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THE GEOLOGY OF THE CRESSBROOK-BUARABA AREA

BY

K. S. W. CAMPBELL, B.Sc.

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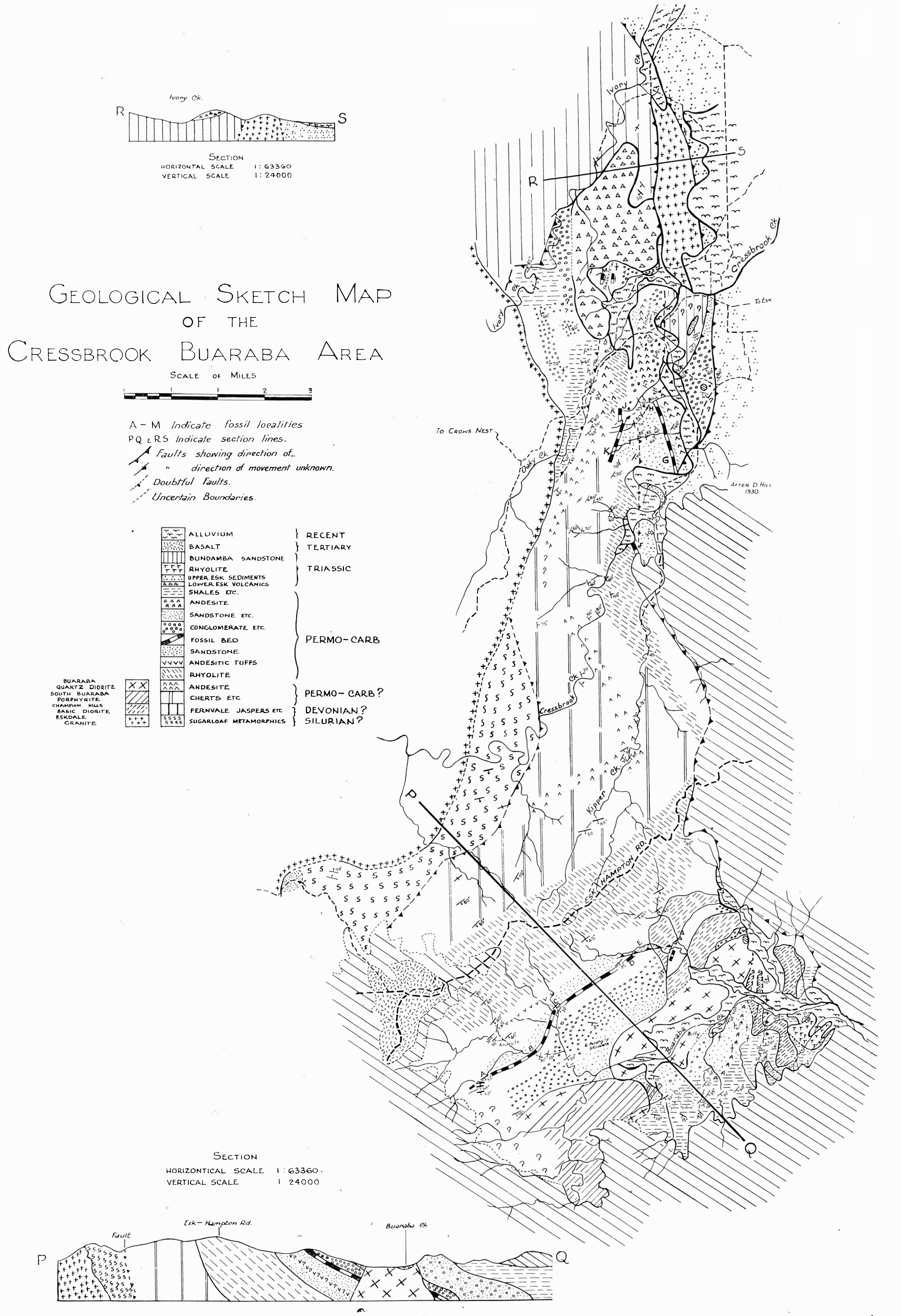
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THE GEOLOGY OF THE CRESSBROOK-BUARABA AREA

By K. S. W. CAMPBELL, B.Sc.

I. ABSTRACT.

The general geology, petrography, structure, palaeontology and stratigraphy of a Permo-Carboniferous fault block west of Esk in the Brisbane Valley is discussed.

It is a highly complex area structurally, with several plutonic intrusions; sedimentation is different in character from other Permo-Carboniferous sequences in this part of Australia; fossils are scarce, restricted to one horizon, and the assemblage has several peculiar characteristics.

The fossil horizon can probably be correlated with the Ingelara or Mantuan Downs Beds of the Springsure area.

II. INTRODUCTION AND ACKNOWLEDGMENTS.

The area under consideration lies in the County of Cavendish, and occupies the western half of Parish Biarra, all except the western end of Parish Deongwar, the north-western portion of Parish Buaraba, and the western portion of Parish Ravensbourne.

The field work has been done over a period of some twenty months, about 110 days being spent in the field. The area has been worked mainly on foot, as roads are few and far between. A large proportion of the area is steep and rugged, and some is covered with heavy vegetation, making traversing difficult, and in one or two small areas, impossible.

A short trip to the Springsure area was undertaken in order to collect comparative palaeontological, stratigraphical and sedimentary data, which proved most helpful in drawing conclusions with regard to the problem.

My thanks are due to Mr. and Mrs. W. Budd of "Biarraville," Mr. and Mrs. Barbour of "Kipper," Mrs. Ward and Mr. J. Ward of Buaraba, and Mr. L. Head of "Forestry House," Deongwar, for assistance and hospitality in the field; to Mr. and Mrs. M. Wells of "Rewan," and the Ogg family of "Ingelara" and Mr. Basire of the Shell Coy. for their interest, kindness and hospitality during the Springsure excursion; to Professor W. H. Bryan for assistance, particularly with the petrographical and structural sections; to Associate Professor Whitehouse who has been willing to discuss problems at all times; and finally to Dr. D. Hill without whose inspiration, unflagging interest and assistance in all aspects the work would never have been completed.

The work was financed from Commonwealth funds.

III. PREVIOUS WORK AND LITERATURE.

Previous work in the area has been limited to observations made on small areas for economic purposes, and work done during brief excursions by members of the University staff over a period of some 20 years.

The earliest published work was by C. F. V. Jackson in 1901, when he dealt with the " Rising Star, North Star and Great Pyramid Prospecting Areas, Parish of Biarra." He recorded the occurrence of volcanic rocks and altered sediments intruded by basic dykes in this area, together with the presence of granite to the west.

In 1926 W. H. Bryan exhibited Permo-Carboniferous fossils from Cressbrook Creek to the Royal Society of Queensland.

In 1930 D. Hill recorded the presence of Permo-Carboniferous rocks and fossils in the Biarra and Kipper Creek areas, and proved the existence of a major fault along their eastern boundary. However, she mistook the Permo-Carboniferous Hampton Road rhyolites outcropping in the Kipper Creek area for Tertiary " Ettswold " rhyolites.

During the field work I have had access to the field notes of the late Professor H. C. Richards and Professor W. H. Bryan, and these have proved a most useful source of information over the central portion of the area.

IV. PHYSIOGRAPHY.

The block is roughly triangular in shape with its greatest length approximately north-south. On the east it is bounded by Esk and Bundamba and Marburg ? sediments; on the south by Bundamba and Marburg ? sandstones and the Sugarloaf metamorphics ; and on the north-west by the Eskdale granite and jaspers. Thus it would be expected to form a characteristic topographic belt readily distinguishable and sharply delineated from its surroundings. This was found to be apparent, especially when the area and its surroundings were studied from aerial photographs.

The area is divisible into two parts on the direction of the physiographic trends.

Northern Section.—Here the trend is N.-S. To the N. and N.-W. is the Biarra Range forming the watershed between Maronghi and Ivory Creeks, and rising to its highest point, Sugarloaf, at 1786 ft.

The backbone of this section of the block is the range containing Mt. Tin Tin and Mt. Deongwar, and rises to over 1,500 feet. The ridges which are given off have a general easterly direction.

The drainage system is centred upon Cressbrook Creek, which is a permanently running stream carrying quite a considerable volume of water. Even in this area, where it is in its middle course and traverses quite hilly country, it has developed several evidences of maturity, viz., flood plains and river terraces, and just east of Mt. Tin Tin meanders have formed a billabong. The waterholes in its course are never short and deep, but on the contrary are nearly always long and shallow. The drainage is " subsequent " in type.

Southern Section.—Here the backbone of the area is formed by a ridge of rhyolite on an approximate N.E.-S.W. trend, and along which runs the Esk-Hampton Road. It forms the watershed between Cressbrook Creek to the north and Buaraba Creek to the south. The gullies draining the southern slopes of this ridge descend very rapidly down waterfalls and through gorges which have been cut in the rhyolite, forming a very rugged topography (*See* Pl. III, Fig. 6). Buaraba Creek in its upper course also descends rapidly by waterfalls, but when it encounters the softer Permo-Carboniferous sediments it rapidly flattens and flows in a broad alluvial valley.

Surrounding Areas and Margins.—On the east and south of the block the low, rolling hills, and broad, rounded valleys of the Mesozoics are abruptly terminated against the high ridges with sharp deeply sculptured drainage patterns of the Permo-Carboniferous sequence. In the area between the junctions of the Kipper Creek and

Crow's Nest Roads north to Cressbrook Creek, the faulted junction is marked by a straight ridge of vertical Esk conglomerates. This line is outstanding on aerial photographs. In the south-east a sharp change in physiography occurs where the Bundamba Series is faulted against the Permo-Carboniferous, this being very noticeable on the Esk-Hampton Road, where the ascent is 700 feet in two miles.

On the south-west the Permo-Carboniferous rocks are overlain by Bundamba (? Marburg) sandstones, which in turn are covered by sheets of basalt giving the typical flat skyline, sharp waterfalls and abundant rain forest.

An interesting variation occurs in the topography of the Eskdale granite where there is a change from the grey to the pink phase in the area west of Mt. Deongwar. The grey rock alters to a fine grained pink on the margins, the pink phase being several hundred yards wide in some places, and giving rise to a topography similar to the old Permo-Carboniferous sediments. In places precipitous cliffs are formed. In the grey phase the ridges are dotted with the characteristic granitic tors, but the pink phase produces only angular blocks.

V. THE FERNVALE-NERANLEIGH GROUP

These rocks are found along the north-west margin of the block where there are faulted relations between them and the Permo-Carboniferous rocks. They extend westwards over to the margin of the Eskdale Granite which intrudes them. Their topography is very rugged and outcrops are very frequent.

Three main rock types commonly occur in this sequence :

(*a*) Black to greyish quartzite.

(*b*) Jaspers.

(*c*) Olive to brownish shales.

(*a*) The quartzite is by far the most abundant member outcropping on Ivory's Creek. In colour it is most often a brownish grey, though it varies to whitish, pinkish, brown and black. It is usually quite massive, showing few traces of bedding, but at 397362* is some which shows bedding and minor folding and faulting. Usually it is very fine grained, but in some places arenaceous material became incorporated during deposition, but not in sufficient quantity to warrant calling it a quartzitic sandstone.

(*b*) Red jaspers are found outcropping around 423396, 410376 and 397362. In the first locality they are banded with the quartzites, and in other localities they have light and dark bands. They are commonly riddled with an anastomosing mass of fine quartz veinlets.

(*c*) Olive to brownish shales, which would probably be more correctly termed phyllites, are found interbedded in the quartzites. They show the obvious effects of thin incompetent beds interbedded between more competent massive beds.

As would be expected, all the above rocks show the effects of vast faulting movements both within themselves and along the margins. As with all fine grained brittle rocks subjected to intense shearing stresses, they fractured on very minute intricate patterns, which are particularly well shown in the jaspers. Great shears have been developed in some areas and are particularly well exposed at 390253.

Large dykes and veins of quartz are common in all rock types. Dykes of andesite have been found at numerous places in Ivory's Creek, usually on a northerly to north-easterly trend. There are also felspar porphyry rocks intrusive into the sequence as at 432273.

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* Locality numbers are Military Map (Cressbrook and Crow's Nest) Grid References.

I have doubtfully included the horst of older rocks in the neighbourhood of the Eskvale trigonometrical station with the Fernvale Jaspers. This has been done because of the occurrence of quartzites and jaspers at several points along the fault line east of the horst, and at 420315 and 422295 on the western side. The quartzites are white, grey, green or red, the latter being the most common, due to the widespread iron staining. In places these rocks appear to have been extensively fractured and then re-cemented with a siliceous cement, whilst another common feature is a dense reticulation of fine quartz veinlets.

The main part of the horst, however, is composed of black slates and highly siliceous fine grained arenaceous rocks which would be termed arenaceous quartzites. This latter rock type is well exposed on Cressbrook Creek at 424294. Quartz veins and veinlets are common.

There is a closer comparison between these rocks and those outcropping on Ivory's Creek than any others in the area, but there is certainly not identity, because of the greater development of the slates.

VI. THE SUGARLOAF METAMORPHICS.

These beds outcrop in the south-west corner of the block investigated, being best exposed in Cressbrook Creek between 352166 and 323155. Exposures are easily accessible, there being cliffs on the creek bank, and ridges, where there is usually only a thin soil mantle. The beds are bounded on the western side by the Eskdale granite and on the east are faulted against the Permo-Carboniferous rocks.

Lithology.—Three distinct lithological types are present :—

(*a*) Thin bedded fine grained sandstone.

(*b*) Black slates.

(*c*) Contorted phyllites.

Sandstone.—This rock type is by far the most abundant of the three and occurs over practically the whole area. It outcrops as regularly thin bedded fine grained sandstone, usually light brown in colour, and it appears to be even textured throughout its whole range, both vertically and horizontally. It is largely composed of quartz and felspars, and the white micas are usually well developed along the bedding planes, imparting a high degree of fissility to the rock. Contortion of the bedding does occur, but not frequently. In many places (*e.g.*, 265115) the rock is penetrated by numerous quartz veins and often by a reticulation of quartz veinlets.

Where the effects of contact metamorphism (by the Eskdale Granite) are visible, the rocks are very hard and have a pinkish colour. Their rather high porosity seems to render the rocks very susceptible to thermal metamorphism. Granite dykes and their aplite associates are common and are quite well exposed near 248120 and 255125.

Slates.—Very fissile, hard black slates occur interbedded with the sandstones along the easternmost margin of these beds, and are seen well exposed in Cressbrook Creek along the western side of the Sugarloaf, at 327130 and at 337142, where they are seen faulted up against Permo-Carboniferous shales. These slate beds range up to hundreds of feet in thickness.

They are very hard when unweathered and give a metallic sound when struck with a hammer. In some places they are riddled with quartz veins, and an occasional granitic dyke intrudes them (*e.g.*, at 325137).

Phyllite.—This was found outcropping around 328142, where it apparently overlies the sandstones. It is a fine grained rock which has been altered, and subjected to a considerable amount of folding and contortion, minor folds and thrusts being very marked. They, too, have been subject to the formation of numerous quartz veins throughout. It is possible that they represent a further stage of alteration of the slates.

Quartzites.—A number of specimens of black and white banded quartzite was found to the west of " Pinecliffs " but none of them was found *in situ.*

Age of Beds.—Palaeontologically the beds are barren, and so no direct determination of their age is possible. The sandstone presents none of the typical characters of a geosynclinal arenaceous deposit, but by its bedding, open structure and even texture would rather suggest a still water marginal deposit. Thus on lithological grounds, a correlation with any of the better known geosynclinal deposits would be presumptuous.

Its degree of metamorphism, the occurrence of numerous quartz veins and its structural position stamp it as being pre-Permo-Carboniferous. However, since no beds of known age are exposed beneath it, this is as far as the evidence will permit an age determination.

VII. THE PERMO-CARBONIFEROUS SEQUENCE (WITH NOTES ON THE SEDIMENTATION).

It should be mentioned before describing this sequence, that the age of some of the rocks, particularly those at the base, is unknown, as it is thought that only one fossil horizon is present in the sequence, and this is towards the top. It is possible that the lowest rocks are Carboniferous or even Devonian in age.

The succession of rock types is by far the most easily studied to the south of Mt. Sugarloaf where Cressbrook Creek swings to a north-easterly from an easterly course, as the disturbance of this region is not nearly as severe as that of the north. However, in these descriptions the variations of each stratigraphic unit over the whole area will be taken into consideration.

No unconformity has been discovered, the strikes and dips being concordant throughout the complete sequence.

(A). At the base of the sequence is a series of fine grained siliceous rocks, green and greyish cherts and fine quartzites, associated with thin bands of heavily altered bluish conglomerate and shale. It is possible that some of the fine siliceous rocks are heavily altered mudstones, as the conglomerates show the effects of strong thermal metamorphism by the nearby Eskdale Granite. The rocks are intruded by a series of fairly coarse andesites, and are also rather strongly fractured and sheared due to their proximity to the major fault on their western boundary. Their thickness is indeterminable, due to their truncation by the Sugarloaf fault.

(B). Lying conformably above are andesitic rocks, flows (spilitic) and agglomerates of the order of 500 feet in thickness. It is most likely that these rocks were deposited in a submarine environment as the overlying sediments are found mingled in the top of a flow, and Professor W. H. Bryan and the late Professor H. C. Richards in field notes record the occurrence of pillow structure in the lavas at the old timber slide on Cressbrook Creek. This structure would suggest that the rocks may be spilitic, but no further work has been done to confirm this view. Another interesting rock type at this same locality is a beautiful variolite, but its outcrop is restricted.

The associated pyroclastics are quite distinctive. At the base pieces of porphyritic andesite are set in an andesitic base whilst at the top pieces of pink rhyolite sometimes showing fluidal structure are set in a tuffaceous andesitic base. This rock serves as a useful horizon marker throughout the area of its outcrop.

In the north these rocks become much more tuffaceous and agglomeratic. The tuffs are rather even grained, and the agglomerates consist of longer fragments of porphyritic andesite set in a tuffaceous groundmass of similar material. Epidotisation is of common occurrence. Flows are associated with the pyroclastics as at 400295, and the agglomerate with the rhyolite pebbles outcrops on the Esk-Crow's Nest Road at 412302. All of these northern rocks are greenish or purplish in colour, often the felspars which form the phenocrysts are pinkish in colour, giving the rock a very characteristic appearance.

(C). Lying conformably above is a further outcrop of chert and other siliceous sedimentaries, with interbedded conglomerates which are of small thickness and small areal extent. Where they are best exposed (*i.e.*) on Cressbrook Creek along the reach around 375197, they appear to be lenticular and formed by the infilling of scours in the surface of deposition of the finer rocks. The cherts, particularly those immediately above the andesites, are banded and greenish in colour, whilst those overlying are more massive. Their total thickness is approximately 1,700 feet. Interbedded also are a few andesite bands and there are some andesites which may be intrusives.

Interbedded with these rocks in a band about 20 feet in thickness, at 384244 and nearby localities, is a very coarse felspathic greywacke with large fragments of a fine grained sedimentary rock.

For the rocks included under (A), (B) and (C) the name *Pinecliff* Formation* is here proposed. It is defined so as to include the andesitic rocks, for which the name *Kipper Creek Andesites* is proposed. The type section for the formation is on Cressbrook Creek between 352166 and 380199 where the approximate thickness is 5,000 feet.

(D). Apparently lying conformably on these rocks is a thick sequence of rhyolitic rocks with associated bands of sediments, usually grits and sandstones, and occasional fine grained silicified rocks. The rhyolites are both flows and pyroclastics, the flows exhibiting a wide range of types, most of which, however, are very fine grained and have been secondarily silicified. They may be glassy, spherulitic, fluidal or normal, whilst colours range from pink and white through grey to black. The pyroclastics are usually fairly coarse, and appear to be more abundant in the southern area than the northern. Indeed, the whole of the rhyolite is much thicker in the south, suggesting that this area was much nearer the source.

They are further described under the heading "Volcanic Activity."

These rocks form one of the most valuable stratigraphic markers in the area, as they are found outcropping from the Esk-Hampton Road in the south to the Esk-Crow's Nest Road in the north, over which area they outline the major structures very well.

For these rocks, the name *Hampton Road Rhyolites* is proposed. The type section is taken to be across the Esk-Hampton Road from approximately 315093 to 315053, where their apparent thickness is of the order of 5,000 feet. In this estimate no allowance has been made for possible strike faulting.

(E). Interbedded near the base and at the base of these rhyolitic rocks are two or three thin bands of andesitic tuffs of very characteristic appearance. They have a fine green tuffaceous base in which fragments of purple andesite are set.

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* Named after Pinecliff Ridge.

Such rocks have been found across the whole of the southern part of the area near the base of the rhyolites, while in the north they outcrop on Cressbrook Creek at 385215. For these rocks the name *Dry Creek Andesitic Tuffs* is proposed.

(F). These are followed conformably in the section on Dry Creek at 339055 by grit and sandstones, a thin band of rhyolite, and then thin bands of conglomerate hard black mudstone and grit, together with fossiliferous sediments. In this section the fossiliferous beds are as follows in descending sequence :—

Barren conglomerates and sandstones.

Sandstones and sedimentary breccia with abundant lamellibranch fragments, *Terrakea*, gasteropods and fenestrellinids ; about 15 feet.

Grits, very weathered and crowded with *Terrakea ;* about 18 inches.

Barren sandstones ; about 10 feet.

Blackish chert with a few *Terrakea* and gasteropods.

This fossil horizon, thought to be the only one in the area, is represented in several other localities, but the sections are not always as well exposed. In the headwaters of South Buaraba Creek, a molluscan facies occurs in very fine grained black calcareous rocks in a sequence of fine black mudstones. On the ridge south of Oaky Creek at 368068, fenestrellinids, small stenoporids, crinoid columnals, *Strophalosia* and *Terrakea* occur in a very compact black calcareous mudstone, whilst in the bed of Oaky Creek at 375074 a few cladochonids have been found in a green cherty rock.

In the northern area the best exposure occurs west of Cressbrook Creek from " Biarraville " at 415255. Here on the side of a ridge the following section is exposed :—

Barren sandstones.

Heavy andesitic conglomerate with solitary corals, crinoid columnals and fragments of *Thamnopora* and *Cladochonus*.

Limestone formed almost completely of *Cladochonus* and crinoid columnals, with a few fragments of *Thamnopora.* It has andesitic material embedded in the top ; about 15 feet.

Grits with some andesitic material and *Thamnopora*, *Cladochonus*. *Euryphyllum* and *Martiniopsis* chiefly at the top ; about 100 feet,

The limestone rapidly grades into a gritty limestone and calcareous sandstone to the north, but the andesitic grit continues and has been picked up in Francis Gully where it contains *Terrakea*, *Fenestrellina*, *Cladochonus*, *Streptorhynchus* and a few lamellibranchs. A similar limestone is found outcropping again at 403275 associated with mudstones, and crowded with fragments of *Cladochonus*, *Thamnopora* and a few lamellibranchs. Similar mudstones are found at 398260 and near Cressbrook Creek at 395220.

For these rocks the name *Biarraville Formation* is proposed, after " Biarraville," a homestead near which it outcrops. The type section is on Dry Creek, Buaraba, at 339055, measurements of which are stated above.

(G). In the southern area the fossiliferous horizon is succeeded by conglomerates and sandstones with the conglomerates predominating. Going up through the sequence the proportion of sandstone increases until the sandstones become predominant around the junction and North and South Branch Buaraba Creeks.

In the south the conglomerates are rather light, pebbles ranging about the size of 1 cm. grading down to sands. The matrix is almost always sandy, though in places it is muddy. Pebbles, only moderately well rounded, with some somewhat angular, are composed of black and grey quartz, pinkish rhyolite and pebbles of sandstone.

Variations from this typical southern conglomerate are common, particularly in the north, where conglomerates formed and large angular pebbles of sandy rock set in a fine friable shaly matrix are found, as at 418293. However, the finer type of rock predominates in this area also.

The sandstones are invariably blackish and greyish in colour, usually fairly even grained, though silty material is frequently intermixed. Angular fragments of fine grained rocks up to ¼ inch across are quite frequent, and mudstreaks are found in several localities (*e.g.* 398238). Sorting is usually good.

A slide cut from sandstone on Buaraba Creek shows this rock to be composed mainly of quartz grains with felspars, the quartz being irregularly angular and the felspar cloudy and somewhat decomposed. A small quantity of biotite is also present.

In general they are not calcareous but often the finer varieties are somewhat carbonaceous.

Jointing is particularly well developed in the southern area, and near the junction of North and South Branch Buaraba Creeks, where the rocks are very well exposed, jointing is seen to be on three systems (*see* Pl. II, Fig. 3). Close jointing due to the nearby faulting is well exposed in Francis Gully.

Interbedded in the sandstone and shales on Buaraba Creek is a vesicular andesite which has been described under the heading " Volcanic Activity."

For these sandstones and conglomerates the name *Box Gully Formation* is proposed, Box Gully being a tributary of Buaraba Creek. The type section is taken to be in the Buaraba basin from 340054 to approximately 373018. The thickness is approximately 4,000 feet.

(H). Lying above these sandstones and conglomerates are shales and mudstones, usually black in colour, but occasionally brown. In places these rocks are massive, whilst in many outcrops they are rhythmically interbedded with gritty material or sandstones. (Pl. II, Fig. 4 ; Pl. III, Fig. 5). Where the mudstone is exposed it always weathers by disintegrating into small hard angular fragments, usually with one dimension greater than the other two. These fragments undergo further disintegration, and so on until the final powdery stage is reached. This type of weathering is characteristic of the mudstones over the whole area. Sorting is usually good.

The rock is rarely if ever calcareous, but some specimens appear to contain some carbonaceous matter, as at 416282 where streaks of carbonaceous matter are included.

The above type of sediment is not continuous through any great vertical range, but is broken by beds of sandstone and, more rarely, conglomerate. However, it is the predominant type in the uppermost beds of the area.

South of Buaraba Creek interbedded in the mudstone, is a vesicular andesite which is a very useful marker horizon over its limited area of outcrop.

These rocks are to be known as the *Buaraba Mudstones*. Their type section is in the south-east corner of the fault block as here deliniated. Their thickness is unknown, due to the overlap of the Bundamba Sandstones.

Notes on the Sedimentation.—The following significant sedimentary characters are apparent :—

1. There is an occurrence of cherts and associated andesitic rocks (probably spilites) at the base of the sequence.

2. Organic remains are sparsely distributed (field work has indicated their absence) throughout most of the sequence.

3. There is a general absence of carbonate rocks ; few, if any, of the clastics being calcareous.

4. Sandy rocks are often massive, showing no traces of current bedding.

5. The pebbles in the conglomerate are rather small and only moderately well rounded, suggesting that they have not been worked and re-worked as on continental shelves.

6. The bedding of the sediments towards the top of the sequence is often rhythmic, there being a regular rhythm of grits and mudstones in bands about 6 inches and 1 foot respectively.

7. The total thickness of the sequence is immense.

8. Greywacke, on a restricted scale, has been found.

9. The conglomerates exhibit a sudden change from pebble size to sand or even silt size grains, and sandy mudstones and muddy sandstones occur, indicating poor sorting in some of the argillaceous, arenaceous and coarser materials.

10. Some of the sandstones contain a high percentage of felspars, which although in a weathered condition, are not indicative of re-worked shelf deposits.

11. There is an absence of plant beds.

12. In the north accumulations quite typical of shell banks occur.

13. Conglomerate beds up to 500 feet thick have been found.

The first eleven of these characters are, according to Jones (1938) and Dapples, Krumbein and Schloss (1947), associated with geosynclinal or perhaps unstable shelf deposition. That it is not typically geosynclinal is indicated by the absence of *thick* deposits of greywacke, and the occurrence of shell bank accumulations at one locality. However, the thickness of the deposits, absence of plant beds and the presence of a thick deposit of cherty rocks do not suggest typical unstable shelf deposition. It is most probable that the environmental conditions prevailing during the final phases of the life of the main Tasman geosyncline were of both geosynclinal and unstable shelf types and these are reflected in the nature of the sediments.

Permo-Carboniferous rocks have been discovered at Texas, Silverwood, Gympie, Gigoomgan and Yarrol in the area of south-east Queensland east of longitude 151° and between the parallels 25° and 29° S. Published reports, manuscripts and personal communications with Professor W. H. Bryan and Dr. D. Hill indicate that none of these areas are characterised by geosynclinal deposits, but rather that shelf type deposits are the most common. Plant beds are found interbedded in the sequence at Gympie and Silverwood, whilst insufficient work has been done in the other areas to prove conclusively that plant beds do not occur.

It thus appears that a narrow unstable area existed in the Cressbrook-Buaraba area, surrounded by shelf areas of much greater extent. The orientation of the geosyncline, or geosynclinal arm, is unknown, but the attitude of the Permo-Carboniferous sediments suggests that it was approximately N.-S. This point will probably defy confirmation because of the structurally isolated position of the rocks.

VIII. MESOZOIC ROCKS.

The following Mesozoic rocks outcrop in the area :—

Triassic { Bundamba Sandstones.
Upper Esk Sediments.
Lower Esk Volcanics.

Lower Esk Volcanics.—Rocks assigned to this age outcrop over an irregularly shaped patch some five square miles in area, between Oakey and Ivory Creeks.

At the base of the sequence, at 422325 (near Ivory Creek) andesitic " conglomerates " outcrop. These rocks are composed largely of roughly rounded green andesitic pebbles set in a fine matrix of andesitic material, also green in colour, and are quite distinct from the other material in the sequence. They appear to have been deposited under water.

Overlying this are tuffs, agglomerates and flows of andesitic type, together with a small amount of trachyte which may be either intrusive or extrusive. Agglomerates with angular fragments of purplish or greenish porphyritic andesite set in a finer greenish matrix, are the most abundant rocks. The fragments may vary in composition towards trachytes, and vary in size from a fraction of an inch to about 18 inches. Some of these rocks are not normal agglomerates, as the fragments are set in flows rather than in finer clastic material. A possible explanation is that large pieces of porphyritic andesite have been thrown into flows of similar composition by intense explosive volcanic activity.

The associated tuffs are composed of similar material. One or two outcrops are composed largely of felspar fragments and may warrant the name " crystal tuff." The flows are greenish or purplish in colour, and may be either fine grained or porphyritic. Surprisingly the felspar phenocrysts are often pink in colour, suggesting that this rock is rich in orthoclase. Hornblende phenocrysts do occur, but are rare.

Epidote is a very common mineral and occurs as veins, as a cement in some of the tuffs (*e.g.* at 422332), or as small crystals distributed throughout the rocks.

No detailed petrographical work has been done on the suite.

Dorothy Hill (1930), pp. 41, 42, describes the rocks of the Andesitic Boulder Beds of the Lower Esk Series as follows : " Cream or sometimes flesh coloured felspars, usually lath shaped and of varying sizes, with sometimes a few needle shaped hornblendes fairly closely set as phenocrysts in a very fine grained or glassy matrix, the colour of which varies from red through intermediate shades to bluey grey or green. The boulders vary in size from 2 inches in diameter to as long as 4 feet, while the commonest sizes are 4 inches and 1 foot.

" Where the matrix of the boulders is a flow, the flow is also a porphyritic andesite, and its greenish matrix has phenocrysts of creamy felspar which are rather stouter than those of the boulders, and tend to be arranged with their longer axes parallel, giving a fluxion structure. Where the matrix is tuffaceous it is generally very weathered, but well shaped felspars may usually be distinguished in it."

This could be a description of the rock types occurring over large portions of the area under consideration. The fluxion structure outlined by the felspars has not been observed, and the boulders are much smaller on the average in the present material. This disparity in size may well be explained by the greater distance of this area from the source of the volcanic material.

This is only the second record of this rock type outside of the Brisbane Valley, the other one being of a small outcrop to the west of Kilkivan (Tommerup M.S. map).

Structure.—The mapping shows conclusively that these volcanics lie unconformably upon Permo-Carboniferous and Fernvale sediments. They are not flat lying, as their outcropping in Ivory Creek suggests a gentle tilting to the west.

On their south-eastern margin, and in the outcrops on Ivory Creek, they have been strongly fractured, suggesting that there has been posthumous movement along both the Ivory Creek and Sandy Gully faults. These movements were probably adjustments during the downfaulting of the Upper Esk sediments further to the east, and to them may be ascribed the westward tilting noted above.

Upper Esk Sediments.—These rocks are found faulted against Permo-Carboniferous and Fernvale rocks along the north-east margin of the area, where they are represented by conglomerates. These rocks have been described by Dorothy Hill (1930) and I have not observed them closely in the field.

Bundamba Sandstones.—Rocks placed in this formation have been found faulted against the Permo-Carboniferous on the east and south-east, overlapping it on the south and south-west, and at several isolated localities on the Esk-Hampton Road. In addition there are several small isolated overlaps of sandstone and billy as at 415070 (Verandah Creek) and 395065 (Buaraba Creek), and a well exposed outcrop of sandstone on Permo-Carboniferous rhyolite at 396216 (*see* Pl. II, Fig. I).

These sandstones in the basin of the lower Kipper and Little Kipper Creeks are rather coarse and siliceous, often current bedded and are quite typical of the lower Bundamba sandstones. (Pl. II, Fig. 6). However, on the Esk-Hampton Road, they are finer grained, often thin bedded with shaly bands, and are highly ferruginous. The outcrop on the road at " Forestry House " 365096 has thin coal seams, and a bore put down nearby indicated two or three seams of approximately 1 foot in thickness.

These rocks are all very deeply weathered and give rise to a deep red or purple coloured soil.

These features are characteristic of the Marburg Stage which overlies the massive siliceous Bundambas.

It thus appears that both stages of the Bundamba sandstones (following Whitehouse) are developed in this area, the Marburg stage being much more extensive than the preceding, and probably covered the whole southern part of the area.

IX (A). VOLCANIC ACTIVITY.

The chief volcanic rocks are :—

Tertiary	Ravensborne Basalts.
Triassic	Rhyolite of Buaraba Creek. Lower Esk Andesites.
Permo-Carboniferous	Vesicular Trachyte from 404327. Andesites of the Box Gully Formation. Dry Creek Andesitic tuffs. Hampton Road Rhyolite and Trachyte. Kipper Creek Andesites.

Kipper Creek Andesites.—These rocks, as mentioned previously, are both flows and pyroclastics. No slides of the pyroclastics have been cut and their macroscopic characters have been previously described.

The flows are fine to medium grained, sometimes porphyritic with felspar phenocrysts, green to grey in colour, holocrystalline ; in good specimens the structure of the felspars can be seen in the hand specimen, but other minerals are indeterminable.

Microscopically (1075)* the most common rock is found to consist of plagioclase, augite, magnetite, chlorite, ilmenite and calcite.

Plagioclase, the most abundant mineral, occurs in lath shaped crystals with very irregular terminal faces. Many of them are twinned, usually simply but sometimes on the albite law. The augite is somewhat extraordinary in that it frequently occurs in elongate crystals, though the small polygonal sections are just as abundant. Magnetite is very abundant as a primary mineral, and ilmenite also occurs primarily, but in much smaller quantity. Chlorite is abundant throughout the slide. Some of it is secondary after augite, but most of it appears to be primary and crystallising after the felspar. It may be the result of deuteric action. Calcite occurs in veinlets.

The structure of the rock is typically pilotaxitic.

The sequence of crystallisation appears to have been largcly normal, but a few examples of ophitic structure between felspar and augite occur.

A fine variolitic rock occurs at the " slide," but I have been unable to locate it. A section cut from a specimen collected by Professor W. H. Bryan and the late Professor H. C. Richards shows the variolites set in a very fine groundmass.

Rhyolites/Trachytes of Hampton Road.—These rocks are very variable in type. Colour varies from white and pink to black, and structure may be normal, fluidal or spherulitic. Usually they are very fine grained so that individual crystals are rarely seen even with a lens ; occasionally felspar phenocrysts are visible, occurring with their long axes parallel with the direction of flow. Usually they have been silicified, the secondary silica occurring in veinlets which may be either interlacing or parallel, imparting a pseudo flow structure to the rock.

Microscopically (R's 1067-1073 and 1084-1086 incl.), it is found that these rocks are composed almost entirely of felspar and quartz in varying proportions, with smaller amounds of magnetite, and occasionally epidote and calcite which have been introduced after consolidation.

Phenocrysts.—Orthoclase frequently occurs as phenocrysts, but they are usually very sparse. They are often well formed but resorption is a common phenomenon, and in many cases the phenocrysts appear to have been completely permeated by the groundmass. They often exhibit carlsbad twinning. Some of the trachytes (1084) are almost monominerallic, being composed of small interlacing crystals of orthoclase. In the spherulitic varieties (*e.g.* 1085) the spherulites appear to be composed of orthoclase with quartz centres.

No mineral other than orthoclase has been found as phenocrysts.

Groundmass.—In almost all of these specimens the groundmass is either microcrystalline or cryptocrystalline. The component minerals are not always determinable, though felspar laths and small pieces of quartz are occasionally visible. A feature of some of the groundmasses is the way that they exhibit shadow

* Numbers refer to catalogue numbers of rock sections in the University of Queensland Geology Department.

extinction over small irregular patches, indicating that they are cryptocrystalline. It is most likely that the groundmass in most specimens is a devitrified glass.

1070 exhibits vast numbers of crystallites throughout the slide, without any regular orientation. At least three types—globulites, margarites and longulites—occur.

Magnetite is an abundant accessory.

Secondarily introduced minerals.—Quartz is the most abundant mineral of this type, but it is associated with epidote, chlorite and calcite. These minerals are introduced in veinlets which are often associated with heavy deposits of magnetite. In the veinlets they occur as aggregates of irregular grains of varying size. The chlorite often occurs outside of the veinlets and in some cases is found outlining or replacing felspar phenocrysts (*e.g.* 1070).

Structures.—Several interesting structures are associated with these rocks.

(A). Flow structure is clearly visible in the orientation of the minerals and other units in the groundmass ; (*e.g.* 1086) exhibits flow structures due to the orientation of (1) some magnetite grains in linear patterns, (2) the felspar phenocrysts have their long axes in one direction, (3) some of the smaller quartz crystals are segregated into layers, (4) the irregular extinction patches have a linear orientation.

(B). 1069 shows particularly well the flow of units of the groundmass around the felspar phenocrysts.

(C). 1072 shows small spherical aggregates of small grains of some darkish brown or green mineral or combination of minerals, probably decomposed felspars and chlorite.

Remarks of the Petrography.—The following points are of interest :—

(A). No ferromagnesian minerals have been discovered in any of the sections.

(B). No quartz has been found in the first generation of crystals.

(C). All the specimens have undergone secondary silicification.

(D). The rocks could be called leuco-rhyolites and leuco-trachytes.

Dry Creek Andesitic Tuffs.—Sufficient description of these rocks has been given previously.

Buaraba Creek Andesites.—In the hand specimen it is usually typical greenish grey colour, fine grained even textured (but sometimes vesicular) and holocrystalline. The felspar and augite can be seen with the aid of a lens and the vesicles are usually filled with calcite.

Under the microscope (1074 and 1076) the felspars are quite typical in form except that their outlines are almost always broken by crystals of augite. The felspar is slightly more abundant than the augite. In 1076 the augite occurs in small, rounded colourless crystals, whilst in 1074 the crystals are larger and better shaped, and are of a brownish colour.

Chlorite is quite abundant in both sections, sometimes occurring interstitially but often also as fibrous radial aggregates.

Calcite fills the vesicles and is distributed in small quantity throughout the slide.

1076 shows the normal sequence of crystallisation, but 1074 often shows evidence of ophitic structure.

Trachyte from 404327.—In the hand specimen it is a grey rock with multitudinous vesicles filled with black calcite. Microscopically (1054) orthoclose felspar is found to be by far the most abundant primary mineral. Augite is the only ferromagnesian mineral and it is rather scarce, occurring in small irregular crystals. Calcite is very abundant both in the vesicles and as small crystals distributed evenly throughout the slide. Chlorite also is very abundant both in and out of the vesicles. The vesicular type always adopts a radial structure, whilst the remainder consists of irregular aggregates of tiny crystals.

Rhyolite from Buaraba Creek. These rhyolites occur both as flows and dykes in the extreme S.E. corner of the area. They intrude and overlie the Permo-Carboniferous rocks but are overlain by Bundamba sandstones, indicating a post Permo-Carboniferous, pre-Bundamba age. They may be either massive or fluidal, the massive type being much more common.

In the hand specimen they are white, purplish, buff or pink in colour, very fine grained with an occasional felspar phenocryst, but usually even grained.

Microscopically (1077 and 1078) the rock is found to be composed of quartz and felspar in variable quantities. 1077 is quite acid and is a true rhyolite, but 1078 has smaller quantities of quartz and is tending towards a trachyte. Some of the orthoclase occurs as phenocrysts, though these are rather small and infrequent, and most of the remainder occurs in small irregularly shaped crystals or very tiny laths. The quartz in 1077 is also irregular, suggesting that the quartz and felspar crystallised out together, quite rapidly. Haematite occurs in small quantities, and a number of tiny prisms of apatite are found.

1078 is composed largely of small spherical bodies formed of intergrowths of quartz and felspar. These are visible in ordinary light only by the fact that each aggregate is associated with a number of dust-like opaque particles, probably haematite. Each of the aggregates extinguishes as a unit, indicating more than just intergrowth.

Ravensborne Basalts.—These rocks overlap the Mesozoic sandstones on the Esk-Hampton Road west of 301073 and presumably are continuous over through Crow's Nest to the Main Range. They are very similar to the Main Range basalts and so they have not been closely observed.

IX (B). PLUTONIC AND HYPABYSSAL IGNEOUS ACTIVITY.*

Four major plutonic masses with their accompanying hypabyssal rocks intrude the Permo-Carboniferous sequence.

They are :—

(A). Eskdale Granite and associated rocks.

(B). Champion Hills Basic Diorite.

(C). The Buaraba Quartz Diorite.

(D). The South Buaraba Felspar Porphyrite.

(A). *The Eskdale Granite and Associated Rocks.*

This rock occurs along the western margin of the area investigated, and continues far to the north, south-west and west.

Petrography.—The rock is medium grained, even textured and holocrystalline. The main mass is grey in colour, though the marginal aplite in the northern section

* This paper, and particularly this section, has been considerably abbreviated. The complete MS. is housed in the University of Queensland Geology Department.

of the area and a medium grained rock in the neighbourhood of **245117** are pink in colour. Felspars, quartz, biotite and hornblende are distinguishable in the hand specimen.

Microscopic Characters (1059, 1061, 1064).—Felspars (plagioclase more abundant than orthoclase) are somewhat more abundant than quartz, with hornblende and biotite in varying quantities—biotite predominating. Apatite, magnetite and ilmenite are accessory, and chlorite is secondary after biotite. The sequence of crystallisation is normal.

Remarks.—The rock is not a normal granite due to the occurrence of the particular plagioclase. However, it cannot be a granodiorite because of (*a*) very high quartz content ; (*b*) micro-perthitic intergrowth ; (*c*) biotite predominating over hornblende.

Instrusions Directly Associated with the Eskdale Granite :

(1) *Sandy Gully-Avondale Intrusion.*—This intrusion is made up of a complex of igneous rocks of which the chief are :—

(*a*) Grey granodiorite.

(*b*) Fine pink granite.

(*c*) Grey alaskite.

(*d*) Hornblende diorite.

In addition, D. Hill (1920) records a blue andesite intruding these rocks, but I was unable to locate it.

(2) *Porphyritic Intrusions Around and East of Mt. Deongwar :*

There are at least two types of porphyritic rock in this area :—

(*a*) The normal granite porphyry, as intruding the fossil beds near **395220**. (Slide No. 1066).

(*b*) A greenish blue porphyritic rock with pinkish felspar phenocrysts as is best shown on Mt. Deongwar itself.

(B). *Champion Hills Basic Diorite.*

This is one of the most abundant of the igneous rocks in the southern part of the block. It is found outcropping in several isolated patches of anything up to about five square miles in area, all over the south-east corner. Dykes are of very frequent occurrence.

The outcrops in every case are somewhat elongated and the elongation is, without exception, in the direction of the strike of the country rocks. It is obvious from the position, arrangement and extent of the outcrops, and the occurrence of an isolated roof pendant on Oakey Creek, that the roof of a batholith is now being uncovered.

Petrography (1045, 1049, 1053, 1057, 1065). Greenish grey rock when fresh, brownish when weathered ; holocrystalline, medium grained and even textured. The most abundant mineral is plagioclase, mostly andesine ; augite of both titaniferous and normal varieties are next in abundance. Chlorite, and golden yellow chlorite, occur in vesicles with a spherulitic habit.

Clinozoisite is found abundantly in **1045**, but in accessory amounts in the other slides. Other accessories are zircon, magnetite and ilmenite. Quartz occurs as a deuteric constituent.

Remarks.—The mineral relationships indicate that the primary minerals were crystallising simultaneously, without regard to the normal sequence. The relation of the chlorite to the felspars and its general interstitial and vesicular occurrence suggests that the residual liquor of the magma was rich in this mineral, and that it became concentrated in the roof of the intrusion, crystallising out deuterically. This suggestion is supported by the presence of deuteric quartz, and by the association of clinozoisite with the chlorite. Clinozoisite is usually deuteric when occurring in igneous rocks.

Associated Rocks.

(a) *Gabbro.*—On the western bank of Verandah Creek at 410060 there is a small outcrop of a gabbroic dyke which is apparently a marginal product of the nearby basic diorite. In order of abundance the minerals are (1042 and 1043) calcic plagioclase, diallage, augite, hornblende, sphene, uralite, quartz and chlorite. Ophitic structures are common.

(b) *Dioritic apophyses at* 375090.—An outcrop of this rock several hundred yards wide occurs on a ridge around 375090, being completely surrounded by Permo-Carboniferous volcanics and sediments. It is a greenish, holocrystalline medium grained and even textured rock (1057). The minerals in order of abundance are calcic felspars, augite, epidote, magnetite and chlorite, the latter being partially secondary. Ophitic structure is again common.

(c) *Diorite at the " Slide " on Cressbrook Creek.*—This intrusion extends over into Kipper Creek at 395200. It also is a greenish rock with laths of whitish felspar and small streaks of epidote. The minerals in order of abundance are calcic felspar, epidote, chlorite, augite, quartz, ilmenite and magnetite.

Remarks on the petrology of the basic diorite suite.—From the foregoing descriptions it appears that the magma was that of a basic augite diorite rich in epidote and titanium minerals (*e.g.*) sphene, ilmenite and titaniferous augite. The residual liquors were rich in the golden yellow and green varieties of chlorite, epidote and quartz, these minerals being segregated in the roof of the intrusion and some being sent out with the dykes.

(C) *Buaraba Quartz Diorite.*

This rock is intruded in a strip some four miles long and one mile wide on the north bank of Buaraba Creek. It is relatively uniform over the whole area of outcrop.

Petrography (1058, 1060, 1062, 1063, 1082).—It is a greyish rock, sometimes with a pinkish tint, holocrystalline, medium grained and even textured. The most abundant mineral is plagioclase felspar of the andesine variety. Quartz is always abundant. Hornblende occurs in both green and basaltic types, the green greatly predominating. Biotite occurs in lesser amounts. Chlorite is a frequent secondary mineral. Orthoclase occurs in small quantities and apatite, zircon and magnetite are accessories.

(D) *The South Buaraba Felspar Porphyrite.*

This intrusion covers an area of some seven or eight square miles to the south-west of the quartz diorite.

Petrography (1055, 1056, 1083).—The rock is black and porphyritic, with a very fine groundmass and small to medium phenocrysts, the larger of which may be up to 3 × 2 mm. Phenocrysts are almost entirely of intermediate plagioclase felspars, though specimens from the north (1083) often show phenocrysts of hornblende. Augite occurs as phenocrysts only on rare occasions, *e.g.* (1056).

The groundmass is often cryptocrystalline and microcrystalline. In the north of the mass, the groundmass is more coarse, and is composed largely of felspar laths. Quartz occurs in minor quantities. Chlorite is secondary.

Age and Relations of the Intrusive Rocks.

Relations to the Sedimentary Rocks.—Each major intrusion is found either intruding rocks of the fossiliferous formation or younger, and therefore they must be post Ingelara or Mantuan Downs, in age.

As mentioned previously, the Sandy Gully intrusions are faulted against Upper Esk sandstones and conglomerates along their eastern margin and, therefore, they must be Pre-Upper Esk in age. This indicates a Pre-Upper Esk age for the whole of the Eskdale granite and the other three major intrusives, since it is highly probable that all these rocks were derived from the one magma. Direct evidence of the age of these southern intrusives is obtained by the overlap of Bundamba sandstones on to each of them. The southern border is formed in part by the Bundamba's overlapping on to the porphyrite, and basic diorite, while " billy " formed from Bundamba sandstones, is found on the quartz diorite at 395045 and 413070. Thus all these intrusions must be pre-Bundamba even if they are not pre-Upper Esk, in age.

Inter-Relations of Intrusions.

Relations of quartz diorite to basic diorite.—These relations were best elucidated at the contact near Oakey Creek 400065. At this point, although the actual junction cannot be seen, the change from quartz diorite to basic diorite takes place within a few yards. Of particular interest is the inclusion of small spheroidal pieces of basic diorite, ranging in diameter from that of a marble to about 6 inches, in the quartz diorite. They have resisted weathering better than the enclosing rock and stand out distinctly in the bed of the gully.

A very interesting relation was discovered on the contact in the bed of Oakey Creek. Specimens were taken from the basic diorite and sections cut (1047 and 1048). In the hand specimen the rock is greenish grey, holocrystalline and even textured. Hornblende and felspars are the predominant minerals.

Under the microscope, hornblende is seen to be the most abundant mineral. It is greenish in colour and pleochroic from straw yellow to grass green. It occurs in aggregates of small granular crystals, as separate small, well formed laths, and as single large crystals. In many cases the small laths are oriented and often occur in parallel stringers in the cleavages of felspar crystals, whilst most frequently they are unoriented and distributed at random.

Many of the larger hornblende aggregates are formed around augite crystals, and occasionally the augite margins appear to have been resorbed. There is also a small amount of diallage associated with the hornblende.

The felspars are similar to those usually found in the normal rock, but a small amount of quartz has been introduced.

Remarks.—The basic diorite normally contains little or no hornblende, and so the hornblende of the marginal rock is probably due to basification by the intrusion of the quartz diorite, which has abundant hornblende. The mode of occurrence of the mineral also suggests this.

This evidence of the intrusion of quartz diorite into basic diorite, coupled with the inclusion of the spheroidal masses of the latter in the former as previously described, is quite conclusive proof that the former intrudes the latter.

Relationships of the Porphyrite.—Porphyrite dykes have been found in the basic diorite behind Buaraba Post Office, thus showing their relative ages.

Although the quartz diorite is in contact with the porphyrite in three localities no clear cut evidence of their relative ages has been derived from these contacts. The best evidence comes from a dyke of the quartz diorite in the porphyrite at 339985, striking 38° E. (true), and from the distribution of the quartz diorite, which suggests that it intrudes the porphyrite.

The sequence of intrusion would thus appear to be: basic diorite, porphyrite and then quartz diorite; all probably taking place between Ingelara or Mantuan Downs, and Upper Esk times; and definitely between Ingelara or Mantuan Downs, and Bundamba times.

X. PALAEONTOLOGY.

Fossils are sparingly distributed in the Permo-Carboniferous rocks, being found only on what appears to be one horizon, from the field evidence. They have been found at the following localities:—(A) The headwaters of Buaraba Creek at 307035; (B) Shelly fragments on North Branch Buaraba Creek at 332040; (C) on Dry Creek at 340055; (D) South of Oakey Creek at 368068; (E) On Oakey Creek at 375074; (F) On Cressbrook Creek at 397222; (G) Near Cressbrook Creek at 414254; (H) In Francis Gully at 410273; (I) North of Francis Gully at 410276; (J) At 405276; (K) In the headwaters of Duggua Gully at 397260; (L) Behind "Well Station" homestead at 407324; (M) Behind "Well Station" homestead at 404325.

In addition D. Hill (1930A) records fossils from 405245 with the remark that they probably belong to an horizon below those collected at 397222.

Phylum BRACHIOPODA
Class ARTICULATA
Order PROTREMATA
Family PRODICTIDAE
Genus **Terrakea** Booker
Species **Terrakea solida** (Etheridge & Dun).

Only one specimen of this species has been recorded from the area. It is from Locality L., and is rather crushed. It is very similar in all observable characters to the specimens from the Mantuan Productus bed.

Terrakea fragilis (Dana).

(See Pl. I, Figs. 5, 6 and 7).

F 12023-26, F 12155-12163, University of Q'ld. colln.

Numerous specimens of this species have been collected from localities C, H and F and L. None are complete and most are either internal moulds of the ventral valve or external moulds of the dorsal valve, which are distorted to some extent.

Observations.—These specimens are similar to those which are usually described as *Terrakea brachythaerus* (G. B. Sowerby). The type specimen of this species has been found to be a *Strophalosia* (Hill 1950), thus invalidating the species, and such forms are here referred to *T. fragilis* (Dana) specimens, which differ only in their smaller size.

Comparisons have been made with material from Banana, Dry Creek, Ingelara, and from the Mantuan Downs Bed, close similarity being observed in all cases.

It was found that each specimen from the Cressbrook-Buaraba area could be matched by a specimen from the Mantuan Downs Bed.

Genus **Strophalosia** King.
Species **Strophalosia sp. a.**
F 12164-65, University of Q'ld. colln.

Specimens of this species have been recorded from Locality D, and consist of a partly decorticated ventral valve, an internal mould of the ventral valve, and an internal mould of a dorsal valve.

Observations.—This form differs from *S. clarkei* Etheridge in its transverse shape, short septum in the dorsal valve, spinosity of the dorsal valve and arrangement of the muscle scars ; and from *S. jukesii* in the transverse shape, arrangement of muscle scars and other minor features.

Insufficient well preserved material is available to warrant further discussion.

Strophalosia sp. b.

F 12166-72, University of Q'ld. colln.

Several specimens have been collected from Locality D, all being either internal or external moulds.

They are smaller and less transverse than the previously described specimens.

This form differs from other Australian species of *Strophalosia* in the greater relative width of the hinge line. It is probably closely related to *S. clarkei* Etheridge.

Genus **Cancrinella** Fredericks.
F 12182, University of Q'ld. colln.

A fragment of a specimen referable to this genus has been collected from Locality D.

Family STROPHOMENIDAE King
Genus **Streptorhynchus**
Species **Streptorhynchus sp.**
F 12173, University of Q'ld. colln.

One internal mould of a ventral valve has been collected from Locality H.

Measurements (of internal mould) are :—Length, 3.6 cm.; Max. breadth, 3.4 cm.; max. depth, 1.1 cm.

Observations.—The specimens figured by Jack and Etheridge 1892 (Pl. 12, Figs. 1-6) from Pelican Creek, 1 mile above Bowen-Sonoma Road, Bowen River, are much larger than the present specimen, being 5.8 cm. long and 5.6 cm. wide and 2 cm. deep, though the proportions are approximately the same. Density of the ribs is also approximately equal, there being about 18 per cm. These forms are Middle Bowen.

Forms from the limestones at Cracow differ in their smaller size and in the coarser ribbing.

Order TELOTREMATA
Family SPIRIFERIDAE King
Genus **Martiniopsis** Waagen 1883.
F 12174-80, University of Q'ld. colln.

Eight widely varying specimens referable to this genus have been collected from Localities C, F and L. All are incomplete internal moulds or decorticated specimens, seven of ventral valves and one of a dorsal. Most of them are probably referable to *M. subradiata* G. B. Sowerby, but the poor state of preservation does not warrant a specific identification. The hinge line and dental lamellae of some specimens show close similarity to specimens figured as *M. subradiata* G. B. Sowerby, by Jack and Etheridge [1892 (Pl. 11, Fig. 14)].

Phylum BRYOZOA
Class ECTOPROCTA
Order CRYPTOSTOMATA
Family FENESTRELLINIDAE Bassler
Genus **Polypora** McCoy
Species **Polypora sp.**

F 12019, University of Q'ld. colln.

One incomplete specimen from Locality D is referred to this species.

Specific Characters.—Form of zoarium indeterminable. Branches straight and bifurcating at distant intervals. Zoecia arranged in three rows on the branches, often decreasing to two just after and increasing to four just before bifurcation. Zoecia elongate with vertically directed vestibules in the middle row and somewhat laterally directed in the lateral rows, sometimes encroaching into the fenestrules. The apertures are circular. Fenestrules are oval and twice as long as broad; dissepiments much narrower than the branches, and expanding when they meet the branches; carinae and nodes not preserved if they were present; reverse surfaces of the branches are evenly rounded and smooth, but those of the dissepiments are higher and sharper.

No. of zoecia per 1 fenestrule and 1 dissepiment ...	=5; less often 4
No of rows of zoecia per branch	=3
No. of branches laterally in 10 mm.	=8 or 9
No. of fenestrules vertically in 10 mm.	=6
Average length of fenestrules	=1.5 mm.
Average width of fenestrules	=.9 mm.
Width of dissepiments	=.2-.3 mm.
Average width of branches (almost const.)	=.7 mm.

Observations.—The above specimen is a mould of the reverse surface with the internal moulds of some of the zoecia, and all the characters are not shown.

This species is closest to *P. triseriata* Crockford, but differs in having wider fenestrules (.35-.42 mm. wide), narrower dissipiments (.38-.48 mm.), and also in that there may be four apertures in the central row to each fenestrule, with an extra one opposite each dissepiment. *P. triseriata* was described from the Ulladulla mudstones of the N.S.W. Upper Marine.

Genus **Fenestrellina** d'Orbigny
Species **Fenestrellina cf. exserta** Laseron.

F 12020, University of Q'ld. colln.

One specimen from Locality D is referred to this species.

Specific Characters.—Shape of zoarium not shown; branches straight and bifurcating at infrequent intervals. Zoecial apertures in two rows on each branch; median carina well defined and bearing numerous small nodes, the exact number per fenestrule being indeterminable. Dissepiments vary in size but are never as broad as the branches. Fenestrules are sub-rectangular to oval and about three times as long as broad; zoecial apertures sub-circular. Characters of the non-celluliferous surface are not shown.

	Present specimen	*Fenestrulina exserta* (Laseron)
No. of zoecia per 1 fenestrule and 1 dissepiment ...	5–6	5–6
No. of branches laterally in 10 mm.	11–12	10–11
No. of fenestrules longitudinally in 10 mm. ...	4½–5	5.5–6
Length of fenestrules	1.8–2.0 mm. av. 1.9 mm.	1.16–1.93 mm. av. 1.58 mm.
Width of fenestrules	.4–.75 mm. av. .60 mm.	.32–.58 mm. av. .44 mm.
Min. width of dissepiments	.2–.27 mm. av. .24 mm.	.17-.32 mm.
Width of branches	.3-.45 mm. av. .36 mm.	.32-.56 mm. av. .46 mm.
No. of apertures in 10 mm.	Approx. 28	29

Observations.—This form differs from *F exserta* (Laseron) in the size of the fenestrules and width of the branches, but the differences are slight. Preservation is not good enough to measure the apertures or discern if they are exsert or not.

This species has been recorded from the Fenestella shales, Higher Horizon, Branxton; Ulladulla; por. 15, Par. Belford; por. 126, Par. Mulbring. All these belong to the Upper Marine Series. No specimens have yet been recorded from lower horizons in N.S.W or from Queensland.

Fenestrellina sp.

F 12015, University of Q'ld. colln.

One incomplete specimen from Locality D is referred to this species.

Specific Characters.—Shape of zoarium not shown; branches straight or curved, bifurcating at frequent intervals, sometimes as small as 5 mm. Zoecial apertures in two rows, increasing to three within one fenestrule of bifurcation. Apertures oval, slightly longer than broad. Dissepiments are relatively narrow, increasing slightly in width towards the contacts with the branches. The fenestrules are sub-rectangular in shape, and about twice as long as broad. Carina broad and rounded, but the material is too poor to observe any nodes which may be present. Reverse surface not shown.

No. of zoecia in 1 fenestrule and 1 dissepiment	5–7
No. of branches laterally in 10 mm.	6–8
No. of fenstrules longitudinally in 10 mm.	3.5–4.5
Length of fenestrules	1.9–2.6 mm. av. 2.15 mm.
Width of fenestrules	.67–1.37 mm. av. 0.99 mm.
Min. width of dissepiments	.07–.37 mm. av. 0.25 mm.
Width of branches	.5-.9 mm. av. 0.6
No. of zoecia per 10 mm.	24-26

Observations.—This species, on the measurements, is quite different from any other fenestrellinid yet described from Australia or Timor.

Fenestrellina granulifera Crockford.

F 12006-07, University of Q'ld. colln.

Three specimens ; one an internal mould of the reverse surface from Locality D, and the other two internal moulds of the obverse surface, have been collected from Locality K.

Fan shaped zoarium with curved branches which bifurcate at frequent intervals, as short as 5 mm. near the base of the colony, but becoming less frequent distally. Zoecial apertures circular ; the long zoecial vestibules well preserved in this specimen. Zoecia in two rows, one on either side of the median carina, except immediately before bifurcation where three rows may be developed. The carina is low and broad with large blunt nodes about 1½ mm. apart, or two to one fenestrule and one dissepiment. Fenestrules are sub-rectangular to oval, being about 2½ times as long as broad. Dissepiments usually are not quite as wide as the branches, but broaden slightly at their junction with the branches. The reverse surfaces of both branches and dissepiments are gently rounded and both show very fine striations.

	Specimen from Loc. D	*F. rockhamptonensis* Crockford
No. of zoecia to 1 fenestrule and 1 dissepiment	3-3½	4
No. of branches laterally on 10 mm.	12-13	11-14
No. of fenestrules longitudinally in 10 mm. ...	7-8	6-9
Length of fenestrules	1.1-1.4 mm. av. 1.2 mm.	.79-1.5 mm.
Width of fenestrules	.5-.85 mm. av. .64 mm.	.4-.79 mm.
No. of apertures in 10 mm.	20-23	28
Min. width of dissepiments	.15-.3 mm. av. .2 mm.	.08-.38 mm.
Width of branches	.15-.5 mm.	.33-.54 mm.

	F. granulifera Crockford
No. of zoecia to 1 fenestrule and 1 dissepiment	3 (less often 4)
No. of branches laterally in 10 mm.	10-11
No. of fenestrules longitudinally in 10 mm.	7-7.5
Length of fenestrules	.94-1.2 mm.
Width of fenestrules	.3-.51 mm.
No. of apertures in 10 mm.	24
Min. width of dissepiments	.23-.47 mm.
Width of branches	.4-.47 mm.

Observations.—These specimens are similar to both *F. rockhamptonensis* Crockford and *F. granulifera* Crockford, as the above measurements indicate, but differ from both in having wider fenestrules, and more frequently bifurcating branches. They are closer to *F. granulifera* in the number of zoecia to one fenestrule and one dissepiment, and in the number of zoecia per 10 mm. Specimens of

F. granulifera from Lakes Creek named by Miss Crockford, are often branching as frequently as the present specimens.

F. rockhamptonensis so far has been described only from Lakes Creek, Q'ld., which is in the Lower Bowen sequence. *F. granulifera*, however, occurs in the Upper Marine Branxton stage of N.S.W. and has been found in the Trachypora Beds behind Lakes Creek quarry at Rockhampton, as well as in the quarry itself. Thus the species apparently has quite a wide range and is of little value stratigraphically.

Fenestrellina dispersa Crockford.

F 12016-18, University of Q'ld. colln.

Three specimens have been referred to this species—two from Locality D and one from Locality K.

These specimens are very similar to *F. fossula* and *F. dispersa* Crockford in the fine network of straight infrequently bifurcating branches ; sharp nodose median carina ; the arrangement of the zoecia ; and in the size and shape of the dissepiments.

It appears from the measurements that *F. dispersa* Crockford is the more appropriate name in the absence of the character of the reverse surface, which would make the determination more definite. Stratigraphically both *F. dispersa* and *F. fossula* are widely distributed in the Permian of Eastern Australia, *F. fossula* ranging from the Allandale to the Branxton Stage, and *F. dispersa* from the Allandale to the Muree. In Queensland *F. fossula* has been recorded from Gympie, Rockhampton and the Bowen River coal field by Etheridge Jun., and also from Dilly and Consuelo Creek (2 miles above Cattle Creek) in Reid 1930. *F. dispersa* also has been recorded from this latter locality.

	Specimens from Locality D	Neotype of F. fossula	*F. dispersa* Crockford
No. of zoecia to 1 fenestrule and 1 dissepiment	3—4	3—4	3
No. of branches laterally in 10 mm. ...	19—22	13—17	17—23
No. of fenestrules longitudinally in 10 mm.	12	9—11	12—16
Length of fenestrules	Fairly const. .65 mm.	.49—.88 mm.	.46—.71 mm.
Width of fenestrules	.25—.35 mm. Av. 31	.14—.35 mm. Av. .27 mm.	.13—.33 mm.
No. of apertures in 10 mm.	Indeterminable		34.5
Minimum width of dissepiments	.15—.75 mm.	.16—.65 mm.	.13—.24 mm.
Width of branches	.25 mm.	Av. .37 mm.	.24—.33 mm.

Order TREPOSTOMATA

Family BATOSTOMELLIDAE

Genus **Stenopora**

Species **Stenopora sp.**

F 12077, University of Q'ld. colln.

An indeterminable fragment of an encrusting form, from Locality F is referred to this genus.

? Stenopora sp.

Several fragments of fine ramose forms probably referable to this genus have been found at Locality F.

Phylum COELENTERATA
Class ANTHOZOA
Sub-Class ZOANTHARIA
Order RUGOSA
Genus **Euryphyllum** Hill
Species **Euryphyllum mantuani sp. nov.**
(Pl I, Figs. 14-16, 17 ? and 21).

Holotype (here designated).—*Euryphyllum reidi* Hill 1938 (Pl. I, Fig. 8 only). F 12076, F 12089-90, University of Q'ld. colln.

Specific Characters.—Corallum simple, trochoid, erect or slightly curved and regularly expanding. The smallest corallum was $1\frac{1}{2}$ cm. from the apex to the base of the calyx where its diameter was 7 mm., while the largest corallum was 2 × 2.5 cm. at the same position. The calyx is deep, oblique, almost vertically walled and extending into a well marked cardinal fossula. The epitheca shows well marked grooves and ridges.

Only major septa are seen in transverse section, varying in number from 33 to 35. The septa are strongly dilated throughout and are laterally contiguous in the lower part of the corallum. In the upper part of the corallum lengthening spaces are left between the septa, leaving an irregular peripheral stereozone and an irregular axial structure formed of the dilated ends of the septa. The dilated tissue of the septa shows strong growth lamination more or less parallel with the length of the septa, the laminae between two contiguous septa being continuous, arching around in the peripheral stereozone. The shape of the cardinal fossula is clearly outlined by the concentric growth laminae. The median dark line of the septum is usually very distinct, and is often waved. The cardinal septum reaches to the axis, bisecting the cardinal fossula, but its median dark line does not reach the axis. The septa are convex toward the cardinal fossula.

The fossulae are characteristic of the species. The cardinal fossula is strongly club shaped, being broadest axially. It is not continuously bounded by the dark lines of the septa, but they are curved so as to form a discontinuous outline for the fossula. The alar fossulae are curved with their convexity toward the cardinal fossula. They are almost parallel sided but may increase or decrease slightly axially.

Tabulae are excluded due to the density of the septal tissue.

Observations.—The holotype of the species is from L. 239 Univ. of Q'ld. Colln. figured by D. Hill (1938), Pl. I, Fig. 8, as *Euryphyllum reidi* Hill, from the Productus Bed (Lower Bowen) $1\frac{1}{2}$ miles N.W. of Consuelo Homestead, Springsure District. Other specimens have been collected from QR/141, QR/76, and from Dry Creek, Buaraba (375074).

The specimen from the latter locality is much nearer to this species than the holotype of *E. reidi* Hill. It has maximum and minimum diameters of 1.9 + 1.5 mm. at the base of the calyx. The main point of difference is in the crowding of the septa, there being 48 as compared with 33-35 in the holotype and topotypes.

Euryphyllum parallelum sp. nov.

Holotype, F 12078 a/b }
Paratype, F 12079 a/b } in Univ. of Q'ld. collection
Topotype, F 12181 }

(See Pl. I, Figs. 18 and 19).

Several specimens have been collected from Localities F and G.

Specific Characters.—Corallum simple, broadly ceratoid and erect and regularly expanding ; tip of corallum not shown ; holotype attains a diameter of about 2 cm. in a height of about 3.5 cm. No calyx is shown in whole specimens, but sections show it to be deep and steep. Characters of the epitheca are not shown ; stereozone dense and extending from 1/3-1/5th of the distance from the epitheca to the axis.

Only major septa are shown in transverse section, numbering **34-43**. The septa are straight or but very slightly curved and they are strongly dilated, particularly at the periphery and at the axis. They become contiguous axially forming an axial structure. The cardinal and alar fossulae are well developed. The cardinal fossula is on the concave side of the corallum and the alar fossulae are placed so as to divide the corallum into approximately equal alar and lateral segments, tending to impart radial symmetry to the corallum. The fossulae are parallel sided or may increase or decrease slightly in width. The septa are arranged in a strongly pinnate fashion around the cardinal fossula, less strongly so on the lateral side of the alar fossulae. The cardinal septum extends to the axis and bisects the cardinal fossula. The septal median dark line is visible, but the dilated portions of the septa show no lineation, probably due to the poor preservation. The tabulae are few, very steeply domed and usually complete, but may be incomplete.

Observations.—This species has been separated from *Euryphyllum reidi* Hill on the basis of the following differences :—

(*a*) The narrower stereozone in the sections at the base.

(*b*) The sub-parallel fossulae, not having their greatest width at the axis.

(*c*) The more nearly radial position of the alar fossulae.

(*d*) The steeper doming and completeness of the tabulae.

A similar form has been collected from Dry Creek Ingelara, but the specimen is incomplete. It differs from the type material in that the calyx is much deeper, the peripheral stereozone narrower and the shape irregular. It is irregularly expanding in the lower part of the corallum and tends to become irregularly cylindrical above.

Euryphyllum sp.

(See Pl. I, Fig. 20)

Several specimens of *Euryphyllum* included in *E. reidi* by Hill (1938, Figs. 10, 11, 12) are very similar to a specimen collected from Locality F on Cressbrook Creek. The specimens from Castle Creek, Theodore, exhibit a range of variation which may well include the Cressbrook Creek specimen.

Points of similarity between the two forms are :—

(*a*) The size and shape of the corallum, being about 1.7 cm. in diameter at the base of the calyx.

(*b*) The number of septa (about 43).

(*c*) The cardinal fossula broadening at the axis.

(*d*) The position of the alar fossulae.

Points of difference are :—

(*a*) The stereozone becomes much broader towards the base of the corallum in the Castle Creek specimens.

(*b*) The cardinal septum extends to the axis in the Castle Creek but not in the Cressbrook Creek specimens.

(*c*) Tabulae are somewhat more numerous in the Cressbrook Creek specimens.

Order TABULATA
Genus **Thamnopora**
Species **Thamnopora wilkinsoni.**

This species has been collected from Localities C, F, G, H, I, J and K.

They exhibit a wide range of variation in size, shape, position of the corallites and other features and are almost useless stratigraphically at present.

Genus **Cladochonus**
Species **Cladochonus sp.**

This form has been collected from Localities C, D, E, F, G, H, J and K. It, too, exhibits a very wide range of variation and is valueless as a horizon marker at present.

Phylum MOLLUSCA
Class LAMELLIBRANCHIA Blainville
Family NUCULANIDAE Stoliczka
Genus **Glyptoleda** Fletcher
Species **Glyptoleda buarabae sp. nov.**

Holotype F 12011 } Univ. of Q'ld.
Paratypes F 12012 and F 12014 ; F 12183-86 } collection

(The species is named from Buaraba Creek, in whose basin it has been found).

(See Pl. I, Figs. 8-12)

This species is based on :—An imperfect mould of a left valve ; an external mould of the posterior half of both left and right valves ; an imperfect external mould of a right valve ; a complete internal mould ; several fragments of moulds of the external ornament ; and an external mould of the umbonal regions.

Specific Characters.—Shell elongate, about twice as long as high. Posterior long and acuminate, internal mould sweeping upwards at extremity ; anterior short, inflated and rounded. Umbones small and depressed, recurved posteriorly and situated within the anterior half of the shell. Rather sharp, broadly concave umbonal ridges are directed posteriorly becoming rapidly less pronounced, and joining at the posterior extremity. Anterior umbonal ridges very faint and joining half way from the umbones to the anterior margin.

Escutcheon broad and long, developed between the umbonal ridges ; divided on each valve by a ridge originating beneath the umbonal extremity and joining the hinge line half way to the posterior margin. This ridge isolates a narrow pointed area on which the ornamental striae are finer, less wavy and more longitudinal than in the rest of the escutcheon, though continuous with it. Ornament on the remainder of the escutcheon not as strong as on the body of the shell, and is directed at an angle to the hinge line, the angle increasing posteriorly.

The lunule is very narrow and extends from the umbo half way to the anterior margin.

The hinge line is depressed anteriorly and elevated posteriorly, reaching the strongest elevation where it is joined by the ridges which divide the escutcheon.

The surface ornament consists of about 40 fine wavy costae which in general follow the growth lines of the shell. On the anterior end the costae are concentric and unwaved, but a small amount of waviness begins just anterior of the umbo and increases slightly posteriorly where they join the umbonal ridge at an acute angle. Some of the waves are sharp and V-shaped, but most are more open.

The internal mould shows a large, deep, oval muscle scar up against the anterior margin and a large scar of indeterminate shape just below the umbonal ridge towards the posterior extremity. The specimen is not sufficiently well preserved to show a pallial sinus even if one exists. There are about 12 strong teeth anteriorly decreasing rapidly in size beneath the umbo: posteriorly several teeth are missing, but those present are not as strong as the anterior ones. Also a shallow groove extends from the umbo towards the inferior margin. About 4 mm. from the apex of the umbo in this groove is an oval muscle scar that is deeply excavate on the dorsal side, and from this scar, two grooves continue towards the inferior margin, the anterior one being shallower than the posterior. They both die out about half way from the umbo to the inferior margin.

Beneath and just posterior of the umbo are two large projections which apparently extend into the body cavity beneath the hinge plate.

Dimensions are as follows :—

	Holotype	*Internal mould of paratype*
Length	40 mm.	30 mm.
Height	22 mm.	18 mm.
Thickness	18 mm.	11 mm.
Apical angle	——	110°

Observations.—This species is similar to *G. reidi* Fletcher in all characters except—

(*a*) the ornament on the posterior part of the valve is not directed at right angles to the umbonal ridge,

(*b*) the lunule is smaller,

(*c*) the V-shaped ornament is almost completely absent.

Although not mentioned in Fletcher's description of *G. reidi* topotypes indicate the presence of a groove on the internal mould beneath the umbo, and a projection into the body cavity beneath the umbo. Similar features to these have been described above in *G. buarabae.*

The ornament of this species is very similar to that of some species of *Nuculana* Link, 1807, but it has been placed in the genus *Glyptoleda* Fletcher, 1945, because of its large size and thick solid test. These are two of the three characters originally used by Fletcher in separating the two genera.

Family PECTENIDAE Lamark
Genus **Aviculopecten** McCoy
Species **Aviculopecten subquinquelineatus** McCoy

F 12012, F 12097-99, Univ. of Q'ld. colln.

(See Pl. I, Figs. 13 and 22)

Specimens ascribed to this species include three external moulds and three internal moulds of left valves, all from Locality M, none of which is complete, usually lacking portion of the auricles and the ventral margin. The characters of the hinge are not preserved in any specimen.

Observations.—The specimens have been compared with a photograph and plaster casts of McCoy's types of " Pecten subquinquelineatus." Comparison is good, the observable differences being as follows :—

(*a*) The auricles of the type are considerably larger.

(*b*) Convexity of the types is slightly but not markedly greater.

(*c*) The anterior and posterior slopes of the type are straight whereas those of the present specimens are markedly concave.

The specimens have been compared with similar material from the Wallaby Rocks at Warwick. All these specimens are very much smaller and less convex than the specimens from Locality M and the type. In common with the former specimens, their anterior and posterior slopes are concave and their auricles small, whilst in contrast the ornament is much stronger and the posterior auricle separated by a much sharper sinus in the Wallaby Rocks material.

The specimens probably do not belong to the species *A. subquinquelineatus* sensu stricto but would be included in that species, on the basis of the broad interpretation at present placed on the limits of the species at present in Australia.

Newell (1935) in dealing with the Lower Carboniferous and Permian Pectinacea of Australia states :—"A monograph on pectinoids from eastern Australia, by Etheridge and Dun 1906, contains descriptions of the following :—" and then he lists *Deltopecten subquinquelineatus* (McCoy) under the genus *Limipecten* Girty. The generic description of Limipecten Girty includes " . . left valve with intercalate costae crossed by the edges of regular lamellae which swing downward toward the margin between costae in short flattened pointed projections similar to *Acanthopecten*, somewhat more numerous and prominent on the posterior part of the shell, . . " This ornament is characteristic of the genus. I have been unable to observe it on the specimens figured by Etheridge and Dun and it is not mentioned in their text.

It does not occur on the specimens from Locality M. It cannot be placed in the genus *Deltopecten* Etheridge Jr., and is best placed in genus *Aviculopecten* McCoy emend. Newell.

Genus Streblochondria Newell

Species Streblochondria englehardti (Eth. fil. & Dun).

F 12200-02, F 12013, Univ. of Q'ld. colln.

(See Pl. I, Fig. 4)

The material assigned to this species consists of :—An internal mould of a complete specimen and an external mould of a left valve from Locality A ; internal moulds of two right valves and a left valve from Locality K ; and two internal moulds of right valves from Locality C, which are doubtfully assigned to the species.

The specimens from Localities A and K agree in all discernible features with the specimens figured and described by Etheridge fil. and Dun in their original description of the species.

The specimens from Locality C, however, are rather poorly preserved and are much larger, more opisthocline, and have a more concave anterior slope and acute umbo than those included in the original description. The dimensions of the left valve are :—Height 6 cm. and length 4.9 cm., whereas the largest of the specimens figured by Etheridge fil. and Dun was 4.7 cm. high and 4.9 cm. long. The difference in proportion also is probably of considerable significance. The specimens should probably be assigned to a new species.

Localities A and K

Max. Height	*Max. Length*	
2.7 cm.	2.4 cm.	right valves
2.1 ,,	2.2 ,,	
2.7 ,,	2.7 ,,	
2.0 cm.	1.8 cm.	left valves
2.5 ,,	2.7 ,,	

Dry Creek Ingelara

Max. Height	*Max. Length*	
2.3 cm.	1.9 cm.	left valve
1.9 ,,	1.8 ,,	

Observations.—The specimens included in the species by Etheridge fil. and Dun came from both Upper and Lower Marine Series of N.S.W. The specimens collected from Dry Creek, Ingelara, are two rather poorly preserved internal moulds of left valves, which in all discernible features are very similar to the type specimens and therefore also to those from Localities A and K.

Newell (1945, p. 115) doubtfully includes this species in his new genus *Streblochondria*, and this classification is followed here.

Class GASTEROPODA
Family PLEUROTOMARIIDAE d'Orb
Genus **Mourlonia** de Koninck
Species **Mourlonia strzeleckiana ?** (Morris).

F 12009-10 and F 12187-93, Univ. of Q'ld. colln.

(See Pl. I, Figs. 1 and 2)

Numerous specimens referred to this species are all from Locality A and consist of internal and external moulds and partly testiferous specimens, but none are complete.

Test trochoid usually with four whorls. Apical angle varies but slightly, four specimens being 86°, 86°, 88° and 90°. Size varies widely, the largest specimens measuring about 5 cm. from the base of the body whorl to the apex, and the smallest about 1.5 cm. Sutures between the whorls are distinct, and the rounded whorl profile is broken by the slightly projecting keel; slit band situated slightly above the median position and not quite covered by the next succeeding whorl; upper and lower margins of slit on body whorl defined by a fine carina, becoming rapidly less distinct apically. Umbilicus broad and open. No aperture has been found. Ornament is not very strong and consists of slightly curved, posteriorly directed striae on the upper surface of the whorl and similar striae which are convex posteriorly on the slit band; no sufficiently well preserved specimens of the lower whorl surface have been found to describe the ornament of this portion of the test.

Observations.—These specimens differ from the specimens figured and described by Morris in P. E. de Strzelecki's " Physical Description of New South Wales and Van Diemen's Land," in having one whorl less, and in the size of the apical angle (according to Morris' figure in which the apical angle is about 75°).

Similar material from Ingelara also differs in the size of the apical angle (60°, 70°, 62° and 65°).

Family BELLEROPHONTIDAE McCoy
Genus **Warthia** Waagen
Species **Warthia** sp.

F 12194-96, Univ. of Q'ld. colln.

Three poorly preserved internal moulds, one from Locality C and the other two from Locality A have been referred to this species.

Observations.—They are all smaller than *W. micromphalus* (Morris) figured originally by Morris and similar specimens from Ingelara.

Family EUOMPHALIDAE de Koninck
Genus **Keenia** Etheridge
Species **Keenia ?** sp.

F 12022, F 12203-05, Univ. of Q'ld. colln.

(See Pl. I, Fig. 3)

Four incomplete internal moulds, three of which are slightly distorted, have been assigned to this genus. All specimens are from Locality C.

Observations.—These specimens have been placed in the genus *Keenia* Etheridge rather than in *Platychisma* McCoy because of the presence of the distinct keel.

CORRELATION

Comparison of the specimens with similar specimens from other localities has been discussed after the description of each species. The following is a summary of the evidence from the various groups.

Corals.—The *Thamnopora wilkinsoni* and *Cladochonus* assemblages stratigraphically indicate little. They occur in similar lithological associations in the Condamine Block near Warwick, and they form the characteristic assemblage of the Ingelara beds in the Springsure area, but their range is so broad as to make correlation unsafe.

The species of *Euryphyllum* described, form a much stronger basis for inter-regional correlation. It has been shown that forms from the Cressbrook-Buaraba area are very similar to those from the Ingelara and Mantuan Downs Beds, whereas no forms similar to specimens from lower horizons have been collected.

Brachiopods.—The only brachiopods of value are *Terrakea* and *Streptorhynchus*.

Terrakea solida (Etheridge and Dun) is the characteristic form of the Mantuan Productid Bed ; *T. fragilis* (Dana) also occurs in large numbers in the Mantuan Productid Bed, and in the Upper Marine Series of N.S.W. It has been possible to match each specimen from the Cressbrook-Buaraba area with a specimen from the Mantuan Bed. No forms similar to *T. pollex* Hill (1950), which is characteristic of the Dilly Stage of the Lower Bowen, has been collected.

The *Streptorhynchus* sp. collected from the area has been shown to be nearer to the Middle Bowen types than to those of the Dilly Stage.

Bryozoa.—The only Bryozoan which gives any indication of age is *Fenestrellina cf exserta* (Laseron) which in N.S.W. is restricted to the Upper Marine Series.

Gasteropods.—*Mourlonia* is a very common genus in the Ingelara beds but, as has been shown, the present species is not identical with the one from this stage and so there is no correlation.

The genus *Keenia* in N.S.W. is characteristic of the Lower Marine Series and in Queensland has been recorded from the Wallaby Rocks. As far as can be ascertained no record has been made of the occurrence of *Keenia* in rocks of the Upper Marine Series.

Lamellibranchs.—The genus *Glyptoleda* has been described from only three localities, the Ingelara Stage and Condamine Beds of Queensland, and the Cundlego Series of Western Australia. This is another point in favour of a tentative correlation with the Ingelara beds. However, further collecting may well lengthen the range of the genus and invalidate this suggestion.

Conclusions concerning the age of the fossil beds are thus seen to be largely negative. No form has been found which would suggest an horizon lower than the Ingelara beds of the Springsure area, and most of those with a relatively restricted stratigraphic range, particularly the species of *Euryphyllum*, *Terrakea* and *Glyptoleda*, would appear to suggest a correlation with either the Ingelara or Mantuan Downs beds.

However it is emphasised that this conclusion rests upon very slender evidence. Further collecting at the localities indicated above may produce more satisfactory material, but since each of these has been closely searched, it is unlikely that further information will be forthcoming until new localities are discovered.

NOTES ON THE FAUNA

There are many unusual features in the palaeontology of the area. The most remarkable is the restriction of fossils to one narrow band, and their absence from great thicknesses of sediment which apparently would be quite suitable for their preservation. Secondly, few species are identical with those described from other Queensland or Australian Permo-Carboniferous sequences. Thirdly, facies appear to play quite an important part in faunal distribution in some areas, particularly in the south where a molluscan facies is developed in calcareous rocks on Upper Buaraba Creek, a brachiopod-molluscan facies occurs in grits and cherty rocks on Dry Creek, a fenestrellinid-brachiopod facies is in calcareous mudstones on Oakey Creek, and a coral-brachiopod facies on Cressbrook Creek.

The first two of these features may be the results of the geosynclinal or unstable shelf type of sedimentation as pointed out previously (p. 13). As far as can be ascertained from the literature none of the areas in Queensland and New South Wales are characterised by geosynclinal deposition in the Permo-Carboniferous, and the lack of faunal similarity with these areas may be correlated with the lack of sedimentary similarity.

XI. STRUCTURAL GEOLOGY

The dominant structural features of the area may be classified as follows :—

(A). The marginal fault system.

(B). Internal folding of the fault block.

(C). Internal faulting of the fault block.

(A). *The Marginal Fault System.*—The marginal fault on the eastern side of the block is part of the " Western Border Fault " of D. Hill (Hill 1930B). In the north-eastern sector, Upper Esk conglomerates are faulted down against the Sandy Gully granite and Permo-Carboniferous sediments. Between the Esk-Crow's Nest Road and Cressbrook Creek to the north this fault line is marked by a ridge of resistant Esk conglomerates which stand vertically. These vertical dips in the Esk rocks occur along this fault line as far north as traversed, and high dips occur away from the fault for considerable distances. Slickensiding and shearing have been found in the Permo-Carboniferous sediments, the granite and the Esk conglomerates.

In the south-east sector Bundamba and Marburg ? sandstones are faulted against the Permo-Carboniferous rocks (see Pl. III, Figs. 1 and 2), but with much less severity than are the Esks. In some localities, *e.g.*, on Little Kipper Creek and on the Esk-Hampton Road, the Bundamba sandstones are vertical along the fault and are almost horizontal at a distance of 200 yards from the fault.

This whole section of the " Western Boundary Fault " suggests that considerable movement occurred along the fault in post Esk-pre Bundamba times, and lesser movements in post Bundamba times.

Ivory Creek Fault.—This fault separates the Permo-Carboniferous rocks and Fernvale jaspers in the north-west sector. Here the magnitude of the movement is shown by the extent of the shattering of the rocks, particularly the Fernvale jaspers and quartzites (Pl. II, Fig. 2). Whether this fault continues into, or is truncated by, the Eskdale granite is unknown, and so the nearest age that can be assigned to it is post the Permo-Carboniferous rocks of the area. The Lower Esk volcanics in the area around 405361 are fractured to a slight degree, suggesting that there may have been movement along the fault in post Lower Esk times, but this is most likely due to rejuvenation.

It is very likely that an approximately S.E.-N.W. fault runs beneath the Lower Esk volcanics from 390352 towards Sandy Gully School, separating the Permo-Carboniferous sediment from the older quartzites and jaspers.

In the south-western sector the *Sugarloaf Fault* causes the Permo-Carboniferous rocks to be downthrown against the Sugarloaf metamorphics. This fault has been observed in several localities and in each case Permo-Carboniferous rocks are found to be vertical, sheared and sometimes brecciated, *e.g.*, 377142. Once again it is not known whether this fault is continuous into the Eskdale granite, but the mapping suggests that it is truncated by the granite.

(B). *The Internal Folding.*—From Mt. Deongwar to the southern margin the Permo-Carboniferous rocks have been warped into a broad anticlinal nose. Near the axis of this anticline the dips are rather high, but they decrease gradually towards the flanks. This peculiar distribution of attitude of the strata is the result of the Sugarloaf fault and other internal faults (which are discussed later) being imposed upon the basic folding. The axis of this fold trends approximately W.N.W.

To the north and north-east of Mt. Deongwar a sharply folded syncline has been developed, which has been axially and transversely faulted. It trends approximately N.N.W., its exact extent being unknown as it is overlapped by the Lower Esk volcanics in the north and is overlapped by and faulted against the Bundamba (Marburg) sandstones in the south.

Major intrusions into the Permo-Carboniferous rocks in places where folding is the major structural feature, *e.g.*, in the Buaraba area, are always concordant, suggesting that the folding took place in pre-intrusion times. Also as the Lower Esk volcanics in the north lie with marked unconformity on the Permo-Carboniferous rocks, the folding and probably much of the faulting, is pre Lower Esk.

(C). *Internal Faulting of the Fault Block.*—The dominant internal faults have a roughly north-south trend, paralleling the margins of the block, but associated are a series of complimentary east-west faults. The pattern of faulting is extremely complicated and undoubtedly there are numerous faults which remain to be detected.

Faulting has not been evenly distributed throughout the area, the section north of Mt. Deongwar being highly complex, whilst the rocks on Buaraba Creek appear to have been only slightly dislocated. It appears to be most satisfactory to deal with the faulting in the two areas separately.

1. *The Northern Area.*

Sandy Gully Fault (named after Sandy Gully School).—A fault has been traced from "Avondale" on Ivory Creek to 420290 on Cressbrook Creek, with a probable extension down Cressbrook Creek.

The existence of this fault is demonstrated by the following :—

(*a*) The straight junction between dissimilar rock types, *e.g.*, granite and quartzite.

(*b*) Shearing and fracture are very noticeable, particularly in the quartzite.

(*c*) Slickensiding is common in the quartzites, and in Permo-Carboniferous conglomerates on the Esk-Crow's Nest Road at 420300.

(*d*) Fine shales in the quartzites up against the granite are not thermally metamorphosed.

(*e*) Quartzites, white or pink in colour, and riddled with quartz veins, which are very similar to the Fernvale quartzites, are brought up at 422295 and 422715. This indicates that the basement has been brought up along a fault.

(*f*) Granite porphyry is intruded on the ridge north of "Belleville."

(*g*) The extension to the south along Cressbrook Creek is covered with alluvium, but its presence is indicated by the consistently discordant strikes on either side of the creek. It is probably truncated by the Western Boundary fault in the south, and becomes confluent with the same fault in the north.

Along this fault the western side appears to be the downthrow.

The Eskvale Fault (named after old Eskvale homestead).—Another fault curves south-west from "Leighton Farm" on Cressbrook Creek, crosses beneath the alluvium near 423282, and thence is parallel with Francis Gully. Its western extent is unknown, but in the north it joins the Western Boundary fault.

Just to the east of Eskvale trigonometrical station, phyllites striking 200° magnetic and dipping vertically outcrop. These appear to be much older than the nearby Permo-Carboniferous rocks, and are associated with quartzites very similar to those at 422295 and 422315. Also, on the road at 427284 are greenish quartzose rocks which are older than Permo-Carboniferous.

North of Francis Gully the fault is indicated by the displacement of the Permo-Carboniferous conglomerates, the shearing and fracturing of the rocks, and the disarrangement of the dips and strikes.

Along this fault the eastern side appears to be the downthrow.

The above two faults, together with portion of the Western Boundary fault, isolate a long narrow horst of older rocks and granite elongated N.-S., between the Esk-Crow's Nest Road and "Avondale" on Ivory Creek.

Tinton Fault (named after "Tinton" homestead).—The syncline previously mentioned, to the N.E. of Mt. Tin Tin has been faulted along its axis, at least in the southern part. The dips in its vicinity in Duggua and Francis Gullies are either vertical or very steep; the rocks are very closely jointed, shearing and breccia-tion are common, and magnesite and dolomite are often found along fractures. Its extent northwards is unknown, as along its strike it would disappear beneath alluvium. Southwards, its existence is indicated near 400231 on Cressbrook Creek, where the fracturing of the rocks has been intense and dips are steep, and further south from this point where the dips and strikes are discordant, and even rocks such as the granite porphyry at 397222 have been minutely joined (see Pl. III, Fig. 3).

The exitence of a fault just to the east of and parallel with Ivory Creek seems highly probable, since black shales and sandstones which are high in the stratigraphic sequence are in juxtaposition to those low in the sequence, and would appear to dip under them. A coarse breccia at 392301 also suggests faulting. The main part of its course would be hidden by the Lower Esk volcanics.

Numerous other smaller faults have occurred, as is shown by the broken strike pattern in several places, but their position has not been determined.

2. *The Southern Area.*

Only three faults have been definitely located in this section. One, trending almost N.-S. and crossing Buaraba Creek at 416042, it cuts through fine grained sedimentary rocks, causing vertical dips and much fracturing.

A second fault has caused slickensiding and displacement of a diorite dyke along the southern bank of Oakey Creek. The northern side has probably been downthrown.

Much slickensiding, brecciation and local repetition of beds from 389105 to 384095 suggest a fault in this region.

The thickness of the series from Mt. Sugarloaf southwards to Buaraba Creek is enormous. Coupled with this is the gradual decrease in dip toward the south. These two factors suggest that there may be considerable undetected strike faulting increasing the apparent thickness of the sequence.

DISCUSSION

The evidence at present is insufficient to determine whether there is any regularly intersecting pattern of faults, but it is apparent that the main internal faults, particularly in the north, are parallel or sub-parallel with the marginal faults, and those in other directions are subsidiary. The effect of the faulting in the north was to produce three elongate fault slices parallel with margins of the fault block.

Are these faults normal or thrust ? Firstly, I have been unable to observe the hade of any fault plane in any section, and neither have I been able to find the direction of hade by the relation of the fault plane to the topography.

Secondly, it has been possible to map the faults accurately only in certain localities, with the result that interpolation has been frequently used. More accurate mapping may make some differences, *e.g.*, the arcuate shape of the Sugarloaf fault may well be changed to rectilinear.

Thirdly, parallelism of tectonic elements is quite noticeable, *e.g.*, the Sugarloaf fault and the Bundamba Permo-Carboniferous boundary to the east ; the Eskdale Granite bulge on Oakey Creek is parallel to the Permo-Carboniferous Esk boundary to the east ; and the warping of the Permo-Carboniferous is sub-parallel with the faulted margins. These sub-parallel arcuate structures may suggest thrusting from the west.

All the facts on the disposition and structural relations of the beds can apparently be explained by normal faulting. However, insufficient local evidence has been assembled to warrant a definite conclusion. Inferences on the nature of the deforming forces drawn from regional tectonics will be discussed in the appendix.

XII. CONCLUSIONS

1. The area consists broadly of Permo-Carboniferous, and perhaps older, sediments faulted down between the Fernvale jaspers and Sugarloaf metamorphics on the west, and Esk Series and Bundamba sandstones on the east.

2. The main sequence of beds is of cherts, quartzites, andesites, rhyolites, sandstones, conglomerates and shales. There is no evidence of unconformity in the sequence.

3. Fossils found toward the top of the sequence suggest an Ingelara or Mantuan Downs age for these upper beds, but the lower beds may extend as far down as the Devonian.

4. The type of sedimentation suggests geosynclinal or unstable shelf conditions.

5. The area has been subjected to folding and intense faulting probably in Upper Permo-Carboniferous times, and subsequent movements have taken place along the same lines in post-Esk and post-Bundamba times.

6. The faulting has been most intense in the north, where a number of fault slices have been formed.

7. Plutonic activity in the Upper Permo-Carboniferous (post-folding and pre-faulting) has resulted in the emplacement of the Eskdale Granite, the Champion Hills Basic Diorite, the South Buaraba Porphyrite and the Buaraba Quartz Diorite.

XIII. APPENDIX

(This section is rather more speculative than the foregoing and so has been included as an appendix.)

The Brisbane Valley, although one of the most dominant and obvious structures of south-east Queensland, has received little attention as a unit, in relation to the regional tectonics of the area. It will be here discussed, with particular reference to the determination of the forces causing its development in an attempt to discover the type of faulting, compression or tension in the Permo-Carboniferous fault block previously discussed.

The following elements form the backbone of the discussion :—

1. West Moreton fault and associated serpentines.
2. The nature and structure of the valley sediment.
3. Movements in adjacent areas.
4. Application of modern theories.

1. *West Moreton Fault, etc.*—This fault separates rocks of the Esk Series from members of the Brisbane Schist Formation along the greater part of its length, and to the south it cuts through the Triassic Ipswich Series. (Denmead 1928). Along the fault at several localities (Fernvale, Northbrook and Kilkivan) serpentines are intruded In the light of recent investigations of the tectonic relationships of serpentines, it is probable that originally this fault was compressional in type, and the serpentine was intruded along it soon after its formation. Ages suggested by different authors for the serpentines range from Silurian to Permo-Carboniferous, but all are agreed that they are pre-Mesozoic.

The conclusion is thus drawn that a thrust fault was developed along the present West Moreton Fault in pre-Triassic times. There has been subsequent movement along this fault line which may well be tensional, as is indicated by the presence of faults splaying out from its southern end into the Ipswich Coal Measures.

2. *The Nature and Structure of the Valley Sediments.*—Hill (1930B) has outlined the sequence and major structures of the Esk Series, which consists of the first rocks to be laid down in the Brisbane Valley rift after its formation. Briefly, the sequence consists of andesitic rocks overlain by sediments.

The occurrence of extensive volcanics at the base of the sequence is of importance. Holmes (1944) considers the absence of volcanics on the floor of a trough as evidence for a compressive origin for fault troughs. H. L. Sikes (quoted from Taber, 1927, p. 601) has found that the " characters of the rift valley near Nairobi in Kenya Colony, where volcanism has been important, are quite different from those of most of the major troughs in the African rift valley system, which are located in districts where volcanism has been absent or unimportant." He has found that " near Nairobi the trough is characterised by numerous parallel fault block ridges and valleys, the limits of the trough being indefinite, as it is not bounded by high steep fault scarps."

With regard to the structure of the valley sediments, reference to Hill (1930B) brings out the following points :—

(*a*) There is a predominance of monoclinal over other types of folding.

(*b*) The folds are oriented parallel with the marginal fault system.

(*c*) The anticlinal and monoclinal folds are frequently intruded axially by felspar hornblende porphyrite.

(*d*) The synclines are either relatively flat bottomed or slightly centrally arched, *e.g.*, Maronghi Syncline.

(*e*) The whole floor of the valley appears to have been tilted to the west, as the Lower Esk rocks are exposed only on the east.

Monoclines are not common in areas which have been subjected to compression (Nevin, p. 64) and the formation of fractures along which dykes are intruded is indicative of tension (Anderson, p. 21). If the formation of the fractures and the intrusion of hornblende porphyrite is concomitant as Hill states, then the fractures must have been formed under tension. All the above features seem to be best explained on the basis of vertical stresses rather than horizontal compression.

It is agreed that the floors of rift valleys are often faulted parallel to the length of the trough (Taber, 1927). If it be admitted that the original floor of the Brisbane Valley trough was so faulted, then the following is a possible explanation of the structure of the valley rocks as they appear at present :—

After, and perhaps during, the formation of the trough and faulting of the floor the Lower Esk volcanics were extruded. This was closely followed by the deposition of the Upper Esk sediments, after which further movement along the marginal and valley floor faults took place. The effect on the less indurated Esk rocks was folding of the Saxonian type. Naturally fractures would be quite common along the axes of these folds, and along these fractures the hornblende porphyrite was intruded.

(Fairbridge (1948) suggested widespread Saxonian type movements have taken place in eastern Queensland. The ideas presented above were developed independently, and the Saxonian movements postulated are obviously the result of localised stresses.)

The nature and structure of the valley sediments appear to be adequately explained by invoking tensional and/or gravitational forces, and certain features are inexplicable on the basis of dominant compressive forces.

3. *Movements in Adjacent Areas.*—Carey and Browne (1938) summarising the

previous work of Benson, Osborne, Carey, Sussmilch, Reid and Voisey, state that the Carboniferous and Kamilaroi rocks of northern N.S.W. were involved in an orogeny commencing toward the end of the Upper Marine epoch. They suggest a line of thrusting from Maitland to Townsville.

This supposed line of thrusting extends several hundred miles west of the Cressbrook area, and is mentioned merely to point out that thrusting movements were occurring in south-east Queensland at approximately the same time as the Western Border Fault was being formed.

The work of Carey (1934) on the Werrie Basin (p. 368) indicates that subsidiary normal faulting also occurred in northern N.S.W. in Upper Kamilaroi times. This movement he ascribes to "settling at the close of the orogenic cycle."

Richards and Bryan (1924) have shown that Permo-Carboniferous blocks in the Silverwood area have been let down into Devonian rocks in post Permo-Carboniferous and pre Jurassic times. Probably the movement was toward the close of Permo-Carboniferous time.

In the Silverspur area Ball (quoted from Bryan, 1924) suggests the area has suffered heavy block faulting into four distinct blocks with quite diverse strikes. Extensive normal faulting of the Gympie area has also been postulated by Dunstan.

In his summary of Upper Palaeozoic Movements in 1925, Bryan divides the Permo-Carboniferous formations into three groups, the third of which is :—" Down-faulted blocks of Permo-Carboniferous age in which steep dips and crush effects have in some cases been found, but in none of which has actual folding been demonstrated."

It is now suggested that the Permo-Carboniferous rocks of south-east Queensland were slightly folded (and perhaps overthrust to the west) during the Hunter-Bowen orogeny, and extensive normal faulting ensued causing the down-throw of such blocks as the Fault Block Series of Silverwood. To this extensive normal faulting may be ascribed the initiation of the Brisbane Valley rift, and such blocks as the Cressbrook-Buaraba fault block.

4. *Application of Modern Theory.*—Regardless of the origin of the forces invoked to cause the orogenesis of geosynclines, a well established and generally accepted sequence of events occurring during the latter phases of the life of a geosyncline has been proposed. It is as follows :—

(1) Serpentine is intruded during the compressive phase of the orogenesis. For the purposes of this discussion it is of little importance whether we restrict its intrusion to the first phases of orogenesis (Hess, 1938) or permit it at later phases.

(2) After folding, the area rises isostatically. (Umbgrove (1939), Stille (1941), Kraus (1928), Bubnoff (1947), Meinesz (1948)). (Kraus, Bubnoff and Stille quoted from Glaessner and Teichert (1947)).

(3) Associated with and preceding this isostatic adjustment, acid batholiths are intruded.

Also Vening Meinesz has shown from studies on the Banda arc and associated deeps (Q.J.G.S., 1948) that isostatic readjustment after orogeny causes great tensional fractures in the earth's crust, often in the form of rifts, *e.g.*, the Weber Basin. These rifts in general follow the structural pattern of the areas in which they occur.

Now, in the earlier parts of this work it has been shown that folding of Permo-Carboniferous and earlier rocks in the Brisbane Valley area probably took place in Upper Permo-Carboniferous times. (A similar age for folding of other areas in the Tasman Geosyncline has been deduced by numerous other authors, *e.g.*, Carey and Browne (1938). Hunter-Bowen orogeny). Following these movements, the area was intruded by acid and sub-basic intrusions, and then severe faulting and rifting ensued along a dominantly N.-N.N.W. trend. This is the dominant structural trend of south-east Queensland.

The close analogy between these events and those suggested by Meinesz for the Banda region is obvious. If his theory is correct it is possible that the Brisbane Valley rift zone is the result of tensional stresses due to isostatic uplift occurring after the final folding of the Tasman Geosyncline.

Summary.—The above four lines of approach suggest that the Brisbane Valley trough (and therefore the Cressbrook-Buaraba Fault Block) could have been formed under tensional or dominantly vertical forces. Strong compression is unnecessary to explain any of the features above discussed except the original West Moreton Fault, and as has been previously stated, this fault line could have been the site of later tensional movements.

Summarising the above suggestions, the sequence of events appears to be as follows :—

(*a*) Gentle folding, with possible overthrust to the west in late Permo-Carboniferous or very early Triassic.

(*b*) Isostatic uplift and formation of normal faults dropping down the Brisbane Valley trough, and forming the marginal fault blocks. Subsidiary horsts and valleys were formed in the valley floor.

(*c*) Closely following this movement the Lower Esk volcanics were deposited, probably being extruded along the faults.

(*d*) Deposition of the Upper Esk sediments and erosion of the border highlands formed by the faulting.

(*e*) Rejuvenescence of faulting both along the margins of the trough and in its floor causing the disturbance of the Esk volcanics and sediments, and throwing them into folds of the Saxonian type.

(*f*) Along the fractures which would naturally be incidental to such folding, the Brisbane Valley porphyrites and other hypabyssal rocks were intruded.

(*g*) Rapid erosion and deposition of the Bundamba sandstone ensued, the basin of deposition becoming rapidly more extensive.

(*h*) Slight faulting then occurred along the old trough margins.

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PLATE I

Fig. 1—*Mourlonia strzeleckiana* ? (Morris). Internal mould. X 1 1/7 ; from Loc. A.

Fig. 2—*Mourlonia strzeleckiana* ? (Morris). Internal mould. X 1 1/8 ; from Loc. A.

Fig. 3—*Keenia* sp. showing prominent keel. X 1 1/10 ; from Loc. C.

Fig. 4—*Streblochondria englehardti* ? (Eth. fil. and Dun) ; X 1 1/10 ; from Loc. A.

Figs. 5, 6 and 7—*Terrakea fragilis* ? (Dana). Fig. 5 lateral view of ventral valve X 1 1/10. Figs. 6 and 7 external moulds of dorsal valves X 1 1/7 ; all from Loc. C.

Fig. 8—*Glyptoleda buarabae* sp. nov. External mould of left valve showing ornament (holotype) X 1 1/8 ; from Loc. A.

Figs. 9 and 12. The same. Lateral and dorsal views of a plaster cast of the posterior of a specimen X 1 1/8 ; from Loc. A.

Figs. 10 and 11. The same. Lateral and dorsal views of an internal mould, slightly incomplete posteriorly, and showing the teeth impressions and large anterior muscle scar ; X 1 1/10 ; from Loc. A.

Figs. 13 and 22—*Aviculopecten subquinquelineatus* McCoy. Showing ears and ornament X 1 1/10 ; from Loc. M.

Fig. 14—*Euryphyllum mantuani* sp. nov. (holotype). Reproduced from D. Hill (1938), Plate I, figs. 8 and 9.

Figs. 15, 16 and 21—The same. Views of specimens showing shape of the corallum, and septal arrangement ; note the size and shape of the cardinal fossula ; X 1 1/10, from Locs. QR/76 and QR/141. Univ. of Q'ld. colln.

Fig. 17—*Euryphyllum mantuani* ? sp. nov. natural size ; from Loc. C.

Fig. 18—*Euryphyllum parallelum* sp. nov. (holotype). Transverse section ; natural size ; from Loc. G.

Fig. 19—The same. Vertical section showing domed tabulae ; natural size ; from Loc. G.

Fig. 20—*Euryphyllum* sp. natural size ; from Loc. G.

PLATE II

Fig. 1—Bundamba sandstone lying unconformably on Permo-Carboniferous rhyolite at 397222 on Cressbrook Creek.

Fig. 2—Quartzites of the Fernvale-Neranleigh Group in Ivory Creek.

Fig. 3—Three systems of jointing in almost horizontal Permo-Carboniferous sandstones on North Branch Buaraba Creek.

Fig. 4—Rhythmically banded Permo-Carboniferous grits (whitish beds) and sandstones in the Buaraba basin.

Fig. 5—Permo-Carboniferous grits near the timber chute on Kipper Creek.

Fig. 6—Cross bedded Bundamba sandstones from Little Kipper Creek.

PLATE III

Figs. 1 and 2—Junctions between the Permo-Carboniferous and Bundamba rocks on the Esk-Hampton Road near " Yarallah."

Fig. 3—Close fracturing in granite porphyry on Cressbrook Creek, due to faulting.

Fig. 4—Basic diorite near the " slide " on Cressbrook Creek.

Fig. 5—Rhythmically banded sediments from the Buaraba basin.

Fig. 6—Gully following andesite dyke in Permo-Carboniferous rhyolite south of the Esk-Hampton Road.

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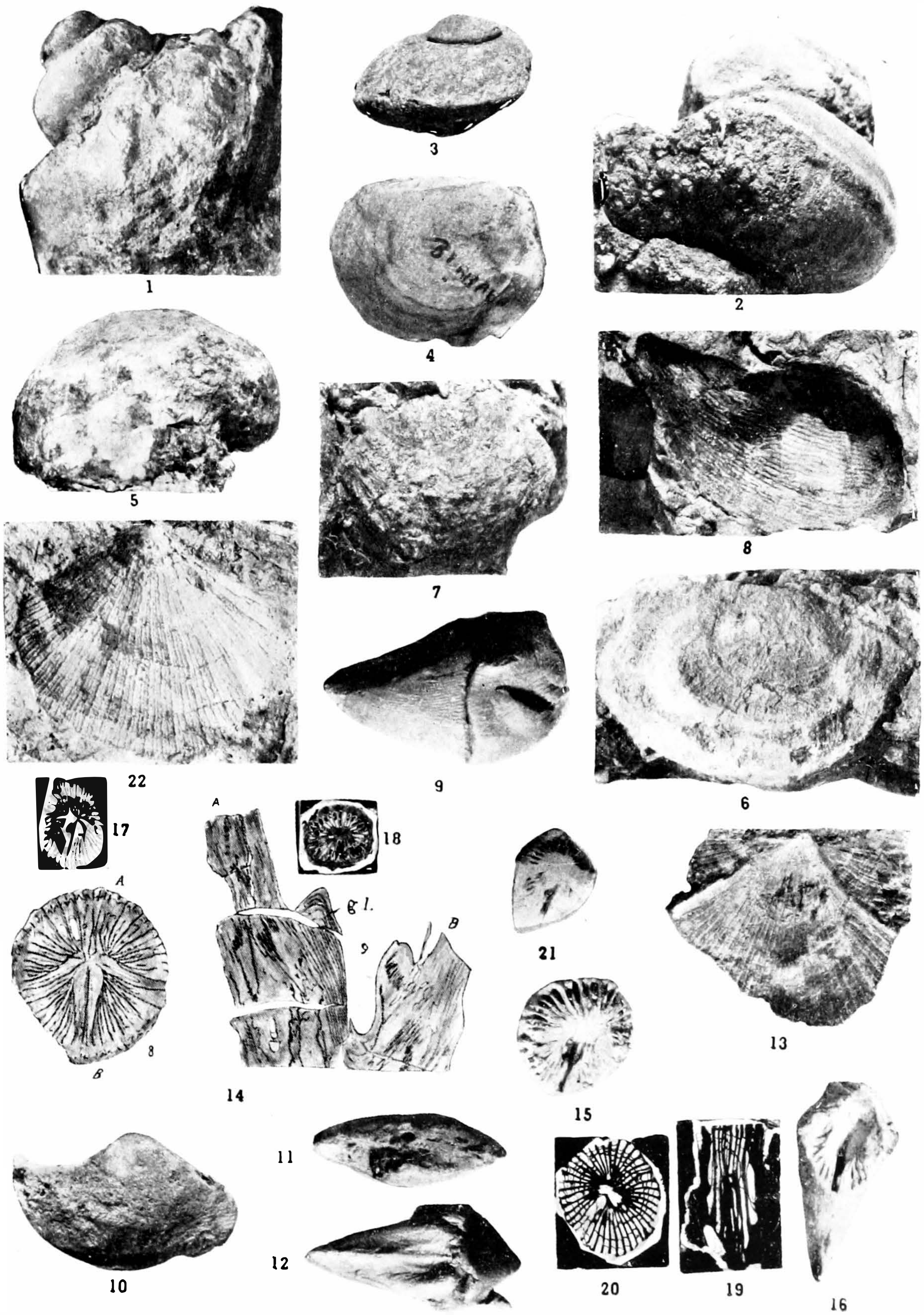

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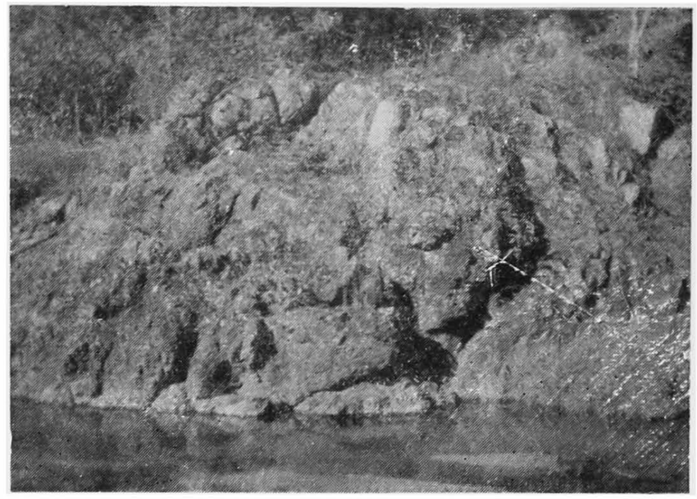

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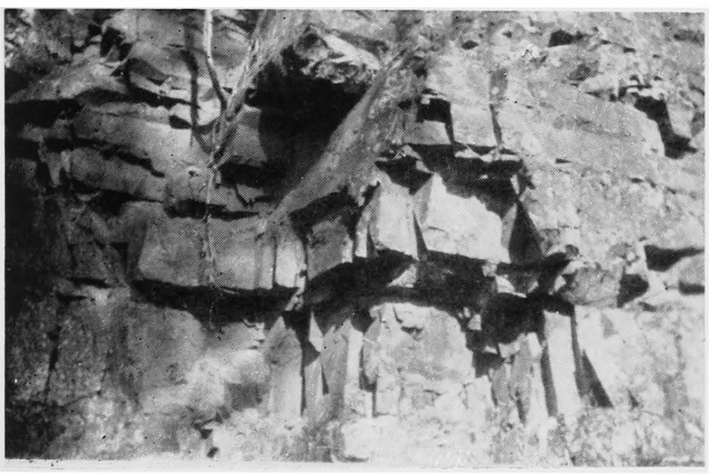

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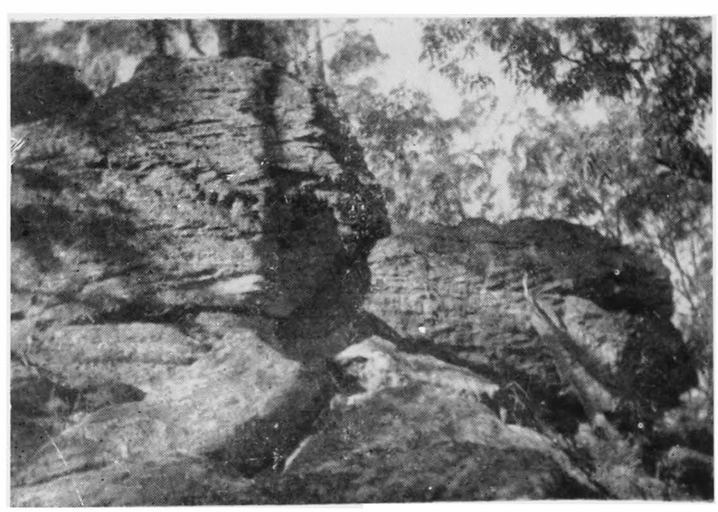

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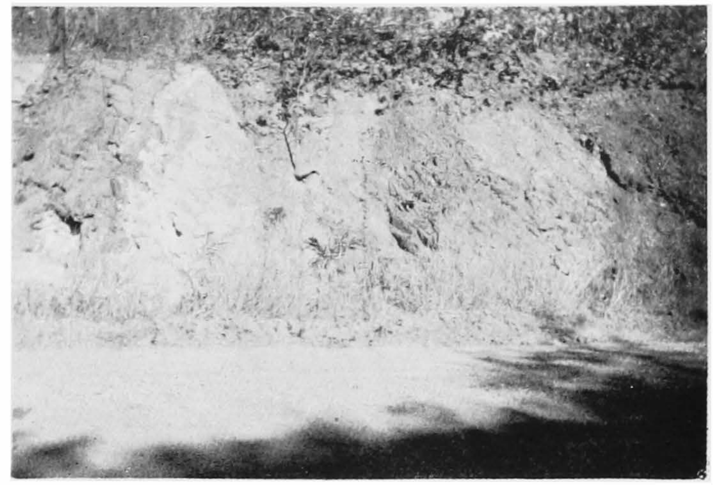
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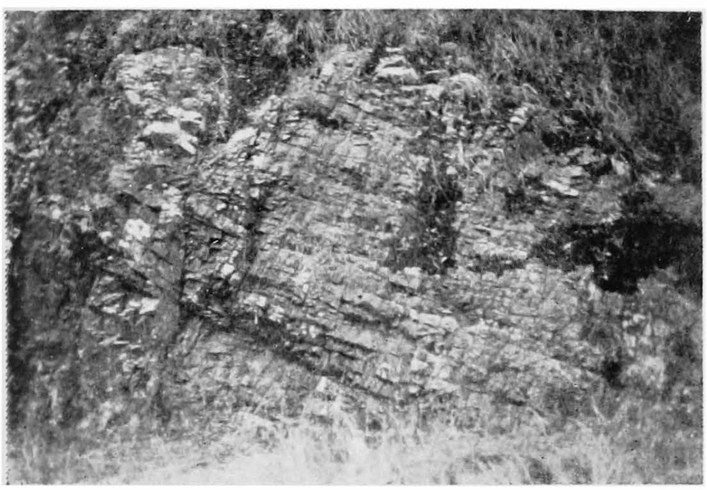
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