THE PRECAMBRIAN ROCKS OF TASMANIA

PART III, MERSEY-FORTH AREA

By

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(With 7 Text Figures, 3 Plates and 1 Map)

ABSTRACT

The area shows considerable relief and a complex land surface in which the following elements were recognised; a pre-Permian surface, a Tertiary surface of mature river erosion, a flat, post-Tertiary-basalt surface, a maturely dissected and a young plateau (Central Plateau). The area has been affected markedly by the Pleistocene glaciation which produced mammilated surfaces, U-shaped valleys, roches moutonnées, till and varves. The till in the Mersey and Forth Rivers has been cut into a well-developed set of river terraces which show a possible climatic control.

The rocks in the area consist chiefly of a thick sequence of regionally metamorphosed sediments of Precambrian age which have been subdivided into several groups and formations. They are overlain by thin basal Permian sediments which have been intruded by a Jurassic dolerite sill. Tertiary volcanism has been active with the accumulation of 400 feet of coarse pyroclastics and 400′+ of basalts.

The regional structure is shown to be similar to that in several places around the edge of the Precambrian "nucleus". A major syncline occurs in this area with a major anticline to the north, the folds trending at 280°. Two fault systems are present; high-angle reverse faults striking at 280° and transcurrent faults striking at 315°. Schistosity is well-developed parallel to the bedding of the Precambrian rocks which also show lineation trending at 280°.

INTRODUCTION

The area was mapped for the Hydro-Electric Commission from December, 1955, to early March, 1956. The base map was a two-inch to the mile, 50 feet contour interval map, supplied by the Department of Lands and Surveys. Typical rock specimens were collected and are housed in the Geology Department of the University of Tasmania; the numbers in this report are those in the Geology Department catalogue.

Location of the Area

The area is located near the headwaters of the Mersey and Forth Rivers, immediately east of the Cradle Mountain Reserve, and south of Lorinna, Liena and Mole Creek.

Acknowledgments

The author must acknowledge the considerable help given by Mr. J. Davies of the University of Tasmania and Mr. J. N. Jennings of the National University in Canberra in the interpretation of the physiographic history of the area. Mr. I. McDougall assisted in the field and carried out the mechanical analysis of the till. This report is published by courtesy of the Tasmanian Hydro-Electric Commission.

Previous Literature

There has been no previous work published on this area but literature relevant to the adjacent areas is available.

Ward (1909) included the rocks to the south in a general summary of the Precambrian rocks of Tasmania. Benson (1916) made some brief geological notes on the area around Cradle Mountain. Reid (1918) gave a general description of the Mount Pelion region and made some reference to the geology along the Forth River. Clemes (1924) described the glacial features of the Lake St. Clair district. Lewis included this area in his account of Pleistocene glaciation in an extended series of papers, particularly (1932) and (1944). David (1950) made a general reference to glaciation in this area. Elliston (1954) mapped to the north around Lorinna.

PHYSIOGRAPHY

The area is one of considerable relief being situated where the edge of the high Central Plateau has been dissected by the north-flowing Forth and Mersey Rivers. The land surface is complex, being controlled by a number of different erosive processes which have acted on different structures.

The following physiographic units have been recognised:—

(1) Pre-Permian surface.—A flat surface generally at about 2400 feet but dipping south, exposed in some places by the stripping off of the sediments.

(2) Pre-basalt (Magg's) surface.—An undulating surface of fluviatile erosion of early Tertiary age dominated here by a mature valley which was developed by modification of the pre-Permian surface.

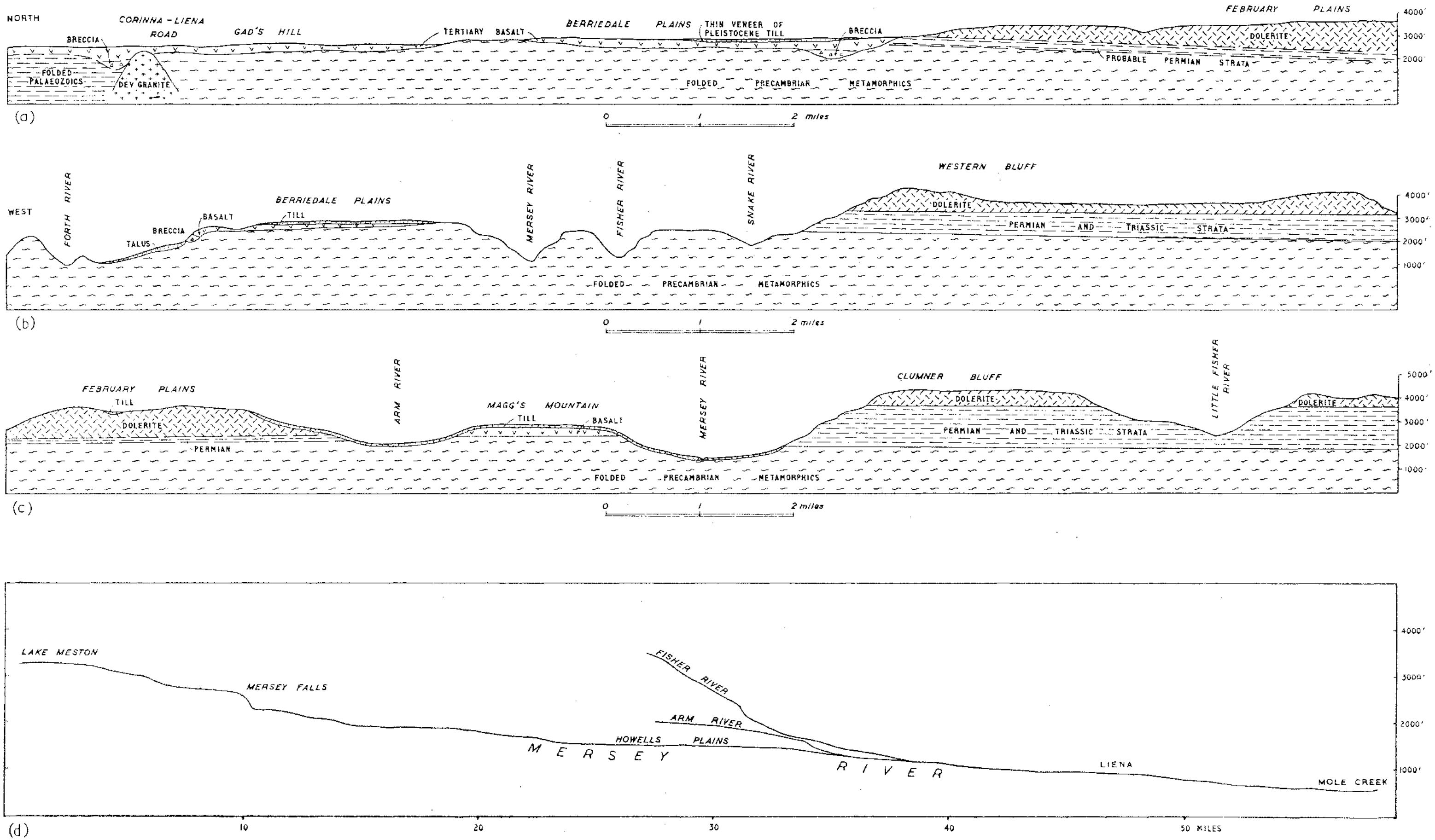

FIG. 1 (*a*, *b*, *c*).—Cross sections showing the physiography of the region and its relation to the geology.
FIG. 1*d*.—Longitudinal profile along the Mersey and its tributaries in its upper section. It has been glaciated for about the first 40 miles.

(3) Post Tertiary-basalt (Berriedale) surface.—A flat surface which is underlain by a variety of rocks and which descends from 3600 feet to 2350 feet in a northerly direction in 20 miles.

(4) Central Plateau.—A high (4000′+) extensive surface controlled by a great resistant dolerite sill. It is bounded on the north by the Western Tiers, a steep line of cliffs.

(5) Fold-mountain surface.—The strongly folded Palaeozoic rocks around Lorinna, Mt. Roland, Mole Creek, &c., show a strong W-N-W "grain" with ridges and cuestas.

(6) Karst surface.—An excellent, mature Karst landscape is developed in restricted areas near Mayberry which are underlain by Gordon Limestone.

The land surface owes its form to three processes:—

(*a*) Normal (river) erosion has been dominant with the production of the present valleys and the pre-basalt surface while the pre-Permian surface is probably a peneplain owing much to fluviatile action.

(*b*) Glaciation during the Pleistocene Epoch has greatly modified certain parts of the area, particularly the top of the Plateau and the river valleys.

(*c*) Pediment action has been dominant in the formation of the Tiers during scarp retreat.

Land Surfaces

1. *Pre-Permian Surface*

The surface upon which the Permian sediments were deposited has been exposed in some parts of the area lying between the Mersey and the Plateau near the Mersey-Arm junction. It has been dissected by the Fisher River and its tributaries. and remains as a flat top to a number of hills, e.g., Union Peak. It descends from 2450 feet to 2200 feet altitude in a distance of six miles from north to south, there being a component of dip of the Permian sediments in this direction. Ford (personal communication) reports that this surface changes in attitude and dips north-easterly just south of Western Bluff. This surface, which is underlain by folded Pre-cambrian and Lower Palaeozoic rocks, has had a profound effect, either directly or indirectly, on the development of all other surfaces in this area.

2. *Pre-basalt (Magg's) Surface*

This is defined as the land surface exposed immediately prior to the Tertiary volcanism. It has been buried by the basalt and its form was obtained by mapping the base of the basalt. The contour map, fig. 2, which shows the approximate configuration of this surface, was obtained by plotting the base of the basalt on a 200 foot contour interval map using the technique developed by Carey.

3. *Berriedale Surface*

This is a broad surface which has been dissected by the Mersey and Forth Rivers and remains as remnants, one of which is the flat-topped divide between the Mersey and Forth Rivers extending north of Mts. Pillinger and Oakleigh, through the February Plains, Magg's Mount, the Berriedale Plains and extending beyond Gad's Hill.

Magg's Mount is the flat-topped divide between the Mersey and Arm Rivers. The sides are steep and the top is generally at 2800 feet although there are undulations up to 2975 feet. It is underlain by a flat sheet of Tertiary basalt about 400 feet thick with a superficial layer of Pleistocene till, which may reach 100 feet in thickness.

The February Plains form the interfluve between the Forth and Arm Rivers north of the Mt. Oakleigh-Mt. Pillinger scarp. It reaches an altitude of about 3900 feet in the south but much of it lies at approximately 3600 feet altitude. It is 10 miles long and triangular in shape being six miles across in the southern end and two miles across in the north. It is underlain by a thick dolerite sill and thus is structurally akin to the Plateau but it is generally about 400 feet lower and is separated from it by the Mersey River.

The Berriedale Plains are the flat extension northwards of the February Plains and lie between the Mersey and Forth Rivers at an altitude of 2850 feet. The plains are about two miles wide from east to west and five miles long from north to south. They are underlain by Tertiary Basalt with a surface layer of Pleistocene till and are structurally similar in every way to Magg's Mount.

The Berriedale Plains descend gently to the north and after a slight depression become the Emu Plains then Gad's Hill. This has an altitude of about 2550 feet and is underlain by folded Precambrian and lower Palaeozoic sediments, Devonian granite and Tertiary Basalt.

Thus as the section fig. 1 (*a*) shows, there is a broad surface (here defined as the Berriedale surface) a residual of which forms the interfluve between the Mersey and Forth Rivers and which descends from south to north. It lies at 3600 feet at the February Plains, 2850 feet at the Berriedale Plains, 2550 feet at Gad's Hill and 2300 feet to the east of Lorinna. It averages about four miles wide and falls 1300 feet in its length of 20 miles. Another residual occurs on the west side of the Forth River where the surface descends to the north in exactly the same way.

This surface is independent of structure and rock type. It descends to the north even though the dolerite and pre-Permian surface descend to the south at the February Plains; and it cuts across folded Palaeozoic and Precambrian rocks and Tertiary basalt. It owes some of its flatness to the upper surfaces of the basalt flows which filled up irregularities in a previously undulating landscape and it has been partly smoothed by the Pleistocene glaciation.

4. *Central Plateau*

This is a major physiographic feature of Tasmania and extends over hundreds of square miles as a high level surface with a general altitude of 4000 feet. It rises to 4600 feet in some places and is bound in the north and east by the steep scarp of the Western Tiers. The western boundary of the Plateau is indefinite but has been regarded as approximating to the eastern side of the Cradle Mountain Reserve and the Mersey River; thus the

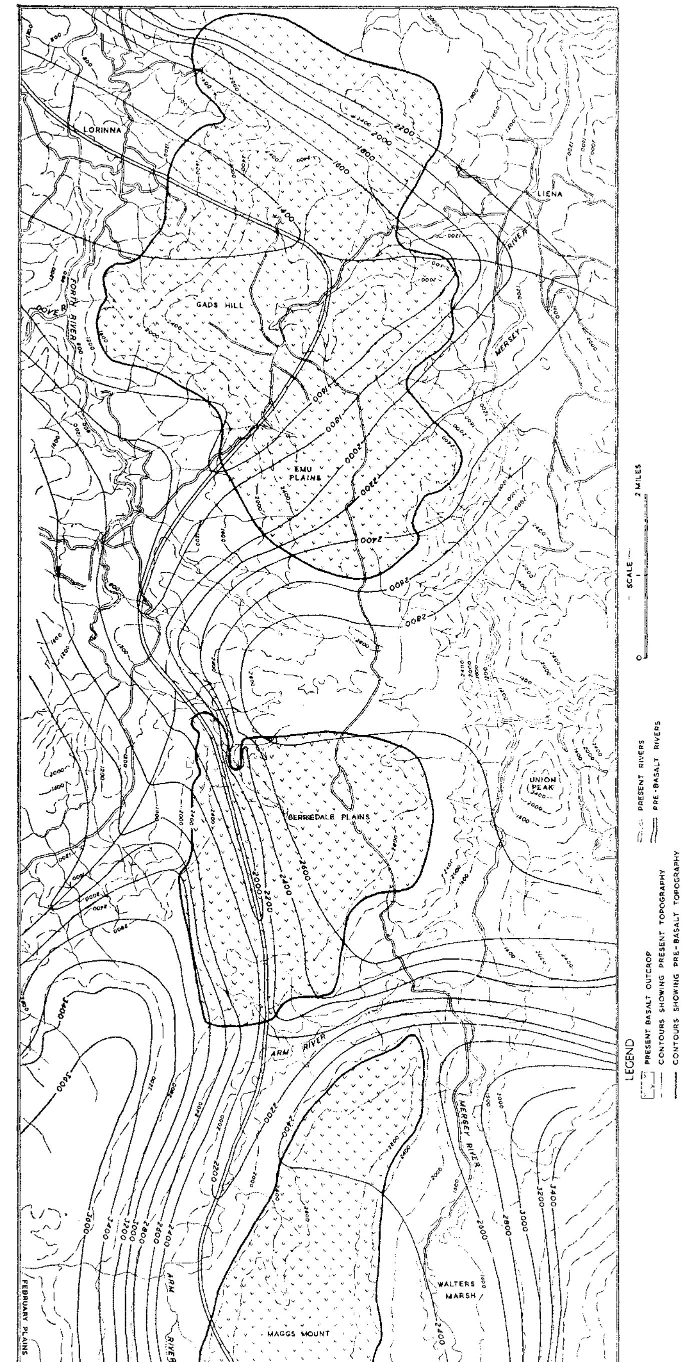

FIG. 2.—Contour map showing the distribution of Tertiary basalt and the relation between the pre-basalt topography (heavy contours) and the present surface (light contours).

rugged country in the Reserve with its peaks reaching over 5000 feet, although structurally cognate, may be regarded as a separate physiographic unit. The upper surface of the Plateau is comparatively flat, especially towards Great Lake but is cut by many 600 feet deep valleys in the vicinity of the Walls of Jerusalem, where it has been strongly glaciated. There is an irregular, raised rim which reaches an altitude of 4600 feet and this is a characteristic feature of the Tiers.

The Plateau owes its form to a resistant dolerite sill which is over 1000 feet in thickness and from which practically all the roof sediments have been stripped. In some places (Liaweenee, Wentworth Hills) there are small areas of Tertiary basalt resting on the upper surface.

The scarp of the Plateau constitutes the Western Tiers and is made up of an upper, dolerite cliff as much as 1000 feet high although generally not being more than 400 feet, and a lower, steep slope up to 2000 feet high underlain by subhorizontal Permian and Triassic sediments. Giant scree slopes of dolerite debris are a common feature.

The Plateau originally extended at least as far west as the Eldon Range and Mt. Dundas but the dolerite and the Permian and Triassic sediments have been removed, except for a few small outliers. The reason for the abrupt change from a youthful, undissected plateau in the east to a mature strongly broken plateau in the west is not known although some suggestions were made by Spry (1956).

The Western Tiers from Western Bluff to Table Mountain is practically unbreached for about 80 miles and the major drainage from the youthful Plateau is to the south-west except where locally controlled by Tertiary faulting. The present Central Plateau is a small remnant of the surface which must have extended over at least two-thirds of Tasmania during the late Mesozoic and it remains unbroken because of the lack of north flowing rivers.

River System

The two chief rivers are the Forth and the Mersey and these show quite straight courses for 20 miles in this area. Both rivers show a long and complex history of development extending back to the beginning of the Tertiary Period.

Mersey

The longitudinal profile of the Mersey (see fig. 1) shows many of the characters typical of glacial valleys.

The Mersey rises high on the Plateau at Lake Meston and runs south-west across morainal ridges and glacial steps before descending rapidly down the scarp in a series of waterfalls. In this section it descends 2000 feet in five miles in a U-shaped valley. Beyond the turn to the north at Cathedral Mountain, past Mt. Pillinger and Rugged Range to Howell's Plains it has a markedly different character. It meanders slightly across its broad, flat, till covered floor which is up to one mile wide, and it has a characteristic U-shaped section with walls nearly 2000 feet high. The valley takes two right-angled bends. It has cut chiefly through Permian sediments in this section and spurs are lacking.

Between Walter's Marsh and the Arm River junction, the valley is narrower, although the U-shape persists (fig. 3*c*, 3*d*). The river here cuts through steeply dipping Precambrian sediments which strike obliquely across its course. Steep cliffs, truncated spurs and smoothed quartzite faces occur. Low rock bars cross the river in several places. The river terraces which are strongly developed in this section are described in detail later and are shown in fig. 5.

North of the Arm junction (fig. 3) the river becomes narrower and has steep sides with a V-shaped section. The bottom is still rather flat in parts and some terraces are developed. While it is not obvious in the field, the contour maps show spurs which appear to be truncated but interlocking spurs occur just north of the Fisher-Mersey junction. Quartzite scree slopes are prominent in this section.

The valley becomes broader and flatter bottomed at Liena (fig. 3) where the river has cut through Gordon Limestone. There is a gorge through the anticlinal ridge of Ordovician quartzite and then the river turns east where it occupies a broad flat-bottomed limestone valley west of Mole Creek (fig. 3).

Forth River

Although not studied in detail, the Forth River shows features in common with the Mersey. It rises in the area around Mts. Achilles, Ossa and Pelion East and has a steep gradient west of Mt. Oakleigh. From here north to Gisbourne's Hut it occupies a broad, straight, deep, U-shaped, glaciated valley. North of Gisbourne's Hut the valley narrows and becomes V-shaped (although interlocking spurs are lacking) until north of the Dove junction where it passes out of the Precambrian into Ordovician quartzite and limestone. In the vicinity of Lorinna it occupies a moderately broad valley which is underlain by limestone (fig. 3).

Arm River

The Arm River is a tributary of the Mersey and is only about 14 miles in length. For the greater part it occupies a very broad valley (fig. 1*c*) between the high February Plains and Magg's Mount. Spurs are truncated although two low rock bars cross the river. There is an abrupt change of character in the last 2½ miles before it joins the Mersey and here it descends rapidly with rapids and small waterfalls through a small gorge cut in the floor of the valley.

Erosive Processes

The most important agents responsible for the development of the present physiography were the Mersey and Forth Rivers, aided by the Arm, Fisher and Little Fisher Rivers. The area is youthful, being a complex plateau slightly dissected by young river valleys.

The effect of ice action during the Pleistocene glaciation although quite extensive is quantitatively less important than river action. The glacial physiography will however be discussed in detail because its effects are for the most part much more important than has been recognized in the past.

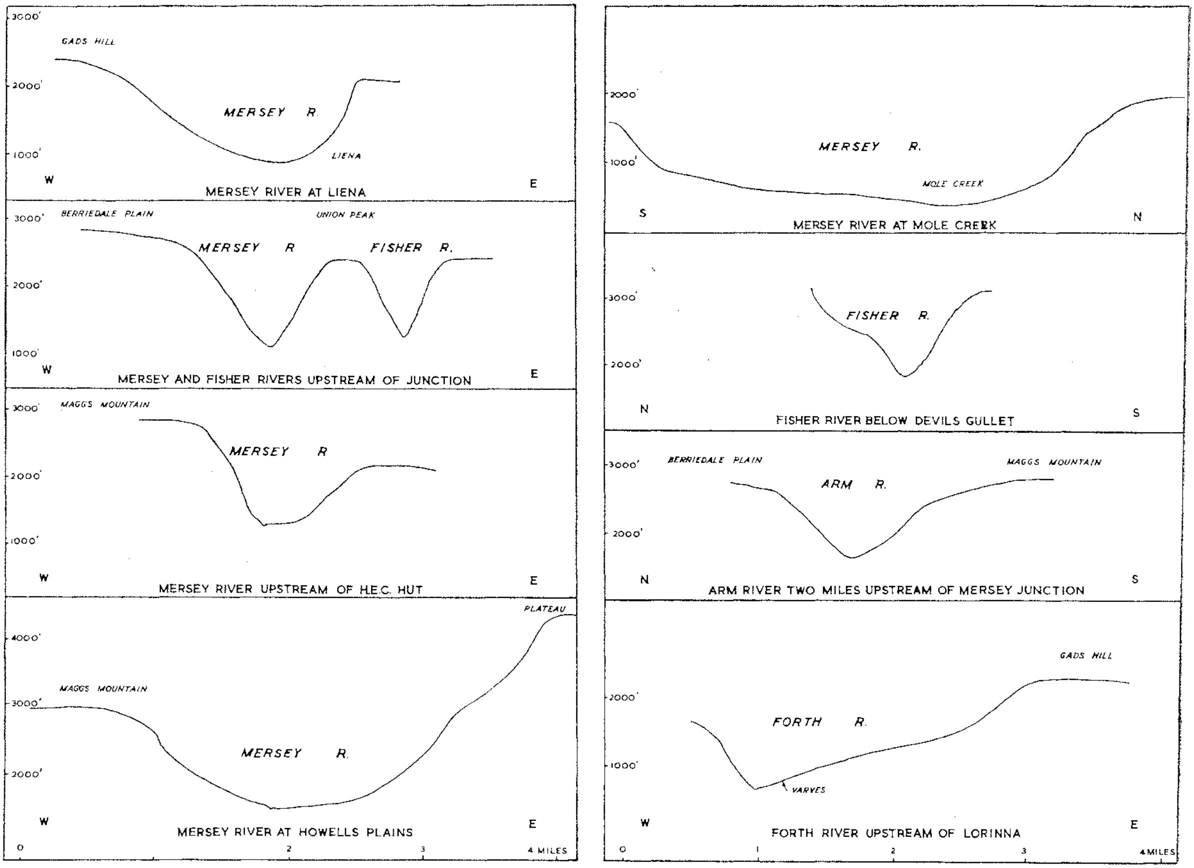

FIG. 3.—Transverse sections across the valleys of the Mersey, Forth, Arm and Fisher in various places.

The Plateau shows abundant evidence that it was covered by an ice cap of considerable magnitude and the complex effects are at present being studied in detail by J. N. Jennings of the National University, Canberra. At present it can be said that one centre of the cap was in the vicinity of the Walls of Jerusalem and that the extensive area of large and small lakes represent the eroded zone with areas of deposition to the east and south. The ice spilled over the edge of the Plateau in many places, filled the previously existing Forth, Mersey and Little Fisher Rivers and covered the interfluves. All these rivers (together with the Arm) show clear evidence of glacial action. They possess U-shaped valleys with truncated spurs, hanging valleys, smoothed quartzite outcrops, and roches mountonnées on their floors. There are end moraines in the Little Fisher Valley and varved shales in the northern part of the Arm, Fish and Forth Rivers (south of Lorinna). In the Arm River, the main body of varve laps against moraine material but the characteristic form of end moraines is not very clear. Some varved shale lying between till indicates slight recession and re-advance of the glacier (plate No. 2).

There are several more points of considerable importance which indicate that the ice in the Forth-Arm-Mersey area must have been nearly 2000 feet thick. In addition to the clearly demonstrated glaciation of the river valleys, the flat-topped interfluves (i.e., Magg's Mount and February and Berriedale Plains) and the high steep sides of the valleys are covered with many feet of till. The nature of this material is described in detail later but briefly it consists of a mixture of round dolerite boulders in a fine matrix. This material rests on Tertiary basalt at Berriedale Plains and Magg's Mount and in the latter case there is no way that such large (up to 6 feet) boulders of dolerite could be transported for 10 miles across a flat plain except by glacial action.

It would then appear that the ice flowed off the Plateau along the Forth River but *across* the Mersey River, possibly covered Mt. Pillinger and Mt. Oakleigh and passed across Magg's Mount and the February and Berriedale Plains to the Forth River. It is possible that the upper parts moved in this direction while the movements at the base of the sheet were controlled by the underlying physiography and the ice there flowed north-

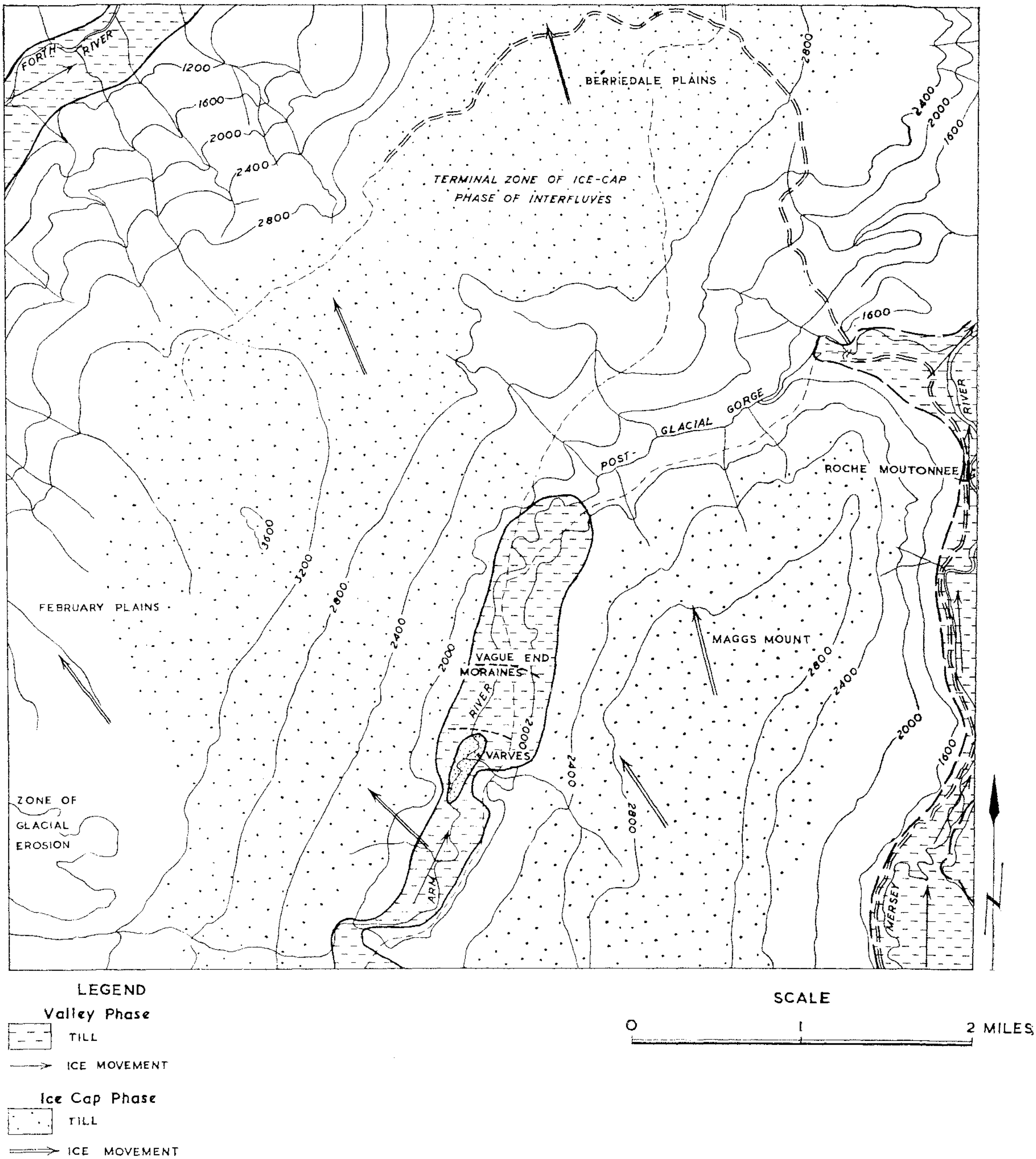

FIG. 4.—The approximate distribution of Pleistocene glacials and the probable directions of ice movement during the two phases of the glaciation.

wards along the Forth, Arm, Little Fisher and Mersey Valleys. The ice would then be at least 1600 feet thick and probably not less than 1800 feet in the Arm-Mersey-Forth area.

Many of the highest peaks in the Cradle Mountain Reserve show glacially smoothed sides and a sharp top with abundant evidence of frost action. This sharp difference suggests that the peaks might have projected through the upper surface of the ice cap as nunataks and that the altitude of the cap reached approximately 5000 feet in its thickest parts where it had a maximum thickness of 3000 feet. There is no doubt that frost attack is proceeding at present and that there has been sufficient time since the glaciation for the high dolerite peaks to have become jagged, but some parts of the Mersey valley, e.g. Rugged Range, show sharp, rough outcrops immediately next to smoothed, glaciated areas and it is clear both on the air-photos and in the field that some places within the glaciated areas have not been affected by glacial action. The altitude of the upper surface appears to have been about 4000 feet at Mts. Oakleigh and Pillinger and 3000 feet at the Berriedale Plain.

It is difficult to estimate the extent of the valley glaciation although the ice undoubtedly flowed north along the valleys beyond the edge of the thick ice cap. The rivers are clearly glaciated as far north as a line (Gisbourne's Line) joining Gisbourne's Hut, the Arm-Mersey junction and just south of the Devil's Gullet, but there is some evidence that the valleys may be poorly glaciated for at least three miles north of this line which marks the moraines on the Little Fisher and the varves and moraine of the Arm. The varves in the Forth River are eight miles north of this line and 150 feet above river level and probably filled a lake dammed behind a 400 feet high terminal moraine at Lorinna, the remnants of which are vaguely recognisable on the sides of the valley. North of the line, the Forth, Mersey and Fisher (particularly in the Devil's Gullet) show V-shaped valleys lacking the typical glacial form, but as there is no evidence of extensive post-glacial river erosion, it seems that all these valleys must be feebly glaciated. There appear to be truncated spurs in the Mersey for nearly 10 miles north of this line but as the valley shows no abrupt changes in character in this section it is not possible at present to recognize the limit of the glaciation. Cross sections across the Mersey valley at several points and also the Arm and Fisher valleys are shown in figs. 1, 3 and 4.

It is difficult to divide the glacial epoch into distinct stages but it is clear that apart from remnants of an early cirque-forming phase, there was a major ice cap and a later valley phase. It is considered that these are phases of one major glaciation.

The old cirques which have been almost destroyed by ice moving *across* them during the ice cap phase occur further south on the Plateau and were not studied, and for this reason are not discussed here.

During the ice cap phase, the ice moved to the north-west across the interfluves approximately as far north as the Gisbourne line and extended further northwards along the valleys as tongues. It is difficult to recognize the terminal moraines of the ice cap although the ground moraine covers the landscape. There is a vague moraine at Lorinna but it seems possible that the terminal moraines may have been removed by melt waters during the retreat of the ice cap.

The second phase was less severe and the glaciers were restricted to the valleys. Well developed glacial valleys were produced and striae and roches mountonnées show the ice to have moved northwards along the valleys. The Gisbourne Line marks the northern-most limit of the distinct U-shaped sections of the Mersey and Forth Valleys, the till on the floor of the Mersey, the end moraines of the Arm and Little Fisher and the varves of the Arm.

At present it is not possible to decide whether the first and second phases were separated by an interglacial period or whether the ice cap merely shrank leaving valley glaciers which were active for a considerable period with minor advances and recessions.

River Terraces

There is an extensive development of river terraces on the floors of the Forth and Mersey Rivers. The Mersey terraces are best shown in the two mile long section between the Mersey-Arm junction and Howell's Plains and these have been mapped in some detail as shown in fig. 5. Mapping was carried out using the pace and compass method for the base map and establishing heights by clinometer. The heights shown on the map are those above the river level at the nearest point. The terraces are generally well preserved and undissected with continuous, clear-cut flat surfaces. They are composed of a uniform, unsorted boulder-rich material and evidence produced later indicates that this is Pleistocene till. The terraces range in height from 3 feet to 400 feet above river level, the lower, more perfect ones being cut in till and the higher, fragmentary ones being cut in the solid rock of the spurs. There is no doubt that the terraces have been *cut* and not *deposited* by the river.

The Mersey Valley was occupied by a glacier during the last stage of the glaciation and was joined by a tributary glacier down the Arm. Removal of the ice left the floor of the Mersey Valley covered with at least 160 feet of till which definitely extended as far north as the Mersey-Arm junction and probably as far as the Mersey-Fisher junction. Further north at Liena the river terraces are composed of better sorted and rounded material which is probably fluvioglacial. The Arm contained 120 feet of till near its junction with the Mersey but this thinned rapidly upstream. It is difficult to estimate the actual thickness of till as the sides of the valleys and the interfluves are also covered. The terraces have been carved both in the valley walls and the till as the river cut down in post-glacial times.

The terraces do not show any marked differences in the type of material or soil development but may be divided into four groups depending on their heights above river level. There are small, flat-topped, rock-cut terraces at quite high levels on the side of the Mersey Valley. North-west of the Arm-

Mersey junction there are flats covered with water-worn quartzite and dolerite pebbles at 1800 feet, i.e., 400 feet above river level. There is a terrace at 1880 feet south-west of the junction above the Arm Bridge. There are similar vague flats on the west side of the Mersey opposite the Fisher River at 140* feet, 150* feet, 310* feet, 330* feet, 350* feet and 370* feet above river level. On fig. 5 are shown terraces at 160* feet, 150* feet, 145* feet and 130* feet, 120* feet and 95* feet.

The next group occurs at 75 feet, 65 feet, 65* feet 60 feet and 55* feet above river level and although fragmentary, they are better preserved and more extensive than the previous group. The 75 foot level is the highest cut in till and the 55 foot is the lowest rock-cut terrace. The next group occurs at 45 feet, 40 feet and 35 feet and these are very extensive, well preserved surfaces. All th previously mentioned terraces are too fragmentary to say whether they are matched or unmatched across the river, but although the 45 feet, 40 feet and 30 feet are well developed, once again this point is not clear. In some places the 45 feet and 35 feet are clearly matched across the present river but it is likely that the 45 feet on the west bank slopes down to 40 feet on the east bank and back to 30 feet on the west. Since the 65 feet level the river has progressively occupied less and less of the valley floor, and between the 40 feet and 30 feet level there was a distinct straightening of the river leaving truncated meanders and other parts of the course perched on the terraces. The river meandered around several low rocky hills on the 45 feet and 40 feet levels but these also were left stranded as the river straightened and cut downwards.

The group 30 feet, 26 feet, 20 feet, 16 feet, 10 feet and 3 feet are narrow and follow the present river course very closely. At the points marked T.B.L. there are marked constrictions of the course by islands and although there is continuity of surface of the terrace there is rapid decrease in height of 45 feet to 30 feet and lower from 40 feet to 30 feet. Above the constriction the surfaces of the terraces have a gentle slope indicating a flat grade with rapids across the temporary base level where the course narrowed and was held up by the hard quartzite bed rock.

There are two nodes showing restriction in the course of the river since the 45 feet and 30 feet levels.

The constant height of the upper surfaces of the terraces above the present river level indicates that the Mersey has not appreciably changed its grade since the 45 feet level and probably the 65 feet also. The Arm terraces however are more complex and show that the grade was much flatter at the 120 feet and 20 feet to 30 feet levels than at present; this is clearly shown by the terrace which is 30 feet above river level at the junction with the Mersey, but only 19 feet above at a point half a mile upstream. By contrast the 40 feet terrace of the Mersey is constant for half a mile and the 33 feet to 35 feet terrace rises only about two feet in almost one mile.

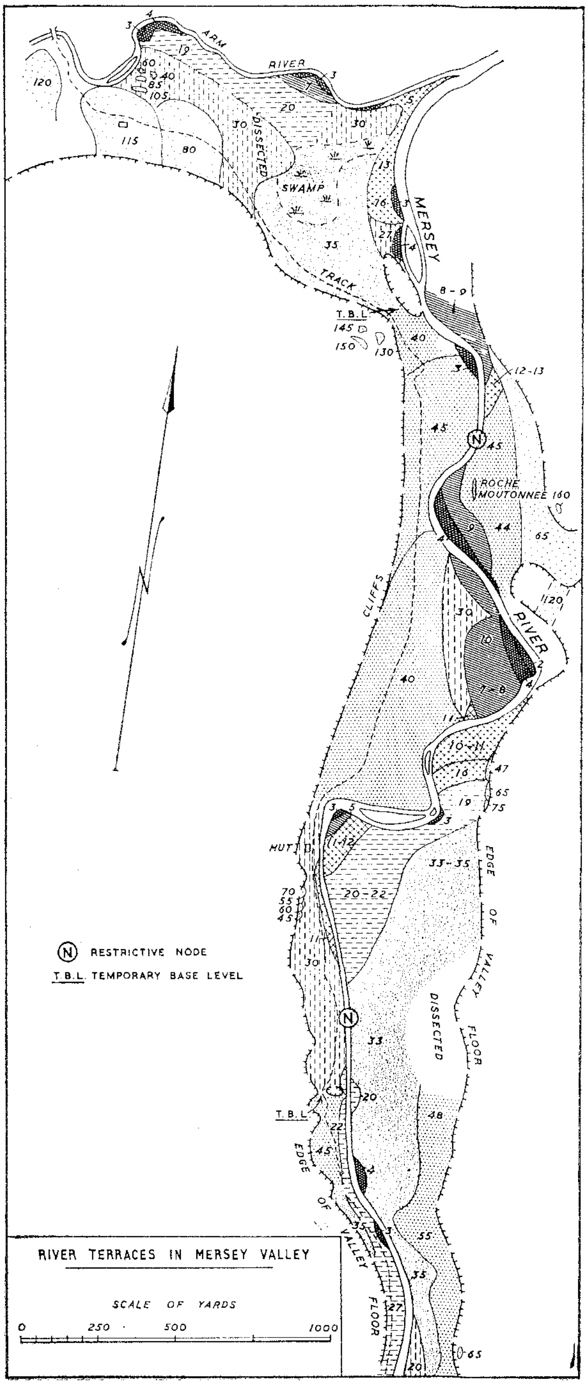

FIG. 5.—Sketch of the river terraces in the Mersey between its junction with the Arm and Walters Marsh.

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* Denotes rock-cut terraces.

At the close of the glaciation the Arm was left as a hanging valley perhaps 60 feet above the Mersey and the 120 feet and 110 feet terraces show it to have had a shallow gradient near the junction. However, as the Mersey cut quickly down through the till the Arm had to erode its quartzite floor and has produced a 60 foot gorge with waterfalls and rapids just above the Arm Bridge. In the zone at the Mersey-Arm junction there is a complex set of terraces shown in fig. 5 but no attempt has been made to interpret these.

A study of the river terraces reveals something of the history of the area since the Pleistocene and although the picture is by no means clear, the following interpretation seems likely.

The high level rock-cut terraces are possibly post-glacial as they occur in unprotected positions in areas which were clearly covered by ice and yet retains a cover of water-worn pebbles. It is possible that the valley contained till up to the 400 feet level and that the river meandered across this as it cut down in post-glacial times. Under these circumstances the meanders might cut nicks in the side of the valley wall in various places. This explanation requires a long period of active meandering and down-cutting and a great thickness of till in the valley.

It seems more likely that the flats were cut by meltwater streams flowing along depressions at the contacts of the glacier with the valley walls. These proglacial streams would be quite active. The varves in the Fish River were probably deposited in a lake dammed by the Mersey glacier at this time.

After the disappearance of the ice from this stretch of the river the Mersey proceeded to cut steadily down through at least 75 feet of till. This indicates a gradual alleviation of the climate and as the river showed no tendency to cut a gorge through the soft till it seems that there was neither a sudden release of meltwater nor a period of excessive rainfall.

The river has since cut a series of meander terraces as it swung from side to side, occupying progressively less and less of the valley floor. There was a slight change at the 55 feet level but the only distinct break in the river's history was at the 30 feet to 40 feet level. The river had been held up by two local base levels (shown in fig. 5) and had meandered behind them, but rejuvenation led to a straightening of the course and a rapid down-cutting. The series of terraces in 5 feet steps from 0 to 30 feet is probably related to the removal of local base levels further downstream.

It is unlikely that change in sea level either during or after glaciation would affect the river near its headwaters at a distance of 40 miles from the sea and 1600 feet altitude, and it seems that any rejuvenation must be related to increased rainfall as there is no possibility of any major river capture further upstream.

Gill (1954) has summarized evidence for climatic changes in Victoria during recent times. Although there is not necessarily any close relation between the climates of Victoria and Tasmania during this time, the Mersey terraces may be placed in their approximate time positions. If the correlation is

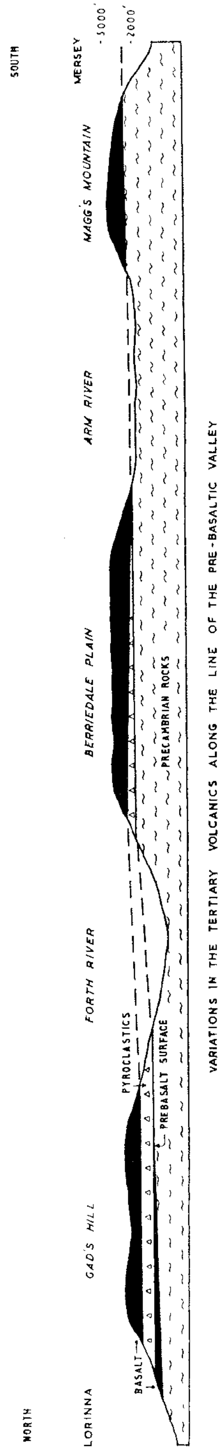


FIG. 6.—Sketch along the centre line of the pre-basaltic valley shown in fig. 2 indicating the relative distribution of lavas and pyroclastics.

correct, the period from the 75 feet to the 55 feet terrace would correspond to the gradually warming up from glaciation to the Post-glacial Thermal Maximum and this seems a reasonable fit. The rejuvenation at 30 feet would be associated with increased rainfall after the dry Thermal Maximum leading up to the Little Ice Age. The reconstruction here will not be clear until the history of the lower part of the river and the sequence of eustatic changes of the coastline are determined. One should not overlook the possibility of rejuvenation of the rivers due to isostatic recoil of the area following the removal of a large ice cap, although this ice cap was much smaller than known caps whose melting was followed by recoil.

Geomorphic Evolution

By the end of the Mesozoic Era, following intrusion of dolerite during the Jurassic Period and denudation during the Cretaceous Period it seems likely that the west-north-west trending Tiers were breached in this area by the north-flowing Mersey River. By both fluviatile action and pediment erosion, the Tiers retreated towards the west and east leaving an embayment. The softer Permian sediments were stripped off easily where not protected by dolerite and the rivers eroded this material until the underlying harder Precambrian sediments were reached. Thus by the early Tertiary (?) (perhaps Oligocene) a mature river system had been developed within this Mersey-Forth embayment. The land surface owed its form partly to the stripped pre-Permian surface. The dolerite of the February Plains stood above this level to the west and that of the Plateau to the east. The ancient Mersey occupied a channel cut through this surface. The channel is not recognizable at Howell's Plains, but where it is exposed in the Arm, it is 400 feet deep and at Gad's Hill possibly 600-800 feet. The Forth was quite probably a tributary which joined the Mersey near Gisbourne's Hut.

In the Tertiary the basalts were poured out along the valley line, filling the valley and then covering the adjacent flatter landscape. The occurrence of a 400 feet layer of coarse breccia and tuff on the floor of the buried valley suggests that the centre of volcanism may have been located somewhere between Gisbourne's Hut and Liena and that the lava flowed *upstream* towards Howell's Plains as well as downstream. This is supported by the fact that no source was found in the Howell's Plains area. Figure 6 shows the probable variation within the volcanics along the old Mersey Valley.

The Mersey became displaced by the basalt and cut a channel along its eastern margin thus taking up its present position and the Forth became a large river along the western boundary of the basalt. The Tiers of Western Bluff at this time would have been immediately east of the Mersey. Since the extrusion of the basalt, the following events have occurred:—

(*a*) The Forth has cut a valley 2000 feet deeper;
(*b*) The Mersey has cut a valley 1600 feet deeper;
(*c*) The Arm has appeared;
(*d*) The Tiers south of Western Bluff have retreated at least two miles, exposing a pre-Permian surface which is not covered by basalt;
(*e*) During the Pleistocene the valleys were smoothed and deepened possibly as much as 100 feet. The interfluves were possibly a little eroded but were more likely positions of deposition and possibly 100 feet of till was deposited on Magg's Mount.

STRATIGRAPHY

Beneath a widespread blanket of Pleistocene till the area is underlain by a thick sequence of metamorphosed sediments of Precambrian age. These are overlain unconformably by sub-horizontal Permian sediments which have been intruded by a sill of Jurassic dolerite. Tertiary volcanics occur above these rocks in a discontinuous meridional strip running through the centre of the area.

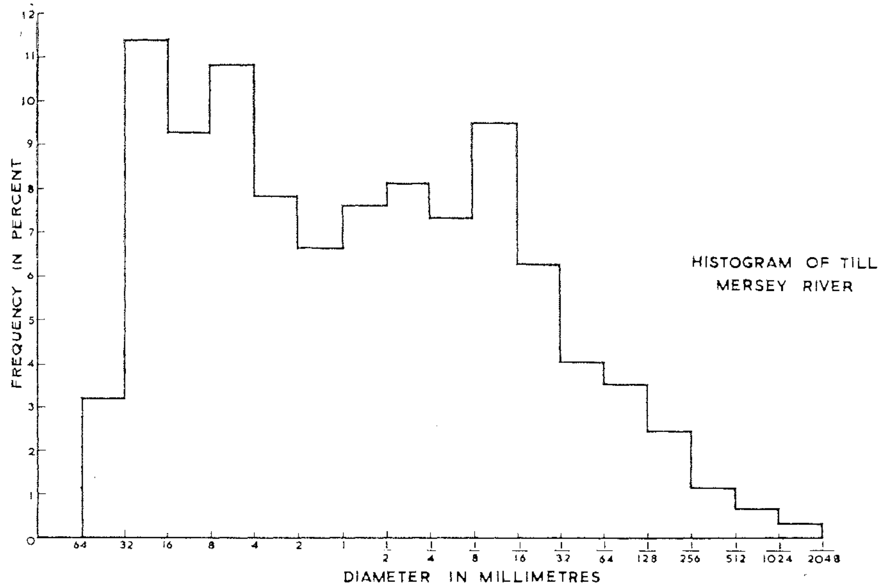
Precambrian Rocks

Within the restricted area there are approximately 14,000 feet of quartzites, mica schists (some with garnet or albite) phyllites and slates. The structural thicknesses as measured at the present time may be many times greater than the stratigraphic thickness due to pronounced thickening during folding. Exposures are poor so that the detailed structure cannot be determined and as the stratigraphy must follow the structure (not *vice versa* as in most structurally simpler rocks), it is not possible to unequivocably find the stratigraphic sequences. One structural peculiarity which causes considerable difficulty, is the lack of repetition of beds on the opposite limbs of major folds. As the sequences on the northern and southern limbs of the Mersey Syncline are quite different one must presume that there has been strike-faulting; there is no way of knowing whether either of the sequences is complete.

The best that can be done at present is to recognize the existence of separate groups possessing characteristic lithologies and to attempt to put these in their correct order. It must be emphasised that differences in the apparent degree of metamorphism of two rock-types (e.g., garnet-schist and slate) does not necessarily mean that the more altered one is older and separated from the less altered by an unconformity.

Howell Group

This group is probably the oldest in the area although the stratigraphic position is rendered obscure by faulting. It exceeds 5000 feet in thickness and consists of mica schists, garnet-mica schists, albite-mica schists, mica-quartzites and pure quartzites. These all show pronounced evidence of regional metamorphism. The type locality for the group is along the western wall of the Mersey Valley at Webster's Marsh. It also occurs along the southern end of the track to the Pelion Wolfram Mine on the Forth River.



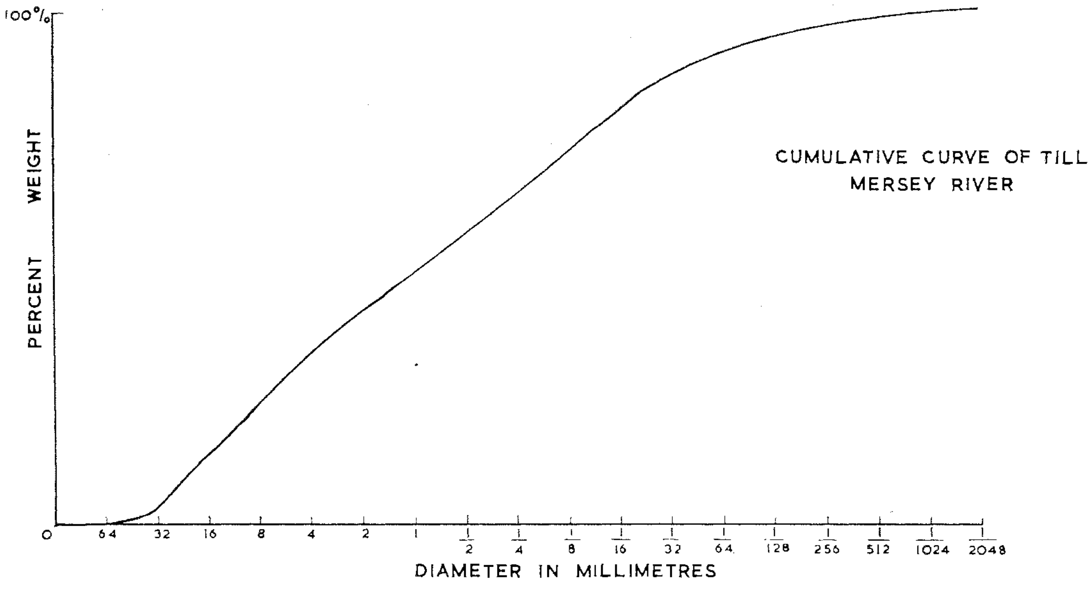


FIG. 7.—Histogram and cumulative curve of Pleistocene till from the Mersey Valley. Analyst: I. McDougall.

Fisher Group

This group probably lies above the Howell Group and below the Arm Schist. It exceeds 5000 feet in thickness and consists of interbedded formations of slate and quartzite with the latter dominant. The type locality is the western side of the Mersey River between the Fisher River and a point half a mile north of the Arm River. The group is well exposed on the Forth River for several miles south of Gisbourne's Hut.

The slates have a very characteristic appearance, being black with thin ($\frac{1}{4}''$) bands of light quartzite showing contortion and possessing a moderately well-developed cleavage oblique to the bedding.

The major quartzites are massive and pure, and show well-preserved ripple marks and even cross-bedding.

Arm Schist

There is about 2000 feet of muscovite, garnet and albite schist with minor quartzites occurring at the Mersey-Arm junction and probably lying above the Fisher Group and below the Magg's Quartzite. This formation is probably represented on the other side of the Mersey Syncline by the garnet and albite schists occurring along the western side of the motor track half to one mile south of the Hydrographic Hut on the Mersey River.

Magg's Quartzite

Massive to well-bedded quartzites occur in the centre of the Mersey Syncline and are exposed along the Mersey River motor track for one mile north of the Hydrographic Hut. The formation overlies the Arm Schist and thus is the youngest found in this area. Folding in the axial zone of the Syncline makes the measurement of the thickness of the quartzite quite impossible but there is probably in the order of 2000 feet exposed.

The quartzite is generally massive and thickly bedded but some specimens are vitreous saccharoidal, ripple-marked, laminated, schistose or lineated. Tourmaline needles along the bedding-schistosity of one specimen give an appearance similar to that of the Raglan Quartzite (Spry, 1957).

Dove Schist

There are dull-green mica schists on the Forth River just south of the Dove-Forth intersection and these are correlated with about 5000 feet of garnet and mica schist exposed along the Mersey Forestry Road extending north of a point about half a mile north of the Mersey-Fisher junction. From its structural position on the flank of the Fisher Anticline, lying below the lower Palaeozoic strata, this could be the youngest formation in the area.

The following section is tentatively advanced.

Dove Schist	5000′?
Magg's Quartzite	2000′?
Arm Schist	2000′?
Fisher Group	5000′+
Howell Group	5000′+

The lithological similarities of the Arm Schist, Howell Group and Dove Schist suggest that these might be equivalent but the Arm Schist is much thinner than the Howell and Dove, and the Howell contains much quartzite whereas the Dove contains practically none.

Permian System

1. *Forth Section*

A total of 250 feet only of Permian rocks overlie the Precambrian unconformably along the upper slopes of the Forth River, west of the February Plains. The Permian is poorly exposed but sections are visible in some of the steep creeks which flow down from the February Plains into the Forth. The lithology of the basal Permian is quite unusual when compared with exposures elsewhere in Tasmania, although it is typical of the area between Western Bluff and Cradle Mountain. Apart from a general induration due to the Jurassic dolerite which has intruded just above these rocks, they are characterised by their white colour, well rounded pebbles and lack of fossils.

The basal conglomerate is 50 feet thick and contains well-rounded quartzite and schist pebbles up to three inches across in a white sand-silt matrix. Towards the base there are beds of sandstone one foot thick but at the top the proportion of matrix decreases and the rock is a typical quartz conglomerate.

The conglomerate passes upwards into a light-grey micaceous sandstone 120 feet thick which weathers to a red colour.

This passes upwards into a light-grey, shaley, micaceous siltstone 40 feet thick which becomes sandy and pebbly and passes into a buff pebbly sandstone. The last formation is only visible for a few feet as Jurassic dolerite has intruded at this level.

2. *February Creek*

There are Permian rocks exposed in the bed of the February Creek which is the southernmost tributary of the Arm from the west. It is very probable that Permian sediments occur along the western side of the Arm Valley where it shows a series of distinct benches but the whole is covered with a persistent layer of Pleistocene till. The following beds probably lie almost immediately above the sequence given above for the Forth River.

The lowest bed appears at an altitude of 2320 feet and is a buff coloured sandstone, with streaky irregular bedding and abundant rounded pebbles, usually one inch across. It is massive to flaggy in outcrop. After 10 feet of this the rock becomes less pebbly for 10 feet then the next 10 feet is much more pebbly and fossiliferous. There are pectens (up to three inches across), spirifers and martiniopsids.

The next bed is 30 feet thick and is tillite with abundant boulders in a sandy matrix.

This is followed by 10 feet of "Fontainbleu" sandstone with scattered pebbles. It is a medium-grey greywacke sandstone with large glittering plates of calcite and is described in detail later.

The last bed begins at 2390 feet but outcrops cease after a few feet until dolerite appears at 2600 feet. It is a tillitic greywacke which is dark-grey and very massive with abundant large boulders up to four feet across.

Jurassic System

The Jurassic Period was one of intrusion, and the thick dolerite sill of the February Plains intrudes the Permian strata only about 250 feet above the base. The dolerite has been eroded towards the north, but at Mt. Oakleigh is about 1000 feet thick.

Tertiary System

The rocks formed during this period are almost entirely volcanic in origin, the only exception being a small patch of fluviatile breccia on the northern end of Magg's Mount at 2415 feet altitude.

There is about 10 feet of this breccia visible but it may extend for 50 feet to 100 feet up the hill. It is horizontal and rests with marked unconformity on the eroded surface of the steeply dipping Precambrian quartzites. The lowest two feet is sandy and well cemented with abundant angular boulders up to three inches across. The rock is poorly sorted. This grades upwards into a bed with abundant rounded and angular boulders in a sandy matrix. Many of the boulders stand on their ends.

The volcanic rocks may be divided into two main parts. The lowest portion which is exposed only in the bottom of the buried valley between the Arm and Forth Rivers consists of coarse volcanic breccia with vitric tuffs and some white clays. This reaches 400 to 440 feet in thickness in the Forth Valley.

Overlying this is between 400 and 440 feet of basalt being composed of at least 10 flows.

The section in the Arm Valley contains more basalt (600 feet?) and the pyroclasts consist only of tuff probably about 100 feet or so in thickness, with some white clays.

Pleistocene Epoch

The rocks formed at this time were all glacial. Much of the landscape is covered by a layer of till which is probably normally not more than 20 feet thick but reaches 50 feet in places and would certainly be 120 feet in parts of the Arm, Fish and Mersey Valleys.

There is at least 10 feet of varved clay in the Arm Valley and probably more in the Forth Valley. At the bridge near the Dove Mill, on the Forth River, varves 20 feet thick cover the Precambrian rocks, and further downstream, about three miles south of Lorinna, the varves occur in a road cutting about 150 feet above the present river.

In the Arm River there is about three feet of varve forming a layer within a thick till which is overlain upstream by the main thickness of varves.

PETROLOGY

The chief petrographic characteristics of the rocks met in this area are summarized and criteria given for recognizing various types. Extensive petrological investigation of the genesis of these rocks is not given here and will be presented elsewhere.

Precambrian Rocks

These are regionally metamorphosed sediments, originally chiefly arenites and pelites, which have suffered considerable deformation. The members of the Howell Group, Dove Schist, Arm Schist and Magg's Quartzite belong to the garnet zone but the slates of the Fisher belong to the chlorite zone.

Howell Group

This is a sequence of schists and quartzites. The schists are generally coarse and glossy, and rich in muscovite with knots of garnet and albite. There is a good bedding-plane-schistosity with an irregularly developed fracture cleavage at about 30°. Lineation is well shown in some specimens.

Specimen 7408 is a glossy, contorted schist with a lineation rather than a schistosity. In thin section it is coarse-grained and consists of quartz and muscovite with about 10 per cent of albite and a little biotite and accessory zircon and tourmaline. No. 7387 is coarse and platy with some knots but no lineation. It differs from the previous specimen in containing more albite (large poikiloblastic porphyroblasts with single albite twinning), some chlorite and accessory rutile, apatite and zircon.

Specimen 7388 is an excellent example of these schists. It is an albite-rich, quartz, garnet. muscovite schist with much chlorite which has replaced garnet and possibly biotite. This shows slip planes at an angle to the major schistosity with quartz and chlorite growing along them.

The quartzites are rather fine-grained rocks forming beds a hundred or so feet thick. They tend to platy with thin bands of muscovite and are characterized by a strongly developed lineation.

Fisher Group

This group consists of alternations of quartzite and slate in beds about a thousand feet thick.

The quartzites are white, massive and thickly bedded with well developed ripple marks and cross-bedding in some specimens. Despite the preservation of these sedimentary structures the rocks show evidence of complete internal reconstitution and deformation. The original coarse clastic quartz grains have been broken down in size giving the typical "mortar" texture of cataclasites, i.e., large, xenoblastic or lenticular quartz grains showing undulose extinction and "Boehme" lamellae, set in a fine-grained matrix of recrystallized quartz with a strong preferred orientation.

Numbers 7394 and 7405, from the western bank of the Mersey River, about one mile south of its junction with the Fisher are characteristic examples. They are massive in the hand specimen with tiny white spots which are seen to be feldspar by examination under the microscope. The rocks are fine-grained with a strongly crushed texture in which the quartz shows sutured margins. Most notable is the presence of about 20 per cent of feldspar, microcline and albite (this is the first record of microcline in Precambrian rocks in Tasmania). The feldspars are quite rounded and show undulose extinction, bent twin planes, are clouded with inclusions and have a thin peripheral layer of muscovite flakes. These feldspars are so different from the metamorphic feldspar in the adjacent schists that it is not unlikely that it is original clastic feldspar. The preservation of such relics in a rock which contains recrystallized quartz has been recognised elsewhere many times. This fact is important because it means that the original sandstones were at least feldspathic and in some examples, arkosic.

The slates of the Fisher Group are lithologically distinctive and are the distinguishing feature of this group. The name " slate " is used to separate the rocks from the schists and phyllites of the area even though the term might not strictly be correct. The rocks are dark-grey and fine-grained with alternating pelitic and arenaceous layers averaging about one-eighth inch thick. The thin layers are puckered into tiny crenulations and there is a distinct cleavage, oblique to the bedding, visible in the hand specimen. Most examples are glossy and coarser than the average slate and might be better termed phyllites.

In thin section, e.g., numbers 7406 and 7390, they are seen to be very fine-grained rocks consisting chiefly of quartz and sericite with accessory zircon and iron ore. The cleavage is due to the presence of parallel mica laths and elongated quartz crystals and clearly transgress the alternating mica and quartz-rich layers which are the bedding.

Arm Schist

The garnet, mica and albite bearing schists of this group together with their schistose quartzites are sufficiently similar to those of the Howell Group as to warrant no further detailed description.

Magg's Quartzite

This quartzite is generally thickly bedded but there are laminated and very massive varieties. Some specimens show glossy muscovite along the bedding which is the schistosity direction and some have a lineation across the schistosity.

Specimen 7385 from just north of the Hydro-Electric Commission Hut on the Mersey is a white saccharoidal quartzite with feldspar visible as tiny white spots. It is a fine-grained quartzite consisting chiefly of quartz but with about 10-15 per cent of xenoblastic albite and some fine muscovite. The quartz shows a distinct preferred orientation with some elongation parallel to the schistosity marked by parallel muscovite flakes. The albite is lenticular to tabular in shape with the C-axis tending to be parallel to the schistosity.

Dove Schist

Although these rocks do not occur within the mapped area they outcrop well along the Forestry Road on the east side of the Mersey, north of its junction with the Fisher, and a few of the characteristic features are described.

This formation is a very thick mass of mica schist with garnet and albite in varying amounts and contains very little quartzite. Lithologically the rocks show a strong resemblance to the schists of the Howell Group.

Typical is 7370, a fine-grained, dark-grey, knotted, glossy schist. In thin section it is schistose with alternating thin layers rich in quartz and muscovite. Small porphyroblasts of garnet occur with larger ones of albite. There are sheafs and flakes of chlorite, much athwart the schistosity. Accessories are tourmaline and iron ore.

No. 7382 is an excellent example, and differs from 7370 in containing biotite, much of it growing along a second cleavage which is sporadically developed at about 35° to the major schistosity. In No. 7372 and others, the bedding plane schistosity is crenulated and a second fracture cleavage is developed across the tightly squeezed limbs of the tiny folds.

Thermal Metamorphic Rocks

The Devonian granite intrudes along the unconformity between the Dove Schist and the Ordovician quartzite on the Mersey River and here some schist has been hornfelsed. These rocks clearly show the effects of thermal metamorphism superimposed upon regional, e.g., 7384, 7377.

These are dense, reddish-brown rocks with a vitreous lustre and a hackly fracture. A thin section shows the original compositional layering to be present but the schistosity has been obliterated by the random growth of large quartz, muscovite and biotite crystals. There are numerous round and prismatic masses of very fine sericite and these are clearly pinite pseudomorphs of some metamorphic mineral which from the form is presumed to be andalusite. As these pseudomorphs only appear immediately next to the granite, the andalusite would be a thermal not regional metamorphic mineral.

Permian Rocks

These are flat-lying generally unmetamorphosed clastic sediments most of which have marine and glacial affinities. The basal rocks on the Forth River west of the February Plains are unusual and so will be described in some detail.

Specimen 7322 is from 50 feet above the base of the Permian in the Forth River and is a tough, massive, white, non-friable sub-greywacke sandstone with mica flakes visible in the hand specimen. It is composed of 70 per cent of quartz, 5 per cent muscovite and a little biotite and iron ore and 25 per cent of fine-grained clay matrix which has been recrystallized by the adjacent dolerite to a mesh of interlocking flakes. The quartz grains average ·25 mm. in diameter and are angular but with a medium to high sphericity. The muscovite flakes range up to ·5 mm.

The matrix of the underlying conglomerate is very similar and this rock has also been baked by the overlying dolerite sill which is only 200 feet away. The conglomerate is characterized by containing abundant well-rounded quartzite and schist pebbles with a high sphericity. The quartzite pebbles are peculiar in that a high proportion of them show small circular depressions about 1 cm. across on their smooth surfaces. These depressions were also found in pebbles from this horizon below Western Bluff, about 10 miles to the north-east.

The Permian beds in the south-western portion of the Arm Valley are tabulated elsewhere but one particular rock is distinctive and is described in detail here.

Specimen 7361 is a light-grey sandstone with a calcite cement which forms crystals over a centimetre across, enveloping the clastic grains; the crystals reflect the light giving bright flashes. It is composed of angular fragments between ·2 mm. and ·5 mm. across of quartz (50 per cent) plagioclase (10 per cent) muscovite flakes and rock fragments (slate 10 per cent, schist 10 per cent, chert and basaltic rocks) with a calcite cement comprising 15 per cent of the rock. The plagioclase is an acid andesine such as would be derived from the Devonian granites and some grains have been partly or wholly replaced by authigenic calcite. The calcite enclosed the grains with a seive structure and apparently has completely replaced an original clay matrix. The apparently high degree of sorting is due to the replacement and disappearance of the smaller particles. The rock is a sub-greywacke with a structure somewhat like that of a Fontainbleu Sandstone due to the addition of calcite by the adjacent dolerite.

Tertiary Volcanics

The volcanic rocks are chiefly basalts with pyroclastics occurring in the north-west of the area.

Pyroclastics

The thickest (400?) feet pyroclastic is a very coarse volcanic breccia which outcrops from 2000 feet to 2400 feet on the eastern side of the Forth River just below the Berriedale Plains and one mile north-east of Gisbourne's Hut. It is the movement of this material which resulted in the landslides covering the whole of the hillside. The breccia contains blocks and bombs of basalt and tachylyte up to three feet across, with the majority being about six inches in diameter. Many of the fragments are scoriaceous and the rock is loosely compacted and partially cemented with zeolite.

This breccia occurs on both the east and west sides of Gad's Hill on the road from Liena to Lorinna and appears to be confined to the centre of the pre-basaltic river valley.

Further up this valley, where it intersects the northern side of the Arm, the pyroclastics are thinner and finer grained, and on Magg's Mount they seem to be absent.

The tachylyte tuff 7411, from the north side of the Arm, is rather weathered, with dark glassy fragments in a clay-rich cement. A thin section shows that the particles are tachylyte containing crystallites, cemented by opal, calcite and a ferruginous weathering product.

Basalts

The basalts occur as flows varying from about 25 feet to 150 feet in thickness and reach a maximum total thickness of 350 feet and possibly 440 feet on the Berriedale Plains. They vary from dark-grey to black in colour when fresh but become light-grey and brown when weathered. Most are fine-grained and massive but some are completely scoriaceous and others are massive with a scoriaceous top. Jointing is chiefly in a rectangular prismatic form but a few flows show a platy flow structure; some have regular hexagonal prisms about 18 inches across. One variety which occurs in situ on the southern end of Magg's Mount and as large masses on the top and sides of Magg's Mount shows a strong development of curved and twisted columns from 6 inches to 12 inches across, with the columns commonly horizontal.

From a petrological examination of 30 thin sections it appears that there are four chief types.

The most common variety is a *porphyritic olivine basalt with black "glass"*, e.g., 7353, 7350, 7340, 7332, 7327, 7335, 7354, 7342, 7356, 7346. This type has olivine phenocrysts (5 to 20 per cent) averaging 1·5 mm. across, but ranging from ·5 mm. to 2·5 mm., in a fine-grained groundmass of pyroxene, plagioclase and black "glass", showing intergranular structure or a parallel flow structure, e.g., 7332. There is generally 5 per cent of brown and green or even orange opal and some calcite and chalcedony either as amygdale fillings or as intergranular patches. The olivine is almost invariably partially or wholly pseudomorphed by a brown carbonate which has the optical properties of magnesite or calcite. The proportions of pyroxene and plagioclase vary, depending on the amount of glass present, but they each constitute from 30-50 per cent with the pyroxene in excess of plagioclase. The plagioclase usually forms small laths about ·2 mm. long but may form phenocrysts up to 2 mm. across; it shows twinning on the Albite or Albite plus Carlsbad laws and is labradorite varying in composition from Ab_{42} to Ab_{50}. The pyroxene is pale-green to colourless with a low 2V around 35° and is generally from ·05 to 2 mm. across, but reaches 2·5 mm.

The black "glass" fills the intergranular spaces and consists chiefly of tiny closely packed granules and rods of opaque iron oxide. Between this is visible in some rocks a green isotropic material, presumably glass, e.g., 7340, in others is a dense aggregate of tiny pyroxene microlites and in others, e.g., 7357 there are crystallites of plagioclase and pyroxene.

The second type is the *porphyritic olivine basalt without glass*, e.g., 7358, 7333, 7329. These differ chiefly from the previous group in lacking the black glass, but in addition appear to contain a little less olivine (10 per cent) which is generally unaltered, and flow structure is more abundant.

The third type is the *semi-ophitic basalt*, e.g., 7325, 7409, 7355, 7339, 7326 and 7341. These rocks are rather fine-grained with phenocrysts of olivine in a groundmass of pyroxene, plagioclase, a little glass, opal and calcite. Pyroxene is abundant (up to 60 per cent) and forms crystals from ·2 to 1·2 mm. across or aggregates of granules up to 2 mm. across enclosing laths ·2 mm. long of plagioclase in an ophitic manner. The plagioclase usually does not exceed 35 per cent and forms small crystals with sporadic phenocrysts up to 2 mm. long. The pyroxene is pale-green to colourless and is characterized by having a low 2V, measurements ranging from 30° in 7339 to 40° in 7335. Olivine phenecrysts (5-20 per cent) range up to 1·5 mm. across and are mostly fresh with some alteration to carbonate or opal in a few specimens. One example (7325) contains up to 15 per cent of brown opal; another (7339) contains yellow and green opal, chalcedony and dark glass; 7355 shows amygdales with a lining of opal and a core of calcite and contains black "glass".

The fourth type is a *glomeroporphyritic basalt*, e.g., 7343, 7345, 7332, 7344. These are glomeroporphyritic in texture with large (3·5 mm.) aggregates of pyroxene crystals (·5 mm. across) and phenocrysts of plagioclase (up to 3 mm.) in a holocrystalline groundmass of pyroxene and plagioclase. Olivine is generally not present but there is very little, completely altered olivine in some specimens. Glass is lacking and there is usually about 10 per cent of brown opal or chalcedony. Amygdales (e.g., 7345) have a rim of opal and a centre of calcite. The plagioclase ranges in composition from labradorite Ab_{45}-Ab_{32}.

The distinguishing characteristics of the four groups are summarized below.

The chemical analysis of the four main types in table I show so few differences that the reasons for the marked textural differences between the flows are not clear. One significant fact is that of the porphyritic olivine basalts, those containing glass have three per cent more silica than those without and thus the glass must be rich in silica and perhaps is opaline. The lack of olivine in the glomeroporphyritic variety may be attributed to the fact that it contains about two to three per cent less magnesia than the other basalts.

The next specimens (2760 feet Forth, 2780 feet Arm and 2765 feet Magg's Mount where it is the highest flow) are all *semi-ophitic basalts* and thus could be the same flow.

Beneath these in the three sections are *porphyritic olivine basalts*. No. 7333 at 2700 feet on the Forth lacks glass but otherwise all are similar and we may correlate the specimens on the Forth ranging from 2700 feet down to 2500 feet with those on the Arm at similar heights and on Magg's Mount with rocks collected at 2765 feet, 2740 feet and 2710 feet (lack of outcrop prevented collection of specimens just below this).

The *porphyritic olivine basalt* at 2500 feet on the Forth may be correlated with the lowest flow found, at 2525 feet, on Magg's Mount.

The lowest flows before the underlying breccia is met, on the Forth section, are glomeroporphyritic, and outcrop at 2490 feet and 2460 feet. These are below the base of the basalts on Magg's Mount, but there is at least 50 feet of *glomeroporphyritic basalt* (No. 7345) on the Arm section at about 2500 feet.

A lower *porphyritic olivine basalt* (No. 7352) occurs in the Arm section at about 2300 feet and is the lowest found.

	Porphyritic olivine basalt with glass	Porphyritic olivine basalt	Semi-ophitic basalt	Glomeroporphyritic basalt
Texture	Intergranular and Porphyritic		Semi-ophitic	glomeroporphyritic
Olivine	Common			lacking
Alteration of olivine	to carbonate		fresh	
Glass	Black	lacking	brown to black	lacking
Chemical Analyses	(Analyst W. St. C. Manson)			
	(No. 7335)	(No. 7329)	(No. 7339)	(No. 7345)
SiO_2	49·58	46·66	49·48	49·80
Al_2O_3	13·69	13·06	13·32	14·25
Fe_2O_3	3·52	2·10	3·20	3·38
FeO	8·34	9·87	9·14	7·70
CaO	8·52	10·33	8·62	9·78
MgO	8·46	9·11	8·18	5·79
Na_2O	2·47	2·65	2·70	2·96
K_2O	0·59	0·91	0·71	0·93
H_2O	1·29	1·02	1·18	0·71
H_2O—	1·86	0·88	1·52	1·69
CO_2	—	1·02	—	—
MnO	0·18	0·18	0·16	0·13
TiO_2	1·69	1·77	1·66	2·05
P_2O_5	0·23	0·34	0·24	0·34
	100·42	99·90	100·11	99·51

One of the purposes of the petrological examination was to endeavour to correlate flows between the Forth, Arm and Mersey Rivers and despite the fact that the basalts do not differ much in composition it has been found to a certain extent possible to correlate the flows using the textural criteria.

The highest flow (2780 feet to 2810 feet) of the Forth section is similar to the highest (2820 feet) of the Arm section in that they are *porphyritic, olivine basalts* but the Forth rocks contain up to 10 per cent glass whereas the Arm rock has none.

Lack of definite correlation is due to the fact that all individual flows could not be recognized and sampled in each area, and all that was done was to collect from every flow recognized, or at 50 feet vertical intervals, whichever was the lesser distance. Differences in height between specimens collected from one flow at different localities is probably due to sampling at different levels in thick flows.

As far as can be determined, the flows are horizontal, as the contact between the upper two flows is at 2770 feet at the Forth and 2760 feet at Magg's

Mount four miles away. This suggests a very slight descent to the south implying that the lavas may have flowed upstream, but the difference is of the same order as the error in height determination by barometer and thus is not regarded as being significant.

There is a similar difference between the similar lavas at the Forth River (2500 feet) and Magg's Mount (2525 feet).

The following general sequence holds quite well for the three sections:

50 feet glomeroporphyritic basalt (top)
250 feet porphyritic olivine basalt
20 feet semi-ophitic basalt
60 feet porphyritic olivine basalt (base)

Pleistocene Till

Introduction

The following investigation was carried out on a specimen of till taken from the 40 feet high river terrace on the western bank of the Mersey, half a mile north of the Hydro-Electric Commission hydrographic hut and 15 feet above river level. The till is variable and this specimen may not be characteristic of all the till although it was chosen as a typical specimen. The sediment is tough and well consolidated; it lacks bedding and comparatively speaking is not friable. The references to toughness and non-friability are comparative as the rock is well lithified for Pleistocene material and is tougher than most Tertiary sediments but is inferior to most unweathered Permian and Triassic sediments.

The till consists of pebbles of all sizes (up to many feet in diameter) commonly several inches across, set in a matrix of sand and silt. Both the cumulative curve and the histogram indicate it to be very poorly sorted. The first and third quartiles are spread over 6·24 Wentworth grades. The histogram is bimodal and there is very little clay and silt present. The larger particles are of dolerite with a little quartzite; the sand is of fine-grained dolerite, quartz, pyroxene and feldspar; the silt of quartz, pyroxene and plagioclase. The particles are fresh and unweathered, and of low roundness and sphericity.

The mechanical analysis was carried out by using seives and the pipette method on the disaggregated material.

Analysis of the Individual Fractions

Each of the fractions was analysed under the binocular microscope as far as possible. In the fractions with a grain size greater than 0·5 mm. the material consists of rock fragments while those with grain sizes less than 0·5 mm. are composed mainly of individual crystals. In all cases in which the fragments are crystal aggregates, dolerite is the main rock type (usually 70 per cent), the rest consists mainly of quartzite with an occasional fragment of mica schist. In the finer fractions, pyroxene (augite and pigeonite) makes up about half the total while the rest is composed of feldspar (plagioclase) and quartz with a little magnetite and muscovite. The rock fragments are usually angular to sub-rounded with the sub-angular fragments predominating. Some pebbles have distinct flat surfaces (facets?) while there are several dolerite pebbles which are flat slivers.

Size	No. of particles examined	Composition, Roundness
+1″	6	Dolerite, 1 very well rounded, 1 sub-rounded, 4 angular
—1″ + ¾″	6	angular dolerite (67%)
	2	angular quartz-mica schist (22%)
	1	angular quartzite (11%)
—½″ + ⅜″	56	angular to sub-angular dolerite (71%)
	22	angular, white and grey quartzite (28%)
	1	sub-angular, quartz schist (1%)
—⅜″ + ¼″	200	angular to sub-rounded dolerite (71%)
	74	angular quartzite (27%)
	3	quartz mica schist (1%)
	3	angular basalt (1%)
—6·35 mm. +4·72 mm.	145	angular to sub-angular dolerite (few basalt?) (70%)
	59	angular quartzite (27%)
	6	quartz muscovite schist (3%)
—4·72 mm. +2·06 mm.	358	angular to sub-rounded dolerite fragments (75%)
	108	white, pink, grey angular quartzite fragments (23%)
	10	quartz muscovite schist—usually cleavage flakes (2%)
—2·06 mm. +1·68 mm.	202	angular to sub-rounded dolerite fragments (74%)
	58	white angular quartzite fragments (22%)
	15	grey cleavage flakes of quartz mica schist (4%)
—1·68 mm. +1·005 mm.	267	sub-angular to sub-rounded dolerite fragments (69%)
	108	angular to sub-angular quartzite fragments (29%)
	6	quartz mica schist cleavage flakes (2%)
—1·005 mm.	93	sub-angular to sub-rounded dolerite fragments 10 of which consist essentially of plagioclase with a small amount of pyroxene (80%)
	19	white to pink quartzite fragments (17%)
	3	quartz mica schist cleavage flakes (3%)

Bromoform Separation

An approximate modal analysis of the finer fraction using a bromoform separation and a grain count under the binocular microscope is as follows:—

plagioclase 48%
pyroxene 39%
quartz 11%
muscovite 1%
iron ore 1%

Heavy Fraction

This fraction consists dominantly of pyroxenes which are generally a pale translucent yellow-brown and rarely almost colourless. Commonly the crystals are encrusted with white earthy material (clay?). On clear faces the lustre is resinous to sub-vitreous while the cleavage is generally not obvious, although many fragments have cleavage faces. Under the microscope a very fine twinning in one direction was observed on many grains. Most fragments show only slight alteration but the extent is quite variable. The pyroxenes are biaxial positive with a 2V ranging from nearly zero to about 60° and thus it is considered that both pigeonite and augite are present, the actual proportions of each being difficult to determine. Due to the lack of centred figures and the presence of two different pyroxenes it was found that accurate refractive indices could not be obtained. The range of the refractive indices measured was from 1·690 to 1·715.

Magnetite comprises perhaps 2 per cent of the heavy fraction. It is opaque (black) and present both as distinct crystals (octahedra) or as irregular grains.

A few fragments of pale-green material (possibly olivine) occurred in the heavy mineral fraction.

Light Fraction

The light fraction consists of plagioclase, quartz and muscovite and in a count of 180 grains 80 per cent of them were plagioclase, 18·5 per cent quartz with the remaining 1·5 muscovite.

The feldspar occurs as opaque white to translucent laths having a sub-vitreous lustre on fresh faces. Alteration resulting in turbidity of the fragments is commonly present. Two cleavages, approximately at right angles are developed and albite twinning is present. In the majority of cases the refractive indices lie in the range 1·550-1·570 indicating a plagioclase of labradoritic composition. Several fragments of plagioclase were recognised with one RI = 1·5295 and another less than 1·5295 and from these it is inferred that the fragments are albitic in composition.

Conclusions

Assuming the quartz and muscovite came primarily from the Precambrian rocks the remaining constituents recalculated to 100 per cent are:—

plagioclase 54·5%
pyroxene 44·3%
iron ore 1·2%

This corresponds to the mode of dolerites quite well, allowing for the absence of the mesotasis, which would break down very easily and would have a finer grain than this fraction. The calculated mode therefore supports the results obtained in the coarser fractions that the greater part of the sediment resulted from the break down of dolerite.

From both the histogram and cumulative curve it can be seen that there is a considerable spread of sizes. There is about 80 per cent of the total in the pebble, granule and sand grades with the silt and clay grades comprising only about 20 per cent. These facts are brought out by the statistical treatment of the curves also. Thus the geometric quartile deviation (the ratio between the quartiles) or sorting coefficient (S_0) is 8·87. A value of S_0 less than 2·5 indicates a well sorted sediment, a value of about 3·0 indicates a normally sorted sediment, while a value greater than 4·5 a poorly sorted sediment. Thus a value of 8·87 indicates a very poorly sorted sediment which bears out the direct observation from the curves.

This result can be better visualized by application of the phi scale to the quartile deviation. Thus in this sediment the first and third quartiles are spread over a distance of 6·24 Wentworth grades and consequently the curve is decidedly drawn out. Krumbein and Pettijohn (1938) cite an example of a glacial till in which the spread is 4·9 Wentworth grades.

Thus it can be seen that the sediment is very badly sorted. The histogram it bimodal but not distinctly so; one mode lies in the pebble range and the second in the fine sand grade. From the results given above, therefore, the sediment may be glacial till but the small amount of material in the silt-clay grades is surprising. This may be explained by the fact that the material was derived from hard crystalline rocks and not much rock flour was produced.

Although the degree of sorting is not unlike that of some river gravels, the composition (particularly its content of fresh, sand-silt size pyroxene and plagioclase) is quite different.

STRUCTURE

Regional Structure

The regional structure here is similar to that shown near Deloraine, Tullah and Frenchman's Cap, i.e., around the edge of the Precambrian nucleus. The Precambrian rocks are regionally metamorphosed and show a pronounced bedding-plane schistosity and a lineation which is parallel to the axes of broad folds. The axes of these folds are parallel to those in the overlying lower Palaeozoic sediments which are generally unmetamorphosed. An angular uncomformity between the Precambrian and Palaeozoic rocks does not occur in most places despite the fact that there was a period of considerable metamorphism and deformation before the deposition of the Dundas Group.

The Cambrian is missing against the nucleus and a sandstone facies of the Ordovician overlies the Precambrian and is followed by the Ordovician Gordon Limestone. In this area (as near Tullah) there is a granite with a lithology similar to the Devonian granites, intruded along the unconformity between Precambrian and Ordovician rocks.

The lower Palaeozoics are folded with the same trend as the Precambrian. In the core of the first major anticline away from the nucleus, thick Cambrian sediments and volcanics of the Dundas Group occur and in this zone the lowest Ordovician is represented by a very thick Owen Conglomerate. The lower Palaeozoics here are strongly deformed and tend to be over-folded and thrust towards the Precambrian nucleus.

The similarity in dip of the Precambrian and Lower Palaeozoic rocks across the unconformity and the parallelism of the fold axes in rocks of both ages indicates that the major part of the folding in the Precambrian occurred simultaneously with that in the Palaeozoics during the Tabberabberan Orogeny .

The Precambrian rocks are regionally metamorphosed and thus there was a period of metamorphism and orogeny before the Palaeozoic. Before the Tabberabberan orogeny, the Precambrian rocks would have been sub-horizontal with a schistosity parallel to the bedding and a pronounced lineation parallel to broad folds which were increased in amplitude during the Tabberabberan.

The faulting is closely related in direction to the fold axes and the major faults are probably high-angle reverse types.

Folds

The major structure in the Precambrian rocks is a synclinorium which plunges at about 20° in a direction 100° and this is named the Mersey Syncline. There is a major anticline (named the Fisher Anticline) which has a faulted axis, running parallel to that of the Mersey Syncline and which crosses the Mersey River about half a mile north of its junction with the Fisher. The general synclinal form is complicated by minor folds of all sizes and these may be grouped in the following way. The synclinorium is the first order fold about 10 miles across. There are second order folds about a quarter of a mile across. Third order folds about 10 to 100 yards across are quite common. The fourth order folds are small, apparently incongruent flow folds looking like strongly distorted drags about one foot across. The fifth order is represented by fine crenulations which extend down to microscopic dimensions.

The thick, massive quartzites usually show only first and second order folds and one example of the second order occurs about half a mile north of the Arm-Mersey junction; the thin quartzites and interbedded quartzites with slate or schist show second, third and fourth order folds. Third order folds are common in the Magg's quartzite north of the Hydro-Electric Commission hut. Fourth order folds are excellently shown by schist and thin quartzite of the Howell Group half a mile south of the Hydro-Electric Commission Mersey hut; fifth order folds are best shown by the slates of the Fisher Group and schists of the Dove and Howell group.

Foliation

The Precambrian rocks have been recrystallized during a period of regional metamorphism characterized by deformation which has impressed a strong schistosity on most rocks. It is, of course, less apparent in the quartzites which lack mica and is best developed in the slates and schists.

There are several completely different types recognizable and many of the rocks show two foliations. Most prominent is the schistosity which is parallel to the original bedding planes; this is produced by parallel muscovite flakes. There is considerable evidence in the schists that this is a direction of slip.

Many schists and quartzites show a second, poorly developed cleavage at about 30° to the bedding. This is due to the growth of late biotite and chlorite.

The third type of cleavage is developed at varying angles to the bedding in the slates of the Fisher Group. This is a "false" cleavage due to attenuation and close packing of the limbs of tiny asymmetrical folds where the bedding plane foliation has been crenulated.

Lineation

Lineation is well developed in most rocks, but particularly in the schists and quartzites of the Howell Group. It occurs as a streakiness of mica flakes on the schistosity plane, as a ribbing in quartzites or as a crenulation and is parallel to the axes of third order folds. The Arm Schist about half a mile south of the Hydro-Electric Commission hut, right on the track, shows a broad crenulation parallel to the axes of third order folds, together with a fine crenulation perpendicular to the axes.

The lineation commonly strikes parallel to the axis of the main fold but plunges flatly in the opposite direction, i.e., the fold plunges 20° towards 100 ° but the lineation is commonly plunging 30° towards 280°.

Faults

Three distinct sets of faults have been tentatively identified:—

(*a*) Major Precambrian, or Tabberabberan high-angle reverse (?) fault system trending at 280°;
(*b*) Minor sets of Precambrian or Tabberabberan transcurrent (?) faults trending at 315°;
(*c*) Possible set of Tertiary faults trending at 340°.

(*a*) It was seen here that the rocks on the opposite limbs of the major folds differed in character, particularly in the case of the Fisher Anticline. This has been repeatedly observed in many areas of Precambrian rocks in Tasmania and has been interpreted in the Frenchman's Cap area by Spry (1957) as being due to high-angle thrust faulting of large magnitude along the fold axes. If this is also true in this area, then there is a large fault striking at 275° half a mile north of the Mersey-Fisher junction. As there is a much larger width of outcrop of the Mersey Quartzite north of the major synclinal axis than there is to the south, it seems that a similar fault has removed part of the southern limb of the Mersey Syncline. On the northern limb of the Mersey Syncline, the

Fisher Group underlies the Arm Schist, but on the southern limb, the Howell Group lies below the Arm Schist. Various explanations are possible, e.g.—

(1) The Howell lies between the Arm and the Fisher but has been faulted out on the north limb;

(2) The Fisher lies betewen the Howell and the Arm and has been faulted out on the south limb.

(3) The Howell and the Fisher are equivalent.

Of these, the second alternative is preferred. The third is unlikely because, as is shown in the petrology and stratigraphy sections, there are very great differences between the Fisher and Howell Groups, and it is extremely unlikely that they are equivalent. The first is unlikely because the swing in strike of the Fisher-Arm contact between the Mersey and Forth Rivers makes faulting unlikely. These faults do not displace overlying Permian strata and are closely related in direction to folds in the Precambrian rocks and thus would be either Precambrian or Tabberabberan in age.

(*b*) The Fisher Group rocks on the east side of the Forth Valley, a mile south-west of Gisbourne's Hut appear to be cut by several faults trending at 315°. These cause considerable drag in a horizontal direction and are thus interpreted as transcurrent faults. It appears that the base of the Arm Schist is twice displaced for half a mile by these faults, but this cannot be proved at present because of the difficulty in locating the boundary between the Arm Schist and the Fisher Group.

(*c*) The dolerite of the February Plains, like that of the Plateau, is traversed by a prominent system of fractures which are clearly visible on the air photos. It was not possible to view these in the field but from their persistence and great length (8 miles maximum) it seems unlikely that they are merely tensional joints. The physiographic expression is simply a shallow, linear depression with no apparent topographic displacement or fault scarp. No displacement of the Permian sediments is visible on the air photos. It seems possible that they are Tertiary faults of very small throw and this could be verified by field observations where they cross the Permian rocks beneath the dolerite. They may well be persistent Tertiary shear joints with very slight horizontal movement.

Joints

Some Tertiary basalts show columnar jointing which may be divided into two types:—

(*a*) Normal, thick (2 feet across), hexagonal columns which are vertical and have parallel sides and cross-jointing which may be planar or ball and socket.

(*b*) Twisted, narrow (6 inches to 1 foot) columns which vary considerably in attitude and which do not have parallel sides, being fluted and irregular.

Apart from the possible shear joints mentioned above, the dolerite shows prominent joints on the air photos and these trend 310° and 350°.

The Precambrian rocks are well jointed in many directions but it was not possible to find much regularity. The small folds in the quartzites frequently show perfect joints normal to the fold axis ("ac") or vertical joints symmetrically disposed to the axial plane as shown in plate III.

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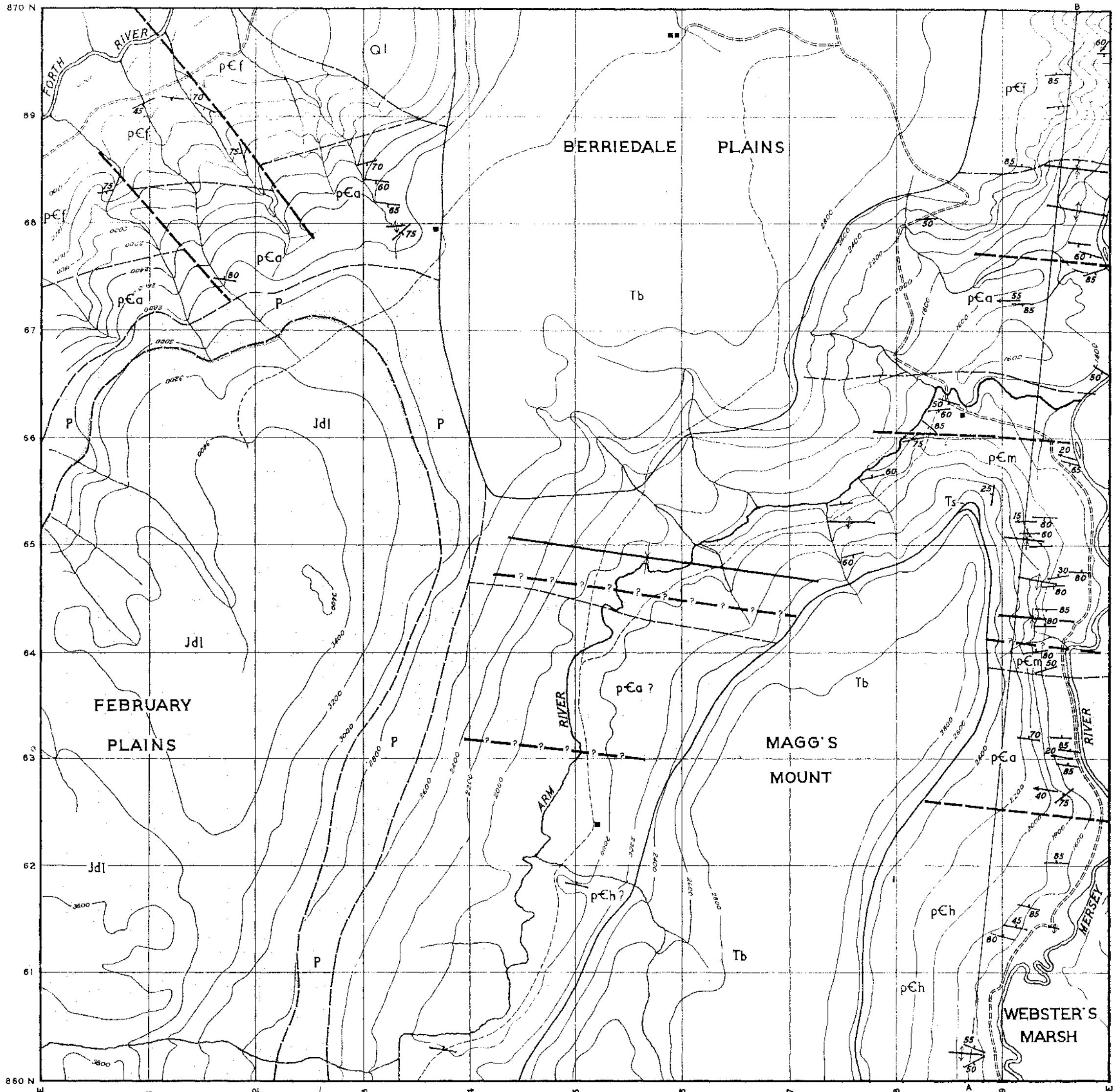
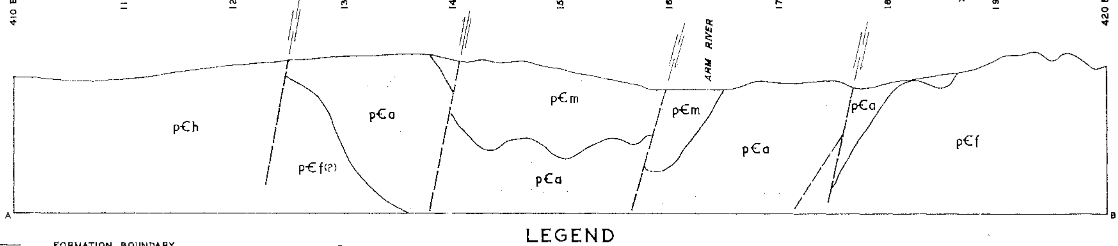
LOCALITY INDEX

	Internat. Grid Reference K/55	S. Lat.	E. Long.
Arm River	Middlesex 45	41° 58′	146° 10′
Berriedale Plains	Middlesex 45	41° 40′	146° 8′
Cathedral Mountain	Ducane 52	41° 54′	146° 8′
Cradle Mountain	Mackintosh 44	41° 41′	145° 58′
Deloraine	Quamby 46	41° 31′	146° 40′
Devil's Gullet Ravine	Middlesex 45	41° 41′	146° 0′
Dove River	Mackintosh 44	41° 35′	146° 0′
Eldon Range	Murchison 51	41° 59′	145° 50′
February Plains	Ducane 52	41° 47′	146° 7′
Fish River	Ducane 52	41° 47′	146° 14′
Fisher River	Middlesex 45	41° 42′	146° 16′
Forth River	Sheffield 37 Middlesex 45	41° 25′	146° 15′
Frenchman's Cap	Pillinger 65	42° 17′	145° 50′
Gad's Hill	Middlesex 45	41° 33′	146° 10′
Gisbourne's Hut	Middlesex 45	41° 38′	146° 7′
Great Lake	Great Lake 53	41° 55′	146° 45′
Howell's Plains	Middlesex 45	41° 45′	146° 12′
H.E.C. Mersey Hut	Middlesex 45	41° 42′	146° 11′
Lake St. Clair	St. Clair 59	42° 4′	146° 10′
Lake Meston	Ducane 52	41° 52′	146° 15′
Liaweenee	Great Lake 53	41° 52′	146° 41′
Liena	Middlesex 45	41° 33′	146° 16′
Little Fisher River	Middlesex 45	41° 42′	146° 18′
Lorinna	Middlesex 45	41° 32′	146° 9′
Magg's Mount	Middlesex 45	41° 40′	146° 10′
Mersey River	Sheffield 37 Middlesex 45	41° 19′	146° 28′
Mole Creek	Middlesex 45	41° 33′	146° 25′
Mount Achilles	Murchison 51	41° 54′	145° 58′
Mount Dundas	Zeehan 50	41° 55′	145° 27′
Mount Oakleigh	Ducane 52	41° 50′	146° 3′
Mount Ossa	Ducane 52	41° 54′	146° 3
Mount Pelion	Murchison 51	41° 52′	146° 0′
Mount Pelion East	Ducane 52	41° 52′	146° 5′
Mount Pillinger	Ducane 52	41° 49′	146° 10′
Mount Roland	Sheffield 37	41° 28′	146° 16′
Pelion Wolfram Mine	Ducane 52	41° 58′	146° 2′
Rugged Range	Ducane 52	42° 46′	146° 16′
Table Mountain	Oatlands 68	42° 14′	147° 9′
Tullah	Mackintosh 44	41° 44′	145° 35′
Union Peak	Middlesex 45	41° 39′	146° 12′
Walls of Jerusalem	Ducane 52	41° 49′	146° 19′
Wentworth Hills	St. Clair 59	42° 13′	146° 19′
Western Bluff	Middlesex 45	41° 35′	146° 16′
Western Tiers	Lake River 54	41° 38′ to 42° 6′	146° to 147° 16′

ARM RIVER





LEGEND

FORMATION BOUNDARY
FORMATION BOUNDARY POSITION APPROX.
FAULT PROBABLE
FAULT INFERRED
SYNCLINAL AXIS, FIRST ORDER
SYNCLINAL AXIS, SECOND ORDER
ANTICLINAL AXIS, SECOND ORDER
DIP AND STRIKE OF STRATA
PLUNGE OF LINEATION
MOTOR TRACK
FOOT TRACK
HUT

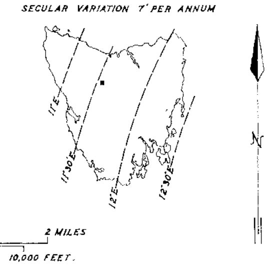
Quaternary
Ql LANDSLIDE DEBRIS
Tertiary
Tb VOLCANICS
Ts SEDIMENTS
Jurassic
Jdl DOLERITE
Permian
P SEDIMENTS
Precambrian
p€m MAGGS QUARTZITE
p€a ARM SCHIST
p€f FISHER GROUP
p€h HOWELL GROUP

Compilation from Aerial Photographs.
Trigonometric Station Control by courtesy Lands and Surveys Department.
Origin of coordinates 400,000 yds. West and 1,800,000 yds. South of True Origin of Zone 7 of the International Grid.

MAPPED AND COMPILED BY
A.H. SPRY 1956

SCALE
0 1 2 MILES
0 1 2 3 4 5,000 10,000 FEET.

KEY MAP SHOWING MAGNETIC DECLINATIONS
SECULAR VARIATION 7' PER ANNUM



GEOLOGY OF THE RIVER ARM AREA

Pleistocene Glacials covering approximately half of the area are not shown.

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2. STRATIGRAPHIC TABLE:

AGE	GROUP	FORMATION	LITHOLOGY	THICKNESS
Recent			Landslide debris	(?)
Pleistocene			Till, varves	160'+
		EROSION INTERVAL		
Tertiary			Basalt flows and pyroclastics	800'
		EROSION INTERVAL		
Jurassic			Dolerite sill	
Permian			Basal conglomerate, sandstone, siltstone	250'
		UNCONFORMITY		
		Magg's	Quartzite	2000'
Precambrian		Arm	Schist and Quartzite	3000'
	Fisher		Slates and Quartzites	5000'+
	Howell		Schists and Quartzites	5000'+

3. LOCALITIES OF SPECIAL INTEREST:

Pleistocene varves on Arm River	E414600.N862400
Minor folds in Arm Schist	E419400.N862700
Roche moutonnee	E419800.N866200
Tertiary basalt section	E41500.N86200 to E415600.N865500
Minor anticline	E419700.N861400

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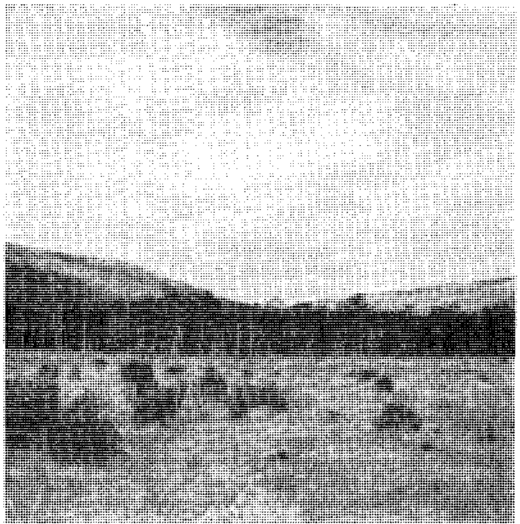

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PLATE I

No. 1.—View from the Plateau near the Fisher River to the south-west. The flat surface in the centre is Maggs Mount with the February Plains beyond and Barn Bluff (right) and Mt. Pelion West (left) on the skyline.

No. 2.—Facing the dolerite scarp of the Plateau at Western Bluff from a point north of the intersection of the Mersey and Fisher Rivers. The flat in the foreground is the stripped pre-Permian surface.

No. 3.—Looking up the Arm River towards Mt. Pillinger. The flat plains are underlain by terminal-zone glacials of the Pleistocene.

No. 4.—The scarp between two terraces in the Mersey Valley, half a mile north of the H.E.C. hut.

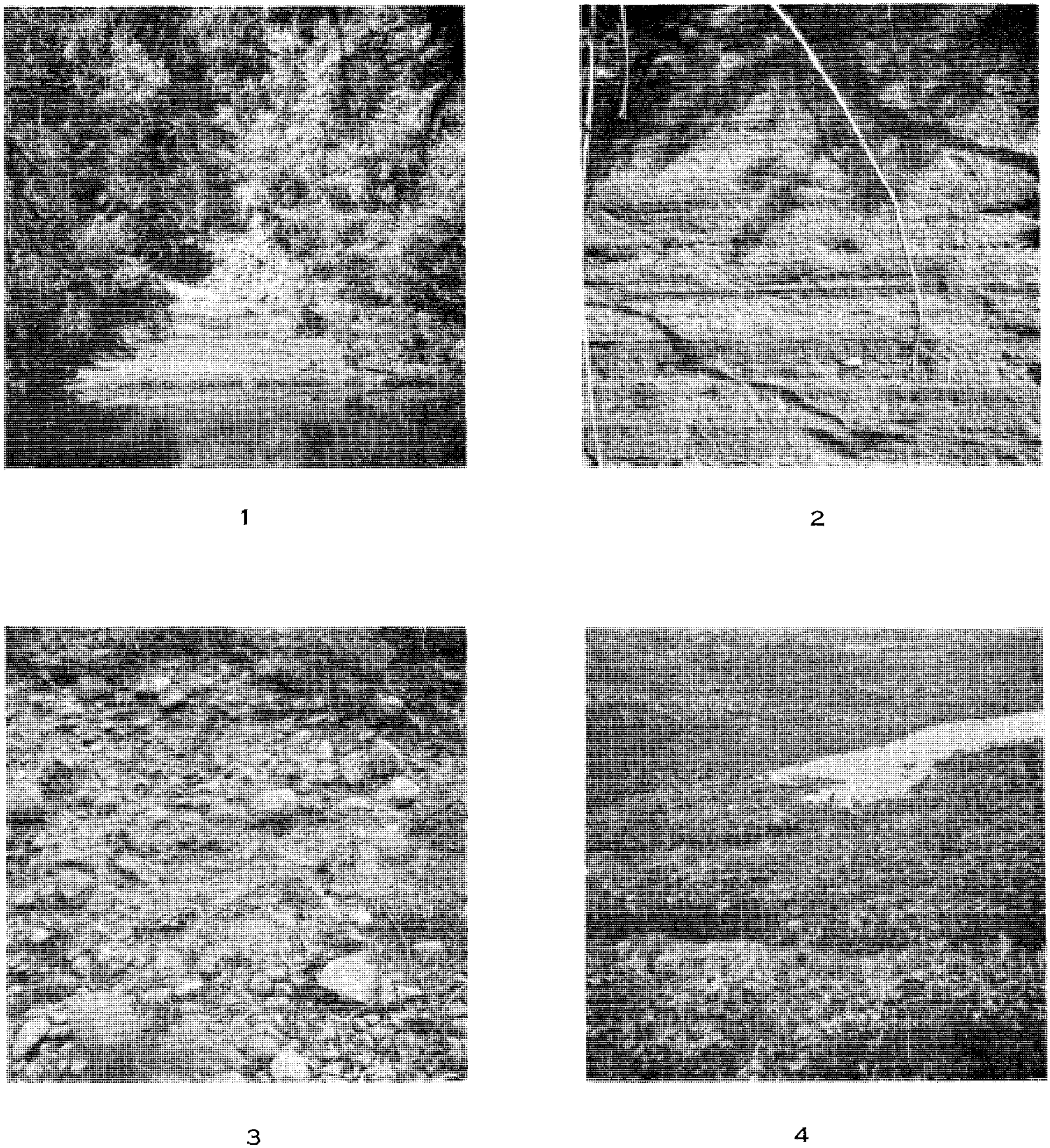


PLATE II

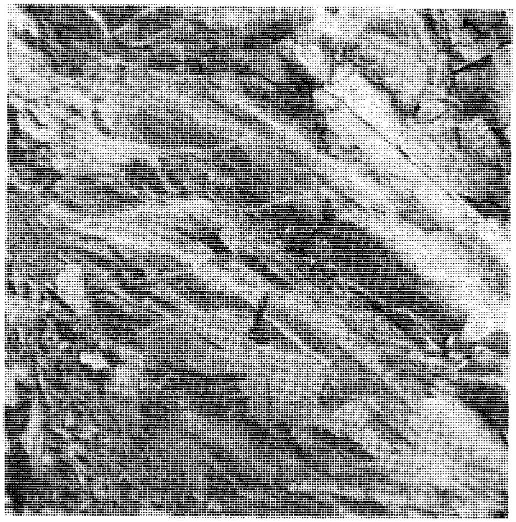
No. 1.—Pleistocene till overlying varves in the bank of the Arm River, three miles upstream from its junction with the Mersey.

No. 2.—Detailed view of the Arm River varves. The section is about three feet across.

No. 3.—Pleistocene till in a river terrace on the Mersey. A mechanical analysis is given in this paper.

No. 4.—Moraine-dammed lake on the Central Plateau to the south-east of this area.

1



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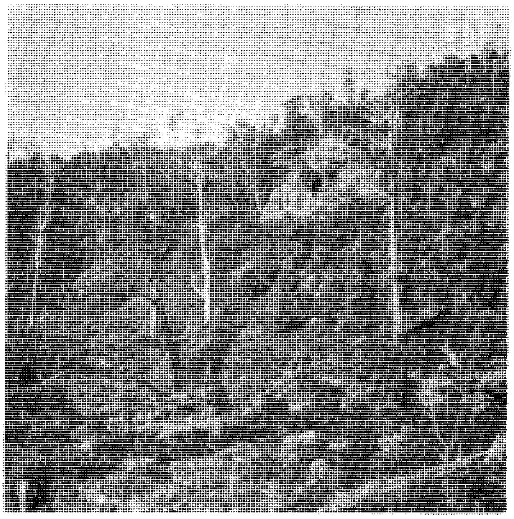

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PLATE III

No. 1.—Nearly vertical Precambrian quartzites in a gorge of the Forth River just north of Gisbourne's Hut.

No. 2.—Lineated quartzites of the Fisher Group at the Mersey-Fisher junction.

No. 3.—Quartzite in the Arm Schist at the rapids just north of Walters Marsh. Lineation (ribbing) is parallel to the axis of a minor anticline and joints are symmetrically disposed.

No. 4.—Conical shaped outcrop of Tertiary volcanic breccia on the slope from Berriedale Plains to the Forth River. An extensive landslide area begins at the base of this slope.