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The Age and Physiographical Relationships of some Cainozoic Basalts in Central and Eastern Tasmania

By

A. B. EDWARDS, Ph.D., D.I.C.

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PLATES XVII, XVIII

INTRODUCTION

The problems associated with the determination of the age of the Cainozoic volcanic rocks of Tasmania are closely analogous to those presented by similar rocks in Victoria. In Tasmania, as in Victoria, certain volcanic rocks are known to be of pre-Lower Miocene age, while others are known to be post-Lower Miocene from their relationships with fossiliferous marine sediments (Nye and Blake, 1938, pp. 50-51).

More generally, however, in both States the lava-flows are associated with Cainozoic sediments of uncertain age, or directly overlie still older rocks. In such circumstances one must turn to physiographical and petrological evidence in any attempt to determine their age. Both these methods have been applied in Victoria recently with considerable success. It was shown that in Victoria while the lava-flows (mainly basaltic) form two distinct petrological suites corresponding to an Older and a Newer Volcanic Series (Edwards, 1938), neither of these series of rocks was confined to a single geological period of time (Hills, 1938), thus confirming previous opinion. The Older

Volcanic Series was shown to range from the Oligocene into the Lower Miocene, while the Newer Volcanic Series ranged from the Middle Pliocene to the Recent.

It seems highly probable that the Tasmanian lava-flows, which are also mainly basaltic, exhibit somewhat similar age relations, which can be investigated by similar means. As a preliminary step in such an investigation, I recently visited and collected from a number of areas of Cainozoic basalt in Central and Eastern Tasmania. This paper records my conclusions with regard to the physiographical evidence of the age of these basalts.

The Time-Scale Terminology

The time-scale terminology used in this paper is as follows:—By *Cainozoic* is meant what is generally termed in Tasmania, Tertiary and Post-Tertiary. By *Pleistocene* is meant the duration of the Glacial Epoch. For North America and Northern Europe, the Pleistocene, so defined, begins with glaciation on a large scale, and is divisible into two parts, the Glacial Epoch and the Post-Glacial Epoch (Daly, 1934, pp. 14-15). The Post-Glacial Epoch covers what is commonly referred to as the *Recent.*

In Tasmania the Pleistocene is divided into three stages, (1) the Malanna or oldest period of glaciation, (2) the Yolande, and (3) the Margaret or youngest stage (Lewis, 1934). Both the Malanna stage and the Malanna-Yolande interglacial period are thought to have been of much longer duration than the Yolande stage, while the Margaret stage was of shorter duration.

Acknowledgements

I have to thank Dr. A. N. Lewis for reading through the manuscript critically, and generously placing at my disposal his considerable knowledge relating to the problems under discussion. Many of his suggestions have been adopted in the paper.

SOME GENERAL FEATURES OF BASALTIC TERRAINS

Before proceeding to the description of the basalts under discussion, it will be as well to summarize certain concepts which apply to basaltic regions generally, and to Victoria and Tasmania in particular.

Lava fields are of two types:—(1) Confined lava fields and (2) extensive lava fields (Keble, 1918). A confined lava field is one which is confined between the pre-basaltic watersheds: an extensive lava field is one where the lavas have overflowed such watersheds. Both types of lava field occur in Tasmania, but all those to be described here are confined lava fields.

Confined Lava Fields

A confined lava field more or less fills the existing valley, deranging the pre-basaltic drainage. In the inauguration of a new drainage system the location of the new stream is guided by the position of the lines of least resistance to erosion, and by the direction of the gradient. These are frequently combined at the edges of the confined lava field, where the lava-flow and the bedrock are in contact. A pair of *lateral streams* develops, one stream on each side of the lava-flow parallel to the original valley, and to one another, and the original lava-filled valley is left in the position of a ridge. The widening of the lateral valleys gradually restricts the residual volcanic rock, and may completely remove it. Generally an *uncovered residual* can be recognized.

It often happens that a confined lava-flow has failed to fill a valley. In such valleys the deranged drainage might form normal lateral streams, but frequently the major part of the water has meandered across the uneven surface of the lava-flow, incising its course upon the lava field. From this a single stream has developed, with minor laterals as tributaries, and tends to divide the basalt into a number of isolated residuals arranged linearly.

If the basalt does not fill the upper part of the original valley, lake conditions will develop upstream from the basalt barrier until such time as the barrier is breached.

Extensive Lava Fields

In extensive lava fields the lava-flows have infilled the pre-existing valleys, and then covered the interfluves between such valleys, so that the pre-basaltic topography is completely obscured beneath wide lava plains. The variations of gradient over the surface of the lava plain decide the course of any new stream, and by the time such a stream has cut down below the surface of the lava its course is impressed upon it. Such streams have a meandering course, and give little indication of their presence from a distance. Impressed meanders and small hanging valleys developed by intermittently flowing tributaries are characteristic of them. They do not develop large tributaries after they have descended below the plain. Such drainage as would form a tributary finds its own path over the plain, and it will be accidental if it should connect with another stream.

If the gradient of the lava plain does not provide any outlet, swamps or shallow lakes will develop as temporary features until they overflow the rims of the natural lava basins.

Local Complications

The widespread occurence in Tasmania of Mesozoic dolerite, which is more or less equally resistant to erosion as are the Cainozoic basalts, introduces complications rarely met with in Victoria, where the bedrock is almost always more susceptible to erosion than the basalts which overlie it.

Thus, other factors being equal, a basalt flow infilling a valley carved in sediments would give rise to physiographic features very different from those produced by a contemporaneous lava flow in a valley eroded in dolerite. Later stream action would erode the sedimentary interfluves much more rapidly than it would the dolerite interfluves, and the lesser resistance to erosion of the sediments as compared with the basalt would give rise to well defined lateral streams, and leave the basalt as an elevated ridge or line of residuals. In the dolerite valley, on the other hand, the erosion would go on more slowly, either along both sides of the lava field as laterals, or as a single stream, and the lava flow would tend to retain its original appearance longer. The basalt filling the sedimentary valley would accordingly assume a deceptive appearance of greater age unless some other feature provided an independent check. An excellent example of this is provided by the basalts of the Interlaken district and those of the Macquarie River, both of which are discussed later. The contrast between them is brought out very clearly in the geological map of the Midlands (Nye, 1921), in which they appear in juxtaposition.

Another effect of this type of difference in the nature of the walls and floor of the original valley would be that lakes formed upstream from the basalt barriers in sedimentary valleys would tend to have a much shorter life than similar lakes formed in dolerite valleys. Still further complications would be introduced where the valley sides changed from dolerite to sediments or *vice versa* along the course of the infilled valley. This also is illustrated by the basalts of the Macquarie River.

A fourth effect is introduced by the shape of the original valley at the time of the basaltic eruption, particularly for dolerite valleys. In a valley with high steep walls, such as the South Esk, the likelihood of the basalt filling the valley to any great height above its floor would be remote, so that there would be little chance of the reconstituted drainage eroding away the original valley walls. On the other hand, where the original valley was broad and shallow, as at the southern end of Great Lake, the level of the basalt might approach the top of the dolerite valley walls. Lateral valleys would be more likely to develop, and the reconstituted streams might be able to erode away the relatively low dolerite interfluves, and leave the basalt as a low ridge.

All these possibilities need to be kept in mind, therefore, during any attempt to assess the age of Tasmanian basalt flows from their physiographical relationships.

Post-Basaltic Faulting

Allowance must also be made for the varying degree of erosion resulting from the post-basaltic faulting which has caused the elevation of the Central Plateau. Streams on the uplifted block have been rejuvenated, and have transformed their valleys into deep gorges. These gorges are deepest near the fault scarp or scarps (Lewis, pers. comm., indicates that the uplift occurred as a series of step faults), and become progressively shallower upstream towards the interior of the Central Plateau. The Nive River basalts provide an example. At Tarraleah a flow of basalt, infilling the pre-basaltic Nive valley, occurs at a height of about 1000 feet above the valley floor of the present Nive River. At Marlborough, about 10 miles further upstream, however, where the basalt again occurs infilling the valley of the pre-basaltic Nive, the present Nive River flows in a narrow gorge-like valley only 100 or so feet deep, and is still vigorously eroding down into the basalt. These two basalt flows are presumably of the same age, but the Marlborough basalt offers the better basis for estimating their age, since it has not undergone such abnormal erosion as the Tarraleah basalt. Other examples are provided by the basalts of the Bashan Plains, which stand at a height of 1000-1500 feet above the floor of the Ouse Gorge, and probably by the basalts of the Interlaken region.

I. CENTRAL PLATEAU BASALTS

Areas of basalt occur on the Central Plateau of Tasmania near the southern end of the Great Lake, along the Nive River, near Lake Echo, between the Dee and the Kenmere Rivers, and in the vicinity of Lake Sorell and Lake Cresent at Interlaken. Johnston (1888, pp. 217, 249) regarded these basalts as 'marking the close of the Palaeogene period in Tasmania,' i.e. as Miocene in age, and subsequent workers tended to accept this view (Twelvetrees, 1908). Nye (1921, p. 67; 1924, p. 34) suggested, however, that the Interlaken basalts are either contemporaneous with or somewhat older than the basalts of the Macquarie River, which he considers are probably Pliocene. This view is endorsed by Lewis (1927, p. 22) who considers that 'on the Central Plateau glacial features are superimposed on the newer basalts' and further 'that the Yolande glaciation was more recent by a considerable space of time than the eruption of the newer basalts' (Lewis, 1934, p. 71). The Malanna glaciation he thinks probably occurred after the extrusion of the basalts, although he is not satisfied on this point. Subsequently he has recognized the possibility that the basalts may have been early Pleistocene extrusions (Lewis, 1935, p. 76). Nye and Blake (1938, p. 26), however, now correlate the Interlaken basalts (their 'high level basalts of the Midlands') with the Oligocene basalts of Marrawah. With this I am unable to agree.

(1) *The Great Lake Basalt*

Basalt outcrops over a considerable area at the southern end of the Great Lake, on both the eastern and western sides. On the western side a ridge of this rock extends as a peninsula for three miles into the lake. Along the northern shore of this peninsula are groups of basaltic cliffs (the Beehives) at intervals. The cliffs are of uniform height, from 25-30 feet above water level. Each group of cliffs consists of about half-a-dozen faces of finely columnar basalt, each face projecting outwards so that the cliff face forms a wavy line 'which when viewed from the water resembles a number of beehives' (Legge, 1904, p. 354). The land at the top of the cliffs is flat for some distance, and then slopes gently down towards the table land which stretches westwards to the Ouse Plains. For some miles back from the cliffs this flat surface is thickly strewn with boulders of basalt.

On the eastern side, 'after being submerged opposite the mouth of the Shannon (the outlet of the Great Lake), it appears again towards Todd's Corner at the Battery, and thence extends southwards over the shoulder of Barren Tier' (Lewis, 1933, p. 24).

The total area covered by this basalt flow or flows is about nine miles from W.N.W. to E.S.E., and about four miles in width. Presumably it fills an old valley which debouched towards the Lagoon. The surface of this basalt area, away from the immediate vicinity of the lake, is distinctly youthful. The original flat surface of the flow is still largely retained over the greater part of it. Moreover, at Liaweene a hill of soft scoriaceous basalt, which may represent a centre of eruption, forms a hill about 100 feet above the level of the plain, and is still as high as a dolerite hill of somewhat similar appearance at the junction of the Miena-Marlborough and Miena-Tingara roads (Lewis, pers. comm.).

Both of these features indicate that the basalt is relatively youthful and but little eroded by subsequent glaciation, a fact appreciated by Lewis, who wrote concerning the basalts of this region generally: 'were it not for the conclusive evidence of surrounding districts, I would hesitate to say that these basalt plains had been affected by ice' (Lewis, 1933, p. 26). This youthful appearance precludes the likelihood that the basalts are of pre-Malanna age. However, glaciation appears to have occurred after their extrusion, because the surface of the area occupied by the Lagoon, which is 50 or more feet below the level of the adjacent basalt, is covered by moraine material (Lewis, pers. comm.), and glacial erratics occur along the valley of the Shannon, south of the Shannon Outlet (Lewis, 1934, p. 25). This would indicate that the basalts are interglacial in age, presumably post-Malanna and pre-Yolande, and therefore Pleistocene. There remains some possibility that they are pre-Malanna and of Pliocene age, because the Malanna glaciation may not have affected this part of Tasmania. However, they are much less eroded than the basalt flows at Scottsdale, which are regarded as Upper Pliocene or younger (see below). Also, they have undergone much less erosion than basalts in Victoria, which are correlated as Upper Pliocene from their association with marine sediments (Hills, 1938), but this is perhaps an unsafe analogy.

Origin of the Great Lake

Certain considerations with regard to a possible origin of the Great Lake support this conclusion.

Lewis (1933, p. 23 *et seq.*) has shown that glaciation has played some part in the origin of the northern part of the Great Lake, but under no circumstances could it be called a typical glacial lake. Legge (1904, p. 352) has drawn attention to its extraordinary shallowness, and the level nature of its bottom. It has an area of 60 square miles, with an average depth of only 12 feet (prior to the building of the Miena Dam), and with very few places exceeding 20 feet. On the other hand, the valley of the Shannon, south of the dam, 'shows unmistakable evidence of glaciation' (Lewis, 1934, p. 25). This suggests that glacial erosion played some part in developing the whole of the broad valley in which the lake now lies: but there is no indication that it was responsible for the formation of the lake. The outlet through which it debouches into the Shannon River is cut in basalt and dolerite—not in glacial moraines.

It seems probable, in my opinion, that the Great Lake originated as a result of the outpouring of the basalt about Miena. Lewis (1934, p. 25) suggests that 'it is possible that the Great Lake once drained to the Lagoon, *via* Todd's Corner.' Prior to the basalt outflow there was, as indicated, a valley trending more or less in this direction, into which the broad, shallow valley now occupied by the Great Lake may have drained (assuming that it was formed in pre-basaltic times). As to the origin of this broad valley, no suggestion is offered, but that a correspondingly broad, shallow valley from the north-west joined it at its southern end is clear from the disposition of the basalt.

The outpouring of the basalt lava developed in this north-west valley, probably near Liaweene, and flowed down it, more or less completely filling it, towards the Lagoon. It also probably flowed up the valley now occupied by the Great Lake to some extent, since Legge (1904) describes columnar basalt at water level at Helen's Isle. This may explain the constriction of the lake near this point. The lava flow closed the outlet of the Great Lake valley and dammed back the drainage until it overflowed the basalt and joined the southern lateral stream to the basalt, which is now represented by Swan Bay. Instead of following the course of the pre-basaltic stream to the north of Barren Tier, the dammed up drainage escaped southwards, to the west of it, along the course of the present Shannon River. The outlet of the lake is cut in the dolerite which formed the southern interfluve of the infilled pre-basaltic valley. Presumably the pre-basaltic interfluve was relatively low at this point. That the waters of the lake once extended for a considerable distance over the surface of the basalt prior to the breaching of the dolerite is indicated by the fact that the land at the top of the cliffs at its southern end 'is for miles thickly strewn with basalt stones' (Legge, 1904). The level of the lake must, therefore, have then been at least 30-40 feet higher than it was at the time when the construction of the Miena Dam was commenced. Prior to the building of the dam, it was draining away. The cliffs of basalt along the Beehive Peninsula were probably developed after the breaching of the dolerite outlet. Legge (1904) indicates that the basalt lies on the dolerite almost at water level, and this would render the columnar basalt liable to undercutting, while collapse of the columns would produce cliffs.

Lewis (1933, p. 25) indicates that in the post-basaltic glacial period the whole of the Great Lake valley was filled with an ice sheet. The youthful surface features of the basalt show, however, that the amount of erosion caused by this post-basaltic glaciation was relatively slight and probably added little to the valley structure of the lake. In view of this, the presence of glacial erratics in the Shannon Outlet suggests the possibility that the breaching of the lake had occurred before this period of glaciation developed, rather than that it was brought about by the glaciation. If this is so, the continued existence of the lake confirms the postulate that the basalt flows are relatively young and of Pleistocene age.

Dr. Lewis has wisely counselled caution in accepting this view as to the origin of the lake. He has pointed out (pers. comm.) that a very slight tilting of the Central Plateau block to the north, when it was faulted in post-basaltic times, would have been sufficient to produce the Great Lake. Such a tilt to the north would also have affected the direction of the later consequent streams, and tended to give rise to north-flowing streams or tributaries. More accurate and detailed mapping of the region may establish this, but there is no indication of it on available maps.

(2) *Nive River Basalts*

As indicated above, the valley of the pre-basaltic Nive River is marked by basalt residuals near Tarraleah and at Marlborough. As a result of post-basaltic faulting, and consequent rejuvenation of the river, the Tarraleah basalt now stands at a height of about 1000 feet above the floor of the Nive Gorge. A long spur of dolerite, which divides the Nive from the Derwent, rises for another 200 feet or more on the western side of the basalt, and gives some measures of the pre-basaltic erosion.

About 10 miles upstream is the Marlborough basalt, which extends from the junction of the Pine River with the Nive, down to the confluence of the Clarence River with the Nive. The basalt forms a plain about 10 miles long and about 4 miles wide, with hills of dolerite and Permian limestone on either side. The surface of the plain is distinctly youthful (Pl. xviii, Fig. 2). The Nive now flows in a narrow, gorge-like valley through, and along the edge of, the basalt plain. Being further back from the fault scarp (or scarps), this basalt has undergone much less erosion than the Tarraleah basalt. The valley of the Nive, where the West Coast Road crosses it, is still vigorously cutting down into the basalt. It appears younger than valleys which have been cut in what are presumed to be late Pliocene members of the Newer Volcanic Series of Victoria.

Lewis (1934) has shown that the faulting which affected these basalts was post-Malanna, but pre-Yolande, which fixes the upper limit of age for the basalts as pre-Yolande. The question remains as to whether the basalt is pre- or post-Malanna. The Malanna glaciation extended down to 900 feet above sea-level in the Florentine Valley, immediately south of the junction of the Nive with the Derwent, but the youthful appearance of tbe Marlborough basalt precludes the possibility of its having suffered intensive glaciation. This suggests that it is post-Malanna, i.e. Pleistocene in age. There remains the possibility, however, that the Malanna glaciation did not extend to this area, and the youthful appearance of the basalts may indicate merely that they are of late Pliocene age.

The basalt infilling the valley of the pre-basaltic Little Pine River is also probably of the same age, since the pre-basaltic Little Pine River was evidently a tributary of the pre-basaltic Nive.

Such large outflows of basalt must have seriously deranged the existing drainage systems, but it is clear from the continued existence of the pre-basaltic interfluves near Tarraleah and Marlborough, that the pre-basaltic valleys were not completely filled by the lavas. Presumably lake conditions would have developed upstream from the lava flow or flows prior to their being breached; and this may have been a contributive, or at least a predisposing, factor in the development of the Ninety-Nine Lagoon region. Since the basalts did not overflow the original interfluves, the rivers returned more or less to their original positions once the basalt barriers were breached. The later fault movements have rejuvenated them, so that they are now actively cutting deep gorges through the basalts and underlying rocks.

(3) *Lake Echo Basalts*

Basalt flows (the Bashan Plains) cap the ridges between Lake Echo and Waddamana (Lewis, 1933, Pl. xiv). The Bashan basalts stand 1000-1500 feet above the Ouse Gorge, resembling in this respect the Tarraleah basalt. From this it is concluded that the Bashan basalt is of pre-Yolande age. The drainage from this area has reformed as twin lateral streams, the Bashan Plains Rivulet and the Boggy Marsh Rivulet, tributaries of the Ouse. Midway along Boggy Marsh Rivulet, between two areas of basalt, is Martin Cash's Marsh, which presumably owes its origin to the influence of the basalt, indicating that the basalt is relatively young.

Several miles to the south of Lake Echo lies the Dee River basalt, which forms a flat-topped ridge between the Dee and the Kenmere Rivers. These two rivers appear to be lateral streams developed more or less at the edges of the lava flow. The infilled valley, which may be called the 'pre-basaltic Dee' valley, drained much the same country as is now drained by the Dee (and is presumably a continuation of the valley in which Lake Echo now lies. Here, as in the Nive River, the damming back of the drainage must have contributed to the formation of lake conditions, and it is a question whether Lake Echo, which is another of these peculiar shallow lakes, rarely more than 20 feet deep in any part (Lewis, 1934, p. 28), did not once extend as far southwards as the northern end of the Dee basalt.

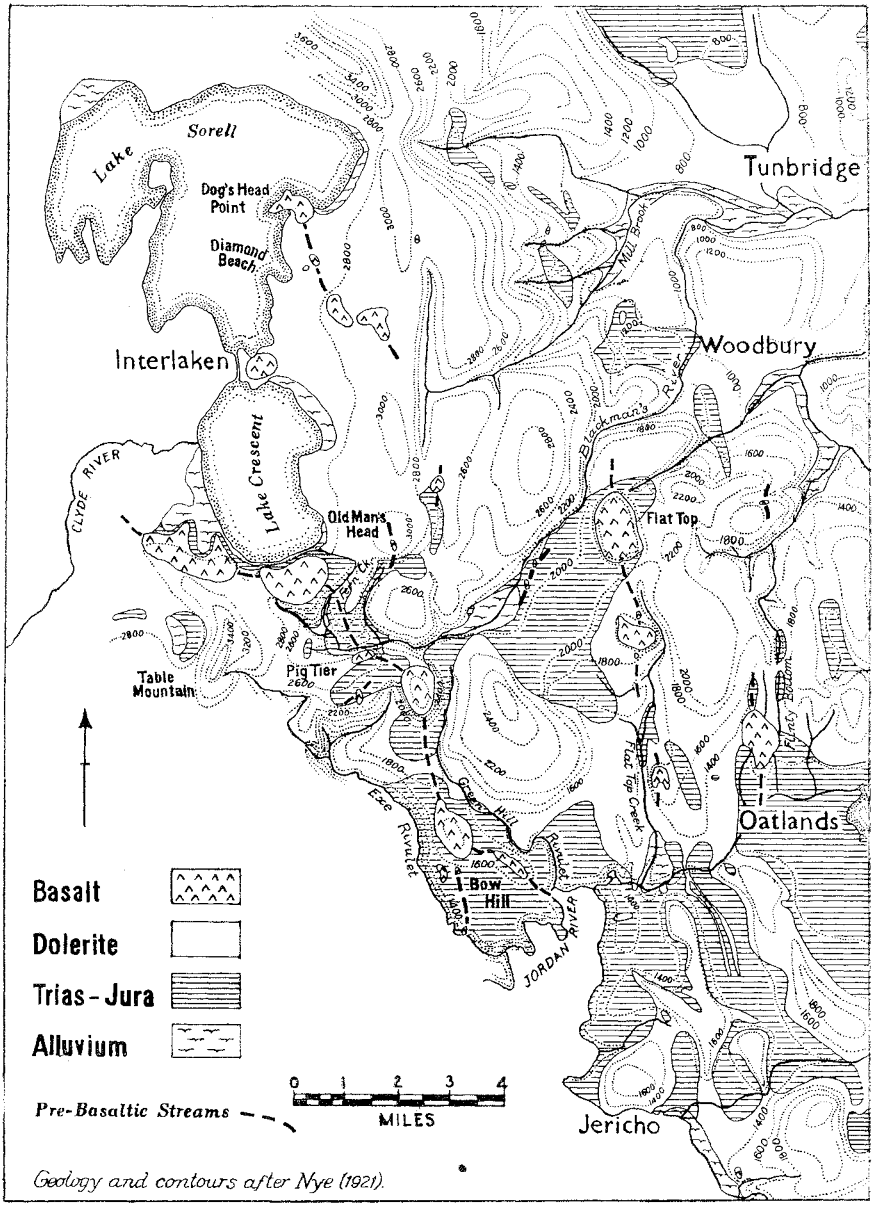

Fig. 1.—Geological Sketch Map showing the distribution of the Interlaken-Jericho basalts and their relation to pre-basaltic stream courses.

Subsequently the basalt barrier was breached by the present Dee River, which, as it cuts vigorously downwards, is causing Lake Echo to recede more and more. Lewis (1934, pp. 27-28) considers that post-basaltic glaciation has contributed to the origin of the Lake Echo valley, so that here again there is evidence that the basalts are probably pre-Yolande. When allowance is made, however, for the fact that they have been subjected to increased erosion as the result of post-basaltic faulting, it seems highly improbable that they could be older than late Pliocene. The continued existence of Martin Cash's Marsh suggests that they are likely to be post-Malanna.

(4) *The Interlaken Basalts*

The basalts in the vicinity of Lake Sorell and Lake Crescent are shown on the geological map of the Midlands (Nye, 1921), on which Text fig. 1 is based. Here again, broad shallow lakes are associated with basalt flows. Lake Sorell is five miles from north to south, and six miles from east to west, and only 13 feet deep in the centre, While Lake Crescent is about 3·5 miles by 2 miles, and only 8 feet deep in the centre (Twelvetrees, 1902, p. 159).

The succession of flat-topped basaltic residuals running south-east from the southern end of Lake Crescent to Bow Hill, each successive residual having its base at a lower elevation, marks the position of a pre-basaltic valley down which the lava flowed. This valley seems to have been a north-westerly continuation of the present Jordan River. The Exe Rivulet has developed as a lateral stream on the south-west side if this lava-filled valley, eroding away the sedimentary interfluve, while the lateral on the north-east side is represented by Fern Creek in the upper reaches, and by Green Hill Rivulet in the lower reaches.

A tributary stream ran due southwards from Flat Top to join this pre-basaltic Jordan, as is shown by the descending level of the bases of the successive basalt residuals in that direction, while another stream flowed southwards from the residual near Flinty Marsh, and a further valley extended from Vincent's Hill *via* Coal Mine Hill towards Andover. Flat Top Creek, Flinty Marsh, Flinty Bottom, and the upper reaches of York Rivulet appear to be lateral streams induced by the filling of these valleys with lava.

It seems probable that the valley now occupied by Lake Crescent and Lake Sorell originally drained into this pre-basaltic river, and the flow of basalt dammed back such drainage, giving rise to, or contributing to, the present lakes. Another stream, now filled with basalt, existed in the vicinity of Dog's Head Point on the eastern shore of Lake Sorell.

A striking feature of the basalt residuals of the pre-basaltic Jordan is that although they are relatively horizontal, considerable differences of elevation exist between successive residuals. For example, there is a difference in elevation of about 800 feet between the base of the residuals near Pig Tier and those at Bow Hills, two miles further 'downstream,' Text Fig. 2. Similarly, the basalt residuals filling the tributaries of the pre-basaltic Jordan are at markedly different elevations. This is well illustrated by Nye (1921, Pl. iii, Sect. EFG).

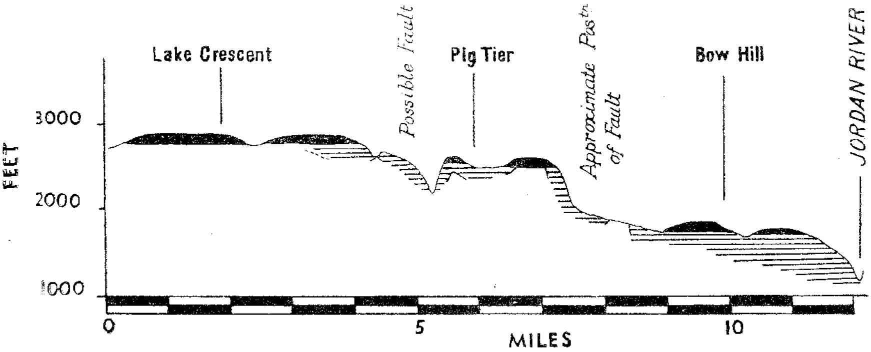

Fig. 2.—Sketch section along the course of the "pre-basaltic Jordan," showing the different levels of the basalt residuals (black).

There can be little doubt, therefore, that the extrusion of the basalts occurred prior to step faulting which uplifted the Central Plateau, despite views to the contrary (Nye, 1921, p. 71). Lewis (1934, p. 20) considers that the valley occupied by the two lakes underwent glaciation during the Pleistocene, so that if the basalts are regarded as responsible for the formation of the lakes, both they and the faulting may be pre-glacial. It seems highly probable that the faulting was more or less contemporaneous with that which affected the basalts further to the west, and that the uplift of the Central Plateau was everywhere pre-Yolande.

The combined effect of the faulting and the infilling of pre-existing valleys by basalt has been to divert much of the drainage into the Clyde River. The waters from Lake Crescent have also found an outlet into the Clyde, round the back of the basalt barrier, and have commenced to drain away. This must have commenced in geologically recent times, because the water level in Lake Sorell is only 2·16 feet higher than that of Lake Crescent (Twelvetrees, 1902, p. 159). The water in Lake Sorell cannot have stood much higher in the past than it does now, because there is no indication that it ever covered the flat-topped basalt residual at Dog's Head Point. This residual now juts out into the lake as a promontory 20-30 feet above the level of the lake, to which it descends abruptly as a result of wave erosion. The two lakes are connected by a shallow channel through a narrow strip of flat land not more than half a mile wide. The small hill of basalt to the east of this may mark an earlier connection between the valleys these lakes occupy.

The flat surfaces of these basalt residuals, as at Dog's Head Point, a feature upon which Twelvetrees commented (Twelvetrees, 1902, p. 160), suggest that the basalts is relatively youthful. Support for this interpretation might be adduced from Twelvetrees' description of the two small areas of basalt about half a mile east of Diamond Beach (Lake Sorell) as lava cones. Of the smaller he says (1902, p. 165): 'The cone . . . is the most perfect survival of a volcanic cone which I know of in the island. No ash or scoriae are to be seen.' Nye, however, doubts whether they are true cones, and thinks they may be merely residuals.

Reference of these basalts to the Pliocene, or possibly to the Pleistocene, runs strongly counter to the views recently expressed by Nye and Blake (1938, p. 26), but, as indicated in the previous section, I think that the deceptively old appearance of these rocks is due not to their being of great age but to the fact that they were extruded in a region which was relatively susceptible to erosion, and which has developed steep gradients as a result of post-basaltic uplift.

II. The Basalts of the Midlands

Certain small residuals of basalt, properly occurring within the Midlands, have already been described in connection with the Interlaken district. The main areas of basalt in the Midlands are the flows in the valleys of the South Esk and the St. Paul's Rivers, extending from Glen Esk Bridge to above Avoca, and the much larger sheet of basalt stretching more or less along the Macquarie River from Conara Junction to south of Tunbridge. Both of these areas are shown in detail on the geological maps of the Tasmanian Geological Survey (Nye, 1921, 1926), and it will help the reader greatly if he refers to these maps in connection with the ensuing discussion.

Occasional exposures show that the basalts overlie lacustrine or fluviatile Tertiary sediments, both in the valleys of the South Esk and St. Paul's Rivers (Nye, 1926, p. 14) and along the southern bank of the Macquarie River (Nye, 1921, p. 50), to a height of 40 feet above the present stream levels. These sands are considered to represent the southern extension of the beds of the Launceston Tertiary basin, which are correlated as Lower to Middle Pliocene by Edgeworth David (1932, Table I, p. 87) and by Nye and Blake (1938, p. 50), who therefore regard the basalts as Upper Pliocene and possibly contemporaneous with the Newer Volcanic Series of Victoria (Nye, 1921, pp. 67-68).

Age of the Tertiary Leaf Beds

Johnston (1874, 1888, p. 268 *et seq.*) divided the sediments of the Launceston Basin into three zones:—

(1) An unfossiliferous upper zone, consisting of drifts;
(2) A middle zone, containing remains of coniferous trees and *Banksias*, and including the basalt flows;
(3) A lower zone containing remains of *Betula, Fagus*, and *Cinnamomum*, as well as other leaves.

It is not clear how well defined these zones are; *Banksia* and *Cinnamomum*, &c., occur together in some localities. This division assumes significance, however, in the light of the recent suggestion (Hills, 1938) 'that *Cinnamomum* and other genera belonging to Deane's "brush" type of flora, not now living in Victoria but found in the warmer and moister parts of Australia, serve to indicate (in Victoria) an Oligocene, Miocene, or possibly Lower Pliocene age,' while '"and open forest" flora, from which the above types are absent but which includes *Eucalyptus, Banksia*, and *Casuarina*, and other genera now living in the State, indicates a post-Lower Pliocene age.' If this interpretation applies to Tasmania as well as to Victoria, the sediments of the Launceston Tertiary basin may be regarded as ranging from Miocene or Lower Pliocene, in the lower zone, into a post-Lower Pliocene middle zone, while the upper zone may be Upper Pliocene or even Pleistocene. If this is so, the basalts of the Midlands and the North-East, which overlie sands presumed to belong to the Middle Zone of the Launceston Tertiary Basin, should be either Upper Pliocene in age or possibly Pleistocene.

The leaf beds of the Derwent Basin, on the other hand, appear to be mostly Lower Pliocene or earlier, although Baron von Mueller (1884) indicated that the presence of *Alnus* among the leaves suggests a Pliocene age. The basalts overlying these leaf beds are to be regarded, therefore, as Pliocene or younger.

(1) *Basalts of the South Esk and St. Paul's Rivers Valleys*

The South Esk and St. Paul's Rivers were firmly established before the extrusion of the basalts, and had entrenched themselves in valleys 200-300 feet deep, with steeply sloping walls. The basalt flows, which were 30 or more feet thick (Nye, 1926, p. 14), were confined to the valleys and failed to more than thinly cover their floors. As a result, once the basalt barriers were breached the South Esk and St. Paul's Rivers resumed more or less their pre-basaltic courses, cutting new beds along the northern contact of basalt and dolerite. The high dolerite walls and their resistant character have prevented the development of typical 'lateral' streams, so that the basalts have not been left as high-level ridges as was the case with the Interlaken basalts, whose valley walls in large part consisted of softer sediments.

The basalts successfully dammed back the drainage in these two rivers for a period, giving rise to lakes which slowly spread over the basalts until their waters finally escaped over its surface. Evidence of the existence of these lakes is provided by deposits of loose sands overlying the upper reaches of the basalt flows and at the same level as the basalt downstream from them. These sands are described as 'probably Upper Tertiary' (Nye, 1926, p. 15), because 'the basalt is usually regarded as closing the Lower Tertiary period.' However, the surface features of the basalts are far too youthful for this to be the case. It is unlikely that the basalts would have retained their almost flat surfaces if they had been subjected to the erosion of such vigorous streams as the South Esk and St. Paul's Rivers since even early Pliocene times; and it is still more improbable that the coverings of lacustrine sands in their upper reaches would have persisted under these conditions.

The more recent view that they are Upper Pliocene basalts (Nye and Blake, 1938) fits much better with the appearance of the basalts. The possibility must be considered, however, that they may have been extruded during the Pliestocene. The fact that the lakes formed as a result of their extrusion have been drained, while those of the Interlaken area have not, may indicate that the South Esk basalts are the older of the two: but this is more probably due to their different geological setting, which prevented the dispersion of the pre-basaltic drainage into lateral streams.

(2) *The Macquarie River Basalts*

This sheet of basalt forms a long, narrow plain about 24 miles long, and is about 5 miles broad at its widest point, near Campbell Town, with an average thickness of about 100 feet (Nye, 1926, p. 18). The surface of the plain is generally flat, apart from a few mound-like hills which probably represent some of the original points of extrusion. At its southern end it dies out into isolated residuals.

The basalt has infilled the valley and tributary valleys of a river which was as strongly developed as the pre-basaltic South Esk River, and which I shall call the 'pre-basaltic Macquarie' River. At its southern end it appears to have had two main tributaries, of which the eastern is represented by the basalt residuals of Kitty's Rivulet, and the western by the residuals just east of Tunbridge.

The development of the post-basaltic drainage has been of a different character to that of the South Esk, and this difference has arisen from the difference in rock character of the valley walls of the pre-basaltic Macquarie River. The eastern headwater of the pre-basaltic Macquarie had developed entirely in resistant dolerite, and since the basalt did not fill this valley completely, the drainage soon flowed over the basalt without cutting down the original valley walls, just as in the case of the South Esk River. This gave rise to the present Kitty's Rivulet.

The western headwater, on the other hand, had its valley in much less resistant Trias-Jura sediments. The deranged drainage gave rise to a single 'lateral' (the York Rivulet and the lower part of Blackman's River), which eroded the valley sides in preference to the more resistant basalt, and ultimately left the basalt as a series of elevated residuals.

For a distance of 5 miles north of One Tree Hill (i.e. nearly to Ross), the pre-basaltic Macquarie valley had dolerite for its eastern interfluve, and Trias-Jura sediments for its western interfluve. As a result the western lateral—the York Rivulet and the lower part of Blackman's River—developed a valley below the surface of the basalt, and acquired most of the drainage, including the reconstituted Macquarie River and its tributaries. Still nearer to Ross, however, the sedimentary western wall of the pre-basaltic Macquarie changed to dolerite, with the sediments further to the west. This seems to have deflected the western lateral, now the combined Macquarie River and the Blackman's River, to the west of the old valley course. A further tributary comes to this river across the basalt through another small sedimentary 'gap' to the north of Ross.

A marked feature of the Macquarie River and the York Rivulet is that alluvial flats extend up their courses from where the Macquarie River crossed the dolerite at the south-western end of Mount Augustus to as far south as Tunbridge on the Blackman's River and the York Rivulet, and Glen Morrison and Kitty's Rivulets on the Macquarie River. The probable explanation of this is that as the Macquarie cut down through the Trias-Jura sediments it became superimposed on this dolerite bar, giving rise to slack water or lake conditions upstream, which in turn caused the deposition of alluvium. This alluvium forms a narrow plain whose surface is about 100 feet below the surface of the basalt.

The Elizabeth River which now flows across the basalt plain just south of Campbell Town to join the Macquarie, was also a tributary of the pre-basaltic Macquarie. Its valley is filled with basalt to a height of 1400 feet at the eastern end, the basalt flow culminating in a small hill which was clearly a point of eruption from which a flow issued and helped give rise to the broad plain north-east of Campbell Town. The new Elizabeth River forms the southern lateral of this flow, while Blanchard's Creek, which reaches the Macquarie *via* Conara Junction, forms the northern lateral. As a result, the basalt flow filling the pre-basaltic Elizabeth River has been elevated to a ridge.

In view of the large amount of river erosion which has gone on since their extrusion, the basalts cannot be very young. Two factors have contributed to the apparent youthfulness of the plain between Conara Junction and Campbell Town, namely, the resistant nature of the valley walls which consist of dolerite, and the deflection of the Macquarie

River to the west of the basalt plain, so that only minor streams have affected it. A more accurate estimate of age may be obtained from the residuals near Tunbridge. These are still flat-topped and relatively youthful in appearance (Pl. xvii, Fig. 3). Physiographically they are to be regarded as not older than Upper Pliocene, which is the age assigned to them by Nye on the assumption that both the pre-basaltic and post-basaltic sands at Conara Junction are related to the upper beds of the Launceston Tertiary Basin. On the other hand, a north-south section across the Elizabeth River, east of Campbell Town, suggests that the basalt north of the river lies in a valley eroded in the pre-basaltic sands, which might indicate a time gap between the deposition of these (?) Upper Pliocene beds and the extrusion of the basalts. There is thus a suggestion that these basalts may be of Pleistocene age.

III. The Coal River and Sorell Basalts

(1) *Coal River Basalt*

A basalt flow extends down the valley of the Coal River from Lowdina, north of Campania as far south as Richmond (Nye, 1922). At Lowdina, where the bedrock consists of Trias-Jura sediments, the flow has been eroded to a series of residuals, but further downstream where the bedrock is dolerite it forms a narrow, flat plain, one to two miles wide, and seven to eight miles long. The flow is about 100 feet thick at the northern end, and dwindles to a thickness of about (?) eight feet at its southern extremity near Richmond. It covered the floor of the Coal River valley, but not to a sufficient depth to derange the drainage. The Coal River overflowed the basalt and cut a new channel along its eastern edge. There is no trace of lacustrine deposits upstream from the basalts, although some must have formed. These being deposited on Trias-Jura sediments, would, like the northern extremity of the basalt, have been exposed to relatively greater erosion than the basalt downstream.

The basalt overlies sands which Nye (1922, p. 37) regarded as Lower Tertiary, and now places in the Lower Pliocene (Nye and Blake, 1938); and it is overlain to the south by gravels and conglomerates which Lewis (1935, p. 81) correlates as pre-Malanna (? Pleistocene). The basalts, therefore, are probably of Upper Pliocene age. The youthful appearance of the flow would suggest that it might be younger and Pleistocene, but this youthful appearance is perhaps deceptive. The eroded state of the northern extremity of the flow probably provides a better basis for estimating the age of the flow.

(2) *Sorell Basalts*

Somewhat more extensive flows, with a Trias-Jura bedrock, occur behind Sorell, and to the west of that township, infilling the valleys of former tributaries to the Coal River. These flows give rise to flats which are distinctly youthful in appearance, and cannot be older than Upper Pliocene and are probably contemporaneous with the basalts of the Coal River.

IV. BASALTS OF THE DERWENT VALLEY

(1) *The Upper Derwent*

Basalts occur in the vicinity if Ouse, Hamilton, and Glenora, and are all of relatively young appearance. The largest flow is at Glenora. It overlies Tertiary sediments which contain leaves of *Fagus* and *Cinnamomum* (Johnston, 1888, p. 289), and are therefore presumed to be Lower Pliocene or older. The basalt has infilled a stream which flowed southwards as a tributary to the pre-basaltic Derwent, and also a part of the Derwent valley. The bedrock in this area consist largely of Trias-Jura sediments, which has enabled lateral streams, the Allendale Rivulet and the Belmont Rivulet, to develop on either side of the basalt-filled tributary. In addition, the Derwent developed as a lateral stream on the north-western side of the flow until it breached it near Gretna, and then continued as a lateral along the south-eastern side of the basalt. Similarly, the Styx River, near its confluence with the Derwent, was turned by the basalt, and now flows along the south-western margin of the basalt, converging towards the Derwent. The basalt remains as a flat-topped ridge with steep slopes to the Derwent and the Styx (Pl. xviii, Fig. 1).

The flow just west of Hamilton infills another south-flowing tributary of the pre-basaltic Derwent. The Clyde River has returned to this original valley, partly on the basalt, and partly along its edge. The Ouse basalt infills the lower reaches of the pre-basaltic Kenmere River. The present Kenmere and the Ouse now form the eastern lateral of this flow.

From their appearance, taken in conjunction with their situation in the path of strong rivers which are still vigorously eroding their valleys, these basalts cannot be older than late Pliocene, and are in all probability Pleistocene in age. Presumably, they are contemporaneous with the uplifted basalts of the Central Plateau.

(2) *The Lower Derwent*

Opinions as to the age of the basalts of the Lower Derwent have varied considerably. Johnston (1888) regarded them as Miocene; Allport (1875, 1877) thought them to be Pleistocene, but revised this opinion to Pliocene when they were found to underlie and not overlie the Geilston travertine beds; Noetling (1914) considered them to be Pleistocene, though on somewhat unsound evidence. They are now regarded as Upper Pliocene (Nye and Blake, 1938), although Lewis (1935) has recognized the possibility that they may be Lower Pleistocene.

At several localities they overlie beds containing the *Cinnamomum* flora (e.g. at Geilston, One Tree Point, &c.), while near New Norfolk and Bridgewater they are overlain by gravels which Lewis (1934) correlated as 'immediately pre-Malanna.' This would have established their age definitely as Upper Pliocene, but actually 'the real pre-Malanna gravels at Old Beach, Millbrook Rise, and elsewhere do not overlie the basalts' (Lewis, pers. comm.), so that the basalts may possibly be Pleistocene.

The most extensive of these basalt flows is that stretching from Pontville to Bridgewater. This has been mapped by Nye (1922). It filled the pre-basaltic valley of the Jordan River from its confluence with the Derwent to its original junction with the Bagdad and Strathallern Rivulets, the valley of a tributary which previously flowed eastwards along a dolerite-sediment contact to this point, and the lower reaches of the Bagdad and Strathallern Rivulets. These streams were all ponded until they overflowed and breached the basalt, and it is a question whether the alluvial deposits occuring upstream may not have originated partly in this way. Except in the case of the Jordan River, the valleys of these creeks across the basalt are still narrower than their valleys upstream, so that alluvium may be still depositing. The stronger Jordan River, however, has cut a sufficiently wide valley in the basalt for it to cease depositing alluvium upstream, and appears to be eroding previously deposited alluvium. There is here a suggestion of youthfulness that confirms the youthful appearance of the basalt surface, and supports Lewis's earlier suggestion that these basalts 'may not date further back than the opening of the Pleistocene period' (Lewis, 1935, p. 76).

The basalts outcrops downstream from Bridgewater are presumably of a comparable age. Dr. Lewis has suggested to me that they may be part of one extensive flow (or flows) that continued down the valley of the Derwent from Bridgewater, but are now dissected and submerged beneath the waters of the estuary.

The ridge of basalt extending from Rokeby to Droughty Point probably infills an elevated tributary of this pre-basaltic Derwent. In some occurrences in the Hobart district, however, the basalt has undergone elevation by faulting of uncertain age, and occurs as isolated residuals, as in the vicinity of Cambridge, Kingston, and Margate, and on the summit of Mt. Wellington. The age of these residuals will remain uncertain until the extent and age of the faulting has been ascertained. In close association with these faulted residuals now standing at various elevations are further residuals at sea-level which appear to be of comparable age to the Pontville-Bridgewater basalts.

V. SOME NORTH-EASTERN BASALTS

Observations of the basalts in this part of Tasmania were limited to the flows along St. Patrick's River, at Scottsdale, along the Ringarooma River, and at Weldborough Pass.

(1) *Weldborough Pass*

As indicated by Nye and Blake (1938, p. 26), the small area of basalt outcropping at the top of Weldborough Pass is much older than the other basalt flows of this region, with the probable exception of a small residual of high-level basalt at Bulman Bluff, near Branxholm (Nye, 1925, p. 21). The basalt at Weldborough Pass originally filled a valley in the granite, of Blue Tier, and is presumably a remnant of an old land surface which was eroded away prior to the development of the Launceston Tertiary Basin, so that the basalt is of Miocene or possibly earlier age.

(2) *Basalts of the Ringarooma Valley*

These basalts, on the other hand, are relatively young. Nye and Blake (1938) regard them as post-Miocene and probably Upper Pliocene. Edgeworth David (1932, Table I, p. 87) places them as Werrikooian, since they overlie sands which contain fossil fruits and wood, and are therefore correlated with the sediments of the Launceston Tertiary Basin (presumably the Middle or Upper Zone). The basalt has been mapped in detail by Nye (1925). In the southern part of the area the basalt did not completely fill the pre-basaltic Ringarooma valley. This is shown in a photograph (Pl. xvii, Fig. 1) taken looking south from near the fork of the Branxholm-Ledgerwood and Branxholm-Launceston roads. The youthful, flat surface of the basalt can be seen running back to hills of granite and Lower Palaeozoic sediments in the right middleground. The northward profile of the basalt is equally youthful (Pl. xvii, Fig. 2). North of Branxholm a greater number of flows was extruded, and these seem to have completely filled and somewhat overflowed the pre-basaltic valley. As a result, the post-basaltic Ringarooma River, which established itself on the basalt in the southern part of the area, became the eastern lateral in the northern part, and eroded down the granitic interfluve of the pre-basaltic valley.

The relations of the base of the basalt to the contours on Nye's geological map indicate that the surface of the pre-basaltic sands was more or less flat with a gentle, northerly slope, and that the streams had cut valleys about 50 or more feet deep in these sands, indicating that the estuarine conditions had passed away before the extrusion of the basalts.

Downstream from Herrick it seems probable that the pre-basaltic Tertiary sands completely filled the existing valleys, and even may have covered the interfluves between them. Once the Ringarooma River was established on the eastern margin of the basalt with the bedrock, it probably tended to continue in this position further downstream, getting below the level of the surface of the sands until it became superimposed on the underlying granite well to the east of its pre-basaltic course. The Boobyalla River also seems to have developed as a 'lateral' to the Tertiary sands.

(3) *Scottsdale Basalts*

The large area of basalt in the vicinity of Scottsdale overlies granites and Tertiary gravels in a valley excavated in the granite. The basalt has been considerably eroded, so that it now caps a series of radiating ridges in the floor of the older valley. It appears to be older than the Ringarooma basalts, but this may be due to the fact that the valley in which it lies has always been at a higher level than the Ringarooma valley, since it escaped sedimentation during Lower-Middle Pliocene times. The gravels underlying the basalt are presumably to be correlated with this period, while the basalt is probably Upper Pliocene in age. The pre-basaltic drainage has been dispersed and replaced by the Cox Rivulet and Muddy Creek.

(4) *St. Patrick's River Basalt*

The extent and shape of the St. Patrick's River basalt is shown in a sketch map accompanying the report on the Lisle Goldfield (Twelvetrees, 1908). The youthful appearance of the basalts indicates that they belong to the Upper Pliocene-Pleistocene series of basaltic eruptions, but insufficient time was spent in the area more than to suggest possible explanation of the various physiographic problems associated with these flows.

The basalt has filled the valley of a pre-basaltic stream which flowed southwards from Myrtle Bank, and was, like the St. Patrick's River, a tributary of the North Esk, but joined it much further to the north than does the St Patrick's River. In its lower reaches this pre-basaltic river followed the same course as the Distillery Creek. The more northerly part of the lava flow filled a valley in the Cambro-Ordovician sediments, and the deranged drainage developed as lateral streams, the Patersonia Rivulet and the St. Patrick's River, which have cut down into the bedrock and left the basalt more or less as an elevated ridge. Proceeding downstream, however, the bedrock changes to dolerite, and this deflected the Patersonia Rivulet across the surface of the basalt, causing it to combine with the St. Patrick's River.

Under normal conditions one would expect the St. Patrick's River to continue along the basalt-filled valley, as e.g. the South Esk River does, and Twelvetrees' map suggests that it formerly did so, along what is now Distillery Creek. Some abnormal factor must have intervened to turn the St. Patrick's River southwards across the dolerite wall of the pre-basaltic valley. It is to be noticed that the St. Patrick's River follows a relatively straight course from the place where it leaves the pre-basaltic valley to its present junction with the North Esk River, and it appeared to me, from my very brief observations, that the country immediately east of the St. Patrick's River was at a lower elevation than the country to the west. These two observations lead me to think that either (1) the St. Patrick's River may have been deflected from its former course down the pre-basaltic valley by a post-basaltic fault, or (2) that the bedrock east of the river is composed of sediments and not dolerite, as shown on the Geological Map of Tasmania. Twelvetrees' map is not complete at this point, but he shows a dolerite boundary on the western side of the river.

Another unsolved problem is presented by the right-angled bend in the St. Patrick's River near Myrtle Bank. This may simply be a lateral stream, but the alignment of the basalt residuals in this vicinity, shown in Twelvetrees' map suggests the possibility that there may have been a pre-basaltic stream here which flowed to the north, and formed the headwaters of the pre-basaltic Little Foresters Rivulet. If this were so, the upper part of St. Patrick's Creek was turned southwards by the basaltic barrier.

SUMMARY OF CONCLUSIONS

Study of the physiographic relationships of some Cainozoic basalts of Central and Eastern Tasmania shows that most of these extrusions were confined within pre-existing valleys, and frequently failed to fill the valleys, much less to cover their interfluves. This was particularly so when the pre-basaltic valleys were deep and narrow. The nature of the bedrock has considerably influenced the rate and effects of the post-basaltic erosion. Where the bedrock consisted of sediments, lateral streams have frequently developed, and the basalt has become an elevated ridge or series or residuals. Where the bedrock consisted of resistant dolerite, the post-basaltic drainage has tended to return more or less to its pre-basaltic course, and has not been able to erode away the interfluves to the same degree. As a result, a basalt flow with a sedimentary bedrock may have developed a misleading semblance of greater age in comparison with a basalt flow of similar age on a dolerite bedrock. Further complications are introduced where the character of the bedrock varies along the course of the lava flow, and where post-basaltic faulting has caused rejuvenation of the rivers.

Of the basalts examined, all but one are relatively young extrusions, ranging in age from Upper Pliocene to Middle Pleistocene. The lavas whose age is most readily gauged are those of the Central Plateau, where the basalt flows are associated with distinctive shallow lakes, which may owe their origin, at least in part, to the basalt flows. These basalts have undergone pre-Yolande faulting, so that they cannot be younger than Middle Pleistocene; their youthful features indicate that they cannot be older than late Pliocene, and there is some suggestion that they are post-Malanna.

In the Derwent valley equally youthful-looking basalts overlie Tertiary beds containing the *Cinnamomum* flora, and are overlain by gravels which may be pre-Malanna or younger. Recent studies have indicated that in Victoria the *Cinnamomum* flora may range from Oligocene to Lower Pliocene. The upward gradation of this flora in the Launceston Tertiary Basin to a flora tentatively regarded as post-Lower Pliocene in Victoria may indicate that the basalts in the Midlands, which overlie the Launceston Tertiary beds, are not older than Upper Pliocene. The degree of preservation of the basalt surface suggests that they may be still younger.

Of the north-eastern areas examined, little can be added to the conclusions of previous workers. The youthful appearance of the basalt surfaces suggests that they are of Upper Pliocene to Pleistocene age. The basalt at Scottsdale appears to be somewhat older than that at Ringarooma and Branxholm, and if the Scottsdale basalt is regarded as Upper Pliocene, the Ringarooma basalts may well be Pleistocene. It seems probable that intermittent extrusions occurred in different parts of the State throughout Upper Pliocene and Pleistocene times.

Only one area of basalt among those examined, that at the top of Weldborough Pass, appears to be older than Upper Pliocene. This basalt, like the high-level basalt at Bulman's Bluff near Branxholm, is a residual from a pre-Pliocene landscape, so that it is of Miocene or earlier age and may tentatively be correlated with the pre-Lower Miocene basalts of North-Western Tasmania. The high-level basalts of the Midlands, on the other hand, have been shown to belong not to this early period, as has been suggested, but to the (?) Pleistocene extrusions of the Central Plateau. The apparent age of these basalts is the outcome of the special susceptibility of their environment to erosion.

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PLATE XVII

FIG. 1.—Branxholm: Basalt-filled valley, looking south from near the fork of the Branxholm-Ledgerwood and Branxholm-Launceston roads. The youthful, flat surface of the basalt can be seen running back to hills of granite and Lower Palaeozoic sediments in the right middleground.

FIG. 2.—Branxholm: The northward profile of the basalt is equally youthful. (Same locality as Fig. 1.)

FIG. 3.—Tunbridge: Showing the youthful profile of the basalt residuals east of Tunbridge outlined against dolerite hills in the background.

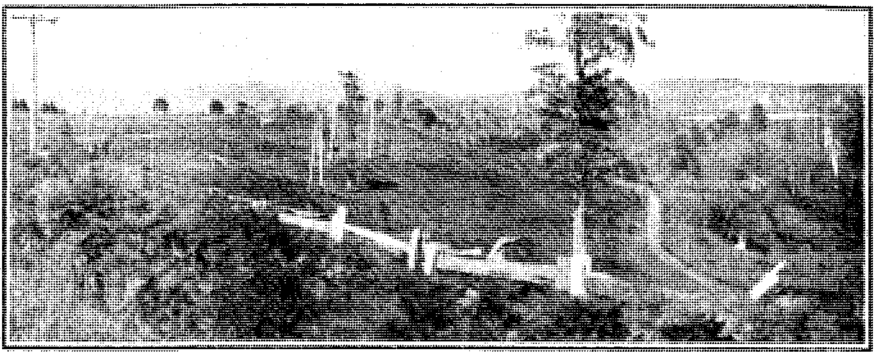

Fig. 1.

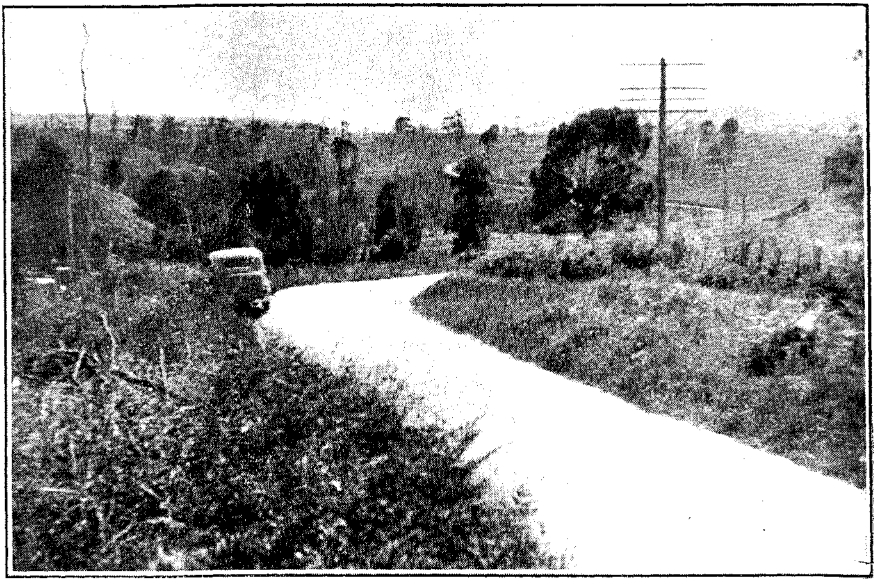

Fig. 2.

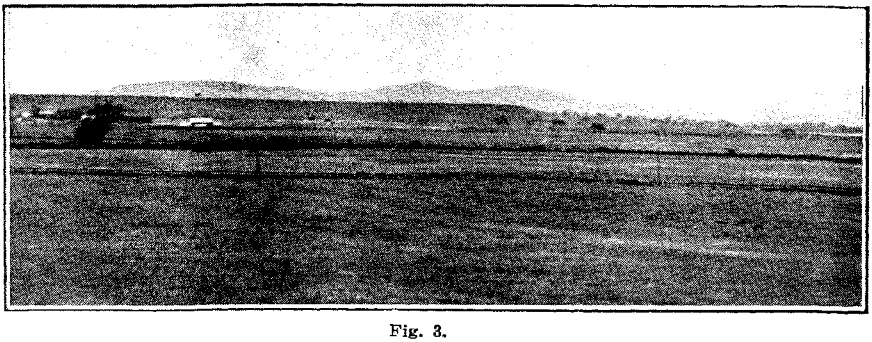

Fig. 3.

PLATE XVIII

FIG. 1.—Macquarie Plains Railway Station: Showing the youthful profile of the Glenora basalt (on the right) viewed across the Derwent. The hills in the left middleground and the background consist of dolerite and Palaeozoic sediments.

FIG. 2.—Marlborough: View across the youthful valley of the Nive (marked by the line of trees) from the West Coast Road, looking E.S.E.

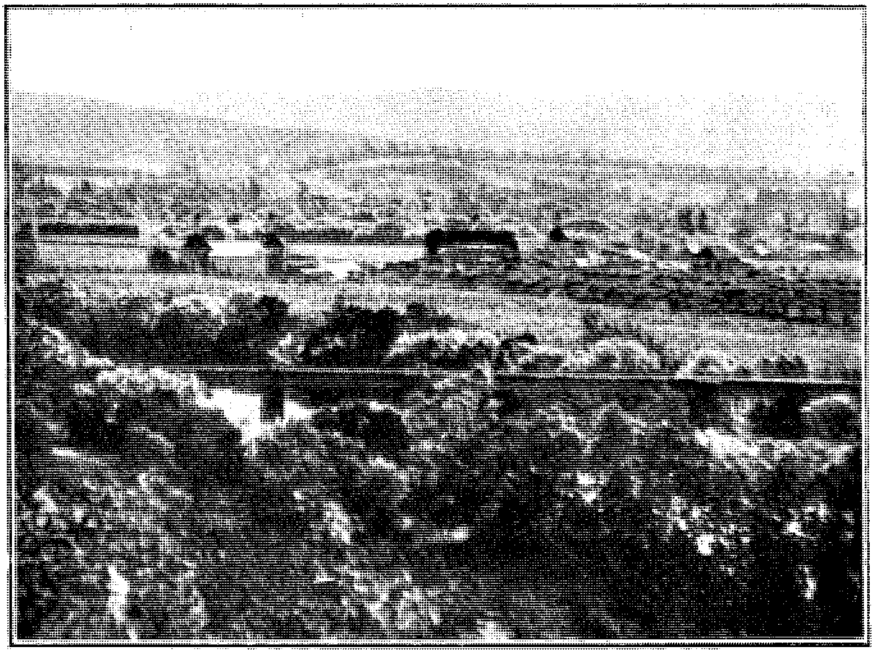

Fig. 1.

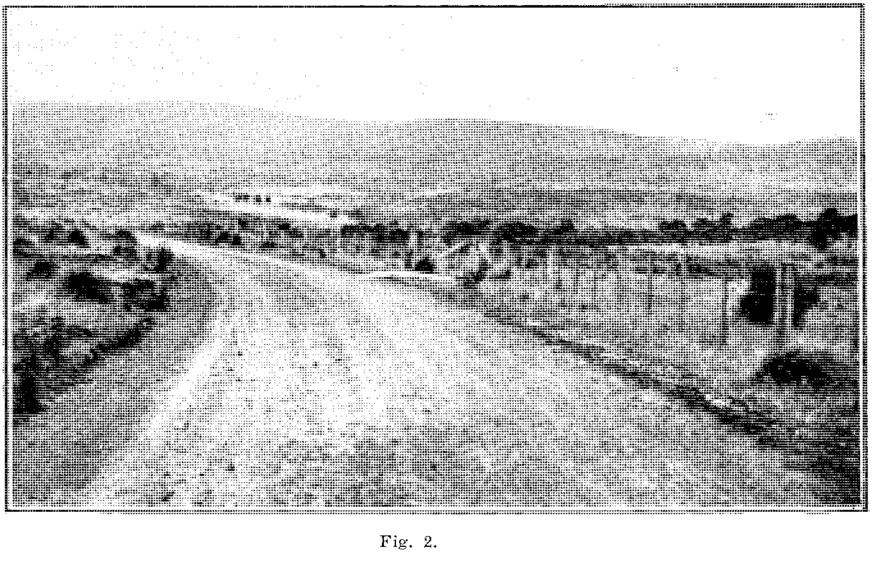

Fig. 2.