THE PRECAMBRIAN ROCKS OF TASMANIA, PART IV— THE MT. MULLENS AREA

By

Alan Spry
Department of Geology, University of Tasmania,

and

Don Zimmerman
Department of Geology, University of Queensland

(With 2 Plates and 1 Map)

ABSTRACT

The area about Mt. Mullens (Lat 42° 13′ S., Long. 145° 52′ E.) in Central Western Tasmania is underlain by rocks of Precambrian age, with a possible area of Ordovician sediments in the south-eastern corner, and a discontinuous veneer of Pleistocene glacial and fluvioglacial sediments. The Precambrian rocks are from oldest to youngest, the Joyce Group (garnet-mica schists) overlain by the quartz schists, quartzites and phyllites of the Mary Group, next garnet-mica schists, correlated with the Franklin Group in a downfaulted block. Jane Dolomite occurs in the south-east, and Scotchfire (?) Group phyllites, schists, calc-schists and dolomites occur immediately to the east of the area. There may be a major unconformity below the Jane Dolomite. The Scotchfire (?) sediments have been intruded by pre-metamorphic basic igneous rocks. The area is divided up into an eastern and a western structural unit and the contact of the two units is shown to be a fault. The Precambrian sediments have been regionally metamorphosed in varying amounts and range in grade from unmetamorphosed (?) Jane Dolomite, through the chlorite zone to the garnet zone. The sediments were folded into the Collingwood Syncline during the Tabberabberan Orogeny and are strongly faulted. Evidence of two phases of Pleistocene glaciation is seen in the area, an earlier extensive ice-cap and a later, less extensive, valley phase.

INTRODUCTION

This area was mapped as part of a regional investigation by the Hydro-Electric Commission of Tasmania under the direction of D. O'Driscoll and Professor S. Warren Carey.

The major part of the field work was done by D. Zimmerman with the assistance of D. Woolley, during January and February, 1955. A. Spry carried out a reconnaissance through the area in the summer of 1954 and spent a further week in the field during October, 1956. The compilation of the map and preparation of the paper was carried out by A. Spry. The specimen numbers are those of the rock catalogue in the Department of Geology, University of Tasmania.

ACKNOWLEDGMENTS

The base map was prepared from air photos by the Hydro-Electric Commission, by whose courtesy this paper is published.

PREVIOUS LITERATURE

No detailed work has been carried out in this area previously, although a reconnaissance of the Loddon River-Jane River area was described by Ward (1908, 1909a), and Ward (1909b) summarized the knowledge of the Precambrian rocks of Tasmania. Brief surveys of the Jane River, Prince of Wales Range, Surveyor Range and Deception Range were described by Finucane and Blake (1933), and Blake (1936, 1937). The glacial physiography was referred to by Johnston (1894a, b), Lewis (1944), and Moore (1896).

PHYSIOGRAPHY

The area possesses considerable relief with altitudes over 2,000 feet in places. It shows a rugged mature surface which has been chiefly moulded by fluviatile action, and the valley glaciers which were active only a few miles away up the Franklin, Surprise, Stonehaven and Alma Rivers probably did not erode the land surface here appreciably .

The major physiographic unit to the east, north and north-west is the Central Plateau, which is underlain by Jurassic dolerite, with Permian and Triassic strata. Remnants are visible at the King William Range, Mt. Gell and the Eldon Range. The Mt. Mullens area represents the deeply dissected infra-structure of the Plateau where not only have the flat-lying Permian, Triassic and Jurassic rocks been removed, but the pre-Permian surface has been obliterated.

As in most parts of the surrounding district, the highest points, e.g., Mt. Hardy (2,900 feet), Mt. Mullens (2,200 feet), Junction Peak (2,150 feet) and the Collingwood Range (2,500 feet) are underlain by quartzites of the Mary Group. By contrast, the schists of the Franklin Group and the Jane Dolomite form low rounded hills. The Collingwood range forms an excellent strike ridge with the hard quartz-schists dipping west at 70° and has the form of a steep cuesta or a hogback with a very steep scarp which rises 1,300 feet above the flat plain of the Collingwood River. Cuestas are only crudely developed elsewhere and the strike of the rocks is commonly quite oblique to the long ridges.

The area is dominated by the drainage system of the Franklin, Collingwood and Loddon Rivers, whose courses have been strongly controlled by the geological structure in some places.

The Franklin River has its source in the strongly glaciated Plateau-remnant of Mt. Gell and in its upper reaches possesses many glacial features. It begins in the rock basin, Lake Hermione, drops into a second rock basin, Lake Undine, then descends to the south down a U-shaped valley for ten miles until it is joined by the Surprise River coming from the east. The Surprise also is clearly glaciated in its upper reaches, but neither river shows glacial forms for several miles above their junction.

In the area mapped here, the Franklin varies considerably in character. Near the Jane River track huts, it has cut 40 feet through a well-developed terrace, but, nevertheless, possesses meanders and a divided course. The bed-rock is the Jane Dolomite which is overlain by Pleistocene glacial and fluvioglacial sediments. Downstream the river crosses a fault and enters the quartzites of the Mary Group and to the south of Artist's Hill its course becomes straighter and constricted for about a mile. Prior to the Pleistocene glaciation the river was apparently held up by the quartzites which formed a local base level and the river cut a broad flood plain upstream in the softer Jane Dolomite. During the Pleistocene at least 60 feet of glacial sediments were deposited in the river valley. The river once meandered across this material and cut several 10-feet-high terraces, now visible near the highway where they have a thin upper layer of normal river deposit, but has cut 40 feet through this terrace. Further downstream there are further developments of broad terraces.

The river turns south-west at Junction Peak and changes character markedly. Upstream from here the river is mature and runs parallel to the strike of the sediments, but beyond Junction Peak it cuts a youthful gorge across the structure and shows the superimposed characteristics which were described further downstream by Spry (1957b).

Both the Alma and the Stonehaven have their heads in the glaciated country around Mt. Gell and Gould's Sugar Loaf and possess U-shaped valleys for the first few miles. Then they pass into broad valleys choked with glacial and fluvioglacial debris and covered with button grass. The Stonehaven, in the north-south stretch a mile or so north of Artist's Hill, wanders through glacial debris with a very irregular flat course until it turns west at Artist's Hill and cuts steeply down to join the Franklin.

The Collingwood River leaves the high country north-east of Bubb's Hill and shows a fairly broad straight, mature valley which follows the trend of the rocks as the strike swings from about 110° near the Raglan Range to 150° at the Collingwood Range.

The Junction Peak quartzite has acted as a local base level to the Collingwood also, and upstream from this there is a broad terrace almost a mile wide and two miles long, through which the river has become entrenched by about 120 feet.

The upper surface of this terrace has an altitude of a little over 1,200 feet, with small hillocks rising to 1,250 feet, and the terrace in the Franklin just south-east of Artist's Hill has the same altitude. This latter terrace is underlain by Pleistocene fluvioglacial sediments and the extensive flat area around Stonehaven Creek (just north of Artist's Hill), which is covered by glacial materials, lies between 1,200 and 1,250 feet also. There are button grass flats up the Alma River for several miles above its junction with the Collingwood; these lie between 1,200 and 1,250 feet altitude lower down but rise to about 1,400 feet further upstream.

It is suggested that these flats represent a comparatively undissected level formed by deposition of glacial sediments in the late Pleistocene. A few miles away to the north-east and east it would be underlain by till but in this area only by fluvioglacial or glaciolacustrine materials. The varved mudstones suggest strongly that there has been damming of the Collingwood and Franklin. The altitude of the river itself before the glaciation was only a little higher than at present but a lake formed extending for several miles up the Collingwood, Franklin, Alma and Stonehaven. There was up to 100 feet of sediment deposited in this lake and its river tributaries, leaving at the end of the glaciation a fairly level surface of deposition at about 1,225 feet, but rising upstream. Since the Pleistocene the rivers have cut right through this soft material and have begun to erode the bed-rock beneath.

The probable position of the dam which caused the lake is an interesting problem. The narrow gorge at Junction Peak would be easiest to dam but the only reasonable explanation would be a landslide. It may be significant that the Loddon Plains have an altitude of between 1,200 and 1,250 feet, thus suggesting that the dam was further downstream than the Loddon-Franklin Junction. There is no way of being sure at present how much of this 1,200-1,250 surface is due to older normal river erosion related to some base level downstream, especially with regard to the Loddon Plains, but if these Plains are cognate with this surface to the north, it allows a ready explanation of the damming. Frenchman's Cap was glaciated during the Pleistocene and evidence of smaller glaciers coming down to low levels on the north, east and south is clear. It is not unreasonable to suspect one such tongue of coming down the glaciated valley which joins the Franklin from the south almost two miles west of the Loddon-Franklin junction and actually reaching the Franklin to dam it up temporarily to the 1,200-1,250 feet level.

Structural Control of Physiography

As is commonly found in this district, there is only a moderate degree of structural control of the physiography. The quartzites of the Mary

Group form the highest points and in some cases there are strike ridges of quartzites. The Franklin and the Collingwood run parallel to the strike upstream from Junction Peak and the un-named river just west of the Collingwood Range follows a major fault. The tributaries of the Franklin and Loddon in the Mt. Mullens area show a rectangular pattern determined by the strike of the sediments and by small faults and joints. There are a few small sinkholes in the Jane Dolomite along Carbonate Creek and these occur even on parts of the steep valley wall.

Glacial Control of Physiography

As there are Pleistocene glacial deposits in this area, it is perhaps surprising that the land surface shows no characteristic glacial forms and this is attributed to the fact that this represented the marginal zone for much of the glaciation with deposition predominating over erosion.

The upper parts of the Surprise, Franklin, Alma and Stonehaven have clearly been shaped by glaciers, probably during the most recent phase of the Pleistocene, but the U-shaped form ceases at least five miles upstream from here on all of these rivers. No evidence such as roches moutonnées or smoothed rock surfaces was found in this area.

On the other hand, there are large boulders of Jurassic dolerite on the top of Artist's Hill (about 1,800 feet altitude) and thus approximately 600 feet above the present valley floor. Boulders of Crotty Sandstone at an altitude of about 1,300 feet on the south side of the Franklin River (co-ordinates E388-N801) are probably not *in situ* and have been transported.

Glacial sediments occur in the cliff cut by the Franklin River south-east of Artist's Hill (south of the 34 mile post from Queenstown) where there are varved mudstones containing erratics, till and fluvioglacial sands and conglomerates. Many exposure of fluvioglacial sediments may be seen along the Lyell Highway, particularly near Stonehaven Creek. Extensive deposits of till which contains abundant Owen Conglomerate occur along the Jane River track about 2½ miles south of the Franklin River.

It is not possible to recognise the dam which caused the lake into which the early-formed varves were deposited. There may once have been a large terminal moraine a little upstream from Junction Peak. During the period of maximum glaciation the ice probably extended down the Franklin to the Collingwood-Franklin junction. It is notable that dolerite boulders occur in deposits along the Collingwood for about four miles upstream from the junction although no more were found further up. This suggests that the ice may have passed from east to west and have been diverted by the Collingwood Range, up the Collingwood valley.

It seems likely that there was an extensive, major ice-cap phase which deposited the dolerite boulders on top of Artist's Hill, followed by a lesser valley glacier phase which was restricted to the headwaters of the Franklin, Stonehaven, Alma and Surprise, &c.

A similar twofold division in the glaciation was recognised at the Arm River by Spry (1958) and it may be possible to correlate the glacial phenomena of the two areas. One very important difference, however, lies in the degree of weathering of the till. At the Arm and Mersey Rivers, even the silt-size particles of pyroxene and feldspar in the till were fresh, and the dolerite boulders were unweathered. In the Mt. Mullens area some boulders of dolerite up to a foot in diameter are found to be completely weathered through.

The difference in the degree of weathering suggests that the Franklin glacials are much older than those of the Mersey, but in contradistinction to this is the fact that many of the dolerite boulders in the Linda moraine (dated by Gill 1956, as 26,400 ± 800 years old by radio-carbon) are completely weathered. We are faced with three possible alternatives: (1) the climate has differed so much in the two areas since the glaciation that dolerite erratics were weathered in the Franklin-Linda area, but not in the Arm; (2) the extensive glaciation in the Arm-Mersey-Forth area took place after the Linda episode, i.e., took place less than 26,000 years ago; (3) there is some error associated with the radio-carbon dating.

At present it seems that the first alternative is most likely but it is quite clear that much more field work and more actual dating is necessary to clarify Tasmania's glacial history.

STRATIGRAPHY

The area is chiefly underlain by rocks of Precambrian age which are correlated with the Joyce, Mary and Franklin Groups and the Jane Dolomite. A correlate of the Scotchfire Group occurs just east of the area where it probably underlies the Jane Dolomite. The sequence of Joyce Group (oldest), followed by Mary Group and the Franklin Group (youngest), is fairly clear, but there is no direct evidence in this area of the stratigraphic position of the Jane Dolomite and Scotchfire Groups, although there is some indication that the Jane Dolomite is the youngest Precambrian formation present. Altered basic igneous rocks occur within the Scotchfire Group and these are correlated with the Older Basic Igneous Group (Spry, 1957b) to the west. Lower Palaeozoic rocks, extending from the Owen Conglomerate up into the Eldon Group, occur in the valley of the Loddon River immediately to the south, and these may extend into the south-eastern corner of the area where they are covered with the Pleistocene glacials which are widespread there.

The Precambrian rocks which are almost entirely sedimentary, show evidence of low to medium grade regional metamorphism and strong deformation and have a total thickness of about 20,000 feet.

Precambrian Rocks

Mary Group

A considerable development (approximately 12,000 feet) of quartz schists, massive quartzites and phyllites, is correlated with the Mary Group, which has its type area immediately to the west. Despite the complexities of structure, the similarity in lithology and thickness and the continuity of outcrop are sufficient to make this a reliable correlation.

It is not possible to give a stratigraphic sequence of formations within this group in this area and reference may be made to the sequence given by Spry (1957b) a few miles to the west. One difference, however, lies in the lack here of the typical dark-grey phyllites such as occur at the base of Mt. Mary. The phyllites in the Mt. Mullens area are less abundant, are paler in colour and richer in silica. It was suggested by Spry (1957b) that the quartz schists might have been formed from the phyllites by silicification, and, if this is so, then there has been a regional increase in silicification from west to east, i.e., from Mt. Mary to Mt. Mullens. On the other hand, it is quite possible that the difference in silica content is a primary feature of the sediments and that there was a facies gradation with more argillaceous varieties occurring to the west.

The massive quartzites, such as those on Mt. Mullens, are characteristically ripple-marked.

Franklin Group

About 4,000 feet of mica schists, some of which are garnetiferous, outcrop along the Collingwood River and the Lyell Highway, north of Junction Peak, but their stratigraphic relations are obscure.

They might be considered to dip beneath the Collingwood Range quartz-schist and thus be the Joyce Group, or they could be faulted against the quartz-schist and thus belong to the Franklin Group. The two alternatives are outlined below.

The schists might be correlated with the Joyce Group because they have the same dip and strike as the Collingwood Range quartz-schist (Mary Group) and appear to dip regularly beneath it along a contact which curves through 40° over its exposed distance of two miles. Garnet schist and quartz schist occur, apparently undisturbed, within ten yards of each other, and a dark phyllite in this zone has characteristics common to the Mary and Joyce Groups. Similar garnet schist dips in a similar fashion beneath similar quartz schist on the other side of the Collingwood Syncline only four miles away, and this was interpreted as being the Joyce Group dipping beneath the Mary Group and there is no evidence yet to suggest that this is incorrect.

On the other hand, these rocks are also lithologically identical with schists of the Franklin Group and there is a continuous outcrop of such rocks along the Lyell Highway to the Raglan Range, where they certainly belong to the Franklin Group. In clarification of this point, it should be noted that there is at least one major fault between here and the Raglan Range and that, whereas the strike swings gently round, the direction of dip changes abruptly from south-west to north-east across the fault. A further point in support, is that the quartzite near the 26-mile post on the Lyell Highway, occurring within the schists along the Collingwood River, is lithologically very similar to the Raglan Quartzite in the Franklin Group.

The second choice is preferred on structural grounds and the evidence suggesting that these schists belong to the Franklin Group is given in the structural section on page 6.

Jane Dolomite

Dolomite occurs over a broad area as outcrops in the bed of the Franklin River around its junction with Carbonate Creek, and extending for at least a mile up the latter. It varies in lithology from a massive or thickly-bedded grey or buff dolomite to a dolomite breccia. The breccia consists of angular fragments of dolomite, mudstone, quartzite and schist, usually a few inches across but reaching a foot in some places, set in a dolomite matrix. Similar breccia occurs in the Jane Dolomite at Christmas Rock and elsewhere. Irregular silicification of the dolomite has given rise to white, grey and black cherts.

The attitude of the dolomite is difficult to determine, but in general it strikes at about 320° and dips at 60° to the south-west, and if this is constant, the bed would be several thousand feet thick, but, as it is not possible to see the top and bottom, a thickness of 3,000 feet is very tentatively advanced.

A detailed description of the dolomite breccia is given in the petrology section and it seems clear that the breccia marks a hiatus of some kind, although it is a little difficult to estimate the magnitude of the break. The evidence for the hiatus is as follows:—

(1) The Jane Dolomite is fine grained, and apparently unrecrystallized, unmetamorphosed and undeformed, even though to the south it rests directly on the Lachlan Conglomerate, which is strongly sheared and metamorphosed, containing biotite and chloritoid, or on the Scotchfire Group, which is also strongly deformed and metamorphosed.

(2) The dolomite breccia contains pieces of unmetamorphosed mudstone together with fragments of schist.

(3) The breccia is composed chiefly of large, angular fragments of dolomite identical with the underlying massive dolomite and thus containing some particles of local, and probably penecontemporaneous, origin.

(4) It contains fragments of mica schist which clearly had been metamorphosed prior to the deposition of the breccia. Some of the larger particles are similar to the local Precambrian rocks.

The first conclusion obtained from this evidence is that the breccia was derived from erosion of *local* rocks and that it marks a period of at least local tectonic uplift.

A second, more important conclusion, based on these facts needs investigation on a regional basis. If the dolomite is indeed unmetamorphosed and undeformed, then the base of the dolomite marks a major unconformity and it was deposited after erosion of the previously metamorphosed Precambrian rocks. It would then be older than the Ordovician Owen Conglomerate but younger than the adjacent Precambrian schists, and thus might be Upper Precambrian.

Scotchfire Group

These rocks do not actually occur within the mapped area, but appear to underlie the Jane Dolomite to the east, being well developed along the Lyell Highway. Prominent is a pale-green, lustrous phyllite with a strong lineation. Thin dolomites occur also and some of these are oolitic, and some have been silicified to white, grey or black chert. Thin quartzites are present and calc-schists (dolomitic phyllites) outcrop on the Lyell Highway near the mile post 38 miles from Queenstown.

Pleistocene Sediments

There are sediments with glacial and fluvioglacial appearance, particularly in the eastern part of this area and these are attributed to the Pleistocene Epoch. The glaciation has been discussed in the physiography section.

No measurements of thickness and sequences were made, but in the river terraces of the Franklin, south-east of Artist's Hill, there is a total of at least 40 feet and probably nearer 60 feet. The lowermost bed here is a varved mudstone, about 10 feet thick, and this contains numerous erratics in some parts. It is overlain by cross-bedded sands with discontinuous conglomerates and a probable till.

Up on the sides of Artist's Hill, the basal bed is a till containing thoroughly weathered dolerite boulders, but just a little north of here and slightly downhill the lowest bed is a thinly-bedded, fine-grained sandstone, resembling the varve in the Franklin River.

The till on the south side of the Franklin, almost opposite the cage on the Frenchman's Cap track, contains boulders of fossiliferous Crotty Sandstone up to four feet across and the till which occurs along the Jane River track, two miles south of the Highway is rich in large Owen Conglomerate boulders. Most of the till in this area, however, contains a large number of Jurassic dolerite boulders.

STRUCTURE

The major structure of the Mt. Mullens area is the Collingwood Syncline which runs across the western side. The beds generally strike north-westerly and dip to the south-west at an average of about 60°, thus forming the eastern limb of the syncline. The Franklin Group occurs as a down-faulted block along the Collingwood River.

This area lies on an important structural zone. A western structural unit is composed of rocks of the Franklin, Mary and Joyce Groups, and an eastern structural unit is composed of rocks of the Scotchfire Group and Jane Dolomite, together with those of the Lower Palaeozoic, Junee and Eldon Groups. It is not possible at present to recognize fully the relationships between the two units, but in this area at least they are separated by a fault of major dimensions (the Artist's Hill Fault). The nature of this fault and its amount of movement cannot be stated at present.

Major Folds

The Precambrian rocks were broadly folded during the middle Palaeozoic Tabberabberan Orogeny but the folding appears to have followed Precambrian trends and to have been associated with considerable faulting.

Mary Anticline

The Mary Anticline is very prominent immediately to the west but is difficult to follow into this area. It plunges flatly to the east-south-east and the axis appears to merge with that of the Collingwood Syncline.

Collingwood Syncline

This is an asymmetrical syncline with the west limb dipping at an average of 35° and the east limb at an average of 50°. The axis runs along the valley of the un-named river just west of the Collingwood Range, trending at about 320° in the northern part and swinging to about 20° near the southern boundary, but it is difficult to find the continuation of this fold beyond the boundaries of this area. It is faulted along the axial zone by a steep thrust fault which is discussed below. The convergence of the thrust faults associated with the Mary Anticline, Collingwood Syncline and Loddon Syncline is striking.

Beyond the northern boundary the position of the synclinal axis is also indefinite. There is a major synclina axis north of the Collingwood River trending at about 300°, but if this is the Collingwood Syncline it has been offset by several miles. It might well be equivalent to the minor faulted syncline in the north-east of the map-square immediately to the west.

Faults

There are a large number of faults in this area some of which are of considerable magnitude and the more important are given names. The faults may be divided up into groups according to their direction, but it is probable that most of them, if not all, are cognate and were formed practically simultaneously during the Tabberabberan Orogeny. Many of the faults are curved in plan and several may be followed for nearly fifteen miles.

(1) There is a set of faults trending east-south-easterly in the area to the west. These were mapped by Spry (1957b) and it was shown that some, at least, were faults of large magnitude (greater than 5,000 feet throw) and were probably steep thrusts. One such fault can be followed from the King Valley up the Governor River, where it trends west-south-west, just to the north of Flat Bluff, down the Joyce Creek, where it trends east-south-east, and past Ward's Bluff to the Franklin River west of Junction Peak.

This fault, and others of the set, disappear against the Junction Peak Fault, which is described below. Another fault of this set, south of Mt. Madge, curves in a similar fashion to the fault mentioned above, passing north of the Franklin River to the Loddon River, then parallel to the East Loddon River beyond the new Jane River track.

(2) It is considered that there is a major fault along the axis of the Collingwood Syncline. It is a high angle reverse fault which has moved the flatter-dipping beds of the west limb which lie near the base of the Mary Group up over the more steeply-dipping beds of the east limb, which are near the top of the Mary Group. Evidence supporting the existence of this fault, which is named the Junction Peak Fault, is as follows:—

(*a*) Dips and strikes are strongly discordant in many places across the axial zone, e.g., at co-ordinates E393-S803 the axis strikes at 185° and the beds on the east limb strike at 300° and dip south at .0°, whereas the beds on the west limb strike at 300° and dip north at 30°. There is a similar occurrence at co-ordinates E395-S802.

(*b*) Many of the major faults, which enter the area from the west, end at a line marking the axis of the fold.

(*c*) The beds immediately to the west and east of the axis appear to be separated stratigraphically by several thousand feet. In the south-western part of the area it appears that the beds on the west limb are about 2,000 feet above the base of the Mary Group, whereas those on the east are about 8,000 feet above the base.

(*d*) It is possible to follow a linear on the air photos from a known fault near Bubb's Hill across to the line of this fault. The sense and amount of movement measured independently at Bubb's Hill and in this area are the same, i.e., north or east side down about 6,000 feet.

The Junction Peak Fault appears to end against the east-west thrust on the Loddon River mentioned previously.

(3) There is a block, one mile across and at least three miles long, composed of garnet and mica schists, extending along the Collingwood valley, north of Junction Peak. These schists were tentatively correlated with the Franklin Group on page 7.

The best explanation for the occurrence of an isolated mass of schist, surrounded on three sides by the lithologically quite dissimilar Mary Group, is that it is a downfaulted block.

The fault of the southern boundary of the block is seen just north of Junction Peak, where the mica schists to the north pass abruptly into quartzite to the south along the strike.

The fault on the eastern boundary of the block is indicated by the crushing exposed in the road cutting just west of the large creek, which is west of the 30-mile post from Queenstown.

The curved nature of the western boundary of the schist and the comparative lack of contortion there does not greatly favour the hypothesis that it is a fault, but it should be remembered that many of the faults in this area are curved and that many of the major thrusts are unaccompanied by obvious crushing and drag.

This block appears to lie along a continuation of the downfaulted zone at Bubb's Hill. In this locality there are a number of long blocks of the Eldon and Junee Groups which have been downfaulted at least 6,000 feet into the Franklin Group which surrounds them on three sides. The appearance of the block of Franklin Group schist at the Collingwood River is very similar.

The two faults bounding the eastern and western sides of this block are named the Mt. Hardy Fault and the Alma Fault and are shown on the map. They are parallel to and cognate with the Junction Peak Fault and thus with the faults at Bubb's Hill. The Bubb's Hill system, then, appears to consist of a group of faults extending from the King River to Junction Peak, i.e., for 15 miles. It forms a zone 1-2 miles wide and curves in direction from 280° in the west to 350° at Junction Peak and 10° at the Loddon River. There are cognate faults transverse to the system. It might correspond with the Linda Disturbance at Mt. Lyell, which is only seven miles west of the known westernmost limit of this system, and directly in line with it. As some of the faults in the Linda Disturbance and near Junction Peak are steep thrusts, it seems possible that some of those at Bubb's Hill are thrusts also.

(4) There is a fault in a direction 325° from the 34-mile post on the Lyell Highway and it is named the Artist's Hill Fault. It separates rocks of the Mary Group, striking at about 280° and dipping south-west from the Jane Dolomite, which has a similar attitude. This is a very important fault which marks the contact between two structural units in this area.

It is not possible yet to determine either the type of fault or its amount of movement because of lack of knowledge of the stratigraphic relationships of the rocks in the structural units, but it seems possible that it may be a Precambrian fault of very large throw, possibly with later Palaeozoic movement.

(5) There is a set of faults which trend north-north-easterly and which are probably normal faults of small throw. This group is common in the Mt. Mary area but is less important here. There are a number of these on Mt. Mullens, but the most important are those faults, trending at 60°, which displace the Collingwood Range quartz-schist, in the north-western part of the area.

PETROLOGY

The petrographic character of the most important rock types is given and this is discussed from a purely stratigraphic viewpoint to show how the major stratigraphic groups can be distinguished from each other, and to allow comparisons with adjacent areas.

A detailed study of the petrology of the rocks in this and the adjacent areas is now in progress.

The Precambrian rocks in this area consist almost entirely of regionally metamorphosed sediments with some minor pre-metamorphic basic intrusives. The grade of metamorphism is different in the different stratigraphic groups, as the Jane Dolomite is apparently unmetamorphosed, the Scotchfire and Mary Groups belong to the chlorite zone (muscovite-chlorite subfacies of the greenschist facies of Turner and Verhoogen, 1951), and the Joyce and

Franklin Groups belong to the garnet zone (chloritoid-almandine subfacies of the albite-epidote amphibolite facies).

Mary Group

This is composed of massive, white siliceous rocks (here called "massive quartzites"), platy, white siliceous rocks with some sericite (here called "quartz schists"), and light-grey foliated, sericite-rick rocks (here called "phyllites"). This follows the nomenclature used for similar rocks by Spry (1957b).

The fundamental difference between these three rock types lies in the composition, and in particular in the relative proportions of quartz and sericite. Differences in the quartz-mica ratio have resulted in structural differences because of their different methods of deformation. The coarse-grained quartzites behaved differently from the fine-grained, mica-rich phyllites.

The massive quartzites are coarse-grained, non-schistose rocks, with not more than 1% to 2% of mica. The quartz schists are fine, even-grained rocks with a distinct foliation and contain about 10% to 20% of mica. The phyllites are very fine grained rocks with a strong foliation and contain up to 50% of mica.

Massive Quartzite

Specimen 6827 from the Collingwood Range is a typical massive quartzite. It is white in colour, well bedded, and has grains of quartz visible in the hand specimen. In thin section it is moderately coarse grained with a mortar texture. Large (up to .5 mm.) xenoblastic quartz grains, showing undulose extinction, are set up in a matrix of quartz grains about .15 mm. across, showing a slight tendency towards elongation.

Quartz Schist

Specimen 6970 is a typical example from very near the base of the Mary Group and it outcrops just west of the Franklin River, ¼-mile north of its junction with the Loddon River. It is a white, fine-grained, platy quartzite, with sericite visible on the foliation planes. A distinct lineation is caused by tiny crenulations. In thin section it is a very fine-grained rock, consisting chiefly of quartz grains ranging in size from .05 mm. to .2 mm., together with about 10% sericite as tiny parallel flakes giving the foliation. The quartz shows a slight tendency towards elongation and shows undulose extinction. Accessories are well rounded zircon, rutile, a little iron ore and abundant tourmaline showing a skeletal form.

Specimen 6815 occurs in the un-named large creek west of the Collingwood Range in the vicinity of the Junction Peak Fault. In hand specimen it is quite similar to the rock described above, but the microscope shows it to be much more strongly deformed. It is a rather fine grained quartzite with a pronounced foliation produced chiefly by strong elongation of the quartz grains, together with a little parallel sericite. The quartz grains show undulose extinction and are crossed by parallel lines of opaque inclusions which traverse the whole slide.

It is possible that the trains of inclusions mark the original bedding and that the schistosity has been produced at an angle to this. It at first appears significant that the most deformed rock found in the Mary Group occurs very close to a major fault and has a schistosity which dips and strikes (strike 360°. dip 60° W.) parallel to the fault whose attitude was determined independently. Throughout the area, the general degree of deformation and the foliation are clearly not related to the faulting, which can be shown to be later than the metamorphism, but it is possible that some of the faults were formed during the Precambrian with repeated movement in the Tabberabberan.

Franklin Group

This consists chiefly of mica schists with some garnetiferous and albite-rich varieties and some which are sufficiently coarse to be called gneisses.

Specimen No. 6799, from the Lyell Highway, 29½ miles from Queenstown, is a fine-grained, light-grey crenulated schist. In thin section it is a moderately fine-grained, schistose rock consisting of quartz (60%), muscovite (15%), chlorite (15%), and albite (about 10%), with accessory rutile, tourmaline, zircon and iron ore. The quartz ranges in size from .05 mm. to .2 mm. and forms xenoblastic interlocking crystals, some of which are elongated parallel to the schistosity. The albite forms shapeless crystals with abundant inclusions and a few crystals are twinned.

Specimen No. 6800, from just north of the Franklin-Collingwood junction, is somewhat similar except that it contains more muscovite and no chlorite. It shows one foliation due to bands of muscovite flakes with a second lesser foliation at 20° to the first in the quartz-rich layers between the bands. The albite occurs mostly as small lenticular crystals rimmed with iron ore and embedded in the mica-rich layers. The quartz is elongated parallel to the major foliation.

Specimen No. 6801, from the Lyell Highway, 28½ miles from Queenstown, is a silvery-grey schist with small garnets. Under the microscope, it is a fine-grained schistose rock consisting chiefly of quartz and muscovite with lesser garnet, chlorite and biotite. The quartz is elongated parallel to the foliation which is marked by layers of parallel muscovite flakes. The garnet has been replaced by chlorite.

Specimen 6797 occurs ¼-mile east of the Lyell Highway, up the creek which crosses the Highway 27¾ miles from Queenstown. It contains large crenulated porphyroblasts of biotite, some of which have been chloritized, set in a fine-grained schistose matrix rich in quartz and muscovite.

Jane Dolomite

This consists of massive dolomite together with dolomite breccia, but, as a large number of thin sections of the former variety in the type locality to the south consist merely of a fine-grained aggregate of dolomite with a little quartz and talc, only the breccia is described in detail here.

The breccia is massive and unbedded and contains angular fragments, chiefly of dolomite, but some of unmetamorphosed mudstone, up to several feet across, the majority being a few inches across. In thin section the rock consists of angular fragments of all sizes in a dolomite matrix. Most of the fragments are composed of dolomite; some are very fine grained, but others are irregularly recrystallised with coarser veins and patches through the fine-grained carbonate.

Some particles are composed of quartz and muscovite with a distinct schistosity and are classed as fine-grained schist. One such grain contains a number of idioblastic tourmaline crystals. The direction of schistosity is constant for any given grain, but is unrelated in adjacent particles.

There are a few fragments of extremely fine-grained slate and siltstone and some rather coarse, even-grained quartzite.

The matrix consists chiefly of idioblastic dolomite rhombs, together with quartz, sericite and a little pyrite.

Scotchfire Group

The glossy, pale-green phyllites and fine-grained schists, together with thin dolomites. dolomitic schists, quartzites, slates and basic intrusives, extending along the Lyell Highway from the 34-mile post almost to the King William Saddle, are correlated lithologically with the Scotchfire Group. Specimens 7152, 7703 and 7706 illustrate some of the schists of this group.

Specimen 7152 is a dark-grey, lustrous phyllite from the Lyell Highway below Mt. Arrowsmith. It shows a strong foliation and lineation. Under the microscope it is seen to be a fine-grained rock consisting of quartz (about 50%) and sericite (40%) with abundant chlorite and accessory tourmaline and iron ore. The quartz ranges between .04 mm. and .1 mm. in size, whereas the sericite is very small. The schist shows three distinct foliations.

Number 7703, from the Lyell Highway near the 40-mile post from Queenstown, is a dolomitic schist. It is a very pale brown, glossy, fine-grained, contorted schist with a distinct lineation (fine crenulation). In thin section it is a banded and schistose rock, cosisting chiefly of quartz, sericite and dolomite. The structure is complicated because there are three distinct foliations, and these complexities will be dealt with elsewhere.

Specimen No. 7706, from the Carbonate Creek, a little over a mile up from its junction with the Franklin, is an excellent sample of a calc-schist. It is a dark-grey, lustrous, fine-grained schist with bands of fine-grained dolomite parallel to the foliation. Under the microscope it is seen to be a fine-grained schistose rock consisting of approximately 40% dolomite, 40% quartz and 20% of mica (sericite and chlorite), with accessory tourmaline and iron ore.

Older Basic Igneous Group

There are at least two small exposures of metamorphosed basic igneous rock to the east of this area. They are tentatively correlated with the pre-metamorphic basic intrusives of the Mt. Mary area because of the severe shearing they have suffered, even though they are of a lower metamorphic grade. Specimen No. 7704 was taken from a small quarry about a chain south of the Lyell Highway in the disused picnic grounds on the Surprise River about 35¾ miles from Queenstown. It was recorded by Finucane and Blake (1933) and presumed to be a Cambrian intrusive, but the authors think that it is more likely to be of Precambrian age. Microscopically, it is a fine-grained, rather schistose rock with a greenish-grey colour and contains abundant small porphyroblasts of epidote, chlorite and feldspar.

In thin section it is schistose with large fractured crystals of albite and lenses of chlorite set in a fine-grained matrix of albite, actinolite and chlorite. Epidote occurs as scattered large crystals and rutile is accessory.

The large (.9 mm.-4 mm.) crystals of albite are dusty with inclusions and are shattered; augen shapes are common and some crystals are sliced through with fracture planes. The feldspar of the matrix occurs as tiny (.05 mm) grains and is fresh, clear and untwinned. It occurs somewhat patchily and looks as though it has been derived from large crystals which have been smashed up and mixed with other secondary products.

There is about 5% to 10% of idioblastic epidote in prisms up to .5 mm. long; it is pleochroic in pale yellows and has a 2V of about 80°-ve.

Lenticular masses from .5 to 2 mm. across of chlorite are pale-green, pleochroic and almost isotropic. It has probably replaced large pyroxene crystals.

A pale-green actinolite occurs abundantly as needles in the groundmass where is forms a poorly-directed mesh with albite, epidote and chlorite.

The augen shapes, schistosity and fragmentation all indicate considerable deformation, but from the lack of preferred orientation of the actinolite, there has probably been a good deal of post-kinematic crystallization of amphibole.

The assemblage albite-epidote-actinolite-chlorite is typical of the greenschist facies, whereas the albite-hornblende-garnet assemblage of the amphibolites in the Franklin Group is of distinctly higher grade and belongs to the albite-epidote-amphibolite facies.

Specimen No. 7705, from just east of the 34-mile post from Queenstown, on the Lyell Highway, is possibly related to the above. It is a light, greenish-grey rock, fine-grained and weakly-schistose with a mottled appearance. In thin section it is seen to be a fine, even-grained rock consisting of chlorite, albite and sericite with a little ilmenite and apatite. The only signs of any original igneous structure are a few scattered laths of albite and some skeletal grids of ilmenite.

The chlorite, which is pale-green and almost isotropic, forms a fine mesh. There is a set of parallel planes cutting the rock; these are marked by lines of tiny opaque granules and parallel chlorite flakes.

The feldspar is albite and occurs both as large prisms, some of which show Carlsbad twinning and sericite flakes along the cleavage, or as shapeless granules in the groundmass.

Small flakes of sericite occur together with the chlorite flakes and in parts these have reacted to give small, pleochroic flakes of biotite. This indicates that the rock is in the transition stage from the muscovite-chlorite to the muscovite-biotite sub-facies of the greenschist facies.

Conclusions

As elsewhere in this region, there is a difference in the degree of metamorphism of the different stratigraphic groups. The Jane Dolomite seems unmetamorphosed; the Mary and Scotchfire Groups belong to the chlorite or lower biotite zone (greenschist facies), whereas the Joyce and Franklin Groups belong to the garnet zone (albite-epidote-amphibolite facies). This problem was mentioned by Spry (1957b) and is at present being investigated.

Locality Index

	Internat. Grid Reference K/55	S. Lat.	E. Long.
Alma River	Lyell 58	42° 7′	145° 59′
Artist's Hill	Lyell 58	42° 12′	146° 0′
Bubb's Hill	Lyell 58	42° 7′	145° 45′
Carbonate Creek	Lyell 58	42° 12′	146° 0′
Christmas Rock	Lyell 58	42° 22′	145° 52′
Collingwood Range	Lyell 58	42° 10′	145° 53′
Collingwood River	Lyell 58	42° 10′	145° 59′
Eldon Range	Murchison 51	41° 59′	145° 50′
Flat Bluff	Lyell 58	42° 10′	145° 44′
Forth River	Sheffield 35	41° 25′	146° 15′
	Middlesex 45		
Gould's Sugar Loaf	Lyell 58	42° 4′	146° 59′
Governor River	Lyell 58	42° 12′	145° 42′
Jane River	Pillinger 65	42° 28′	145° 50′
Joyce Creek	Lyell 58	42° 10′	145° 48′
Junction Peak	Lyell 58	42° 13′	145° 56′
King River	Strahan 57	42° 10′	145° 30′
	Lyell 58		
King William Range	King William 66	42° 20′	146° 8′
Lake Hermione	St. Clair 59	42° 7′	146° 3′
Lake Undine	St. Clair 59	42° 6′	146° 3′
Lake Dixon	St. Clair 59	42° 8′	146° 3′
Loddon River	Lyell 58	42° 16′	146° 0′
	King William 88		
Mersey River	Sheffield 37	41° 19′	146° 28′
	Middlesex 45	42° 12′	146° 4′
Mount Arrowsmith	St. Clair 59		
Mount Gell	St. Clair 59	42° 9′	146° 1′
Mount Hardy	Lyell 58	42° 11′	146° 59′
Mount Madge	Lyell 58	42° 7′	145° 45′
Mount Mary	Lyell 58	42° 12′	145° 50′
Mount Maude	Lyell 58	42° 13′	145° 48′
Mount Mullens	Lyell 58	42° 13′	145° 59′
Queenstown	Lyell 58	42° 5′	145° 33′
Stonehaven River	Lyell 58		
(Creek)	Lyell 58	42° 12′	145° 59′
Surprise River	St. Clair 59	42° 15′	146° 3′
	King William 66		
Surveyor Range	Pillinger 65	42° 24′	145° 52′
Ward's Bluff	Lyell 58	42° 11′	145° 52′

References

Blake, F., 1936.—District between Jane River and Prince of Wales Range. *Tas. Dept. of Mines Typewritten Rept.* (Unpub.)

———, 1937.—Report on Geological Reconnaissance of Surveyor and Deception Ranges. *Tas. Dept. Mines Typewritten Rept.* (Unpub.)

Finucane, K. J., and Blake, F., 1933.—Country between the West Coast Road and the Jane River. *Tas. Dept Mines Typewritten Rept.* (Unpub.)

Gill, E. D., 1956.—Radiocarbon Dating for Glacial Varves in Tasmania. *Aust. Jour. Sci.*, Vol. 19, No. 2, p. 80.

Johnston, R. M., 1894*a*.— The Glacial Epoch of Australasia. *Pap. Proc. Roy. Soc. Tasm.*, 1893 (1894), pp. 73-134.

———, 1894*b*.—Notes on the Geology of Lake St. Clair. *Pap. Proc. Roy. Soc. Tasm.*, 1893 (1894), pp. 135-146.

Lewis, A. N., 1944.—Pleistocene Glaciation in Tasmania *Pap. Proc. Roy. Soc. Tasm.*, 1944, pp. 41-56.

Moore, T. B., 1896.—Further Discoveries of Glaciation, West Coast of Tasmania. *Pap. Proc. Roy. Soc. Tasm.*, 1894-95.

Spry, A., 1957*a*.—The Precambrian Rocks of Tasmania, Part I. *Pap. Proc. Roy. Soc. Tasm.*, 91.

———, 1957*b*.—The Precambrian Rocks of Tasmania, Part II. *Pap. Proc. Roy. Soc. Tasm.*, 91.

———, 1958.—The Precambrian Rocks of Tasmania, Part III. *Pap. Proc. Roy. Soc. Tasm.*, 92.

Turner, F. J., and Verhoogen, J., 1951.—Igneous and Metamorphic Petrology. London.

Ward, L. K., 1908.—King William River to King William Range. *Dept. Lands and Surveys Rept.*, 1903-1908.

———, 1909*a*.—Report on the Geological Exploration of the Loddon and Jane River Country. *Dept. of Lands and Surveys Rept.*, 1908-1909.

———, 1909*b*.—Contribution to the Geology of Tasmania—The Precambrian. *Pap. Proc. Roy. Soc. Tasm.*, 1909, pp. 124-126.

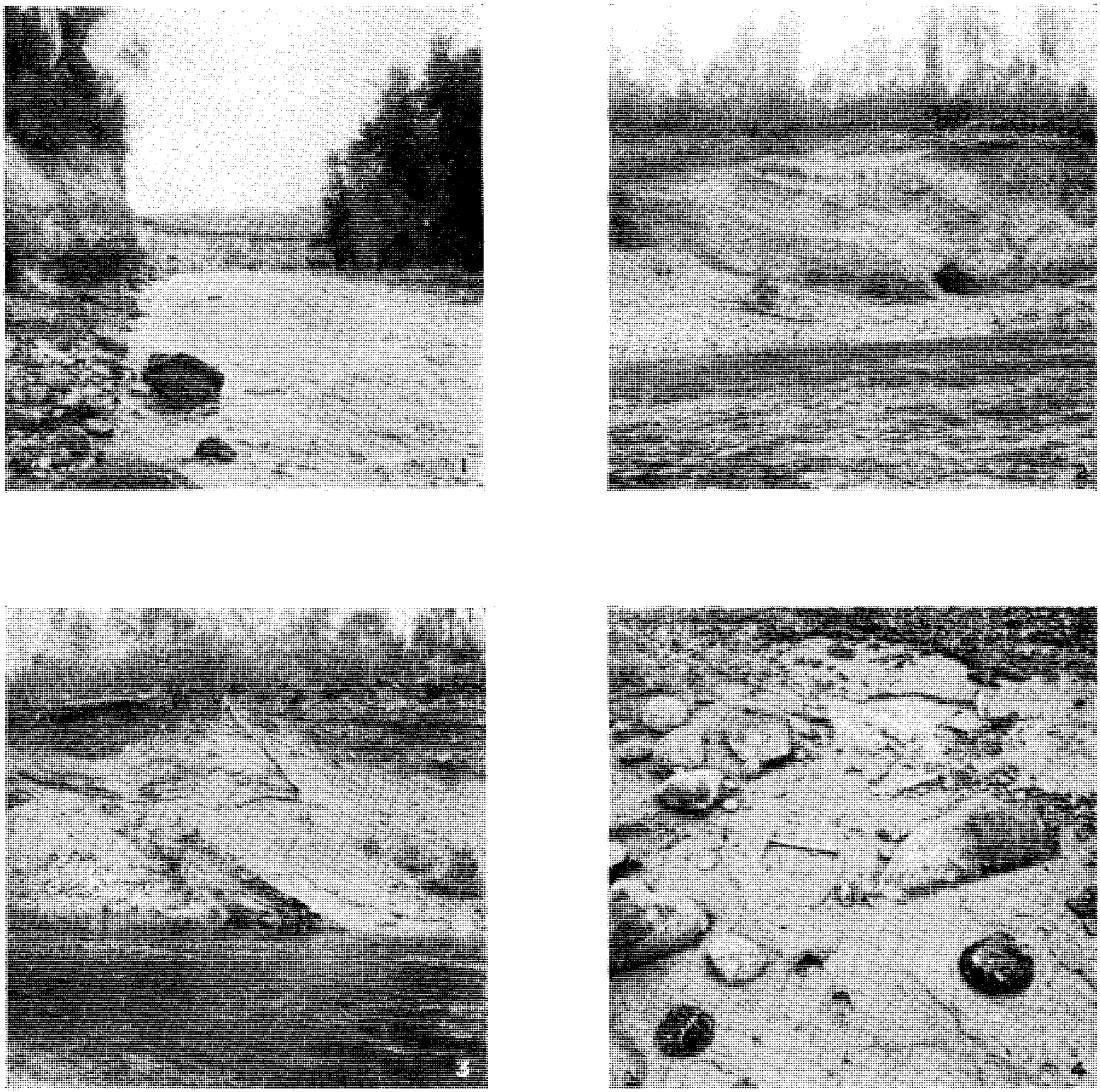


PLATE I.

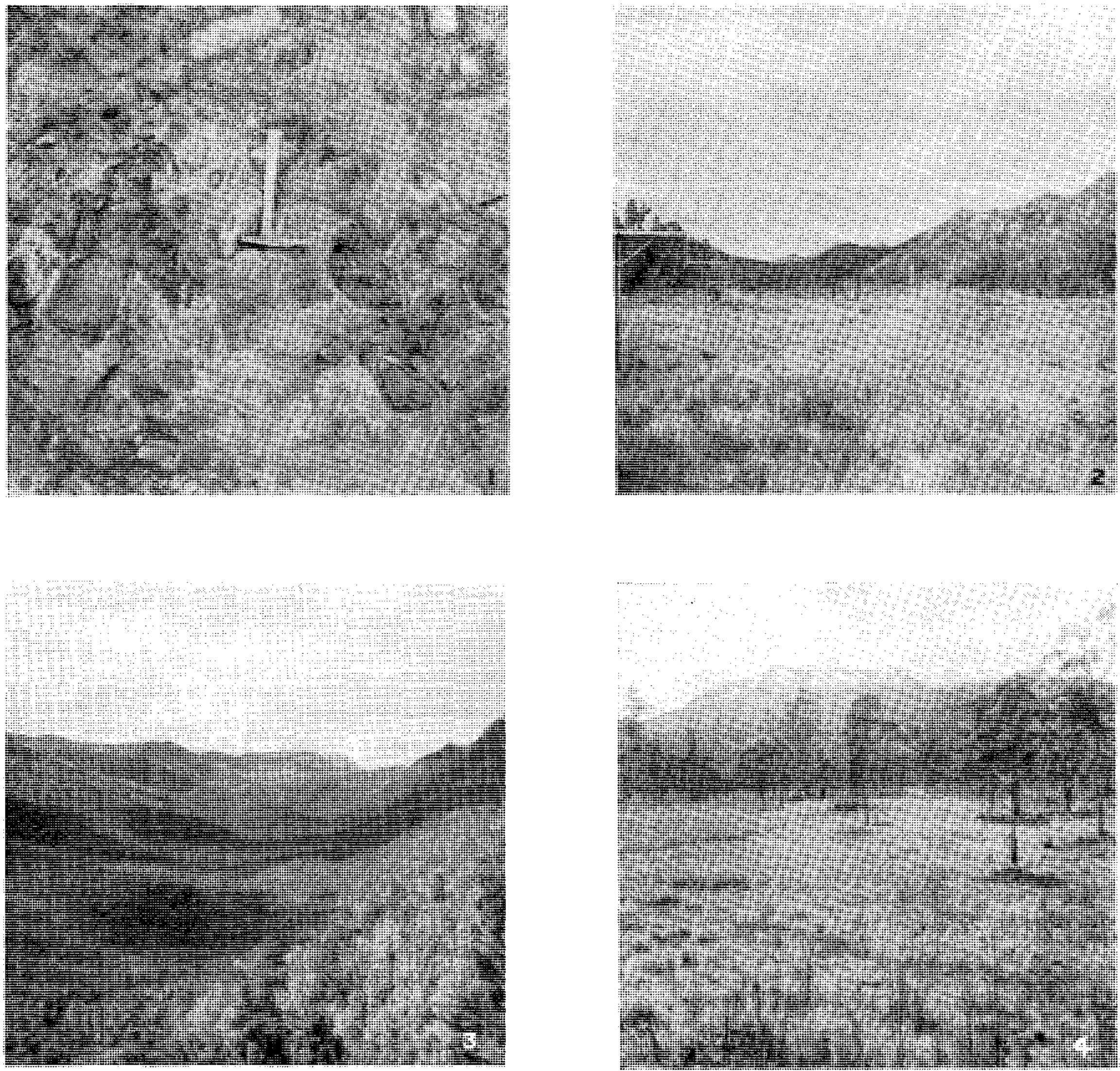
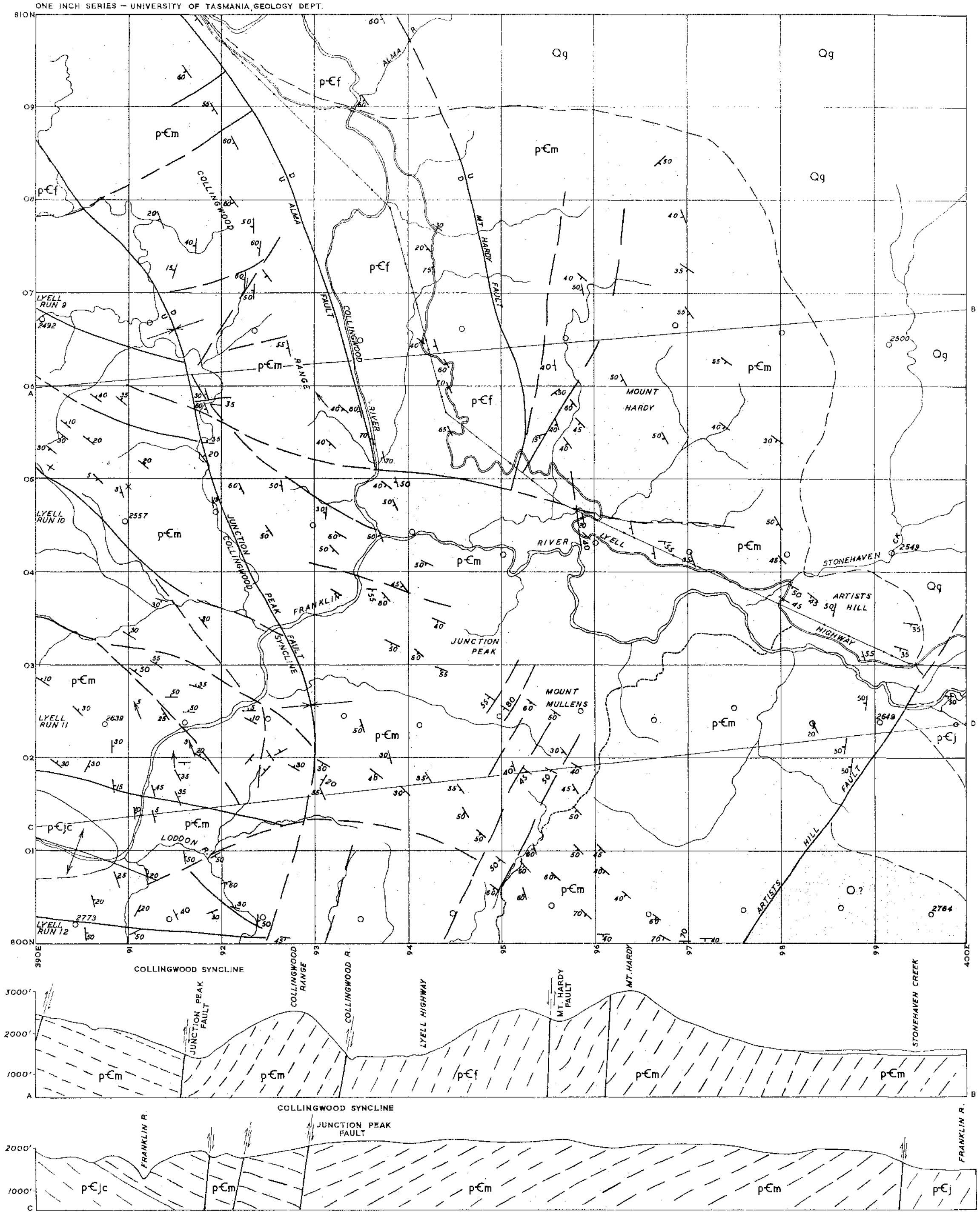


PLATE II.

GEOLOGY OF TASMANIA — MOUNT MULLENS — 3980

ONE INCH SERIES – UNIVERSITY OF TASMANIA, GEOLOGY DEPT.



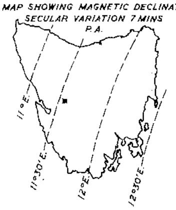
SCALE

0 — 2 MILES

0 1 2 3 4 5,000 — 10,000 FEET

KEY MAP SHOWING MAGNETIC DECLINATIONS

SECULAR VARIATION 7 MINS



Compilation from Aerial Photographs. Trigonometric Station Control by courtesy Hydro-Electric Commission. Origin of co-ordinates 400,000 yds. West and 1,800,000 yds. South of True Origin of Zone 7.

Pleistocene Series

- Qg — GLACIAL AND FLUVIOGLACIAL SEDIMENTS

Ordovician System

- O — UNDIFFERENTIATED SEDIMENTS

Precambrian

- p€j — JANE DOLOMITE
- p€f — FRANKLIN GROUP
- p€m — MARY GROUP
- p€jc — JOYCE GROUP

MAPPED AND COMPILED BY A. H. SPRY AND D. O. ZIMMERMAN – 1956.

- FORMATION BOUNDARY
- FORMATION BOUNDARY APPROX.
- U / D FAULT SHOWING MOVEMENT
- FAULT PROBABLE
- SYNCLINAL AXIS
- ANTICLINAL AXIS
- 40 DIP AND STRIKE
- PLUNGE OF LINEATION
- ROAD
- TRACK
- TRANSMISSION LINE
- \+ HORIZONTAL DIP

GEOLOGY OF THE MT. MULLENS AREA

1. BIBLIOGRAPHY:

FNUCANE, K. J. and BLAKE, F., 1933: "Country between the West Coast Road and the Jane River". **Tas. Dept. Mines Typewritten Rept. Unpub.**

JOHNSTON, R. M., 1894a: "The Glacial Epoch of Australasia". **Pap. and Proc. Roy. Soc. Tas.,** 1893 (1894) pp. 73-134.

JOHNSTON, R. M., 1894b: "Notes on the Geology of Lake St. Clair". **Pap. and Proc. Roy. Soc. Tas.,** 1893 (1894) pp. 135-146. ETAO ETAO

LEWIS, A. N., 1944: "Pleistocene Glaciation in Tasmania". **Pap. and Proc. Roy. Soc. Tas.,** 1944, pp. 41-56.

2. STRATIGRAPHIC TABLE:

AGE	GROUP	FORMATION	ROCK TYPE	THICKNESS
Pleistocene			Glacial and Fluvioglacial Sediments	60'?
		TABBERABBERAN OROGENY		
Devonian / Silurian / Ordovician	Eldon / Junee		Possible existence	
		TYENNAN OROGENY (?)		
		OROGENY		
Precambrian		Jane	Dolomite	3,000'?
		UNCONFORMITY (?)		
	Franklin		Mica, garnet schists	4,000'
	Mary		Quartz schists, massive quartzites, phyllites	12,000'
		MINOR UNCONFORMITY (?)		
	Joyce		Garnet-mica schist	?

3. LOCALITIES OF SPECIAL INTEREST.

Pleistocene glacials and fluvioglacials over Jane Dolomite	E399500.N803000
Pleistocene erratics of Crotty Sandstone	E397000.N803000
Pleistocene erratics of Jurassic Dolerite	E398500.N803500
Fault between Mary and Franklin Groups	E395200.N805300