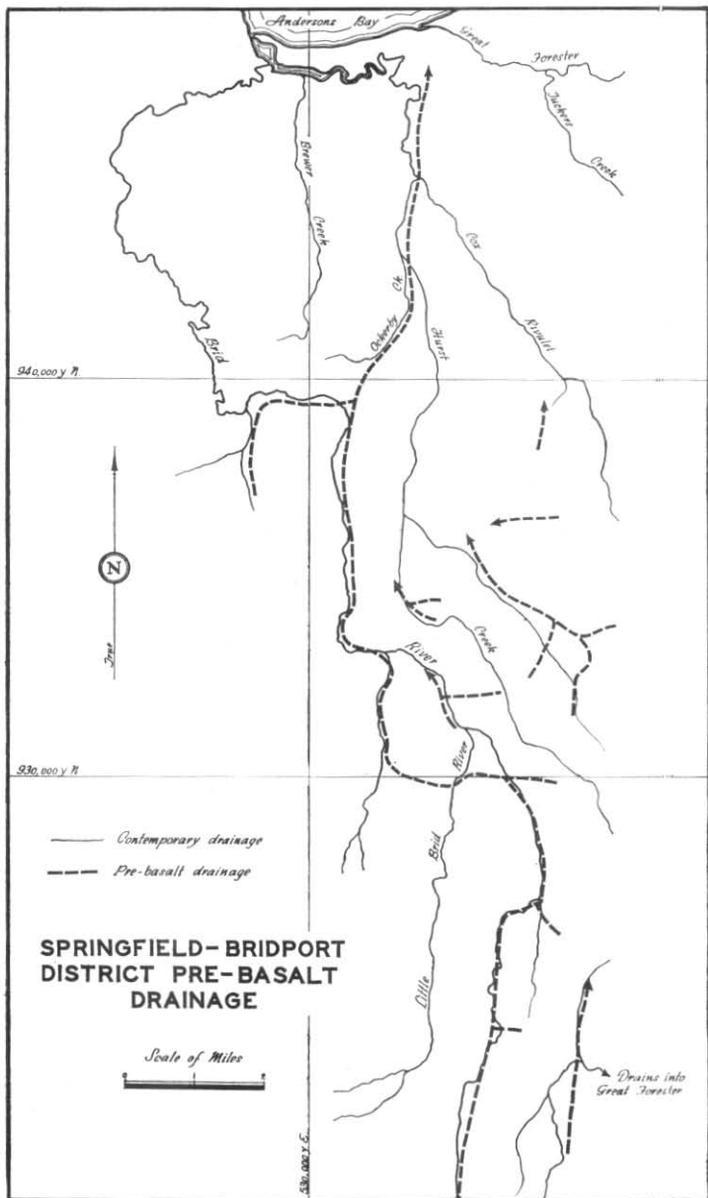


FIGURE 17

5 cm

The pre-basalt topography of the Bridport-Springfield district (fig. 10) was one of shallow gradients. Its main feature was an open asymmetrical valley in which the Brid River flowed N. A reconstruction of pre-basalt drainage has been attempted in figure 17 and it may be noted that—

- i. Over much of its length the present Brid River has inherited the pre-basalt channel. The swing to the W near Duncraggen Hill is attributed to base-level elevation by basalt, with consequent capture by, or spillover into, the headwaters of an adjacent drainage system. N of this the channel is followed by Ockerby Creek, a minor tributary of Cox Rivulet.
- ii. Streams in the Springfield area that once drained N, possibly via a pre-basalt equivalent of Cox Rivulet or Tuckers Creek, now run W to the Great Forester. This is attributed to the damming influence of basalt.
- iii. The Little Brid River and Brewers Creek probably formed along the Mathinna/basalt boundary, and migrated downslope parallel to the retreating basalt scarp. As a general principle, 'permanent' streams may form where the rate of incision exceeds the rate of lateral migration.
- iv. The relationship of the intervening basalt ridge to the Brid and Little Brid Rivers is suggestive of twinning, but since the mechanism of formation is incorrect, the term pseudo-twinning has been used.

There is insufficient data in the Little Forester system to enable much to be said about the pre-basalt topography. Stream gradients have been ascertained (p. 61) and probable twinning N of Greta referred to (p. 61). The disposition of Cainozoic deposits, particularly siliceous conglomerate, between Bridport and the Ferny Hill district, suggest that the present land-form closely resembles the pre-basalt topography.

The astounding similarity, particularly NNW from 5110E/4340N, between the pre-basalt topography and drainage of the Pipers Brook district (figs. 12 and 18), and their contemporary equivalent is best explained by exhumation. Easily weathered basalt would appear to have been largely stripped off thereby revealing the older land-form and permitting inheritance of the older drainage. The question arises as to why drainage should be inherited rather than a new system superimposed, especially since contemporary streams, still flowing over basalt, are apparently influenced by pre-basalt directions. The following ideas, either individually or in combination, might constitute an explanation.

- i. Should the basalt's rate of weathering exceed the rate of incision by marginal drainage paralleling the basalt/Mathinna boundary, the streams will migrate down the Mathinna/basalt interface as the basalt recedes. Inevitably, with complete removal of basalt the stream would occupy any pre-basalt channel. Alternatively should the pre-basalt profile become narrower and more steeply incised, the marginal streams will coalesce with drainage consequent on the basalt flow, to form a medial channel essentially

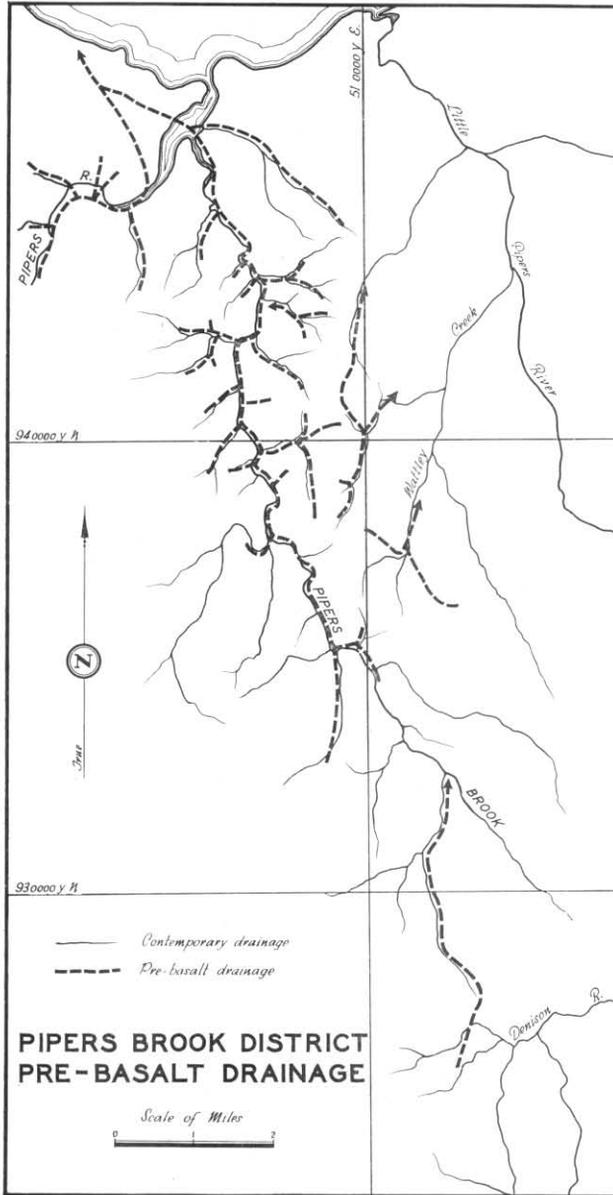


FIGURE 18

5 cm

coincident with pre-basalt drainage. Imperfect evolution of either sequence could result in basalt outliers on the flanks of the valley.

- ii. Should marginal channels not form, consequent drainage will arise on the basalt sheet. It is argued that when streams cut down to the basalt/Mathinna interface they will again migrate along the interface towards a pre-basalt channel.
- iii. The preceding notions rely on migration of streams towards pre-basalt base-levels; pre-basalt channels being deemed to exert no influence on supra-basalt drainage. However, this is not so: unless a flow is dammed and backs upstream, the slope of its upper surface, and thereby the direction of run-off, will reflect the underlying gradient; further since the part of the flow overlying the pre-basalt gully will, because it is thickest, be the region of greatest contraction and sinking, the composite supra-basalt dip will be obliquely towards this region and the main drainage channel will lie along it.

Contemporary drainage and topography in the Pipers River-Back Creek district intimately reflect their pre-basalt counterparts (figs. 13 and 19). A possible pre-basalt extension of Back Creek would have suffered elevation of base level, following the first basalt extrusion, such that the greater part of Back Creek would have been captured by the Pipers River.

Sub-basalt tuff is confined to two closely related localities (4978E/9372.5N, 4986E/9372.5N) SW of Pipers River. In neither place is it well exposed, but 3-4 feet of the deposit are evident in the roadcutting (4986E/9372.5N). The rock has a porous earthy appearance, is fairly soft, and is pale greyish-green to brown in colour. Distinct banding is probably a function of bedding.

Seen in thin section, the rock consists of euhedral to anhedral crystals of pyroxene and olivine, up to 0.5 mm. long, abundant laths and microlites of plagioclase approximately 0.2 mm. in length, and accessory lithic fragments, in a matrix of shard-like glass fragments, palagonite(?), and zeolites. The latter are usually fibriform, and occur as thin layers bounding pores in the rock, which may be termed a glassy crystal tuff.

Metamorphic Rocks

REGIONAL METAMORPHISM

The Mathinna Beds have suffered orogenesis, as a consequence of which they show closely appressed folds and are strongly cleaved. On the microscopic scale this is expressed as a strong planar preferred orientation of the micaceous sub-fabrics, the clay minerals of the original sediment having been recrystallised and reconstituted to form sericite, muscovite, and chlorite. Thus, the cleaved rocks are tectonites arising from low grade regional (essentially dynamic) metamorphism of geosynclinal sediments.

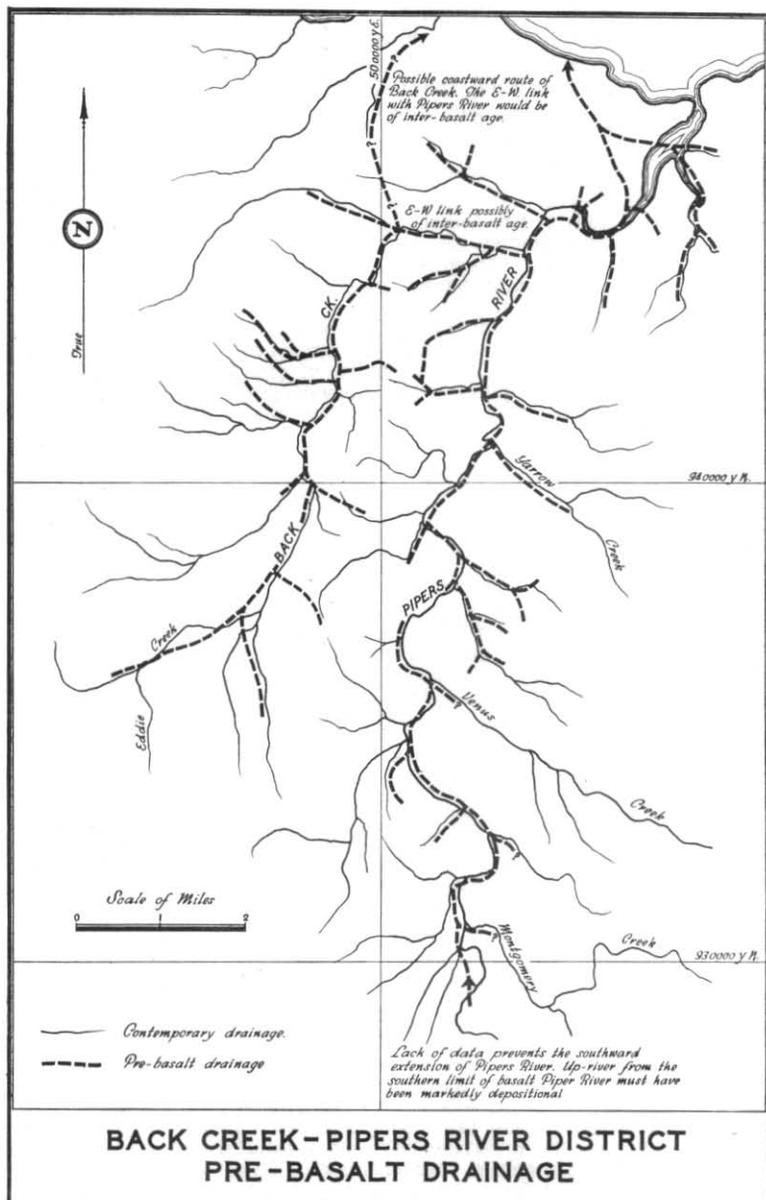


FIGURE 19

5 cm

CONTACT METAMORPHISM

Emplacement of granodioritic magma in the regionally metamorphosed Mathinna Beds has resulted in the formation of a contact-metamorphic aureole that is particularly well-developed in the Lisle-Golconda district and in the Sideling Range. NNE of Lisle it attains a maximum apparent thickness of approximately $1\frac{1}{2}$ miles. Good sections through the aureole were not available but the following generalised sequence may be recognised—

- i. A zone of quartz-feldspar-biotite schist immediately adjacent to the granodiorite. The strongly preferred orientation of biotite, compared with the decussate biotite in specimens further from the contact, is indicative of mimetic crystallisation within the pre-existing cleavage. For this to occur it is suggested that the maximum compressive stress would need to have been orientated within a 60° cone centred on an axis that was normal to the cleavage. Emplacement of the granodiorite could have caused such a stress system.
- ii. Moving down the metamorphic gradient the narrow schistose belt gives way to a completely recrystallised dark bluish-grey hornfels, somewhat basaltic in appearance (cf. Twelvetrees, 1909, p. 15). Bedding is usually discernible but cleavage is visible neither in outcrop nor in thin section where the rock is seen to consist of decussately orientated stubby biotite crystals, quartz, sodic plagioclase and sometimes cordierite.
- iii. With decrease in grain-size the 'basaltic' hornfels passes outward into a spotted hornfels. As in (ii) the rock comprises a quartz-feldspar mosaic with an abundance of randomly oriented brown biotite. The spots are of indeterminate composition but could be incipient chiastolite or cordierite.
- iv. Downgrade from (iii) the rocks have not completely recrystallised, and vestigial cleavage is apparent. In thin-section relict muscovite and sericite, showing planar preferred orientation, are interspersed with decussately orientated chlorite and incipient biotite. Spotting is characteristically present, and persists to the outer limit of contact-metamorphism where the rocks are spotted slates and phyllites with minor development of new chlorite.

Longman (1966, p. 24) reported that the Jurassic dolerite sheet baked the underlying sediments, and gave rise to columnar jointing in the overlying baked Permian mudstone. Dolerite/sediment contacts were not exposed in the Pipers River Quadrangle, consequently, no comparable metamorphism was encountered.

The hydrothermal effects of basalt extrusion have been discussed in the section on Siliceous Conglomerate.

Structure

TECTONIC ENVIRONMENT

Tectonism in NE Tasmania is broadly divisible into—

- i. Lower Palaeozoic orogenesis.
- ii. Post orogenic acidic igneous activity.
- iii. Mesozoic and Cainozoic epeirogenesis and basic igneous activity.

The lower Palaeozoic basement is part of a broad tract of folded rocks, ranging in age from Precambrian to Lower Carboniferous, which runs through Tasmania, Victoria and part of N.S.W. and passes N under the Great Artesian Basin. Packham (1960) has termed this complex the Lachlan Geosyncline.

Recently graptolites of the Lower Ordovician have been recovered from Mathinna Beds at W. Turquoise Bluff in the Back Creek area (M. R. Banks, pers. comm.). Fossil plants described from the Mathinna Beds at Warrentinna in the Ringarooma Quadrangle suggest that the rock sequences there are of the Upper Silurian-Lower Devonian (Cookson, 1937; Banks, 1962). Thus deposition of the Mathinna Beds appears to have continued uninterrupted from at least Lower Ordovician times until the onset of orogenesis which was probably towards the close of the Lower Devonian. In this respect a parallel may be drawn with sedimentation in the Melbourne Trough which, uninterrupted by the earlier orogenic phases of N.S.W. was terminated by Tabberabberan deformation (Packham, 1960).

Although the Mathinna Beds might have been deposited in a S extension of the Melbourne Trough, current directions in the Pipers River Quadrangle indicate turbidity currents from the NW quadrant. Therefore either two depositional troughs existed separated by a zone of shallow-water sedimentation where turbidity currents were initiated and shed directly SE into the Mathinna Trough or turbidity currents developed at the E or W margins of a basin extending from NE Tasmania into Victoria and became directed along the length of the trough carrying sediment SE into the Pipers River region. However, conclusions regarding basin topography are difficult to formulate since current directions in NE Tasmania are extremely variable and Williams (1959 and pers. comm.) has pointed out that at Upper Scamander they were from the SW, at Piccaninny Point from the S, and at Fingal from the NW.

The younger limit of Tabberabberan orogenesis in Tasmania is provided by undisturbed cavern fillings in folded Gordon limestone at Eugenana where spore analysis yielded an upper Middle Devonian flora (Balme, 1960; Burns, 1964). The orogeny would therefore, appear to have been active from late in the Lower Devonian till high in the Middle Devonian, and it is during this period that the Mathinna Beds were probably folded. Partial confirmation of this is afforded by the Scottsdale Granite which intruded the folded Mathinna Beds, and has been assigned a minimum age of 370 ± 10 m.y. by McDougall and Leggo (1965) which according to the time scale that they modified from Kulp (1961), represents Late Devonian time.

Following the orogenesis and granite emplacement the Pipers River Quadrangle was subjected to peneplanation. This continued until the Permian, when glacially derived marine sediments covered much of the area. The rather muddy shallow-water sediments, and the presence of a Middle Permian fresh-water phase, reflect epeirogenic instability, that culminated in marine egression and deposition of the fresh-water Triassic strata.

After the cessation of sedimentation in late Triassic or early Jurassic time dolerite intrusion was post-dated by uplift, faulting and tilting. The history now becomes obscure but it may be deduced that erosion ensued until the Tertiary when, probably following fault reactivation, basalt extrusion occurred. Little evidence exists in the Pipers River Quadrangle for post-basalt faulting, but a substantial increase in sea level must have occurred since pre-basalt river channels are now below sea level.

TABBERABBERAN OROGENESIS

The Tabberabberan Orogeny will be discussed in terms of the fabric and geometry imparted to the Mathinna Beds.

Since the fabric has plane-parallel, rather than linear parallel attributes, planar fabric-elements will receive primary consideration in the ensuing analysis.

Planar Fabric-Elements

Those elements to be described are bedding (ss), cleavage (s_1), and strain-slip cleavage (s_2).

BEDDING (SS)

Throughout the arenaceous sequence bedding is indicated by gross lithological layering discordant with a strong cleavage, and may be proved by sedimentary structures, in the sense used by Turner and Weiss (1963, p. 95). In argillaceous tracts bedding is less easily established, but it may be obtained from siltstone laminae at an angle to cleavage. Parallelism of bedding and cleavage on the mesoscopic scale is observable in tracts of laminite; this is interpreted as the local effect of strong initial planar anisotropism on cleavage orientation rather than in terms of isoclinal folding or complete transposition of bedding.

Frequent folds cause rapid reversal in dip of bedding on the mesoscopic scale; consequently it was not possible to define practical domains that were homogeneous with respect to ss. Figure 20 is a contoured equal area projection of ss-poles measured over the greater part of the quadrangle (sub-area I, fig. 21). The girdle distribution indicates that ss has suffered cylindrical folding on a regional scale, whilst the two strong concentrations relative to the narrow barely continuous portion of the girdle suggest folds with steep axial surfaces, long fairly planar limbs and abrupt zones of closure. β_{ss} , the normal to the ss-pole girdle, is the statistically defined axis of folding; it plunges at 10° towards 139° . The position of the maxima indicate that the NE facing limb is slightly steeper and this is illustrated by the statistically defined axial surface that dips at 83° towards 229° . Thus the folding defined by the ss-pole girdle would appear to possess monoclinic symmetry.

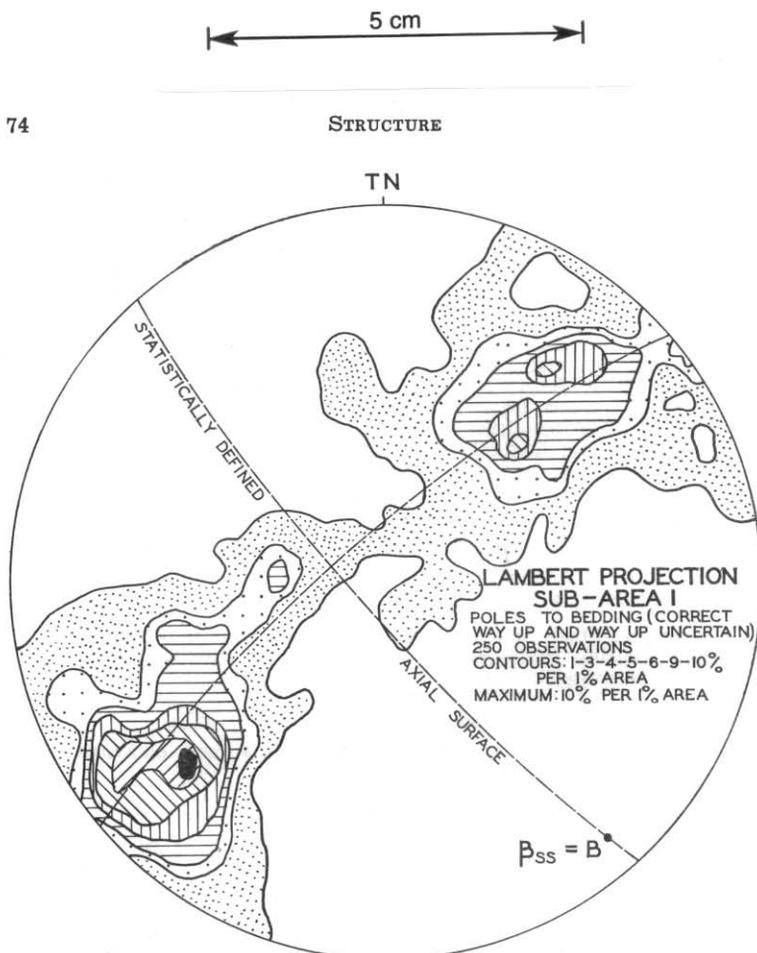


FIGURE 20

Poles to overturned bedding from sub-area 1A (fig. 22) have been plotted in figure 23. The dominant direction of overturning, which is obviously towards the NE, is in full agreement with the N inclination of the axial surface defined in figure 20.

Figure 24 is a plot of poles to bedding from that area excluded from the main ss-pole diagram (sub-area 2, fig. 21). The reason for the preponderance of shallow dips will not be discussed at this stage, but it should be noted that cleavage (s_1) also dips shallowly in this area whilst strain-slip cleavage (s_2) is particularly well developed. Bedding-cleavage relationships, visible in several of the slate quarries that occur in this tract, are presented in figure 25. Twelvetees (1918, p. 4) indicated that, in the strip of slate country between the Bangor Quarries and Just's Quarry 'The planes of the slaty cleavage appear to be coincident with those of bedding' and that 'there is no sign by which one can be distinguished from the other'. This, however, is not so. In contrast, Thureau (1882b), in a report on the Back Creek Goldfield, produced a sketch

AREA DISTRIBUTION MAP, SUB AREAS 1 & 2

PIPERS RIVER QUADRANGLE

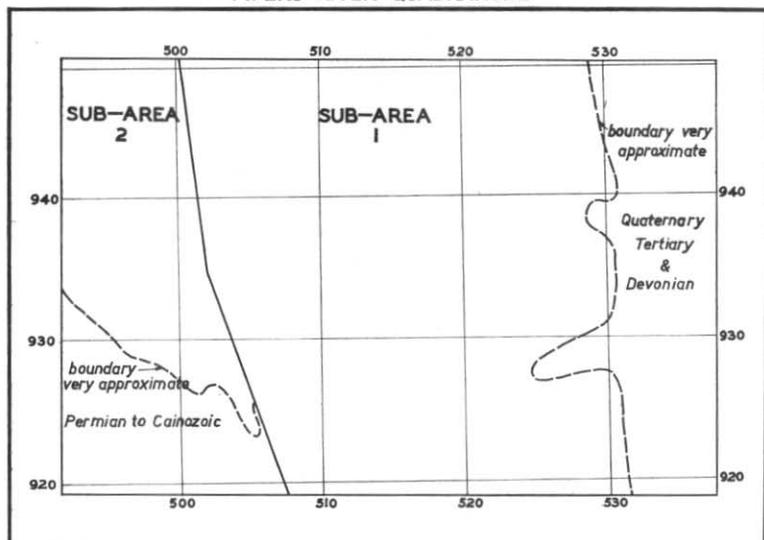


FIGURE 21

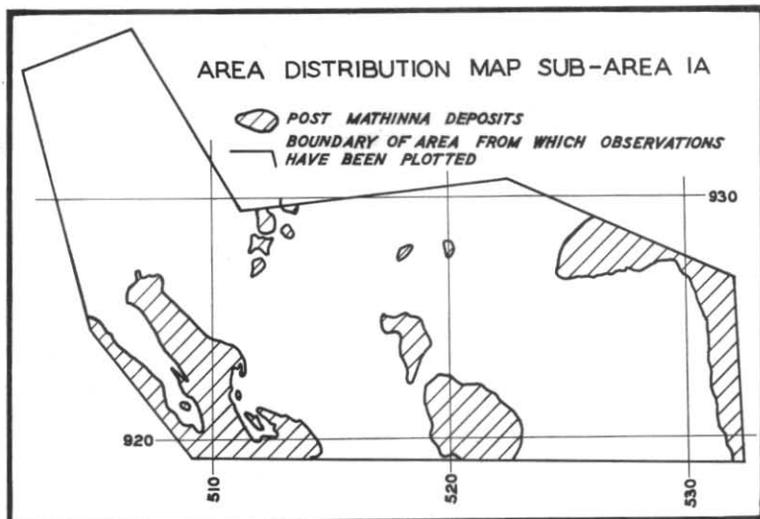


FIGURE 22

5 cm

of part of the Australasian Slate Quarries that, apart from vertical exaggeration, accurately portrayed the bedding-cleavage relationship.

CLEAVAGE (S_1)

Throughout the Mathinna Beds, irrespective of lithology, a cleavage (S_1), that fans slightly about the axial planes of folds, is the dominant tectonically produced surface. S_1 is most commonly a slaty cleavage arising mainly from the strongly penetrative planar preferred orientation of layer-lattice minerals and inequant quartz grains. In some of the more massive quartzose sandstone beds, such as those encountered in and upstream from Lilydale Falls, cleavage takes the form of discrete fractures. Depending upon their spacing this structure may be termed fracture cleavage

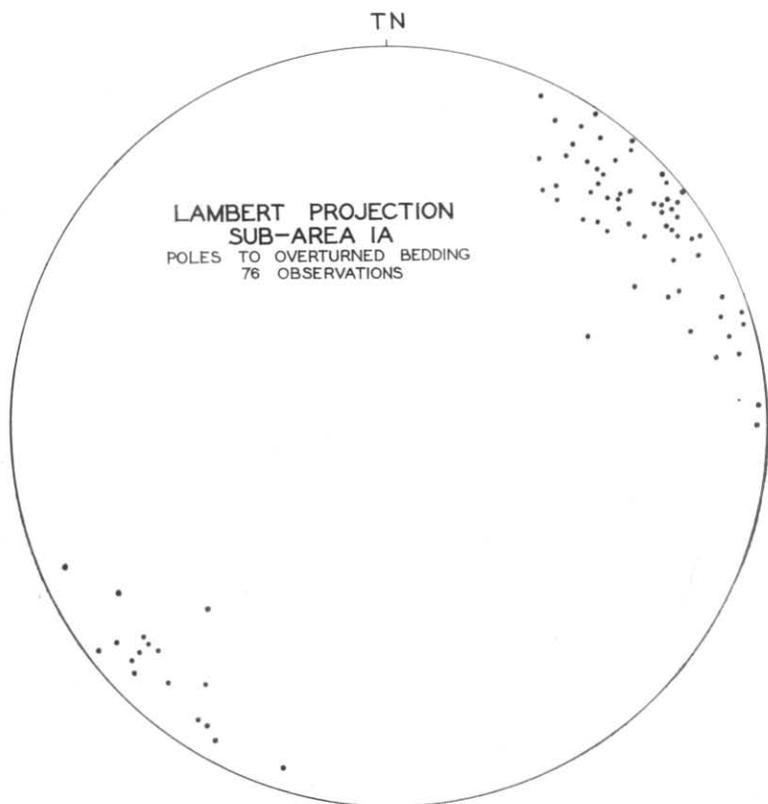


FIGURE 23

5 cm

5 cm

STRUCTURE

77

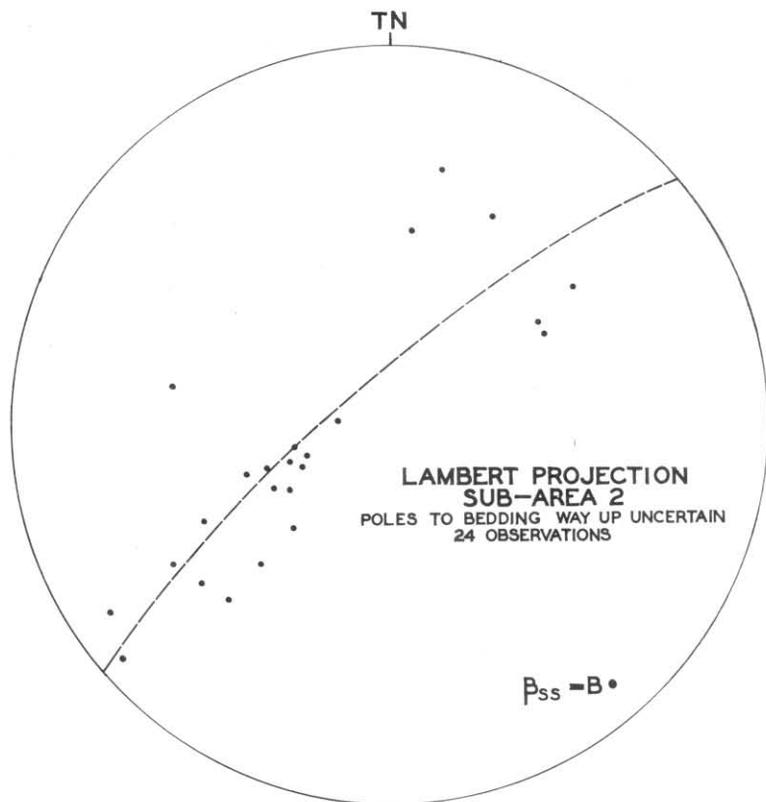


FIGURE 24

(Wilson, 1961) or rotational jointing (de Sitter, 1956). In axial zones of folds in laminated siltstones—rocks possessing a marked depositional fabric—the cleavage comprises discrete planes along which new mica has formed and between which the bedding laminae have been plicated. This may be termed strain-slip cleavage (Bonney, 1886, p. 95).

The Pipers River Quadrangle is divisible into two broad sub-areas with respect to s_1 orientation. Sub-area 1A (fig. 22) is characterised by a predominantly sub-vertical orientation whereas sub-area 2 (fig. 21) has a predominance of sub-horizontal s_1 planes. s_1 poles from sub-area 1A are plotted in figure 26. It will be seen that they have a partial girdle distribution with one very strong maximum. The latter corresponds to a statistically-defined s_1 surface that dips at 77° towards 230° ; it is in accord with the direction of NE overturning of ss and, quite sensibly, closely

$SS = \text{bedding} = \text{dip } 22^\circ \text{ towards } 57^\circ$
 $S_1 = \text{cleavage} = \text{dip } 12^\circ \text{ towards } 225^\circ$
 $L_1 = \text{bedding-cleavage intersection}$
 $= \text{plunge } 2^\circ \text{ towards } 142^\circ$

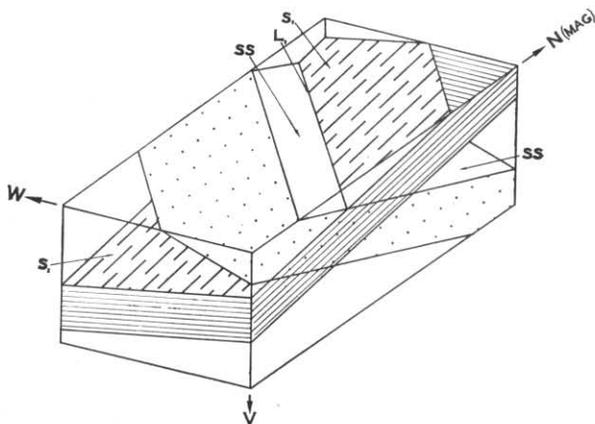


FIG. 25a ORTHOGRAPHIC BLOCK DIAGRAM OF THE BEDDING-CLEAVAGE RELATIONSHIP
BANGOR SLATE QUARRIES

$SS = \text{bedding} = \text{dip } 42^\circ \text{ towards } 30^\circ$
 $S_1 = \text{cleavage} = \text{dip } 11^\circ \text{ towards } 02^\circ$
 $L_1 = \text{bedding-cleavage intersection}$
 $= \text{plunge } 6^\circ \text{ towards } 308^\circ$

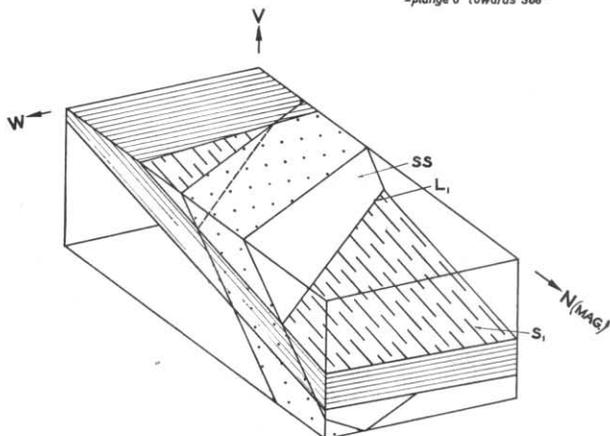


FIG. 25b ORTHOGRAPHIC BLOCK DIAGRAM OF THE BEDDING-CLEAVAGE RELATIONSHIP
AUSTRALASIAN SLATE QUARRIES

5 cm

approximates the statistically defined axial surfaces (see p. 73). The partial girdle of s_1 could be attributed to folding about β_{s_1} , but mesoscopic evidence is lacking. There is, however, mesoscopic evidence for fanning of s_1 about the fold axial planes, very shallow dips being obtained from fracture cleavage on sub-vertical fold-limbs, and it is to this that the partial girdle is ascribed.

The s_1 -poles in sub-area 2 (fig. 21) have a girdle distribution with a strong centrally disposed maximum (fig. 27) corresponding to a statistically defined s_1 -surface that dips at 12° towards 224° . This marked change in the dominant orientation of s_1 , coupled with the strong girdle distribution, is most sensibly attributed to folding about $\beta_{s_1} = B_{s_1}^{s_2}$.

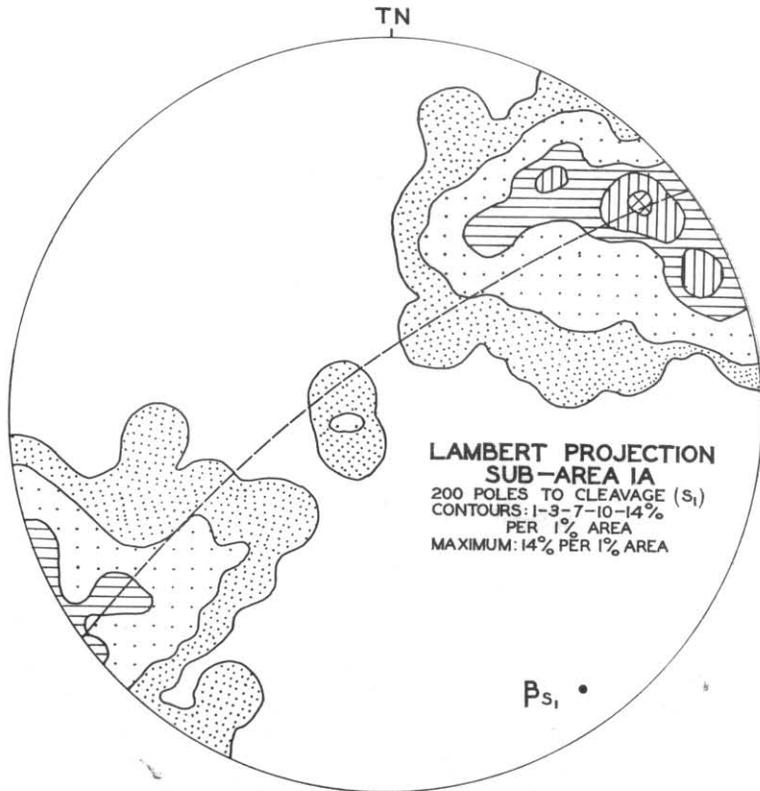


FIGURE 26

5 cm

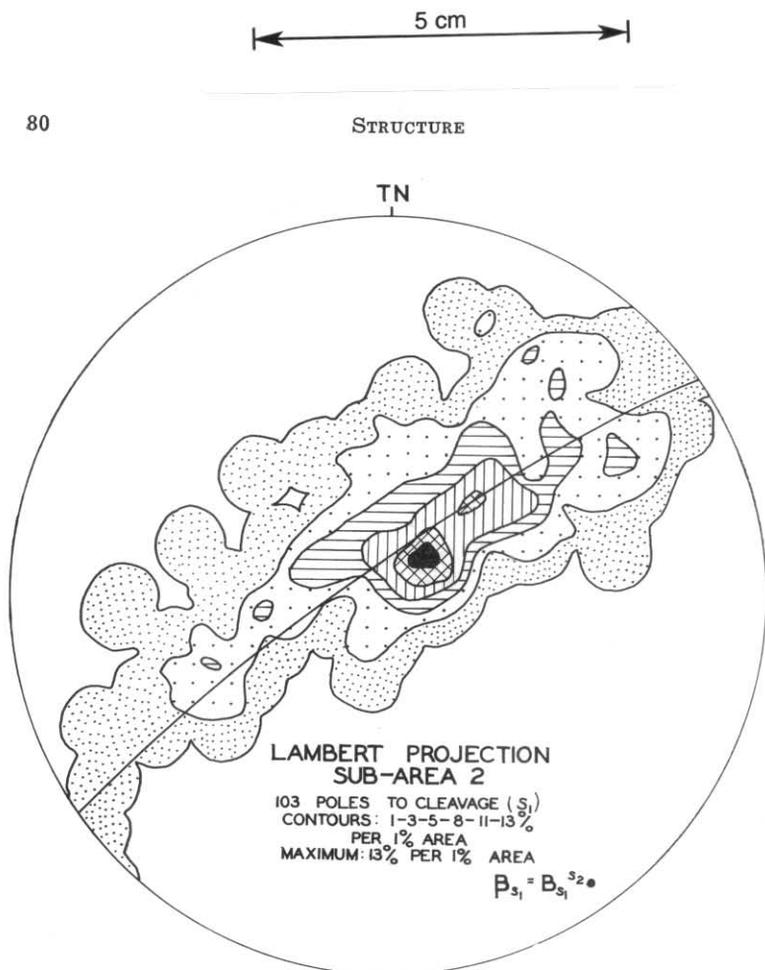


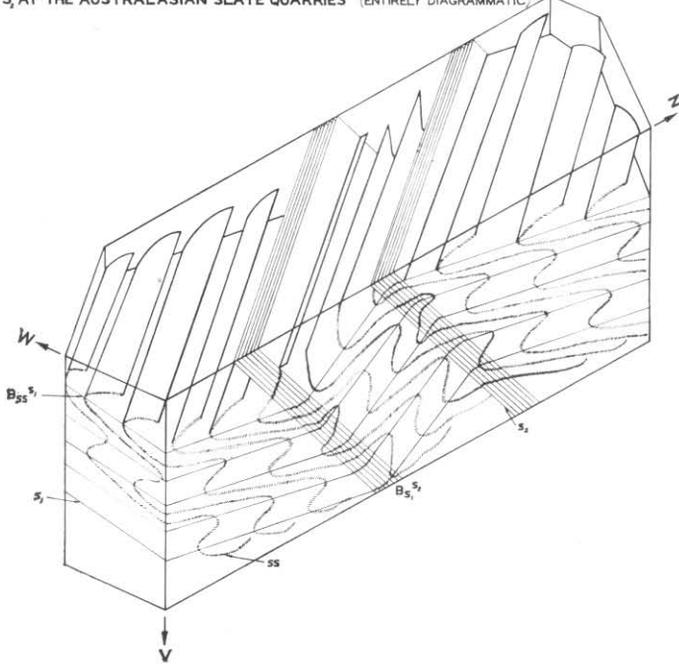
FIGURE 27

STRAIN-SLIP CLEAVAGE (S_2)

Outcrop is scarce in sub-area 2 (fig. 21), but the abundant float often shows a well-developed strain-slip cleavage.

The geographic distribution of this structure is uncertain, but it would appear to be heterogeneous since all outcrops and float do not show strain-slip cleavage. It is absent from Bangor and Just's Slate Quarries, whilst in the Australasian Slate Quarries (4969E/9442N) it is restricted to certain sub-vertical bands. E of the boundary separating sub-areas 1 and 2 (fig. 21) the only known occurrence of s_2 is in a fold at Tunnel (5098E/9257.5N). Passing from the Pipers River Quadrangle W into the Lefroy district strain-slip cleavage appears to be more common and Groves (1964, p. 69) was of the opinion that its heterogeneous distribution might be related to axial zones of shallow folds.

FIG 28d ORTHOGRAPHIC BLOCK DIAGRAM OF THE RELATIONSHIP BETWEEN ss , s_1 & s_2 AT THE AUSTRALASIAN SLATE QUARRIES (ENTIRELY DIAGRAMMATIC)



Thin-section examination has confirmed that s_1 is the plicated surface and therefore, as is the case with strain-slip cleavage when the plicated surface is of tectonic origin, the term crenulation cleavage (Rickard, 1961) may be applied.

The relationships of ss , s_1 and s_2 at Tunnel and in the Australasian Slate Quarries are portrayed in figure 28, and may be seen in plate 7. The π diagrams in figures 24, 27 and 29 confirm these relationships and show that whereas sub-area 2 is homogeneous with respect to s_2 ss and s_1 have heterogeneous girdle distributions indicative of folding about $B_{ss}^{s_2}$ ($= \beta_{ss}$) and $B_{s_1}^{s_2}$ ($= \beta_{s_1}$). Whether s_2 is symptomatic of, or caused by, the folding has not been proved, but they are genetically related, and since some $B_{s_1}^{s_2}$ flexures have only a poorly defined strain-slip cleavage the latter is considered to be a secondary response to primary flexing.

Linear Fabric-Elements

Elements that will be described are a bedding-cleavage lineation (L_1), and a crenulation (L_2) arising from the intersection of s_1 and s_2 . Other linear features have been grouped into a miscellaneous category.

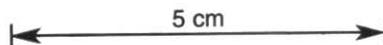
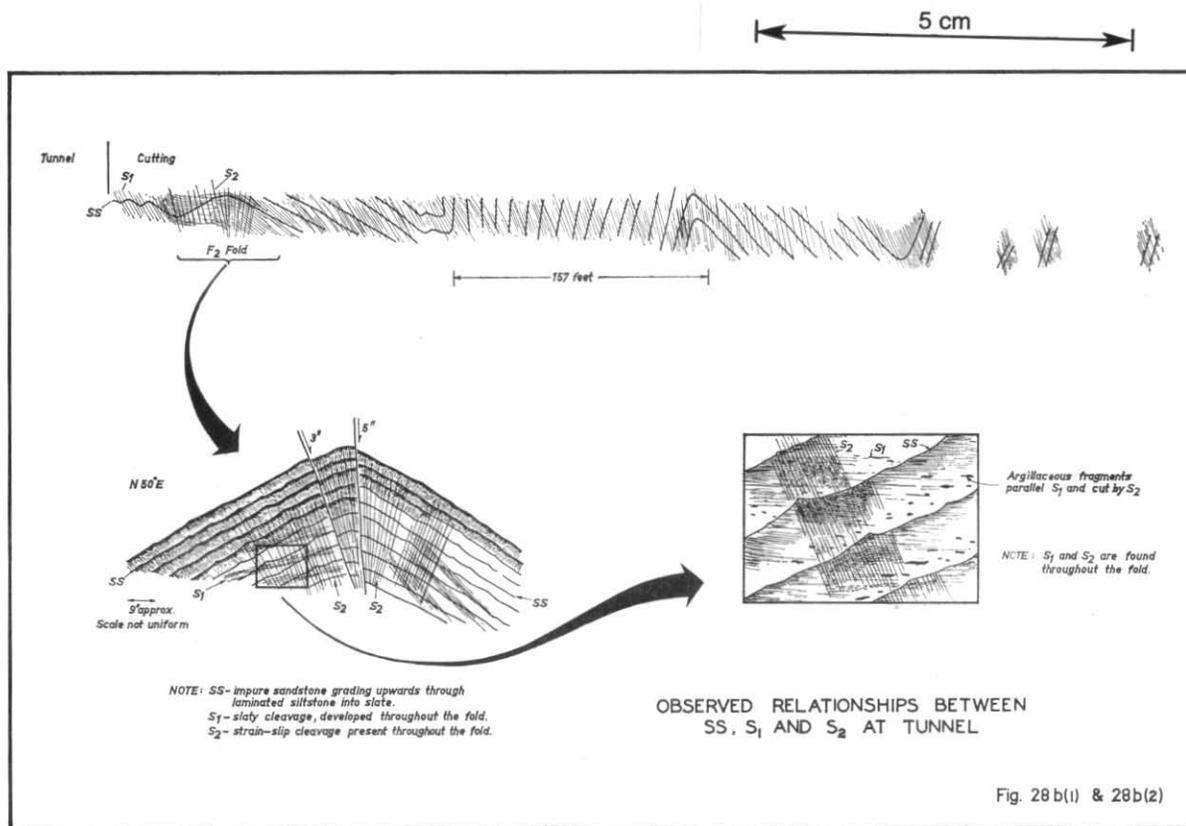


FIGURE 28



BEDDING-CLEAVAGE LINEATION (L_1)

The trace of bedding on cleavage or vice-versa may be distinguished throughout the arenaceous sequence and may commonly be found in the argillaceous rocks.

L_1 measurements from the whole Quadrangle have been plotted and contoured in figure 30 which reveals that—

- i. The Quadrangle is homogeneous with respect to L_1 .
- ii. The statistically defined plunge of L_1 is 6° towards 140° , and is co-linear with β_{SS} as defined in figure 20.

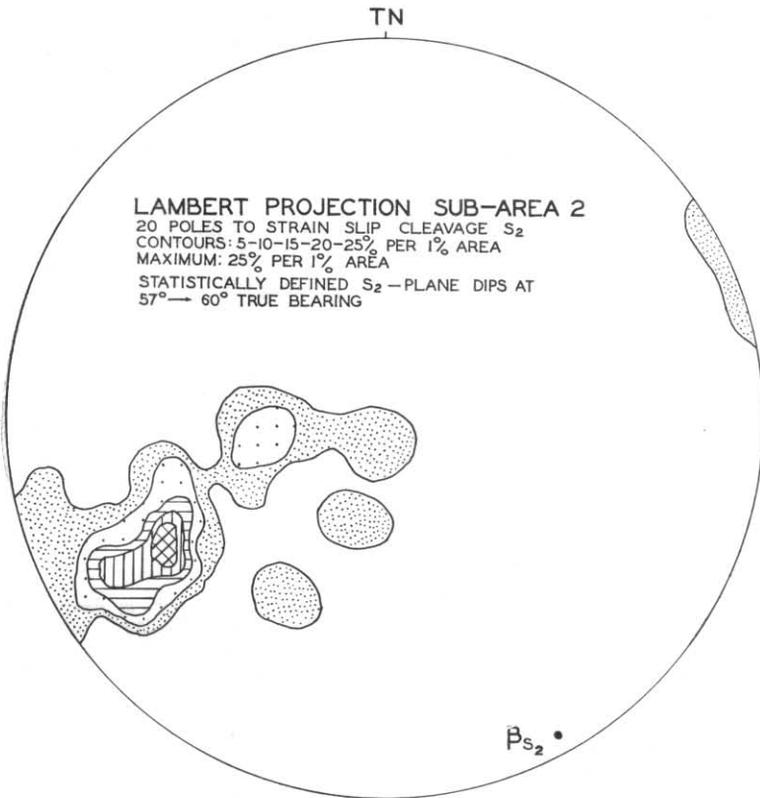


FIGURE 29

5 cm

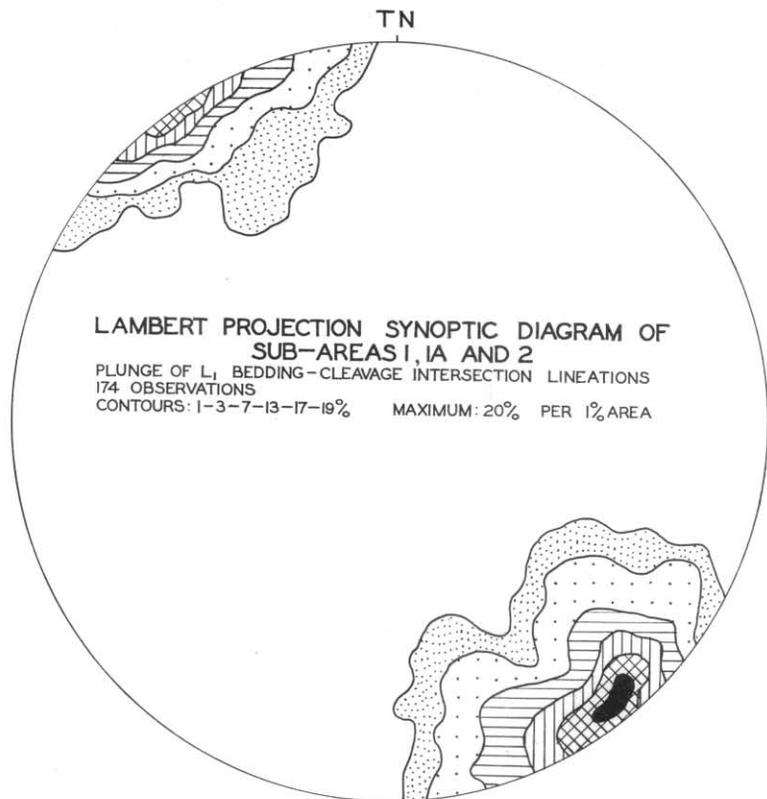


FIGURE 30

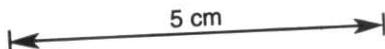
CRENULATION LINEATION (L_2)

In the W portion of the Quadrangle wherever s_2 is developed, a strong crenulation may be equated with plication of slaty cleavage (s_1) by strain-slip cleavage (s_2). A plot of crenulations (fig. 31) measured in sub-area 2 (fig. 21) indicates that—

- i. Sub-area 2 is homogeneous with respect to L_2 .
- ii. The statistically defined plunge of L_2 is 7° towards 151° .

It is approximately coincident with β_{s_2} (fig. 29).

Although L_1 and L_2 are not statistically co-linear, the amounts of plunge are essentially the same and the directions of plunge differ only by 11° . It is therefore suggested that no great significance should be attached to these divergent trends.



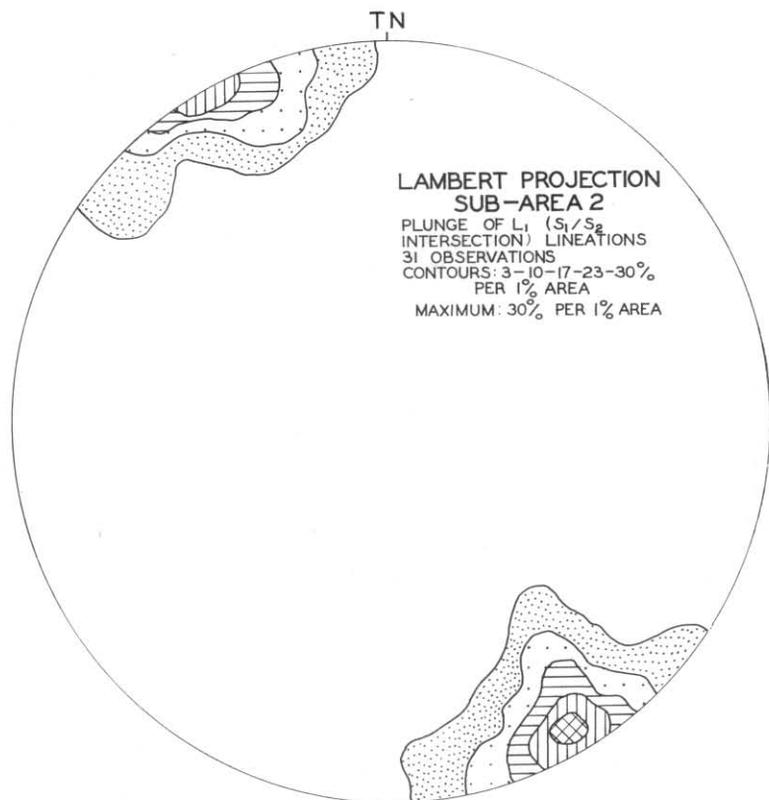
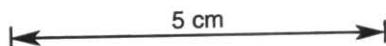


FIGURE 31

MISCELLANEOUS LINEATIONS

Occasionally, in some of the better quality slates a lineation attributable to preferred orientation of fabric-elements such as pressure shadows and matrix lenticles, is disposed, at 90° to L_1 . Dale, *et al.* (1914) termed this the grain of the rock. It is interpreted as an a -lineation caused by extension within the ab plane at 90° to the fold axis, and is designated L_1' .

Massive quartzose beds frequently exhibit quartz slickensiding that is probably due to bedding-plane slip during flexural slip folding. This suggestion is supported by figure 32, which shows that, with one exception, the angle between L_1 and slickensiding measured within the plane of ss is close to 90° .



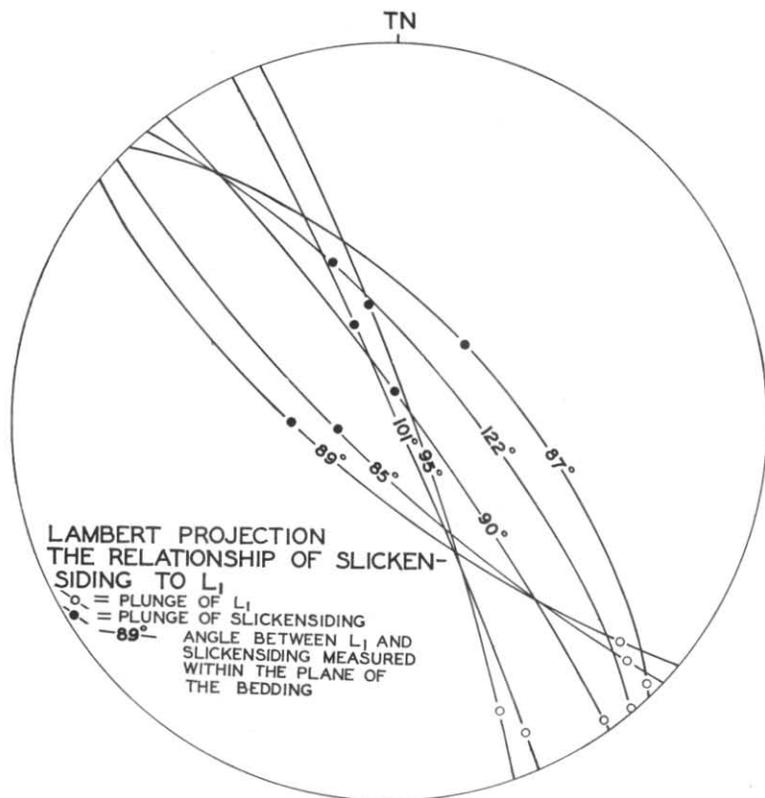


FIGURE 32

Groves (1964, p. 67) referred to lineations on folded slaty cleavage (s_1) in the Lefroy district that were 'markedly oblique to the fold axes' and were 'apparently not related to the crenulation cleavage' (s_2 in the report). Dearth of outcrop in the sub-area forbade satisfactory resolution of this lineation but the following items suggested that it predated L_2 —

- i. Within the plane of the form-surface s_1 , the lineation formed an angle of 60-70° with L_2 .
- ii. The angle between the lineation and L_2 appeared to be reasonably consistent all over the folds in s_1 . This would indicate that the lineation was folded concentrically during generation of L_2 and s_2 .



Should the interpretation be correct, the lineation could well be that designated L_1' above. The marked development of this lineation in areas affected by s_2 could be due to—

- i. Intensification of L_1' by the F_2 phase of deformation.
- ii. L_1' having preferentially developed in argillaceous rocks which similarly localised s_2 formation.

Folding

THE FIRST PHASE (F_1)

The first phase of deformation resulted in folding of bedding (ss) and formation of lineations L_1 and L_1' . Excellent examples of fold-styles may be seen in the W railway cutting at Tunnel, in railway cuttings immediately W of Golconda, and in the wave-cut platform at Pipers Heads (plate 8).

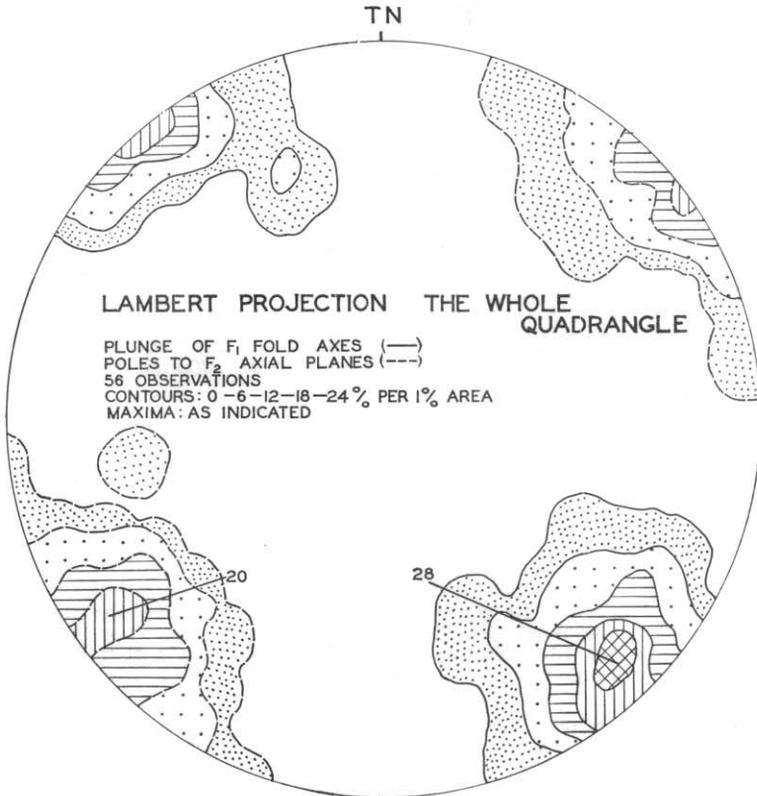


FIGURE 33

5 cm

The generally inequant fairly tightly appressed folds plunge shallowly towards NW and SE, whilst the axial surfaces are slightly inclined from the vertical. Figure 33 is a contour plot of 56 F_1 axes and axial surfaces. The statistically defined fold axis plunges at 12° towards 136° , whilst the axial surface (corresponding to the 20% per 1% area maximum) dips at 78° towards 236° . As is to be anticipated from folds that are geometrically planar and cylindrical, the lineation defined by bedding-cleavage intersection (fig. 30) is coincident with the plunge of the fold axis. Less satisfactorily the axial surface is opposed in inclination to the cleavage (s_1 , fig. 26).

It has not been possible to delimit macroscopic folds, although the disposition of the argillaceous tract E of Lebrina could be explained in this manner.

Cross-folding, as described in the Launceston Quadrangle (Longman, 1966, p. 24) was not present.

THE SECOND PHASE (F_2)

In the second period of movement s_1 was folded and strain-slip cleavage s_2 and lineation L_2 were generated. The fold-style is best seen in the W railway cutting at Tunnel and in the Australasian Slate Quarries.

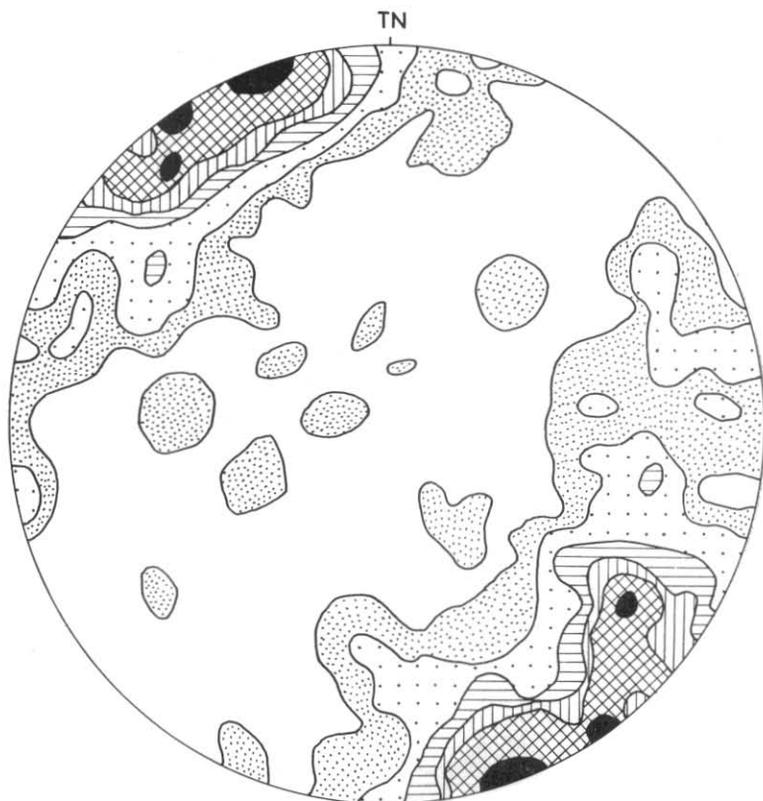
The folds are inequant and shallowly open; as indicated by L_2 and s_2 in figures 31, 29, they plunge shallowly SE and their axial planes are steeply inclined towards the NE.

Macroscopic structures cannot be delimited, but it is suspected that shallow large wavelength folds may have affected the area W of Pipers River.

Jointing and Faulting

No attempt has been made to measure every joint in the Mathinna Beds and, consequently, the contoured pole diagram in figure 34 only represents the more commonly encountered joints. From figure 34, it is apparent that joints occupying a statistically defined ac position with respect to the F_1 fold axes are the most common. A tendency to spread anticlockwise from the main maxima indicates that oblique joints of approximately N-S trend are fairly common.

From a detailed study of the joint relationships between the Mathinna Beds, an intrusive granite, and the unconformably overlying Permian at Dalrymple Hill, near Rossarden, Williams (1967) was able to show that all joints affecting the Mathinna Beds were of pre-Permian age. The absence of a sufficiently well exposed unconformity between the Permian and the Mathinna Beds within



LAMBERT PROJECTION OBSERVATIONS MADE SOUTH
OF A LINE RUNNING FROM NABOWLA THROUGH LEBRINA

325 POLES TO JOINT PLANES IN MATHINNA BEDS

CONTOURS: 1-2-3-4-5-6% PER 1% AREA

MAXIMA: 6% PER 1% AREA

FIGURE 34

the Pipers River Quadrangle, has prevented a similar study, but there is every reason to suspect that joints in the Mathinna Beds originated before the Permian.

Slickensiding provides evidence that some cleavage and bedding planes have been active surfaces of movement, but lack of adequate marker horizons prohibits satisfactory recognition of major faults in Mathinna Beds strata. In fact, other than where extrapolated from Permian rocks, only one significant fault, located in the NW corner of the quadrangle and of *ac* orientation, has been mapped. Faults affecting both the Permian and Mathinna Beds are probably re-activated trends of pre-Permian age (pp. 97 and 98 and Marshall, 1969).

5 cm

STRUCTURES IN THE POST-OROGENIC GRANODIORITE

The mechanism of emplacement and contact effects of the granodiorite have previously been mentioned (p. 57).

The post-orogenic age of the acidic igneous activity is based on radiogenic data (Spry, 1962, p. 265; McDougall and Leggo, 1965) and the absence of any secondary tectonic foliation.

Very infrequently, a weak planar preferred orientation of biotite flakes and prismatic hornblende crystals has resulted in an ill-defined foliation. This, being the orientation of early-formed minerals by flow during granite emplacement, is primary tectonism.

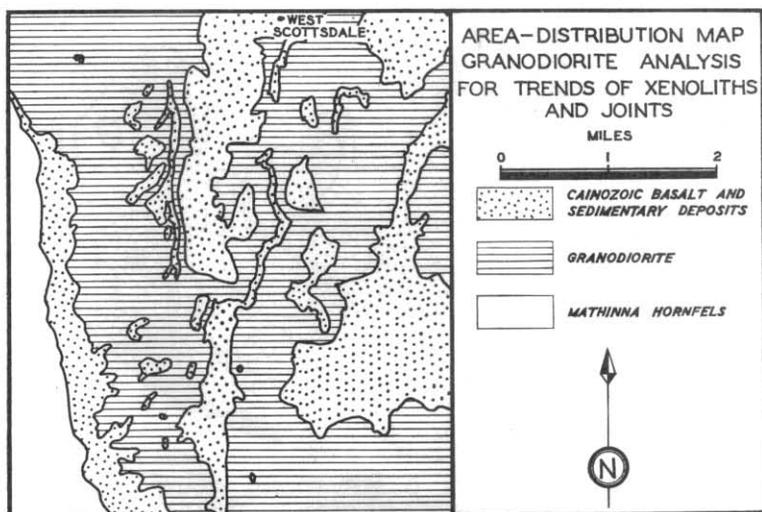
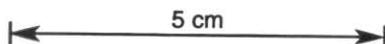
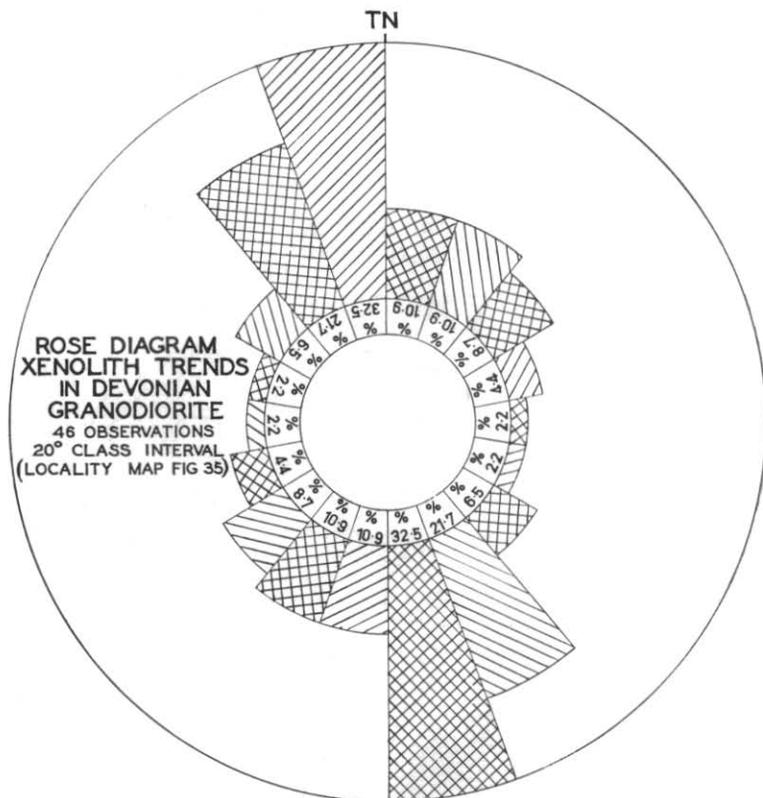


FIGURE 35

Cognate and accidental xenoliths varied from rare well-formed 'tadpoles', through common flattened 'egg' and ellipsoidal shapes to somewhat irregular forms, and had a definite planar preferred orientation despite the paucity of primary foliation. They generally dip steeply and strike at about 350° , but along the Little Brid River between 9230N and 9250N they have a shallow (less than 15°) NW dip. This possibly reflects proximity to the roof of the intrusive. The traces of steeply dipping xenoliths on sub-horizontal surfaces from an area around Springfield (locality map fig. 35) have been plotted in figure 36. The dominant trend of 355° parallels the granodiorite contact and suggests that the planar orientation of xenoliths was induced by laminar flow and reflects the disposition of the granodiorite-Mathinna Beds contact.

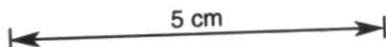




A degree of linear preferred orientation was possibly present but the relatively few xenoliths on which the true plunge could be measured forbade statistical confirmation of this. Such values as were obtained indicate a shallow plunge toward 350° .

The orientation of joints from part of the granodiorite are plotted in figure 37 and summarised in figure 38. The statistically defined orientations (fig. 37) might readily be interpreted in terms of the four main types of primary fracture (Q-joints, S-joints, flat-lying joints and diagonal joints) encountered in igneous bodies. Under such circumstances it would not be difficult to relate joint directions in the granodiorite to structures in the Mathinna, since the contact is largely controlled by s_1 or ac -jointing in the area of interest (fig. 35). However, an alternative explanation is favoured for the following reasons:—

1. Primary fractures, with the exception of S-joints, are commonly filled with aplite or hydrothermal minerals, and frequently show signs of differential movement



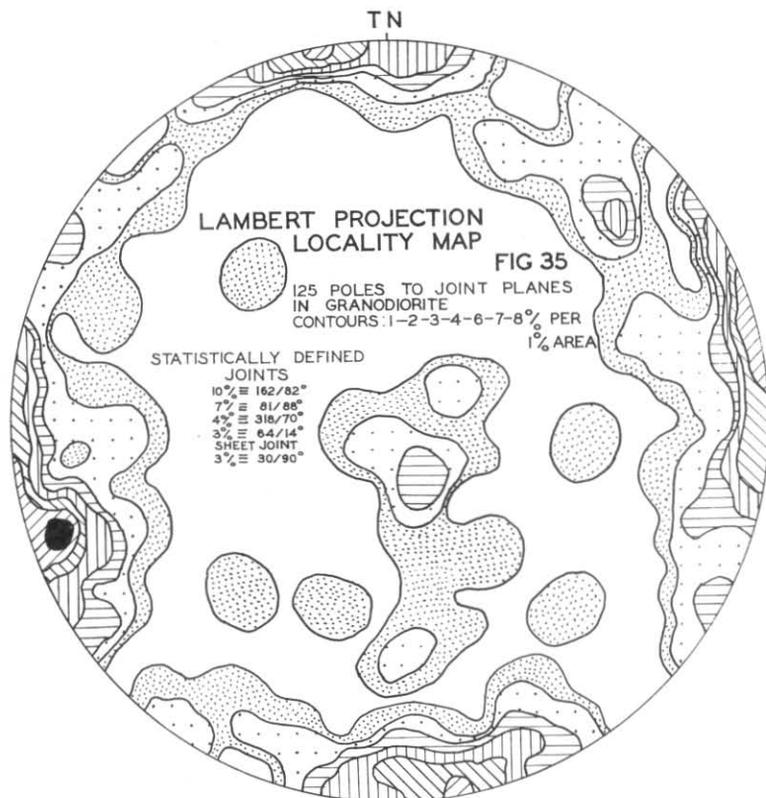
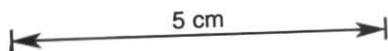


FIGURE 37

(cf. Price, 1966, pp. 157-158). The fractures plotted in figure 37 are true joints in which there is no filling and along which there has been no movement on the mesoscopic scale.

2. Primary fractures are normally defined in relation to flow lines. When these are absent, primary fractures cannot be identified with certainty and possibly do not form.
3. Igneous rocks will almost certainly contain joints due to regional tectonic compression (Price, 1966, p. 159). In particular, Williams (1967, p. 251) has suggested that, in the Dalrymple Hill district, 'faults which dislocate the Permian rocks may have . . . affected the granite before Permian times, resulting in joints of similar pattern to the Permian rocks . . .'



4. The geology of the Piper River Quadrangle is very similar to that of the Dalrymple Hill area, and the joint pattern in the granodiorite (figure 37) is indistinguishable from figure 5d of Williams (1967, p. 248).
5. The shallowly dipping fractures (figure 37) could be sheet joints (Price, 1966, p. 160).

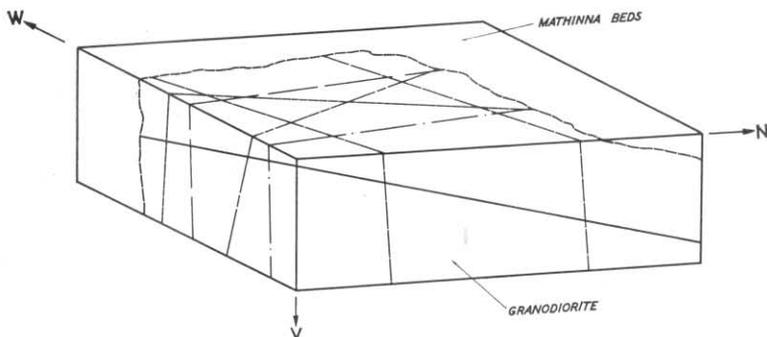


FIG 38 ORTHOGRAPHIC BLOCK DIAGRAM OF THE RELATIONSHIP BETWEEN STATISTICALLY DEFINED JOINTS (FIG 37) AND THE GRANODIORITE / MATHINNA CONTACT

FIGURE 38

Because of the foregoing items the joints system in the granodiorite is considered not to be a primary feature, but to be the product of a regional stress system that, as will become apparent (pp. 97 and 98) was perhaps active or reactivated well into the Tertiary (Marshall, in press).

POST-TABBERABBERAN EPEIROGENESIS

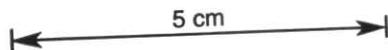
Permian to Cretaceous Structures

The Permian to Jurassic rocks have suffered epeirogenic oscillation, tilting, faulting and joint development.

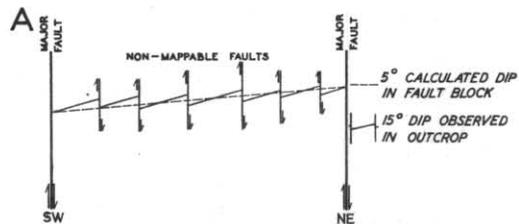
Epeirogenic movements are indicated during the Permian by the alteration of marine and non-marine deposits; these ultimately give way to more stable Triassic sedimentation.

Longman (1966, p. 26) has identified a post-Permian pre-dolerite period of faulting, but other than the assumption that dolerite was partly emplaced along pre-existing fracture surfaces, no evidence for this phase of deformation was found in the Pipers River Quadrangle.

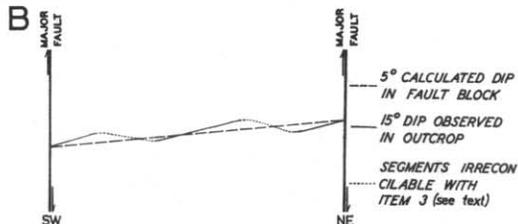
The next period of instability probably accompanied dolerite intrusion. Emplacement of 500+ feet of dolerite would fault and uplift the capping strata, thereby increasing the rate of denudation and effecting a change in sedimentation.



5 cm



RELATIONSHIP BETWEEN CALCULATED AND OBSERVED DIP ACCORDING TO LONGMAN (1966)



RELATIONSHIP BETWEEN CALCULATED AND OBSERVED DIPS IN TERMS OF LOW AMPLITUDE FOLDING



--- 5° CALCULATED DIP IN FAULT BLOCK
 | PROPOSED RELATIONSHIP BETWEEN OBSERVED DIPS AND ROTATIONAL DISPLACEMENTS ON CURVED FAULTS

FIGURE 39

94

STRUCTURE

DEPARTMENT OF MINES — TASMANIA	
RELATIONSHIPS BETWEEN CALCULATED AND OBSERVED DIPS IN PERMIAN STRATA	
DATE	APRIL 1967
GEOLOGIST	B. MARSHALL
DRAUGHTSMAN	T.R. BELLIS
REVISIONS	MAPSHEET & NO PIPERS RIV. JV FILE NO 3141

The ensuing period, before commencement of Tertiary sedimentation was one of major co-genetic faulting and tilting (there is no evidence for post-Permian folding), as a result of which the Permo-Triassic rocks strike at 320° - 330° and dip from 5° - 18° SW. Within fault blocks the distribution of stratigraphy is best satisfied by a dip of approximately 5° (calculated from structure contours), despite higher angles of dip being observed in outcrop. To explain a similar discrepancy between the calculated and often observed dips in the Launceston Quadrangle, Longman (1966, p. 25) invoked 'numerous small non-mappable faults'. A diagrammatic interpretation of this suggestion is given in figure 39A and, whilst it demonstrates how a set of 'non-mappable' faults may cause a 15° dip to be interpreted as a 5° regional dip, as an explanation of relationships in the Launceston and Pipers River Quadrangles it is inadequate. The facts requiring interpretation are—

- i. Observed dips range approximately from 5° to 20° .
- ii. The calculated dip is approximately 5° .
- iii. Observed dips less than the calculated value were not found.

Suggestions based solely on open low amplitude folding cannot be reconciled with iii (see fig. 39B) so some modification of Longman's fault hypothesis would appear in order. It is proposed that certain 'non-mappable' faults are curved in form and have a rotational component. Differential rotation would adequately explain the range of encountered dips (fig. 39C).

In part due to the absence of marker horizons in the Mathinna Beds the recorded faults are restricted to the SW corner of the area. Their age (post-dolerite and Pre-Tertiary deposits) is based on the following items:—

- i. Post-dolerite—W of Lower Turners Marsh—
 - (a) Faults affect the Permo-Triassic sediments and dolerite.
 - (b) It could not be proved that the Permian and the dolerite were equally displaced, but displacements were of insufficient magnitude (usually about 100 feet) to suggest repeated significant movement.
- ii. Post-dolerite—E of Lower Turners Marsh—
 - (a) In the Launceston Quadrangle the S extensions of many of these faults cut Permian to Jurassic rocks.
 - (b) Longman (1966, p. 26) stated that the Permian and the dolerite were equally displaced by the faults.
- iii. Pre-Tertiary—
 - (a) Tertiary sedimentary deposits and basalt show no evidence of faulting.
 - (b) Basalt in the Launceston Quadrangle (Longman, 1966, p. 26) is similarly unfaulted.

The dominant NW and subordinate NE orientations, revealed by the rose diagram of fault trends (fig. 40), parallel the dip and strike respectively of Permo-Triassic strata. Because of the paucity of data no significance is attached to the divided trend in the NW quadrant. Nine out of thirteen NW trending faults down-throw to the E; those with other trends have an inconsistent movement-sense. The throw is usually less than 250 feet, notable exceptions being the first and third faults E of Bangor Slate Quarries (400 feet and 750 feet displacements respectively), and the third fault W of Lilydale Station (approximately 500 feet displacement).

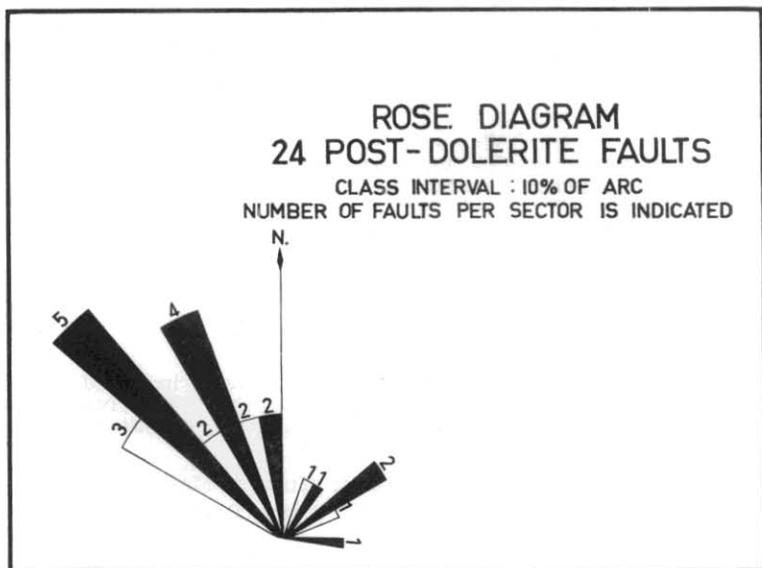
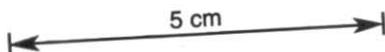


FIGURE 40

Photo-interpreted lineaments in dolerite have been plotted on a rose diagram (fig. 41). The most common orientation of 330° is attributed to faulting since it closely approximates the dominant fault trend in the area. The concentration at 65° parallels a strong often closely spaced (2 to 4 inches) joint system, and also approximates the subordinate fault trend. Other common orientations at 25° , 85° and 35° correlate with often observed joints.

Joints abound in the Permo-Triassic rocks, relative abundance being largely a function of grain size and bed thickness. Thus the medium to coarse grained cross-bedded sandstones have widely spaced joints, the non-fissile siltstones of the Upper Permian have a well-developed joint set the spacing of which is approximately one and a half times the bed thickness, whilst the fissile mudstones fragment into myriad of pieces bounded by curved non-systematic fractures. A detailed investigation of joint orientation was not undertaken, but, from field observation, joints in the non-fissile



that there would have been no change in the orientation of the principal stress axes is not reasonable. I suggest, therefore, that such stress-field variation as did occur, did not influence the fracture pattern because of the overriding control exercised by early-formed trends. Since the earliest of the similar fracture patterns is found in the Devonian granodiorite it is possible that this controlled later failure. However, a strong similarity of orientation exists between the fracture patterns, the trends of strike and dip in the Permian to Jurassic sequence, and the trends of slaty cleavage (s_1) and *ac*-jointing in the Mathinna Beds. I consider that the strong anisotropy of steeply dipping s_1 -planes exercised the previously mentioned overriding control of fracture patterns in overlying sequences.

Comparable sets of data have been presented by Williams (1967) who concluded that (*op. cit.*, p. 251) 'faults which dislocate the Permian rocks may have been established earlier and affected the granite before Permian times, resulting in joints of a similar pattern to those in the Permian rocks but of different age.' It is possible that the early-formed anisotropy of s_1 , in association with faults paralleling and at 90° to it, has influenced the orientation of pre-Permian and post-granite(?) faults referred to by Williams (1967).

A synopsis of Williams' work together with a condensation of the ideas propounded in the foregoing sections have been presented elsewhere (Marshall, in press).

Cainozoic Structures

Re-activation of old NNW fault-lines was probably associated with the phases of basalt extrusion and expressed the instability of the period.

Post-basalt relative changes in sea level are witnessed by Tertiary deep leads lying below present sea level, and Quaternary erosional terraces in older gravels E of Bridport. Despite this, although Montgomery (1894b) recorded fault relationships between the Lisle gravels and the granodiorite, no basalt faults were recognised during the present survey.

Cooling joints are well-developed in basalt, excellent columnar structure having been noted at Weymouth (Montgomery, 1894a), whilst exfoliation structures are common in basalt, Tertiary and Cainozoic sandstone and conglomerate, and in Cainozoic ironstone horizons.

Appendix 1

ECONOMIC GEOLOGY

by A. J. Noldart

The S and W districts of the Pipers River map sheet have, at various times been subjected to intensive, although usually short-lived 'gold rushes', particularly in the Lisle, Back Creek and Den Goldfields. A significant proportion of the early Tasmanian gold was produced from these districts but the fields have been virtually abandoned for about 60 years. Gold mining activities are now

restricted to weekend prospecting and small scale mining, usually by small parties operating on small pockets of gold bearing gravels left by the early miners. No other metallic mineral is known to occur in economic concentrations in the area.

Another early mining activity was the extraction of commercial grade slate from horizons in the Mathinna Beds which crop out in the Bangor and Back Creek districts. Considerable quantities of good quality slate were apparently marketed. Limestone and 'oil shale' occurrences are recorded, but are not of commercial grade or size.

Large scale exploitation of Tertiary and other Cainozoic gravel deposits for construction purposes is the only significant activity currently in progress.

HISTORY AND PREVIOUS INVESTIGATIONS

The earliest reference to mineral occurrences in the Pipers River Quadrangle is that by Gould (1864), when he stated:—

'Gold has, indeed, been found in small quantities at many points throughout the district, and in some instances the character of the gold has been such as to indicate its source near at hand; . . . Among the places in which gold has been already obtained may be enumerated the Devil's Den, the third branch of the Piper, Nine Mile Springs, and the vicinity of the Little Forester'.

The place names mentioned refer to the present localities of The Glen, the Bangor district and Lefroy respectively whilst the Little Forester tributaries drain the Lisle-Cradle Creek-Golconda goldfields.

Thureau, referring to the Den Goldfield in 1882(a), stated—
' . . . over twenty years ago gold was found here in the alluvium, which latter averaged from 6 to 20 feet in depth.'

From the above it would appear that the discovery of gold in the area, and in particular the discovery of the Den goldfield, dates to around 1860-1861. This was some 8 or 9 years after the initial discovery at the Nook, Fingal district, in 1852. However the main fields at Back Creek and Lisle were not discovered until 1870 and 1878 respectively. Discovery of other fields such as Golconda, Lone Star, Panama and Denison would probably date about the same time as that of Lisle but no information is available on these districts.

Little is known of the history of slate quarry operations. Thureau (1882b) stated that the Back Creek slates 'have formerly been wrought very extensively' and inferred that they were still operating, but Montgomery (1894a), stated that 'no work has been done in it for many years.'

At Bangor mining leases for slate were held by a Major L. Hood before 1872 but quarry activity did not commence until 1874-1875. Operations ceased in 1888. Nothing is known of Just's quarry 2 miles to the N of Bangor but it is probable that it was being actively worked about 1872.

Gravel quarries have been worked spasmodically for many years, mainly for road repairs, but over recent years construction demands have created a major industry which operates over large areas.

At the present time mine workings are largely inaccessible or overgrown and recourse must be made to reports by earlier investigators, particularly for descriptive information on the old workings. Reports on the Back Creek field by Thureau (1882b) and Montgomery (1894a) contain the basic data used by most later investigators on this field, as do reports by Thureau (1882c) and Twelvetrees (1909) on the Lisle field; and a report by Thureau (1882a) on the Den field.

Comprehensive examinations were later carried out in the Bangor district by Twelvetrees (1918b); in the Golconda district by Reid (1926) and at Back Creek by Broadhurst (1935). There were a number of investigations by other workers on specific mines or prospects.

In the compilation of this report the writer has drawn heavily on the above reports, and descriptive passages are quoted as such to retain the original author's emphasis on specific aspects of the various fields as observed at that time. Only superficial examinations were possible during the course of the present survey.

MINERAL OCCURRENCES

I. Metallic Minerals

GOLD

Gold is the only metallic mineral known to occur in the area in economic concentrations. The main production has been from detrital deposits composed of Tertiary gravels, and a variety of reworked forms of these gravels, in association with Recent alluvials. Reef and lode mining operations were generally unsuccessful where attempted and only minor quantities of gold were won from primary sources.

PRODUCTION

Production records for the different fields are incomplete, and in some cases non-existent, due to the major proportion of the initial production from the alluvial fields being taken to New South Wales and Victoria for sale. Official records show gold production from the Lisle district generally as 88,000 oz. to 1925, with no recorded production from any of the other alluvial fields.

Estimates of the actual production from the fields have been made from several sources but not with any accuracy. Twelvetrees (1909) quotes a production of about 250,000 oz. from the Lisle Goldfield as estimated by one of its discoverers, Mr. Charles Bessel, in 1894. This estimate was based on examination of such gold buyers certificates as were available, personal knowledge of the field, and on enquiries among other mining syndicates.

Production estimated from the Back Creek field was given by Montgomery (1894a) as about 9,000 oz. and from the Cradle Creek-Tobacco Creek field by Twelvetrees (1909) as about 2,000 oz. No information is available for other alluvial fields.

SECONDARY DEPOSITS

Lisle Goldfield

The Lisle Goldfield is located near the southern limits of the Pipers River map sheet, 6 miles ENE of Lilydale railway station. Access is by road S from Nabowla [on the Scottsdale-Lilydale road] for 7 miles, or northerly from Targa [on the Launceston-Scottsdale road] for a similar distance. The E and S flanks of the basin are under soft-wood plantation development, and a few huts and foundation remains are the only indication of the once large mining community.

History

Discovered in late 1878 by the Bessell brothers, the Lisle goldfield was the focus of a rapid influx of miners, which raised the number of men on the field from about 100 in January, 1879 to some 2,500 within a few months.

By the end of 1879, mining activity had settled to a steady level with a reported yield of about 400 fine ounces per week. However, this peak was not long maintained and in July 1881 Mr. B. Shaw, Commissioner of Goldfields, reported:—

‘The yield of alluvial gold has greatly fallen off, and does not now exceed an average of eighty ounces a week. Most of the shallow deposits in the creeks have been worked out and the principal mining is on the high ground, . . . The population at the time the Census was taken was 350, of whom 185 were men. The number has since decreased.’

In July, 1882(c), Thureau described several attempts to explore for lode and vein deposits. Considerable emphasis was placed on this phase of mining at that time.

By September, 1894(b), Montgomery reported that the population was ‘only about 30 miners’ with all activity centred on alluvial deposits. All work on the alluvial deposits up to this time had been by ground sluicing with later, low pressure hydraulic sluicing.

In 1899 a Launceston company, The Lisle Dredging Company, was formed to work the Main Creek deposits on the eastern flank of the basin. A total of 1,605 fine ounces is recorded as recovered from this operation over the period 1901 to 1904.

In 1909 Twelvetrees reported:—

‘The present output as reported to the Department of Mines is from 30 to 40 ounces per month, but there is reason to believe that it is slightly in excess of this.’

At this period 13 claims or leases were being actively worked giving employment to 23 men.

Later efforts by Hobart companies to work the Main Creek deposits (New Bonanza Gold Mining Co. N.L.) and the deposits on the W flank of the basin along Bessells and Thomas Creeks (Lisle Hydraulic Gold Mines N.L.) were largely unsuccessful. The recorded production from the latter Company was 1,349 fine ounces over the period 1914 to 1918.

Over recent years activity on the field has been restricted to individuals or small parties prospecting or working small claims on a part time basis.

The Deposits

The geology of the Lisle basin is described by Marshall in the main portion of this text (p. 46). Lithological sections of the Cainozoic deposits comprise Appendix 3. Further descriptions are not necessary except where observations by previous workers contain information on areas now obscured by talus, spoil dumps or collapse of workings.

Economically the entire production from the field was won from alluvial, eluvial and 'lead' deposits along Main (Lisle) Creek on the E flank of the basin; along Bessells and Thomas Creeks on the W flank; and from the slopes and terraces above them. Gold also occurs in small quartz veins in the granite, and in the adjoining contact metamorphosed Palaeozoic sediments, but no economic concentrations have been found.

Auriferous gravels and wash have been exploited on at least three levels on and above Main Creek as evidenced in a report by Thureau (1882c):—

' . . . not less than three successive deposits of gravel occur above each other, the highest being 600 feet above the much more recent and present drift alluvial in the "Gorge" . . .

But what concerns us most is the fact of the remnants of these gravelly deposits proving *auriferous* to more or less an extent. At the entrance to Titmus' "upper tunnel," a sandy, quartziferous wash (O.N. on plan), *older pliocene*, is found, which, though limited in extent, is sufficiently developed to establish its position of having once formed a portion of a shingly beach, composed principally of rounded quartz and of hard metamorphic schists. It also contains gold, which latter circumstance is of some importance, as this deposit occurs *above* the junction or contact of the schists with the granitoid rocks lower down.

The second auriferous deposit (V.V.), *newer pliocene*, occurs some three hundred feet down the range, and it, as well as the first, now appears to skirt the contour lines of the ranges, . . . , this second auriferous deposit occurs within the decomposed syenitic granite exclusively, and rests directly upon it.'

This report by Thureau contains the only specific reference to the higher level deposits. These deposits were apparently worked out or abandoned prior to examination by later workers.

Montgomery (1894b) commented only on the lower deposits:—

'The bottom of the valley has been worked for some five or six hundred feet in width, from which it would appear that the auriferous material could not have been confined to one narrow lead but must have spread over some distance. Round the edges of the flatter ground at

the foot of the slopes of the surrounding hills, there are large terraces of alluvial material, some of which have been successfully worked.'

Twelvetrees (1909) commented only on the lower alluvial deposits as follows:—

'The ground which has been worked, and some of it re-worked, forms a belt of 500 or 600 feet in width along Main Creek, and also a belt on the western side of the valley along Bessell's Creek. The large terraces at the foot of the hills on each side of the valley have likewise been worked with great success.'

Reid (1926) in a brief general description of the field stated:—

'An area of ground 200 yards wide and 1 mile long has been worked along Lisle or Main Creek, and ground about half that extent has been worked along Bessell Creek. The richest ground formed the beds and banks of the streams, but profitable dirt was found also high up on the eastern and northern hillsides in tributary gutters of the two streams beneath a great depth of talus material. The terrace stones are angular, and waterworn only in the beds and banks of the streams.'

Present day examinations of the deposits can add nothing to the above extracts. The old workings are inaccessible due to vegetation, talus and scree creep, landslips and collapse of working faces. The lower level and terrace deposits are recognisable, although generally masked by spoil material, but the highest level deposits recorded by Thureau could not be located.

Distribution of Gold

There does not appear to be any pattern of distribution of gold within the gravels. It occurs erratically throughout, subject only to some enrichment at or near the base.

From a report prepared by Charles Bessel in 1894, on behalf of a proposed hydraulic mining company, Twelvetrees (1909) quoted extracts containing the following observations:—

'As to the probable yield per cubic yard, this is rather a difficult question to deal with, as in some places the gold is distributed through the ground from the surface to the bottom, while in others it is confined to the wash on the bottom, which varies from 1 foot to 5 or 6 feet . . . I may state that there are many indications of false bottoms existing on the terraces; in fact, Cashman and party are at present working under 2 feet of false bottom, and again, it can be seen where I am now working at the camp . . .'

Twelvetrees recorded the occurrence of gold 'in the grass, over a loose stratum of sand and stones 40 feet deep,' on the E hill slopes towards the head of Main (Lisle) Creek. From workings on Thomas Creek on the W side of the valley he recorded the following succession:—

'Below the surface is red ironstone gravel for 4 feet, resting on 4 feet of sandy silt. Below this is a stratum of stones of quartz and grey sandstone for a foot in

thickness, which rests upon 6 feet of clay and stones of slate. The whole deposit lies on granite bedrock. In each bed there is gold, but the heaviest gold is on the bottom.'

He further commented from observations in the Lockwoods Terrace workings on the W slopes above Thomas Creek:—

'The best gold, as usual, was found at the bottom; still, a little was obtained all through the deposit.'

From the New Bonanza Gold Mining Company's workings on the E terrace towards the N (Gorge) end of the basin Reid (1926) recorded:—'2 to 4 feet of gold-bearing wash overlain by 15 to 20 feet of barren sandstone talus and yellowish-red soil,' but from workings only a few hundred feet to the S on the same slopes he reported that a little gold was found 'in the talus here where quartz is prominent.'

Gravel or 'wash' was not a prerequisite for gold accumulations. At Donnelly's Creek and terrace workings the following sections were observed by Twelvetrees:—

'The top part of the terrace for 10 or 11 feet consists of clay and angular stones of reddish sandstone, highly micaceous and ferruginous . . . This rubble bed passes downward at one part of the face into a bottom layer of yellowish drift sand and clay 4 feet thick. This layer contains some rounded pebbles and yielded the heaviest gold. At the same time prospects were obtained from the upper beds, and nearer the road gold was won from all through the deposit, which there consisted nearly entirely of surface clay with scarcely any stone.'

In general the terrace and higher level deposits appear to have carried some gold throughout the entire thickness, although not always in payable quantities, whilst the deposits on the valley floor are more typically 'wash' or 'placer' deposits with the concentration of gold in the lower sections.

As suggested by Marshall (p. 46) the lake concept of Reid (1926) could feasibly explain the successive auriferous gravel horizons. Contraction of the lake surface with attendant superposed drainage on the unconsolidated lake sediments would result in a continuous erosion of these sediments and the recycling, probably several times, of the gold content. This would result in rich concentrations in the basal wash of the present valley floor.

Source of the Gold

There is little doubt that the origin of the gold in the district is closely related to the intrusion of the Devonian granites, but the source of the gold exploited from detrital and alluvial concentrations is not clear.

Thureau (1882c) considered that it was derived from the contact metamorphosed sediments adjacent to the granite. From observations of gold bearing gravels above the granite-sediment contact near the Gorge and from other observations such as the following, he stated:—

'On examination, and from facts gathered at Lisle, miners have traced the gold up the slopes of the Bessell's Rivulet, and I was assured that approaching a certain line

of altitude, coarser gold had occasionally been found than in any of the lower alluvium . . . Bearing in mind that the whole of the granitoid formations are traversed by attenuated quartz veins charged with very fine gold, it may be inferred that if any vein matrices with coarse gold—of whatever form the former may assume—exist, the probability is that they occur at or near the points of contact of the granitoid with the metamorphic or other schists on the Lisle divide, and in the eastern foothills of Mount Arthur.'

Montgomery (1894b) reported:—

'A set of gold-bearing veins have been discovered in the granite bedrock which may turn out to be of some importance. There are five or six of these veins lying close together, and forming a belt three to five feet wide which contains gold. The veins consist of $\frac{1}{4}$ to $1\frac{1}{2}$ inches in thickness of quartz, quartz and kaolin, and quartz and oxides of iron and manganese, running very straight over considerable distances . . . All along the course of the set of veins where they have been exposed a little gold can be got by crushing them. The soft granite in which they lie yields a little gold, but the principal value seems to be in the veins themselves which require crushing.'

However no mention was made of the higher level deposits nor of any other possible origin for the gold.

Twelvetrees (1909) with respect to the deposits on the eastern side of the basin, considered that the bulk of the gold was shed from the altered sediments and stated:—

'There may possibly be a few gold-bearing veins in the surrounding hills, but any gold which they may have contributed must have been inconsiderable in amount, and they may be neglected in this enquiry . . . An important clue to the solution of the problem is furnished by the discovery of visible gold in the dark metamorphic sandstone frequently referred to in this report. One of the rock specimens which I brought home showed distinct specks of gold free from gold (*sic*) or pyrite. Unfortunately, I have not been able to observe this in any other specimens, though I have broken hundreds of stones. However the fact that gold is present in the sandstone is undoubted, and is sufficient to outweigh innumerable negative results.

The suggestion which I advance is that the bulk of the Lisle alluvial gold has been derived from the wasting away of the impregnated stratified rock near its contact with the granite.'

Reid (1926) pointed out that under normal conditions of disintegration, considerable quantities of gold could reasonably be expected to have been carried through the Gorge and deposited along the river flats below the Gorge, whereas prospecting in these areas had been largely fruitless. His conclusion was 'that almost

all the gold won from detrital and alluvial deposits is of secondary origin', and further considered that the source was from quartz veins in the sandstone. He summarised the evidence as follows:—

'Generally both metamorphosed sandstone and vein quartz are barren, but some pieces of quartz contain a little gold, and occasional specks are found in the sandstone. The fact that gold is found in association with quartz and altered sandstone suggests the idea that it originated in quartz-veins contained in sandstone. Moreover, the coarsest gold is found high in the hillsides, near the edge of the granite mass and not in that rock.

The following is a summary of the evidence:—

1. All the gold at Lisle has been won from alluvial, detrital, and chemical deposits.
2. The free gold is almost pure; that locked up in quartz contains a high proportion of silver.
3. Except that found in creek beds, the surface of the gold is rough.
4. The gold is generally of fine to medium grain, pennyweight nuggets being rare.
5. Gold-quartz specimens are conspicuously rare.
6. Gold is everywhere found in association with quartz.
7. The quartz, except one or two veins in granite, is barren, or almost barren.
8. Sulphidic ore minerals, such as arsenopyrite and chalcopyrite, commonly associated with gold at Panama, Golconda, Denison, and Lebrina, are not known at Lisle.
9. Gold is found associated with vegetable matter and charcoal underneath talus material all the way up the hillside on the east side of Lisle Creek.
10. Very little gold is found in the talus material.
11. Gold is found on the east and north sides only of Lisle basin where metamorphism has been most intense.
12. Almost all the gold has been derived from veins in the contact rocks.
13. The granite, even along the more acidic fringe where it has been affected by the agents of metamorphism, is barren, or almost barren.
14. That section only from the outlet of the gorge to a point $1\frac{1}{2}$ mile upstream is known to contain gold in profitable proportion.
15. Very little gold is found in the beds of creeks outside the basin.

With regard to item 7, it is interesting to note that very little gold is found in the talus material, but a comparatively great quantity is found underneath it associated

with organic matter, such as decomposed vegetation and charcoal. The fact opens the way to another line of research worthy of further pursuit: that is, deposition from gold-bearing solutions.'

From the available literature most of the gold in the Lisle valley appears to have been derived from sources at or near the granite/sediment contact. However the actual locations or forms of such gold deposits are not known. Gold was found in, or adhering to, quartz fragments, particularly towards the headwaters of tributaries of Main (Lisle) Creek. This type of occurrence was more frequent than was suggested by Reid. Gold also occurs as disseminations in the metamorphosed sediments, probably erratically distributed and confined to wall rock adjacent to gold bearing quartz reefs.

Emphasis has been placed on the consistent association of quartz rubble with gold, particularly in areas of richer concentrations, and earlier workers regarded this as an indication of derivation of the gold from the breakdown of quartz reefs. Emphasis has also been placed on the high degree of purity of the gold in the free state compared to the appreciable percentages of silver contained in gold found adhering to quartz.

Reid's suggestion of the progressive leaching of gold from quartz reefs followed by redeposition is feasible. It would explain most of the phenomena associated these deposits such as: the relative purities of gold; the gold distribution related to grain size; the occurrence of barren quartz rubble with suspected gossanous structure; the association of angular gold with organic matter; the lack of associated sulphides; and the lack of gold in quartz reefs exposed in higher level workings.

On the other hand, the gold-in-sediments theory of Twelvetrees (1909) does not appear feasible. Where the sediments were demonstrably gold bearing they were variously reported as 'hard', 'baked', 'silicified', etc. Rocks of this nature are not readily susceptible to penetration by solutions or other agencies unless impregnation occurred before metamorphism while the sediments had a more open grained texture. Examination of the talus shed from these metamorphosed rocks indicates that mechanical breakdown predominates with minor chemical breakdown occurring on joint faces. No gossanous structures have been recorded in the talus from these rocks.

If these rocks were the host for most of the gold found in the Lisle basin then it would be expected that gold-in-sediment specimens would be prevalent throughout the deposits. However such specimens are rare and were probably derived from breakdown of wall rock which has been contaminated by intruded gold bearing quartz veins.

Future of the Field

It is not possible to make any estimate of the size, grade or number of auriferous bodies occurring in the contact zone. Some indication of their location may be gained from a detailed study of the distribution of gold in the terrace deposits, and of the sub-talus drainage patterns, if secondary deposition from solutions, or

of colloidal gold from downward moving groundwaters, is assumed. This would only indicate a general area. Investigation and follow-up prospecting along these lines would be expensive and highly speculative and can not be recommended.

Removal of the talus overburden by hydraulic sluicing, bulldozing, or any other mechanical means is not considered practicable unless carried out as an adjunct to mining of auriferous pockets. Considerable expenditure would be required to locate and define any such pockets.

The valley is not suitable for dredging operations due to foreign material such as timber in old workings, inconsistency of gravel thickness, and lack of water.

Gold is still being obtained in small amounts in the N portion of the valley but it is unlikely that any large unworked pockets remain. Should water supplies be available the sluicing of terrace remnants, or the working of valley bottom deposits with a gravel pump or similar method, by small syndicates should prove feasible.

Lone Star Goldfield

The Lone Star Goldfield is located on the upper reaches of Lone Star Creek, 3 miles S of Golconda and 2 miles NW of Lisle. The goldfield is a small replica of the Lisle basin. A small valley underlain by granite and surrounded by high ridges of metamorphosed sedimentary rocks has been filled to varying depths by Cainozoic gravels, auriferous in part. These are in turn overlain by scree and talus material from the surrounding hills.

Information on the deposits is scanty and there is no record of production from the area. Reid (1926) very briefly described the area and commented:—

‘Some of the claims were highly productive, some were poor . . .

The wash-dirt consists largely of water-worn quartz and friable white sandstone and rests on soft decomposed granite. A shaft . . . did not reach the bottom rock at 50 feet.

Here the gold is much coarser than the generality of that at Lisle . . . It is interesting to note that the gold is closely associated with white sandstone which is suggestive of its origin from beds of that rock, . . .’

There is no record of any occurrence of, or any attempts to mine, lode or other primary gold deposits in the Lone Star basin.

Examination of the old workings indicated that the gold bearing gravels were restricted to a narrow zone along Lone Star Creek and mainly confined to the eastern banks. Recent cultivation, etc., has, however masked the outline of much of the worked area and the full extent of the workings cannot be determined.

Tobacco Creek-Cradle Creek

Alluvial gold was discovered by Mr C. Bessell in Tobacco Creek, 2 miles N of the Lisle basin in 1877 about 18 months prior to the discovery of the Lisle deposits. Subsequent production from Tobacco and Cradle Creeks is reported by Twelvetrees (1909) to have been 'about 2000 oz.'

The deposits consist of 6 to 18 inches of gold bearing gravels resting on members of the Mathinna Beds and overlain by up to 10 feet of clay and soil. The following description was given by Twelvetrees (1909):—

'The stones of slate in the wash are angular, and the gold is not water worn. When pieces of any size are found the gold is usually attached to quartz. The run of gold extends for nearly 20 chains, and has been worked up to the brow of the hill . . . The gold in this creek is coarser than at Lisle, and nuggets up to 15 dwts. have been found. The ground has been worked over three or four times, the workings widening each time.'

He further stated that at the top of the hill dividing the two creeks, 'some quartz veins have been found, one of which carried gold' indicating the source of at least portion of the gold.

These workings are now completely overgrown and cannot be properly examined but recent prospecting operations in Tobacco Creek tend to confirm these findings. There would be little prospect of large scale mining operations.

The Den (The Glen)

The old Den goldfield, since renamed The Glen, is located approximately six miles NNE from Mt. Direction. The field is small, information on the area is very sketchy, and doubt arises as to the actual location of the early workings. Thureau (1882a) recorded the presence of gold bearing wash averaging from 6 to 20 feet in depth which extended for about 1 mile along Fourteen Mile Creek. It is probable that these deposits were actually on the section of Den Creek which drains the western foothills of the Den Range about 1½ miles NW of The Glen. Den Creek is a W flowing tributary of Fourteen Mile Creek.

Twelvetrees (1902) described the old Den workings as a 'flat of four or five acres in extent' at the S end of a spur of the Den Range, ½ mile N of The Glen, and stated that 'This field must not be confused with the new Den further to the north on the west side of the same range'. The latter ('new Den') was probably the deposit described by Thureau.

No production figures are available but the gold bearing areas were of limited extent and large production could not be expected. The field was probably in full activity about 1867. The gold was coarse in grain size with occasional gold/quartz specimens. Prospecting along the hill slopes above the creeks and flats resulted in the discovery of some small, low grade auriferous quartz reefs of no economic value.

Back Creek Goldfield

Discovered in about 1870, the Back Creek goldfield is located in the NW section of the Pipers River map sheet, $3\frac{1}{2}$ miles S of Lulworth (on Tam O'Shanter Bay) and 6 miles NE of Lefroy.

A comprehensive description of the composition of the gold-bearing gravels and their relationship to basalt flows in the area is given by Marshall (this publication, pp. 31-42, figs. 5, 6) and need not be repeated. A further report by Marshall, 1969, considers in detail the origin of the leads; their possible extensions; and their relationship to the basalts.

Four main 'leads' were worked for an estimated production of 9,000-10,000 oz. of gold. The bulk of production was in the period 1870-1872. Broadhurst (1935) reported that in 1871 400 oz. of gold were produced, but in 1872 the amount had fallen to 25 oz. Production subsequent to 1872 was included with Lefroy returns. The gold was reported by Broadhurst (1935) to be very pure with a grade of about 980 fine.

White Lead

This, the most northerly of the leads, was worked from a succession of shafts throughout the upper reaches with a small amount of sluicing towards the lower end. The gold bearing wash was reported by Montgomery (1894a) to be composed largely of angular quartz. The contained gold was also angular and often attached to quartz fragments suggesting a nearby source.

The trend of the lead is SE in the upper reaches but swings sharply to the E in the lower section.

Red Lead (Albion Lead)

Situated approximately 16 chains SW of the White Lead this lead is the longest in the area and averages 2 to 3 chains in width over a length of approximately 80 chains. It is parallel in trend to the White Lead and also has a pronounced swing to the E over the lower few chains. Gold and wash occurrences are similar in all respects to those of the White Lead.

Both these leads occur in the N flanks of low ridges, and both have been cut by recent drainage systems which has resulted in minor redistribution of material from the leads.

Blackman's Lead (Old or Back Creek Lead)

Located a few chains to the SW of the White Lead, Blackman's Lead is only about 30 chains long, but is broader and deeper than the previous two leads. It differs from the White and Red Leads in that the gold bearing wash consists of from 3 to 7 feet of heavily water worn pebbles and boulders of quartz, slate and sandstone. The contained gold is also markedly water worn. The trend of the lead is to the SSE and transgresses a recent drainage valley and two ridges. It deepens rapidly to the S.

Cardigan Lead (Prince of Wales Lead)

This is the smallest of the main leads, being less than ten chains long. It trends SE where it joins Blackman's Lead. The lead is

comparatively shallow until close to its junction with Blackman's Lead where it rapidly deepens. The gold was reported as 'very shotty and rounded' and occurred in a water worn wash composed largely of rounded sandstone boulders usually cemented with iron oxides. This lead carried only small concentrations of gold and was not worked to any extent.

Source and Deposition of Gold

As in the Lisle Goldfield the source of the gold contained in the lead channels can not be determined. Unfortunately there is no information available on the purity of the gold in gold/quartz specimens in the White and Red Leads compared to other detrital gold in these leads. Rich, small, gold bearing quartz reefs occur in the vicinity of the upper reaches of these two leads and it is possible that some of the angular gold in these leads is of secondary origin.

The shotty water worn gold occurring in the Blackman's and Cardigan Leads cannot be explained in this way however, unless some secondary deposits have been reworked by later stream action. This premise would require different ages of deposition of the two sets of leads. The relationship of each of the leads to the basalt (Marshall, in press) indicates that this is not feasible and some other explanation must be found to account for the marked difference in the angularity of both the wash and the gold between the N and S lead systems.

The distribution of the gold was similar in all leads. It was concentrated in the lower horizons of wash overlying bedrock except where the leads deepened to pass under basalt cover. At this point gold was found in two distinct wash horizons. One horizon of gold bearing wash was found to follow the steepening floors of the leads, however, the gold content in this horizon was reported to be comparatively low. A second, younger, gold bearing wash carrying good values occurred on a 'false bottom' representing the top of an older channel fill. All deposits above this 'false bottom' would be of the same age as the material contained in the leads up channel from the basalt.

It is probable that the sharp gradient of the channel floor below the 'false bottom' would preclude the concentration of payable gold deposits in the deeper sections.

Other Detrital Deposits

Small auriferous alluvial/detrital deposits have also been worked in the North Bangor district, in the Panama goldfield and at the Major (Leura) mine at Back Creek. Traces of gold have been recorded from other tributaries of the Pipers and Forester-Denison River systems but economic concentrations have not been found.

PRIMARY DEPOSITS

Auriferous quartz veins occur in several localities in the Pipers River Quadrangle. However few occurrences have any economic significance and recorded gold production from these sources totals only about 260 ozs.

*Back Creek District**Major (Leura) Mine*

A detailed description of these workings is given by Montgomery (1894a) with a surface plan of the workings. A production of 42 tons of ore yielding 85 ozs. 9 dwts. of gold was reported. The grade of gold was reported as very high, and as the gold was sold for similar prices to that recovered from the Back Creek Lead systems, a grade of about 980 fine is implied. The main quartz reef has been traced over a length of approximately 1,200 feet and prospected by a series of shafts to depths varying from 12 to 100 feet. The reef strikes ENE-WSW with a general steep dip to the N. A second quartz reef (South reef) striking E-W occurs to the S of the main reef and appears to merge with the main reef towards its W end.

Mineralization was reported as sporadic throughout varying from a trace to several ounces per ton. Vein widths are variable from a few inches to 2½ feet.

Sir John Franklin and Union Mines

These mines are located at the head of the drainage channel flanking the Red Lead and at the head of the White Lead drainage channel respectively. Mineralization is in the form of gold associated with groups of small quartz veins from ½ to 3 inches in width irregularly traversing a white sandstone host rock. Values were reported to be variable up to 15 dwts. per ton over a gold bearing zone also variable up to 15 feet in width. In general the quartz/sandstone admixture contains less than 6 dwts. gold per ton.

Other Mines

The Lady Emily, All Nations and Moonlight mines located above the head of Blackman's Lead are reported to have the same type of mineralization as occurs in the Union and Sir John Franklin mines. All were small and no economic gold values were found.

The Never Mind mine located across the gully from the Sir John Franklin, and the Hidden Treasure mine, located on the southern flank of the Red Lead, were reported to be on quartz reefs carrying a little gold but no payable values were found.

Lefroy Goldfield

Only the Welcome, Monkland and the eastern portion of the Volunteer reefs occur within the limits of the Pipers River map sheet. The geology and mine descriptions of the Lefroy Goldfield are given by Broadhurst (1935), Groves (1965) and Montgomery (1897).

Den Hill Goldfield

A succession of exploratory adits into the southern spur of the Den Range intersected several narrow quartz veins. Gold mineralization was sparse. No payable values were found.

Bangor District

Prospecting trenches and minor underground exploration in the North Bangor area indicated the presence of small irregular gold bearing quartz veins traversing the country rock. Pyrite and graphite occurred as gangue. Gold grades were low, and assays showed the silver content to be considerably in excess of gold. No payable ore bodies were found.

Denison Goldfield

A number of small mines were operating on this field about 1880. The workings were on a series of parallel ENE-WSW trending quartz reefs, located $1\frac{1}{2}$ miles N of Golconda. Reid (1926) commented:—

'Many factors contributed to the failure of the companies, the chief of which were: narrow veins; short productive sections; irregular distribution of gold; and interruption of veins by faults.'

The deepest workings on the field were on the Wiangata reef where a 3 inch vein was followed to a depth of 260 feet. Reid stated:—

'Gold was extracted from several lots in the proportion of 2 oz. 4 dwts. per ton, and was almost pure.'

In the Alacrity mine a quartz vein 12 to 18 inches wide was followed to a depth of 200 feet. Values of 1 oz. per ton were reported from sections of this vein.

In other mines such as the Sir William Denison, Star, Brooklyn and Globe, gold values were reported to vary from 5 to 15 dwts. per ton. Vein widths varied from 6 to 18 inches. Gold distribution, however was apparently extremely patchy and the average values were too low for profitable mining operations. Pyrite, arsenopyrite and galena occurred as accessory minerals.

Lebrina Mine

Located $\frac{1}{2}$ mile NW of Wyena, this mine was operating over the period 1909-1916. The quartz vein worked was one of a series in a mineralized zone trending ENE. Production figures are quoted by Reid (1926) as—'200 tons of ore were treated and 40 oz. only of gold was obtained.' The quartz vein varied from 6 to 24 inches in width and has been proven over a length of 600 feet by underground exploration, and to a depth of 100 feet. Values were erratic and the overall grade was too low for profitable mining operations. Pyrite and arsenopyrite were commonly present as gangue minerals.

Panama Goldfield

The Panama area is located $1\frac{1}{2}$ miles SW of Golconda. There is no information available on the area covering the period of active mining. Reid (1926) recorded the occurrence of detrital gold bearing quartz and stated:—

'The rich pieces of ore came from a vein in the soft granite floor of the basin upon which they lay, . . . Neither this vein nor any of the others opened in the

many long adits and shafts is of economic importance, . . . One or two of these narrow veins, however, are sufficiently rich to allow profitable operation on a very small scale.'

Reid also recorded the presence of gold bearing quartz reefs at the granite-sediment contact and in the adjoining metamorphosed sediments. Arsenopyrite, pyrite, galena, sphalerite and chalcopyrite were reported as accessory minerals.

Golconda Goldfield

Located 1 mile S of Golconda the Golden Crest and Enterprise mines were worked sporadically from about 1890 to 1918.

The Golden Crest workings were on a gold bearing quartz reef in granite close to the N margin of the granite. Mineralization was reported by Reid (1926) to be predominantly in cracks and fractures in the quartz vein with only minor occurrences in the more massive quartz. Accessory minerals were arsenopyrite, pyrite and chalcopyrite in that order of abundance.

The gold was unevenly distributed throughout the reef with occasional bunches of very rich ore occurring as short narrow shoots. The overall average grade was too low for economic mining. The vein varied from 6 to 24 inches in width and unavoidable wall rock dilution during mining further lowered mill head ore grades.

In the Enterprise mine a number of 6 inch quartz veins occurred but the ore shoots were small and irregular. The average gold content of the veins was reported to be about 6 dwts. per ton.

Bessell's Reward Mine

Note:—This mine is incorrectly located on the Pipers River geological map sheet. Its true location is 4/10 miles due S of the position shown. It lies on the divide between the headwaters of Cradle and Tobacco Creeks.

Reid (1926) distinguished between 'Bedded Deposits' and 'Quartz Veins' in his discussion of primary gold occurrences in this locality. Describing the 'Bedded Deposits' he stated:—

'These consist of narrow beds of sandstone intercalated with wider beds of purple, grey, and bluish-black slates. The strike is N 50° to 60° W and the dip at high angles to the north-east. They vary in thickness from 1 to 6 feet, and are uniform both along the strike and dip. Where opened on this property the seams are at every point gold-bearing, but the content varies considerably. A number of samples taken from the several seams of sandstone exposed in the trenches yielded gold in the proportion of 2 dwts. 3 gr. per ton (average of 10 samples), and two in the proportions of 9 and 11 dwt. per ton.'

He then described the quartz veins:—

'Narrow, persistent veins of quartz (1 to 4 inches) form crosscourses to the gold-bearing sandstones, trending north 45° to 65° east and dipping north-west. The quartz

is commonly of the milk-white variety, mineralized in parts, and, as a rule, almost barren. A few rich specimens have been found.

Further descriptions of individual prospects and pits indicate that where these sandstones were tested and found to be gold-bearing, there was usually close association with quartz veining.

It is probable that the gold was introduced into the sandstone by media of these veinlets, and that the sandstones are not gold-bearing throughout. The gold content of the sandstone is low and erratic in distribution and no economic concentrations were found.

COPPER

Thureau (1882b) recorded the presence of native copper in the Sir John Franklin mine adit, and in clay at the head of the Red (Albion) lead at Back Creek, and of copper sulphides and carbonates in the old slate quarry tunnel nearby.

Chalcopyrite is a common accessory mineral in gold/quartz veins throughout the area.

LEAD

Occurs only as an accessory mineral in gold/quartz veins.

MOLYBDENUM

Molybdenite is recorded occurring as small flakes in joint planes in granitic rocks on the S end of the Lisle basin; in quartz tourmaline veins with 'much molybdenite' traversing granite near the Enterprise mine, Golconda Goldfield; and as scattered flakes on joint faces in the granite of the West Scottsdale-Blumont district.

TIN

A little tin is recorded in association with molybdenite in the granite of the Lisle basin. Traces of tin occur in beach sand deposits E of Pipers Head.

TITANIUM

Ilmenite occurs in thin beach sand deposits between high and low water mark on the foreshore of Noland Bay E of Pipers Head. Reserves are small and of no economic significance.

II. Non Metallic Minerals

GRAPHITE

Graphite is recorded as a gangue mineral in gold/quartz veins in the North Bangor district. The occurrence has no economic significance.

LIMESTONE

Permian limestone crops out on a hillside immediately E of the Pipers River bridge on the Karoola-Bangor road. The limestone has a thickness of 3 feet and is overlain by 30 feet of sandstone. It has no economic potential.

An impure deposit of secondary limestone occurs as a superficial cover at the Third River, 1½ miles E of Bangor. Small quantities of burnt or ground lime may be obtainable from this deposit.

PHOSPHATE

Wavellite (hydrated phosphate of aluminium) occurs in slate at Back Creek, and along the Den Range. It was first recorded about 1876 from the Back Creek slate quarries. The mineral occurs in a radiate form on joint faces in the slate.

Recent prospecting on the Den Range has shown that wavellite occurs on joint planes in massive slates, and as part of the matrix in brecciated zones in the slates. The mineralised zone extends for about 2 miles along the top of the Den Range. The zone averages about 100 feet in width. The prospecting exposed a decomposed igneous intrusive rock thought to be a lamprophyre which contains accessory apatite. There is evidence of partial mobilisation of the apatite and this may be the source of the secondary wavellite.

Variscite (hydrous phosphate of aluminium) was recorded from Back Creek prior to 1910, but the occurrence has not been substantiated. Turquoise (hydrous phosphate of aluminium and copper) has recently been identified in association with wavellite in the Back Creek slate quarries (L. Sutherland, pers. comm.) and it is likely that the original variscite identification was incorrect.

III. Fuel Minerals

A dense, black, carbonaceous shale crops out near the summit of the hill on the E bank of Pipers River, about midway between Bangor and Karoola. The shale horizon is very thin and consists of narrow shale layers interbedded with clay. Laboratory tests gave a yield of 15-20 gallons of crude oil per ton.

IV. Construction Materials

SANDSTONE (FREESTONE)

Sandstone of both Permian and Triassic age outcrops in the SW portion of the area. Both types are suitable for building or ornamental purposes. Supplies are plentiful.

SLATE

Good quality slate has been quarried in the Back Creek and Bangor districts.

The Bangor deposit was worked from 1872 to 1888. Production was mainly from underground workings which are no longer accessible.

The Back Creek production was mainly from open cut mining with subsidiary production from underground workings. The quarries were in operation at about the same time as those at Bangor.

The slate from both districts was reported to be of good grade and quality, except where shearing and quartz veining resulted in hardening and/or contortion of the slate.

GRAVEL AND SAND

Gravel deposits suitable for most construction purposes are prevalent in the N and NW of the area. Extensive areas have been worked and production is increasing.

Sand deposits occur in the Weymouth-Lulworth area and from Weymouth to Bridport, but as yet have not been extensively exploited.

V. Gemstones

A few small sapphires and rubies have been found in the auriferous gravels of the Lisle goldfield.

Pleonaste, a variety of spinel, also occurs in the gravels of the Lisle basin. Some fairly large specimens have been found.

Turquoise is found in the slate quarries at Back Creek. Small quantities are being mined and sold as gemstones.

Some australites (obsidianites) have been found in the gravels in the Lisle basin. They are composed of acid or sub-acid volcanic glass and have been found in circular button, dumb-bell and beetle shapes.

Appendix 2

TERTIARY PLANT FOSSILS FROM PIPERS RIVER QUADRANGLE

by C. M. Barton

Introduction

Three poorly preserved dicotyledonous leaves or leaflets, from a locality (4985.5E/9353N) N of Pipers River, are briefly described.

Plant remains occur as imprints on a coarse-grained, well-cemented 'volcanic' sandstone which is closely associated with the Tertiary basaltic rocks of Pipers River area. B. Marshall is the collector.

Descriptions and Comparisons

1. SPECIMEN 1

This is an entire margined, ovate-lanceolate leaf or leaflet with a round-cuneate base; the apical parts and the petiole are not preserved. The maximum width is 1.5 cm. and the preserved length is 5.5 cm. (fig. 42).



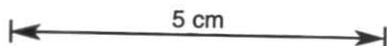
FIGURE 42



FIGURE 43

Thin, closely spaced, opposite to alternate secondary veins diverge from the prominent slightly curved midrib at initial angles of approximately 65° . Secondary veins curve upwards towards the margin and bifurcate; the proximal branch is confluent with the distal branch of the superjacent secondary vein and forms a closed marginal loop. Thin upwardly directed lateral veins occasionally branch from the outer side of the marginal loops and extend to near the leaf margin where they become obscure. Tertiary venation is in the form of a loose acutely branching network arranged at approximately right angles to the course of the secondary veins; one, initially reflexed, tertiary vein curves upwards across this line to join with the marginal secondary vein loops.

Although this 'leaf' is, in its visible features, similar to the New South Wales fossil described by Baron C. von Ettingshausen as *Quercus wilkinsoni* Ett. (Ettingshausen, 1888, pl. IX, fig. 16) it is too fragmentary and too poorly preserved to enable any identifications to be effected. There is, moreover, no sound evidence for correlation of this Tasmanian 'leaf' with the genus *Quercus*.



2. SPECIMENS 2 AND 3

These leaves or leaflets are very poorly preserved. Sp. 2 (fig. 43a) is 4.4 cm. and Sp. 3 (fig. 43b) is 1.4 cm. in preserved length. They have stout prominent midribs with prominent, upwardly directed, sub-parallel secondary veins which diverge from the midrib at angles of approximately 35°.

The fossils are far too fragmentary to identify; they do however, have a main venation similar to that of many Tertiary *Nothofagus* leaves.

Appendix 3

SECTIONS THROUGH CAINOZOIC DEPOSITS IN THE LISLE-GOLCONDA DISTRICT

by B. Marshall

(compiled from work by Naqvi and Marshall)

A. THE TOBACCO AND CRADLE CREEKS AREA. 5216E/9259N

	<i>ft. in.</i>
1. Humous Layer	0 3
2. Silty clay with mica flakes, quartz granules, and rare pebbles of vein quartz and quartzite	2 6
3. Vein quartz and quartzite pebble horizon	0 2
4. Silty clay as in 2	0 3
5. Vein quartz and quartzite pebble horizon	0 4
6. Silt and sand with some clay, occasional mica flakes, and rare quartz granules	3 0
7. Purplish-grey humic clay with root capillaries	0 10
8. As in 6	1 0
9. Rounded quartz and quartzite pebble gravel with interstitial clay; this horizon is auriferous	0 8
Mathinna Beds.	
Units 1-8 form the composite soil profile.	

B. THE LISLE BASIN. 5211.5E/9217.5N

	<i>ft. in.</i>
1. Humic soil layer	1 6
2. Sand and silt with quartz granules small pebble trains and abundant mica	3 0
3. Purplish brown, humic, silty clay with root capillaries and no mica	0 9
4. Sandy clay with quartz granules and mica	1 3
5. Humic layer as in 3	1 0
6. Pale grey clay (Kaolinitic?) with quartz granules and some mica	2 0
7. 2"-6" well rounded gravel with pale grey clay matrix. Pebbles are mainly Mathinna quartzite and vein quartz, tend to increase in size downward, and are imbricated. The unit is auriferous	3+
Units 1-6 composite soil profile.	

C. LISLE GOLD MINE OPEN-CUT. 5199.5E/9221.5N

	<i>ft. in.</i>
1. Humic soil with angular Mathinna pieces up to 3" long	1 6
2. Clayey soil with angular Mathinna pieces up to 6" long; a talus deposit	3 0
3. Sandy clay with occasional Mathinna pieces up to 4" long	0 10
4. Silty clay with abundant sub-angular to well-rounded pebbles of Mathinna	0 10
5. Brown sand with some interstitial clay, and sparse pieces of vein quartz	2 0
6. Red-brown clay	0 2
7. Light brown sand, increasing in clay content towards the base, with sporadic vein quartz fragments	1 3
8. Pebbles increasing in size downward to large cobbles, in a sandy clay matrix; an auriferous gravel	5+

D. LISLE GOLD MINE. 5199E/9219N

	<i>ft. in.</i>
1. Humic soil	0 3
2. Sandstone bed (fine-medium grained) with 1" thick limonite horizon. Weak joints are present at 90° to bedding	2 0
3. Angular to rounded Mathinna pieces up to 6" in size in a sandy clay matrix; Mathinna Beds talus	10 0
4. Fine sand with mica flakes and sporadic sub-rounded vein quartz pebbles	1 6
5. Abundant sub-angular to rounded pebbles ($\frac{1}{2}$ "-2" in size) in a sand and clay matrix. This unit was possibly auriferous	2 6

Devonian granodiorite.

E. NEW BONANZA MINE CREEK. 5212E/9221N

	<i>ft. in.</i>
1. Humic soil with Mathinna and vein quartz fragments	3 0
2. Mathinna Beds talus: angular to rounded pieces up to 18" in length of the Mathinna sandstone and some vein quartz, embedded in a silty clay soil	35 0 (ap.)
3. Sandy clay lenses with some mica	1 10
4. Sub-angular to rounded pebbles (up to 2") of predominant vein quartz and Mathinna sandstone in a sandy matrix; probably auriferous	2+

Probable Devonian granodiorite.

Additional data on the Lise Cainozoic deposits may be found in Reid (1926).

Appendix 4

PETROGRAPHICAL DESCRIPTIONS OF TERTIARY VOLCANIC ROCKS FROM PIPERS RIVER AREA

by C. M. Barton

Introduction

Five Basalts, from three localities near Lebrina, are described.

Rock specimens have Serial Nos. 64/295, 64/296, 64/297, 64/298, 64/299 and 64/300. Specimens 64/295, 64/298 and 64/299 are taken from basalt which caps the hills NE of Lebrina. Specimens 64/296 and 64/300 are taken from near the valley floors, W of Pipers Brook road junction and SE of Lebrina respectively.

Descriptions

1. Sp. No. 64/295, 5120.3E/9296.6N

A hemicrystalline olivine-basalt, or possibly basanite, composed of olivine and augite phenocrysts set in a fine-grained groundmass of augite, olivine, feldspar, feldspathic material and iron ore. Optically positive euhedral-subhedral olivine phenocrysts, up to 3.0 mm. in length, are abundant; iddingsite and serpentine occur in cracks and zones peripheral to the crystal margins. The scattered, generally subhedral clear augite phenocrysts ($c:\gamma = -53^\circ$) are frequently encircled by iron-rich titanite rims. The groundmass is made up of crystallites, microlites and small granules of augite, olivine, feldspar, feldspathic material and iron ore, together with a little interstitial pale-green glass. Small amygdales are scattered throughout the groundmass; they have centres of zeolite (?chabazite) which is surrounded, in turn, by a zone of radially directed acicular microlites, a chlorite-rich layer and an outer zone of colloform-spherulitic glassy material.

2. Sp. No. 64/296, 5135E/9296N

An olivine-basalt which consists of olivine phenocrysts set in a groundmass of feldspar laths and augite, olivine and ilmenite crystals or granules. Olivine phenocrysts are usually subhedral, 1.0 to 2.0 mm. in length and are, in many cases, optically negative. They tend to occur in monomineralic clusters. Serpentine is present along cracks and around the periphery of the crystals. The groundmass has an intersertal texture and is made up of feldspar laths with an approximate composition of $Ab_{30}An_{70}$, subhedral augite crystals and granules, scattered irregular tabular and skeleton ilmenite crystals and pale-green glass. Some of the olivine occurs as microphenocrysts while the augite is colourless, $c:\gamma = -51^\circ$ with an ophitic-subophitic relationship to the feldspar laths. In the weathered parts of the rock, glass is replaced by brown microvesicular palagonite.

3. SP. NOS. 64/298 AND 64/299, 5131.2E/9288.6N

These specimens are petrographically analogous. The rock is an olivine-basalt, or possibly basanite, composed of euhedral-subhedral olivine phenocrysts set in an extremely fine-grained groundmass of feldspar and pyroxene microlites, crystallites, indeterminate felsitic material and abundant granules of magnetite. Olivine phenocrysts are usually between 0.7 mm. and 1.0 mm. in length, optically positive and partially replaced by iddingsite and serpentine. Magnetite-rich rims encircle many olivine phenocrysts and irregular patches within the groundmass are packed with subhedral crystals and granules of olivine.

4. SP. NO. 64/300, 5121E/9271.8N

An olivine-basalt composed of olivine and augite phenocrysts which are set in an intergranular-intersertal groundmass of feldspar laths, with an approximate composition of $Ab_{35}An_{65}$, augite granules and iron ore. The euhedral-subhedral olivine phenocrysts are up to 2 mm. in length (?Fe rich) and are partially altered by serpentine and iddingsite. Some crystals are deeply embayed by the material of the groundmass while others are completely pseudomorphed by iddingsite. Clear augite occurs as well-shaped phenocrysts, $c:\gamma = -50^\circ$, and as monomineralic clusters in which the separate crystals often exhibit patchy extinction. Sub-orientated, closely packed feldspar laths are deflected around the phenocrysts. Scattered and clustered granules of clear augite, ilmenite and magnetite crystals and granules with a little interstitial chlorite, serpentine and pale-green glass comprise the remainder of the groundmass.

Discussion

Selected Cainozoic volcanic rocks from N Tasmania have been subdivided by A. B. Edwards (Edwards, 1950, table 1) into 9 basaltic rock types. Two of these, namely the Mersey and Waratah types, have certain petrographical affinities with basalts described in this report. For example, green-coloured volcanic glass and colourless augite crystals are common constituents. Essential feldspar phenocrysts of the Waratah type are, however, absent and, in contrast to rocks of the Mersey type, specimens 64/295 and 64/296 possess distinct augite phenocrysts.

According to Edwards (1950) the presence of green glass is of diagnostic importance in the sub-division and classification of Cainozoic basaltic rocks in N Tasmania. Chemical analyses show (Edwards, 1950, p. 115) that these basalts are distinguishable from basalts with black glass by a lower FeO/MgO ratio. Furthermore, basalts with green glass are associated not only with titanaugite-basalts but also with undersaturated olivine-basalts similar, in type, to the nepheline-basalts of Pipers River area W of Scottsdale.

Specimens 64/295, 64/298 and 64/299, from the topographically higher level, are distinguishable from the remainder by their extremely fine-grained groundmass. Further petrological work is needed in order to assess the significance of these textural differences.

Appendix 5

PETROGRAPHIC NOTES ON BASALTIC ROCKS FROM THE SPRINGFIELD-W. SCOTTSDALE DISTRICT

by Brian Marshall

1. Sp. No. 64/234, $\frac{1}{4}$ MILE NE OF 64/285, 5336E/9238N—OLIVINE
BASALT

A hemicrystalline olivine basalt, composed of anhedral olivine and minor subhedral pyroxene phenocrysts, in a groundmass of subhedral colourless augite, olivine, feldspar, glass and magnetite. The phenocrysts are abundant and range up to 2.0 mm. in length. Iddingsitic and serpentinitic decomposition products are found in cracks of olivine and peripheral zones adjacent to olivine. Pyroxene and feldspar microlites of the groundmass are usually less than 0.1 mm. in length, and are associated with indeterminate felsitic material and very pale green intersertal glass. Occasional amygdales infilled with zeolites, and exhibiting peripheral chalcedonic hemispherulites, may be seen.

2. Sp. No. 64/285, $1\frac{1}{2}$ MILES W OF SPRINGFIELD, 5334E/9235N—FINE
GRAINED NEPHELINE BASALT

Intermediate between 64/284 and 64/287 in that (feldspathoidal) glass and amygdales are more common than in the former, which lacks nepheline, whereas the grain-size is finer and there is less nepheline than in the latter.

3. Sp. No. 64/287, $1\frac{1}{2}$ MILES N OF SPRINGFIELD, 5365E/9261N—
NEPHELINE BASALT

Consists of highly corroded olivine and pyroxene phenocrysts up to 2 mm. in length, in a matrix of nepheline, stubby prisms and laths of pyroxene, granular olivine, magnetite and pale green feldspathoidal glass. The matrix olivine and glass are intergranular and intersertal respectively in their relation to the pyroxene laths (up to 0.2 mm. long). Nepheline forms anhedral plates (up to 0.9 mm. diameter) which poikilophitically encloses the mafic minerals.

4. Sp. No. 64/395B, QUARRY $\frac{3}{4}$ MILE E OF W. SCOTTSDALE, 5362E/
9268N—NEPHELINITE

Consists of nepheline euhedra and subhedra, in association with prismatic twinned titan-augite, and intersertal yellowish-green and brown glass. The grain size range between 0.5 mm. and 2.0 mm. Pale green margins to some titan-augite crystals are probably aegiritic. Amygdales infilled with zeolitic minerals are fairly common.

5. Sp. No. 64/395C, QUARRY $\frac{3}{4}$ MILE E OF W. SCOTTSDALE, 5362E/
9268N—NEPHELINE BASALT

Composed of phenocrysts of olivine and pyroxene up to 3.0 mm. across in a ground mass of olivine, pyroxene iron ore (magnetite) and a small amount of feldspathoidal glass. Pyroxene of the

matrix is prismatic, nepheline though equant is subhedral, whilst the granular olivine is anhedral. Amygdales with zeolites are fairly common.

An unusual feature of this slide is an olivine phenocryst approximately 1 cm. in length, surrounded by a 1 mm. thick layer of cross-hatched olivine euhedra, grading into 0.5 mm. of fine grained granular olivine and pyroxene, in turn passing into a peripheral 0.5 mm. thick layer of optically continuous pyroxene (that is the whole rim is of one crystallographic orientation), which is integrated with the normal rock texture on its outer margin. This is an excellent example of a kelyphitic rim.

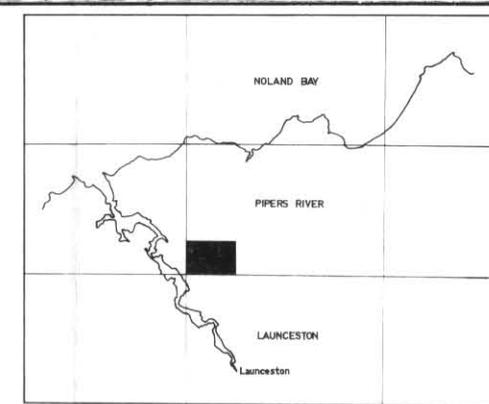
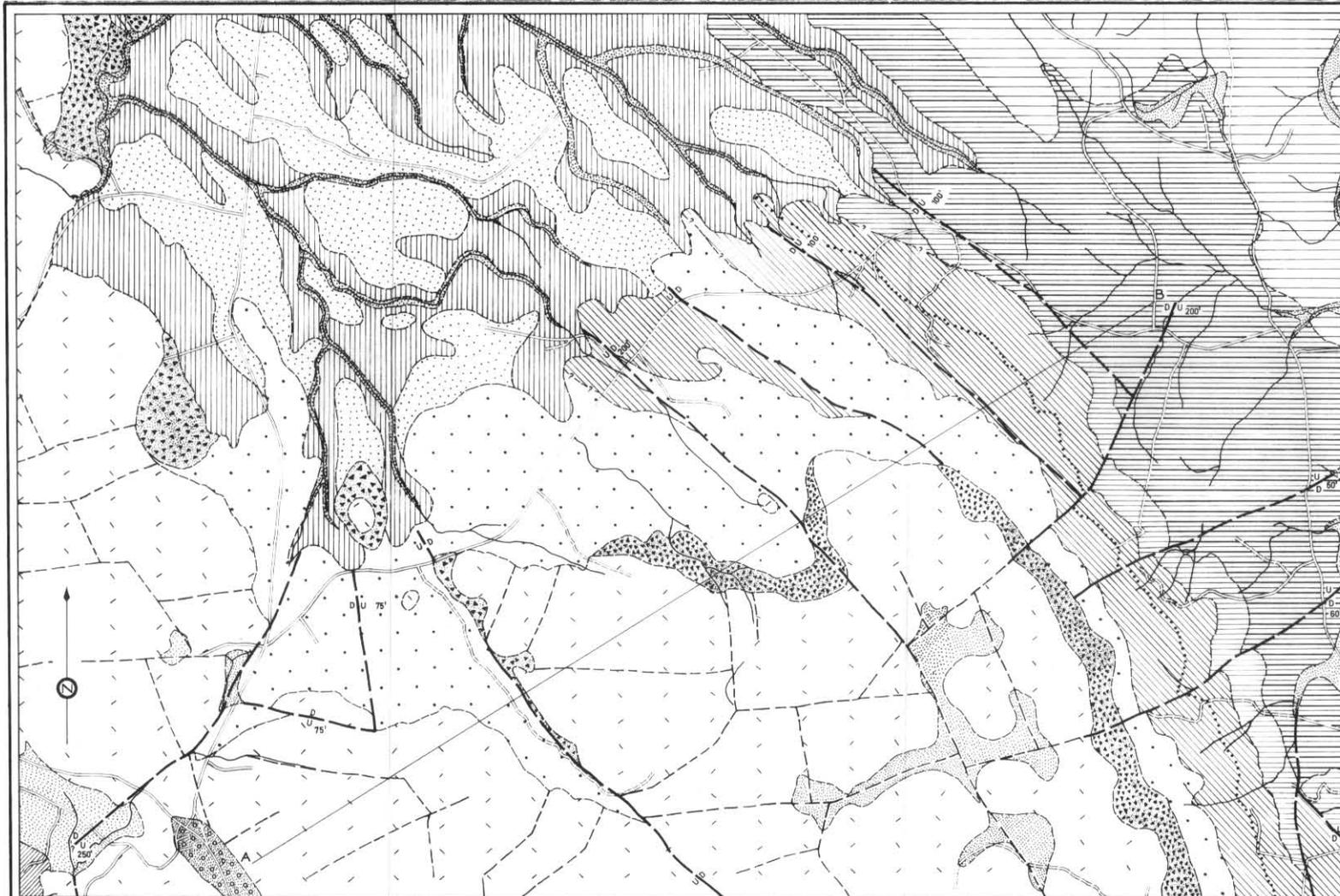
References

- BALME, B. E., 1960—Palynology of a sediment from Halletts Quarry, Melrose, Tasmania. *Palyn. Rep., Dep. Geol., Univ. W.A.*, 62.
- BANKS, M. R., 1959—Introduction, pp. 9-17, in Tasmania, *Lexique Stratigraphique International*, VI, 5d, *Int. geol. Congr. Stratig. Comm.*
- , 1962—In the Geology of Tasmania. (A. Spry and M. R. Banks, Editors) *J. geol. Soc. Aust.*, 9 (2), 107-362.
- BONNEY, T. G. H., 1886—Anniversary address of the President. *Proc. geol. Soc.*, 1885-86, 55-115.
- BOUMA, A. H., 1962—*Sedimentology of some Flysch deposits*. Elsevier Publishing Co.
- BROADHURST, E., 1933—Report on Black Beach Sands between the mouths of the Piper and Little Piper Rivers. *Unpub. Rep. Dep. Min. Tasm.*
- , 1935—Lefroy and Back Creek Goldfields. *Bull. geol. Surv. Tasm.*, 42.
- BURNS, K. L., 1964—Devonport. *Explan. Rep. geol. Surv. Tasm.*, 1-mile geol. Map. Ser. K/55-6-29.
- CAREY, S. W. and AHMAD, N., 1961—Glacial Marine Sedimentation, in G. O. Raasch (Ed.) *Geology of the Arctic*. 2, 865-894, *Proc. 1st. Symp. Arctic Geol.*
- COOKSON, I. C., 1937—Occurrence of fossil plants at Warrentinna. *Pap. R. Soc. Tasm.* (1936), 73-78.
- DALE, T. N., et al., 1914—Slate in the United States. *Bull. U.S. geol. Surv.*, 586, 1-220.
- DAVIES, J. L. (Ed.), 1965—*Atlas of Tasmania*. Lands and Surveys Dept., Hobart.
- EDWARDS, A. B., 1950—The petrology of the Cainozoic Basaltic rocks of Tasmania. *Proc. R. Soc. Vict.*, 62, 97-120.
- ENGELN, O. D. VON, 1930—Type form of faceted and striated glacial pebbles. *Am. J. Sci.* ser. 5, 19, 9-16.
- ETTINGSHAUSEN, C. VON, 1888—Contributions to the Tertiary Flora of Australia. *Mem. geol. Surv. N.S.W., Palaeontology*, No. 2, 189 pp.
- GOULD, C., 1864—Report on Part of County of Dorset. *Tasm. House of Assembly Pap. No.* 39.
- GROVES, D. I., 1965—Geology of the Lefroy Goldfield. *Tech. Rep. Dep. Min. Tasm.*, 9, 58-76.
- JENNINGS, D. J., 1966—Piper's River Area: Tertiary Sediments and Recent Gravels. *Rep. Dep. Min. Tasm.* (Unpublished).
- KULP, J. L., 1961—Geological Time Scale. *Science* 133 pp. 1105-1114.
- LANGFORD-SMITH, T., DURY, G. H. and MCDUGALL, I., 1966—Dating the duricrust in Southern Queensland. *Aust. J. Sci.*, 29 (3), 79-80.
- LONGMAN, M. J., 1966—Explanatory Report. 1-mile geol. Map Ser.—Launceston. *Dep. Min. Tasm.*
- MCDUGALL, I., 1959—The Brighton Basalts, Tasmania. *Pap. R. Soc. Tasm.*, 93, 17-28.
- , 1961—Determination of the age of a basic intrusion by the Potassium-Argon method. *Nature*, 190, 1184-1186.
- and LEGGO, P. J., 1965—Isotopic age determinations on granitic rocks from Tasmania. *J. geol. Soc. Aust.*, 12, 295-332.
- MARSHALL, B., 1968—Joint and fault development in north-east Tasmania. *Geol. Mag.*, 105, 186-187.
- , 1969—Aspects of the Back Creek Goldfield. *Tech. Rep. Dep. Min. Tasm.*, 13, 27-33.
- , BARTON, C. M., and JENNINGS, D. J., 1965—Scottsdale-Pipers River-Bridport Region, in *Geological Excursions for the Australian and New Zealand Association for the Advancement of Science* (E. M. Smith and E. Williams, Editors). *Dep. Min. Tasm.*, 96 pp.
- , BARTON, C. M., JENNINGS, D. J., and NAQVI, I. H., 1965—Pipers River 1-mile geol. Map Ser. Sheet No. 31.
- MCKELLAR, J. B. A., 1957—Geology of the Western Tiers near the Great Lake, Tasmania. *Rec. Q. Vict. Mus.*, 7.
- MONTGOMERY, A., 1894a—Report on the Back Creek Goldfield, County of Dorset. *Rep. Secy. Min. Tasm.*
- , 1894b—Report on certain portions of the Lisle Goldfield. *Rep. Dep. Min. Tasm.* (Unpublished).
- , 1897—Report on the Geological Structure and Mining Development of the Lefroy Goldfield. *Rep. Secy. Min. Tasm.* 1896-7.
- NYE, P. B., 1924—Report on the Lilydale-Lebrina District. *Rep. Dep. Min. Tasm.* (Unpublished).
- PACKHAM, G. H., 1960—Sedimentary History of part of the Tasman Geosyncline in South Eastern Australia. *21st. Rep. of Int. geol. Congr.*, 12, 74-²⁰
- PETTIJOHN, F. J., 1957—*Sedimentary Rocks*. Harper Bros., New York, 718 pp.
- PRICE, N. J., 1966—Fault and joint development in brittle and semi-brittle rock. Pergamon Press, London, 176 pp.
- REID, A. M., 1926—The Golconda Gold Mining District. *Bull. geol. Surv. Tasm.*, 37.
- RICKARD, M. J., 1961—A note on cleavages in crenulated rocks. *Geol. Mag.*, 98, 324-332.

- SITTER, L. U. De, 1956—*Structural Geology*. McGraw-Hill Book Co., New York, 522 pp.
- SOLOMON, M., 1962—In the Geology of Tasmania. (A. Spry and M. R. Banks, Editors). *J. geol. Soc. Aust.*, 9 (2), 107-362.
- SPRY, A., 1955—The Tertiary rocks of Lower Sandy Bay, Hobart. *Pap. R. Soc. Tasm.*, 89, 153-168.
- , 1962—In The Geology of Tasmania. (A. Spry and M. R. Banks, Editors). *J. geol. Soc. Aust.*, 9 (2), 107-362.
- and FORD, R. J., 1957—Reconnaissance of the Corinna-Pieman Heads Area, Geology. *Pap. R. Soc. Tasm.*, 91, 1-7.
- SUTHERLAND, F. L., 1966—The Tertiary volcanics of the Tamar Valley, Northern Tasmania—A preliminary report. *Aust. J. Sci.*, 29, (4), 114-115.
- THUREAU, G., 1882a—Report on the Mineral Resources and Permanency of the Den Goldfield. *Tasm. House of Assembly Pap. No. 44*.
- , 1882b—Report on the future prospects, as regards productiveness and permanency, of the Back Creek Gold Field, County of Dorset. *Tasm. House of Assembly Pap. No. 45*.
- , 1882c—Report on the Mineral Resources and on the permanency of the Lisle Goldfield. *Tasm. House of Assembly Pap. No. 46*.
- TURNER, F. J. and WEISS, L. E., 1963—*Structural Analysis of Metamorphic Tectonites*. McGraw-Hill Book Co., New York. 694 pp.
- TWELVETREES, W. H., 1902—Report on the Den Hill Gold Deposits. *Rep. Secy. Min. Tasm.* 1902-3.
- , 1909—The Lisle Goldfield. *Bull. geol. Surv. Tasm.*, 4.
- , 1918a—Gold and oil shale at Bangor. *Rep. Dep. Min. Tasm.* (Unpublished).
- , 1918b—The Bangor Mineral district. *Bull. geol. Surv. Tasm.*, 27, 20 pp.
- WENTWORTH, C. K., 1936—An analysis of shapes of glacial cobbles. *J. Sedim. Petrology*, 6, 85-96.
- WILLIAMS, E., 1959—The sedimentary structures of the Upper Scamander sequence and their significance. *Pap. R. Soc. Tasm.*, 93, 29-32.
- , 1967—Joint Patterns at Dalrymple Hill, Northeast Tasmania. *Geol. Mag.*, 104, 240-252.
- WILLIAMS, H., TURNER, F. J. and GILBERT, C. M., 1954—*Petrography*. W. H. Freeman and Company, San Francisco. 406 pp.
- WILSON, G., 1961—The tectonic significance of small scale structures, and their importance to the geologist in the field. *Annls. Soc. geol. Belg.*, 84, 523-548.

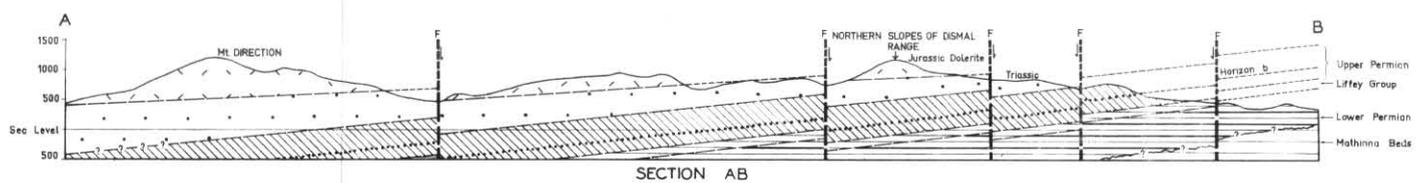
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- QUATERNARY ALLUVIUM
- QUATERNARY DOLERITE TALUS
- QUATERNARY CLAYS
- QUATERNARY VEIN QUARTZ GRAVELS
- TERTIARY COARSE QUARTZ SANDS
- TERTIARY LATERITE
- TERTIARY DOLERITE COBBLE DEPOSIT
- TRIASSIC SANDSTONE
- UPPER PERMIAN LIFFEY GROUP
- LOWER PERMIAN
- SILURIAN-DEVONIAN MATHINNA SLATE
- GNEISS
- JURASSIC DOLERITE
- FAULT POSITION APPROXIMATE (Down thrown side indicated)
- LINEAMENT PHOTO INTERPRETED

5 cm



DEPARTMENT OF MINES — TASMANIA	
GEOLOGICAL MAP BANGOR AREA	
DATE MAY 1968	SCALE OF CHAINS 0 20 40 60
GEOLOGIST B MARSHALL	MAP SHEET & N° PIPERS RIVER 31
DRAUGHTSMAN TR BELLIS	FILE N° 3159
REVISIONS	

FIGURE 8

ER3159



FIGURE 11

5 cm

ERB315N



FIGURE 10

5 cm

ER8315N

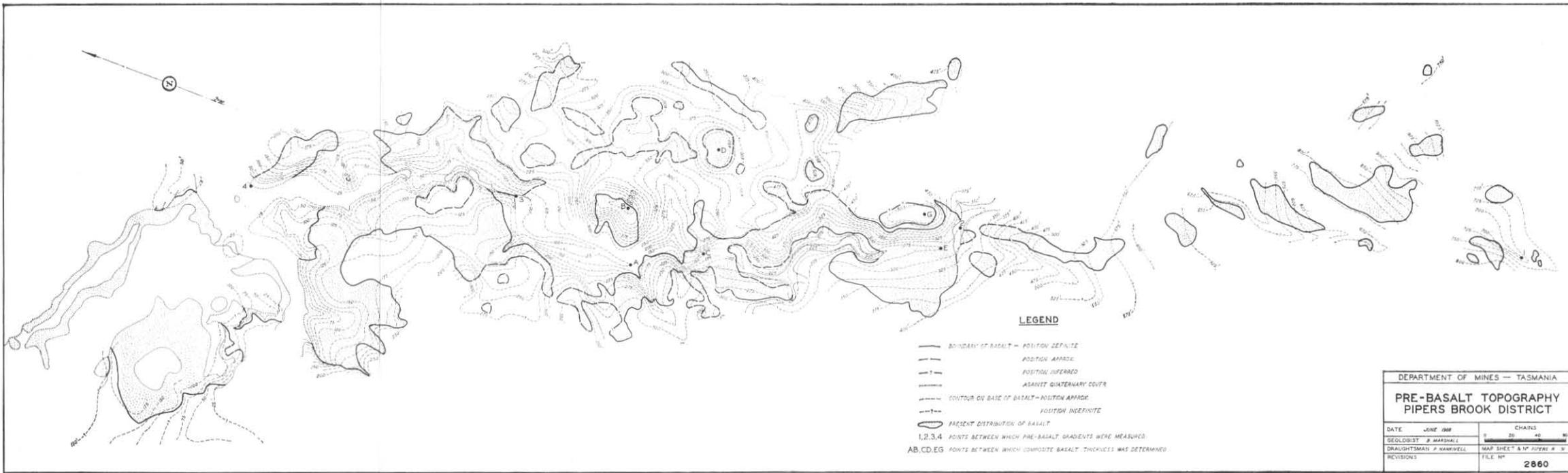


FIGURE 12

5 cm

ER8315N

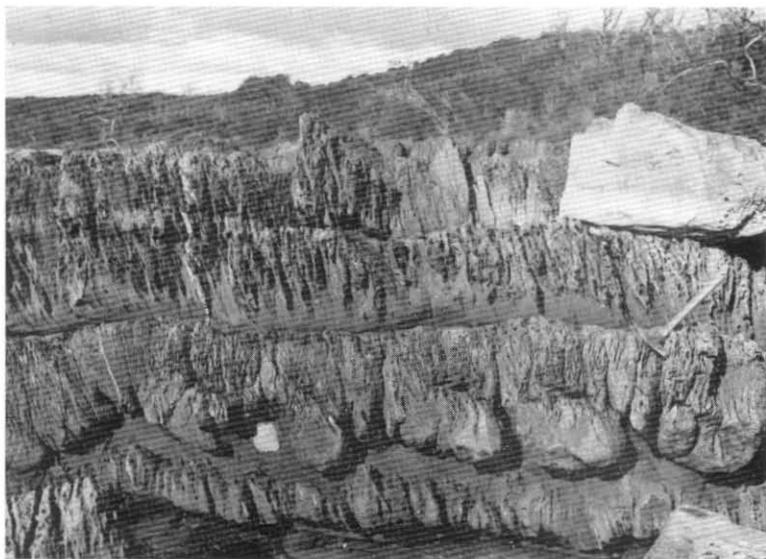


PLATE 1



PLATE 2

ERB315N

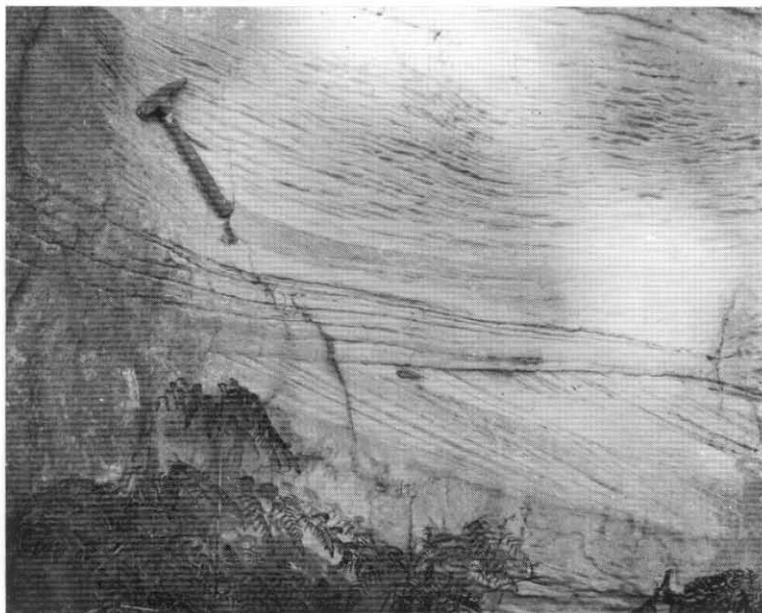


PLATE 3



PLATE 4



PLATE 5



PLATE 6

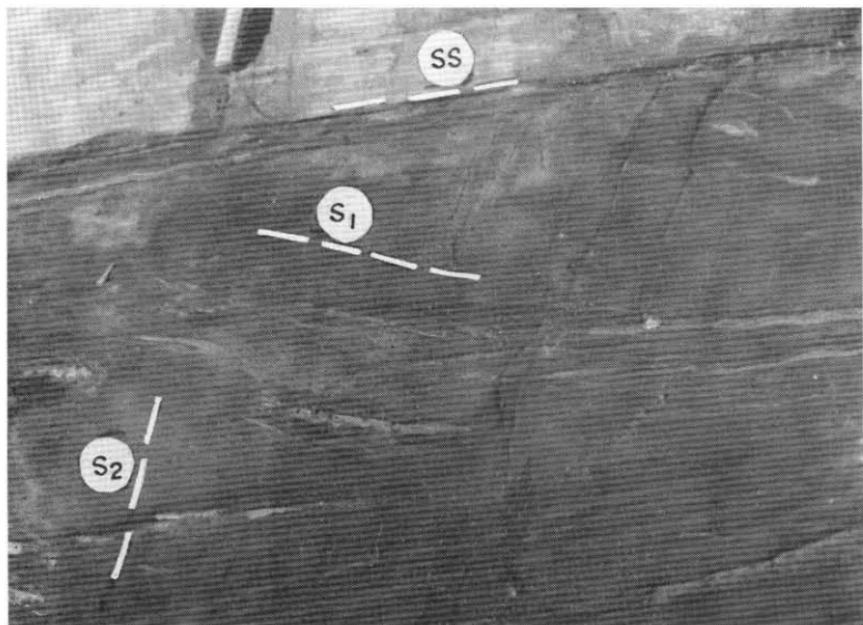


PLATE 7



PLATE 8