Some Observations on the Physiography of the Brisbane River and Neighbouring Watersheds.

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The writing of these notes is occasioned by the recent visit of Mr. C. A. Sussmilch, the pleasure of whose company in the field and whose lecture before the Royal Society of Queensland were of such stimulating interest that the publication of his views is keenly awaited. Knowing that, approaching the subject from a different angle, his views are not likely to be identical, and feeling that it is desirable that all aspects should be considered at the same time, the writer has endeavoured to put together observations which are in themselves scattered and incomplete.

**Differential Erosion.**

As is usual elsewhere differential erosion appears to be the most important factor in the development of land forms within the area considered. It is the factor which has to be excluded, and which is usually difficult to exclude, in regard to all suggestions of relative movement.

The rock formations are very varied and vary in themselves in resistance to weathering. The basement rocks, the Brisbane Schist Series, vary from soft phyllites to hard massive greywackes and quartzites, the granitic rocks from more acid to more basic types, from coarser to finer grain, with accompanying change in land form. The mesozoic shales, both of the Ipswich Series and Walloon Series are interspersed with varying proportions of more durable sandstone and even the extensive sandstone of the Bundamba Series varies greatly in character and resistance. While the Cainozoic strata are soft the variability of the volcanic rocks is very marked.

Though differential weathering is the major factor, perhaps the only important factor, in the sculpturing of the land into the form in which we now know it, we must be careful not to credit to it what may have been due to relative movement. Because an area is hilly we are not entitled to argue that the rocks are resistant, though that is the most probable explanation.

**Fixity of Divides.**

In physiographical literature the migration of divides under the influence of denudation is usually accepted as having an important part in the development of the drainage systems either directly or by river-captures.

In a previous paper the writer questioned this widely accepted view and gave evidence for concluding that the process takes place
only to a minor extent and in unusual circumstances. Having appealed in vain to various authorities for some definite logical evidence in favour of the migration hypothesis it is necessary to accept the conclusions previously arrived at from field observations, and realise that so far as denudational effects are concerned divides may be regarded as stationary.

**River Courses and Drainage Areas.**

This general fixity of the divides gives to them a much greater significance in physiographical interpretation than they are usually accorded.

Observations on the streams indicate with equal clearness the fixity also of their courses apart from the trivial effect of meanders. This is the generally accepted view, except for questions of river-capture which depend on the misconception that divides migrate, and in any case have never seriously been claimed in this area.

The fixity of the divides and of the streams means that these are the most permanent, the most important and probably the oldest features of the landscape. Their positions must have been determined by tectonic movements, lava flows, or a combination of these with the pre-existing irregularities of the surface, and are independent of any present elevation which may depend largely on subsequent erosion.

In considering the physiography of an area we have thus two aspects to deal with:—

1. The positions of the streams and divides.
2. The present land forms, elevation, etc., in conjunction with the solid geology.

While the former, because of the action of denudation, necessarily affects the latter, the present land form may have little similarity to the surface on which the streams originated.

**Streams and Divides of the Area.**

In a general way the streams arrange themselves into fairly well-defined groups, a grouping due presumably to some common tectonic origin.

Let us consider the main Brisbane River first as being the main drain into which the others, or most of them, empty. It turns and twists in large irregular meanders, "entrenched" in the harder ground, meanders that have no suggestion of that swinging to and fro in wider and wider curves that gives rise to true meanders in an alluvial plain. No doubt there has been some cutting away of the concave bank, but the irregularity and the frequent straight reaches show some other control than oscillation. Indeed the straightest part of the river is its estuary.

From near Ipswich to the sea there are few large tributaries but above this, with the confluence of the Bremer, the basin opens out like a fan. From its source to near Ipswich the main stream is remarkable in meandering about a straight N.N.W.-S.S.E. line. This is in line with, and to the south coincides with the great fault to the west of Ipswich. Dr. Hill has shown that the Upper Brisbane lies in a geological trough with this axis. Leaving this axis the general course of the river turns eastwards, skirting the edge of the Brisbane
Schists. The wide meanders, however, both along the line of fault and after leaving the fault, seem to take the river quite impartially into the hilly schist country or the less hilly mesozoic strata. The great fault for some distance forms the boundary of the schists, but east of this line the boundary is not a faulted one though in some places perhaps it may be determined by some of the numerous faults known to have affected the Ipswich coalfield.

Tributaries of the Upper Brisbane.—With the exception of the Stanley the larger tributaries are all on the western side. They run courses north-east to join the main stream at right angles. They rise in the Main Divide and mostly run considerable distances at an elevation comparable with the streams on the western or Darling Downs side of the divide. Northward of the Brisbane watershed, the headwaters of Barambah Creek and the Stuart River are parallel, have a similar elevation, and head in the same line of divide but are part of the Burnett River watershed. They are plainly part of the same group of streams.

The Main Divide, at least North-West from Crow’s Nest, is very straight although it varies in elevation from 2,000 to 3,600 feet, and has been extensively denuded as is shown at the Bunya Mountains. This line is nearly parallel to the axis of the Upper Brisbane and the streams on its western fall run regular courses away from it at right-angles. It seems difficult to avoid the conclusion that the divide was a tectonic ridge or anticline on the N.E. side of which the water flowed into the roughly parallel depression, be it trough or syncline, deep or shallow, now occupied by the Brisbane River.

The drainage down the slope was not quite regular, and there is a suggestion of a minor N.W.-S.E. ridge a few miles N.E. of Crow’s Nest. On the other side of the river the smaller tributaries also come in at right angles representing perhaps the other side of the trough or syncline. While Cooyar, Emu, Anduramba and Maronghi Creeks each show the characteristic N.E. direction of the group, Buaraba Creek the next large stream to the south does not show this. The Lockyer, however, into which it runs, also shows the regular N.E. direction from near Gatton, and if we take Flagstone Creek as the main head, the course is regular from the source in the Main Divide to the junction with the Brisbane. Throughout practically the whole of its course the Lockyer is in a widely alluviated valley from the foot of the Main Range escarpment. Apart from Buaraba Creek all its tributaries worth mentioning are on the southern side, and with them there is a merging of the drainage arrangement into another quite distinct group.

These branches on the right or southern side of the Lockyer rise in the Main Divide and mostly traverse deep valleys with flat alluvial bottoms, valleys separated by remnants of the basaltic tableland, as has been shown so well by Mr. Reid. At Toowoomba the divide is on the scarp overlooking the low Lockyer drainage, and there is no range of hills as approached from the Darling Downs side. The appearance of the scarp is very suggestive of being eaten back by the steep eastern drainage, an appearance supported by the map. It is difficult to determine actually how much migration there has been, and one must remember that the appearance would be much the same in the field if the divide be stationary or migrating. There is nothing to indicate a migration of more than three or four miles, if so much.
Southward the divide is a range of hills as approached from the west, a range increasing in altitude. At the head of Heifer Creek (of the eastern drainage), about 20 miles from Toowoomba the stream gradient and the ridge at its head forming the divide are much the same as on the western side of the ridge, showing that migration is not taking place there. This is also indicated by Ma Ma and Flagstone Creeks heading in the same line, an occurrence which would be extremely improbable if they were independently eating back the divide, while north of it the divide not being on the edge of the high ground there is not even any theoretical reason for it.

Ma Ma, Blackfellow and Laidley Creeks run northerly courses to join the Lockyer. On its eastern side Laidley Creek is separated from the Bremer by the Little Liverpool Range, which is not so high or important looking as the similar range separating Blackfellow’s Creeks. Indeed part of this was called Mount Mistake because it was originally thought to be the Main Range, and not merely a spur off it. To the east the Bremer is separated by a low divide (from which rises the Mount Walker residual) from its tributary Warril Creek, and this from the Teviot Brook of the Logan watershed.

These streams, Ma Ma, Blackfellow’s and Laidley Creeks of the Lockyer drainage, the Bremer and its tributary Warril Creek, and Teviot Brook of the Logan waters form our second group of streams having much in common. They have fairly regular, more or less parallel courses, diverging slightly so that a north direction becomes a north-east in the Teviot. Four of these streams head in the vicinity of Mount Castle which is on a spur slightly in front of the Main Range at a node where this changes its direction from N.W. to a more westerly direction, and is joined by the Little Liverpool and Mount Mistake Ranges. From Mount Castle the Main Divide runs for 20 miles south-easterly to Wilson’s Peak where the Macpherson Range joins it. For the first 12 or 15 miles it is very straight and stands up as a bold escarpment, the very picture of a fault scarp, over the low Fassifern district, the peaks being about 4,000 and the gaps 2,000 feet above the sea, but the elevation not affecting the position of the divide. This part of the range will be referred to again later in reference to the question of faulting. From it the drainage runs at right-angles on the western side but at an angle of about 60° on the eastern side.

Running eastwards from Wilson’s Peak, the Macpherson Range at first has an irregular course but later keeps a pretty regular direction which is not deviated from in association with the very great variations in elevation. The main streams from it run north, later trending eastwards. The upper part of the Logan has a series of streams joining it from the western side which form another small but fairly distinct group, of which the lower part of the Teviot Brook seems to be part, before the Teviot joins the Logan and the Logan itself takes a north-easterly trend. There is conveyed from its general direction on the map an impression that the Teviot should have been regarded as the main stream, though it has not so large a drainage area.

Only near the Macpherson Range are there any tributaries on the east side of the Logan, and these, Running and Christmas Creeks, are the first two of another well-marked group rising in the basaltic plateau of the Lamington National Park and Springbrook, and running
nearly parallel as between neighbouring streams, but slightly divergent courses. Some still have part of their courses on the plateau but are mostly sunk in deep valleys separated by remnants of the plateau, until reaching the open country. The summation of the slight divergences of a dozen streams rising within a distance of 20 miles on the northern side of the Macpherson Range converts a western direction of Running Creek to a north-east in Currumbin Creek.

Some of them unite before reaching the sea, but many run long and closely parallel courses before uniting. Their courses seem to have no association with the present height of the intervening divides. For instance, the Canungra and Coomera run closely parallel courses, deep sunk in narrow gorges which later widen out somewhat but are separated by the high basalt-covered remnant of the plateau. Near Canungra there is quite a low gap at the south end of Tambourine Mountain. The Canungra, diverging a little westwards, emerges into the wide open country to join the Albert to the west of the mountain while the Coomera instead of going through the low gap has cut its way in the gorge which separates Beech Mountain from Tambourine, both about 1,800 feet in elevation, and enters the sea independently.

Somewhat similarly the Albert, in wide open sandstone country is, near Plunkett, separated from the Logan by a very low divide, but enters a narrow valley in high schist hills before finally uniting. The Logan, again, is separated from Oxley Creek and the Brisbane watershed by a very low divide, but passes through comparatively hilly schist country before joining the Albert and entering the sea.

It was suggested by Richards that the long, finger-like processes of basalt separating the streams in their upper courses had originated as flows down pre-existing valleys and that the valleys had since developed in the softer rocks between. A consideration of Back Creek, for instance, which runs for some miles on the top of Beech Mountain parallel to and between the Nerang and Coomera Rivers (both at low level), before Back Creek itself drops into a deep gorge and continues the same course at the lower level, leaves no doubt that the streams must have originated on the surface of the basalt and have merely cut down their gorges into the rocks below.

From near Ipswich to Moreton Bay, and running northwards into the river and the bay we find a not very well defined group of streams, none of them important or rising in any well-defined line. This, our fifth group, seems on the west to merge with Purga Creek into the second group, to which Warril Creek its next neighbour belongs. The group includes Bundamba, Woogaroo, Oxley, Bulimba, Tingalpa and Eprapah Creeks. Oxley, the longest, in its upper part has a north-east direction suggesting some consonance with the Logan in this vicinity, it being separated only by a low divide. A curious feature of the upper part of the Oxley is that, owing to some change in the conditions, the main stream has aggraded its bed, damming the branch valleys into shallow lagoons.

To the north of Brisbane we find a sixth group of streams, particularly well-defined and quite distinct from any of the rest of the drainage. It consists of the numerous short streams running easterly courses to the sea and rising in one very regular divide. This group may be said to begin in the south with Moggil and Breakfast Creeks (which join the Brisbane) and includes Kedron Brook, the North and...
OBSERVATIONS ON THE PHYSIOGRAPHY OF BRISBANE RIVER. 137

South Pine Rivers, Burpengary Creek, Caboolture and so on up to the Maroochy River. Beyond this the drainage is on quite a different pattern.

North from Landsborough the divide has a western fall into the Mary River waters, south from this it falls into the Stanley and other eastern tributaries of the Upper Brisbane. This Blackall-D’Aguilar divide runs in a very regular direction, its very minor irregularities having no relationship with its elevation which is very varied. Near the highest point, Mount Glorious, the direction changes from north-south to south-easterly as if here it had come under the influence of the movements which determined the position of the Upper Brisbane. This very regular divide, heading such a distinct series of streams, plainly signifies a tectonic origin though it has no apparent relationship with the solid geology or with faulting. It may have been the crest of an anticline, or monocline with a slope to the east. The western fall has not the regular drainage away from it which characterises the eastern fall.

The only remaining streams to be considered are the Stanley River and its tributaries. This basin seems to form a system of its own, having nothing in common with the coastal streams and very little in common with the Upper Brisbane.

Whatever may be the significance we thus find that the streams of this part of Queensland fall into seven distinct groups, in addition to the main Brisbane River. We have seen that the Upper Brisbane, in a geological fault trough, meanders about a remarkably straight axial line evidently determined by the faulting or by some subsequent movement along the same line of weakness. That it was not determined by the difference in resistance of the rocks of which the faulting has determined the outcrop is shown by the indifference with which the river meanders into the harder or softer country. The lower Brisbane similarly meanders across the boundary of the schists and later rocks, suggesting a similar determining cause for its position. This boundary however is not a faulted one except perhaps for local faults, so this explanation does not hold, whatever may be the true one.

While the Brisbane River is thus seen to have a definite association with the geological structure in its general course (until perhaps in the vicinity of the city itself), in its meanders it shows a complete disregard of structure. All the other streams, whether in their general courses or details seem to show also a complete disregard for the geological structure, be it folding or faulting or the hardness of the rocks. Geological boundaries seem to have no significance for them. This singular disregard for structure is nowhere better shown than by the Stanley meandering into its gorge at Mount Brisbane when a similar meander in the opposite direction would have avoided the obstruction or by Reynold’s Creek cutting through the trachyte mass of Mount Edwards rather than make a small deviation round it.

With the exception of those streams in our first group which rises in the Main Divide north of Toowoomba and have courses at considerable elevation, and of the streams still on top of the basaltic plateau, all the streams are well graded to near their sources, the larger rivers having a very low gradient.
Like the streams, the divides seem also to exhibit a complete disregard for geological structure, unless it be in relation to the edges of basaltic or volcanic plateaus, a relationship which probably indicates that the position of the divide has determined, through denudation, the edge of the plateau. The positions of the divides seem quite uninfluenced either by the elevation or the rocks traversed.

**Surface Relief.**

Having referred to the main features in the drainage distribution we may consider those comparatively ephemeral features, the relative elevations. In contrast to our experience with the drainage system which must have been determined by tectonic movements, volcanic effusions, or a combination of these with the pre-existing surface, and which we found to have little or no relationship to the solid geology apart from the basaltic plateaus, we find a nearly constant association between the elevation and the resistant nature of the rocks. With some few exceptions, this relationship of elevation and the solid geology is not with the structure but merely with the component rock. To interpret the present elevations and what movements they may signify, we have therefore to be very careful to exclude the effects of differential weathering over an area which has suffered thousands of feet of denudation. Until this is done, other reasoning is vitiated.

**Main Divide.**—To the west of our area we have the high lands of the Darling Downs, forming at Toowoomba a scarp of some 2,000 feet. In the region of our survey, right from Wilson's Peak to the Bunya Mountains, the Main Divide is on volcanic rocks—almost entirely basalts. North from Toowoomba the divide ceases to be on the edge of the scarp, the high ground extending to the east and breaking away more gradually to the upper Brisbane valley. The high ground continues northwards into the Burnett watershed from which it is not separated by any marked dividing range.

South of Toowoomba, as already mentioned, the divide becomes a range of mountains, whether approached from east or west. The western aspect of these shows as "juvenile" a topography as does the eastern fall if one allows for the fact that the base level of the western flowing streams is in the region of 2,000 feet and the east is 500 feet.

To the south of Mount Castle the divide reaches elevations of 4,000 feet (Mount Superbus is 4,493) and looks out over the low Fassifern district which has numerous trachitic and other volcanic residuals rising from it, up to over 4,000 feet in the case of Mount Barney, and over 3,000 in Mount Maroon. Mount Lindesay, on the Macpherson Range about midway between the Main Range and the plateau of the National Park which approaches 4,000 feet, is also over 4,000 feet. The mesozoic strata forming the top of the range a little to the west of Mount Lindesay have elevations of from 1,450 to 1,850 feet as observed by Morton.

**Mt. Flinders Area.**—Between the Fassifern and the Beaudesert districts, both consisting mainly of the Walloon strata, but containing also extensive developments of volcanic rocks, there is a range of sandstone hills rising up to 1,500 feet at Mount Joyce. These are on an anticline which has brought up the Bundamba Sandstone, the division stratigraphically next below the Walloon Series. This belt of high sandstone country extends north to the trachyte peak of Mount
OBSERVATIONS ON THE PHYSIOGRAPHY OF BRISBANE RIVER. 139

Flinders (2,223 feet) and to the vicinity of Ipswich and Bundamba, where it gives place to the Ipswich Measures on a lower stratigraphic horizon. The Teviot Brook runs across this anticline from the comparatively open Fassifern district through the hills to join the Logan in the Beaudesert district.

As we travel north the western limb of the anticline steepens until it becomes the great fault which passes immediately to the west of Ipswich, separating the Ipswich from the Walloon strata, and continues northward as already referred to in relation to the course of the Upper Brisbane. It is very noticeable at Ipswich how the Bremer with its tributaries Warril and Purga Creeks have wide valleys with extensive alluvial flats, but immediately the fault is crossed the valley is narrow. The Lockyer also has a very wide valley with extensive alluvium much wider than that of the Brisbane which it joins and which is situated more or less on the fault line.

The different character of the valleys of these streams when they meet this line suggests some comparatively recent relative movement along the line, for the Ipswich Measures are not particularly resistant where the Bremer passes into them though forming hilly country up to 250 feet, while the wide alluvium west of the fault suggests some retardation in the drainage. The Bundamba sandstone is often a very resistant rock and differential denudation could account for the hills of the anticline as compared with the Beaudesert and Fassifern districts. For instance there are sandstone hills in the Birnam Range north of Beaudesert up to 800 feet and this is not on the anticline. Further, the geological structure shows that a very great thickness of sandstone has been denuded away from the top of the anticline. However, allowing as we must that differential denudation could account for all, and almost certainly does account for the greater part of the difference in elevation, there remains a strong suspicion that part may be directly due to a comparatively recent relative movement, so slow as not to disturb the Teviot.

National Park—Tambourine Mountain.—Attaining its greatest elevation, nearly 4,000 feet, at the border, where it falls away in precipices on the New South Wales side the basaltic plateau extends northwards to Tambourine (1,800 feet), though dissected by the streams into long finger-like projections and isolated fragments. It has plainly all been part of the one plateau. As there is a thickness of some 800 feet of basalt at its northmost point and along the western side of Tambourine, it is certain that the area covered by basalt was formerly much more extensive. On the eastern side the main plateau is separated from the smaller Springbrook by the valley of Nerang River with a low gap of not more than 1,000 feet at its head. On the western side, where overlying the mesozoic sediments the plateau remnants stand up in bold precipices.

Southern Schist Area.—At Tambourine Mountain the country on the eastern side is composed of hard greywackes which form ranges up to only a few hundred feet less than Tambourine itself. Now the contrast between the mountain and the wide valley of the Canungra and Albert on its western side is clearly the result of differential weathering for we see the same contrast on either side of the Canungra further up its course, and in various other streams running on sandstone between basalt capped remnants of the plateau, the only difference being that there is basalt capping on one side of
the valley only. Further, this contrast in elevation cannot be due to relative movement for the basalt is not faulted down on the lower side. If now we consider that the basalt covers, at an elevation of 1,000 feet or more, sandstones, rhyolite and greywackes, and that its upper surface is more or less level, we must realise that the relative elevation of the greywacke and the sandstone where not covered by basalt must necessarily also be due to differential denudation and cannot be due to any differential movement.

The greywackes form part of the Brisbane Schist Series of which there is a large area extending from the border at Point Danger nearly to Brisbane. There is great variation in the nature of the contained rocks, some of which as near Tambourine Mountain are very resistant and form mountainous or hilly country. On the whole there is a marked contrast between the schist country and the mesozoic rocks. That this definitely is due to differential denudation and not to relative movement is proved by Tambourine Mountain.

North of the Logan River some of the schist is sandy and weathers into country not very dissimilar to that occupied by sandstone in the vicinity. Near Brisbane is a narrow neck of mesozoic (Ipswich) strata connecting the inland area with that extending along the coast. North of this narrow neck the schists occur again, forming the hills in and about Brisbane and the block of the D'Aguilar Range.

D' Aguilar Block.—This D'Aguilar Block consists of hilly or mountainous country, some 15 miles wide with elevations reaching up to 2,400 feet. It includes several granitic intrusions. These are mostly deeply weathered, and they form, or tend to form areas of mild relief, miniature peneplains surrounded by a sea of schist hills. Of these the Samford Basin, some six miles by four, with an elevation of 200 to 300 feet and surrounded by hills of from 600 to 1,800 feet in elevation, is probably the best example.

On Mount Glorious, almost the highest point of the range, there is a small area of basalt.

Further north is Mount Mee, a tableland of schist 1,500 feet in elevation with some basalt on it. It is about 12 miles long and several miles wide. Mounts Byron and Archer appear to be outlying remnants of the same tableland. North again, across the Stanley valley at Woodford the Belthorpe Range, a southern or south-western extension of the Blackall Range tableland suggests that these were part of the same tableland, now separated by the Stanley. On its eastern side at least the Blackall Range is of basalt capping mesozoic strata, the junction with the more ancient rocks passing under the basalt. With the western side of the tableland I am not acquainted.

The Blackall Range, Mount Mee, Mount Archer and Mount Byron, all about the same level, the two former several miles in length and breadth, appear to be parts of one formerly continuous plateau. Whether this was a plain of sub-aerial or marine denudation there is nothing to show. Part being schist and part basalt would suggest that it was formed after the basalt flow.

At Mount Glorious the D'Aguilar divide is not so narrow as elsewhere, though it can hardly be called a tableland. This greater width however, and especially the presence of basalt is suggestive of it also being a remnant of the old land surface which has been raised higher than Mount Mee. If we look at the summits of the D'Aguilar Range
from certain parts of the southern suburbs of Brisbane we see what appear to be various flat topped mountains all coming up to the same plane which descends to earth so to speak at the observer’s eye. The impression conveyed that they were all part of the same old peneplain is very striking. The summits are not really flat, but more or less horizontal ridges, giving the mountains totally different appearances as seen from different directions. The suggestion that they represent the old land surface, inclined downwards towards the south is very attractive, but numerous difficulties appear when we examine into it, and accentuate the caution required in interpreting such visual impressions.

The mountain tops are mostly narrow ridges, more or less horizontal. Physically it is not difficult to understand remnants of a plateau remaining, not yet dissected. It is however very hard to picture the plateau being dissected to a long narrow ridge, the crest of the ridge still representing the old land surface, while all the rest had been denuded away. While no doubt it is possible, it seems unlikely. Now there is a marked tendency in the schist country for the formation of long leading spurs to the higher points and long horizontal ridges where not leading up to anything. These are plainly the result of some physical control and occur between the higher mountains, as well as elsewhere, in places where they could, as well as where they could not, be interpreted as old denudational levels. The higher mountains may well be something of the same sort on a higher scale.

It is so easy to see in the landscape old surface levels, like seeing pictures in the fire, and so difficult to remove or disprove the impression once our minds are biased to the idea, that we need to be extremely cautious. Nevertheless one has the feeling, not strictly justified, that some of the higher points like Mount O’Reilly and Mount Nebo represent something near the old land surface, in addition to Mount Glorious.

This does not however in any way imply that there has been a differential movement such as block-faulting between the higher ground of the schist block and the lower mesozoic strata around it. We have seen how the schist hills near Tambourine Mountain definitely cannot be due to differential movement and one must look for the same indications in the similar if more extensive D’Aguilar Block. When we do, we find it with equal plainness. As mentioned, there are several areas of deep-weathered granitic rocks within the schist block. The Samford Basin, a miniature peneplain surrounded by schist hills, as well as the other smaller areas, obviously owe their low level and low relief to their weathering character as compared with the mountainous country surrounding them. If these enclosed areas have weathered thus to a low level we must realise that the soft mesozoic strata outside the schist area would do the same.

If we go further north to the Stanley, which crosses the schist block in a fully graded valley, flanked by high ground of 1,500 feet or more, we find the river at Woodford on an area of the deeply weathered granite while further up it is on mesozoic sandstones. On both these the relief is very low, and the river has wide alluvial flats. It is separated by the low escarpment of the D’Aguilar divide (it is hardly a range here), from similar country of low relief on the coastal side.
Jensen thought that the Woodford area represented an elevated Tertiary peneplain, but he could not have been familiar with the similar granite areas entirely surrounded by mountains.

The low escarpment between the two fully graded drainage systems is a divide scarp, such as W. M. Davis has pointed out would result through the longer stream having a higher local base level than the shorter. Actually from the low escarpment rises the trachyte plug, Beerwah, the highest (1,700 feet) of the Glasshouse Mountains, the remainder of which rise from the lower coastal plain. This escarpment is the low part of the D’Aguilar divide plainly lowered at least 1,000 feet by differential weathering and forming almost the ideal natural experiment in differential migration.

After leaving the Woodford “peneplain” and traversing the schist block, the Stanley, near Kilcoy, gets on to tilted strata of the Esk Series (Lower Triassic) which have been intruded at Mount Brisbane by granitic rocks. Here, as previously mentioned, the Stanley meanders into a gorge through the upstanding harder rock, which a similar meander in the opposite direction would have avoided. It is evident that the Stanley must have lowered its bed from an elevation higher than the lower side of the gorge (about 1,000 feet) and probably higher than the higher side, Mount Brisbane, 2,300 feet. The low divide escarpment has an elevation about 500 feet so that the Stanley Gorge is further evidence, were it needed, that the low level is due to denudation. Had it been due to any tectonic lowering of the Woodford “peneplain” the water would necessarily have made exit over the low divide. A similar difficulty would occur on Jensen’s idea of it being a raised peneplain lifted from near sea level.

Evidence of Peneplanation.

Having referred now to the drainage systems and the land-form in a very imperfect and scattered manner because of the imperfect and scattered nature of the observations of an area which should have close, consistent and continuous study, we may consider whether we are in a position to make any general interpretations therefrom. Our first attention must be as to the existence or otherwise of the Tertiary peneplain and its “Kosciusko Uplift” which seem to form almost part of the creed of our southern neighbours. In giving this our attention we must keep our minds quite clear as to whether the peneplain was the surface on which the volcanic rocks were poured out or whether it was a surface reduced by denudation subsequent to the volcanic extrusions. If the latter, was it after the first, second or third of the divisions into which Richards has classified them, he regarding them as being of Lower, Middle and Upper Cainozoic age respectively.

Andrews, the author of the peneplain hypothesis, thought it was late Tertiary. If that is correct, and Richards is correct, the peneplanation must have occurred at least subsequent to the extrusion of the second division. This of course profoundly affects our enquiry for it would at once put out of count any evidence from the base levels of the lower basalt flows. Such evidence might be of value in relation to questions of block-faulting as showing that the faulting had not taken place, but on the other hand the occurrence at different levels would not necessarily mean faulting, for it might have been due to an uneven surface.
We have further the difficulty of deciding in any particular place as to whether the basalt is of the first or the third division. We know that both the first and second division rocks suffered movement as well as denudation prior to the effusion of the third division, for Morton has recorded basalt flows at Widgee Creek tilted with the mesozoic strata, while at Christmas Creek there is a rock mainly of pyroclastic materials both rhyolitic and basaltic, containing some waterworn pebbles, which in one place has a vertical dip. Morton pointed out that the upper parts of the basalt of the plateau did not seem to have been affected by the disturbance.

If we regard the surface on which the third division was poured out as being the peneplain, we must remember that according to Richards a common thickness of the third division was 2,000 feet. Remembering this, we can realise that the topography before that great effusion could have little in common with the present topography in which the remnants of that effusion play so large a part. Add to this both Reid's and Morton's opinions that the surface on which the basalts flowed (presumably the first division) was very uneven and it will be appreciated how unsatisfactory the position is, and how impossible, on the present information, to make any claim of evidence for a peneplain at any stage.

We do not know at what period sedimentation ceased and denudation began or to what extent denudation and the movements indicated by the faulting and folding of the strata were concurrent. We know that some movements went on after some of the vulcanicity and after the formation of the tertiary sediments near Ipswich and Brisbane, involving the basalt associated therewith while there is a flow, apparently of the same basalt, on the denuded outcrop of the great West Ipswich Fault. The basalt associated with these tertiary sediments has been met in boring at a depth of 800 feet below sea level at Bundamba and Wellington Point!

The physiographical history as well as the present topography over great part of the area we are dealing with, is so inextricably mixed up with the volcanic phenomena that it is necessary to deal with the problem they present at some length. The more we know of them the more complicated do they become. Very varied views have been held as to their age or ages both by different writers and even by the same writers. Both R. A. Wearne and the present writer followed Rands and Jack in regarding part at least of the vulcanicity as contemporaneous with the mesozoic strata. Gregory, Skertchly, Jensen and Andrews regarded them all as of Tertiary age (excluding the Brisbane Tuff underlying the Ipswich Measures and certain rocks north of the area we are dealing with which Jensen regarded as mesozoic). Richards in 1916 made a more extensive and connected examination than any of the previous writers and came to the conclusion that excepting the Brisbane Tuff all the volcanic rocks are of Tertiary age and none mesozoic. He showed three divisions in the volcanic rocks, an upper and lower basaltic, and an intermediate acid or sub-acid.

Since that time work in the Esk district has shown contemporaneous andesitic and trachyitic rocks in the Lower Esk Series though both Richards and Miss Hill disagree with Reid and Morton in regard to other trachytes in the district which the latter consider to be mesozoic and the former consider to be Tertiary.
Since Richards wrote his paper we have also become aware of pebbles of igneous rocks in the mesozoic sandstone at Caloundra and in what is probably mesozoic sandstone at Deception Bay. These serve to show with what caution the question of the age of any particular rock must be approached and there seems little doubt that much further work is needed before the relationship of the various igneous rocks to one another and to the mesozoic sediments is fully understood.

For instance Richards' section through Tambourine Mountain does not convey the correct relationship of the rhyolite to the schist and sandstone, between which it occurs in a belt running apparently also under the basalt of Beechmont and across the Nerang Valley to Springbrook, all three rocks occurring in the river beds as well as high up the mountain sides, and all three capped by basalt. It is hoped that further work will elucidate this relationship at present unintelligible.

In their present topographic aspect, as was pointed out by the writer in 1910, there is a great distinction between the basalts forming the cappings of mountains and that associated with the Cainozoic sediments near Ipswich and Brisbane and fringing Moreton Bay. Though in certain localities this forms low hills it mostly is at a low level with higher mesozoic rocks in the vicinity. As mentioned, bores have shown it to extend 800 feet below sea level in two places. A bore at Nundah in a valley surrounded on three sides by hills of mesozoic strata, passed through 40 feet of it down to about 70 feet below sea level. At Manly it surrounds on three sides hills of mesozoic strata as if it had flooded around them. To the writer this seems to indicate a very much more recent age than those rocks which have weathered up into mountains showing denudation of thousands of feet.

On the other hand the tertiary sediments with which these low lying basalts are associated do not give the impression of being particularly recent and the faulting they have been subjected to in places does not show itself in the present topography. They are however very soft and would be rapidly denuded. The occurrence of these tertiary beds, their level and distribution also have a serious bearing on the question of the peneplain, as they have on its elevation or otherwise.

From Bundamba to Oxley they are near the present course of the Brisbane River, and occurring elsewhere mostly in low ground and along the margin of Moreton Bay, suggest having had some association with a drainage which may not have been vastly different from the present though certainly not closely identical with the present course of the river. There is a considerable difficulty in regard to the significance of the great depth, 800 feet, below sea level which the bores at Bundamba and Wellington Point have demonstrated. There is no geological reason to suppose that these areas are faulted sunken blocks which have resulted in the preservation of these strata, formerly more extensive. They may have been sunken areas subsequently filled in by sedimentation, or they may have been valleys in an extremely youthful topography. If the latter is the explanation we must bear in mind that the deep valley at Bundamba is separated from the Welling-
ton Point occurrence by the older rocks. The position is far from clear and their relationship in time to the other volcanic rocks also requires clarifying. Lithologically the sediments do not suggest derivation from the denudation of basaltic areas.

Whatever may eventually be shown as to the occurrence of these areas of Tertiary sediments and as to their age, and the distribution of the associated doleritic basalt, the present knowledge of them does not accord with the peneplain hypothesis.

**Supposed Tertiary Uplift.**

The question of the supposed "Kosciusko" uplift or any other general uplift whether with or without previous peneplanation naturally comes into consideration with these Tertiary sediments for very plainly they have not been affected by any uplift but have been actually depressed.

In dealing with the question of uplift, before we can regard any area as having been raised we must know what the previous level was. We know that the area now occupied by mesozoic rocks was a fresh-water basin undergoing sedimentation at least into the Jurassic period. There are no Cretaceous strata, such as occur in Western Queensland, or to the north in the Maryborough district. Being an inland basin we do not know at what level the basin was, but the probability is that it was not far from sea level. Nor do we know when the change took place from sedimentation to denudation.

What we do know from the geological structure is that there has been an enormous amount of denudation of the mesozoic sediments amounting to several thousands of feet in those parts where the lower beds are now exposed. We also know from the volcanic rocks, particularly the trachyte plugs which are generally accepted as being the pipes or cores of former volcanoes, that several thousands of feet of surrounding strata or volcanic debris have been denuded away even from above the Jurassic strata now exposed. That there has been uplift to expose these rocks to denudation is abundantly clear, apart from the improbability of their being deposited in an elevated basin. That of course applies to any sediments now above sea level. What we do not know is to what extent denudation may have been taking place in some part of our area while sedimentation was in progress elsewhere, nor to what extent in post-Jurassic time denudation was concurrent with the earth movements indicated now by the faulting and folding of the strata. That is to say that while we may reasonably presume that the sediments having now the highest elevation were raised at least to that amount, we do not know how much higher at any time their surface had been—that would depend on the rate of denudation compared with the rate of movement, which may or may not have been very slow.

Volcanic rocks such as constitute a large part of the greater elevations are themselves no indication of elevation as they may have been extruded on the surface at any level.
The greatest heights at which sedimentary rocks occur are of the following order:

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brisbane Schists</td>
<td>D'Aguilar Range</td>
<td>2,400 feet</td>
</tr>
<tr>
<td></td>
<td>near Tambourine Mt</td>
<td>1,600</td>
</tr>
<tr>
<td>Carboniferous</td>
<td>Mt. Barney</td>
<td>2,000</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Tambourine Mntain</td>
<td>1,000</td>
</tr>
<tr>
<td>Mesozoic near</td>
<td>Mount Lindesay</td>
<td>1,850 feet</td>
</tr>
<tr>
<td></td>
<td>Wilson's Peak</td>
<td>2,200</td>
</tr>
<tr>
<td></td>
<td>Ma Ma</td>
<td>1,700</td>
</tr>
<tr>
<td></td>
<td>Mount Joyce</td>
<td>1,500</td>
</tr>
<tr>
<td></td>
<td>Mount Hallen</td>
<td>1,270</td>
</tr>
<tr>
<td></td>
<td>Crow's Nest</td>
<td>2,400</td>
</tr>
</tbody>
</table>

Apart from the general question of uplift and the period at which it occurred some writers have maintained that a relative movement or block faulting occurred which has left its mark on the present topography in the Main Range in the region of Cunningham's Gap. This view was first put forward by Wearne and Woolnough in 1911 who considered there had been a peneplain in Cainozoic times which suffered two distinct faulting movements, the first of 2,000 feet and the second of 2,700 feet. The first resulted in the Lockyer Block and the second produced the Fassifern Block. The Main Range at Cunningham's Gap was held to be a fault-scarp, a view with which Richards expressed general agreement and seems to have been widely accepted until Reid examined the solid geology of the district and disagreed entirely with the evidence of any serious block-faulting. His view was based largely on the levels of the bases of the lava flows, particularly in the part which Wearne had termed the Lockyer Block. His sections seem incontrovertible, and this part not having the marked appearance of faulting, it is doubtful if any one now would maintain its existence. Reid's evidence in regard to Cunningham's Gap region seems to the writer equally inescapable, but here there is the picture-book appearance of a fault-scarp and many physiographers seem inclined to believe the appearance rather than the evidence of solid geology provided by Reid, evidence which one would have otherwise expected to render further discussion unnecessary. It is therefore necessary to refer to it to make the position clear for the purpose of this paper. The Main Range here forms a bold escarpment, on the very edge of which the divide is situated. It runs at elevations of 4,000 feet and more on the peaks and 2,000 feet or more in the gaps, looking out over the low Fassifern district of about 500 feet. Above a certain height the Main Range is composed of basalt and other volcanic rocks. Below that are the Mesozoic strata, mainly sandstone, which also constitute largely the Fassifern district. There are also extensive occurrences of basic volcanic rocks in the lower country as well as numerous upstanding trachytic plugs of which Mount Edwards and Mount Greville are good examples and occur only a few miles in front of the escarpment.

Over the sandstone in the Main Range there is a thickness of some 3,000 feet of volcanic rock. Reid pointed out that quite apart from not being able in the field to find any section showing the fault it was clear that the volcanic rocks had not been faulted down for the sandstones underlying them are exposed on the eastern or downthrow side of the alleged fault. This is of course a simple problem in stratigraphical geology of which the elementary test has always been the ability to draw an intelligible section. We must also remember...
that the fault-scarp alleged is of the order of 3,000 feet. It is not a little curious that Richards who in his text agreed with the faulting hypothesis published a section which does not show the fault. It is plainly necessary for anyone upholding the hypothesis to draw a section showing what has happened to the 3,000 feet of volcanic material on the eastern side of the 3,000 feet fault.

In addition to this very definite geological evidence against the fault interpretation there is also physiographical evidence, little less definite. Reynolds Creek, rising in the Main Range runs a very consistent course throughout its journey to join Warril Creek and the Bremer River. After about 12 miles in moderately hilly country it comes to Mount Edwards, a trachyte mass situated right in its path. This it cuts through in a narrow gorge. So little effect does a trachyte mountain 2,300 feet high have on the course of the creek that one could not pick out the position of the gorge on a map which did not indicate the mountain.

It is plain that the mountain is a residual and owes its present contrast with the surrounding country to differential weathering for it could scarcely be seriously suggested that it was thrust up through the strata so slowly as not to divert the creek. It is I think accepted that these trachyte plugs were the cores, if not the pipes of some sort of volcano, and we know that the hard trachyte is very resistant to weathering. Whether as a volcano, or as subsequently denuded, we can quite confidently say that the trachyte would not form a valley, but a prominence. Yet we know that when Reynolds Creek started its career it must have started in a depression of some sort. For it to have started its regular course in the position it has it is clear that the trachyte, be it volcano or core, must have been covered by some subsequent deposit. We are not aware of any sedimentary deposits that could have done this, but we do know that basalts cover the acidic rocks in the Main Range and other places. If physiographic reasoning has any value, we are in a position to say with considerable confidence that Reynolds Creek started its career on the top of the basalt flows, which extended (as would be expected from their thickness) much further east than their present limit. As denudation proceeded the trachyte became exposed.

The present level of Mount Edwards is comparable with that of the gaps in the Main Range. Reynolds Creek has certainly lowered itself by this amount, and probably much more, merely by denudation, so that faulting would require that originally Reynolds Creek was higher than the present western drainage by at least the amount of the fault.

The most important evidence put forward by its advocates in favour of the fault hypothesis has been the appearance of the scarp and the air gaps. In regard to the first, if we follow the range to the south towards Wilson’s Peak there are high mountains to the east of it, and the appearance is very much less like faulting than ordinary denudational effects. Indeed we get mountains approaching or exceeding 4,000 feet east to the National Park. If we follow the Main Range north we find Mount Castle standing out somewhat in front of the line. From this on everyone seems to have regarded the Little Liverpool Range as the continuation of the scarp, but to the west of
it, separated by the narrow Laidley Creek valley, Mount Mistake tableland is much higher than the Little Liverpool and from the east looks as if it is the Main Range, for which it was at one time mistaken.

From Mount Mistake one looks across the narrow ridge of the Little Liverpool and sees further out a similar but much lower divide from which rises the Mount Walker residual and which also radiates from Mount Castle. They give the impression of being, and are most simply interpreted as the result of different stages of denudation.

Certainly the alleged fault-scarp is straight, but other causes than faulting can produce a straight scarp, and one of these is a straight divide. When as in the present case the streams on one side have a much lower base level than on the other, a level below the base of the volcanic rocks there is not wanting a physical reason for the great difference in the amount of denudation on the two sides of the divide.

Besides the appearance of a scarp, the "air gaps" have greatly influenced physiographers in favour of the fault hypothesis. Text book descriptions of air gaps with inferences as to former stream courses through them seem part of the orthodox physiographical teaching and appear to have influenced the physiographers so that they have not really discussed these particular gaps on their own merits. One would not of course suggest that air gaps are not often disused river valleys, but there are other explanations possible in many cases as in the present instance.

We have a series of parallel streams flowing westward from the edge of the divide scarp. These have cut down their valleys leaving high ridges between them, ridges which run up to the scarp and around the heads of the valleys. As denudation progresses the ridges also get lowered, according to the slope of the valley sides and the branch gullies joining from the sides of the intervening ridges. The slope depends on the depth to which the stream is cut and this on the power of the stream. In other words the depth to which the valley is cut depends on the area draining into the stream at that point and on the nature of the rock. The area depends again on the width of the valley.

These factors must decide whether the intervening ridges or the ridge round the head of the stream, that is the main divide, will first be lowered and the extent of the difference. When we remember that the main divide in this instance is such a high escarpment on the other side of it the reduction of the divide into "gaps" at the heads of some of the streams is only what would be expected. There does not seem to be the slightest ground for "postulating" a former river.

Coastal Movements.

In the coastal part of the area we get some evidence of changes in elevation relative to the sea. Moreton and Stradbroke Islands, consisting almost entirely of wonderful ranges of sand dunes, up to 900 feet in height, only have a bearing on the question by virtue of the few small occurrences of solid rock, at Cape Moreton, Dunwich, Point Lookout and Canaipa. These with the other islands inside the Bay indicate that Moreton Bay is the result of a drowning of a former valley. The great distance from their mouths to which the tidal waters extends also suggests a sinking. The Bremer, for instance, is tidal at Ipswich some 60 miles by water from the sea, and the
Foundations of the new bridge in Brisbane showed rock bottom to be about 100 feet below water level. This would hardly be expected in the ordinary development of a river out of solid rock, whatever might happen in alluvium.

A well-marked terrace occurs along most of the stream suggesting that the most recent movement has been a slight uplift of about 20 feet. One would however have expected this to show up around the shores of the Bay in the form of wave-cut platforms. Not doing so, the meaning of the terraces must still remain in doubt.

**Conclusions.**

These observations are inadequate to piece together into any sort of connected story what seems to have been a very complicated physiographical history. We may however summarise the little that is ascertainable while hoping that further work will elucidate more.

The present drainage system, or the present "cycle" of erosion appears to have originated, at least in the south, west and north-east on the surface of basaltic flows which probably covered the greater part of the area. This surface may have been a peneplain, reduced thereto by denudation, or it may have been a lava plain, the latter being the more probable. That it was probably a fairly even surface is shown by the regularity of the streams in maintaining their general directions in certain groups away from the divides. Whether this regularity of the streams and divides is due to volcanic action or to subsequent tectonic warping is not clear but the latter seems more likely in the Main Range and in the D'Aguilar Range is almost certain.

In the southern and western part of the area there is no evidence at all of the alleged Tertiary peneplain, in fact any evidence we have is against its existence.

The Blackall Range and Mount Mee appear to be remnants of a peneplain formed after the lava flow. Mount Glorious and other summits of the D'Aguilar Range may also be remnants of the same old land surface, raised to different elevations. The age and former extension of this is quite unknown, or the elevation at which it was formed and the reason for its survival. Much information is required before any opinion can be formed.

The D'Aguilar-Blackall divide formed the axis of an anticlinal or monoclinal warp down the eastern slope of which a well-marked group of streams resulted.

The upper Brisbane River appears to have had its course determined by a new movement along an old fault line, for it is the depression into which the streams flow at right angles from the straight ridge on the basalt forming the Main Divide.

The lower Brisbane also seems to have had some relationship with the structural geology, namely the boundary of the schists and Ipswich formations. The nature of it is not clear and may be a mere coincidence.

All the other streams and the divides seem to have no relationship to the pre-volcanic geology.
Differential denudation is very marked throughout the area and entirely over-rides any suggestions of relative movement except of a minor nature. It accounts for, or can account for, all the major differences. The alleged block-faulting at the Main Range is definitely discounted.

That elevation has taken place is indicated by the present heights at which sedimentary rocks are found. There is nothing to indicate what the height was at any time in the complicated history of faulting, folding, vulcanism and denudation prior to the effusion of the upper basalts, nor indication of subsequent elevation for that reason.

On the other hand there has been a depression at least in the coastal region, apart from the significance (not yet clearly understood) of the occurrence of basalts in two bores to a depth of 800 feet below sea level.

In trying to collect together in one purview the results of incomplete and scattered observations and ideas, full and free use has been made of previous publications other than those referred to in the text.

The writer desires to thank Professor H. C. Richards and Dr. W. H. Bryan for their interest and suggested modifications.

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