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BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

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1961/75

THE GEOLOGY OF THE CLERMONT 4-MILE SHEET AREA, QUEENSLAND

by

J.J. Veevers, M.A. Randal, R.G. Mollan & R.J. Paten (Q.G.S.)

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SUMMARY

Parts of three major structural units are exposed in the Clermont 4-mile Sheet area; the Anakie Inlier of pre-Devonian Anakie Metamorphics; the Drummond Basin of Lower Carboniferous Drummond Beds; and the Bowen Basin of Permian Collinsville Coal Measures, Middle Bowen Beds and "Passage Beds", Upper Bowen Coal Measures, and Triassic Carborough Sandstone. Lying between the Anakie Inlier and the Bowen Basin are the Upper Devonian to Lower Carboniferous Bulgonunna Volcanics.

The Anakie Metamorphics are an unknown thickness of folded and sheared quartz schist, quartz mica schist, and mica schist that are older than Devonian. South of Clermont township, they are overlain unconformably by a sequence of Middle Devonian coralline limestone (the Douglas Creek Limestone), brachiopod-bearing siltstone, and Theresa Creek Volcanics that include flows of andesite and trachyandesite and equivalent tuffs. In the west, the Anakie Inlier is overlain unconformably by 14,000 to 20,000 feet of Lower Carboniferous Drummond Beds of rhyolite, conglomerate, and plant-bearing sandstone and siltstone, which are folded into a broad syncline. In the east, the Anakie Inlier is overlain unconformably by an estimated 16,000 feet of Upper Devonian to Lower Carboniferous Bulgonunna Volcanics of acid volcanics and plant-bearing siltstone. At Clermont, the Anakie Metamorphics are overlain unconformably by Permian marine and freshwater rocks, and at Blair Athol by Permian coal measures.

The Permian rocks of the Bowen Basin overlie unconformably the Bulgonunna Volcanics. They comprise, from the base upwards, at least 150 feet of Collinsville Coal Measures, including at least 30 feet of coal, 1000 to 1500 feet of Middle Bowen Beds (marine quartz greywacke and siltstone, with two coquinites near the exposed base) that interfinger with an estimated 2000 feet of "Passage Beds" (alternating marine and freshwater quartz greywacke and siltstone with coal seams), and an estimated

3,500 feet of Upper Bowen Coal Measures (freshwater quartz greywacke, sandstone, lithic sandstone, and coal seams). The Upper Bowen Coal Measures are overlain, probably conformably, by 850 feet of Triassic Carborough Sandstone. The Permian Blair Athol Coal Measures, which comprise 800 feet of conglomerate, sandstone, siltstone, and shale and several coal seams, including one a hundred feet thick, overlie unconformably the Anakie Metamorphics in an isolated basin.

Igneous activity was widespread in the area. The Theresa Creek Volcanics were intruded, probably in the Carboniferous, by monzonite; the Permian rocks in the north-eastern part of the Sheet area by syenite and granodiorite; and the Bulgonunna Volcanics and Permian rocks in the Peak Range and elsewhere by the Tertiary Peak Range Volcanics and by dykes of basalt and trachyte. Tertiary olivine basalt was extruded over a wide area. The Peak Range Volcanics are an exceptionally well-exposed and well-preserved suite of hypabyssal intrusions of soda-rich rhyolite and trachyte.

The Permian rocks are gently folded except where they are arched up by igneous intrusion. Broad folds in the Cherwell Range and small domes elsewhere are potential reservoirs for petroleum generated in bodies of dark siltstone.

INTRODUCTION

The field work described in this report was done in the period June to October 1960. The areas mapped and reported on by individual geologists are as follows:

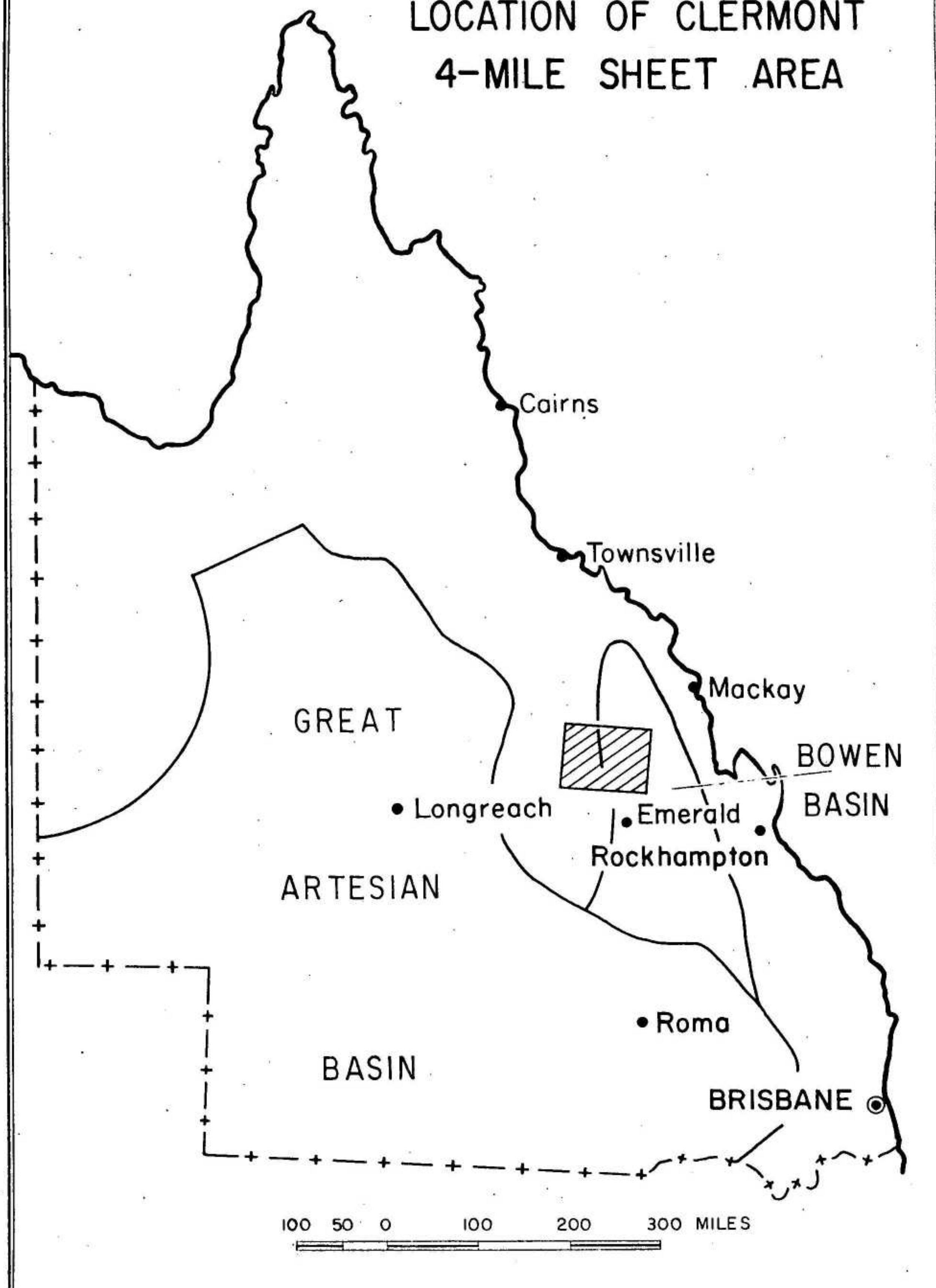
Veevers: Cotherstone and eastern half of Peak Downs 1-mile Sheet areas.

Randal: Grosvenor Downs, Phillips, Monteagle, and Banchory 1-mile areas, and Blair Athol Coalfield.

Mollan: Blair Athol and western half of Peak Downs 1-mile areas; all occurrences of the Peak Range Volcanics.

Fig. 1

LOCATION OF CLERMONT 4-MILE SHEET AREA



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Paten: Mount Rolfe, Mount Violet, Frankfield, and most of Kilcummin and Clermont 1-mile Sheet areas.

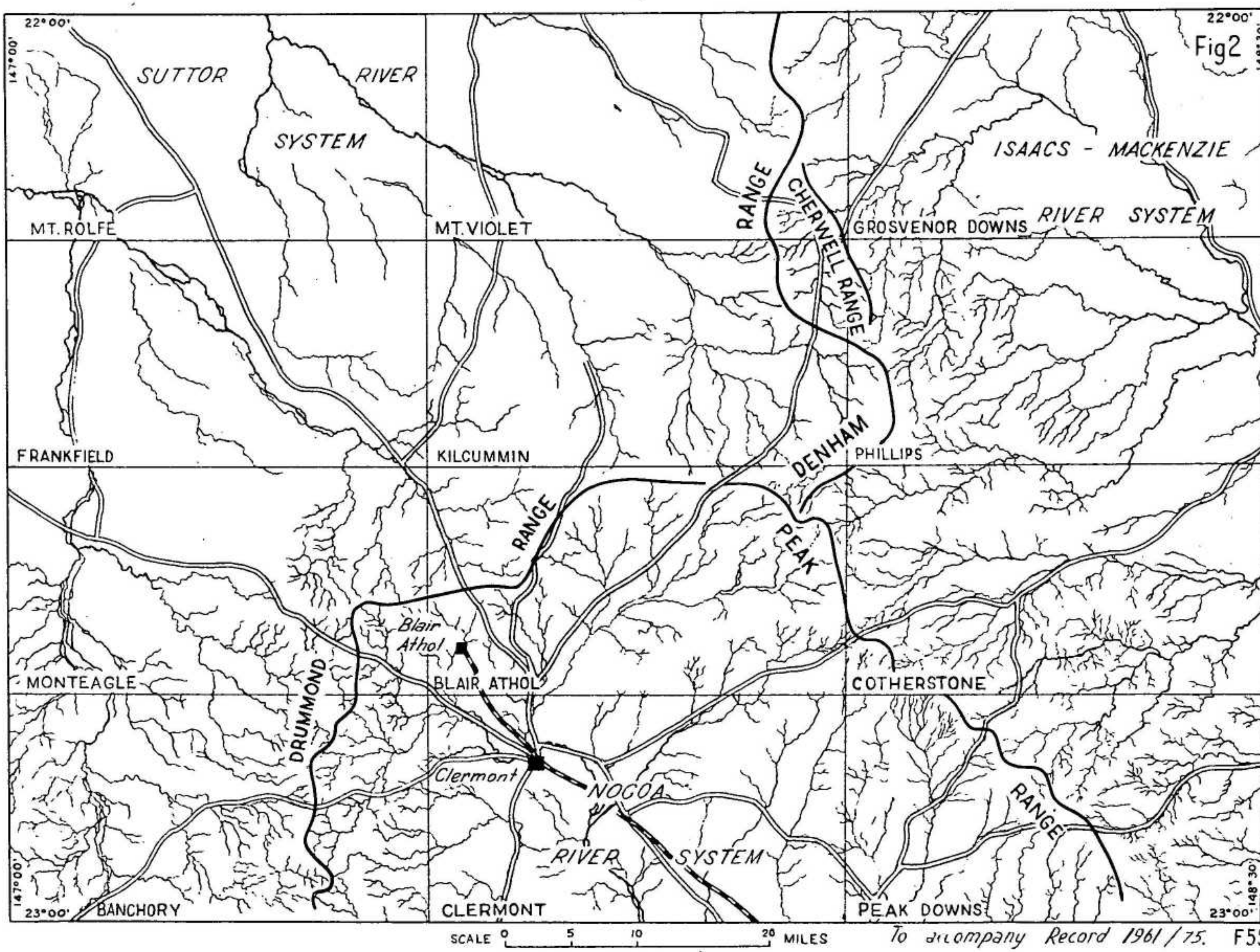
Mapping in the Clermont Sheet area and in the Mount Coolon Sheet area (Malone, Corbett & Jensen, 1961) was carried out as the first part of a systematic plan to map the Bowen Basin in the search for oil. The Geological Survey of Queensland co-operated with the Bureau by attaching a geologist to each party.

Location. The Clermont Sheet area (Fig.1) lies in central Queensland, east of the Great Dividing Range, and 80 miles inland. Clermont and Blair Athol are the only townships, and they are linked by a branch railway-line to Emerald, and served by Queensland Air Lines; the surrounding districts are served by Country Air Services. The Northern Inland Highway, sealed in part, crosses the area; other main roads are the Clermont-Coast Highway, and the Clermont-Alpha Road.

There are at least 300 homesteads in the area, which is used for grazing cattle and sheep except near Clermont, where grain crops are grown. Clermont, with over 1,000 inhabitants, is the main centre, and Blair Athol, 12 miles north-west, is a coal mining town.

Previous Work. The Clermont/Blair Athol area has interested geologists since gold, copper and later coal were found there in the last century. The first geological observations were made by Leichhardt in 1844, when he discovered the Peak Range. The geologists who have done most work in the area are Dunstan, Rands, and Reid, all of the Queensland Geological Survey. Individual references to their work and to that of others are made in the text.

Recent work includes a drilling survey of the Blair Athol Coalfield by the Commonwealth Aluminium Corporation, and regional surveys of the northern part of the Bowen Basin by Santos



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and Associated Freney Oilfields.

Air photographs. This was the first survey to use air photographs in mapping the Clermont Sheet area. Two sets were available: R.A.A.F. photos, taken in 1947, at a scale of 1:48,000, and Queensland Lands Department photos (1952-60) at a scale of 1:24,000. Control sheets were supplied by the Division of National Mapping, Canberra.

Topography and Drainage (fig.2). Relief in the area is 2,135 feet, from an altitude of 2,675 feet at Browns Peak in the Peak Range to 540 feet in Ripstone Creek, on the eastern edge of the Sheet area. Browns Peak stands 1,600 feet above the surrounding plain. The main divides are the Denham Range, Drummond Range, and Peak Range. The Cherwell Range is a spur of the Denham Range. The Peak Range is prominent and picturesque, with plugs and domes rising above the Peak Downs. The Drummond Range is poorly defined and rises only 200 feet above the surrounding country. The Denham Range is barely discernible on the ground, but nevertheless is the watershed between the Suttor River system and the Nogoa/Isaacs - Mackenzie River systems. The main watercourses flow a few months of the year only. Watercourses in the north-west quadrant are braided and, in parts, choked with alluvium.

Heights throughout the Sheet area were measured by barometer. Control was provided by accurate heights on the railway-line, main roads, and at trigonometrical stations.

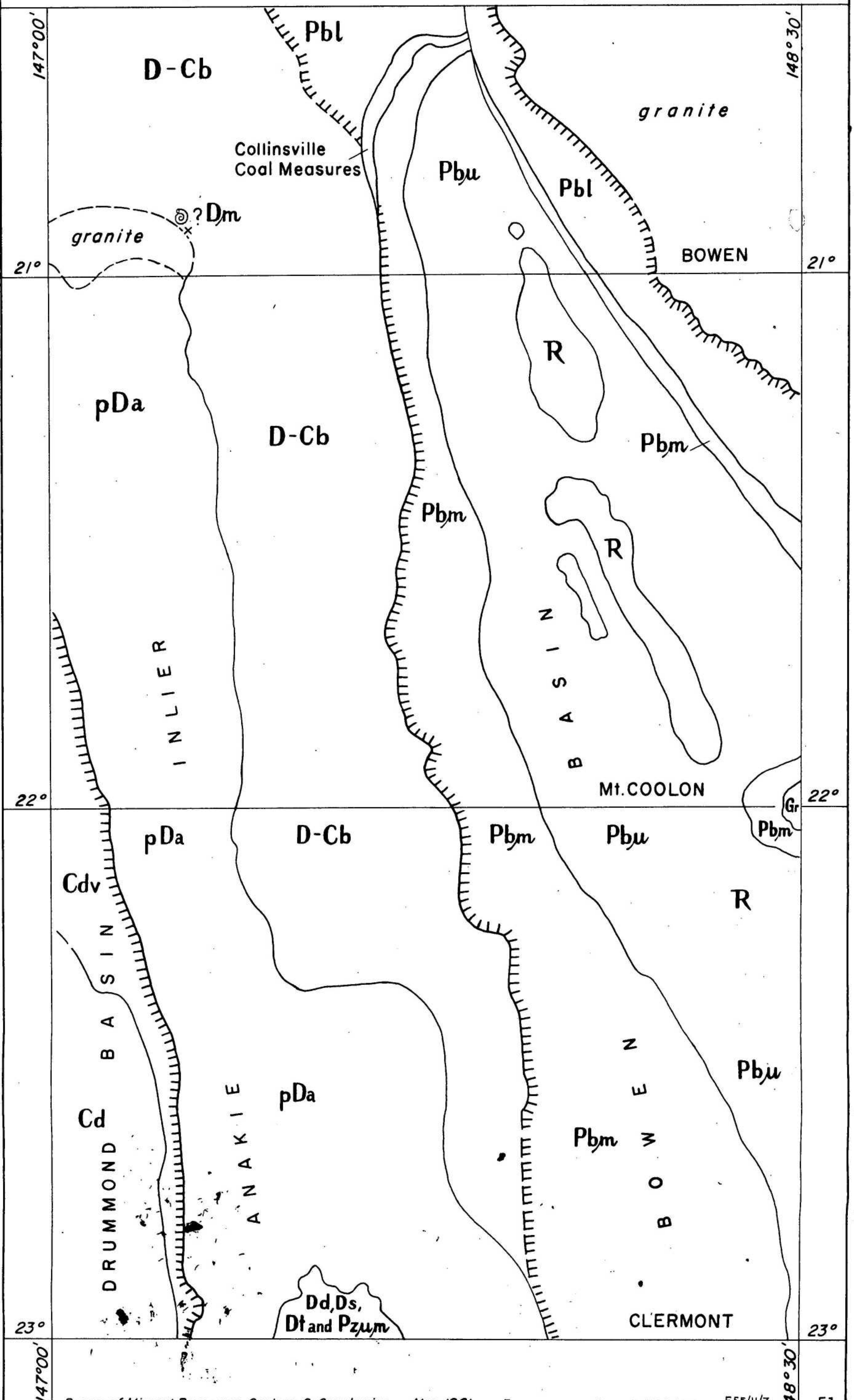
PRE-DEVONIAN

Anakie Metamorphics

The rocks of the Permian Bowen Basin are separated from those of the Carboniferous Drummond Basin by a sequence of folded metamorphic rocks, the Anakie Metamorphics, which consist of schist and slate intruded by granitic rocks. The Metamorphics extend northwards from near Anakie, in the Emerald Sheet area, for

SOLID GEOLOGY OF CLERMONT, MOUNT COOLON, AND PART OF BOWEN 4-MILE SHEET AREAS.

Fig. 3



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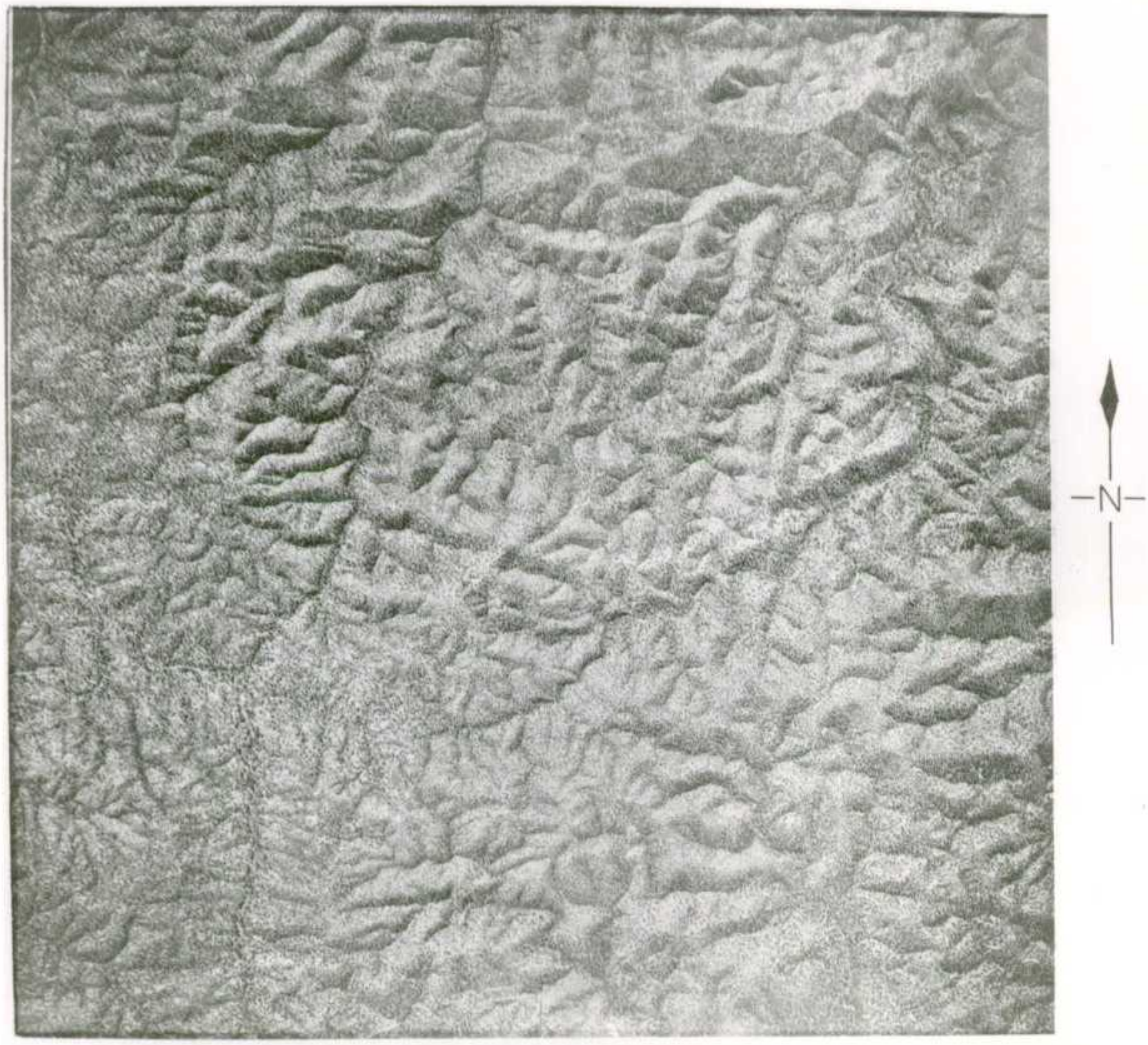

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SCALE

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Figure 4. Variations in airphoto pattern within the Anakie Metamorphics presumably indicating different lithologies. Note strong lineaments at top and bottom of photo.
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over two hundred miles. No estimate of the thickness of the sequence can be given. The age of the Anakie Metamorphics is known only by the superposition of Middle Devonian rocks; they are shown on the map as pre-Devonian. The outcrop of the unit in the Clermont Sheet area was not mapped during the recent survey, but its areal extent has been delineated. In the Clermont Sheet area, the rocks contain gold and copper.

Jensen (1921) used the term Anakie Series for the granite, porphyry, schist and slate in the Anakie area. He referred to the metamorphic rocks around Clermont as the Clermont Series; Reid (1936) called the same rocks the Clermont Slates.

On the Geological Map of Queensland (1953) undifferentiated Lower Palaeozoic rocks that extend from Anakie to south-west of Collinsville are called the Anakie Metamorphics. Tweedale (in Hill & Denmead, 1960) refers to these rocks as the Anakie Complex.

In the Clermont Sheet area, the main area of outcrop of the Anakie Metamorphics occurs in the west; Clermont township is situated on the eastern margin. South of Clermont township, the outcrop is forty-five miles wide; 18 miles north of Blair Athol it is twenty-five miles wide. From here it trends N.N.W. under the widespread superficial deposits, and only few outcrops are visible.

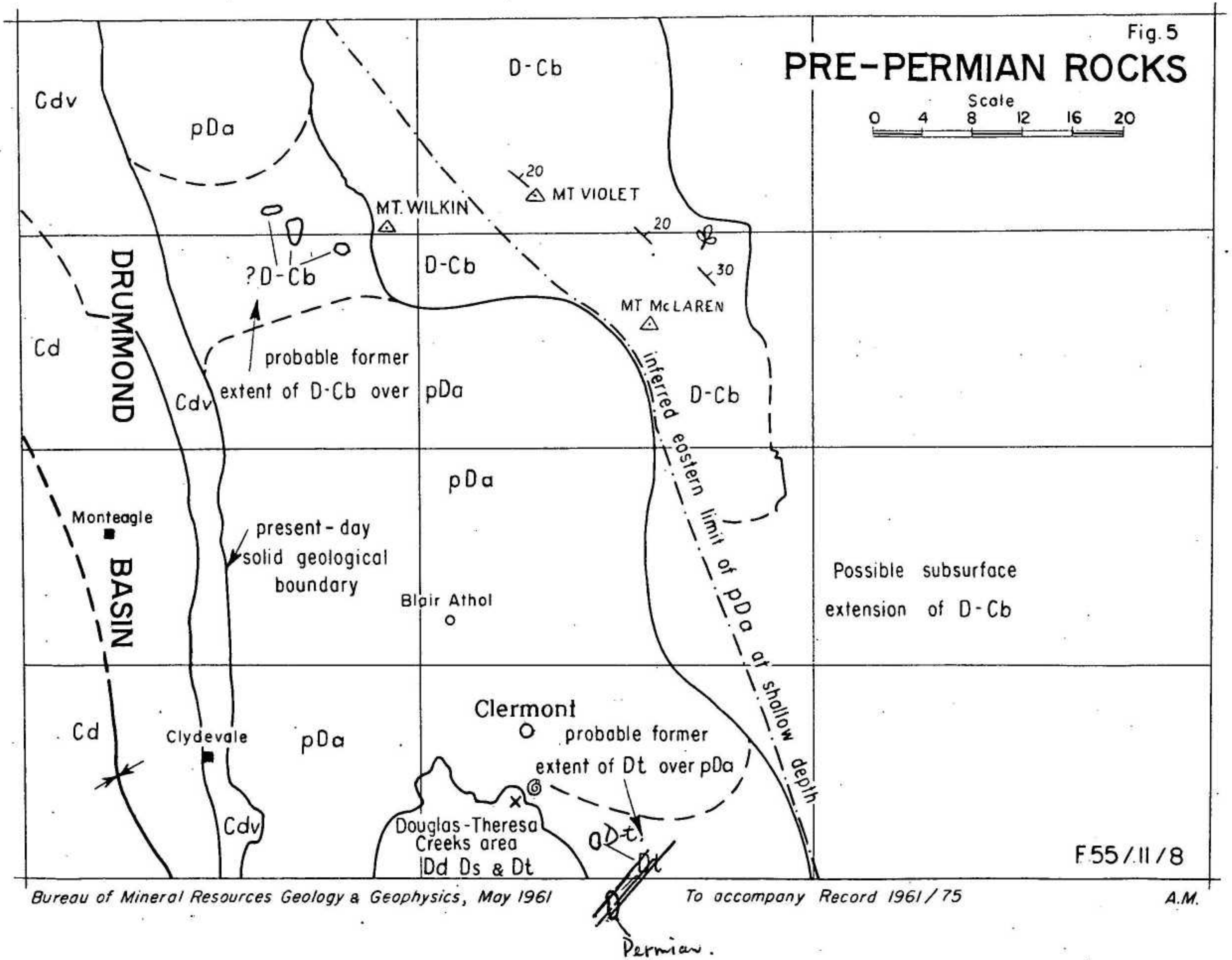
The Anakie Metamorphics south-east and north-east of Clermont township are covered by widespread areas of Tertiary basalt and Cainozoic surface deposits. The presence of the unit near the surface in these areas is inferred by landform and by the occurrence of extensive rubble of quartz and sheared rocks.

The dominant topography of the Anakie Metamorphics is high, gently rounded, closely spaced hills with numerous deep gullies forming a dendritic drainage pattern (fig.4). Variations in the density of the hills and gullies, as seen in air photographs, probably reflect different lithologies. Away from the main area of outcrop low rubble - covered hills with thick vegetation rise to fifty feet above the flat-lying plains of superficial deposits.

A close study of the lithologies of the Anakie Metamorphics has not yet been attempted. Outcrop exposure is poor and the rocks have been examined only in the cuttings on the Clermont - Alpha Road and along the track which links this road with the Douglas Creek area. Hand speciments of the rocks are determined as knotted schist, mica schist, quartz mica schist, slate, and quartzose sediments. The rocks are intruded by monzonite in the Douglas Creek area, and apophyses of monzonite and syenite intrude the sediments near the contact. At CL375 on the Clermont-Alpha Road scattered collinear outcrops of lamprophyre are probably remnants of basic dykes which intrude the folded and sheared rocks; outcrop of the metamorphics is poor here and the exact relationship is difficult to determine. Quartz reefs are common.

The reliability of the lineation directions in the outcrops examined cannot be established because of soil creep; it does appear however that the rocks have undergone more than one period of folding. Commonly measured cleavage directions are 080° and 340°. In the excellent 1:24,000 scale air photographs, the Anakie Metamorphics are seen to be cut by lineaments which trend at widely divergent angles. These lines have not yet been recognised on the surface, and their true nature is unknown (Fig.4).

The Anakie Metamorphics, which occupy about one-third of the Clermont Sheet area, formed a stable block prior to the Devonian and Carboniferous sedimentation. A strong metamorphic and structural unconformity exists between the western flank of the Metamorphics and the overlying Drummond Beds. On their eastern side the Metamorphics are unconformably overlain by the Bulgonunna Volcanics and the Permian sediments of the Bowen Basin. North of Springsure the area of outcrop of the Metamorphics has been called the Anakie Structural High. We prefer to use the term Anakie Inlier.



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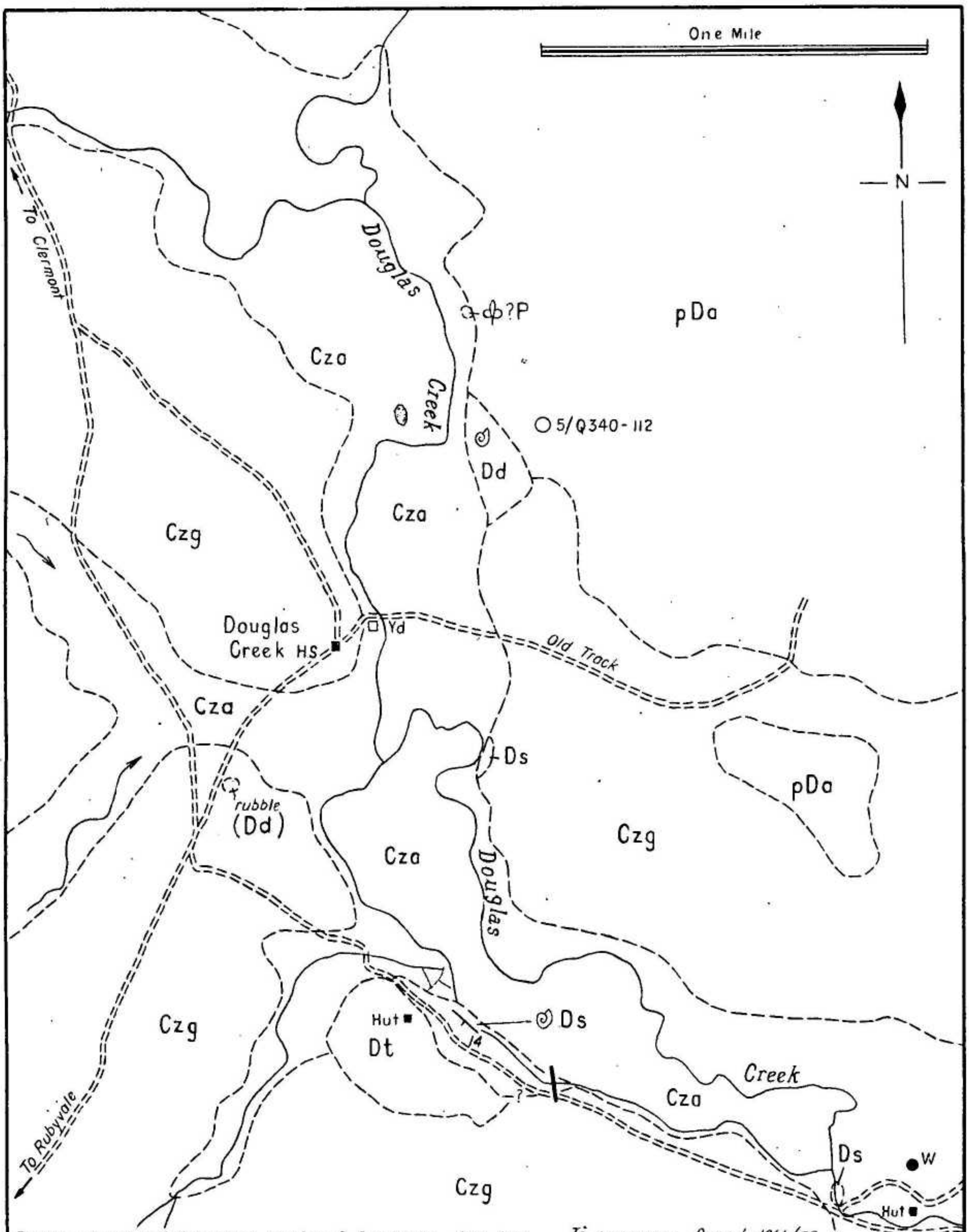
Hawthorne (1950) has suggested that the southwest extension of the Anakie Inlier may underlie the Mesozoic Great Artesian Basin to form the Nebine Ridge.

It is not yet fully understood what part the Anakie Inlier played in the folding of the rocks of the Drummond Basin. The Inlier was folded and sheared before the Middle Devonian; Hill (1951) believes that the Inlier originated at or near the end of the lower Middle Devonian. The Inlier was probably a stable block or buttress during the Upper Palaeozoic folding, against which the younger sediments were pushed. Certainly, the rocks dip off the unconformity at high angles; and in the Emerald and Springsure Sheet areas the contact is a faulted one. Parts of the Anakie Inlier were low land during the Devonian and Carboniferous. In the Douglas Creek Area a Middle Devonian marine incursion is known; and the area between Mt. Rolfe and Mt. Wilkins was probably low land during the extrusion of the Bulgonunna Volcanics (Fig.5).

The Anakie Inlier may contain several sequences infolded together, with unconformities between them. Hill (1951) reports the core to consist of gneiss and schist into which slates have been infolded. Dunstan (1902) recognised two "formations" - metamorphic rocks and slates. The variation in the grade of metamorphism of the rocks within this two-hundred mile long belt shows that the story is not merely the dynamic metamorphism of a single sequence but that it involves a large number of rock types, most of which are now covered by Palaeozoic and younger sediments.

Jensen (1921) considered these rocks to have the same lithological features as the Precambrian of the Northern Territory but nevertheless stated that they were probably of Siluro-Devonian age. Hill & Denmead (1960) discuss the Anakie Inlier in their section on the Precambrian; there is no doubt that it contains very old rocks as it had a complex history before the Middle Devonian, but there is at present no conclusive evidence for a more precise age than pre-Devonian.

Fig. 6



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DEVONIAN AND CARBONIFEROUS

Portions of three areas of Devonian and Carboniferous deposition lie within the Clermont Sheet area (Fig.5). These areas are A, the Douglas/Theresa Creeks area to the south of Clermont; B, an area extending an unknown distance east of the Anakie Inlier, and C, the Drummond Basin, west of the Anakie Inlier. Except the Douglas/Theresa Creeks area, and the area west of Mt. Wilkin, the Anakie Inlier remained stable during this period of deposition while the rest of the Sheet area subsided. This is the first known expression of the Anakie Inlier as high ground.

A. Douglas/Theresa Creeks area

Devonian marine sediments succeeded by volcanics were deposited in a subsiding area in the Anakie Metamorphics south of Clermont. The western limit of deposition is unknown because the sediments and volcanics are thrust against the metamorphics. Southward, the rocks are intruded by granitic rocks. Four units are recognised within the area.

1. Douglas Creek Limestone (Hill, 1939)

The occurrence of small outcrops of coralline limestone on Douglas Creek has been known for 75 years. The Douglas Creek Limestone is described by Rands (1886), Jack (1895), and Dunstan (1900). Etheridge (1911), Hill (1939), and Jones (1941) described the corals. Connah (1958) and Hill (in Hill & Denmead, 1960, p.144) summarized former knowledge.

Two small outcrop areas were found during the present survey (Fig.6). From the published descriptions, Hill (1939) concluded that there were four areas of outcrop. Two of these could not be located last year, and either some localities have been duplicated in the literature, or some outcrops have since been obscured by outwash or alluvium. The main outcrop, $\frac{3}{4}$-mile north-east of Douglas Creek Homestead, is a low rise, 50 yards by 200 yards, that lies at the base of steep hills of metamorphics; the other outcrop is represented by rubble, $\frac{1}{2}$-mile south-west of the homestead.

The limestone is blue-grey, fine grained, massive and well jointed, and contains abundant fossils. Areas of coarse recrystallized calcite are common, but calcite veins are rare. A few parts of the limestone contain silicified fossils, but most of the limestone contains no visible secondary silica. The petrography of a selected specimen is given on p112.

Corals and stromatoporoids are the main fossils; brachiopods, molluscs, and crinoid ossicles are rare. Hill (1939) described the rugose corals, and Jones (1941) the tabulates, which outnumber the rugose corals. Corals described by Hill and Jones include:

Acanthophyllum clermontensis Eth.
Spongophyllum cyathophylloides Eth.
Xystriphyllum dunstani Eth.
Favosites bryani Jones
F. nitidus Chapman
Alveolites suborbicularis Lamarck
Thamnopora meridionalis (Eth.) var. minor Jones
T. foliata Jones
Striatopora ? hillae Jones
S. ? plumosa Jones
Gephuropora duni Eth.
Scoliopora flexa Jones
Syringopora cf. spel.eanus Eth.

Professor Hill examined the collections made by this survey, and found the following hitherto unrecorded species:

Romeria thornii (Chapman)
Favosites goldfussi Auctt.
Xystriphyllum cf. magnum Hill
Thamnopora 2spp.

According to Hill and Jones, the corals indicate lower Middle Devonian, probably upper Couvinian.

Outwash obscures the junction between the limestone and other formations in the area. The main outcrop lies near quartz-veined quartzite of the Anakie Metamorphics, and the junction is inferred to be an unconformity. A difficulty in this interpretation is to explain the absence in the limestone of detritus derived during deposition from nearby hills of Anakie Metamorphics. The junction may of course be a fault, but the limestone seems little disturbed, and contains no quartz veins. Probably only one thick bed is exposed; the outcrop is elongated north-westward, which may be the strike, corresponding to a low dip south-westward.

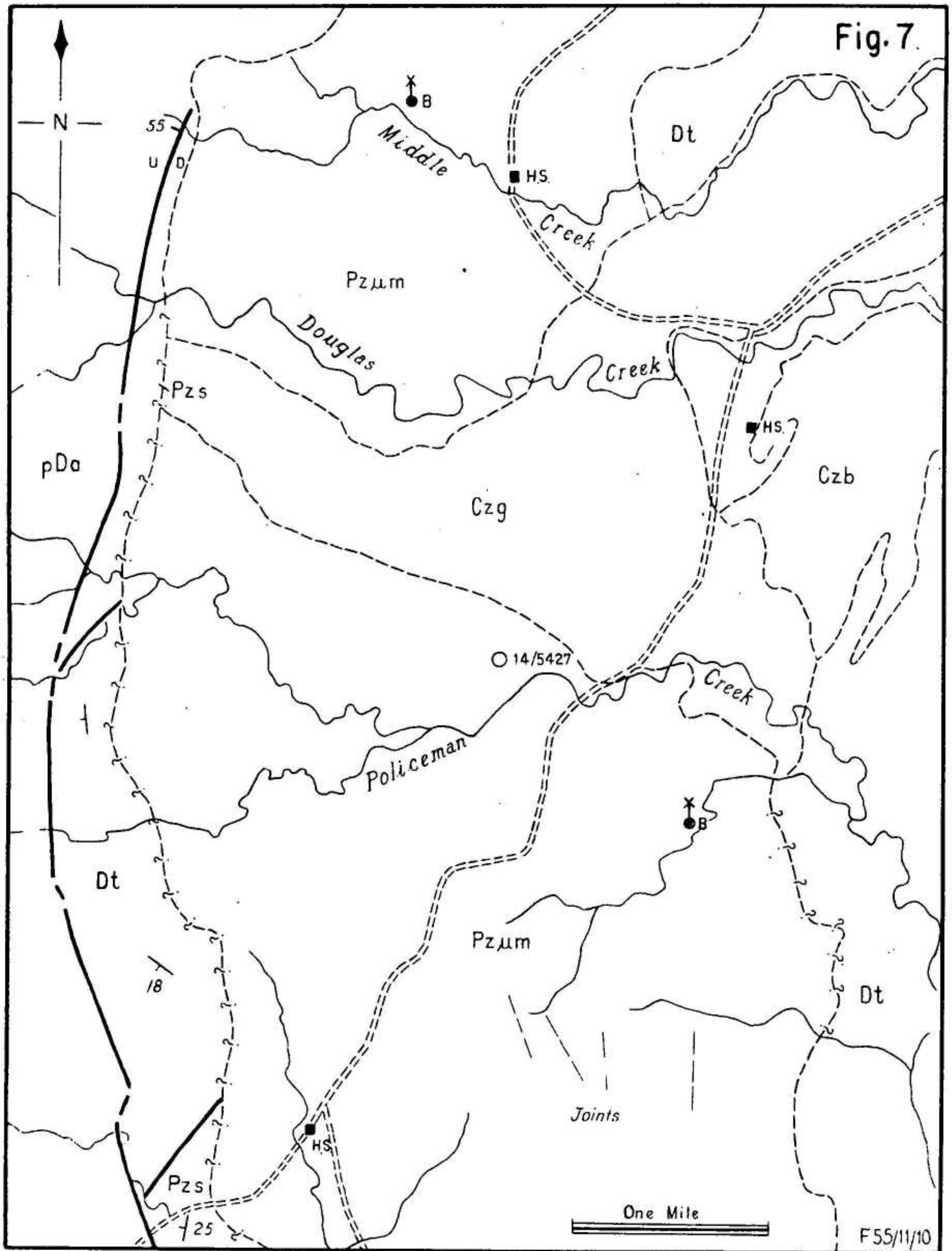
The junction between the limestone and the marine fossiliferous siltstone downstream on Douglas Creek is concealed by alluvium and gravel; according to structure, the limestone is overlain by the siltstone. The limestone and siltstone are the oldest well-dated rocks that succeed the Anakie Metamorphics in the Clermont Sheet area, and together they represent a basal marine sedimentary phase within this area.

The limestone was quarried for the production of lime of excellent quality (Dunstan, 1900).

2. Devonian Siltstone (petrography CL172 p 111)

Three outcrops of hitherto unrecorded siltstone were found in Douglas Creek south of the Douglas Creek Limestone (Fig.6). The main outcrop, about 1 mile south-south-east of Douglas Creek Homestead, is 100 feet of grey to brown micaceous siltstone, which is well bedded, with beds up to 6 inches thick. The siltstone contains brachiopods (two species of stropheodontids, one coelospirid), rare indeterminate pelecypods, gastropods, nautiloids, and crinoid ossicles. One of the stropheodontids is Leptostrophia, a genus which, according to Williams (1953), ranges in Europe and North America from the Silurian to the end of the Lower Devonian. Records, unsupported by description, of Leptostrophia in the lower Middle Devonian indicate that Leptostrophia possibly ranges higher.

A thin band of coarse feldspathic tuff is interbedded with the siltstone near its exposed top, and is probably the first product of continuing volcanism. The siltstone is overlain, apparently conformably, by massive dacite of the Theresa Creek Volcanics.



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3. <u>Theresa Creek Volcanics</u> (new name)

Volcanics are the main outcropping rock in the Douglas/Theresa Creeks area. Most of the discontinuous outcrop in this area is found in strike ridges of more resistant rock. Areas of no outcrop are probably underlain by pyroclastics and sediments.

The sequence consists dominantly of volcanic extrusive and pyroclastic rocks; sediments are minor. Most extrusives are andesite and trachyandesite; rhyolite (flow, spheroidal, breccia) and dacite are less abundant, and basalt is rare. (x For petrography of ... specimens ... see CL149 p 95, CL151C+152 p.96, CL153 p 100, 159D p 102, CL172 p103 ...)
Pyroclastics, particularly lithic varieties, crop out poorly. As already noted, large areas of no outcrop are probably underlain by fine-grained pyroclastics, which may have a greater volume than the extrusives themselves. The main types are crystal and lithic tuffs characterized by ranging amounts of pink and grey feldspar crystals. The lithic fragments include schist and extrusive volcanic rock x (for petrography see CL 149 p 94, CL 150 & 151E p 96, CL 151C p 99, CL 154 E p 100, CL 175B & 176D p 104) The rare sediments are arkose, lithic greywacke, and siltstone. x (petrography, CL 153 p 99, CL 154G p 101 & CL 185 p 105) The arkose contains up to 40% of feldspar, which was probably derived from the local disintegration of contemporaneous feldspar-rich volcanics. The greywacke and associated siltstone are well bedded, whereas the arkose is poorly bedded. The extrusives and pyroclastics are massive, and estimates of dip and thickness could not be made; nevertheless, on the air photographs, the pyroclastics have a distinctive strike pattern roughly alligned north-north-west. Structure within the Volcanics, already obscured by poor bedding, is complicated by later igneous intrusion. In the west, the Theresa Creek Volcanics are thrust at a high angle against the Anakie Metamorphics (Fig.7).

The Theresa Creek Volcanics succeed conformably Devonian marine siltstone at Douglas Creek, and elsewhere they rest directly on the Anakie Metamorphics. Except for an extensive cover of metamorphic outwash, no rocks stratigraphically overlie the Theresa Creek Volcanics, so that their upper age limit is unknown. In the related Bulgonunna Volcanics, probably the same volcanic phase persisted into the Lower Carboniferous.

4. Undifferentiated Palaeozoic sandstone and siltstone

Two fault blocks of probable Palaeozoic sediments lie on the eastern side of the thrust fault (Figure 7). The sediments are fine to medium-grained, cross-bedded, mauve calcareous arkosic sandstone, in which quartz and potash feldspar each make up 35%, and laminated chocolate micaceous siltstone. These sediments contain angular detritus up to 6 inches across, derived from the Anakie Metamorphics. Rare feldspar-rich tuff, coarse recrystallized limestone, and a course basic flow or intrusive, were also seen.

The relationship between these rocks and the Devonian sequence is not known. They are thrust against the Anakie Metamorphics - the thrust is exposed in section at the head of the southern branch of Middle Creek and dips westward at 55 degrees - and faulted against Theresa Creek Volcanics, and are truncated to the east by monzonite intrusions. We regard the sandstone and siltstone as probably part of the Devonian basal sedimentary sequence in the area.

B. Area east of the Anakie Inlier

Bulgonunna Volcanics (Malone et al., 1961)

The Bulgonunna Volcanics are a thick sequence of acid volcanics and probable freshwater sediments. Their outcrop extends southward from the Mt. Coolon Sheet area to a point 20 miles north-east of Clermont (Figs. 3 and 5). To the east, they are overlain unconformably by the Permian sequence of the Bowen Basin, and by basalt, and, to the west, lie unconformably on the Anakie Metamorphics.

Reid (1928), who described the Bulgonunna Volcanics of the Mt. Rankin area, regarded them as equivalent to the Lower Bowen Volcanics, and hence placed them within the Bowen Basin sequence. Except for Rowe's reservation (in Hill & Denmead, 1960, p.194), that 'steep dips near Fletcher's Awl suggest these beds may be older than Permian (N.C. Stevens, pers. comm.)', Reid's view of the age of the volcanics has persisted to the present.

In the Clermont Sheet area, the Volcanics crop out poorly in low strike ridges, and large areas are blanketed by Tertiary basalt and soil. Most of the sequence consists of flow and spherulitic rhyolite, dacite, and acid and intermediate pyroclastics, in part modified by sedimentary processes during deposition. A considerable amount of milky quartz is segregated in veins and in irregular masses within the rhyolite. Flow structure in the rhyolite is regular, except in the Mt. Rankin area, where areas of contorted flow occur within the generally regular flow system (Fig.8). These areas of contorted flow are probably extrusive vents.

The pyroclastics are derived mainly from acid and intermediate volcanics. They range from fine to very coarse, and grade into tough fine to medium-grained dark greywacke and olive-brown and grey siltstone. Some greywacke contains up to 50% potash and plagioclase feldspar, and 50% of volcanic rock fragments. Most greywacke contains less than 10% of quartz. The sediments are well bedded, and were probably laid down in water. The relative amounts of volcanic flows and aqueous sediments, including pyroclastics, are hard to estimate. This is due to complex depositional relationships, and to poor exposure. If the obscured parts of the sequence consist of sediments and pyroclastics, then the apparent dominance of extrusives over sediments would be reversed.

The only place where we attempted to estimate the thickness of the Bulgonunna Volcanics is the Mt. Rankin area (Fig.8) where the thickness estimated from a few dips is 16,000 feet.

Near the head of Rankin Creek (Fig.9), within the top 1,000 feet of the exposed sequence, olive siltstone contains Lower Carboniferous lepidodendroid plants. Mary E. White (Appendix B in Malone et al., 1961) provisionally identified <u>Lepidodendron</u>, <u>Lepidophyllum</u>, <u>Lepidostrobus</u> - all cf. <u>L. aculeatum</u> Sternberg - and <u>Stigmaria ficoides</u> Brong., that indicate Lower Carboniferous. The lower age limit of the Volcanics in the Clermont area is unknown, but to the north (Malone et al., 1961), (?) Upper Devonian lepidodendroids were collected near the exposed base.

The Volcanics overlie unconformably the Anakie Metamorphics to the west, and are overlain unconformably by Permian marine Middle Bowen Beds in the Mt.Lebanon-Mt.Donald area, and probably by Middle Bowen Coal Measures farther north in the Rugby area. (?) Tertiary basalt blankets much of the Volcanics, and plugs of the Peak Range Volcanics pierce them at Fletcher's Awl.

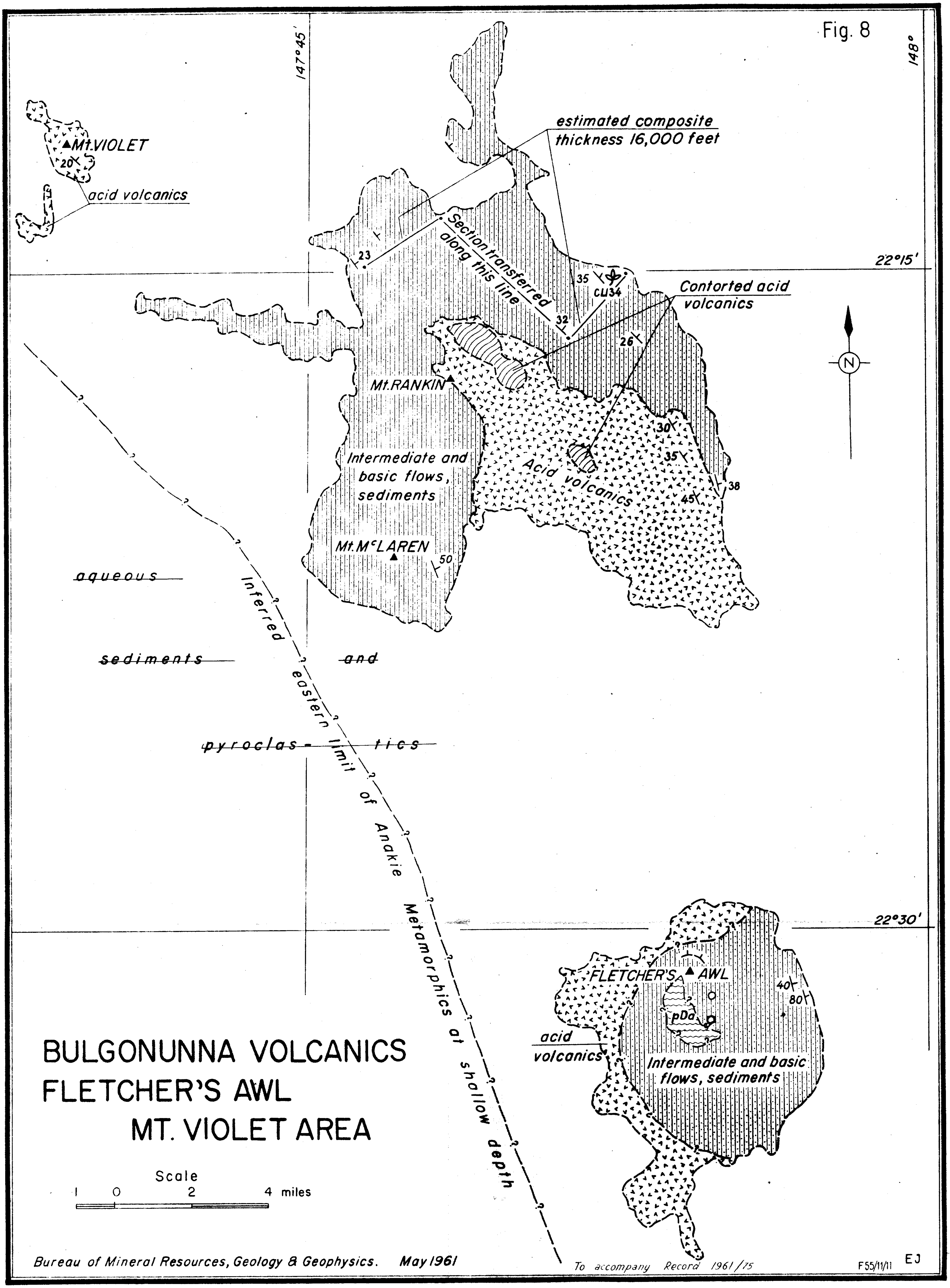
Fig. 8
147°45'
148°
22°15'
22°30'
estimated composite
thickness 16,000 feet
Mt.VIOLET
acid volcanics
Section transferred
along this line
Contorted acid
volcanics
Mt.RANKIN
Intermediate and
basic flows,
sediments
Acid volcanics
Mt.McLAREN
N
aqueous
sediments
and
pyroclas-tics
Inferred eastern limit of Anakie Metamorphics at shallow depth
FLETCHER'S AWL
pDa
acid
volcanics
Intermediate and basic
flows, sediments
BULGONUNNA VOLCANICS
FLETCHER'S AWL
MT. VIOLET AREA
Scale
1 0 2 4 miles
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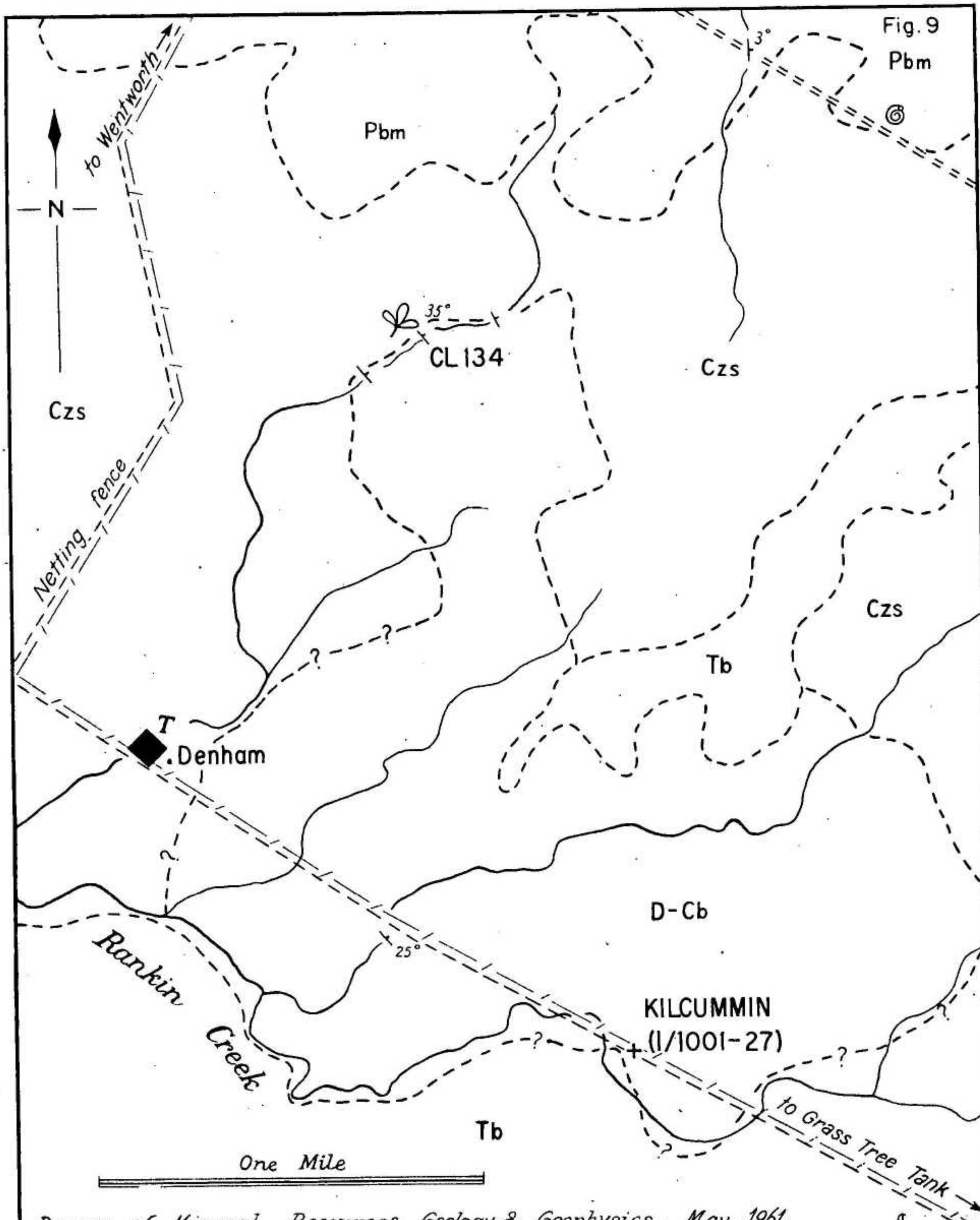

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F55/11/12

In the area east of Mt. McLaren and Mt. Violet (Fig.8), the Volcanics dip north-north-eastward from 20 to 50 degrees. Contorted fine-grained sediments at Mt. McLaren may be slumps. The Volcanics, west of Mt. McLaren and Mt. Violet, have low dips, and they probably rest on a broad shallow platform of Anakie Metamorphics (Fig.5).

C. <u>DRUMMOND BASIN</u>

<u>Drummond Beds</u> (Jack, 1892)

The Drummond Beds of the Drummond Basin ~~that~~ occupy the western portion of the Sheet area and comprise acid volcanics overlain by freshwater conglomerate and plant-bearing quartz sandstone, siltstone and greywacke. The maximum estimated thickness is 20,000 feet. The Drummond Beds overlie unconformably the Anakie Metamorphics; their top is not preserved. The beds are folded into a broad syncline that strikes north-north-west, and, immediately west of the Sheet area, into an elongate dome. The Clermont Sheet area embraces a small part only of the Drummond Beds, which, according to Tweedale (in Hill & Denmead, 1960, p.145, fig.25), extend 80 miles north, and 90 miles south of the Sheet area.

The name Drummond Beds was first used by Jack (in Jack & Etheridge, 1892) for the rocks of the Drummond Range, including those at Bogantungen, whence Tenison Woods (1883a,b) and Etheridge (1891) determined <u>Lepidodendron</u> sp.; Jack regarded the rocks as "Carbonifero-Permian". Reid (1930) extended the known outcrop of these rocks, and referred to them as the "Drummond Series" of Upper Devonian to Lower Carboniferous age. Shell Queensland Development (S.Q.D., 1952) divided the Drummond Beds of the Springsure Sheet area into five formations, two Devonian and three Lower Carboniferous. Hill (1957) used the term "Drummond Series", but restricted it to include only those formations which Shell regarded as Lower Carboniferous. Tweedale (in Hill & Denmead, 1960, 145-147,175-177), recently summarized present knowledge of the Drummond Basin.

The various formations in the Drummond Basin mapped by Shell in the Springsure area cannot yet be traced northward into the Clermont Sheet area, because the lithology and detailed structure of the rocks in the intermediate Emerald Sheet area are not precisely known. A joint

BANCHORY Q225-122 RUN 5

SCALE

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Figure 10. On the west, dip slopes of conglomerate on the eastern flank of the Narrien Range; on the east, low strike ridges of less resistant rock. Reproduced with the permission of the Lands Department Brisbane.

Figure 11. Looking south along the Narrien Range - an asymmetrical dome.

Figure 12. (?) Gas bubbles in tuff, Eastern Creek.

Figure 13. Agglomerate exposed in Eastern Creek. The hammer handle rests against a boulder of rhyolite set in the agglomerate. The light rock in the centre is a boulder of sheared mica schist.

Bureau-Queensland Geological Survey party will map the Emerald Sheet area in 1961, and their work should provide a basis for identification of the various formations of the Drummond Basin in the Clermont, Emerald and Springsure Sheet areas. We therefore defer relating the Clermont and Springsure rocks until this work is done.

The Drummond Beds occupy a belt, 15 to 20 miles wide, on the western portion of the Sheet area, but are well exposed, in dip slopes, strike ridges, and low scrub-covered rises, in the south-west quadrant only (Figs.10,11); farther north, widespread Cainozoic deposits cover the entire area except for gently undulating sandy rises and small hills.

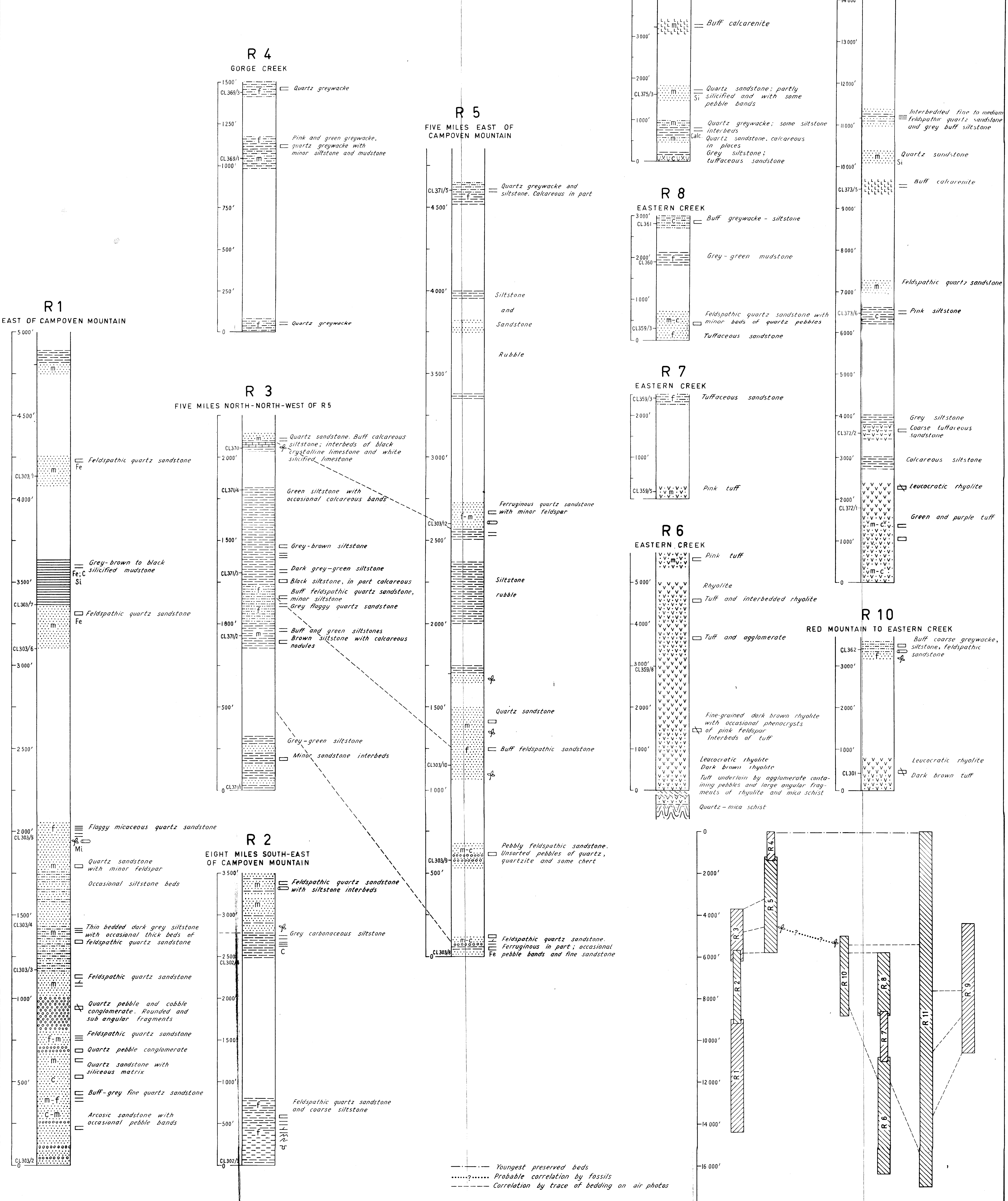
The variable lithology of the Drummond Beds in the south-west quadrant of the Sheet area is shown in Plate 2. The sequence is folded into a broad syncline; the western limb is represented by columns R1 to R5, and the eastern limb by R6 to R11. The lower portion of Section R1 is measured on the eastern limb of the Narrien Range Dome immediately west of the Sheet area. The lowermost beds on the western limb of the syncline are medium-bedded arkose and medium to thick-bedded quartz sandstone with pebble bands and interbedded fine quartz sandstone, overlain by a massive quartz pebble and cobble conglomerate, which constitutes the dip slopes of the Narrien Range (Fig.10 & 11). The conglomerate is succeeded by massive to medium-bedded quartz sandstone with minor lenses of dark grey siltstone (Plate 2,R1), and interbedded sandstone, siltstone, mudstone, and greywacke. Plants occur throughout the section, but determinable specimens were found at localities CL 302/4 (off the Sheet area) and CL 303/10 only.

The basal rocks on the eastern limb of the syncline are an acid volcanic suite of interbedded crystal tuff and rhyolite overlain by tuff and tuffaceous sandstone. These rocks overlie unconformably the Anakie Metamorphics. At locality CL 359/12 on Eastern Creek, interbedded rhyolite, tuff, and agglomerate overlie sheared mica schist, quartz mica schist, and hardened siltstone; the agglomerate contains angular pebbles, cobbles, and boulders of rhyolite and sheared rocks (Fig.13). In places, the volcanics contain large vesicle-like cavities formed presumably by bubbles of escaping gas (Fig.12). The acid volcanic suite is overlain,

DRUMMOND BEDS

SECTIONS MEASURED ON BANCHORY ONE-MILE AREA

SECTIONS R1 TO R5 MEASURED ON WESTERN SIDE OF BASIN
SECTIONS R6 TO R11 MEASURED ON EASTERN SIDE OF BASIN



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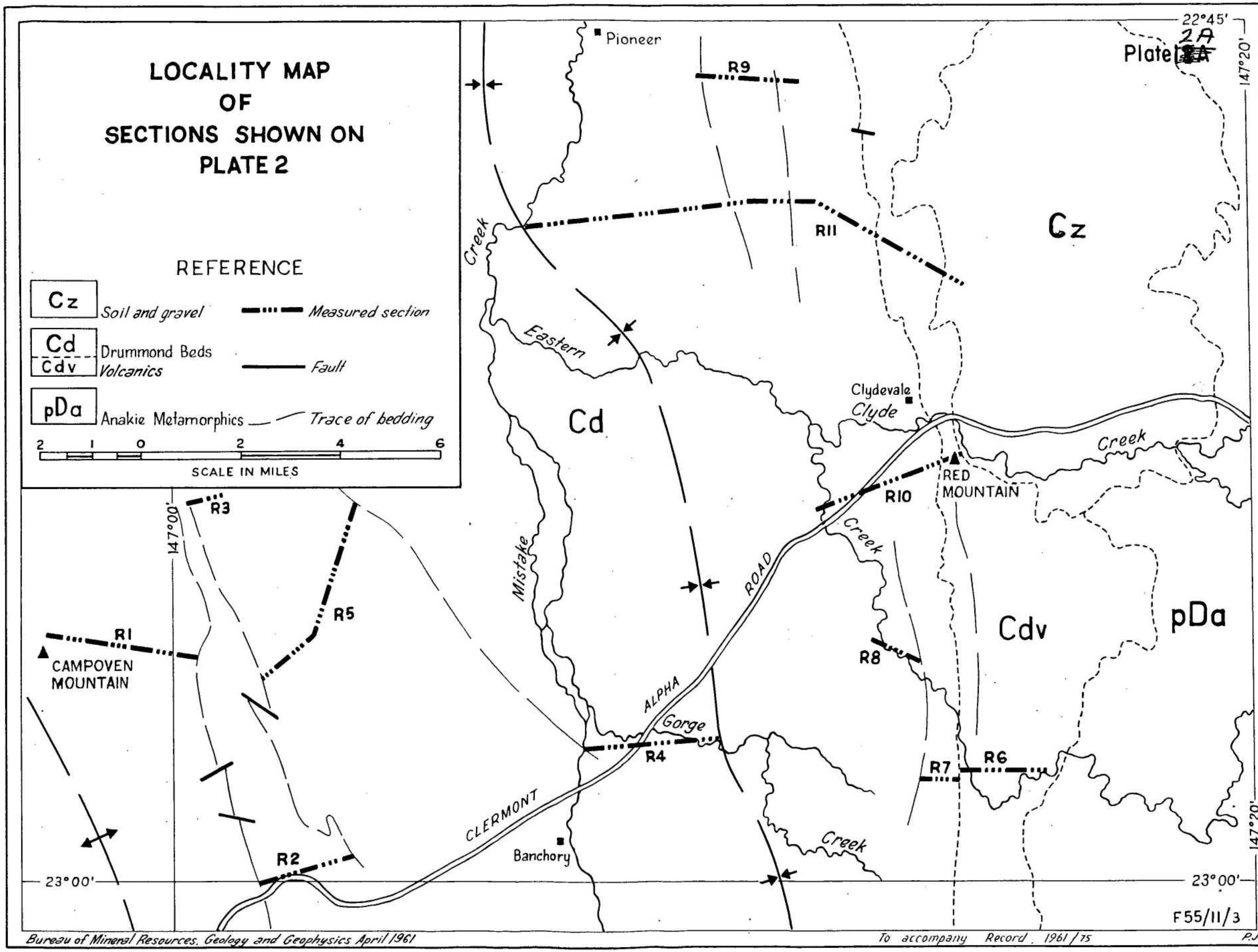


Bureau of Mineral Resources, Geology and Geophysics April 1961

To accompany Record 1961/75

P.J.B.

apparently conformably, by interbedded sandstone and siltstone similar to the rocks in the upper portion of the western sequence.

Poor outcrop in parts of the sequence prevents accurate measurement of the thickness of the Drummond Beds. The stratigraphic columns in Plate 2 were compiled with the aid of measured dips and large-scale air photographs; gaps in the columns are due to poor outcrop. In estimating the thickness of poorly exposed beds, we have assumed a direction and amount of dip consistent with the enclosing exposed beds. The sections on the east and west limbs of the syncline have thus been extended to outcrops of flat-lying rocks that, lying on the axis of the syncline, are the preserved top of the sequence. As already noted, the Drummond Beds have a clear strike pattern on air photographs, and beds were thus traced between section lines, which were chosen in places of simple structure. The results of the measurements are that sections R1 to R5, on the western limb of the syncline, indicate 14,000 feet, and sections R6 to R11, on the eastern limb, 20,000 feet.

The syncline extends north-westward into the Buchanan Sheet area, where it is covered by Cainozoic deposits. Immediately west of the Sheet area, an elongate dome has been carved by erosion into the rugged Narrien Range. Numerous broad folds occur southward, in the Emerald Sheet area. Within the broad syncline of the Clermont Sheet area the rocks are locally folded with minor faulting into small domes and basins.

Fossils from CL 362, 2,000 feet stratigraphically above the volcanics at Red Mountain (Plate 2, R10), were identified by Mary E. White (Appendix B in Malone et al., 1961) as Lepidodendron sp., and Stigmaria ficoides. S. ficoides was also found east of Campoven Mountain (R5, CL 303/10). An indeterminable, but probably the same, species was found in quartz sandstone at CL 302/4, which lies just outside the Sheet area on the Clermont - Alpha road, 4 miles south-west of Mistake Creek. The association of S. ficoides with Lepidodendron indicates Carboniferous. The plant locality at CL 362 is at least 6,000 feet above the exposed base of the volcanics, which points to the possibility that part or all of the volcanics extend downward into the Upper Devonian.

The main outcropping rocks north of the well-exposed Drummond Beds in the south-west quadrant are volcanics. In the south-west quadrant, volcanics extend in unbroken outcrop from Clydevale to Vanguard Creek, east of Monteagle Homestead, which marks the northern extent of good outcrop. Farther north, they are exposed in isolated low hills and ridges. The most prominent of these, Mt. Rolfe, consists of porphyritic rhyolite. (petrography C1195 p113). The Drummond sediments 5 miles north of Malang Homestead are intruded by dykes of lamprophyre. (petrography C1189 pp114,115) East of Mt. Rolfe, isolated outcrops of rhyolite and other volcanics, tentatively identified as Bulgonunna Volcanics, probably provide a link between the Bulgonunna Volcanics and the volcanics of the Drummond Beds.

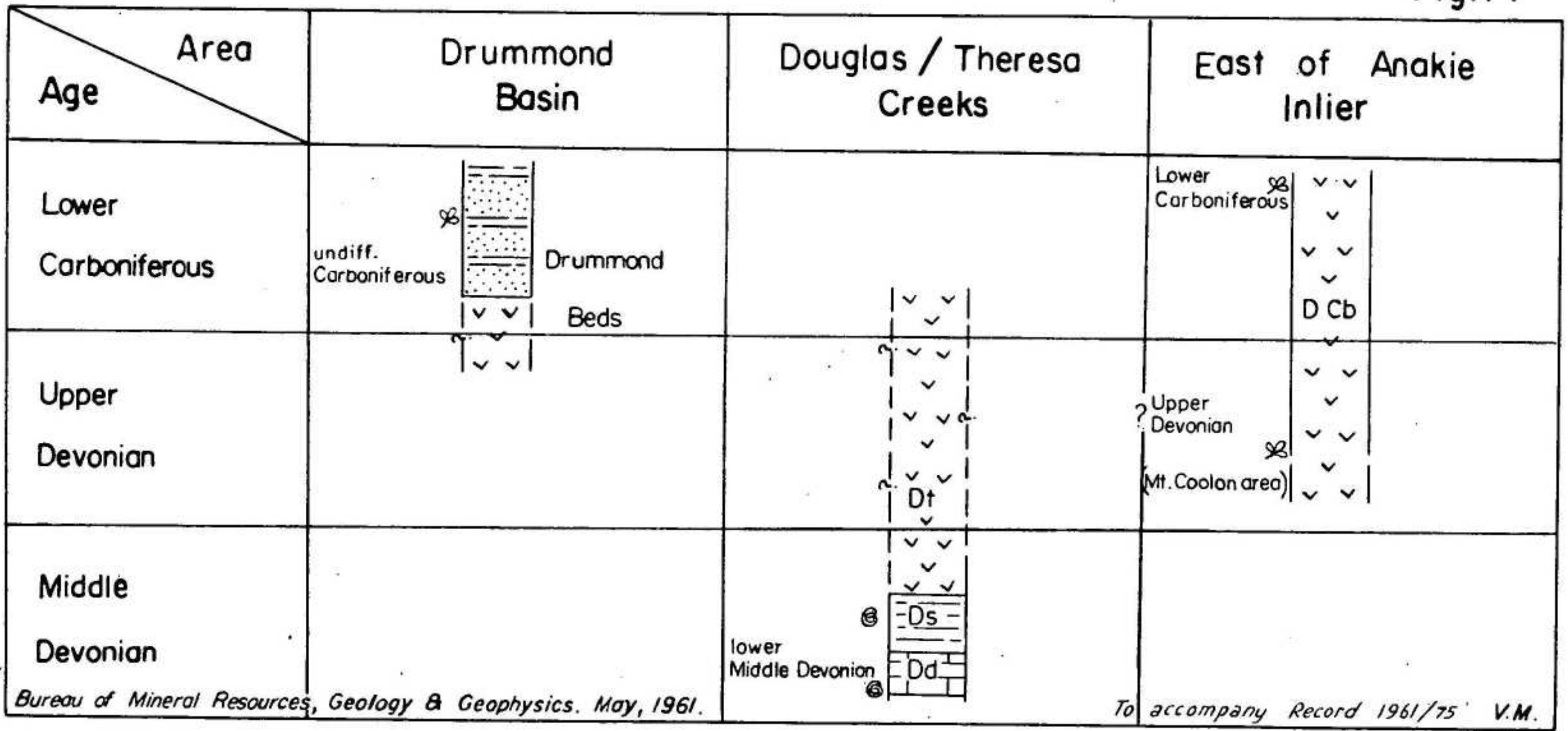
Summary

Residuals of volcanics on the Anakie Inlier, which separates the three areas of Devonian-Carboniferous rocks, indicate that these areas were probably connected during at least part of their depositional history. On that part of the Anakie Inlier that lies between the Douglas - Theresa Creeks area and the outcrop of the Bulgonunna Volcanics, a small outcrop of coarse green agglomerate on the western side of Sandy Creek (Dt, in Fig.5) lies unconformably on the Anakie Metamorphics; * ~~Farther south, immediately south of the Clermont Sheet area boundary, a larger outcrop has been interpreted from the air-photographs as similar rock dipping steeply eastward off Anakie Metamorphics~~. A second link, this time between the Bulgonunna Volcanics and the volcanics at the base of the Drummond Beds, is probably indicated by the isolated outcrops of porphyritic rhyolite that rest on the Anakie Metamorphics between the Northern Inland Highway and Mt. Wilkin.

In the Clermont Sheet area deposition probably took place in the three areas during various parts of the interval Middle Devonian to Lower Carboniferous; during at least part of this interval, the three areas were probably connected. In the Douglas - Theresa Creeks area, the oldest deposits are Middle Devonian shallow marine limestone and siltstone, succeeded by intermediate and acid volcanic rocks. These volcanic rocks are probably equivalent to the lower part of the Bulgonunna Volcanics,

* now known to be Permian

Fig. 14



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CORRELATION CHART OF DEVONIAN AND CARBONIFEROUS ROCKS, CLERMONT SHEET AREA which, north of the Sheet area, contain ?Upper Devonian plants. The acid volcanics that appear higher in the Bulgonunna Volcanics are probably equivalent to the basal acid volcanic rocks of the Drummond Beds, and the sediments near the exposed top of the Bulgonunna Volcanics were deposited probably at the same time as the sediments of the Drummond Beds. These relationships are summarized in Figure 14.

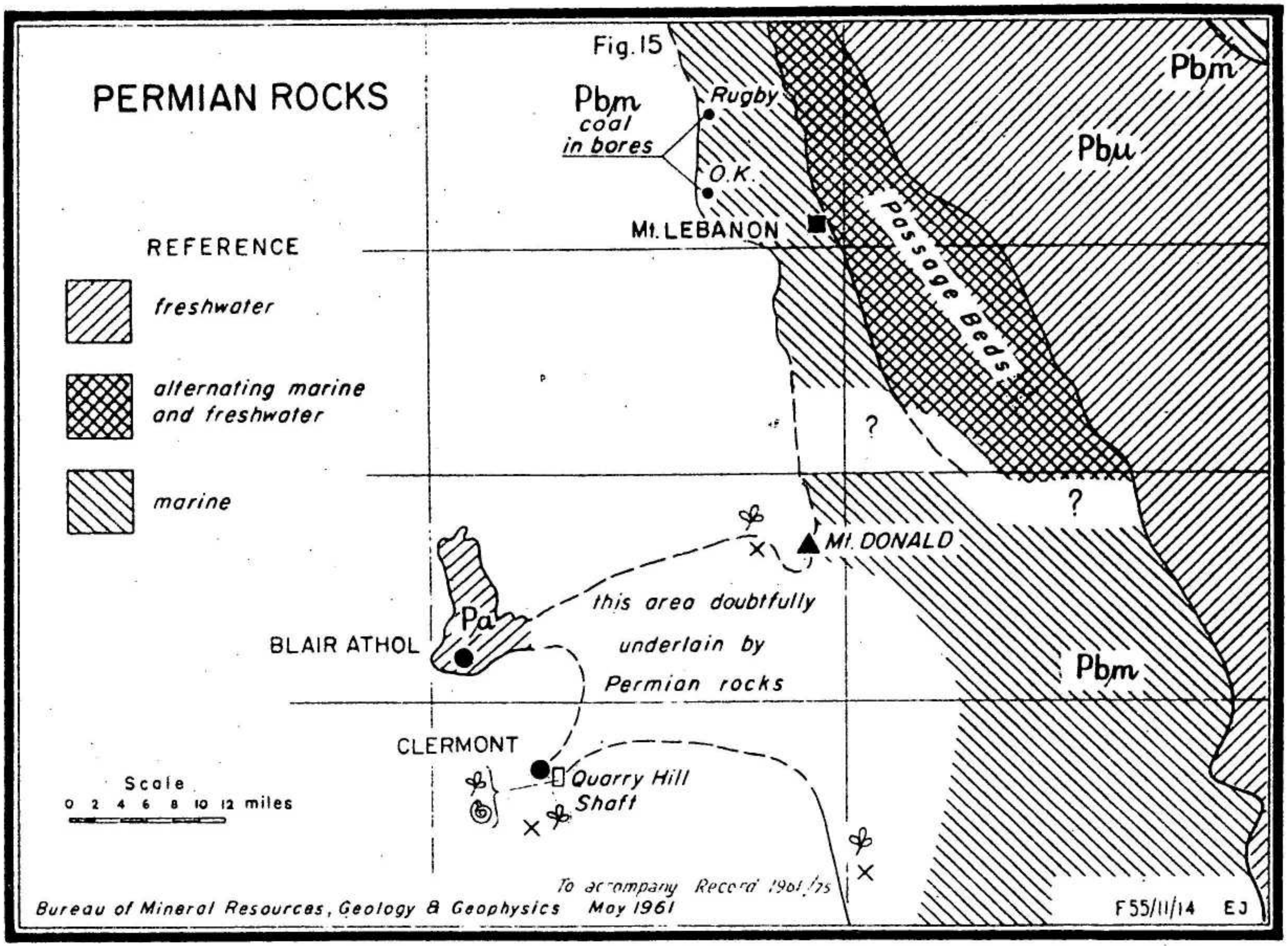
Fig. 15
PERMIAN ROCKS
REFERENCE
freshwater
alternating marine and freshwater
marine
Pbm
coal in bores
Rugby
O.K.
Mt. LEBANON
Passage Beds
Pbm
Pbu
?
?
Mt. DONALD
this area doubtfully underlain by Permian rocks
Pa
BLAIR ATHOL
Pbm
CLERMONT
Quarry Hill Shaft
Scale
0 2 4 6 8 10 12 miles
To accompany Record 1961/75
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PERMIAN

Introduction (Fig. 15)

The known Permian rocks of the Clermont Sheet area are a sequence, from the base upwards, of coal measures (equivalent to the Collinsville or Middle Bowen Coal Measures), the Middle Bowen Beds of marine quartz greywacke, greywacke, and siltstone alternating in the upper part with freshwater greywacke, siltstone, and thin coal seams, and the Upper Bowen Coal Measures of freshwater lithic sandstone, greywacke, mudstone, and coal seams. In the south-eastern part of the area the Middle Bowen Beds are marine throughout. The exposed Middle Bowen Beds are estimated to range from 1,000 to 2,000 feet thick, and the exposed Upper Bowen Coal Measures to be at least 3,500 feet thick. The Lower Bowen Volcanics, which lie beneath the Middle Bowen in the eastern limb of the syncline, are not known in the Clermont Sheet area. West of the main outcrop, the Blair Athol Coal Measures occur in an isolated basin, and marine and freshwater rocks are cut by a shaft at Clermont.

The coal measures at the base of the Permian sequence are known from the records of two, possibly three, water bores only (Rugby, O.K. Bores; possibly the Cherwell Bore); the Middle and Upper Bowen Beds are extensively exposed in the eastern third of the Sheet area but their westward extension is obscured by basalt and thick soil, and, besides small outcrops, they are known only in water bores, shafts, and open-cut mines. The base of the sequence is known in three areas: in the Mount Lebanon/Mount McDonald area, where marine rocks rest unconformably on Bulgonunna Volcanics; at Clermont, where probably equivalent marine rocks rest on Anakie Metamorphics; and at Blair Athol, where undifferentiated Permian coal measures rest unconformably on Anakie Metamorphics. Evidence drawn chiefly from the log of the A.F.O. Cooroorah No. 1 Well, which lies 15 miles east-south-east of the south-east corner of the Sheet area, suggests that Permian rocks older than those known at these unconformities underlie at least part of the known area of Permian rocks. This suggestion of older Permian rocks in the area cannot be developed further other than by geophysical methods or by boring, and consequently this account deals solely


A
A.F.O. Cooroorah
No I.
Crocker Fm
Maria Formation
Siltstone
Sandstone
Siltstone
Volcanic and intrusive rocks
C Mi Kl 'coaly section'
Mi C
Calc Py
crinoid plates
Mi
Calc Py
Spores
Calc
Mi Py
Py Calc
volc tuff
breccia
diorite
acid volcanics
T.D. 3523
B
Composite Diagrammatic
Section Peak Downs
I-Mile Sheet Area
Upper Bowen Coal Measures
Middle Bowen Beds
Coal
C Mi
Pelecypods
Pelecypods
Pelecypods
Pelecypods
Pelecypods
clarkei bed
exposed base
C
Composite Section
Grass Tree Tank Area
(see fig. 18)
Top of section
rare blocks
pelecypods
CL 12/1
Clarkei bed
brachiopods corals bryozoans
Blocks and pebbles of metamorphics and volcanics.
CL 12 2 CL 132
scattered pelecypods and gastropods
CL122 (gastropods) pelecypods
scattered pelecypods and gastropods
Bulgonunna Volcanics
Blocks of locally derived volcanics; pebbles and grit of milky quartz
Purple tuffs
D
Quarry Hill Shaft, Clermont
(Dunstan 1900)
Si('billy')
Mi
Coal bands
W
Boulders of granite, schist
Fe
509 (bottom)
E
Composite Section
Soraji-Lake Vermont
Homestead
L Vermont Hsd CL56
this interval not measurable but probably 200 feet
CL 21/6
Tay Glen Crossing
(Martiniopsis)
Mi C
Calc
pelecypods
clarkei bed probably 50 feet below base of section
F
RUGBY BORE
(Reid, 1928 P. 239)
NO DETAILS
W "chalk"
coaly
coaly
coaly
T.D. 471
G
CHERWELL BORE
blue grey
blue, hard grey
grey and blue
3' coal
black and grey
10' coal
cream and grey 'concrete'
'dark volcanic rock'
T.D. 457
H
Clarkei bed
Feez Creek
(41/11)
pelecypods gastropods bryozoans
S. clarkei
Mi C
I
Upper Bowen Coal Measures
near Booroondara Hsd
(27/3)
No Outcrop
pebbles of quartzite, other metamorphics.
C Mi
J
Upper Bowen Coal Measures
near Picardy Hsd
53/3
flows or sills
Measurements in feet

Fig.16

with those Permian rocks disclosed by natural exposure or by shallow bores, shafts, or open-cut mines. Mary E. White (Appendix B, in Malone et al, 1961) has determined plant fossils, which were found in the Middle Bowen Beds, in the Upper Bowen Coal Measures, and in isolated outcrops.

Marine fossils (Dickins, Appendix 2) include brachiopods, pelecypods, gastropods, corals, crinoid ossicles, and they indicate that the marine beds of the Clermont Sheet area are equivalent to or younger than the Ingelara Shale in the Bowen Basin, or the Maitland Group in the Sydney Basin. Dickins correlates the clarkei-bed with the Big Strophalosia Bed of Collinsville. The older Permian beds below equivalent strata in the Mount Coolon Sheet area are not represented in the Clermont Sheet area.

No new classification of the Permian sequence is attempted. Except for a few minor changes, we follow Reid (1928, p.193), who divided the sequence into:

Upper Bowen Coal Measures

Passage Beds

Middle Bowen Marine Series

Middle Bowen Coal Measures

Lower Bowen Volcanics

~~Our~~ The main advance beyond Reid's work is to show that the volcanics in the Clermont Sheet area mapped by Reid as Permian (Lower Bowen Volcanics) are Lower Carboniferous (Bulgonunna Volcanics), and that the Passage Beds probably interfinger to the south with marine rocks.

Rowe (in Hill and Denmead, 1960, pp.194-195) subdivided the Middle Bowen Marine Series into "Pre-Clarkei Sandstones," "Clarkei Bed," and "Post-Clarkei Formation." Of these, ~~we retain~~ the term "Clarkei Bed." is retained.

Collinsville or Middle Bowen Coal Measures.

The oldest known Permian rocks in the area are the coal measures cut by the Rugby bore (Fig. 16F) (Reid, 1928). The Rugby Bore lies in an area of black soil, and the relationship between the bore section and the nearest exposed rocks can only be inferred. First, on structural grounds, the bore section is believed to lie beneath the

Permian marine rocks to the south and east, because they dip regionally to the east, and no evidence was found in this area to suggest faulting or reversal of dip. Secondly, at the head of Sullivans Creek, in the Mt. Coolon Sheet area, north-north-west of the Rugby bore along the regional strike, Reid (1928, p.240) found sandstone that he identified as Collinsville Coal Measures. This sandstone lies between rhyolite (Bulgonunna Volcanics) and marine Permian beds. Reid (1928, p.239) found "ferruginous sandstone with Linoproductus farleyensis, Fenestella fossula, etc." 2 to 3 miles east of the Rugby Bore; these rocks, which were not seen, are probably exposed in the bed of Grosvenor Creek. The interval separating the coal seam in the bore from the only reliable stratigraphical marker in the area, the clarkei-bed, is not known; if the "fossil shells" recorded 141 feet above the coal seam in the bore are the widespread Permian fossils of the clarkei-bed or of adjacent strata, and not Cainozoic fresh-water shells, then the coal seam and the clarkei-bed occupy similar relative positions as equivalent beds (the top seam of the Collinsville Coal Measures and the Big Strophalosia Bed) at Collinsville.

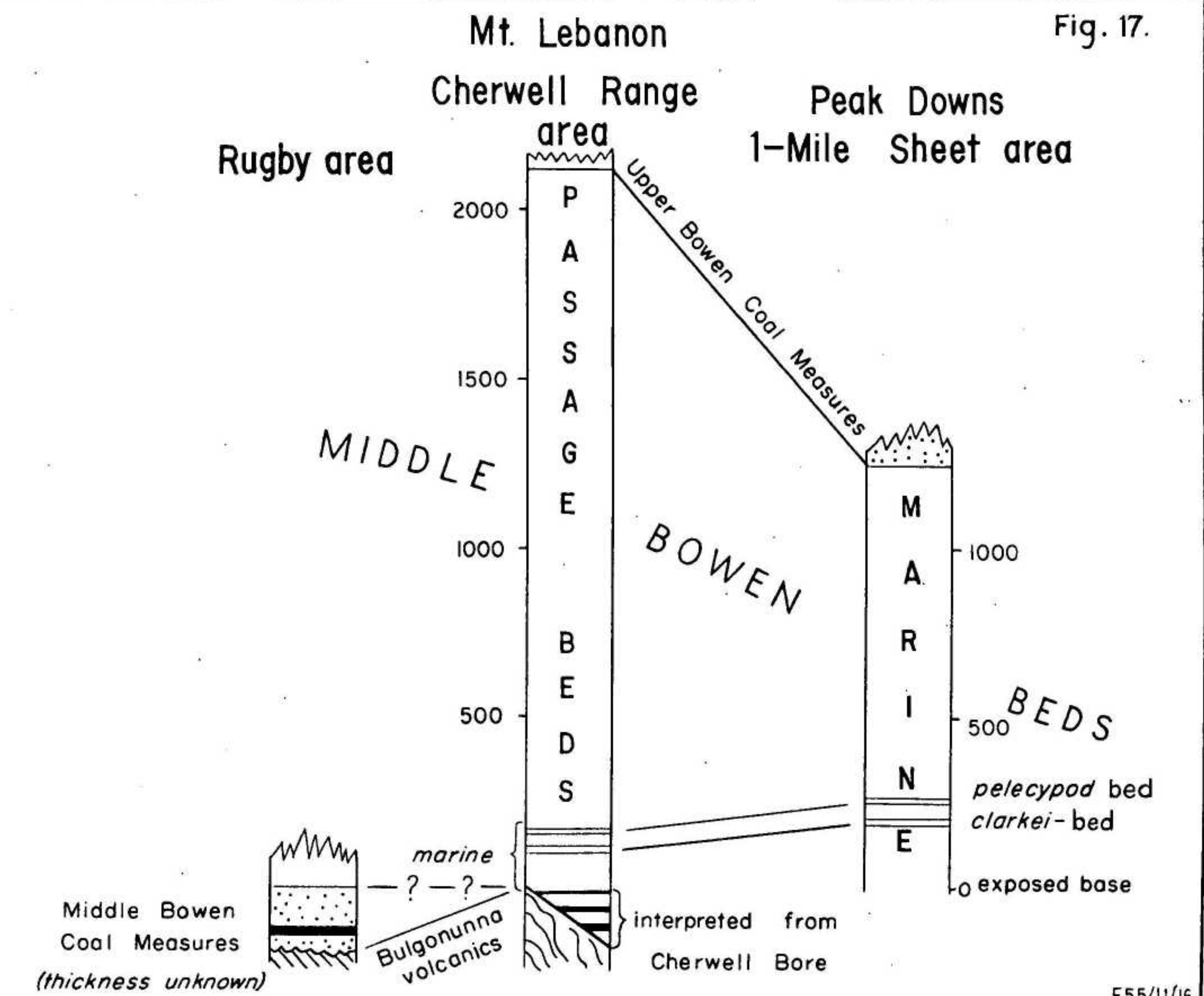
Reid suggested that "a width of 200 yards of iron-stained shales and sandstones in the Denham Range, Logan Downs, between the basal marine and glacial sandstones and the Lower Bowen rhyolites" belong to the Collinsville Coal Measures; the shale and sandstone which dip 30° eastward, are now known to belong to the Bulgonunna Volcanics.

Reid also referred the "freshwater beds of Cluen, Peak Range, underlying the marine series" to the Collinsville Coal Measures, but presented no evidence.

The Collinsville Coal Measures therefore are probably not exposed in the Clermont Sheet area, and further information will probably come only as the result of drilling. Whether the failure of the Collinsville Coal Measures to crop out at the edge of the basin is due to overlapping younger Permian rocks will be discussed later.

In the Rugby area, the only other bore from which coal is recorded is the O.K. Bore, about 5 miles south of the Rugby Bore. The driller's log is:-

Fig. 17.



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0-3 feet	loose rock and sand
3-97	white sand and sandstone
97-101	coal shale
101-148	red sandstone
148-213	coal shale
213-220	red sandstone
220-225	coal shale
225-263 (total depth)	white rotten sandstone

If the "coal shale" at 97 feet is authentic, the Collinsville Coal Measures at this place are at least 166 feet thick. The possibility that the Cherwell Bore cut the Collinsville Coal Measures is discussed below.

Middle Bowen Marine Beds

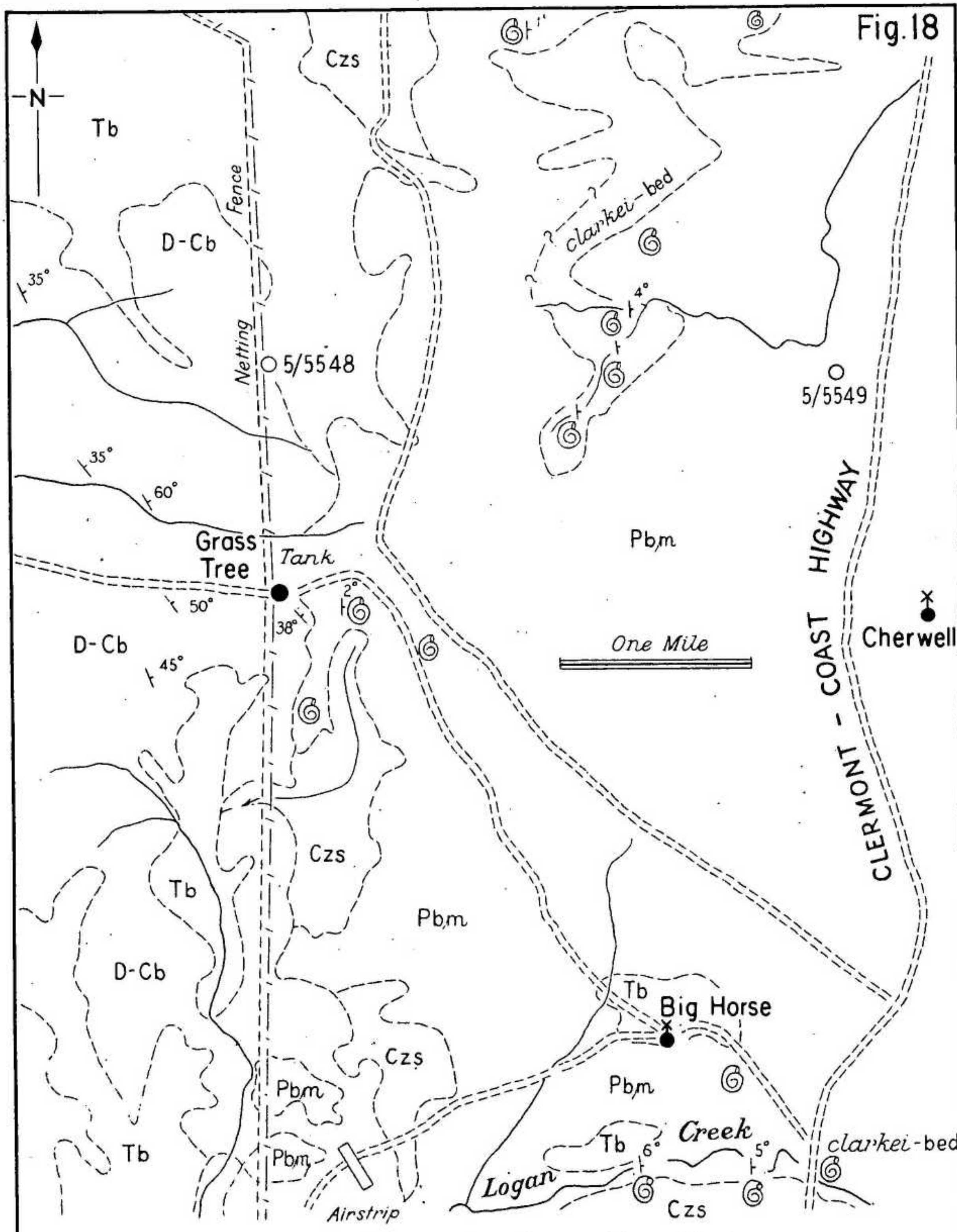
In the northern part of the main Permian outcrop, in the Mount Lebanon/Mount Donald area (Fig. 17), the Middle Bowen Beds rest unconformably on the Bulgonunna Volcanics. As already noted, farther north, in the Rugby area, the Middle Bowen Beds rest, probably conformably, on the Collinsville Coal Measures. In the southern half of the main outcrop, the base of the Middle Bowen Beds is not exposed. In the main outcrop, the Middle Bowen Beds are overlain conformably by the Upper Bowen Coal Measures. These relationships are shown in Fig. 17.

The main differences between the Permian Sections in the north and south are:

1. In the north, the local base of the Middle Bowen Beds rests unconformably on Devono-Carboniferous rocks, or conformably on Collinsville Coal Measures, whereas in the south, equivalent rocks are the oldest exposed, and the underlying rocks are unknown. Drilling is the only way to find out about the underlying rocks.

2. In the north, the Middle Bowen Beds comprise thin basal marine beds succeeded by thick alternating marine and freshwater beds (the "Passage Beds" of Reid), whereas in the south, the section is probably marine throughout.

The oldest known exposed Permian rocks in the Sheet



Unconformity in Grass Tree Tank area.

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area are the fossiliferous quartz greywacke that lies above the unconformity near Grass Tree Tank (Figs. 18, 16C), and the quartz greywacke and siltstone exposed beneath the clarkei-bed in Shell and Tomahawk Creeks, and in the core of the Norwich Dome, in the south-eastern part of the Sheet area. These rocks have the same variability as those that overlie the clarkei-bed; in the core of the Norwich Dome, at CL 47/10, a coarse-grained quartz greywacke contains pelecypods and a martiniopsid brachiopod. The clarkei-bed, as first pointed out by Rowe (in Hill and Denmead, 1960, p.194), persists over a wide area, and hence is an excellent marker for mapping. The clarkei-bed is widely exposed in the south-eastern quadrant of the Sheet area and in the Mt. Lebanon/Splitters Creek area. It is also exposed on the flanks of Mt. Donald, and penetrated by the Quarry Hill shaft at Clermont. In the Mt. Lebanon/Splitters Creek area, the clarkei-bed is a shelly quartz greywacke with erratics that is exposed in long closely-jointed pavements in the beds of water-courses, and in the sides of low mesas. Three parts in the section above the unconformity in this area (fig. 16C) contain blocks and boulders. The first boulder bed is immediately above the unconformity, and contains blocks of volcanics, and pebbles and grit of milky quartz, both derived from the underlying Bulgonunna Volcanics; the second boulder bed is the clarkei-bed itself, which contains angular to rounded pebbles and boulders of dacite, other acid volcanic rocks, including flow-banded rhyolite, and quartzite, quartz schist, milky quartz, phyllite, biotite schist, and, doubtfully, granite. At locality 132/2 a rock pavement 20 feet long and 15 feet wide contains the following boulders:

Type of Rock \ Diameter	3" - 1'	1' - 3'	> 3'
quartz schist	12	1	1
milky quartz	5	-	-
blue-grey phyllite	3	2	-
dacite	2	-	-

Pebbles between ½-inch and 3 inches across have the same composition and abundance. The milky quartz is well rounded, the phyllite

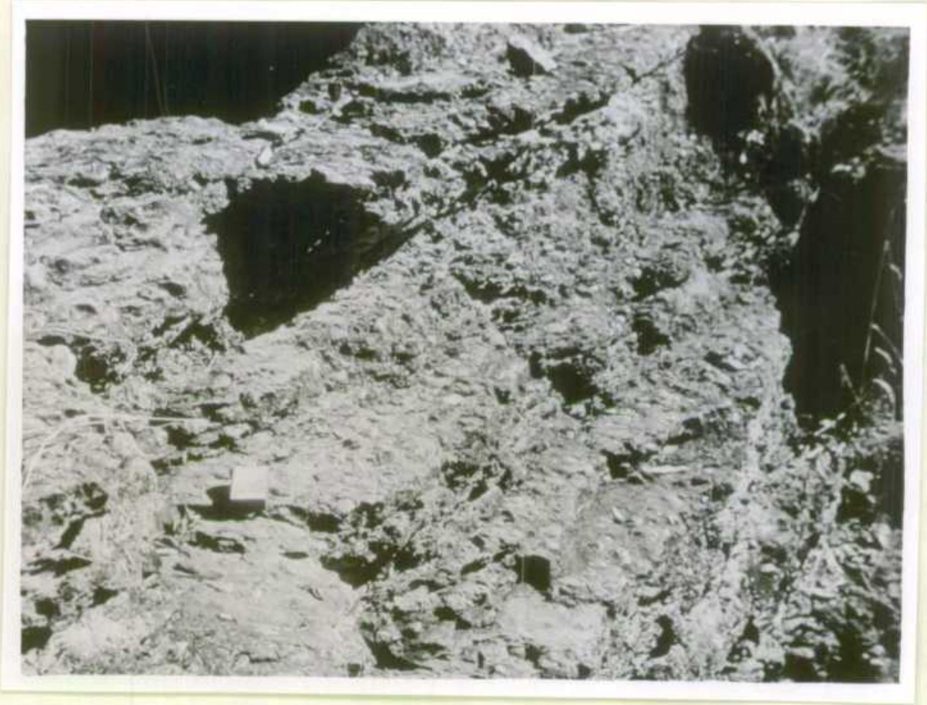


Figure 19. Clarkei-bed, Feez Creek. Scale indicated by match-box.

and quartz schist angular, their faces corresponding to joints and cleavage. Pebbles and boulders occupy about 10% of the area of the rock pavement, but their distribution is patchy. They are not concentrated in layers, but the long axes of boulders lie parallel to the bedding.

At locality 12/1, the largest block observed was a roughly tetrahedral block of quartzite 5 feet across.

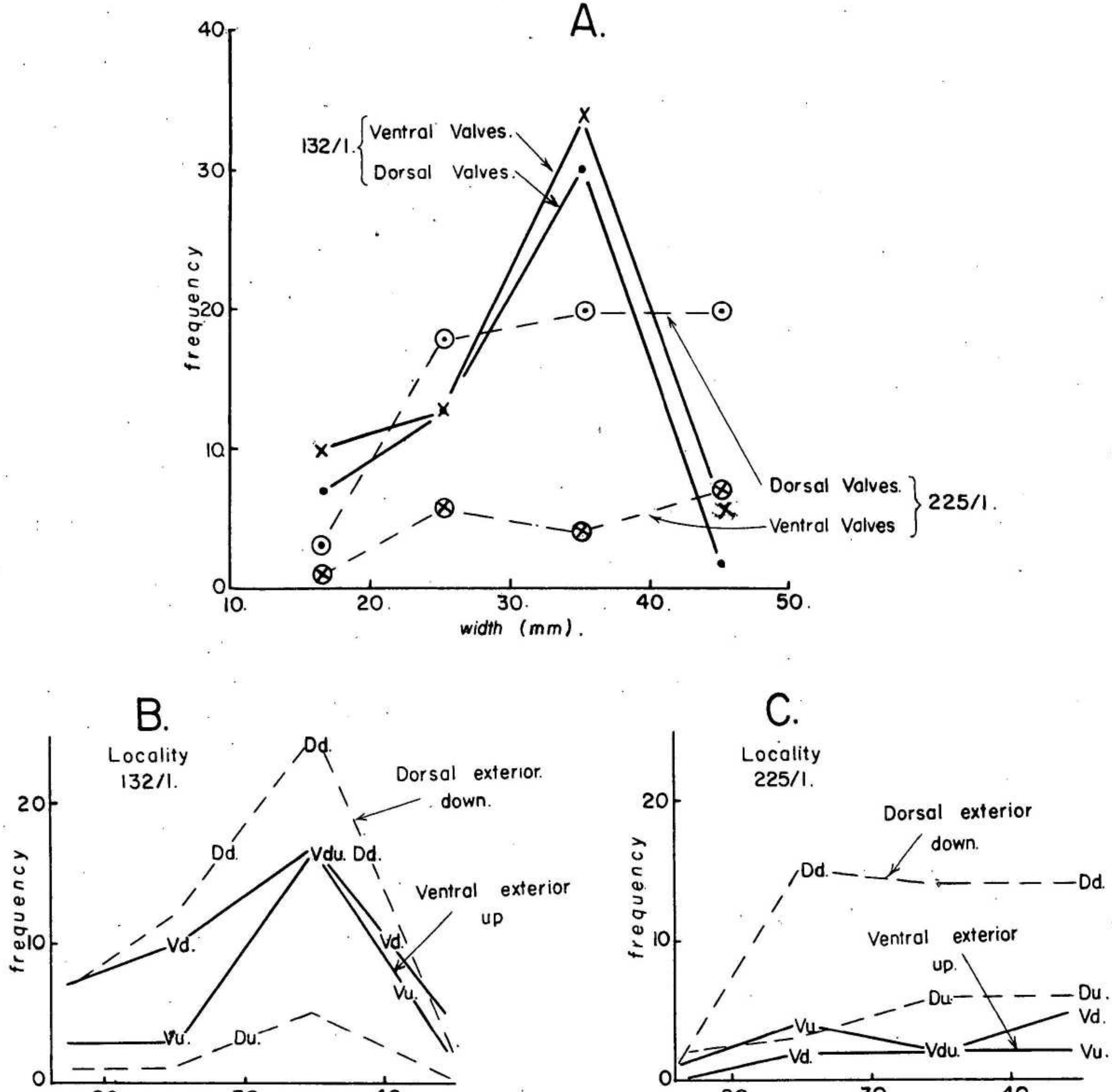
The third part of the section with boulders is a pelecypod-rich bed 20 feet above the clarkei-bed. The boulders and blocks include the same types of rock that are found in the clarkei-bed, but in much less profusion. Both beds contain a lot of fossilised wood.

In the south-eastern quadrant of the Sheet area, the clarkei-bed and associated overlying pelecypod-bed are free of boulders, except for rare erratics up to 2 feet across, but they still contain pebbles. The origin of the boulders in the clarkei-bed and pelecypod-bed will be discussed later.

The clarkei-bed is about 20 feet thick in the Mt. Lebanon/Splitters Creek area. Near Mount Donald, the bed is exposed in pavements in water-courses. In the south-eastern quadrant, the clarkei-bed is thicker (Fig. 16H), and contains a greater proportion of shells, most of them Strophalosia clarkei, and a softer sandy and silty matrix (Fig. 19). In streams, the bed is easy to trace because its outcrop upstream weathers to produce loose valves of S. clarkei which are carried downstream for up to 5 miles. Loose shells, at least in its headwaters, have provided an apt name for Shell Creek.

A census of the fossils on an exposed bedding plane was made at two widely separated localities of the clarkei-bed 132/1, 3½ miles north of Big Horse Bore and 225/1, one mile south of Woolamba Homestead, on Isabella Creek. The census is not strictly quantitative because several fossils were obscured by the matrix; the census nevertheless points out the gross features of fossil distribution.

Fig. 20.



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Isabella Creek (225/1): 1 metre square

Object	Width (mm.)			
S. clarkei	12.5-20	20-30	30-40	>40
Shells (ventral up	1	-	-	2
Shells (dorsal up	-	1	2	-
Single Valves (ventral up	1	4	2	2
Single Valves (ventral down	-	2	2	5
Single Valves (dorsal up	2	3	6	6
Single Valves (dorsal down	1	15	14	14
Other brachiopod (Athyris)	1	-	-	-
pebble	1	-	-	-

A 4 inch-long pelecypod and a small bryozoan colony were also seen.

South of Mt. Lebanon (132/1): 1 metre square

Object / Width(mm.)	12.5-20	20-30	30-40	>40
S. clarkei				
Shells (ventral up	1	-	2	-
Shells (dorsal up	2	1	7	-
Single Valves (ventral up	3	3	17	2
Single Valves (ventral down	7	10	17	4
Single Valves (dorsal up	1	1	5	-
Single Valves (dorsal down	6	12	25	2
Ribbed spiriferid shell (ventral up	-	-	-	3
Ribbed spiriferid shell (dorsal up	2	4	-	1
pebble	1	-	-	-

Three rugose Corals (? Euryphyllum) (two vertical, the third horizontal), one large pectenid pelecypod (5 inches across, convex, left valve up), and a single bryozoan colony were also seen.

Almost all the fossils are single valves of S. clarkei that lie with the plane of commissure parallel to the bedding plane Fig. 20A shows the size-frequency distribution of dorsal and ventral valves from localities 132/1 and 225/1, Fig. 20B the distribution of valves from 132/1, separated into those that lie with ventral or dorsal exteriors facing upward, and Fig. 20C the distribution of valves from 225/1. Obvious features are:-

1. in 132/1 (20.A), ventral and dorsal valves have much the same bell-shaped distribution;

2. 225/1 (20A) contains fewer valves, dorsal valves outnumber ventral valves, and the distributions are skewed to the left;

3. Fig. 20B and C confirm the impression gained at the outcrop that most valves are dorsal valves that lie with their exterior facing downward (i.e. convex upward). This is the position of greatest stability in turbulent water.

According to the work of various authors including Boucot (1953) and Veevers (1959), the frequency distributions shown in Fig. 20A indicate that the samples represent death assemblages derived from living populations by selective removal or destruction of certain size-groups. No shells or valves less than 10mm. across were seen in the bed; small specimens were probably too thin to withstand buffeting by currents. In the sample measured at 132/1, equal numbers of dorsal and ventral valves of the same size were removed from the living population, but in sample 225/1, more ventral than dorsal valves were removed; or if the samples are allochthonous, more of the one kind of valves were deposited than of the other. These observations, together with others on the boulders, point to deposition in turbulent water. This idea will be expanded below.

About 20 to 50 feet above the clarkei - bed is a sandy coquinite consisting mainly of pelecypods. The best exposure of this bed is at 12/1, 2½ miles south of Mount Lebanon Homestead, where 15 feet are preserved capping a low mesa. The bed consists of quartz greywacke with pelecypods, less abundant gastropods, rare productid brachiopods, and plant fossils; it also contains fossil wood and erratics, up to 4 feet across, of dacite, quartzite, and schist, which are not so abundant as those in the underlying clarkei-bed. Wherever the clarkei-bed was found, so was the pelecypod - bed, and this relationship was used to extend the stratigraphical datum provided by the clarkei - bed, which, because, its thickness and fossil content are fairly constant, is more reliable. The pelecypod - bed is particularly useful in tracing the structure of the clarkei - bed northward from the south-east quadrant of the Sheet area into the

Cotherstone/Phillips Creek area, where the *clarkei*-bed is not exposed. For example, the base of the section shown in Fig. 16E is a pelecypod bed with rare brachiopods, which are identified as lying 20 to 50 feet above the *clarkei*-bed.

This is one of the few sections in the area that is sufficiently well exposed for its thickness to be measured directly. The thicknesses of other sections in the Permian rocks were estimated from dip measurements on sparse outcrops, and hence are not reliable.

In essence, the present conception of these beds differs little from Reid's (1928). South of Cotherstone Homestead, thick lenses of quartz greywacke, greywacke, and siltstone, cross-bedded in part, and sparsely fossiliferous, lie above the pelecypod-bed. These lenticular beds have a total estimated thickness of 1000 to 1,200 feet. In the Peak Downs 1-mile Sheet area (the south-east quadrant of the 4-mile Sheet area), pelecypods are intermittently distributed throughout the section. No coal or plant rootlets were found, and the entire section beneath the Upper Bowen Coal Measures is probably marine. Worm-tracks, in various states of preservation, indicate an abundant bottom fauna. Rowe (in Hill & Denmead, 1960) mentions an oil shale in Shell Creek, but this was not seen.

On a small scale, most beds are well bedded; some are planar cross-bedded, but the top and bottoms of the sets, and, where seen, the top and bottom sets, are parallel. On a larger scale, most beds are lenticular so that, when traced on air photographs, most beds are found to wedge out. For this reason, detailed structure cannot be mapped bytracing single beds from the air photographs.

Farther north, on Phillips Creek (Fig. 16E), the section is differentiated into thick bodies of quartz greywacke, and thinner bodies of fine greywacke and siltstone. In this section, the only marine fossils found above the exposed base, which is identified as the pelecypod-bed that lies immediately above the *clarkei*-bed, are the

Plate 2

CL 318/1
White quartz sandstone with some feldspar and mica
Purple, grey and brown siltstone, sandstone lenses near top
Friable quartz sandstone
Ferruginous quartz sandstone with brachiopods and gastropods
Quartz sandstone with pebble bands; pebbles of quartzite and micaceous schist. Abundant "rootlets"
White siltstone; interbeds of ferruginous quartz sandstone with "rootlets"
Dark brown greywacke with gastropods and pelecypods
(b)
CL326/1 2.5m SSW Harrow Bore
Friable quartz sandstone
Quartz sandstone with some feldspar
Buff siltstone with numerous sandstone interbeds
Quartz sandstone with minor feldspar
Vari-coloured siltstone
Friable quartz sandstone
(c)
CL323/1
Friable quartz sandstone
Flaggy quartz sandstone with minor siltstone
Quartz sandstone
Friable quartz sandstone
Quartz sandstone
Quartz sandstone with minor siltstone
Buff red siltstone
Quartz sandstone with some feldspar
No outcrop
Quartz sandstone with some feldspar
Dark siltstone
(d)
CL325/7
Quartz sandstone with minor feldspar
Dark siltstone
Quartz sandstone
Siltstone and sandstone rubble
Quartz sandstone
Buff siltstone
No outcrop
Quartz sandstone
No outcrop
Ferruginous siltstone with interbeds of fine quartz greywacke
Red and white siltstone
Black carbonaceous siltstone interbedded with fine flaggy micaceous quartz sandstone
(e)
CL325/4
Ferruginous quartz sandstone with pelecypods
No outcrop
Grey and purple siltstone
Flaggy quartz sandstone
Red and white siltstone
No outcrop
Hard quartz sandstone
No outcrop
Siltstone and greywacke with interbeds of quartz sandstone
No outcrop
Flaggy quartz sandstone
(f)
(a) Probable structure of the Cherwell Range
(b-f) Measured sections in the Cherwell Range
450' 400' 350' 300' 250' 200' 150' 100' 50' 0
WNW
MT. LEBANON HS.
CHERWELL CK.
CL318/1
CLERMONT-COAST HWY.
CL319/4
CL327/2
CL327/3
COAL HOLE CK.
CL320
CL327/4
CL327/5
CL 323/1 (base)
HARROW CREEK AND BORE
CL325/6
CL325/7
CL325/4
CL325/3
CL325/2
YURA H.S.
ESE
1500' 1000' 500' SEA LEVEL
CLARKEI BED
"PASSAGE BEDS"
"PASSAGE BEDS"
UPPER BOWEN COAL MEASURES
HORIZONTAL AND VERTICAL SCALE
FEET 2000 0 2000 4000 6000 8000 FEET
(a)
Bureau of Mineral Resources Geology and Geophysics, May 1961.
To accompany Record 1961/75
F55/11/4

martiniopsid brachiopods at 21/5 (Tay Glen Crossing). Tubular structures normal to the bedding, either worm-tubes or rootlets, are common; plant detritus is also common, and rare beds (CL4) contain Glossopteris. No coal was seen until the Upper Bowen Coal Measures near Lake Vermont Homestead were reached. Farther north, in the Cherwell Range, outcrop is less continuous, and the succession is known in less detail.

Permian Rocks of the Cherwell Range.

Interbedded fresh-water and marine rocks crop out in the Cherwell Range north-east of Clermont, between Cotherstone Homestead and Mt. Dillingen. These rocks, which lie between the Strophalosia clarkei bed and the Upper Bowen Coal Measures were considered by Reid (1928) to be "passage beds" as they indicate the gradual change from the essentially marine environment of the Middle Bowen to the freshwater environment of the Upper Bowen Coal Measures. Without regard to terminology, Reid's appreciation appears to be substantially correct. An estimate of the thickness of these rocks incurs considerable difficulties due to large-scale cross-bedding and minor reversals; a thickness of 2000 feet is indicated by a series of measured dips between Mt. Lebanon Homestead and Yura Homestead (Plate 3).

The "type area" for Reid's "Passage Beds" is the Cherwell Range; however, as the term "Passage Beds" is not used in a formational sense no type section within the meaning of the Code of Stratigraphic Nomenclature is required.

It is difficult to determine whether the "Passage Beds" are in fact a separate formation from the underlying marine rocks. The rocks of the Cherwell Range can be traced along strike to the south-south-east where similar lithologies form the marine sequence continuing upward from the clarkei-bed. Also, the presence of freshwater material within the Middle Bowen Beds is well known from both field evidence and bore records. It is therefore difficult to draw a sharp boundary between the "Passage Beds" and the underlying fossiliferous beds on lithological or palaeontological grounds. On the other

Figure 21. Benches formed by resistant sandstone beds, Hughes Creek area, Cherwell Range.

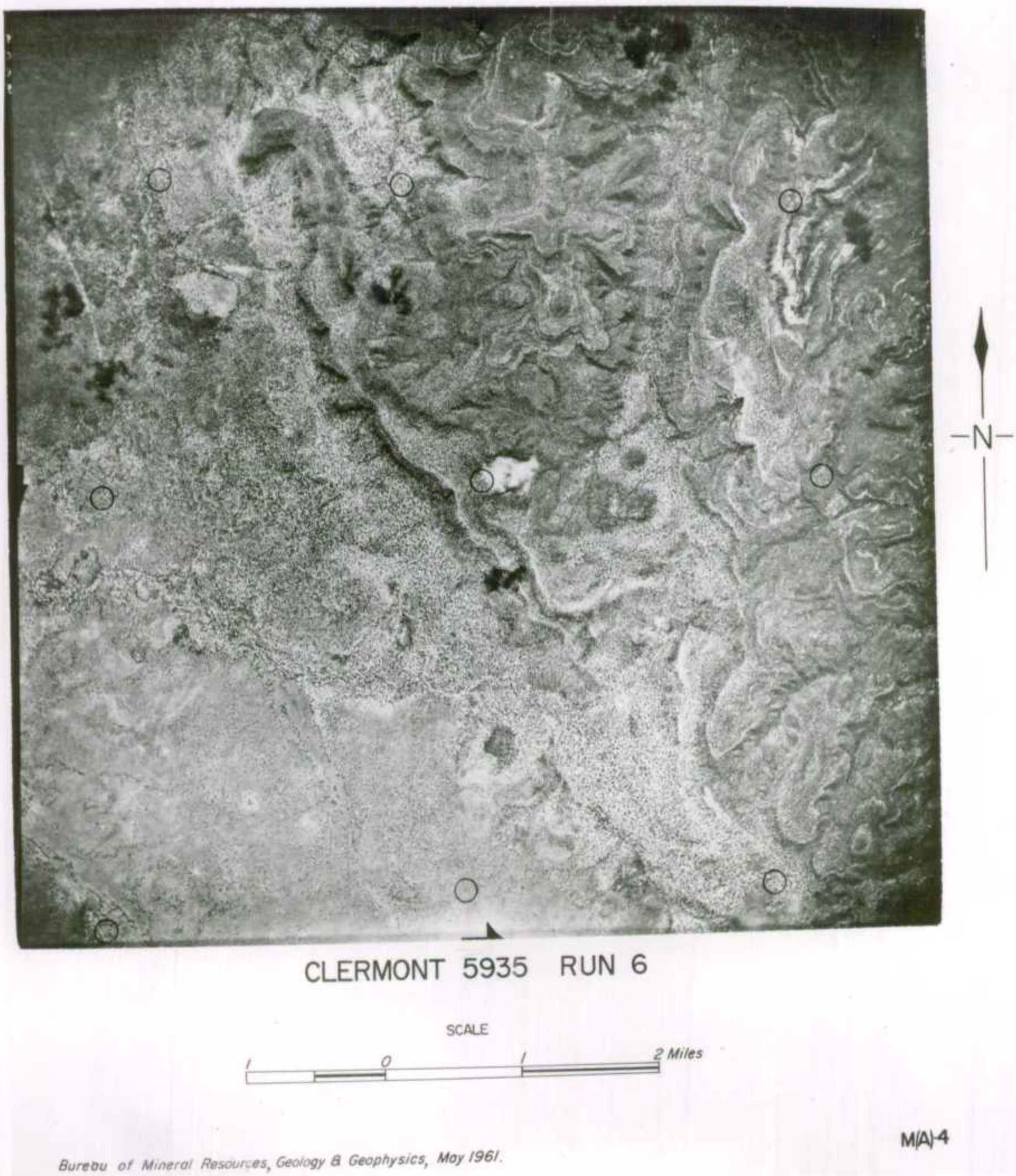

Figure 22. Western escarpment of the Cherwell Range.
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hand the change from "Passage Beds" to the entirely freshwater sediments of the Upper Bowen Coal Measures is strongly marked by lithological types and fossil content.

The rocks of the Cherwell Range crop out as a dissected plateau,
east at a low angle. The plateau forms distinctly
the surface of which slopes gently to the/high country between Campbells Creek near Cotherstone Homestead and Mt. Dillingen, 10 miles west of Grosvenor Downs Homestead. The area is dissected by Cherwell, Coal Hole and Harrow Creeks and by tributaries of Phillips Creek. Resistant sandstones form prominent benches, which in places can be traced for several miles around the gorges cut by streams. (Fig.21)

The western limit of the plateau is the Cherwell Range, which has a maximum relief of 300 ft. (Fig. 22). On the east it slopes gently to the plains of the Isaacs River and its tributaries. South-east from Cotherstone the relief is again high; similar tableland topography occurs in the area west of Norwich Park Homestead.

The rocks of the Cherwell Range are a sequence of fine, medium and coarse quartz sandstones alternating with varicoloured siltstone and argillaceous sandstone. The siltstone beds commonly contain indeterminable fragments of wood and plants and in places are carbonaceous. Fine-grained quartz greywackes occur in thin beds throughout the sequence and occasional beds of tuffaceous sandstone have been noted. Thin coal seams have been observed in outcrop and recorded from bores.

Measured sections (Plate 3) show that sandstones are roughly twice as abundant as siltstones. The sandstones are mainly medium to coarse and form prominent benches around the hills; the less resistant and poorly outcropping siltstones form slopes between the benches (Fig.21).

Plate 3 shows the detailed lithologies of the Cherwell Range as indicated by a series of measured representative sections. The section measured at CL318/1 near Mt.Lebanon is in the lowermost beds of the Cherwell Range. The fossiliferous sandstone and greywacke of this section are found to be within 50 feet of the underlying <u>clarkei</u>-bed, which crops out in Cherwell Creek 2 miles south of this locality, confirming Rowe's (in Hill & Denmead, 1960) inclusion of the "Passage Beds" in his "Post Clarkei Formation". Near the base the section is dominantly siltstone with marine fossils, plants and traces of wood. The fossiliferous siltstone, greywacke and fine quartz sandstone pass upwards into medium quartz sandstone and siltstone which, with coarse sandstone, constitute the main lithologies of the Cherwell Range. Southwards from CL 318/1, on the high ridges overlooking the Clermont - Coast Highway, massive beds of medium and coarse quartz sandstone with small lenses of siltstone conformably overlie the medium quartz sandstone at the top of the section at CL 318/1. This alternation of sandstone and siltstone extends over the entire area of the Cherwell Range except west of Grosvenor Downs where the lithologies appear to be mainly medium and coarse-grained quartz sandstones with only minor siltstone beds. To the east the succession of alternating sandstone and siltstone continues to CL 325/3, 4½ miles west of Yura Homestead, where 55 feet of black and ferruginous micaceous siltstone and black carbonaceous siltstones are interbedded with fine and medium-grained felspathic and micaceous quartz sandstone. Farther east the rocks are mainly quartz sandstone of varying grain size. In the area between the headwaters of Hughes Creek and Saraji Homestead the dominant lithology is a medium to coarse-grained quartz sandstone, medium to thick bedded. Siltstone beds are less abundant compared with the sections in the Mt. Lebanon Homestead and Harrow Creek areas. North of Harrow Bore, in the area south of the confluence of Cherwell Creek and Nine Mile Creek, the beds are sandy with only a little silt. In summary, in the upper part of the "Passage Beds" the ratio of sandstone to siltstone is much higher than it is in the areas west of Harrow Creek except near the contact of these rocks with rocks of the Upper Bowen Coal Measures; and the lithology varies along strike.

Coal and carbonaceous siltstone have been noted in a number of localities. A two-inch coal seam is recorded at a depth of 56 feet in the bore on Coal Hole Creek, four miles south of the Cherwell Creek confluence. The bore, which went to a depth of 126 feet, records alternating sandstone and siltstone. At CL 328/8, one and a half miles west of the Cherwell Creek and Coal Hole Creek confluence, a poor exposure of coal is partially hidden by extensive alluvium. Six inches of poor quality coal occur at the base of 50 feet of interbedded siltstone and fine greywacke overlain by cross-bedded fine-grained quartz sandstone. The coal is underlain by a grey siltstone containing plant fossils. Concentrations of fairly fresh coal debris at various points in Cherwell Creek point to the likely occurrence nearby of coal seams now covered by alluvium. The debris is not concentrated on the inside bends of the creek or near rock-bars, and its upstream limit is well marked by pieces of coal up to cobble size; pieces of coal from pebble to silt size extend downstream for 10 to 15 yards.

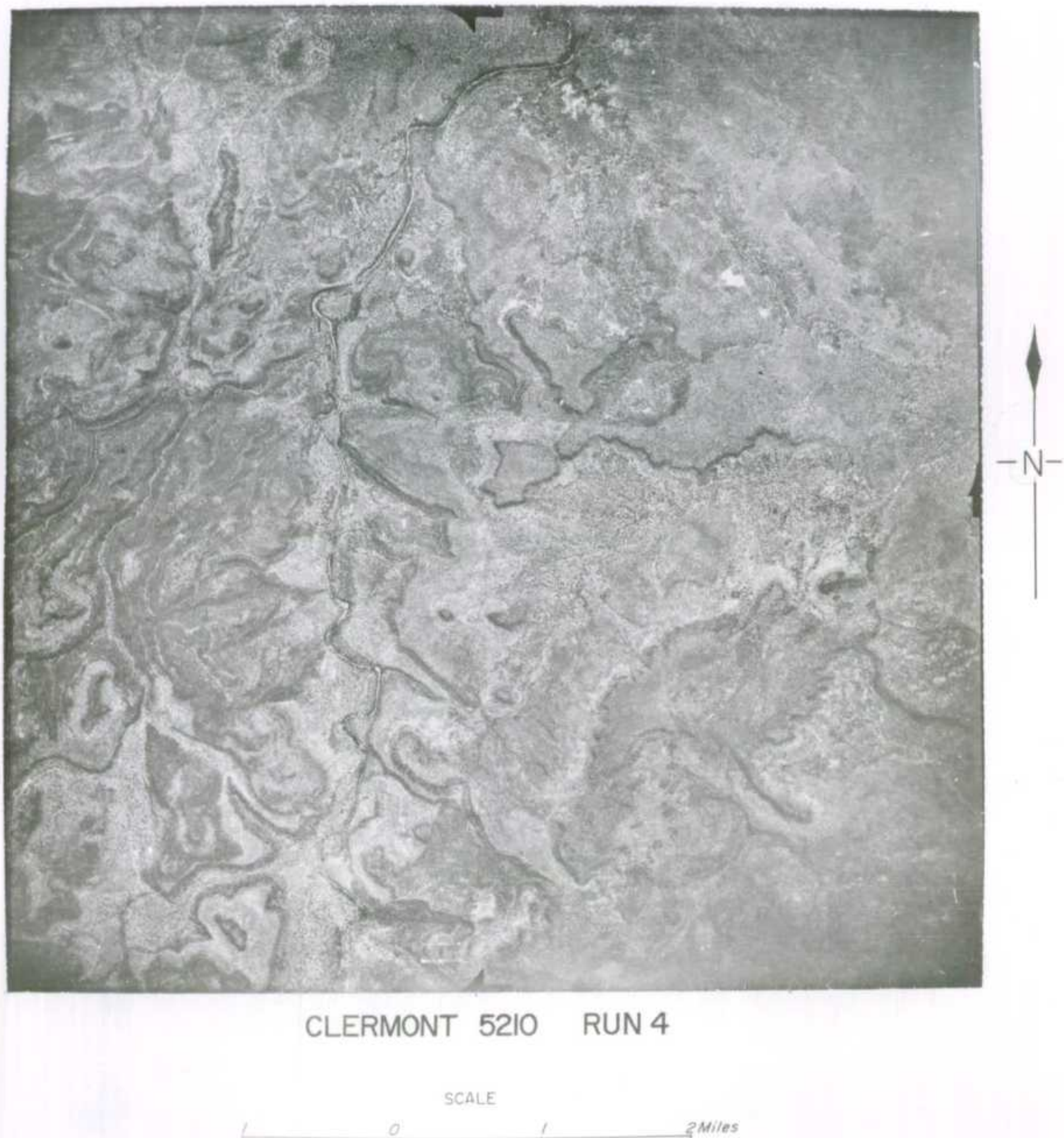
Other exposures of black micaceous carbonaceous siltstone, besides the one already mentioned (CL 325/3), are immediately west of Harrow Bore where ten feet of medium-grained quartz sandstone is overlain by twenty feet of brown and black siltstone, and at CL 325/6, ½-mile south of Harrow Bore, where carbonaceous siltstone and carbonaceous greywacke are interbedded. These carbonaceous rocks all contain abundant mica.

In hand specimen, the sandstone of the Cherwell Range would appear to be a potential reservoir rock for petroleum; but examination of thin sections has shown most sandstone to be almost impervious, due to a fine matrix. Some of the fine matrix is due to the weathering of feldspar, but most is original.

The sandstone beds are extensively cross-bedded. Tabular cross-bedding (Dunbar & Rodgers, 1957) is the commonest. In a few localities only were reliable measurements possible on the directions of the foresets, and these did not provide any definite information on preferred directions. Generally, however, it was noted that the directions of maximum dip of the foresets lay within 30-40° of the regional dip direction; in all localities, the directions of the dip of the foresets range from 030° to 140°.

In places, cross-beds cannot be distinguished from true bedding, and this is probably responsible for anomalous dips, and difficulties in estimating the thickness of the beds. At CL 328/5, near the confluence of Cherwell Creek and Coal Hole Creek, medium and coarse-grained quartz sandstone is exposed in a pavement 3 feet high; it is well bedded with a dip of 23° in direction 090°. However, with small breaks covered by sand, this pavement can be traced ¼ mile upstream where it is seen to be part of a cross-bed 6 to 8 feet thick in a section of 40 feet of interbedded fine, medium and coarse quartz sandstones which dip at 6° in the same direction.

Figure 23. Jointed coarse-grained sandstone, Hughes Creek, Cherwell Range.



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M(A)3

Figure 24. Passage Beds, Cherwell Range, Sandstone benches passing into dipslopes.
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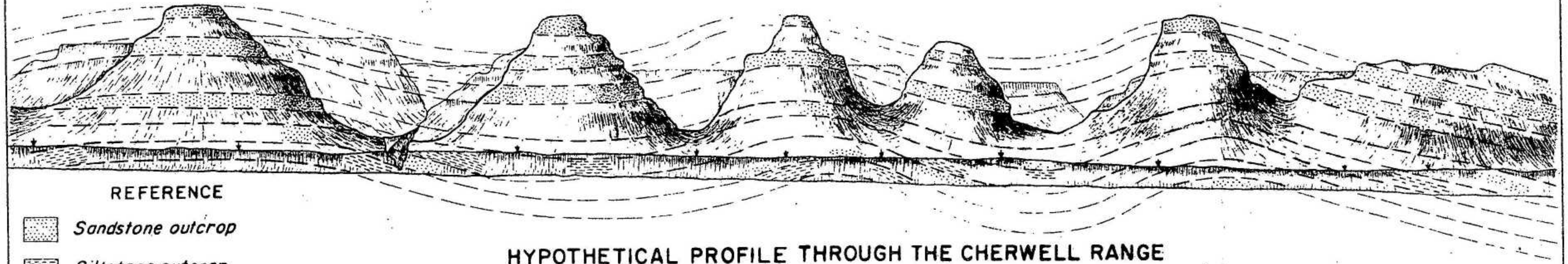
Again, at CL 358/2, south of Plum Tree Bore on Grosvenor Downs, ferruginous coarse quartz sandstone and micaceous quartz sandstone have thick cross-beds with foresets dipping 23° in a direction 070°; the surfaces between numerous laminated and massive beds indicate the true dip as 2° in direction 080°. At only a few localities were the directions of foresets widely divergent from that of the true dip. At CL 321/2, 2 miles north of Harrow Bore, foresets dip 20° in a direction 110° whilst the true dip is 5° to 030°. At CL 351, one mile east of Clermont - Coast Highway in Nine Mile Creek, foresets dip 25° at 140° in rocks which dip 2° to 070°. At a number of localities cross-bedding was random, with variation of direction between one horizon of foresets and the next; nevertheless the easterly component of cross-dip was maintained.

Contrary to expectation, ripple marks were not seen in these rocks. Minor slump roles and loadcasts occur in the siltstone interbeds. A Widespread internal structure of the "Passage Beds" is the occurrence of the "rootlets" described by Reid, and these are considered below in the discussion of the depositional environment of these beds. Strong local jointing (Fig.23) is developed in the sandstone; major directions are 10°, 40°, 70°, 90° and 180°.

The probable structure of the Cherwell Range is shown in Plate 3. The section through the Cherwell Range has been constructed from dip values measured in the field, and indicates a probable thickness of 2,000 feet; the basal beds are approximately 50 feet above the clarkei-bed. Reversals, as shown in the section, have been seen in air-photographs and in the field but they do not extend far. Therefore it is postulated that the Cherwell Range is not a series of north-striking anticlines and synclines but is rather gently undulating with an overall shallow easterly dip. An unusual structural feature of the range is the predominance of apparently flat-lying sandstone benches around the hills, whilst in the stream beds outcrops of gently dipping siltstone are seen. This feature is known not to be an unconformity, because the sandstone of the benches can be traced conformably downward into the outcrops in the creeks. Furthermore, the sandstone benches, particularly those in the north, can be traced into easily discernible dip slopes (Figure 24), and, where it is possible to

Fig. 25



REFERENCE

Sandstone outcrop

Siltstone outcrop

Scree

Creek bank (in profile)

HYPOTHETICAL PROFILE THROUGH THE CHERWELL RANGE

A POSSIBLE EXPLANATION OF ANOMALOUS DIPS IN CREEKS AND HILLS

VERTICAL SCALE EXAGGERATED

F 55/11/36. EJ

Bureau of Mineral Resources, Geology & Geophysics May 1961. To accompany Record 1961/75.

trace the benches far enough at right angles to the general strike, they gradually dip towards the creeks at angles comparable to those of the siltstones. The lithology of the siltstone interbeds between benches is the same as that in the creeks and a possible explanation of the seemingly discordant dips is shown in Figure 25.

The rocks of the Cherwell Range appear to be conformable with the underlying clarkei-bed . On present evidence it is not possible to regard these rocks as a separate formation from the underlying mainly marine rocks; no distinct boundary can be recognised between these and the fossiliferous marine rocks south of Phillips Creek.

The different lithologies and the abundance of fossil plants in the sediments of the Upper Bowen Coal Measures provide good criteria for the separation of this unit from the underlying "Passage Beds".

The interbedded sandstone and shale of the Cherwell Range were laid down under paralic conditions indicating the change of environment from mainly marine to that which produced the freshwater sediments of the Upper Bowen Coal Measures. The association of marine fossils with abundant wood fragments at CL 318/1 is indicative of either near-shore sedimentation or lagoon sedimentation with some seaward connection; the plant-bearing grey shale, interpreted as a seat-earth at the base of the coal seam at CL 328/8 indicates freshwater sedimentation; the occurrence at CL 325/4 of large pelecypods in clean coarse quartz sandstone suggests rapid deposition in a marine environment. The tabular cross bedding is probably indicative of deltaic sedimentation into either a lagoon or lake. The conditions of deposition changed rapidly and were probably cyclic.

A common feature of the sandstone beds is vertical, tubular structures to which Reid (1928) gives the name "plant rootlets". Reid records their diameters as between $\frac{1}{8}$" to $\frac{3}{4}$", up to 5" long, and with the long axis at right angles to the bedding. The outsides consist of thin films of carbon and the centres are now filled with sand grains. Reid considers them "to be undoubted evidence of marine or estuarine conditions", but he also notes that 'as individual beds carrying "rootlets" never appear to have fossil shells it would appear they indicate some change of condition of deposition between strictly marine and freshwater'. There is no record of these structures in the highly fossiliferous freshwater sediments in the Upper Bowen Coal Measures; and as no detailed structures have been preserved it is at present impossible to determine what the organisms were.

The fossils from the Cherwell Range are Permian; the various fossils are listed in Appendix 2 and in Appendix B (Malone et al., 1961).

Upper Bowen Coal Measures

(a) North of Phillips Creek

The Upper Bowen Coal Measures underlie the plains country of the Isaacs River and its tributaries in the eastern portion of the Clermont Sheet area. Outcrop is poor; the area has little relief and is covered by widespread surface deposits. The Measures are apparently entirely freshwater, and consist mainly of medium-grained greywacke, quartz sandstone, lithic sandstone, siltstone and mudstone. Coal occurrences are known from outcrops and from bore records.

The Upper Bowen Coal Measures conformably overlie the marine Middle Bowen Beds. According to White (Appendix E in Malone et al., 1961) the fossil flora ranges from the Permian into the Lower Triassic. The thickness of the entire sequence cannot be determined in the Clermont Sheet area, but it is known to be greater than 3,500 feet.

Jack (1879) used the term Upper (freshwater) Series to describe the rocks of the Upper Bowen in his threefold division of Etheridge's (1872) Bowen River Series; this division recognised the occurrence of volcanics, marine, and freshwater deposits in the Bowen Basin. Later workers used either a two-fold or three-fold division of the Bowen River Series, but all recognised the occurrence of freshwater sediments in the upper portion of the sequence. For this freshwater portion, Reid (1928) used the terms Upper Bowen Coal Measures and Upper Bowen Formation. On the Geological Map of Queensland (1953) the sequence is called the Upper Bowen Coal Measures.

For this unit no type area or type sections within the meaning of the Code of Stratigraphic Nomenclature have yet been chosen. The concept of the unit has evolved as the result of widespread regional mapping by numerous geologists over the last ninety years. In the Mt. Coolon Sheet area, good exposures of these rocks occur east of the Redcliffe Tableland (Malone

Figure 26. Entrenched meander of Isaacs River, looking south-east.

et al.,1961), and after further examination may prove to be a good type section, both for the unit as a whole and for possible division into formations. For the present, the type area embraces the northern portion of the Bowen Basin.

The Upper Bowen Coal Measures underlie the widespread surface deposits on that portion of the Clermont Sheet area that lies east of the belt of high country formed by the Middle Bowen Beds. The main areas of outcrop are east and south-east of Mt. Roper Homestead, in the south-eastern portion of the area, and north of the Isaacs River in the north-eastern portion of the Sheet area. In this area outcrop in situ is rare, and the unit is known mainly from extensive surface rubble and scree. Some good exposures have been seen in Cherwell and Harrow Creeks but very large gaps prevent accurate section measuring. Surface rubble is known in the black soil areas south of Winchester Homestead and south of the highway crossing on the Isaacs River. The black soil plain south of Winchester Homestead has been shown on previous maps as Tertiary basalt; however, in the recent survey, the only outcrops seen in this area were calcareous rocks with wood fragments, and white mudstone, rich in fossil leaves and wood. Scattered outcrops and rubble of the Upper Bowen Measures have been noted in Ripstone, Hughes and Phillips Creeks.

The area of outcrop is a gently undulating plain with a gentle slope to the south-east. Numerous large brigalow stands occur and, with savannah woodland, occupy 90% of the area. The remainder of the area consists of heavy black clayey soils forming open grassy plains. The streams are deeply entrenched meanders (Fig.26); in places alluvial banks are fifty feet high.

The lithologies of the Upper Bowen Coal Measures are complex and varied. Rapid changes from one type to another may occur over several feet of section or merely over a few inches. Rock types are dominantly siltstone, mudstone and quartz sandstone, quartz greywacke and lithic sandstone; calcareous types are common. The lithic sandstone is a rock containing approximately equal portions of quartz and rock fragments, which together total more than half the rock, the remainder is feldspar, mica and other minerals. There is no silt fraction in this rock type. Calcarenite, calcareous greywacke, and calcareous siltstone occur over wide areas and

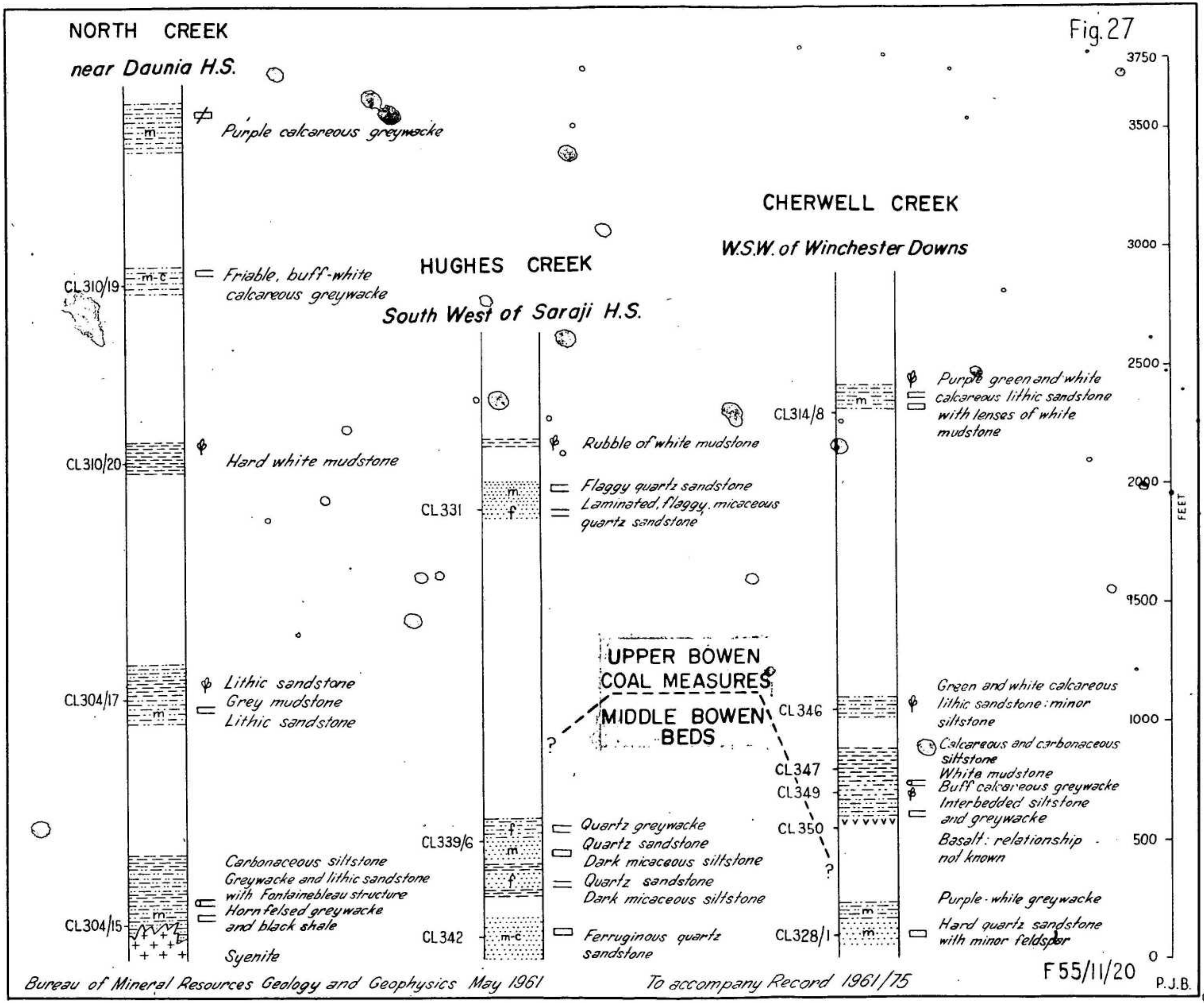


Fig. 27
NORTH CREEK
near Daunia H.S.
Purple calcareous greywacke
CL310/19
Friable, buff-white calcareous greywacke
CL310/20
Hard white mudstone
CL304/17
Lithic sandstone
Grey mudstone
Lithic sandstone
Carbonaceous siltstone
Greywacke and lithic sandstone with Fontainebleau structure
Hornfelsed greywacke and black shale
CL304/15
Syenite
HUGHES CREEK
South West of Saraji H.S.
Rubble of white mudstone
Flaggy quartz sandstone
CL331
Laminated, flaggy, micaceous quartz sandstone
CL339/6
Quartz greywacke
Quartz sandstone
Dark micaceous siltstone
Quartz sandstone
Dark micaceous siltstone
CL342
Ferruginous quartz sandstone
UPPER BOWEN COAL MEASURES
MIDDLE BOWEN BEDS
CHERWELL CREEK
W.S.W. of Winchester Downs
CL314/8
Purple green and white calcareous lithic sandstone with lenses of white mudstone
CL346
Green and white calcareous lithic sandstone: minor siltstone
CL347
CL349
CL350
Calcareous and carbonaceous siltstone
White mudstone
Buff calcareous greywacke
Interbedded siltstone and greywacke
Basalt: relationship not known
CL328/1
Purple-white greywacke
Hard quartz sandstone with minor feldspar
3750
3500
3000
2500
2000
1500
1000
500
0
FEET
F55/11/20
P.J.B.
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To accompany Record 1961/75

Fig. 28

CL 321/8 – HARROW CK.

5 MILES S.W. OF WINCHESTER H.S.

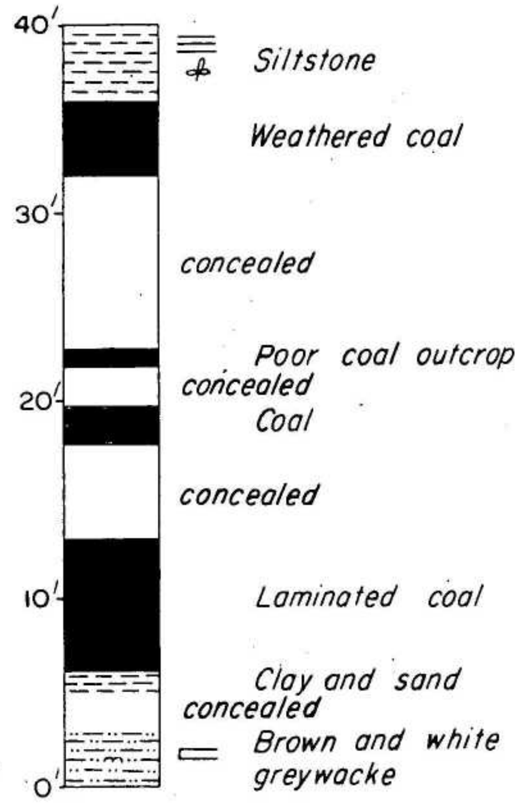

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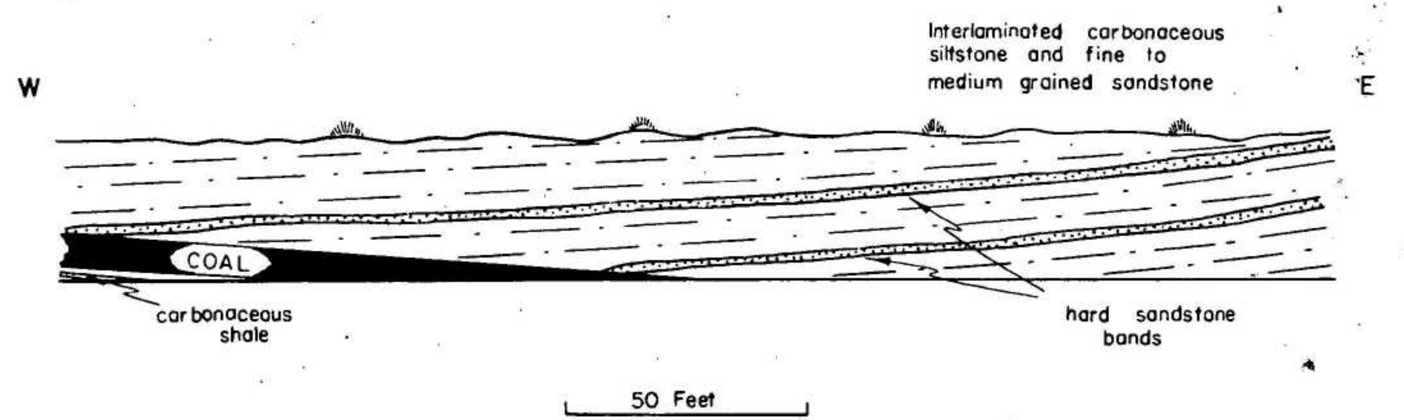
Fig. 29

Creek Section in Upper Bowen Coal Measures
near Lake Vermont Homestead



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the weathering of these rock types has produced the black soil plains in this area. Grey and white mudstones form a large proportion of the Upper Bowen outcrops; however, as they are usually flat-lying or occur as scree, their proportion of the entire sequence is not known. Diagrammatic sections showing the lithologies in Cherwell Creek, Hughes Creek, and near Daunia are shown in Fig. 27.

Coal in the Upper Bowen Coal Measures is known in several localities from either outcrops or bore records. The two best exposed outcrops are at CL 321/8 in Harrow Creek (Fig.28) and at CL 56 near Lake Vermont Homestead (Fig. 29).

The occurrence at CL 321/8 is five miles south-west of Winchester Homestead and is exposed in the right-hand bank of the creek. It is extensively covered by alluvium derived by large-scale collapse of the creek bank. Its lateral extent is not known. Traces of coal are found throughout a measured thirty feet of section but it is not known how much of the upper part is actually in situ. The siltstone at the top and the seven-foot coal band at the base are in situ. The coal is poor quality and readily breaks into very small fragments; it is deeply weathered.

A coal seam six feet thick is exposed in a tributary of Phillips Creek near Lake Vermont Homestead. The coal is underlain by carbonaceous shale, and overlain by interlaminated carbonaceous siltstone and fine to medium sandstone, with an angular discordance of 7 degrees, indicating contemporaneous warping. An analysis of this coal is given in Table 2. (P. 80)

Previous maps of the area show a number of coal seams in Cherwell Creek between Nine-mile Creek and the Isaacs River; these localities were visited during the survey but bank collapse has obscured outcrops which are indicated by debris of coal in the creek bed. Coal debris is extensive in the Isaacs River east of the Highway crossing; the manager of Grosvenor Downs reports coal in Grosvenor Creek near its confluence with the Isaacs River, but the seam is now apparently covered by bank collapse and a long deep waterhole. Reid (1928) reports coal from a number of bores on Grosvenor Downs; one of these, 3 miles south of the highway crossing on the Isaacs River, is recorded as intersecting 12 feet of coal at a depth of 147 feet. The manager of Winchester Downs reports that several old bores

Figure 30. Fossil tree trunk, Upper Bowen Coal Measures, Cherwell Creek.

Figure 31. Slumping in sediments of Upper Bowen Coal Measures, Cherwell Creek.

and wells sunk in the Yura-Winchester area intersected small coal seams. Unfortunately the records of the bores were lost in a fire at Grosvenor Downs some years ago and the holes can no longer be located. Coal is reported from a bore 4½ miles north-east of Lake Vermont Homestead.

A sample of coal from CL 56 near Lake Vermont Homestead gave the following analysis - moisture 7.6%, volatiles 24.3%, fixed carbon 56.2%, and ash 11.9%.

Joints are weakly developed in the arenitic rocks of the Upper Bowen Coal Measures. Directions measured are 15°, 60°, 75°, 105°, 145° and 160°; some of these correspond to joint directions measured in the Middle Bowen Beds. Outcrops are too few for any attempt to be made at an analysis of the joint directions. Iron stains in the joints are common.

As with the rocks of the Cherwell Range, the dip of cross bedding in the Upper Bowen Coal Measures is related to the direction of regional dip. Cross-bedding is found in the arenites only and few observations have been made. In Hughes Creek at Saraji (CL 331) flaggy medium-grained quartz sandstone and laminated micaceous fine quartz sandstone dip 13° to 070°; cross beds in the medium sandstones dip 30° to 030°. At CL 348 in Cherwell Creek buff and purple calcareous greywacke dips 5° to 070°; cross beds dip in the same direction at 20°. Incidentally, this outcrop contains extensive fossil tree trunks (Fig. 30).

Slumping has been noted at a few localities, the best of which is at the Winchester road crossing on Cherwell Creek. (Fig.31)

The Upper Bowen Coal Measures conformably overlie the marine Middle Bowen Beds. The contact was not observed, but the sections for Cherwell Creek (Fig.27) suggest that the change is not sharp. The rocks are overlain, probably disconformably, by the Carborough Sandstone and by the Suttor Formation. Around Grosvenor Downs extensive sheets of (?) Tertiary basalt overlie the unit. Structurally the Upper Bowen Coal Measures are the youngest rocks involved in the folding of the Permian sequence in the Bowen Basin; dips are dominantly easterly or north-easterly and the axis of the basin in this area trends south-east. Some reversals are known and the sequence is probably gently warped.

Figure 32. Syenite intrusion up-doming the Upper Bowen Coal Measures, near Daunia Homestead.

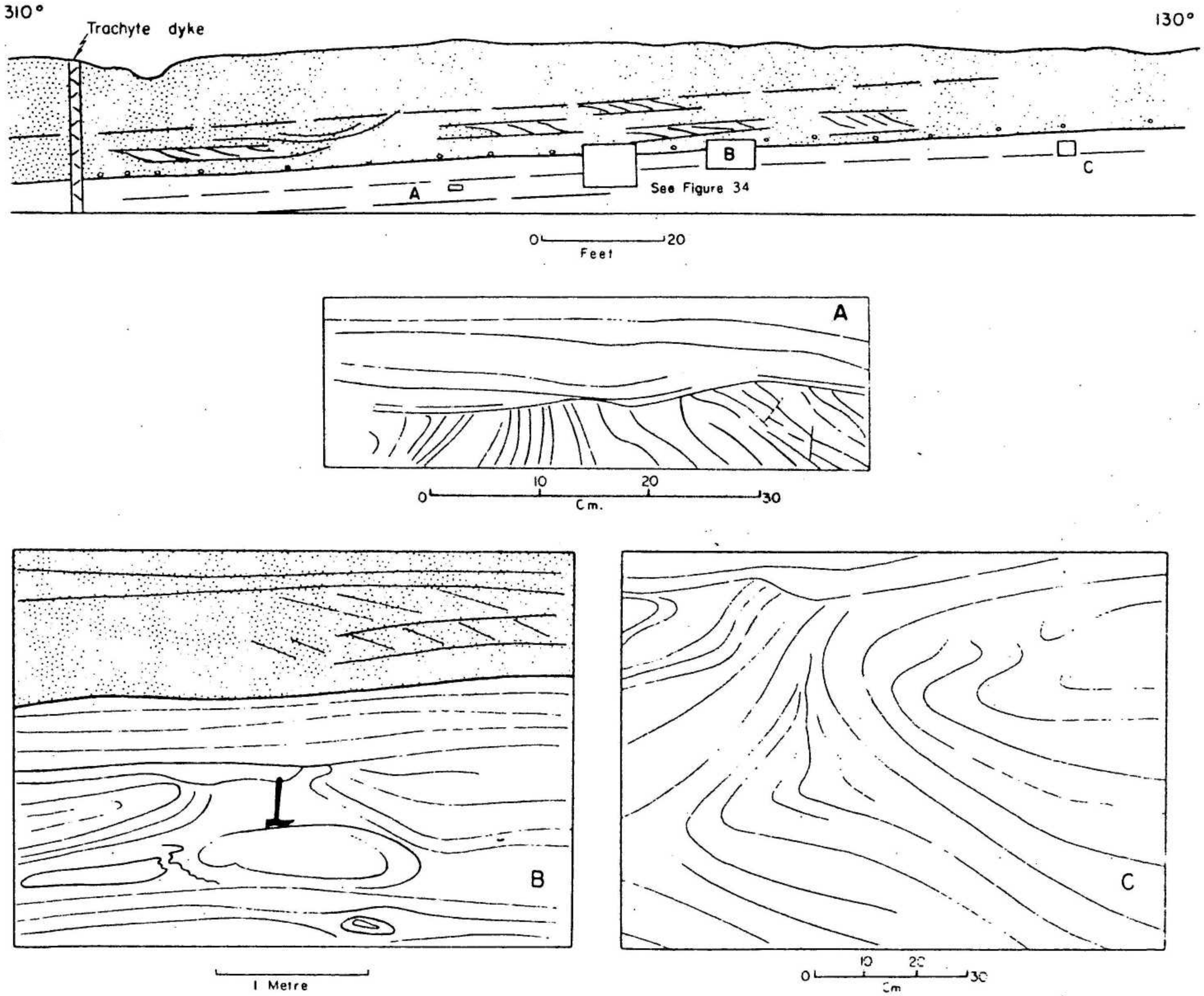
The regional structure of the unit is complicated in the north-eastern portion of the area by the occurrence of three small domes. Two of these are roughly circular in plan and are two to three miles across; the third is elongated and measures four miles long by two miles wide. Outcrop in these domes is poor, and their form **is** indicated (on air photographs) by the alternating brigalow and black soil patterns. Where outcrops are visible the measured dips and strikes conform to the trends seen in the air photographs. In the core of the smaller of the two circular domes near Daunia Homestead (Fig.32), a syenite intrusion crops out as hills and its contact effects on the sediments can be seen. Near the contact the beds dip away at high angles which decrease progressively outwards. The only contact metamorphic effect is hornfelsing. No direct evidence of intrusion was found in the other two domes but by comparison they have probably been arched up by near-surface intrusions.

The Upper Bowen Coal Measures are freshwater sediments that were deposited in a slowly subsiding basin; deposition more or less kept pace with subsidence. The extensive occurrence of plant material and fossil trees, together with the apparent absence of marine fossils, suggests a land-locked area. On the other hand, the transitional nature of the "Passage Beds" and the conformity of the Upper Bowen Coal Measures with the underlying marine rocks suggest that the sea was not very far away; short marine incursions may have occurred, at least in the lower part of the sequence, but they have not been recognized. At times deposition exceeded subsidence and parts of the area became swampy with the subsequent deposition under favourable conditions of coal-forming material.

Plant fossils in the Upper Bowen Coal Measures include *Glossopteris* (several species), *Phyllotheca* (two species), *Cladophebis roylei* and *Nummulospermum bowenensis* (White, Appendix B. in Malone et al., 1961) The range of the various species is Permian to Lower Triassic; consequently the exact upper time boundary of the Measures is not known.

Because of poor outcrop no accurate determination of the thickness of the Upper Bowen Coal Measures can be given. Measured dips and air-photograph interpretations indicate that over 3,500 feet of sediments are involved in the dome north-west of Daunia Homestead. Over ten thousand feet

Fig. 33



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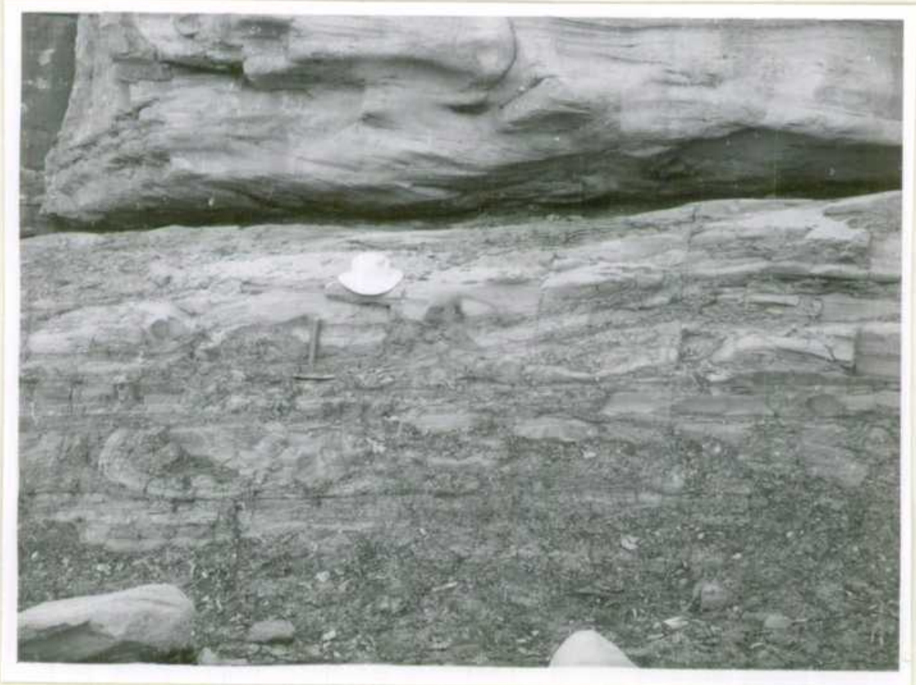
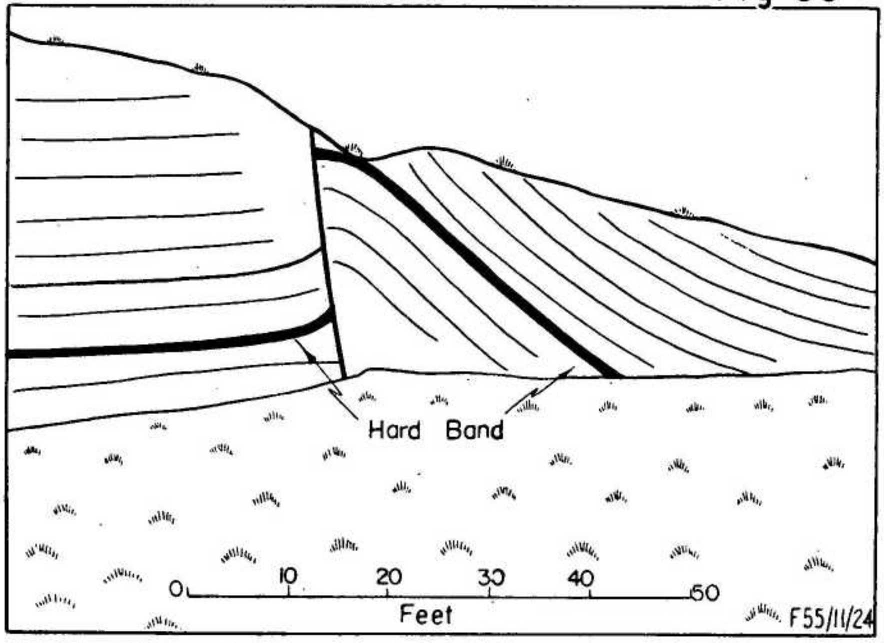


Figure 34. Truncated contorted bedding and slump rolls at 43/3.

Fig 35



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are known in the Mt. Coolon Sheet Area (Malone et al., 1961).

(b) South of Phillips Creek

In the south-east quadrant of the Sheet area, the Middle Bowen Beds are overlain, presumably conformably, by the Upper Bowen Coal Measures of dark siltstone, in many places laminated, quartz greywacke, and coal. The coal measures are poorly exposed and the junction between the marine and freshwater rocks was not seen. The coal measures differ from the marine rocks in containing coal and in most of them being laminated. A thick-bedded sandstone (Fig.16 I) stands out above the soft siltstone and sandstone in an erosional scarp that can be easily traced across the air photographs. Some quartz greywacke bodies are cross-bedded, but most are thin-bedded.

In the banks of Roper Creek, east of Mount Roper Homestead, two isolated outcrops show evidence of slumping. At 43/3, on the north bank of Roper Creek, an exposed 14 feet of thin-bedded, fine-grained graded dark carbonaceous quartz greywacke is conformably overlain by 20 feet of coarse-grained cross-bedded quartz greywacke (Fig.33). These strata dip 2° at 300°, and are intruded on the western side by a trachyte dyke 3 feet across. Most of the graded beds of fine-grained quartz greywacke are ½-inch thick, a few are thicker; the overlying coarse-grained quartz greywacke is even-grained, and individual beds are 6 feet thick. The truncated contorted bedding and slump rolls in part of the lower beds are illustrated in Figure 33 and Figure 34. The graded bedding indicates that the lower beds were deposited in tranquil water, and the slump rolls and truncated contorted beds indicate intermittent current action. A change to sustained deposition by currents is indicated by the overlying cross-bedded coarse quartz greywacke. At 43/4, one mile downstream from 43/3, thin-bedded graded fine-grained dark quartz greywacke, probably the same beds as those exposed in the lower part of 43/3, are cut by a high-angle reverse fault (Fig.35). The beds contain rare slump rolls like those at 43/3. The fault has affected the attitude of the beds for a few feet on the west side and for 100 feet on the east side; the rocks on either side of the affected zone are horizontal. The depositional history of the rocks at 43/3 and 43/4 is interpreted as follows :-

(a) Graded beds of fine-grained carbonaceous quartz greywacke were deposited on a slope in tranquil water; the sediment remained water-logged.

(b) From time to time, in response to an unknown cause (probably instability on a slope), the uppermost layer flowed a short distance down the slope, and was contorted into slump rolls and other, less regular, masses; a smaller part of this slip was taken up in tiny faults (see right hand corner of Fig. 33 A); a few of these contorted masses were truncated by currents before the succeeding graded bed was deposited.

(c) The sediment at 43/4 was water-logged to a depth of several tens of feet below its surface, and this sediment responded to movement along the slope by riding over itself along a high-angle reverse fault (Fig.35).

(d) Sand-bearing currents swept across the area and deposited coarse quartz greywacke in thick beds.

Interpretation (c) is merely speculative. The high-angle reverse fault could also be a post-depositional fracture in dry sediments, but the slump rolls in these beds indicate that small-scale slumping took place during deposition and hence that, in this environment, larger-scale slumping was possible also. The evidence is too scanty to indicate a reliable direction of slope.

<u>Permian marine rocks west of the main outcrop</u>

The Quarry Hill Shaft, at Clermont (Fig.16 D), provides the only evidence of marine Permian rocks west of the main outcrop. Dunstan (1900) recorded marine fossils - pelecypods, gastropods, bryozoans, brachiopods, and a conulariid - from the shaft at a depth of 470 feet, and recognised them as Permian. Other noteworthy parts of the section cut by the shaft are coal bands at 220 feet, and a conglomerate at 395 feet, containing boulders of granite, schist and slate.

These rocks rest unconformably on chlorite slates and mica schists, and the unconformity has an eastward component of slope of at least 10°, equivalent to a relief of 1000 feet per mile. The Permian rocks have probably not been disturbed, and this relief is inferred to be original. The boulders in the conglomerate were probably derived from nearby hills of Anakie Metamorphics.

Dunstan determined the marine fossiliferous beds in the shaft as "probably on the same geological horizon as the fossil localities on the northern side of the Drummond Range, and at Capella"; in other words the fossils from the shaft probably belong to the clarkei-bed. J.M. Dickins (Appendix 2) has examined the fossils from the Quarry Hill Shaft in the Queensland Geological Survey Collection, and he confirms Dunstan's conclusion that these fossils roughly indicate the clarkei-bed.

By comparing the shaft section with the main outcrop, ~~we identify~~ the coal bands at 220 feet in the shaft are identified as equivalent to the coal seams that lie above the clarkei-bed within the Middle Bowen Beds. A consideration of the age of the nearby Blair Athol Coal Measures is now appropriate. Denmead (in Hill & Denmead, 1960, p.223) mentions that the spores of its coal seams suggest correlations with the Upper Bowen Coal Measures, but, as de Jersey (1946) admits, the evidence is tentative. Coal is known to occur in the Clermont Sheet area below the clarkei-bed (Collinsville Coal Measures), above the clarkei-bed within the Middle Bowen Beds, and in the Upper Bowen Coal Measures. Further work on the spores seems to be called for.

Blair Athol Coal Measures

The Blair Athol Coal Measures occupy an isolated basin within the Anakie Inlier between Miclere and Blair Athol. The sequence, which is probably 800 feet thick, consists of sandstone and shale, with four coal seams. The more persistent of these, the Big Seam, is over 100 feet thick, and is currently being mined by open-cut methods. The Coal Measures occupy an asymmetrical, probably depositional, basin, and overlie the Anakie Metamorphics with a marked angular unconformity. The Measures are overlain unconformably by Tertiary basalt and superficial deposits.

Dunstan (1900) called the coal-bearing rocks near Clermont the "Clermont Coal Measures". The term was vague and in fact included coal-bearing sediments other than those at Blair Athol. Reid (1936) variously called the coal-bearing sandstones and conglomerates the Blair Athol Coal Series and the Blair Athol Coal Measures. The key exposures are the open-cuts at Blair Athol and therefore ~~we prefer~~ the name Blair Athol Coal Measures is preferred.

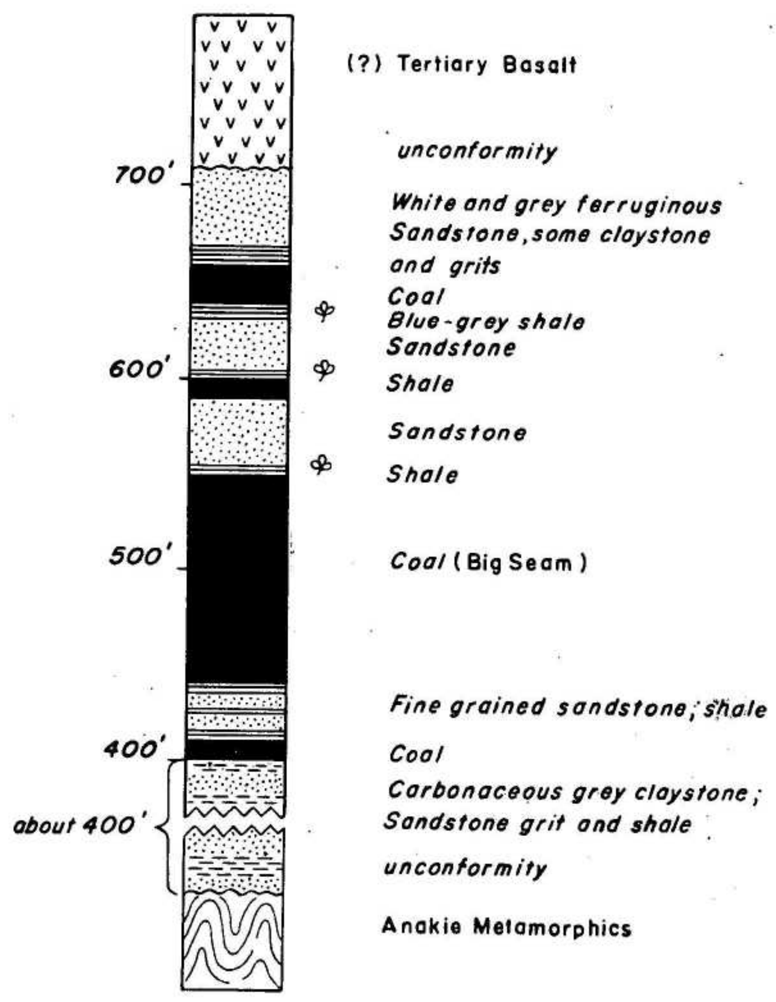

Fig. 36. COMPOSITE STRATIGRAPHIC SECTION IN BLAIR ATHOL COAL MEASURES

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The type area for the Blair Athol Coal Measures embraces the two open-cut mines at Blair Athol. Natural exposure is poor, and because the vertical exposures in the mine change from day to day with quarrying, a type section is not feasible. The section shown in Figure 36 is a composite section from exposures in the open cuts (as at March 1959) and drill holes (Whitcher et al., 1960). The open-cut mines are operated by Blair Athol Open Cut Collieries Ltd and Blair Athol Coal and Timber Co. Ltd; one is $1\frac{1}{2}$ miles north-west of Blair Athol Railway Station, the other $\frac{3}{4}$ mile south.

The basin occupied by the Blair Athol Coal Measures is 10 miles long, 8 miles wide at its southern limit, and two miles wide at its northern limit. Blair Athol Coalfield lies at the southern end of the basin in an area of alluvium, sand, and gravel; elsewhere the rocks are covered by basalt and superficial deposits except for low exposures at the Miclere and Black Ridge Goldfields, and at Cement Hill. The subsurface extent of the sediments was delineated by gravity surveys by Rayner & Thyer (1939) and Neumann (1959). These geophysical surveys were followed by drilling (Reid, 1948; Whitcher et al., 1960).

The area has a subdued topography of low rubble-covered rises, gravel plains, and black-soil plains. This topography has been influenced more by the widespread basalt than by the Permian rocks.

The Blair Athol Coal Measures consist of sandstone, shale, claystone, grit, conglomerate and coal (Fig. 36). The various lithologies are best seen in the open cuts; other lithological information has been obtained from numerous drill holes. The main seam at Blair Athol is 110 feet thick, and is at present being mined; economic aspects of this seam are discussed in the section on economic geology. A gold-bearing quartz pebble conglomerate at the base of the Coal Measures is exposed in discontinuous outcrops at Miclere and Black Ridge. Thin coal seams were intersected by shafts which were sunk to reach the gold-bearing rocks. Gold occurs in the sheared rocks of the Anakie Metamorphics and the gold in the Permian sediments was probably derived from this source.

Earlier workers regarded the Blair Athol Coal Measures as a part of the Upper Bowen Coal Measures isolated by structural movements; but recent geophysical and drilling surveys of the Blair Athol area suggest that the

Blair Athol Coal Measures are restricted to this area by deposition. The coal seams thin out and interfinger with sediments on the north-eastern, south-eastern, and southern margins of the basin, as is to be expected on the margins of a depositional basin. The gravity and drilling surveys indicate low dips, and the few known undulations are attributable to coal compaction. The correspondence between coal isopach maps and the structure contour map of the base of the Big Seam shows that this seam has been virtually undisturbed. The presence of basement hills that influenced sedimentation is known from drill holes and gravity anomalies. Finally, most normal faults exposed in the open-cuts have a throw of 2 to 3 feet; the greatest throw is 20 feet. Much greater throws would be expected if the basin had been formed by structural disturbance; large-throw faults however are unknown.

The strongest evidence for the coincidence of the depositional margin with the present day margin is found on the eastern side of the basin. Yet this is the very side on which one would expect to find the features of the central part of a basin had the present-day outline been determined by tectonic movement.

The Blair Athol Coal Measures lie in an asymmetrical basin within the Anakie Metamorphics. High gravity gradients in the northern part of the area indicate the slope of the basement rocks towards the surface. On the southern margin the gradients are gentler. Part of the basement surface is uneven; one drill hole intersected the metamorphics at 140 feet and another nearby at 580 feet. As computed from gravity anomalies, the maximum depth of the basement surface below ground level is 800 feet. Drilling has confirmed Neumann's (1959) estimates, by gravity measurements, of the extent of coal beneath the surface.

The Blair Athol Coal Measures were deposited in a slowly subsiding freshwater basin. Abundant plant remains occur in the shale and siltstone. The thick coal deposits indicate that the area was swampy for long periods and that such conditions were cyclic. The environment was probably similar to that prevailing in the Bowen Basin during the deposition of the Upper Bowen Coal Measures. Writing of the Blair Athol Coal Measures, Denmead (in Hill & Denmead, 1960) states that "the spores of its coal seams suggest correlation with the Upper Bowen Coal Measures". This is the only known evidence for correlation between the two units. The general conditions prevailing in the Permian history of the Bowen Basin must have been widespread, and a slowly subsiding, isolated basin nearby would probably accumulate sediments similar to those of the Upper Bowen. The position of this small basin within the stable block of the Anakie Metamorphics protected it from the subsequent tectonic events which affected the Bowen Basin.

Isolated outcrops of Permian plant-bearing rocks

Four small isolated outcrops of plant-bearing rocks were found in the Sheet area. On the east bank of Douglas Creek (Fig.6), an outcrop 20 feet across of light-grey siltstone contains a profusion of probable cone-scales. Mary E. White (Appendix B, in Malone et.al., 1961) dates them tentatively as Mesozoic, but because Permian siltstone of similar type occurs immediately to the north-east, ~~we prefer to regard~~ this outcrop is regarded as Permian. The other three outcrops contain plants which White dates as probable Permian. These are an outcrop of cherty shale and siltstone (CL 254/2), about 3 miles south-west of Mount Donald, an outcrop of quartz sandstone and quartz greywacke (CL 254/3), about ½ mile to the west, and sandstone with thin bands of siltstone (CL 262/1) west of Peak Downs Homestead.

The Unconformity between the Permian and older rocks

The unconformity wherever it is exposed or known from shafts is an uneven surface, and this is due probably to initial relief, not to subsequent folding or faulting. At Clermont, the unconformity slopes at least 10°, and the Permian rocks above the unconformity contain boulders of locally derived rock; and along the north-western edge of the marine outcrop near Mount Lebanon - the only other place in the Sheet area where the unconformity is known - the lowermost Permian rocks, from the unconformity to the pelecypod-bed 20 feet above the clarkei-bed, contain abundant pebbles, boulders, and blocks which are lacking (except the odd boulder) in equivalent rocks elsewhere in the main outcrop.

The level of the unconformity east of Grass Tree Tank (Fig.18) is not known except perhaps in the Cherwell Bore (Fig.16), which, according to the driller's log, terminated in "dark volcanic rock". ~~We prefer to regard~~ This is regarded as Bulgonunna Volcanics rather than as a (?)Tertiary basalt sill or dyke, which are not seen in this area. Following on this interpretation,

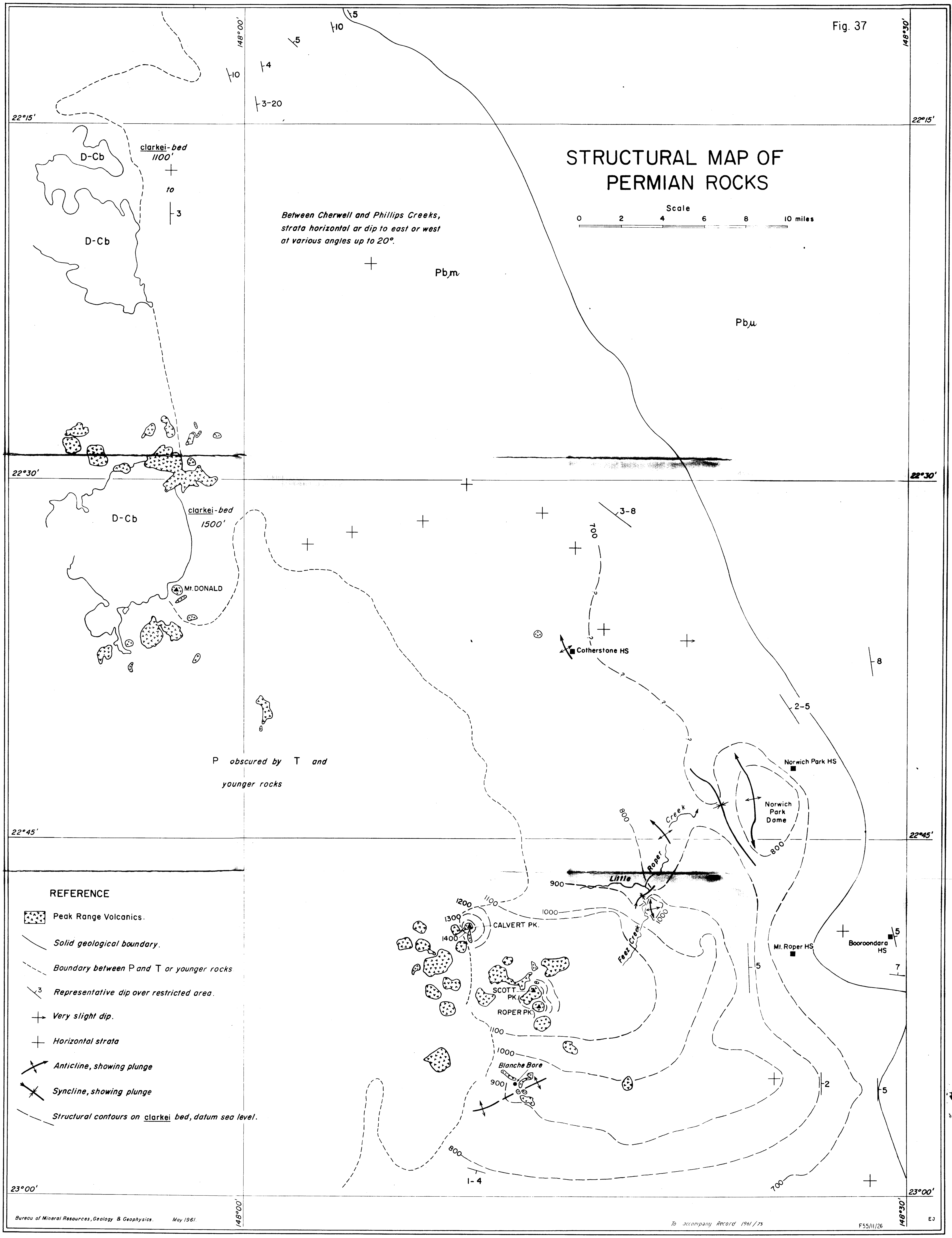

Fig. 37
STRUCTURAL MAP OF PERMIAN ROCKS
Scale
0 2 4 6 8 10 miles
148°00'
148°30'
22°15'
22°30'
22°45'
23°00'
clarkei-bed 1100'
to
clarkei-bed 1500'
D-Cb
Between Cherwell and Phillips Creeks, strata horizontal ar dip to east or west at various angles up to 20°.
Pbm
Pbu
Mt. DONALD
Cotherstone HS
Norwich Park HS
Norwich Park Dome
Little Roper Creek
Feez Creek
CALVERT PK.
SCOTT PK
ROPER PK
Blanche Bore
Mt. Roper HS
Booroondara HS
P obscured by T and younger rocks
REFERENCE
Peak Range Volcanics.
Solid geological boundary.
Boundary between P and T or younger rocks
Representative dip over restricted area.
Very slight dip.
Horizontal strata
Anticline, showing plunge
Syncline, showing plunge
Structural contours on clarkei bed, datum sea level.
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we ~~tentatively identify~~ the "cream and grey concrete" is tentatively identified as the Permian pebble and boulder conglomerate that is found above the unconformity in this area, and the coal as equivalent to the Collinsville Coal Measures. According to this interpretation, which is little better than a speculation, the unconformity has an easterly component of slope of about 450 feet in three miles, or $1\frac{1}{2}^{\circ}$, roughly parallel to the dip in the overlying Permian rocks.

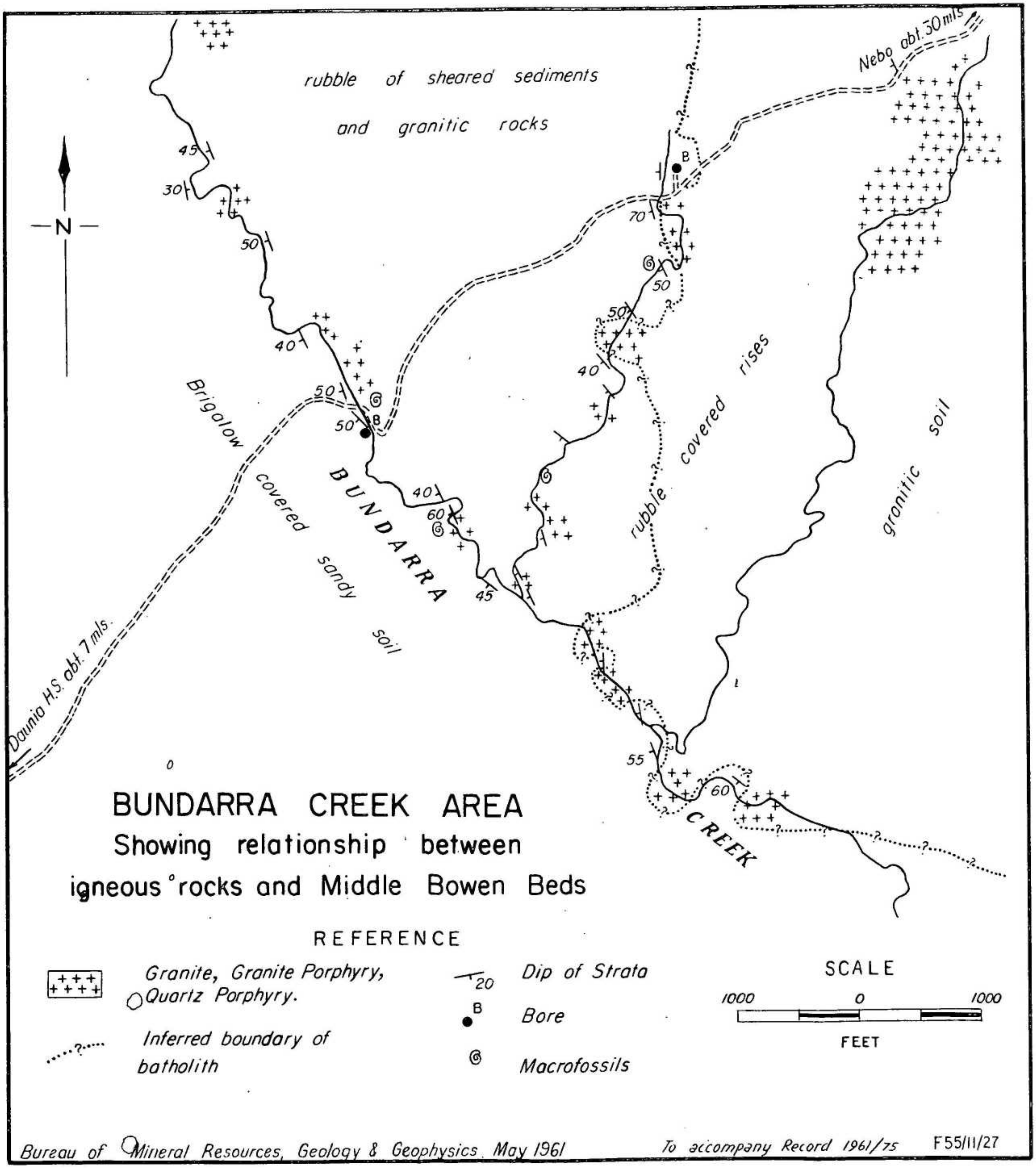
Reid (1928) and later workers have regarded the inclusions in the _clarkei_-bed and adjacent strata in the Mount Lebanon area as glacial erratics, dropped into "normal" marine sediments by melting icebergs. The origin of some inclusions, in particular the larger blocks, may be explained best this way, but ~~we~~ it is considered that most were derived by marine processes from the nearby steep shore. The pebbles of milky quartz at the base of the Permian in the Fletcher's Awl area are easily traced to the Anakie Metamorphics and to the Bulgonunna Volcanics, which today are strewn over by similar pebbles. No inclusion in the basal Permian need be regarded as truly erratic because each rock type can be matched with parts of the nearby outcropping Bulgonunna Volcanics or with the Anakie Metamorphics, which outcrop no farther than 12 miles away. Immediately before Permian sedimentation, the considerable relief of the surface at Clermont Township probably persisted over the Anakie Inlier and over the Bulgonunna Volcanics, which, not long deposited and consisting of acid volcanics including rhyolite, probably stood up above the surrounding country as the acid volcanics of the Peak Range do today.

Structure

The structure of the _clarkei_-bed in the south-eastern quadrant of the Sheet area is fairly well known (Fig.37). Elsewhere, except in the marine rocks between the unconformity and the Cherwell Range, and around the igneous intrusions in the Peak Range and in the north-eastern part of the Sheet area, outcrop is discontinuous, no marker bed was found, and consequently the structure is not clear. The extension of the Permian rocks south and west of Lords Table Mountain is obscured by basalt.

In general, the Middle Bowen Beds are horizontal or dip gently eastward to north-eastward; near their junction with the Upper Bowen Coal

FIG. 38


rubble of sheared sediments
and granitic rocks
Nebo abt. 30 mls
N
Brigalow
covered
sandy
soil
BUNDARRA
CREEK
rubble covered rises
granitic soil
Dounia H.S. abt. 7 mls.
45
30
50
40
50
50
40
60
45
70
50
50
40
55
60
B
BUNDARRA CREEK AREA
Showing relationship between
igneous rocks and Middle Bowen Beds
REFERENCE
Granite, Granite Porphyry,
Quartz Porphyry.
Inferred boundary of
batholith
Dip of Strata
Bore
Macrofossils
SCALE
1000
0
1000
FEET
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Measures, the Middle Bowen Beds are folded into a monocline dipping about 5° eastward to north-eastward; the succeeding Upper Bowen Coal Measures maintain this dip; farther east from the junction, the Measures presumably dip eastward, but their structure is unknown. In the north-eastern part of the Sheet area, at Daunia, syenite has arched the Upper Bowen Coal Measures into a dome; two other domes, not breached by igneous rock, lie nearby. The Mount Flora granite has also domed up strata, and a belt of Middle Bowen Beds two miles wide is exposed. The edge of the batholith with numerous apophyses in the Bundarra Creek area is shown in Figure 38.

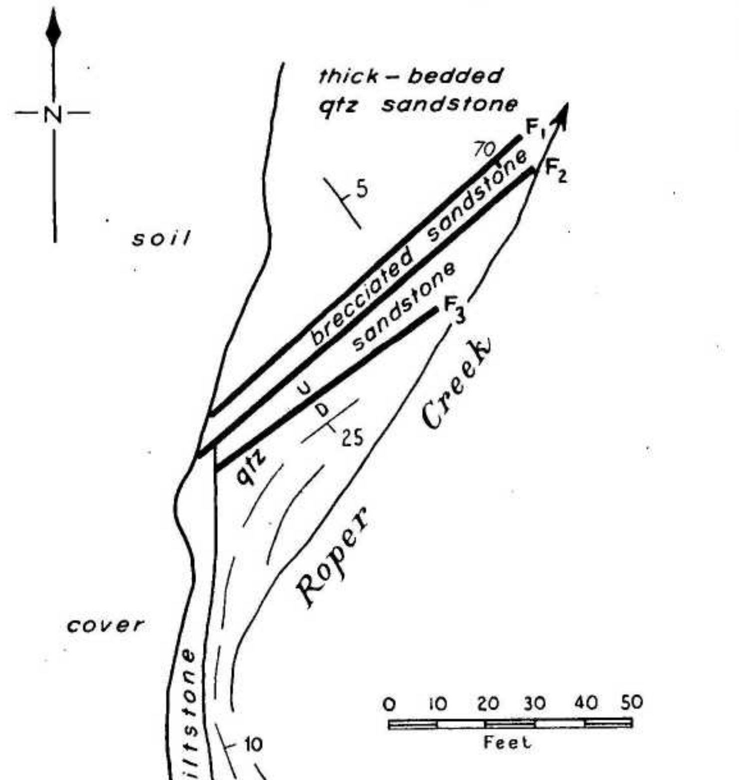
The structure of the Cherwell Range has been described above. More detailed mapping in the south-eastern quadrant of the Sheet area revealed the following folds: Norwich Park Dome . Rowe(in Hill & Denmead, 1960, p.195) first mapped this dome, which he called the "West Dome" (abbreviated from Norwich Park West Dome). The dome is established by dip measurements in the area, and by barometric levels on the *clarkei*-bed. The dome has no obvious topographic expression, and its core is drained by Scott Creek and an unnamed tributary. The *clarkei*-bed, whose outcrop presumably rings the dome, was seen at seven points (see Plate 1) and the steepest measured dip is 5°. The highest preserved *clarkei*-bed is 845 feet above sea-level, and the lowest exposed, on the western flank, 710 feet. The structural relief on the west is therefore about 150 feet. On the east, the *clarkei*-bed dips beneath the Upper Bowen Coal Measures, and relief on this side is probably several thousands of feet. The Norwich Park Dome is complemented on the west by a syncline.

Folds in the Little Roper/Feez Creeks Area.

Three folds were mapped in the area near the confluence of Feez Creek and Little Roper Creek. 2½ miles north of the confluence, on Little Roper Creek, beds dip 5° north-eastward, and a mile to the west 2° westwards. A dome and complementary syncline were mapped immediately south of the confluence. The north-western part of the dome dips steepest, at 13°; the *clarkei*-bed, dipping 13° at 310°, lies at an elevation of 860 feet in the north-west part of the dome; on the axis, on top of a mesa, it lies at 1,060 feet. The structural relief is therefore 200 feet. In the east, the dome dips 2° or less.

Fig. 39

Sketch map of faulted strata, near Mt. Roper Hsd. (28/1)



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Anticline near Blanche Bore.

One mile east of Blanche Bore, beds dip off the axis of an anticline at 11° north-westward, and 9° south-eastward. Probably the same anticline extends to Stonybar Creek, where beds dip off an axis 2° south and 5° north. Farther south on Stonybar Creek, beds are horizontal or dip gently southward.

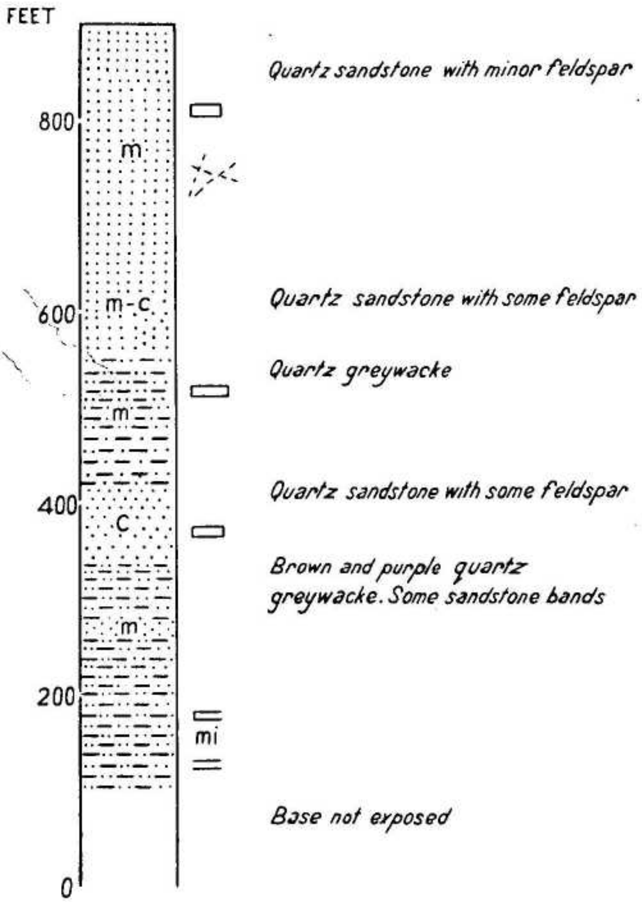
Diapiric Domes. The Peak ~~Downs~~ Range Volcanics at Scott and Roper Peaks, Calvert Peak, and Mt.Donald have domed and pierced the Permian country rock. The clarkei-bed is exposed at all these localities, and, from its elevation, an estimate can be made of the structural relief. Its greatest measured elevations are 1,485 feet between Roper and Scott Peaks, 1,420 feet near Calvert Peak, and 1,550 feet near Mt.Donald. In the Roper, Scott and Calvert Peaks area, most of the structural displacement is found within a half-mile radius of the intrusions, as is indicated by dips ranging up to vertical; regionally the Permian rocks have been domed within a radius of 8 miles. Details of the intrusive relations are given on p.68 . The Permian rocks around Mt.Donald dip up to vertical in a zone 300 yards wide. A syncline which lies immediately west of Mt.Donald has been formed by a westerly tilt from Mt.Donald and by a regional, pre-intrusive, easterly dip near the unconformity.

Faults. The fault at CL43/4, on Roper Creek, has already been described. The few faults seen have small throws. For example, at CL 28/1, near Mount Roper Homestead (Fig.39), three faults cut sandstone snd siltstone of the Middle Bowen Beds. The faults hinge from their southern exposed ends, and despite the short throw, the sandstone between F_1 and F_2 is finely brecciated.

Geological History

The known Permian geological history of the Clermont Sheet area starts with the deposition of coal measures in the Rugby area; how far east and south they extended is not known, but they possibly extended at least to the Cherwell Bore area. The first Permian marine sediments were then deposited in a transgressive sea that spread as far west as the high ground of the Anakie Inlier in the Clermont Township area, and the Bulgonunna Volcanics in the Logan Downs area. The coal measures in the Rugby area were completely covered by marine deposits, which, in their transgression, gathered up loose boulders and blocks of volcanic and metamorphic rock. Sessile benthonic animals, mainly brachiopods (Strophalosia clarkei), and subsequently pelecypods, flourished over the whole area; this was the only uniformly abundant shelly benthonic fauna in the area during Permian deposition. In the Mount Lebanon area, floods running off the steep land brought in boulders and blocks; rarer blocks here, and in the clarkei-bed in the Peak Downs 1-mile Sheet area, at least twenty miles from the shore, were possibly brought in by drifting ice-bergs. Marine sediments accumulated in the south-east quadrant of the area, and alternating marine and freshwater sediments, including coal, accumulated in the shallower area north of Phillips Creek. Despite the interruptions to marine deposition north of Phillip's Creek, the sediments in this area are about twice as thick as the entirely marine sediments of the south-east quadrant. Presumably at roughly the same time, the sea left both areas, and a long period of freshwater deposition started. The western extent of freshwater deposition is unknown. The Blair Athol Coal Measures were probably deposited at this time but in an isolated basin, not connected with the Upper Bowen Coal Measuresto the east. In the north-east quadrant, the Upper Bowen Coal Measures were succeeded, probably in the Triassic, by the freshwater Carborough Sandstone, which, together with the Permian rocks, were gently folded at some later, unknown period in the Mesozoic. Older Permian rocks than those exposed at the surface probably underlie at least part of the main outcrop. The A.F.O. Cooroorah No.1 Well (Fig.16A) started about 200 feet stratigraphically below the top of the Middle Bowen Beds and penetrated 3,000 feet of sediments, probably all Middle Bowen Beds, before entering a sequence of volcanic and plutonic rocks, which is interpreted as equivalent to the Lower Bowen Volcanics or Bulgonunna Volcanics. Unless the Middle Bowen Beds double in thickness between the south-east quadrant of the Sheet area and the Cooroorah Well area, Permian rocks older than those exposed in the Sheet area are present in the well, and possibly extend under at least part of the main outcrop. The postulated older beds, like the Collinsville Coal Measures, are not exposed because they were overlapped by the transgressive clarkei-bed.

Fig. 40



Stratigraphic Section of the Carborough Sandstone at Mt. Iffley

F55/11/29

To accompany Record 1961/75

Questions about the source of the sediments and the precise kind of depositional environment will be answered best when the neighbouring areas have been mapped, and when the petrography of the marginal and basinal rocks is completed.

TRIASSIC

Carborough Sandstone

Several isolated outcrops of quartz sandstone and quartz greywacke have been mapped east of the Isaacs River, between Devril and Iffley Homesteads. The main outcrop is a dissected mesa four miles long and two miles wide in which 830 feet of section are exposed. The rocks are referred to the Carborough Sandstone, which is believed to be Triassic.

Reid (1928) variously called these rocks Carborough Sandstone, Carborough Range Sandstone, and Carborough Series. The type area, the Carborough Range in the Mt.Coolon 4-mile area, is described by Malone et al. (1961).

The lithology of the Carborough Sandstone is shown in the section in Fig.40. This section was measured by barometric levelling on the slopes of Mt.Iffley which, with Mt.Coxendean and Coxens Peak, are erosional residuals in the main outcrop area. At CL306/1, two miles north-west of Mt.Iffley, a bed of quartz sandstone, rich in feldspar and iron, has weathered to a gritty iron-stained clay. The sediments are cross-bedded.

The junction between the Carborough Sandstone and the underlying Upper Bowen Coal Measures has not been seen in this area. In the Carborough Range, structures within the unit are conformable with those in the Coal Measures; Malone et al.(1961) postulate a disconformity between these units on the basis of a lithological break. At Mt.Iffley these rocks appear to dip south-eastward, but the magnitude of dip is obscured by cross-bedding. From the air the mesa appears to dip south-eastward at about five degrees (Fig.41).

At the base of Coxens Peak, a poorly preserved equisitalean plant was found in a medium-grained quartz sandstone. This fossil occurs throughout the Palaeozoic and Mesozoic, and so confirms that these rocks are older than Tertiary.

(?) TERTIARY

Suttor Formation

Isolated outcrops of quartz sandstone and siltstone crop out in the north-east part of the Clermont 4-mile area, and in the Mt. Coolon 4-mile area where they have been named the Suttor Formation (Malone et al.,1961). These rocks are two hundred feet thick, nd unconformably overlie the Upper Bowen Coal Measures.

The Suttor Formation crops out in mesas and tablelands north of the Isaacs River, between New Chum Creek and the Clermont Coast Highway. The mesas range from 80 to 200 feet high, and are bounded by steep escarpments. In the same area low rises covered by sand and rubble are probably erosional residuals of this formation.

The lithology is predominantly clean quartz sandstone with small lenses of siltstone and quartz pebble sandstone and conglomerate. Most pebbles are angular to rounded fragments of quartz and chert. The mesas are capped by a lateritised quartz sandstone 20 to 30 feet thick.

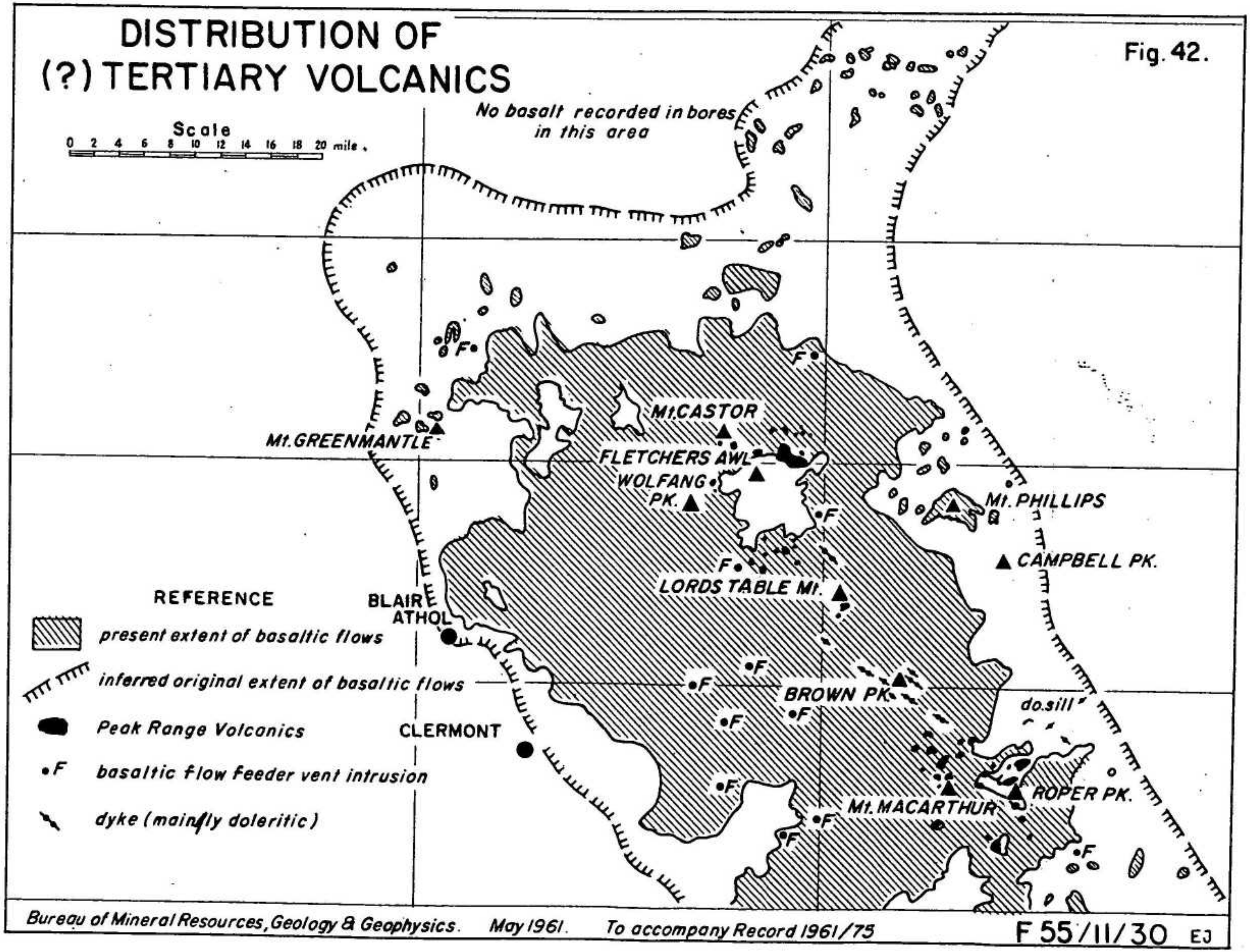
The rocks of the Suttor Formation are flat lying; they unconformably overlie the Upper Boweh Coal Measures, but nowhere in the Sheet area are they in contact with any other unit. East of Mooroombah Homestead they probably overlie the Tertiary basalt but the junction is not exposed. In the Mount Coolon 4-mile area, Tertiary sandstones lie below (Exevale Formation) and above (Suttor Formation) the basalt (Malone et al.,1961). Some outcrops in the Clermont 4-mile area possibly belong to the Exevale Formation. Malone et al. (1961) report the occurrence of a dicotyledonous leaf in the Suttor Formation, and consider, the unit to be a Tertiary freshwater deposit.

(?) TERTIARY VOLCANICS

The probable Tertiary volcanics of the Clermont Sheet area comprise flows of olivine basalt with other minor rock-types, and a suite of soda-rich trachytic and rhyolitic shallow and hypabyssal intrusions with very minor related flows (Peak Range Volcanics).

The basaltic flows now cover less than a third of the Clermont Sheet area in a north-west trending belt, 35 miles wide, but the original flows possibly covered half the area. The flows were poured out on an uneven surface, and thicknesses are locally very variable; the maximum thickness

Figure 41. Oblique air photograph of Carborough Sandstone in a mesa (Mount Iffley) east of the Isaacs River.


DISTRIBUTION OF
(?) TERTIARY VOLCANICS
Fig. 42.
Scale
0 2 4 6 8 10 12 14 16 18 20 mile
No basalt recorded in bores
in this area
Mt. GREENMANTLE
Mt. CASTOR
FLETCHERS AWL
WOLFANG PK.
Mt. PHILLIPS
CAMPBELL PK.
LORDS TABLE Mt.
BLAIR ATHOL
CLERMONT
BROWN PK.
do. sill
Mt. MACARTHUR
ROPER PK.
F
REFERENCE
present extent of basaltic flows
inferred original extent of basaltic flows
Peak Range Volcanics
•F basaltic flow feeder vent intrusion
dyke (mainly doleritic)
Bureau of Mineral Resources, Geology & Geophysics. May 1961. To accompany Record 1961/75
F 55/11/30 EJ

of 1600 to 2000 feet is in the central part of the Peak Range. The main rock is porphyritic olivine basalt with subsidiary amounts of less basic rock, both with vesicular equivalents. Extrusive centres are widely distributed in the form of sills, vent intrusions, narrow doleritic dykes, all with a dominant north-westerly trend. The vent intrusions are circular in plan and the plug rock is either olivine basalt, commonly with nodules of peridotitic material, or a gabbroic rock. The flows are regarded as Tertiary from their field relation to Tertiary sediments in the Mt. Coolon Sheet area.

The Peak Range Volcanics are a suite of soda-rich trachytic and rhyolitic domes, plugs and other intrusions. The petrogenetical relations of these rocks to each other and to the olivine basalts are not yet clear, but they probably all belong to one volcanic phase and are derived from one basic magma-type. The mechanisms of emplacement of the intrusions can be fairly reliably reconstructed, because the form and features of the intrusion have been well preserved. The intrusions diapirically pierce the Devonian-Carboniferous Bulgonunna Volcanics, the Middle Bowen Beds, and, almost certainly, the (?) Tertiary basaltic flows.

Leichhardt (1847) in 1844 was the first to discover and describe the Peak Range, and he named most of the prominent peaks. He compared the peaks to the puys d'Auvergne. Reid (1928) briefly described the volcanics. His report is a topographic description of the Peak Range with a discussion of age relations between the three major rock groups, the olivine basalts, trachytes, and rhyolites, with brief petrographic descriptions by A.K. Denmead.

A short account of the Peak Range Volcanics by Brunnschweiler (1957) contains some stimulating theories on their age. Contrary to Reid's and the present authors' views, he considers this group to be much older than the basaltic flows.

Richards (1918) deals with a similar volcanic sequence in the Springsure area.

The Basaltic Flows

A sheet of (?) Tertiary basaltic flows covers a third of the Clermont Sheet area (see Figure 42). The basalt sheet is now no more than a few hundred feet thick except in the central part of the Peak Range and at Mt. Phillips where it is 1500 to 2000 feet thick. Much of the basalt sheet is covered by heavy-textured dark soil which locally contains basalt boulders; this is open grassy downs country with clumps of trees. Drainage is poor and access difficult after rain.

The sheet consists of numerous flows of porphyritic olivine basalt, some vesicular, that rest on an uneven surface of Anakie Metamorphics, Bulgonunna Volcanics, and Permian sedimentary rocks. Except in a few localities the junction with the older rocks is obscured by soil. The basaltic lava was extruded through fissures, now occupied by sills and dykes, and small circular vents, now occupied by plugs.

Distribution and thickness

Similar basaltic flows cover large areas to the south, in the Emerald and Springsure Sheet areas and to the north, in the Mt. Coolon Sheet area. Smaller outcrops occur to the east of these areas.

The basalt sheet is still an almost continuous sheet except for areas of outliers in the south-east where basalt lies on Permian rocks at heights up to 1200 feet, and in the north and east parts of the Sheet area. In the Mt. Violet one-mile Sheet area there is no evidence of basalt either in outcrop or in bores, and basalt probably did not extend to this area. Also the area to the south of Fletcher's Awl - in places over 2,000 feet above sea level - was probably not covered by flows. The western and eastern boundaries of the basaltic sheet roughly parallel the regional strike. The major part of the basaltic sheet seems to have occupied a broad depression between the higher areas of the Anakie Inlier and the wide ridge of outcropping Middle Bowen Beds to the east.

Most of the basalt sheet is a few hundred feet thick but thickness varies locally with the pre-existing and present relief. Water bore information suggests the basalt is up to 500 feet thick. Most of the sheet is now represented by areas of heavy-textured dark soil that in places contain basalt boulders; water bores indicate that most of these black soil downs are underlain by basalt. Flat-topped remnants of basalt, most about 100 feet high, occur over the western half of the sheet. The remnants of basalt in the eastern part of the sheet, especially to the north of

Figure 43. Central-southern part of the Peak Range showing horizontal basaltic flows. Looking south from summit of Gilbert's Dome.

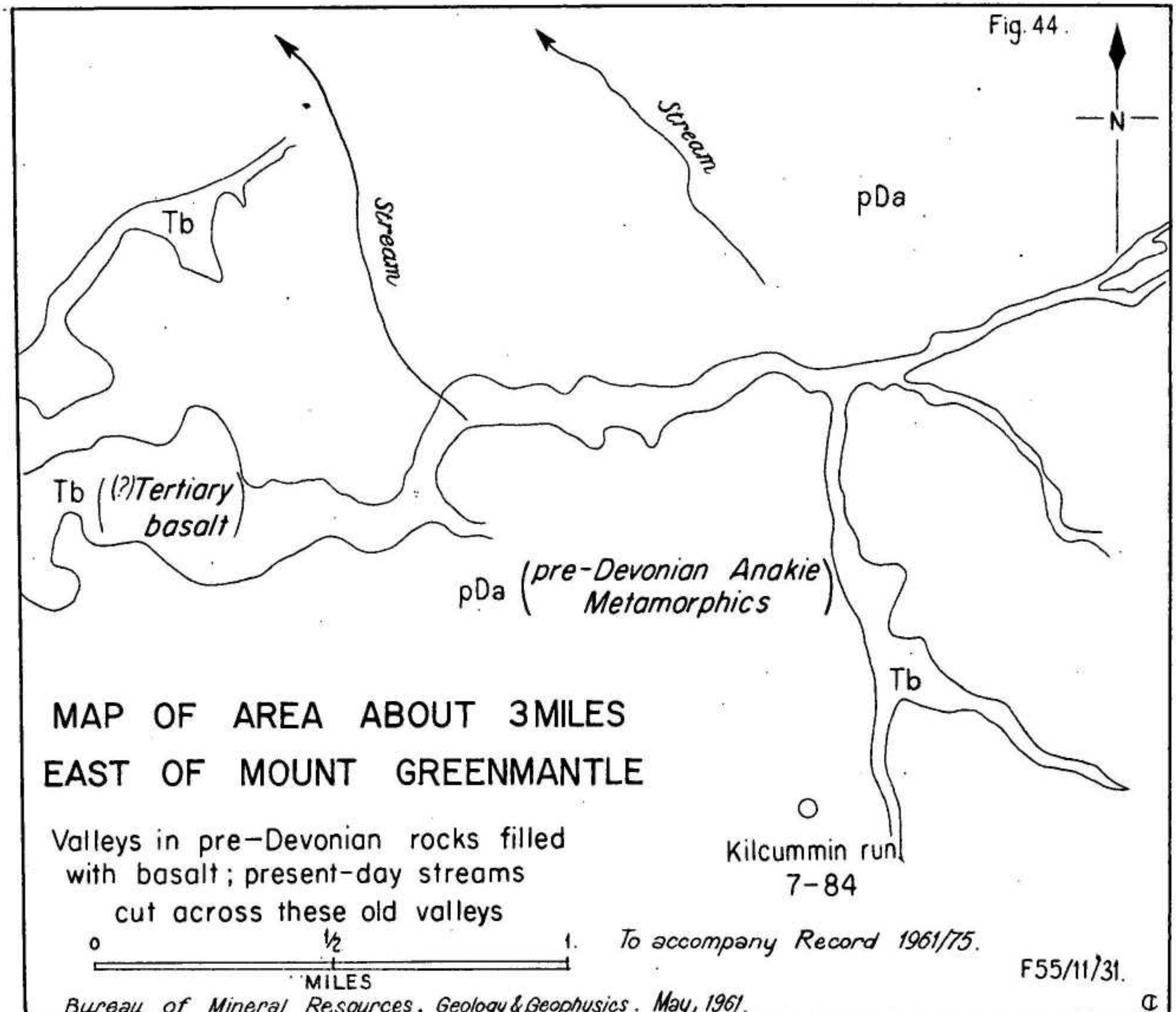


Fig. 44.
N
Stream
Stream
pDa
Tb
Tb ((?)Tertiary basalt)
pDa (pre-Devonian Anakie Metamorphics)
Tb
MAP OF AREA ABOUT 3 MILES EAST OF MOUNT GREENMANTLE
Valleys in pre-Devonian rocks filled with basalt; present-day streams cut across these old valleys
0
½
1.
MILES
Kilcummin run 7-84
To accompany Record 1961/75.
F55/11/31.
Bureau of Mineral Resources, Geology & Geophysics. May, 1961.

Lord's Table Mountain, are thicker and reach 500 feet in places. A maximum thickness of 1600 feet was measured from the plain to the top of Brown's Peak where the flows are horizontal (Figure 43). Water bores on the plain in this area penetrate as much as 300 feet of basalt. The total thickness is therefore nearly 2,000 feet. The only other area with a thick sequence of flows is Mt. Phillips where the estimated thickness is 1500 feet. The thick sequence probably covered a larger area than that of the erosional remnants of the central part of Peak Range and Mount Phillips. The axis of the Peak Range was arched up by the intrusion of the Peak Range Volcanics to form a divide, and only along this divide and at Mount Phillips has thick basalt been preserved.

The number of extrusive phases is not easily deduced due to soil and scree cover and deep weathering. It is tentatively estimated that there are 20 to 25 flows exposed in the central part of the Peak Range. The deep weathering of some flows indicates quiescent intervals between effusive outbursts.

The junction of the basalt with older rocks is visible only in a few places near the preserved edge. In the western parts of the Blair Athol and Kilcummin one-mile Sheet areas, air photograph patterns indicate old water-courses filled with basalt (Figure 44). Water bores in the areas adjacent to the Mt. Violet and Kilcummin one-mile Sheet areas indicate basaltic flows interbedded with (?) Tertiary lacustrine sediments. Other lacustrine sediments were deposited in the Mt. Violet one-mile Sheet area, and interfinger with basalt to the south. The eastern margin of the basalt rests on a dissected surface of Permian rocks, which has a similar erosion surface to that of outcropping Permian farther east. The relief of this surface probably exceeds 300 feet because the base of the basalt at Mt. Phillips lies at 900 feet, and nearby hills of Permian sandstone rise to 1200 feet. No evidence of post-basalt faulting was seen. Similar relief in the pre-basalt surface is also seen at CL 29/1 about four miles north-east of Coomburragee Homestead where the base of a small basalt outlier is 390 feet lower than a hill of Permian sandstone immediately to the north-west. The only locality where a sharp junction was seen between the basalt and older rocks is in a gully near the head of Feez Creek at CL 236/5.

Basalt rests on a dip slope in Middle Bowen sandstone and water issues in a spring at the junction. The sandstone is not noticeably altered.

Petrography.

Probably over 90% of the lavas are porphyritic olivine basalts with vesicular equivalents. They are fine to medium-grained, commonly with phenocrysts of olivine up to ¼ inch long. Olivine-nodules, coarse-grained clots of olivine and pyroxene, up to two inches long, are also common near, and in feeder vents. In some rocks the olivine is seen in thin section only. Olivine percentages vary from about 5% to 25%, but are commonly about 10%. Plagioclase (45-55%), mainly labradorite, and pyroxene (25-35%), mainly augite, have a characteristic ophitic texture. Magnetite, hematite and calcite are accessory and secondary minerals. Aphanitic equivalent rocks occur commonly in vesicular flows. Many vesicles contain amygdales and pockets of banded and massive chalcedony, crystalline quartz, calcite, and zeolites. Ovoid vesicles with their long axes parallel to the flow faces are common in the top part of a single flow. The olivine basalts are commonly a dark steel-blue; lighter colours are rare; some colours are the result of deep weathering, others are probably due to less basic rock, possibly andesite. The deeply weathered and the vesicular flows locally form shallow aquifers. The olivine basalts weather to characteristic 'platy' and 'spheroidal' forms.

Insufficient petrography has been done to indicate any compositional trends, vertical or lateral, within the flows. Denmead (in Reid, 1928) describes an alkali olivine basalt with small anorthoclase phenocrysts, but precise locality details are not given.

Feeders.

The basaltic lava was extruded through fissures and small vents which now form dykes, sills and plugs (Figure 42). Most of the dykes are less than 10 feet wide and over a mile long; they are dolerite or olivine dolerite, and are deeply weathered. They have chilled aphanitic margins and where they intrude Permian rocks have baked a very narrow zone. Dykes are seen in the Feez and Little Roper Creeks Sheet areas at CL 233/4, CL 40/2 and CL 41/2. The dykes have a predominantly north-westerly trend; a few trend north-easterly. Most of the dykes were seen in, and to the east, of the Peak Range area. One concordant doleritic sill intrudes the clarkei-bed of the Middle Bowen Beds at CL 237/4 in Little Roper Creek.

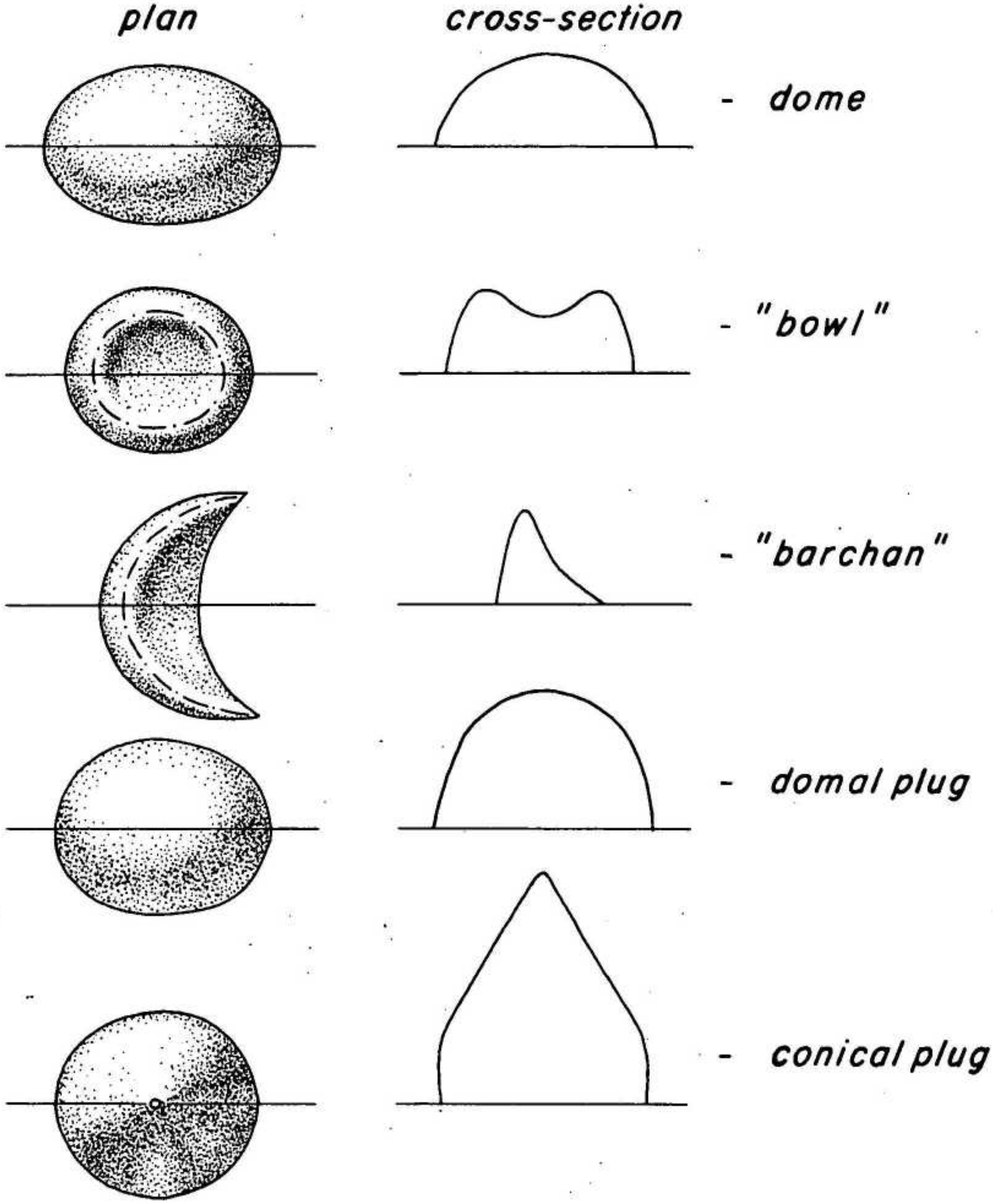
Several feeder-vent intrusions or plugs are shown in Figure 42 but probably many more were not seen. They are now in the form of small symmetrical cones, usually less than 300 feet high and this probably explains why most that were found are in downs country, especially that area between Clermont and the Peak Range where they form prominent knolls including Beacon Hill, Mount Oscar and Pumpkin Hill. In hilly areas they can be easily overlooked but some have been identified from air photographs. The plugs are jointed in vertical columns one to two feet across. The plugs consist of olivine basalt or a coarse-grained plutonic rock that is probably gabbroic. The petrogenetic implications of this rock are not clear as it still requires analysing. The olivine basalt in the vents contains 'olivine-nodules', which are probably small pieces of peridotite dragged up by the effusive basaltic magma.

Concentric ring patterns on air photographs are fairly common in areas of flat-topped remnants and black soil downs. Two such patterns, each about a mile in diameter, occur immediately to the south of Abor Downs Homestead. On the ground the rings are low rubbly rises. Their origin is unknown.

Figure 45a. Panorama looking north-west from the summit of a trachyte dome to the north-east of Scott Peak. It shows some of the intrusion landforms at the southern end of the Peak Range.

Fig. 45 b

Morphology of main types of intrusions of Peak Range Volcanics



Bureau of Mineral Resources, Geology & Geophysics. *May 1961.* E J

The Peak Range Volcanics are the shallow and hypabyssal intrusions and minor extrusions that are exposed in the Peak Range (Figure 42). The intrusions occur mainly in two areas, one at the north end, the other at the south end of the Peak Range.

For the purposes of description the intrusions have been grouped on a morphological basis. The various morphological groups and their distribution are as follows (Figs 45a and 45b):

Morphological Group	Number in Southern Area	Number in Northern Area
Trachytic and rhyolitic domes	8	2
Trachytic and rhyolitic "bowls"	4	-
Trachytic "barchans"	4	-
Trachytic and rhyolitic spurs	4	-
Trachytic ridges with convex cross-section	3	-
Two other intrusions in the southern area are probably the combination of two or more of the above forms.		
Rhyolitic domal plugs	4	3
Rhyolitic conical plugs	3	about 11
Rhyolitic sharp-crested ridges	-	about 8

Probably all the intrusions in each group were similarly emplaced and their present landforms are probably very similar to their original shapes.

Three rhyolitic flows and other rhyolitic bodies of unknown origin occur in the northern area and probably belong to the Peak Range Volcanics. The composite intrusion of Mount Macarthur is described separately. The trachyte plug of Campbell Peak and the trachyte cap of Lord's Table Mountain lie outside the two main outcrop areas, but probably belong to the Peak Range Volcanics.

Trachytic and Rhyolitic Domes

Most domes are elliptical in plan. Their lengths range from one hundred yards to one and a half miles and their height from 100 to 1200 feet above the plain. Flanks slope from 20° to 50°. Mt. Lowe, a trachytic dome, is nearly a mile long and 750 feet high. The steepest flanks slope at about 45°. Platy flow layering is roughly concentric with the dome but is nearly vertical at the base where the flanks slope gently. The lower slopes are covered by soil and scree, and intrusive relationships are obscured. The trachyte is microsheared and microfractured and is everywhere deeply weathered. It has a schistose appearance and is reddish-brown or green. At the summit it is vesicular. Similar rock forms many intrusions of the southern area, and a few fresh samples were obtained, mainly from 'kernels' in the centre of concentrically-weathered boulders. The fresh rock is fine-grained and light-grey with small dark specks.

The largest trachyte dome, locally known as Red Mountain, lies immediately north-east of Scott Peak. Its plan is roughly pear-shaped and about one and a half miles long. It rises 1200 feet above the plain and the flanks slope at about 45°, except on the western face where they are much steeper. Platy flow layering, with layers three to six inches thick, is well exposed in a deep gully on the western face. The layering dips up to 70° near the base. The dome has arched up the Middle Bowen Beds which dip 45° near the intrusion wall on the western face, but the dips quickly decrease away from the dome and the zone of disturbed dips is, at most, half a mile wide. The sediments, even within a few feet of the intrusion wall, are unaltered. The clarkei-bed is exposed at CL218/3, and dips away from the dome at 15°. Most of the dome rock is deeply weathered, but some fairly fresh samples were collected. It is a grey, fine-grained aegirine-trachyte with scattered anorthoclase phenocrysts up to two millimetres long, set in a ground mass mainly composed of anorthoclase, about 5% aegirine, accessory interstitial quartz, and possibly some albite and riebeckite. The dome appears to have been intruded by a plug or dome of a similar but more acidic rock, but relations between the two are obscured. Erosion on the western face of the dome is exposing this second intrusion. It is crossed by two sets of close vertical joints, three to six inches apart, normal to each other. The rock is fresh, light grey and fine-grained. It has a seriate fabric and most grains are anhedral. It contains slightly more interstitial quartz than the trachyte of the main dome. An interesting feature that indicates the lava was moved during solidification is the strained and fractured anorthoclase crystals, which are cross-fractured, their extinction is undulose, and they form interpenetrant grains. The rock on the top of the main dome has an open texture with vesicles filled with weathered amygdales.

Malvern Hill, about two miles to the south, has a very similar air-photograph pattern due to deep radial gullies. This is a trachyte dome with a circular plan, three quarters of a mile across, and a conical-like shape. The rock is deeply weathered and when fresh is light grey, and fine-grained, with porphyritic feldspar. Basalt dips off the lower eastern slopes of the dome.

The emplacement of each of these three intrusions, (Mt. Lowe, Red Mountain, Malvern Hill) was probably very similar. They are steep-flanked domes, probably exogenous, formed from a viscid lava that arched both the Middle Bowen Beds and the basaltic flows. Upward movement continued after solidification had begun and the differential movement within the plastic mass caused microshearing and microfracturing of the rock and the constituent grains. The escape of gas during intrusion is indicated by vesicular, open textured rocks on the summits of Mt. Lowe and Red Mountain.

A mile south-east of Malvern Hill there is a small trachyte dome with an elliptical plan a few hundred yards long. Its intrusive relations are obscured and the microsheared rock is deeply weathered to greenish brown. Two small trachyte domes, roughly elliptical in plan and only a hundred yards long, occur a mile north of Scott Peak. The dip of platy flow layering decreases near the base.

A rhyolitic dome immediately north-west of Mt. Macarthur has an elliptical plan, nearly a mile long and half a mile wide. It is about 500 feet high and the flanks, which are uniformly convex, increase in slope to 45° at the periphery where the lowest 100 feet merge steeply into the plain. The symmetrical carapace is covered by dense thickets of a slender resilient bush that makes access difficult. A major set of vertical joints parallels the long axis of the plan with a subsidiary set at 60° to this. Platy flow jointing dips from the crown and flow banding is seen. Slickensides are common between layers. Intrusive relations are obscured by scree and soil, but in air photographs faint concentric lines in the soil around the dome probably indicate trends in upturned strata. The rock is a pale greenish grey, fine-grained aegirine soda-rhyolite, commonly fairly fresh, and containing small scattered phenocrysts of feldspar up to half a millimetre across. These are mainly albite mantled by anorthoclase set in a very fine-grained matrix of feldspar, quartz and probable aegirine. The intrusion is probably a cumulo-dome. Injection of the lava was slow enough to allow an almost solid carapace to form. As more lava heaved it up, tension cracks were produced which are now seen as the vertical joints.

There are two domes in the northern area. Mt. Commissioner has a roughly circular plan about half a mile across. It is 400 feet high with flanks that level out at the base. Platy flow jointing in layers 2 to 3 feet thick is roughly concentric with the dome; polygonal and hexagonal jointing is normal to this. The rock is green, medium to fine-grained with porphyritic feldspar. A dome of similar rock that weathers spheroidally occurs about two miles south-west of Mt. Donald. It is roughly circular in plan, about three-quarters of a mile across and only about a hundred feet high. It may be a domal intrusion but intrusive relations are obscured. Mt. Commissioner probably had a domal form of emplacement.

Trachytic and Rhyolitic "Bowls"

There are four bowl-shaped intrusions in the southern area. One, immediately west of Calvert Peak, has a roughly circular plan nearly half a mile across; the wall ranges from 100 to 200 feet high and from 500 to 1,000 feet wide. It has been eroded to plain level on the west side. The outer wall is very steep, plunging almost vertically in places. The inner wall slopes 15° to 30° into the centre of the bowl. Thin platy flow layering, one to three inches thick, roughly parallels the wall (Fig. 46) In the centre of the bowl layering is mainly horizontal. The outer wall is auto-brecciated in places, and contorted flow bands have been etched on weathered surfaces. The rock is deeply weathered due to micro-shearing and micro-fracturing. One fresh boulder was found and probably represents the core of a fractured zone. The rock is a light grey, fine-grained riebeckite-trachyte that was intruded in a viscid state. The intrusion probably originated as a dome or a tholoid, an endogenous dome of viscid lava. The centre of the dome collapsed before final solidification due possibly to the release of gas pressure either by escape or by cooling. The wall probably solidified sufficiently to remain rigid. Three similar bodies occur to the south and south-west and, in plan, the four bodies lie on a semi-circle. About two miles south-west is a bowl with similar dimensions but with a more deeply dissected wall. At CL292/4 there is vertical polygonal columnar jointing with fine banding normal to the columns. Similar rock is found in two small knolls immediately south-east at CL292/2 and CL292/3. These bodies may be related to the bowl but their origin is obscure. The rock is an aegirine soda-rhyolite that consists of porphyritic anorthoclase in a groundmass of feldspar, probably anorthoclase, with subordinate albite, probable minor aegirine and interstitial quartz. The phenocrysts are subhedral and are mantled by a zone containing inclusions. The knoll at CL292/2 is probably a breccia of this rock. About a mile south-east there is another bowl with a circular plan half a mile across and a rim about 200 feet high that has a smoothly convex contour. The wall, which is breached on the north-west, slopes steeply.

The rock is deeply weathered and, on the rim, open-textured and vesicular. After domal emplacement, subsequent collapse was probably not as great as in the other bowls because the centre is a shallower depression. To the north-east lies a bowl circular in plan, half a mile across, with a rim 300 feet high and a bowl 100 feet deep. Platy flow layering and jointing roughly parallel the bowl, and peripheral autobrecciation bands consist of angular frag ments cemented by similar rock. Permian sandstone has been diapirically pierced by the intrusion without alteration, and has dips up to 65^{o} in a gully near the south face. The intruding rock is fine-grained, off-white and has a ' 'sugary' texture on the periphery. This possibly represents recrystallisation, or granulation due to differential movement between solidified layers during intrusion. Elsewhere the rock is grey, fine-grained, with porphyritic feldspar, and probably has a rhyolitic composition. This intrusion was formed from viscid lava, and originated as a steep-walled plug dome that was slowly emplaced with a gradual upward swelling. Sodified skins were brecciated by frictional movement as the dome was heaved up by renewed pulses of lava, and brecciated frag ments were cemented by the fresh lava. After upheaval ceased the plastic centre retracted whereas the periphery had solidified sufficiently to remain upstanding. The sinking was probably caused by a release in gas pressure in the magma chamber either by escape or by a sudden cooling of the gas.

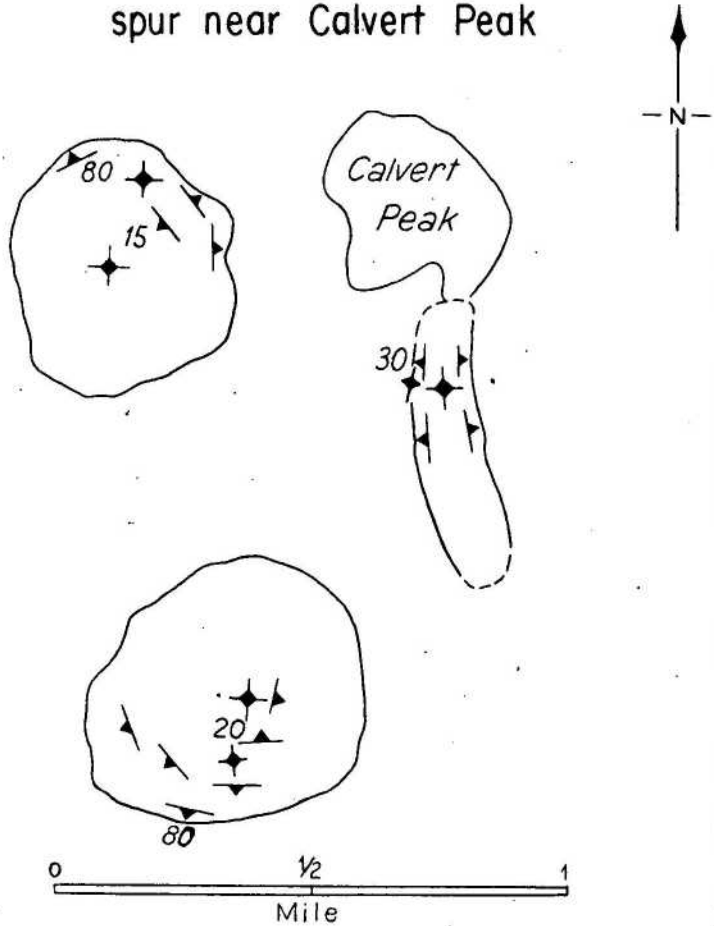
Trachytic "Barchans"

There are four trachytic intrusions in the southern area with shapes like a barchan sand dune. One of these lies two miles west of Calvert Peak, half a mile long and 350 feet high. Rough columnar jointing is developed near the crest on the steep outer flank which dips at 70^{o}, and platy flow layering parallels the inner face which dips at about 45^{o}.

The rock is a dark grey trachyte and near the crest is open-textured with vesicles. It is deeply weathered and the fresh rock is probably a lighter grey. A similar 'barchan' lies about a mile north-west of Scott Peak, with a spur extending for about half a mile to the south-east. Immediately north of this at CL217/1 is an outcrop with platy flow layering dipping east at 30°. The 'barchan', the spur, and this outcrop all consist of fine to medium-grained anorthoclase-trachyte containing abundant phenocrysts of anorthoclase that are mantled by zones containing many small inclusions; it is light grey when fresh and dark grey when weathered. Another 'barchan', a mile long and about 200 feet high, lies north of Lowestoft Homestead. There are two sets of vertical joints at 60°, one set being roughly normal to the arcuate backwall whose outer face is almost vertical. Platy flow layering parallels the low-angled face and auto-breccia is peripheral. The rock is a light grey fine-grained anorthoclase-trachyte that consists mainly of anorthoclase laths trachytically oriented around occasional phenocrysts of anorthoclase. Other alkaline feldspars in subordinate amount, and interstitial quartz may be present. The anorthoclase laths are cross fractured, their extinction is undulose, and they form interpenetrant grains which indicate that the lava was moved during solidification. Immediately north-west of Scott Peak is another poorly exposed deeply-weathered trachytic 'barchan' about half a mile long. The wall has been dissected and few intrusive features were seen. The origin of these 'barchans' is not clear. They may have been emplaced like the bowls, and represent collapsed domes, in which case, the collapse has been more complete and the lava has breached the wall and flowed out which probably explains the spur and outcrop of similar rock near the 'barchan' a mile north-west of Scott Peak. The 'barchan' north of Lowestoft Homestead may have been emplaced in two stages, first by lava rising along an arcuate fracture, and then, within the area encompassed by this arc, like a wedge. The lava was probably more viscid in this intrusion than in the other 'barchans'.

Fig. 46.

Map showing platy flow layering dips in two "bowls" and one trachytic spur near Calvert Peak



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Bureau of Mineral Resources, Geology & Geophysics. May, 1961.

Trachytic and rhyolitic spurs

A trachytic spur with a convex cross-section extends about half a mile from the southern arm of the 'barchan' a mile north-west of Scott Peak and has already been mentioned in connection with the origin of the 'barchan'. A similar trachytic spur extends south for about half a mile from the south-west face of Calvert Peak (Figure 46). Both these spurs are only 50 to 100 feet high with flanks vertical near the base. Platy flow layering is roughly concentric with the convex cross-section. At CL215/8, near the base of the Calvert Peak spur, the layering is overturned. The trachyte here is similar to that in the 'bowl' immediately west of Calvert Peak but contains more mafic minerals. The spurs do not seem to intrude the country rock, and they may be small flows of viscid trachyte (coulees). A dissected spur of trachyte also extends from the west wall of a flat-topped plug south-west of Scott Peak. This is possibly genetically related to the trachytic 'barchan' immediately north-west of Scott Peak, whose origin is obscure. A small sharp-crested spur adjoins the plugs of Scott and Roper Peaks. This ridge and the flat-topped plug were possibly intruded along radial fractures formed in the country rock by the uplift of the two plugs.

Trachytic Ridges with Convex Cross-Sections

South of Wilmor Downs Homestead, near Blanche Bore, there are low ridges with convex cross-sections. Locality CL212 is on a ridge about 50 feet wide and a mile long. The rock is a vesicular riebeckite trachyte that consists mainly of anorthoclase microlites. Riebeckite occurs interstitially and is commonly altered to limonite in weathered samples. Quartz is a rare accessory. A ridge, S-shaped in plan and about a mile long, lies to the south-east. Platy flow layering, parallel to the flanks, is well exposed at CL225/5 where it dips at 45^{o}. The rock is a light grey, fine-grained trachyte that consists of anorthoclase laths, and 5% aegirine microlites. There is accessory interstitial quartz. The form of this ridge suggests it is possibly a viscid flow. Two sharp-crested ridges of trachyte, one immediately north-east of Scott Peak and the other half a mile to the north, about 300 feet long and 100 feet high, have not been thoroughly investigated but they may be genetically related to the trachytic 'barchan' immediately north-west of Scott Peak.

Two intrusions that do not fit into any of the morphological categories will be described here because they have similar features to some of the intrusions already described. Two miles north of Mt. Macarthur a trachytic body about a mile long and nearly half a mile wide is bounded on the south by a steep ridge with an L-shaped plan (CL208/2), on the north and west by a similar, but smaller, ridge with a semicircular plan (CL292/1), and on the north-east by the wall of an adjacent trachytic bowl. To the south-west an extension to the trachyte body is roughly a few hundred yards square. The whole body of trachyte appears to be the combination of a bowl and a 'barchan'. The southern ridge has a steep outer wall and gentler slopes on the inner side where there is a vertical set of joints at an acute angle to the ridge. The outer wall is auto-brecciated in parts. Platy flow layering on the outer face of the northern ridge dips steeply. Basalt is common on the lower outer flanks of both the southern ridge and the small extension of the intrusion to the south-west. The rock is a fine to medium-grained, light grey porphyritic anorthoclase trachyte that consists of 90% anorthoclase in the form of small laths, subhedral phenocrysts, and porphyritic clots. There is accessory quartz and possibly some minor albite. The anorthoclase crystals show signs of strain. The body is probably a composite intrusion; possibly a collapsed dome was later dissected by an arcuate intrusion of viscid trachyte.

An isolated intrusion with an elliptical plan, half a mile long, lies two miles north of Woollamba Homestead. It is about 200 feet high and consists of an almost continuous low, vertical, and narrow wall surrounding an irregularly-shaped mass with a bowl-shaped body, a few hundred yards across, at the northern end. The bowl is crossed by a line of wattles that may indicate a fault. Hexagonal columnar jointing, two to three feet across is seen in the central part of the intrusion and autobrecciation occurs on the narrow enclosing wall. The intrusion consists of a light grey, fine grained rhyolite containing small feldspar phenocrysts. The intrusion was probably emplaced in two stages, first by the intrusion of viscid lava along an elliptical fracture, followed by the emplacement of a domal intrusion within the wall so formed. The dome then probably collapsed. The intrusion probably did not reach the surface because immediately to the north-east are much higher remnant ridges of the basaltic flows.

Rhyolitic Domal Plugs

The domal plugs have circular or elliptical plans from a few hundred yards to half a mile across. Their heights range roughly from 300 to 700 feet. Their flanks are steep, vertical in places, and their carapaces form highly convex domes. There are four domal plugs in the southern area. Two lie a mile north of Mt. Macarthur, and have elliptical plans nearly half a mile long. The westerly intrusion is 300 feet high, the other about 400 feet. Their flanks range in slope from 45^{o} to vertical. Both intrusions are autobrecciated on the periphery and platy flow layering dips steeply. Within the intrusions there is poorly developed columnar jointing. They consist of hard, light grey, fine-grained soda-rhyolite. The rock seems everywhere to be slightly weathered. This is a common feature in many of the plugs and may be due to hydro-thermal action. The intrusions are surrounded by black soil and no intrusive relations were seen. Although there is continuous outcrop between the two they were probably intruded

Figure 47. East face of domal plug, one and a half miles south of Gibson Downs Homestead, showing angular autobreccia etched by weathering - note shear lines. Photograph about ten feet wide.

as separate plugs. A similar intrusion lies a mile and a half south of Gibson Downs Homestead. It is roughly the same size but has a circular plan and a crestal depression. There are similar intrusive features, and on the weathered eastern wall autobreccia is well exposed (see Figure 47). Immediately east of this point Permian sandstone dips away from the wall at 50°. The crestal depression in this domal plug may have originated by an incipient collapse that has been accentuated by erosion. Two miles south of Gaylong Homestead there is another domal plug with an elliptical plan, half a mile long. It is about 700 feet high and the flanks plunge steeply, almost vertically near the base. The walls are autobrecciated and platy flow layering dips steeply. The rock is a light green, fine-grained soda-rhyolite with small amphibole and feldspar phenocrysts.

There are three rhyolitic domal plugs in the northern area of intrusions, namely the Gemini, consisting of Mounts Castor and Pollux, and Mt. Saddleback. Mt. Pollux has an elliptical plan nearly half a mile long. At its southern end there is another very small conical plug only a few hundred feet across. A quarter mile to the north is the other Gemini, Mt. Castor, with a circular plan only a few hundred yards across. Mts. Pollux and Castor are about 700 feet high. Mt. Castor has almost vertical flanks and a highly convex carapace whereas Mt. Pollux has less steep flanks and an almost sharp-crested cross-section. The small plug at the south end of Mt. Pollux has some interesting features. At the base of its north-west face there are a series of low rubbly ridges parallel with the plug wall. The ridge farthest from the plug is a dark reddish-brown, flow-banded, iron-stained rhyolitic glass with perlitic texture. It contains porphyritic anorthoclase and fragments of olivine basalt. The next rubbly ridge consists of a sheared dark green pitchstone adjacent to a pinkish 'sugary' rock that may be a devitrified glass. The intrusion itself consists of a light-grey, flow-banded soda-rhyolite that is columnar jointed. Columnar jointing on Mts. Castor and Pollux is common as polygonal vertical columns, a few feet long, but high on the west face of Mt. Castor the jointing is horizontal. On the west slopes of this peak a small knoll and ridge consist of angular autobreccia. The fragments range from one to six inches long and consist of pinkish-grey, flow-banded rhyolite. Outcrops of breccia occur on the west slopes of Mt. Pollux. Contorted flow banding and slickensides are also common features of the intrusion and are often seen parallel to each other. Rhyolite boulders with weathered out stone-bubbles are common in scree around the intrusions. The flow-banded fine-grained soda-rhyolite of Mt. Pollux contains rounded quartz phenocrysts and anorthoclase and possible sanidine phenocrysts in a cryptocrystalline groundmass of quartz and soda feldspars. The rock is difficult to obtain fresh and has possibly been hydrothermally altered. Boulders of basalt, granitic rock, and metamorphic rock are found in the screes of Mts. Castor and Pollux and were probably dragged up by the intrusions. Mt. Saddleback has a roughly circular plan a few hundred yards across, and is about 400 feet high. It has a dissected domal carapace but the flanks are less steep than those of Mt. Castor. There is a peripheral band of dark green glassy rock containing abundant feldspar phenocrysts. A similar rock occurs around the base of Wolfang Peak and is described later. The main body of Mt. Saddleback consists of a grey flow-banded rhyolite similar to that of Mt. Pollux.

The origin of the domal plugs is probably very similar to that of the conical plugs, and will be described in detail in that section. The term 'plug dome' could probably be applied to them (Figure 45a).

Rhyolitic Conical Plugs

There are numerous rhyolite plugs in the northern area of intrusions and three in the southern area. They form sharp-pointed, rocky peaks whose heights range from about 200 to 1600 feet. Most plugs are circular in plan but a few are

Figure 48. Aerial view of Scott Peak, Roper Peak and Malvern Hill looking south. Note flat-topped L-shaped plug to the right of Scott Peak.

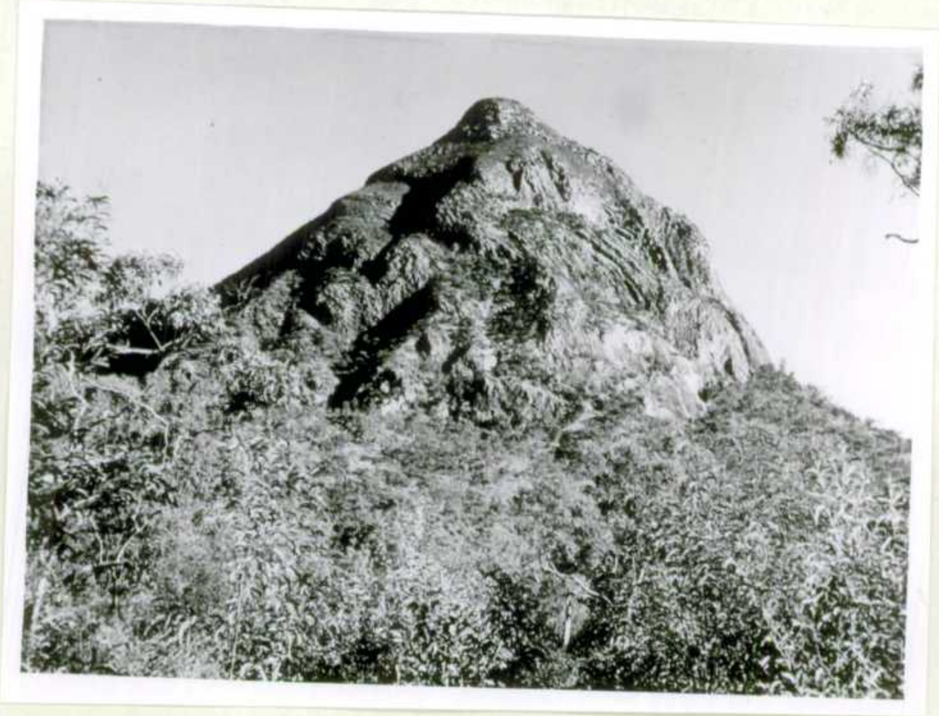

Figure 49. North face of Scott Peak showing columnar jointing contorted.

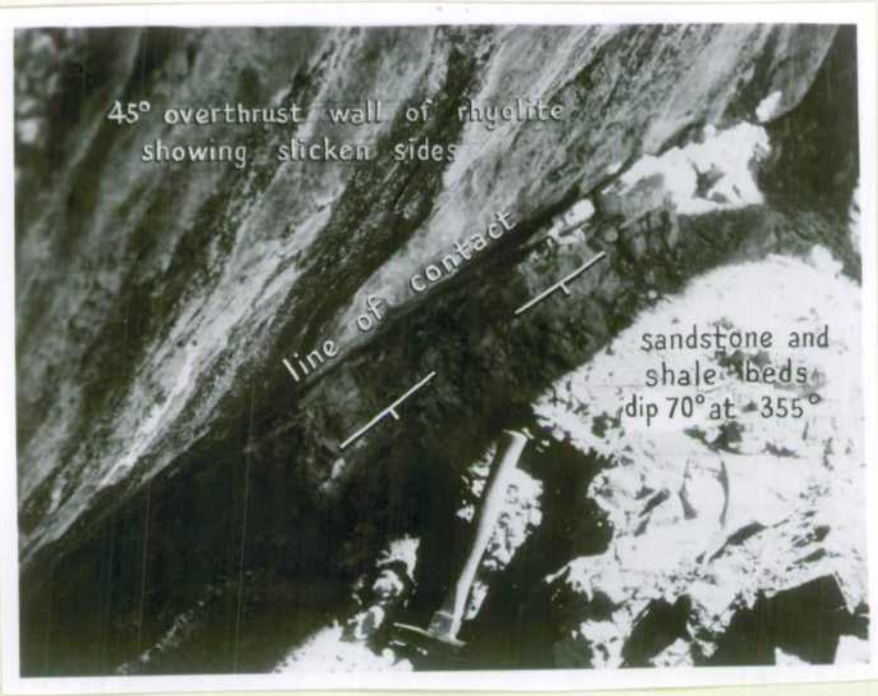

Figure 50. 45° overthrust intrusion wall of rhyolite that cuts across sediments dipping at 70° away from the wall on north face of Roper Peak.

slightly elliptical and range from about 500 feet to half a mile across. The flanks are steep, rarely less than 45°, and in many places, especially near the base, they become vertical and overhanging. The conical plugs have similar intrusive features to the domal plugs, and diapirically intrude the Middle Bowen Beds. Some of the peaks are difficult to approach because of scree slopes of large angular boulders. The scree obscures intrusive contacts which are very difficult to find.

Roper and Scott Peaks are two adjacent and almost identical large conical plugs of rhyolite in the southern group of intrusions. Roper Peak is slightly elliptical in plan, about half a mile long, and about 1,600 feet high (see Figure 48). Scott Peak, with a circular plan, has similar dimensions. The lower 200 feet of both intrusions is much steeper, and in places vertical and overhanging, than above where the flanks converge to a pointed crest. The walls of both plugs are autobrecciated with angular fragments ~~ranging in size~~ up to about six inches long. On weathered and etched surfaces narrow shear zones, many only a few inches long, have been exposed within autobrecciated bands. Slickensides parallel platy flow layering and are found on the layering surfaces. Massive polygonal columnar jointing, with units up to 30 feet long, is a notable feature of both plugs. On the south-east face of Roper Peak the large columns are almost vertical, leaning slightly into the intrusion. More commonly the columns are contorted and fanned out with individual columns bent (see Figure 49). Fine linear flow banding is also a feature common to both plugs. The plugs have arched the Middle Bowen Beds, including the clarkei-bed, which are well exposed, dragging them up diapirically. Away from the intrusion walls the dips in the beds quickly decrease from a maximum of 70°, and the affected zone is only about half a mile wide. Only one contact was found although in many places steeply dipping beds were traced to within a few feet of the wall. The contact is seen on the north side of Roper Peak at CL221/5 (see Figure 50). A wall of rhyolite, overthrust at 45°, is in contact with thin shale

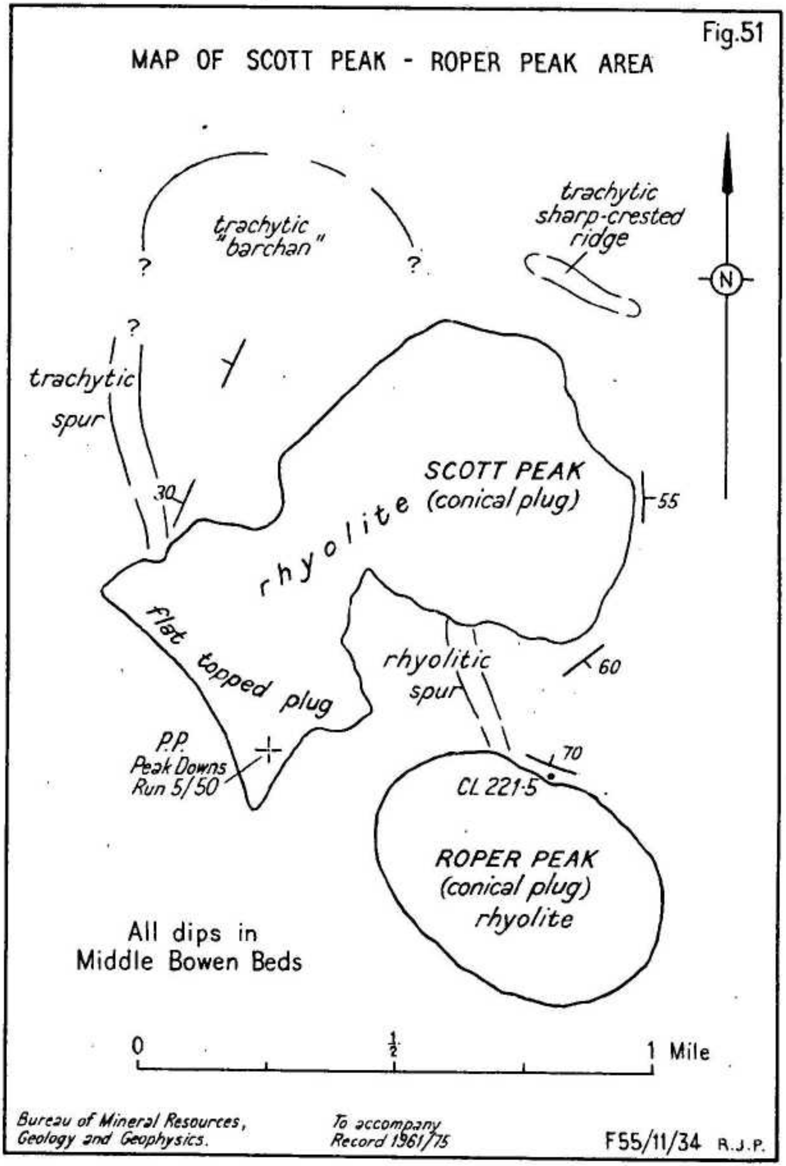
Fig.51
MAP OF SCOTT PEAK - ROPER PEAK AREA
trachytic "barchan"
?
?
?
trachytic sharp-crested ridge
N
trachytic spur
30
SCOTT PEAK (conical plug)
55
rhyolite
flat topped plug
rhyolitic spur
60
P.P. Peak Downs Run 5/50
70
CL 221·5
ROPER PEAK (conical plug) rhyolite
All dips in Middle Bowen Beds
0
½
1 Mile
Bureau of Mineral Resources, Geology and Geophysics.
To accompany Record 1961/75
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and sandstone beds which dip away from the wall at 70°. The sediments are unmetamorphosed but slickensides on the rhyolite wall and on surfaces of platy layering indicate that the lava was cool and plastic when overthrust.

Immediately south-west of Scott Peak is a flat-topped plug with an L-shaped plan, quarter to half a mile long and half as wide. Vertical columnar jointing is seen around the flat-topped plug. An outcrop of rhyolite extends between this plug and Scott Peak and the two are either one intrusion or closely associated intrusions. The north-west face of Scott Peak is a very flat vertical wall and the extension of this line coincides with the line of the vertical wall at the north end of the flat-topped plug. The dissected trachytic 'barchan' and the array of trachytic ridges immediately north and north-west of Scott Peak have already been described (see Figure 51). The origin of this complex volcanic area is not clear.

Scott Peak and Roper Peak consist of a light green, fine-grained aegirine soda-rhyolite containing phenocrysts of anorthoclase. The anhedral phenocrysts up to one millimetre across have alteration rims and occasional small inclusions of albite. Grain size grades down to 0.05 m.m. and the rock has a sub-seriate fabric. Because of a large amount of crypto-crystalline material, identification is difficult but the rock probably consists of 70% anorthoclase and subordinate albite with about 10% aegirine, 5% to 10% riebeckite and interstitial quartz and secondary minerals which may have resulted from hydro-thermal action. The flat-topped plug consists of a similar rock except that riebeckite appears to be absent.

Calvert Peak, a few miles to the north-west is the only other conical plug in the southern area. Its roughly circular plan is a quarter of a mile across and it is about 1,100 feet high. Intrusive features like those of the other conical plugs are seen, and the Middle Bowen Beds dip steeply off the southern face. On the lower slopes to the west, at CL215/2, olivine basalt dips away from the plug at 13°. The columnar jointing

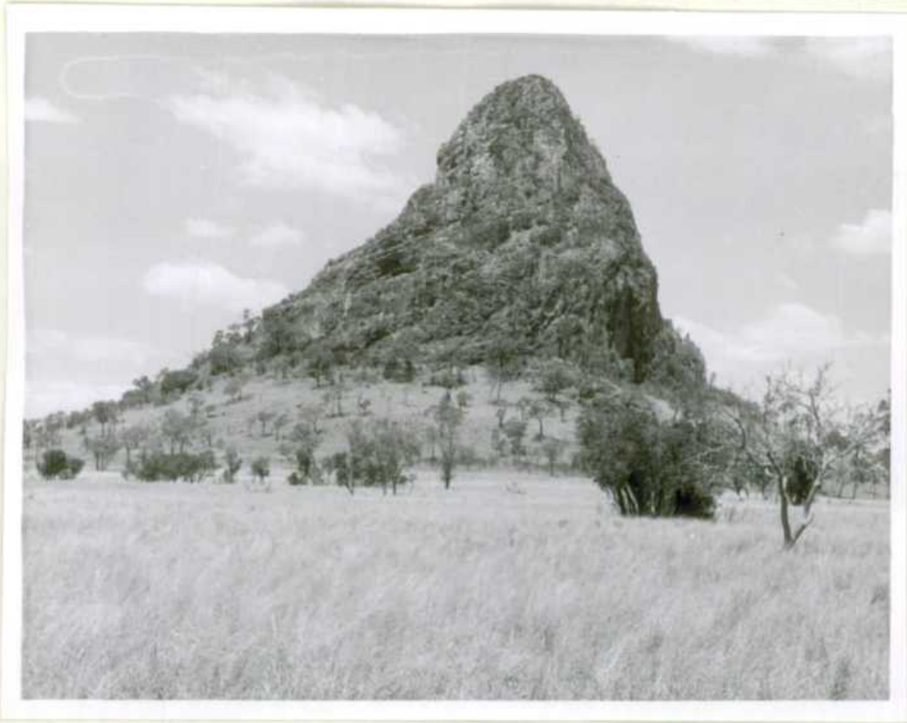

Figure 52. Inclined major jointing that dips to the north on the west face of Wolfang Peak.

Figure 53. High-angled overhanging columnar jointing at the base of Wolfang Peak on the south-west face.

is less massive than in Roper or Scott Peaks, with much smaller columns. The rock is a similar fine-grained rhyolite with feldspar phenocrysts.

Mount Donald, the largest conical plug in the northern area, is closely comparable to Roper Peak in shape and size. Intrusive features are obscured by a fairly thick covering of vegetation and large amounts of scree. However, Middle Bowen Beds, including the cl.rkei-bed, are well exposed on the lower slopes with dips up to 80° on the south side. A few hundred yards from the north-west wall, the beds dip towards the plug at 15° before arching up nearer the intrusion wall. This probably represents the regional dip of the beds before the intrusion was emplaced. The origin of some small outcrops of coarse to fine-grained intermediate igneous rocks on the south-east slopes is unknown. They are possibly flows related to the Mount Donald plug.

Wolfang Peak, near the Clermont Coast Highway, is a steep conical plug 700 feet high, with a circular plan a few hundred feet across. It has features common to Mounts Saddleback, Pollux and Castor. Columnar jointing, with units a few feet long, is roughly normal to a series of inclined major joints which dip at 25° and extend across the full face of the peak (Figure 52). Near the base of the south-west flank there is a large wall of rock with a slight overhang and below this some high-angled, overhanging columns (Figure 53). Autobrecciated and slickensided rock is common in the scree and in patches and bands on the walls of the intrusion. Small peripheral outcrops of a pinkish 'sugary' rock, similar to that at Mt.Pollux, may be a devitrified glass. Concentrically-structured, circular cavities, about a quarter inch across, are found in weathered surfaces and are probably 'stone-bubbles'. Boulders of a dark green vitreous rock with abundant feldspar phenocrysts are common. The rock consists of porphyritic aggregates of mainly euhedral anorthoclase with subordinate albite and occasional flakes of biotite mica in a cristobalite glass. The main part

Figure 54. The deeply eroded face of Fletcher's Awl.

Fig. 55

Idealised diagram to illustrate the probable mode of emplacement of a bulbous plug.

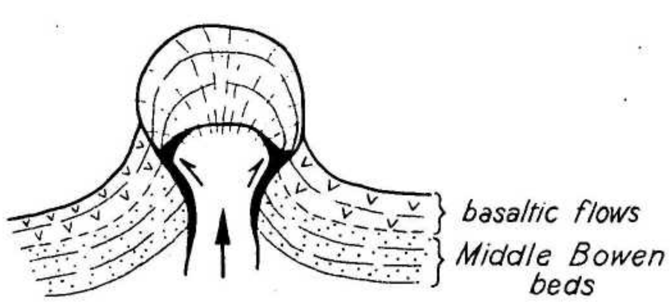

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Figure 55. Idealised diagram to illustrate the probable mode of emplacement of a bulbous plug.

(a) Thick lines indicate glassy skin.
(b) Convex lines indicate growth stages.
(c) Broken lines indicate movement of solidifying, cool lava as pushed by new pulse of magma from below.
(d) Half arrows indicate differential movement between solidifying layers at periphery.

of the plug consists of a light grey, aphanitic, soda-rhyolite with porphyritic sanidine, anorthoclase, minor biotite mica and possible quartz. 75% is a cryptocrystalline groundmass that probably consists of soda feldspar, quartz and secondary minerals. Flow banding units range from microscopic size to two inches across. Black soil, containing basalt boulders, and scree obscure intrusive relations.

Fletcher's Awl (Figure 54), a prominent, nearly vertical spine with a cylindrical form, is only a few hundred feet wide and 300 to 400 feet high. It intrudes steeply dipping siltstone of the Bulgonunna Volcanics which crop out on the west slope. This is the only body seen intruding rocks older than the Permian. The rock is off-white, fine-grained, and in places powdery. Fresh rock is difficult to obtain.

Red Riding Hood, Little Wolfang Peak, and four other small conical plugs lie a few miles to the north and north-east of Corry Homestead. All these are roughly circular in plan, a hundred to a few hundred feet across, and a few hundred feet high. Intrusive relations are obscured by black soil and scree. Outcrops of dark-green vitreous rock with feldspar phenocrysts are found around Red Hiding Hood and around a plug a few miles north-east of Corry Homestead. The plugs consist of flow-banded fine-grained rhyolite with occasional feldspar and quartz phenocrysts. A small conical plug to the north of Wolfang Peak, called Mount Macdonald, appears to be an erosional remnant of a larger intrusion.

Emplacement of the Rhyolitic Domal and Conical Plugs.

The domal plugs and the conical plugs had a similar mode of emplacement and original intrusion form. The difference in the shapes of domal and conical plugs is probably mainly due to erosion. There are obviously slight differences in the mode of emplacement between one intrusion and another and there are some general differences between the northern and southern areas of plugs. Figure 55 is a diagram that illustrates the probable origin of the plugs. The lava was acidic and viscid. Most plugs are probably exogenous intrusions and were not intruded along pre-existing volcanic vents. The magma rose as narrow cupola-like bodies that diapirically dragged up narrow zones of country rock. The release of pressure on the viscid lava as it reached the surface caused it to bulb out within the widening fracture in the country rock. The sudden cooling of the lava formed a glassy skin. Because of the sudden release of pressure on the magma as it expanded into the bulbous form a temporary halt probably occurred in the intrusion of magma and the lava became plastic. With a new surge of magma the cool plastic lava was pushed out of the original bulb and it grew upward and outward. These later pulses caused differential movement between solid peripheral layers and the rock was autobrecciated and recemented by the new lava. The original glassy rock was formed in the lower part of the bulbous body only. Columnar joints, growing normal to the bulb face, were fanned out by later pulses. The southern plugs differ from the northern plugs in the following ways:

1. Most are larger.
2. Columnar jointing consists of much larger units.
3. Only occasional small boulders of glassy rock were found in streams near the southern plugs whereas glassy rocks are consistently found in outcrop round the northern plugs.

These differences are probably due to deeper exposure of the northern plugs. Fletcher's Awl is probably only the neck of an original bulbous plug. It is the only intrusion seen intruding rocks lower than the Middle Bowen Beds. The smaller units of the columnar joints and the glassy rocks in the northern area indicate either:

(a) that the first pulse of quickly cooled lava has been exposed by deep erosion or,
(b) that the magma was hotter at the time of intrusion, and the plugs were intruded with one pulse, although the presence of autobreccia is contrary to this idea.

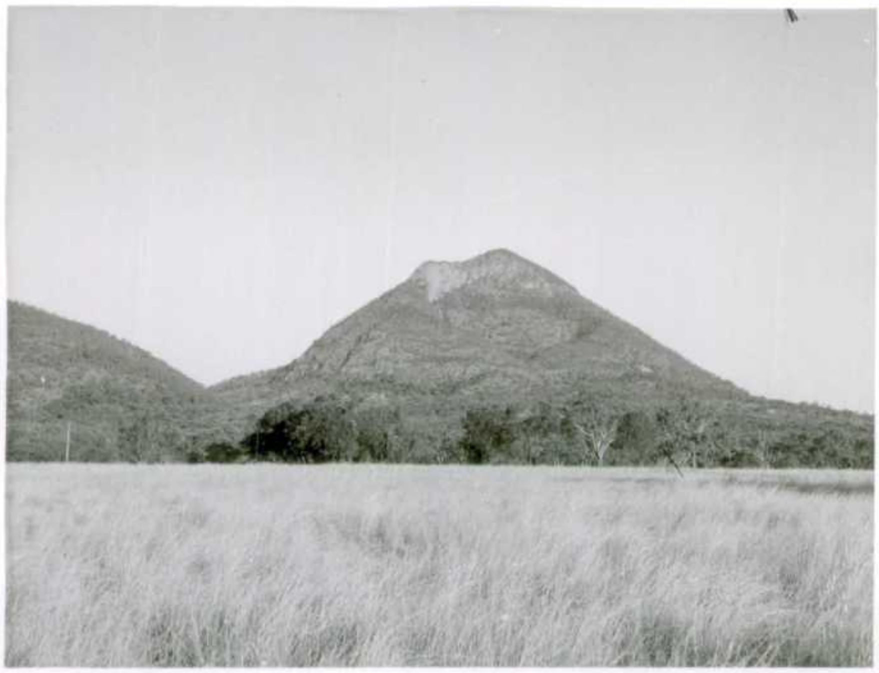


Figure 56. Mount Macarthur, looking south-east, showing caldera-like cavity.

Figure 57. Caldera-like cavity of Mount Macarthur. Note how rock in centre "dips" from high backwal[illegible] Low west wall in foreground.

There is no evidence of an original bulbous shape in some of the plugs, especially the domal ones, and they probably had vertical walls, the intrusive mechanism being similar, however, to the bulbous plugs. The overhanging columns of Wolfang Peak (Figure 53) suggest a bulbous shape as do the many overhanging walls seen. The flat-topped plug, immediately south-west of Scott Peak, was intruded probably along a fracture as a vertically-walled plug that did not reach the surface.

Mount Macarthur (Figure 56)

Mount Macarthur is a large conical plug with a caldera-like cavity in the west face. The intrusion, three quarters of a mile across, and caldera, a quarter of a mile across, are each roughly circular in plan. The east wall of the cavity is 1,200 feet high and the low west wall about 400 feet high (Figure 57). Peripheral rock shows autobrecciation and slickensides, and contorted columnar jointing. The rock that fills the cavity differs from the main rock. The low west wall of the cavity is breached by a gully in bare rock. Vertical joints, three to six inches apart, criss-cross the rock pavements and are in two sets, one parallel to, and the other normal to, the wall. There are gradational changes in the wall rock. The peripheral rock is pale greenish-grey, fine-grained with small, dark, sometimes acicular, phenocrysts and occasional small dark patches and streaks that are roughly oriented into bands. The innermost rock is pale yellowish-grey, fine-grained with many dark patches up to a few millimetres across, rarely oriented into bands. The centre of the wall consists of a similar rock with smaller dark patches and streaks in definite sub-parallel bands, parallel to the wall face. Other wavy streaks intersect these. The dark patches and streaks are irregular grains and microlitic aggregates and strings of riebeckite and subordinate aegirine. Porphyritic anorthoclase and subordinate albite crystals with alteration rims are also present in a finely crystalline groundmass of feldspars and quartz. The rock is a riebeckite soda-rhyolite. The mineralogy of the different grades of the rock is similar.

Platy flow layering, in units three to six inches thick, is seen in the rock within the cavity and dips from the high backwall at about 40^{o}. The dark, porphyritic rock consists of anhedral anorthoclase phenocrysts and subordinate albite phenocrysts rimmed with anorthoclase in a trachytic-textured groundmass of microlites of anorthoclase, minor ferroaugite, accessory black iron ore, apatite, and rare fayalite. Ferroaugite, fayalite and black iron ore also occur as porphyritic crystals, much smaller than the anorthclase phenocrysts and in accessory amount only. The anorthoclase phenocrysts have irregular shells of lower refractive index thatcontain many small inclusions. These may be due to the rapid cryatallisation of a final residium. The fayalite phenocrysts are partly replaced by limonite. Chemical analyses are required of this rock to help determine it accurately and of the riebeckite soda-rhyolite to elucidate the genetic relations of the two.

After the emplacement of a vertical-walled or bulbous-shaped plug as outlined above there was a later eruption that may have been explosive. Long ridges fan out from the low west wall of the cavity. They consist of angular fragments of the riebeckite soda-rhyolite rock that range in size from cobbles to boulders. They are loosely cemented and possibly represent agglomeratic fragments of the west face thrown out after solidification by an off-centred explosion. Fragments of the same rock were found scattered in the soil a few miles to the north-west and also on a small ridge in the same area. After the explosion the fayalitic lava was probably extruded from a vent at the base of the high backwall. Alternatively, the viscid fayalitic lava may have risen along a part of the same vent as the plug and, without explosive violence, heaved out a column of solid rhyolite which slid off the flanks of the plug, and was disintegrated by erosion.

Figure 58. Lord's Table Mountain with the Anvil Peak on the left. In the foreground is the Hodgson Range of horizontal basaltic flows, looking north from the summit of Gilbert Dome.

Campbell Peak and Lord's Table Mountain.

Campbell Peak is an isolated peak of trachyte about fifteen miles east of Lord's Table Mountain. Its steep-flanked conical form is about 600 feet high, circular in plan, and a quarter of a mile across. Columnar jointing is seen near the summit; near the intrusion wall on the south-east there is a small outcrop of almost horizontal Permian sandstone. The scree, which hides intrusive contacts, contains many boulders of vesicular and massive olivine basalt. The rock is a dark, fine-grained trachyte with feldspar phenocrysts. The flat-topped peaks of Lord's Table Mountain and its small neighbour, the Anvil Peak, are capped by 150 feet of a very similar trachyte which lies on 1,500 feet of horizontal basaltic flows (Figure 58.) The trachyte cap is probably a flow and not a sill as no basalt remnants were found on top. There are irregular columnar joints and horizontal to inclined platy layering which is best seen near the base of the cap. The rock texture is trachytic and it contains fragments up to two millimetres long of basaltic rock. The rock is dark, often purplish, fine-grained, porphyritic and consists of anorthoclase, subordinate albite-oligoclase and accessory quartz phenocrysts in a very finely crystalline groundmass of sodic feldspar, subordinate pyroxene (possibly some augite), and accessory black iron ore. The phenocrysts of anorthoclase are partly altered and often occur in anhedral clots, up to three millimetres across associated with subordinate sodic plagioclase. A few large quartz phenocrysts, up to two millimetres across, are very rounded, embayed and fractured. The groundmass is too fine-grained for accurate determination by optical means. A sample from the top of the capping contains spherical bodies of deeper weathered rock, each centred on a phenocryst with radiating fractures and a few millimetres across. The rock is similar to the sample from the middle of the capping described above but contains over 5% augite in equant grains up to 0.3 m.m. across. The phenocrysts also include sanidine. A sample from the base of the capping contains small pyroxene phenocrysts and more sodic plagioclase than the other samples. It also contains corroded sanidine phenocrysts.

It seems that Campbell Peak and this capping are closely associated. Campbell Peak is a trachyte plug that fills a former feeder vent of the basaltic flows and the capping of Lord's Table Mountain is probably the last remnant of a trachyte flow from this vent,

Rhyolitic Flows.

Mapping of the northern area was complicated by the close association of similar rhyolitic rocks belonging to the Bulgonunna Volcanics. Two masses of flow-banded rhyolite, one about two miles north-west of Wolfang Peak and the other about six miles north of Corry Homestead, are similar to a mass of rhyolite flows about four miles south-west of Cumberland Downs Homestead, which lies above Permian rocks and is regarded as (?) Tertiary. It is four miles long and probably consists of intrusions and flows that have merged because two plug-like bodies exist at the western end of the mass (CL256/1) and the eastern end is terminated by a wall of rhyolite that may represent a dyke. The two masses of rhyolite have similar air photograph and joint patterns to this mass but no stratigraphical relations were seen and because of their proximity to outcrops of Bulgonunna Volcanics are tentatively mapped with this group. East of Mount Saddleback there is a possible small associated flow. Also, north-east of Mount Donald there are outcrops of rhyolite that may be flows contemporaneous with the intrusion.

A series of rhyolitic masses, studded in places with small depressions about fifteen feet across and filled with rhyolitic rubble, occur between the Clermont Coast Highway and Cumberland Downs Homestead. The origin of the masses and the depressions is obscure and they have been tentatively mapped as (?) Tertiary.

Rhyolitic Sharp-crested Ridges.

Within the northern group of intrusions are several sharp-crested ridges of rhyolite, a quarter to a few miles long and only tens of feet wide. South of Fletcher's Awl at CL255/3 a sharp-crested ridge a quarter of a mile long consists of light grey, fine-grained rhyolite with small feldspar phenocrysts. Flow bands in the rock are parallel with the south face and dip at 45°. Columnar jointing is also seen in places along the ridge. This is probably a dyke and there are several other similar ridges in this area. Similar ridges are also found three miles south-west of Mount Donald, a few miles north of Corry Homestead and at other localities in the northern part of the Peak Range. They are probably all rhyolitic dykes and are tentatively placed in the Peak Range Volcanics. Air photographs also indicate the possibility of similar ridges in areas three to five miles south-east of Mount Donald.

These occurrences of rhyolite ridges, flows and other bodies require detailed mapping and petrographic description to establish their age. In many cases these bodies of rhyolite occur in rough country, and outcrop at important points is often obscured.

Petrogenesis

Petrographic analysis on the rocks is insufficient to be able to make definite statements on petrogenetic relations. Many of the rocks are too fine-grained for accurate petrographic description and chemical analyses are required. However, it is clear that the Peak Range Volcanics were formed from a magma with an alkaline content dominated by soda. Denmead (in Reid 1928) describes an alkali olivine basalt from the area but does not give a precise locality. No similar rock has been described from the present collection but the presence of this rock seems to confirm the idea that the Peak Range Volcanics are derived from an olivine basalt parent magma that had a high soda content. The association of olivine basalt with alkaline trachytes is common in several oceanic islands and in other parts of eastern

Australia. Shand has suggested that the trachyte in this association results from the mechanical expulsion by gas of a trachyte interstitial residium from a largely crystallised basic magma, a process which he terms 'gas-streaming'. Mount Macarthur is possible evidence of violent expulsion of gas and the collapsed domes suggest a less violent escape of gas also. Some trachyte is notably vesicular in places. The rhyolites probably represent a later stage in the differentiation process and the fayalitic rock of Mount Macarthur could be the final residium.

The Age of the Volcanics

The basalt of the Clermont Sheet area is regarded as probable Tertiary because its northern extension into the Mount Coolon Sheet area lies between two probable Tertiary formations (Malone et.al.1961). The only evidence of age for the basalt in the Clermont Sheet area is that it overlies a dissected surface of folded Permian rocks, and for the Peak Range Volcanics, that they are younger than the basalt which they intrude - only slightly younger because they are petrogenetically related. Some intrusions did not breach the mantle of basalt, and these, recently exhumed, now have a 'youthful' morphology, which is related to the date of exhuming, and not to the date of intrusion.

TABLE 1. CAINOZOIC SUPERFICIAL DEPOSITS.

Deposit	Areas	Origin	Remarks
Heavy-textured dark soil (Czb)	Broad area between main Permian outcrop and Anakie Inlier Part of Grosvenor Downs 1-mile area	(?) Tertiary basalt Calcareous beds in Upper Bowen Coal Measures, and (?) Tertiary basalt.	Overlies (?) Tertiary lake sediments in Mt.Violet and Mt.Rolfe 1-mile areas.
Sand and sandy soil (Czs and Cz)	Eastern part of Sheet area Western part of Sheet area Patches in main Permian outcrop	Upper Bowen Coal Measures Drummond Beds, and Anakie Metamorphics outwash from Middle Bowen Beds and "Passage Beds"	Forms most of the sheet of soil mapped as Cz, which also includes gilgai clay soil and gravel.
Gravel (Czg)	Anakie Inlier and adjacent areas	Quartz reefs in Anakie Metamorphics	
Alluvium (Cza)	along main water-courses		
Magnesian (Czm) limestone	Langton, 8 miles south-east of Clermont, and near Peak Downs Homestead	(?) Tertiary basalt	Analysis in Dunstan (1900)
Laterite	East of Mt.Dillingen, west of Mount Lebanon Homestead; north-east of Mount Rolfe	deep weathering of Middle Bowen Beds & basalt deep weathering of Anakie Metamorphics	
Billy	Clermont township & east of Blair Athol	deep weathering of Permian sandstone	

ECONOMIC GEOLOGY

Coal

Blair Athol Coal Measures

Following the discovery of coal at Blair Athol in 1864, small-scale underground mining was carried out and by 1920 the annual production was 150,000 tons. Production declined but with the start of open-cut mining in 1936 rose steadily despite the cessation of underground mining in 1946. The greatest annual production was 390,000 tons in 1952; since then annual production has dropped to less than 200,000 tons (C.S.I.R.O., 1960). At present two open-cut mines are operating on the field.

The organised exploration for reserves started in 1936, and in 1939 the Aerial, Geological and Geophysical Survey of North Australia undertook a geophysical survey which was followed by drilling. In 1958, the Commonwealth Aluminium Corporation (Comalco) took an option on the leases and, after the Bureau of Mineral Resources (Neumann, 1959) had conducted a gravity survey, undertook an extensive drilling survey.

The results of Comalco's operations are contained in an unpublished report by the Exploration Division of Consolidated Zinc Proprietory Limited (Whitcher, McIver & Knight, 1960). An extensive physical and chemical study on three 4-inch drill cores through the Big Seam was undertaken by the C.S.I.R.O. Division of Coal Research, and the results were published in C.S.I.R.O. Technical Communication No. 39, August 1960.

Operations on the field are at present restricted to the Big Seam (Fig. 36), whose greatest known thickness is 110 feet; the maximum depth of its base is 256 feet. Proved reserves are at least 200,000,000 tons with an overburden to coal ratio of 1.35/1; of these reserves, 55,000,000 tons occur with overburden to coal ratio of less than 1:1.

It has been estimated that 90% of the reserves are available for open-cut operations.

The seam contains high volatile, non-coking, low-rank bituminous coal with an average calorific value of 11,810 B.T.U./lb.; it consists mainly of durain with some vitrain bands. Soot beds are locally developed above the seam and soot partings total 2% to 4% of the seam. Table 2 shows an average analysis of samples from the Big Seam, together with an analysis of a single sample from an outcrop near Lake Vermont Homestead.

Analysis	Blair Athol Coal Measures Big Seam	Upper Bowen Coal Measures Lake Vermont
Moisture at 110°c	7.2%	7.6%
Volatiles	28.4%	24.3%
Fixed Carbon	57.6%	56.2%
Ash	7.4%	11.9%
Sulphur	0.29%	--

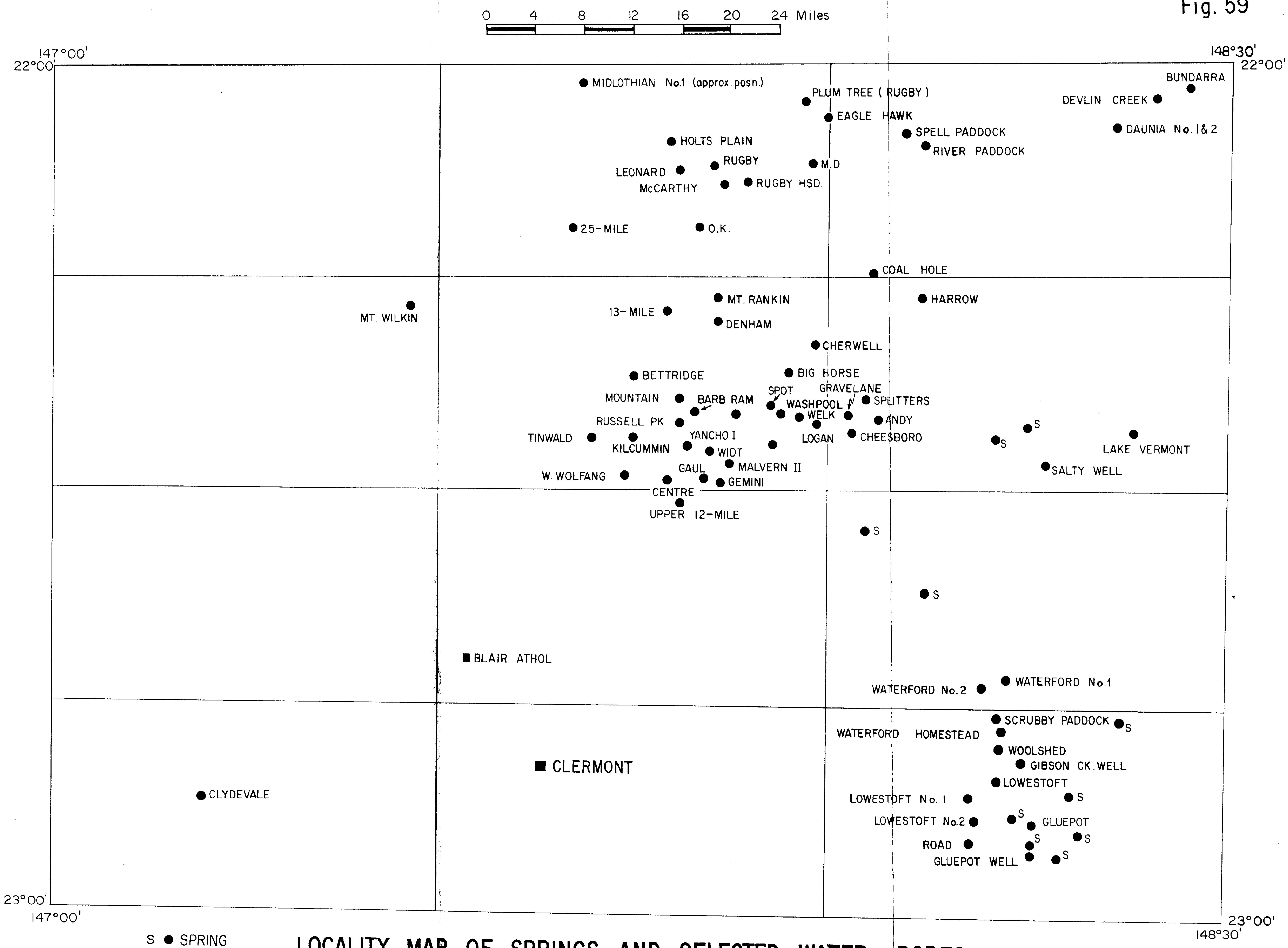
Table 2. Comparison of analyses of coal from the Big Seam at Blair Athol (average of many samples) and from the Upper Bowen Coal Measures (one sample). Lake Vermont Coal analysed by the Government Chemical Laboratory, Brisbane.

The C.S.I.R.O. Division of Coal Research, (1960) considers the Blair Athol coal suitable for steam raising and power generation. Compared to other coals it is low in mineral contamination and would not corrode furnaces.

Upper Bowen Coal Measures

The occurrence of coal in the Upper Bowen Coal Measures has been discussed earlier. The main occurrences are at Harrow Creek and Lake Vermont Homestead and a bore on Grosvenor Downs. The Harrow Creek and Lake Vermont occurrences are shown in figure 28.

Fig. 59



LOCALITY MAP OF SPRINGS AND SELECTED WATER BORES, CLERMONT SHEET AREA.

Bureau of Mineral Resources, Geology & Geophysics. May, 1961.

To accompany Record 1961/75

F55/11/36

TABLE 3. SELECTED WATER BORES AND WELLS, CLERMONT SHEET AREA.

NAME	DATE	DEPTH (feet)	WATER STRUCK (depth in feet)	WATER LEVEL	SUPPLY gallons/hour	QUALITY	STRATA
ANDY	1958	258	19,65,201,237-258		unlimited	good	0-110 basalt; 110-130 pug; 130-136 coal and coal shale; 136-174 shale; 174-177 gy sandstone; 177-237 black shale; 237-258 coarse sandstone.
BARB		355			60		0-90 basalt; 90-140 blue clay; 140-170 cream clay, gravel: 170-172 sandstone; 172-252 clay, gravel, quartz, slaty; 252-350 blue slate.
BETTRIDGE		200	40,123 - 130		300		basalt
BIG HORSE	deepened 1957	400			500	good	298-400 alternating sandstone and shale.
BUNDARRA		127			1100		
CENTRE	1953	99	45, 50				0-50 clay & basalt boulders; 50-99 basalt
CHEESBORO	1957	272	84-88, 272	86	initially 560, later failed	good	basalt
CHERWELL	1940	457					see Figure 16
CLYDEVALE		140		100	1800	good	Drummond Beds
COAL HOLE		126	32(salt),56-59, ? 124	25	? 720	brackish	alternating sandstone & shale; 2"coal at 56'
DAUNIA No.1		193		136			
DAUNIA No.2		292		217			
DENHAM	1956	206	44 - 48		820	good	0-121 basalt; 121-124 blackish soot; 124-206 sandstone.
DEVLIN CREEK		125		71			
EAGLE HAWK				212	180		
GAUL	1955	300					0-45 basalt
GEMINI	1909	102	90		good		14-35 soft basalt; 35-71 hard rock; 71-102 soft rock
GIBSON CREEK WELL		80				good	sandstone
GLUEPOT		340					0-230 basalt; 230-340 dark shale
GLUEPOT WELL		8		surface	500-800		vesicular basalt
GRAVELANE	1959	496					0-40 black soil with basalt at bottom; 40-250 soft sandstone; 250-256 sandy grav[illegible] 256-480 pug and blue-grey micaceous car[illegible] onaceous shale; 480-496 chloritized gr[illegible]
HARROW		93			failed in 1932		0-48 clay; 48-77 basalt; 77-93 hard gy [illegible]
HOLTS PLAIN		287	276		600		0-274 clay with thin seams of sand 274-287 [illegible]
KILCUMMIN	1926	150			good		0-3 soil; 3-106 basalt; 106-112 schist; 112-122 weathered basalt; 122-145 various shales; 145-150 grey clay.

TABLE 3. SELECTED WATER BORES AND WELLS. CLERMONT SHEET AREA.

NAME	DATE	DEPTH (feet)	WATER STRUCK (depth in feet)	WATER LEVEL	SUPPLY gallons/hour	QUALITY	STRATA
LAKE VERMONT						some salts	Cuttings of carbonaceous shale and shaley coal.
LEONARD		311	280,311	161	280'-200; 311'-420	unsuitable for stock	0-180 slippery back; 180-200 chalk; 200-247 fire clay; 247-311 white and yellow sandstone
LOGAN	1957	170	137-140	118	good		basalt
LOWESTOFT		200				good	basalt and clay
LOWESTOFT No.1		168			300	good	0-32 basalt; 32-62 clay; 62-84 black shale; 84-93 clay basalt; 93-16[illegible] sandstone.
LOWESTOFT No.2		286	75, 150		600	good	0-95 rotten basalt; 95-130 clay;130-165 black shale; 165-210 white shale; 210-[illegible] grey sandstone
MALVERN II	1959	278	45-49, 128		300		basalt and pug
McCARTHY		271	250, 271	205	420	good stock	0-50 stony; 50-250 clay; [illegible]-255 sand; 255-271 pug, at 271 sand
M.D.				200-300	300	good	
MIDLOTHIAN No.1		349	239	189	150	unsuitable for stock	0-239 clay; 239-245 fine sand with clay
MOUNTAIN		217	206-217				0-216 basalt, 216-217 porous sandstone
MT. RANKIN					none	good	248-290 chocolate shale; 290-305 blue rock;305-312 decomposed granite;312-34[illegible] granite [illegible] crystalline [illegible]
MT. WILKIN		180		80	880		0-175 basalt; 175-180 shale
O.K.		263	253	168	520	good stock	0-97 white sand and sandstone;97-101 [illegible] shale; 101-148 red sandstone; 148-213 coal shale; 213-220 red sandstone; 220-2[illegible] coal shale; 225-263 white rotten sandstone
PLUMTREE (RUGBY)				220	300	good	
RAM	1953	200	55, 145			good	0-10 red loam;45-50 soft sandstone with brown coal and clay; 50-70 zeolitic basalt; 70-90 decomposed basalt;90-120 clay; 140-145 fine sandstone with pieces of coaly shale;145-200 decomposed basalt.
RIVER PADDOCK					300-400		
ROAD		260	various depths				basalt
RUGBY							See Figure 16
RUGBY HOMESTEAD		[illegible]			good		
RUSSELL PARK		304		55	500		0-30 soil; 30-98 basalt; 98-[illegible]5 clay; [illegible]-179 basalt 179-230 fine grey sandstone; 230-286 clay; 286-304 soft yellow sandstone
SALTY WELL		33		20	1000	brackish	

NAME	DATE	DEPTH (feet)	WATER STRUCK (depth in feet)	WATER LEVEL	SUPPLY gallons/hour	QUALITY	STRATA
SCRUBBY PADDOCK	1939	510	303-306 430-500		320		0-63 soil & clay; 63-210 black shale; 210-255 sandy shale; 255-303 black shale; 303-306 brown sandstone; 306-510 various shales.
SHED	1954	300			1000		finished in hard black sandstone
SPELL PADDOCK					280-300		
SPLITTERS	1912	198	190	66	unlimited		Sandstone and shale
SPOTS	1908	360					322-360 clay and sandstone
TINWALD	1955	144	94-110	10	unlimited		0-60 rotten basalt; 60-144 basalt
UPPER 12-MILE		305					110-149 clay; 149-305 basalt and pug
WASHPOOL	1959	205	10,20,63-65,120-123(main)	10	1320	good	basalt
WATERFORD HOMESTEAD		160					0-124 clay and sandstone; 124-155 hard grey rock; 155-160 clay
" No.1	1929	103	39, 50 - 89		680		0-30 clay and sand; 30-103 sandstone
" No.2	1929	225	72-89,97-129,148-150, 198-204				0-204 basalt; 204-225 grey rock.
WELK	1959	231	26-28, 206-210	29	1120		basalt, possibly interbedded with clay
WIDT	1953	463	409				clay and basalt
WEST WOLFANG	1958	120	31-35	10	1800		0-35 decomposed basalt; 35-120 basalt
WOOLSHED		100				very good	0-30 soil,30-100 basalt over water-bearing'sand'
YANCHO I	1959	243	7-16,226-239(main)	23	1400		0-7 clay;7-16 rotten basalt;16-243 basalt & clay.
13-MILE (WENTWORTH)		361			poor		hard rock
25-MILE (WENTWORTH)		331	230,331	185	at first good, now poor		0-225 clay & gravel;225-331 hard rock

The bore on Grosvenor Downs lies 3 miles south of the Highway crossing on the Isaacs River; records show that it intersected a seam 12 feet thick at a depth of 147 feet. It is not known when this bore was sunk and detailed information on the occurrence is not available. The extent of the other occurrences is not known; an analysis of a sample from the outcropping seam near Lake Vermont Homestead is given in Table 2. Numerous reports of coal within the Upper Bowen are known; however, no detailed work has yet been attempted with a view to assess their coal potential.

Middle Bowen Beds

Thin coal outcrops have been seen in the rocks of the Cherwell Range, and coal is known in certain bores that cut the basal part of the Middle Bowen Beds, but no exploration for coal has been done in these beds.

Underground Water

Details of selected water bores and wells are given in Table 3 and the location of bores in Figure 59. The water prospects in the various units are as follows:

Anakie Metamorphics:	poor supply; good dam storage.
Drummond Beds :	hard drilling, good dam storage, good supply at Clydevale.
Bulgonunna Volcanics:	poor.
Permian :	the few bores in Permian strata give an adequate supply for stock; many are salty but still suitable for stock.
(?) Tertiary Basalt:	good shallow supply but few bores maintain supply. Springs found at contact of basalt and Permian sandstone in Logan Creek, head of Harrow, Feez, Phillips and Gilbert Creeks.
Alluvium :	good shallow supply.

Petroleum Prospects

The only potential oil-bearing rocks in the Clermont Sheet area are the Permian Middle Bowen Beds and Upper Bowen Coal Measures. The transgressive clarkei-bed has masked any older Permian marine rocks that may extend into the Clermont Sheet area from outcrop areas in the Mount Coolon Sheet area (Malone et al., 1961) and perhaps also from the subsurface of the Cooroorah Well area. In the absence of deep bores inthe Clermont Sheet area, this discussion is therefore restricted to outcropping rocks.

The most favourable potential source rocks are the bodies of dark siltstone, individually up to 100 feet thick, that constitute a quarter to a third of the exposed marine or alternating marine and freshwater sequence. Abundant worm-tracks indicate that the bottom was aerated. A sample of siltstone from Phillips Creek (CL21/1), near Tay Glen Crossing, was tested by W.M.B. Roberts for trace elements by X-ray fluorescent spectrography, with the following results: Ti 0.5%, Ba 0.5%, Co Cu Ni trace, I Va not detected. The same sample was tested by P.R. Evans for microplankton and spores but was found to be barren. Unfortunately with samples from the surface, trace and organic constituents, if originally present, are prone to be lost during weathering, so the results of the tests are equivocal. Most of the sandstone in which the siltstone bodies are enclosed has low porosity due to a fine matrix; once again only surface samples were available and unweathered sandstone possibly has higher porosity. More favourable potential reservoirs are beds of porous lithic sandstone in the Upper Bowen Coal Measures.

Small closed structures like the Norwich Park Dome and the dome near the junction of Feez and Little Roper Creeks, and broader structures in the Cherwell Range are potential traps. Beds of impermeable quartz greywacke or siltstone are potential cap rocks.

The main outcrop south of Phillips Creek has been intruded in places by basaltic and trachytic dykes and sills, and, on its western edge, by the Peak Range Volcanics, which have arched up the intruded rocks.

The "Passage Beds" and Upper Bowen Coal Measures are potential reservoirs of dry gas derived from coal seams.

Gold

Today, no gold is being produced in the area except by fossickers. From 1878 to 1901, the period of greatest gold production, the Clermont Goldfield produced gold valued at £711,000. The main areas of gold production were the Miclere, Black Ridge and the Springs Goldfields. The gold occurs in four environments:

1. Quartz reefs in the Anakie Metamorphics.
2. Permian alluvial deposits.
3. (?) Tertiary alluvial deposits beneath the basalt.
4. Recent alluvial deposits.

Most of the shafts are now filled with water and have been abandoned. In 1904 nearly 6,900 ounces were produced from these fields. South of Clermont, shafts, now abandoned, penetrate quartz reefs. Details of the goldfields are given by Dunstan (1902) and Ball (1906). not in list of refs.

Copper

Copper was produced from mines at Copperfield, three miles south of Clermont. Crude copper was extracted from a low-grade ore mined from a mineralized zone in the Anakie Metamorphics.

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The management of Consolidated Zinc Proprietary Limited, Melbourne, kindly allowed us to use some information on drilling in the Blair Athol Coalfield. Professor Dorothy Hill, Queensland University, determined the corals collected from the Douglas Creek Limestone. The Government Chemical Laboratories, Brisbane, analysed a sample of coal from near Lake Vermont Homestead. To Mr. and Mrs. A. J. Rolfe and Mr. and Mrs. V. Rolfe, of 'Cotherstone', we express our thanks for untiring hospitality. We thank our visitors, Mr.G.Tweedale, of the Queensland Geological Survey, and Mr.M.A.Condon, Mr.W.B.Dallwitz, and Mr.J.M.Dickins, all of the Bureau, for advice and help in the field.

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APPENDIX 1.

PETROGRAPHY OF ROCKS FROM THE CLERMONT SHEET AREA.

by

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1. BULGONUNNA VOLCANICS

CL104: LITHIC TUFF

Microslide:- QSG 2057 ex Specimen : - QSG/R 1084

Macro :- A massive, pinkish-grey, clastic rock containing fragments (up to 1 cm.) of dark grey to cream-coloured, fine-grained rocks.

Micro:-

Texture: Clastic.

Phenoclasts: Quartz: anhedra, 0.3 mm., deeply embayed; 5%

Lithic fragments: up to 2 mm., irregular fragments with indented margins; the majority of the fragments are of spheroidal rhyolite; a small number of the fragments are of a basic extrusive (basalt ?); estimated at 30-40%.

Matrix: very fine-grained, cloudy.

Origin: Igneous, pyroclastic.

Parent Material: dominantly rhyolite.

CL123A: TUFF

Microslide:- GSQ 2058, 2059 ex Specimen : - GSQ/R 1086

Macro :- A very fine-grained, massive, light-grey clastic rock which has been heavily iron-stained.

Micro :-

Texture: Clastic.

Phenoclasts: Quartz: subrounded grains of moderate sphericity; grain size 0.05 to 0.1 mm.; about 5%.

Feldspar: similar to quartz, but slightly more abundant.

Lithic fragments: subrounded fragments of fine-grained volcanic material; commonly about 0.2 mm. and of low sphericity; about 5-10%.

Matrix: heavily iron-stained argillaceous material.

Origin: Pyroclastic, probably aqueous.

CL126: RHYOLITE

Microslide:- GSQ 2060 ex Specimen : - GSQ/R 1087

Macro:- A massive, fine-grained, purplish-grey siliceous rock with coarse clots (up to 1 cm.) of white milky quartz.

Micro:-

Texture: Porphyritic.

Phenocrysts: Quartz: anhedra about 0.25 mm.; about 5%.

Groundmass: Cryptocrystalline, quartzo-feldspathic, slightly iron-stained. Dispersed irregularly throughout are formless areas composed of a quartz mosaic, as coarse as 0.05 mm.

Origin: Igneous; extrusive.

Alteration: The feldspar is altered. The silicification is obviously due to late-stage crystallisation of pockets of siliceous liquid rather than to the introduction of silica.

CL128: TUFF

Microslide:- GSQ 2061 ex Specimen:- GSQ/R 1095

Macro:- A massive, khaki-coloured, fine uneven-grained clastic rock.

Micro:-

Texture: Clastic.

Phenoclasts: Quartz: subangular to subrounded, low sphericity; maximum grain size 0.3 mm., dominantly about 0.1 mm.; estimated 5%

Feldspar (plagioclase and potash ?) : subangular to subrounded or as ragged laths; maximum 0.3 mm., dominantly about 0.05 mm.; estimated 15%.

Lithic material : some rock fragments (about 0.4 mm.) can be identified but are almost impossible to distinguish from the matrix.

Matrix: The matrix and lithic fragments are almost impossible to observe owing to an overall limonitic clouding, probably due to clay which has been impregnated with iron.

Alteration: Weathered; little or no alteration.

Origin: Pyroclastic activity.

CL134: LITHIC GREYWACKE

Microslide:- GSQ 2062, 2063 ex Specimen: - GSQ/R 1099

Macro:- An altered, pinkish-grey massive volcanic rock with irregular phenoclasts, up to 2.5 cms. in a very fine-grained matrix.

Micro:-

Texture: Clastic.

Phenoclasts: make up 8-85% of the rock.

Volcanic lavas: rounded, low sphericity, 0.2 to 2.0 mm.; estimated at 50% of phenoclasts; at least three distinct types:-
(i) limonite-stained plagioclase - rich rock;
(ii) porphyritic type, usually iron-stained;
(iii) fresh cryptocrystalline material, some of which is traversed by very fine calcite veins.

Sedimentary fragments: subangular to subrounded, medium sphericity, 0.4 to 3 mm.; estimated at 20% of phenoclasts. Include quartzite, micaceous quartzite, mudstone, interbedded mudstone and siltstone, and siltstone (argillites ?).

Quartz: dominantly 0.25 to 0.5 mm., subangular to subrounded, medium sphericity; commonly deeply embayed; estimated 10% of phenoclasts.

Feldspar: (dominantly plagioclase): broken crystals, commonly 0.25 to 1.0 mm.; crystals altered, clay minerals and calcite being usual products; many of crystals deeply embayed; one crystal with a fringe of myrmekite; estimated 20% of phenoclasts.

Matrix: difficult to distinguish from phenoclast; cloudy, argillaceous - probably dominantly ash.

Alteration: Weathered, calcitisation and limonitisation considerable; minor sericitisation.

Origin: Sedimentary.

Parent Material: Volcanic rock, low grade metamorphics and "granite".

CL134: ALTERED BASALT

Microslide: GSQ 2064 ex Specimen GSQ/R 1100

Macro: A massive, greenish-grey rock composed of black phenocrysts, up to 4 mm., in a very fine-grained groundmass.

Micro:-

Texture: Igneous; porphyritic; groundmass sub-ophitic.

Constituents: Plagioclase: saussuritised; subhedral to anhedral lath-shaped; unoriented; average crystal length about 0.35 mm.; estimated 55-60%.

Pyroxene: crystals very broken - originally phenocrysts up to 2mm.; sub-ophitic texture with plagioclase; estimated 15-20%.

Chlorite (pennine): the "black phenocrysts" seen in hand specimen: occurs in groundmass and pseudomorphous after original phenocrysts; estimated 20-25%.

Epidote: fine granular, associated with chlorite.

Calcite: secondary, not very abundant.

Alteration: Considerable.

Origin: Probably instrusive.

CL135: GREYWACKE

Microslide: GSQ 2066 ex Specimen: GSQ/R 1104

Macro: A massive, dark-grey, fragmental rock. Maximum grain size 5 mm.

Micro:

Texture: Clastic.

Phenoclasts: Feldspar (plagioclase and potash): subhedral and anhedral crystals with "tattered" edges; anhedral crystals have high to low sphericity and are r unded to angular; many of crystals heavily altered, while others are extremely fresh; average grain size about 0.3 mm, maximum 1.5 mm.; estim ted at about 30%; plagioclase andpotash felspar in approximately equal amounts.

Quartz: similar in form to feldspar; estimated at about 2%.

Lithic material: estimated at 60%; apparently about equal proportions of volcanic and sedimentary material. The sediments are argillites (mudstones) and the volcanic fragments include basic lava and spherulitic acid volcanics; average grain size about 0.7mm.; maximum about 3 mm.; subangular to subrounded, low sphericity.

Matrix: Apparently originally argillaceous; now dominantly very fine crystals of light brown biotite with associated opaques. The crystals are metamorphic - not clastic in origin. Estimated at 5-10%.

Alteration: Fresh, little alteration. Rock, however, appears to have undergone low grade metamorphism.

Origin: Sedimentary.

Parent Material: Dominantly volcanics and low grade metamorphic rocks.

Note: This rock is not a true greywacke in that the percentage of matrix is low. In overall appearance in hand specimen and thin section, however, it obviously belongs to the greywacke suite.

The phenoclasts appear to have been forcibly compacted together; possibly the matrix was compacted to a proportionately higher degree.

CL135 II: METASOMATISED GREYWACKE.

Microslide: GSQ 2065 ex Specimen : GSQ/R 1106

Macro:- Similar to GSQ 1104 but there appear to be less rock fragments. Epidote is abundant.

Micro:- The rock is heavily altered and its properties cannot be properly distinguished. However, it appears to be essentially similar to GSQ 2066 in basic texture and composition.

Metasomatism:- Epidotisation has been considerable. Ragged, fine prisms of green hornblende are abundant, commonly associated with the epidote. These crystals appear to have been growing. Green pennine chlorite (with associated opaques) is common, apparently pseudomorphous after ferromagnesian crystals.

CL139 : ANDESITE

Microslide:- GSQ 2067 ex Specimen GSQ/R 1109

Macro:- A massive, fine grained, pinkish-and greenish-grey mottled rock.

Micro:-

Texture: Porphyritic; groundmass microcrystalline allotriomorphic - granular.

Phenocrysts: Plagioclase subhedral or anhedral lath-shaped crystals up to 1 mm. in length; some of the crystals are sericitised and partly replaced by myrmekite but the majority of them are anhedral, extremely altered with a narrow unaltered "fringe" about the margins.

Potash feldspar: occurs in minor amounts in similar form to the plagioclase but most of it is involved in the myrmekitic intergrowths. Total feldspar about 45%.

Hornblende: aggregates of fine anhedra are dispersed irregularly throughout the rock. The crystals are partly pseudomorphed by epidote, penninite and opaques.

Groundmass: composed essentially of feldspar and fine anhedra of hornblende.

Origin: Igneous; intrusive.

CL140: METAMORPHOSED CONCRETIONARY SILTY MUDSTONE.

Microslide:- GSQ 2068 ex Specimen:- GSQ/R 1111

Macro:- A very fine-grained, massive, dark grey rock.

Micro:-

Texture: Clastic; maximum grain size 0.05 mm.

Constituents: Quartz and Feldspar : silt-sized grains,; subangular to angular, low spericity, unoriented; estimated at 1-2%.

Argillaceous Matrix: abundant but indistinct, masked by abundant red-brown staining.

Biotite: occurs as flakes of clastic origin and a greater abundance of fine granules of recrystallised biotite.

Concretions: Average diameter 0.5 mm., occupy about 20% of the rock; they are of silty mudstone surrounded by a rim in which biotite is concentrated; there is little or no biotite within the structures. In some instances two or more of the spherical bodies appear to be joined together.

Origin:- Epiclastic

Alteration:- Fresh; very low grade metamorphism.

CL248/1: ALTERED PORPHYRITIC BASALT

Microslide: GSQ 2116 ex Specimen: GSQ/R 1163

Macro: A massive, dark grey igneous rock with subhedral and anhedral phenocrysts of feldspar up to 1.1 cm.

Micro:-

Texture: Porhyritic; groundmass microcrystalline.

Phenocrysts: Plagioclase (labradorite); subhedral and anhedral laths; sericitised.

Amygdules ? : Certain irregular areas are filled with calcite, radiating quartz crystals, and minor orthopyroxene rimmed with green penninite and epidote.

Groundmass: A microcrystalline mass of feldspar, chlorite, pyroxene, epidote and cubic opaque material.

Origin:- Igneous, probably intrusive.

CL404: BIOTITE RHYOLITE.

Microslide:- GSQ 2117 ex Specimen:- GSQ/R 1164

Macro:- A massive, partially iron-stained, pinkish grey, very fine-grained rock with an abundance of quartz and feldspar (up to 2 mm.) phenocrysts and traversed by a network of very fine veins.

Micro:-

Texture: Porphyritic; groundmass cryptocrystalline.

Phenocrysts: Quartz: anhedral, commonly embayed, 0.5 to 1.5 mm., and commonly composite.

Plagioclase (andesine): euhedral to subhedral 0.1 to 1 mm., somewhat altered. Potash feldspar: altered anhedra up to 0.5 mm.

Biotite: aggregates of fine flakes with associated hematite- and limonite-staining.

Groundmass: Cryptocrystalline, essentially siliceous.

Origin:- Igneous, extrusive.

Alteration:- Secondary or late-stage veins of a fine quartz-plagioclase mosaic traverse the rock.

2. THERESA CREEK VOLCANICS

CL149I : TUFF

Microslide :- GSQ 2070 ex Specimen :- GSQ/R 1115

Macro :- A massive, reddish-brown, fine-grained clastic rock with phenoclasts of pink feldspar, quartz and mica schist ..

Micro :-

Texture: Clastic.

Phenoclasts: dominantly 1-3 mm.

Feldspar : altered almost beyond recognition; subhedral to anhedral; about 5%.

Volcanic rock : dominantly of devitrified vitric tuff but some fine-grained flow rocks; 5-10%.

Mica : extremely altered and iron-stained flakes; < 5%.

Shards : devitrified glass which has been heavily stained with hematite.

Matrix :- Ash : heavily iron-stained and including an abundance of fine opaque material.

Origin :- Igneous; pyroclastic.

Alteration :- Considerable.

CL149II : ANDESITE

Microslide :- GSQ 2071 ex Specimen :- GSQ/R 1116

Macro :- A massive, fine-grained, dark grey rock with fine phenocrysts of feldspar and of a mafic mineral.

Micro :-

Texture :- Porphyritic; groundmass pilotaxitic composed of cryptocrystalline material filling the interstices between crudely parallel microlites of feldspar.

Phenocrysts :- Plagioclase (andesine) : anhedral and subhedral laths, most of which are extremely altered; about 50%.

Hornblende : green, anhedral, up to 1 mm.; partly replaced by chlorite and calcite.

Groundmass :- composed of cryptocrystalline feldspar and hornblende and microcrystalline altered hornblende (with minor chlorite and epidote) filling the interstices between microlites of feldspar.

Origin :- Igneous; extrusive.

Alteration :- Minor calcitisation of the groundmass has taken place; the feldspars have undergone considerable alteration.

CL149IV : LITHIC TUFF

Microslide :- GSQ 2072 ex Specimen :- GSQ/R 1117

Macro :- A massive, purplish-grey clastic rock with an abundance of phenoclasts of decomposed feldspar and rock fragments including one subangular fragment of mica schist, 0.5 mm. x 1.5 mm. x 1.5 mm.

Micro :-

Texture :- Clastic.

Phenoclasts :- Feldspar : embayed anhedra, up to 2 mm.; almost completely decomposed; about 10%.

Biotite : heavily iron-stained flakes up to 1 mm.; about 2%.

Lithic fragments : about 15%.

Muscovite schist : up to 1.5 c.m.

Vitric tuff : heavily hematite-stained, irregular fragments up to 2 mm.

Volcanics (extrusive ?) : very fine-grained, clouded by opaque dust.

Matrix :- very fine ash abounding in hematite-stained devitrified shards.

Origin :- Igneous; pyroclastic - possibly aqueous.

Parent Material :- Low grade metamorphics and fine-grained volcanics.

CL151A : LITHIC TUFF

Microslide :- GSQ 2073 ex Specimen GSQ/R 1118

Macro :- A massive dark grey clastic rock with irregular fragments up to 5 mm.

Micro :-

Texture :- Clastic.

Phenoclasts :- Plagioclase :- anhedral lath-shaped crystals, 0.5 to 2 mm.; zoned and partially replaced by epidote and chlorite; about 15%.

Lithic fragments : the main part of the rock comprises fragments of a number of unidentifiable volcanic rocks, many of which are comparatively rich in epidote; about 55%.

Matrix :- very fine.

Origin :- Igneous; pyroclastic.

Parent Material :- Miscellaneous volcanics.

CL151C : CRYSTAL TUFF

Microslide :- GSQ 2074 ex Specimen :- GSQ/R 1122

Macro :- A massive, greenish-grey rock with clots of epidote (up to 7 mm.).

Micro :-

Texture :- Clastic; maximum grain size 1 c.m.; ranges up from 0.04 mm.

Phenoclasts :- Feldspar : plagioclase and potash which have been sericitised to some extent; the minerals are crystalline and occur as ragged anhedra or as broken laths; the crystals range from 0.04 mm. to 0.5 mm.; about 25%.

Lithic Material : 0.1 mm. to 1 cm.; the fragments have no preferred shape or orientation; the fragments appear to be exclusively of fine-grained extrusives; the coarsest fragment (1 cm.) is of a porphyritic volcanic, probably andesite. It contains phenocrysts of plagioclase (up to 1 mm.) and of epidote, penninite and calcite together pseudomorphous after coarse prisms (up to 2 mm.) of an unknown mineral in a very fine-grained groundmass rich in plagioclase; about 15%.

Epidote and Penninite : fragments up to 1 mm. are present, believed to be derived from the breakdown of these lithic fragments; about 10%.

Matrix : very fine; about 50%.

Origin :- Igneous, pyroclastic.

Parent Material :- Andesite, probably extrusive.

CL151C : ANDESITE

Microslide :- GSQ 2075, 2076 ex Specimen :- GSQ/R 1123

Macro :- A massive, fine-grained, light grey rock containing phenocrysts of feldspar (up to 4 mm.).

Micro :-

Texture :- Porphyritic; groundmass fine (average grain size 0.1 to 0.2 mm.), hypidiomorphic-granular with some crude myrmekitic intergrowths.

Phenocrysts :- Feldspar (plagioclase) : subhedral to anhedral, lath-shaped crystals which are extremely altered and are replaced by sericite, calcite, penninite and epidote; individual crystals are dominantly about 1.0 mm. in length; about 30%.

Groundmass :- Plagioclase : subhedral laths which are extremely altered predominate; about 35%.

Quartz : interstitial; $<$10%.

Potash feldspar : anhedral; appears to have been introduced; about 10%.

Penninite : anhedral, abundant.

Epidote : fine, anhedral.

Origin : Igneous; intrusive.

Alteration :- Extreme.

CL152 : ANDESITE

Microslide :- GSQ 2077, 2078 ex Specimen :- GSQ/R 1125

Macro :- A light grey, massive, fine grained porphyritic rock with fine phenocrysts of feldspar and ferromagnesian mineral.

Micro:-

Texture :- Porphyritic; groundmass hyalopilitic.

Phenocrysts :- Plagioclase (andesine) : subhedral to anhedral lath-shaped crystals; 0.5 to 1 mm.; crystals extremely altered.

Augite : originally subhedral; partially replaced by penninite, pyrite, hematite and minor calcite.

Groundmass :- Feldspar microlites and opaque dust enveloped in devitrified glass. There is a crude fluidal texture of some of the microlites about some of the phenocrysts.

Origin :- Igneous; intrusive.

Alteration :- Considerable.

CL153 : LITHIC GREYWACKE

Microslide :- GSQ 2079 ex Specimen :- GSQ/R 1127

Macro :- An iron-stained, cream-coloured sediment with alternating beds, up to 3 cm. thick, of coarse and fine material. The maximum grain size is about 5 mm.

Micro :-

Texture :- Clastic; since the overall composition varies little from one band to the next, the section may be considered as a homogeneous rock. Maximum grain size 4 mm., dominant throughout 0.3 mm.; subangular to subrounded, sphericity fairly low.

Grains :- Quartz : 5-10%.

Feldspar : dominantly potash; 5-10%.

Lithic fragments : 45-50%.

Quartzite : 2%.

Argillaceous rocks : fine-grained, decomposed; unidentifiable.

Matrix :- Argillaceous; 35-40%; Limonite-staining abundant.

Origin :- Sedimentary.

Parent Material :- Sediments and volcanics.

CL153: DOLERITE

GSQ/R
Microslide :- GSQ 2080, 2081 ex Specimen :- 1128

Macro :- A dark grey massive, fine-grained rock in which crystals of feldspar (up to 1mm.) are in evidence.

Micro :-

Texture :- Porphyritic; groundmass microcrystalline, intersertal.

Phenocrysts :- Plagioclase (labradorite) : lath-shaped crystals mostly anhedral, sharply twinned and zoned; 0.2 to 1.0 mm.; some crystals are clouded with rods of opaque material.

Hypersthene : anhedral to subhedral; 0.2 to 1.5mm. with associated ? pyrite.

Groundmass : A microcrystalline mass of plagioclase laths, bastite, anhedral opaques and minor amounts of calcite and epidote.

Origin:- Igneous; intrusive.

CL154E : TUFF

GSQ/R
Microslide :- GSQ 2083, 2084 ex Specimen :- 1132

Macro :- A massive, cream-coloured rock with phenoclasts of quartz (up to 2mm), red feldspar (up to 2 mm.) and of green lithic material (up to 5mm.).

Micro :-

Texture :- Clastic.

Phenoclasts :- Quartz : 0.3 to 1mm.; anhedral crystals embayed in part; estimated at 2%.

Feldspar (potash) : similar to quartz and slightly more abundant - 5%.

Shards : devitrified; 0.2 to 1mm., pseudomorphed by fine siliceous mosaic.

Matrix :- Argillaceous : composed essentially of potash feldspar derivatives.

Origin: - Igneous; pyroclastic.

CL154G : SUBGREYWACKE

GSQ/R 1133

Microslide :- GSQ 2085, 2086 ex Specimen : 1133

Macro :- A massive, dark reddish-brown clastic rock with a maximum grain size of approx. 1mm.

Micro :-

Texture :- Clastic; maximum grain size 1.2 mm.; dominantly 0.5 mm.; minimum 0.06 mm. The rock is extremely altered and individual constituents are very difficult to distinguish.

Phenoclasts :- Subrounded to subangular; moderate sphericity.

Quartz : fractured and strained; grains commonly composite; estimated 5-10%.

Potash feldspar : altered to clay minerals; estimated at 30-35%.

Plagioclase : altered, epidotised; estimated at 5%.

Lithic fragments : estimated 35-40%; altered. Dominantly (probably 80%) of micrographically intergrown quartz and potash feldspar, together with minor quartzite and fine-grained material (? volcanic), some of which is epidotised; many of the fragments are heavily iron-stained.

Biotite : clastic, altered; estimated at 5%.

Cement :- Siliceous, microcrystalline; estimated 10-15%.

Origin :- Sedimentary.

Parent Material :- Dominantly granitic, possibly some volcanic material.

Alteration : -The parent rocks appear to have been weathered and considerably altered.

CL155 : ODINITE

Microslide :- GSQ 2087, 2088 ex Specimen :- GSQ/R 1134

Four Mile Map :- Emerald

Macro :- A massive, pinkish-grey fine-grained rock with an abundance of zoned feldspar (up to 5mm.) and mafic phenocrysts.

Micro :-

Texture :- Porphyritic; groundmass, intersertal, average grain size 0.1 mm.

Phenocrysts :- Plagioclase (labradorite) : subhedral laths, 0.5 to 4mm.; somewhat altered.

Augite : euhedral to subhedral crystals, mostly about 1mm.; partially altered to Bastite with associated opaque material. Hornblende : euhedral to subhedral; 0.5 to 2mm.; pleochroic in shades of greenish-brown.

Penninite : is pseudomorphous after some unidentifiable crystals.

Groundmass :- Comprises fine laths of plagioclase, fine prisms of hornblende and anhedral penninite. Apatite is relatively abundant.

Origin : - Igneous, intrusive.

CL159D : BIOTITE TRACHYTE

Microslides:- GSQ 2092, 2093 ex Specimen :- GSQ/R 1140

Macro :- A massive, purplish-coloured, fine-grained volcanic rock with pinkish- and dark-coloured crystals and fragments up to 4 mm.

Micro :-

Texture :- Porphyritic; groundmass devitrified glass.

Phenocrysts :- Plagioclase (acid) : anhedral 0.2 to 1 mm. somewhat altered to sericite and clay minerals.

Biotite : altered; pleochroic in shades of brown; flakes 0.5 to 1.0 mm. long.

Inclusions :- Glass - devitrified; up to 3mm. with coarsely crenulate margins; rich in opaques.

Mica Schist : up to 3mm.

Volcanics : cryptocrystalline; quartzofeldspathic; up to 3mm.

Groundmass :- Glass (devitrified) with shards ; composed essentially of potash feldspar; considerably iron-stained.

Spherulites :- occur in discrete vein-like areas.

Origin:- Igneous; extrusive.

Alteration :- Considerable.

CL172 : ALTERED DACITE

Microslides :- GSQ 2096,2097 ex Specimen :- GSQ/R 1142

Macro:- A massive, fine-grained, light greenish-grey rock with phenocrysts of pink feldspar (up to 4 mm.) and calcite or calcite and chlorite (up to 1.5 cm.).

Micro :-

Texture :- Porphyritic; groundmass microcrystalline to cryptocrystalline.

Phenocrysts :- Plagioclase : subhedral laths, 0.5 to 1.5 mm.; considerably sericitised.

Quartz : commonly 0.1 to 0.5 mm. embayed anhedra.

Muscovite : flakes up to 4mm. long; considerably altered and pseudomorphed (totally or partially) by calcite and Penninite.

Groundmass :- Cryptocrystalline quartzofeldspathic material with abundance of microcrystalline sericite.

Apatite is present in accessory amounts.

Origin :- Igneous, extrusive.

CL 176B: METAMORPHOSED CRYSTAL TUFF

Microslides :- GSQ 2100, 2101 ex Specimen :- GSQ/R 1145

Macro :- A massive, dark-grey, fine-grained clastic rock with an abundance of feldspar crystals (up to 2 mm.).

Micro :-

Texture :- Clastic.

Phenoclasts :- Feldspar (acid plagioclase) : Subhedral laths and anhedra; crystals deeply embayed and commonly broken. Some similar crystals of potash feldspar are present also; about 45%.

Augite : partially replaced by bastite; subhedra and anhedra up to 1.5mm.; many of which are quite deeply embayed; about 5%.

Lithic material : fragments of cryptocrystalline material rich in opaques; up to 1.5 mm.; about 10%.

Matrix :- completely obscured by the development of micro-crystalline granular sericite. Minor secondary silicification appears to have taken place also.

Origin :- Igneous, pyroclastic.

Parent Material :- Porphyritic volcanic; probably andesite.

Alteration :- Low grade metamorphism.

CL176D : LITHIC TUFF

Microslides:- GSQ 2102, 2103 ex Specimen :- GSQ/R 1146

Macro :- A massive, fine-grained, dark, greenish-grey, clastic rock with an abundance of phenoclasts up to 5 cm.

Micro :-

Texture :- Clastic.

Phenoclasts :- dominantly 2 to 4 mm. The greatest pro - portion are of

Lithic material :- tuffs, fine-grained extrusives and cryptocrystalline quartzofeldspathic - chlorite material. Most of these fragments are fairly rich in potash feldspar. In general the fragment margins are fairly sharp but not straight.

Plagioclase (andesine) : lath-shaped anhedra, fresh or altered.

Biotite : green flakes, considerably altered; mostly about 1 mm.

Matrix :- Argillaceous : very fine; about 20%.

Origin :- Igneous; pyroclastic.

CL 180 : HYPERSTHENE BASALT

Microslide :- GSQ 2106 ex Specimen :- GSQ/R 1151

Macro :- A massive, dark grey, porphyritic rock with phenocrysts of feldspar up to 1 mm.

Micro :-

Texture :- Porphyritic; groundmass hyalopilitic.

Phenocrysts :- Plagioclase (basic andesine - acid labradorite) subhedral to anhedral lathshaped, zoned crystals; 0.2 to 0.7 mm.

Hypersthene : anhedral to subhedral, fractured and with associated opaques; up to 1 mm.; not abundant.

Groundmass:- Hyalopilitic; comprises microlites of feldspar and opaque dust, brownish and greenish glassy material, partly devitrified.

Origin :- Igneous, volcanic; could be intrusive or flow.

CL185 : ARKOSE

Microslide : - GSQ 2108 ex Specimen :- GSQ/R 1153

Macro :- A massive, dark reddish-brown clastic rock with a maximum grain size of approx. 1 mm.

Micro :-

Texture :- Clastic; maximum grain size 1.0 mm., minimum 0.06mm average about 0.5 mm.

Phenoclasts :- Subangular to subrounded; moderate sphericity.

Quartz : grains strained; estimated at 25%.

Feldspar : dominantly potash, some plagioclase; considerably altered to clay minerals and sericite; estimated 40%. Composite grains of quartz and feldspar are relatively abundant.

Biotite : clastic flakes; estimated 5%.

Lithic fragments : argillaceous, unidentifiable; estimated 15%.

Matrix :- Argillaceous : estimated 2 - 3%

Cement :- Siliceous : microcrystalline ; estimated 2%.

Ferruginous : hematitic; estimated 10%.

Origin :- Sedimentary.

Parent Material :- Granitic, dominantly.

3. ? UPPER PALAEOZOIC MONZONITE AND GRANODIORITE.

CL147 : MONZONITE.

Microslide :- GSQ 2069 ex Specimen :- GSQ/R 1113

Macro :- A light-grey, medium-grained granitic rock.

Micro :-

Texture:- Hypidiomorphic-granular; myrmekite quite common; average grain size about 1 mm.

Constituents :- Labradorite : lath-shaped subhedral to anhedral crystals up to 2.5 mm., margins against potash feldspar mostly embayed and fine fringes of myrmekite are common; 45%.

Potash feldspar :- altered, anhedral pools, commonly enveloping plagioclase; 29%.

Quartz : interstitial ; 6%.

Biotite : brown flakes, 7%; altered with associated chlorite, epidote and opaques (pyrite) (2%).

Hornblende : green, pleochroic, altered anhedral or subhedral crystals; commonly occurs as narrow fringes about augite; 6%.

Augite : anhedral altered crystals, 5% ; commonly fringed by biotite or hornblende.

Apatite : fine, accessory.

Origin :- Igneous, plutonic.

CL154 : MONZONITE PORPHYRY

Microslide : - GSQ 2082 ex Specimen :- GSQ/R 1129

Macro :- A massive, pink, fine-grained rock containing feldspar and mafic phenocrysts up to about 4 mm., fine-grained rock fragments (dominantly metamorphic) up to 1.5 cm. and one fragment of a medium grey, fine-grained rock 8 cm. x 4.5 cm.

Micro:-

Texture :- Porphyritic; groundmass intersertal; grain size about 0.1 mm.

Phenocrysts :- Feldspar : subhedral to anhedral, almost completely decomposed; about 20%.

Penninite : pseudomorphous after subhedral or anhedral prismatic greenish-brown hornblende and colourless augite crystals, commonly about 1 mm. long. Epidote is associated with these minerals in minor amounts; together about 10%.

Groundmass :- composed essentially of micrographically intergrown quartz and potash feldspar and fine anhedra of mafic minerals filling the interstices between fine feldspar laths.

Inclusions :- the very coarse fragment is of very fine, altered andesite. The remainder of the inclusions appear to be of schistose material, mostly cryptocrystalline. The outlines of these fragments are sharp and there appears to have been no metamorphism of them.

Origin :- Igneous; intrusive.

Alteration : - Considerable.

CL156B : TRACHYANDESITE

Microslides :- GSQ 2089, 2090 ex Specimen : - GSQ/R 1137

Macro : - A dark-grey, massive, fine-grained rock with an abundance of cream-coloured feldspar phenocrysts, up to 2 mm.

Micro : -

Texture : - Porphyritic; groundmass very fine - 0.2 mm. to microcrystalline; allotriomorphic - granular.

Phenocrysts : - Plagioclase (basic andesine) : anhedral, lath-shaped crystals, 0.3 to 1 mm. in length. The crystals are extremely altered and are partially replaced by sericite. The margins appear to have been somewhat embayed.

Hornblende : green prismatic crystals up to 0.5 mm. in length: commonly with associated penninite, epidote and pyrite. Clots formed by the aggregation of small crystals are quite common.

Groundmass : - Irregularly changing from microcrystalline to coarser (0.2 mm.) throughout the section. The material is too fine for accurate identification beyond the fact that it is composed predominantly of potash feldspar. The minerals of the phenocrysts can also be detected.

Origin : - Igneous; intrusive;

Alteration : - Moderate.

CL 158 : MONZONITE PORPHYRY

Microslide : - GSQ 2091 ex Specimen : - GSQ /R 1138

Macro : - A massive, pinkish-grey and white mottled rock with cream-coloured phenocrysts in a very fine groundmass.

Micro : -

Texture :- Porphyritic; groundmass microcrystalline; allotriomorphic - granular.

Phenocrysts :- Feldspar (plagioclase) : altered euhedral to anhedral laths, 0.5 to 3 mm., zoned and twinned.

Many of the crystals have been totally or partially replaced by myrmekite. Potash Feldspar : occurs as a fringe about some plagioclase crystals but, in general, is present only in the myrmekite.

Hornblende : subhedral and euhedral crystals, 0.75 to 4 mm., pleochroic from straw yellow to green. The crystals are commonly partly replaced by epidote and opaques.

Biotite : flakes, 0.25 to 1 mm., pleochroic from straw yellow to brown.

Groundmass : - quartzofeldspathic, with minor amounts of slightly coarser anhedra of epidote.

Origin : - Igneous; intrusive.

Alteration : - There has obviously been considerable late-stage activity.

CL178 : GRANODIORITE

Microslide : - GSQ 2104 ex Specimen : - GSQ/R 1147

Macro : - A massive pink and dark grey mottled fine granitic rock.

Micro : -

Texture :- Hypidiomorphic-granular; grain size 1 to 3 mm.

Constituents :- Plagioclase : subhedral to anhedral laths 1 to 3 mm., extremely altered; about 55%.

Potash feldspar: interstitial and as fringes about plagioclase laths; extremely altered; about 15-20%.

Quartz : interstitial, commonly about 0.3 mm.; some crude micrographic intergrowths with potash feldspar are in evidence; about 10%.

Biotite : green altered ragged flakes, dominantly about 1 mm.; about 5-10%.

Hornblende : green altered ragged crystals; about 5-10%.

Pyrite ? and epidote : minor amounts associated with the mafic minerals; about 5-10%.

Origin : - Igneous, intrusive.

CL178 : MONZONITE

Microslide : - GSQ 2105 ex Specimen : - GSQ/R 1149

Macro : - A massive, fine-grained, pinkish-grey granitic rock.

Micro : -

Texture : - Hypidiomorphic-granular; grain size 1 to 2 mm.

Constituents : - Plagioclase (acid labradorite) : subhedral to anhedral laths, sericitised in part; estimated at 25%.

Potash feldspar : altered, anhedral; estimated at 25%.

Quartz : Interstitial; estimated at 5%.

Hornblende : green, subhedral to anhedral, somewhat altered; appears to be growing about original pyroxene crystals; estimated at 35%.

Biotite : commonly chloritised; estimated at 10%.

Opaques : associated with ferromagnesian minerals; minor amounts only.

Apatite : accessory.

Origin : - Igneous, plutonic; potash feldspar late-stage crystallisation.

CL 183 : MONZONITE PORPHYRY

Microslide :- GSQ 2107 ex Specimen : - GSQ/R 1152

Macro : - A massive porphyritic rock with cream-coloured phenocrysts (up to 3 mm.) of feldspar in a fine pink and dark grey mottled groundmass.

Micro : -

Texture : - This rock is extremely decomposed but the texture appears to have been similar to GSQ 2091; the feldspars have been almost completely altered to clay minerals and the epidotisation has proceeded further than in the earlier specimen. Some calcitisation has taken place.

Origin : - Igneous; intrusive.

4. UNDIFFERENTIATED PALAEOZOIC SANDSTONE

CL 159A : ARKOSE

Microslide : - GSQ 2094 ex Specimen : - GSQ/R 1139

Macro : - A pink and white mottled, well-sorted, massive calcareous sandstone with a maximum grain size of 1 mm.

Micro : -

Texture : - Clastic; grain size 0.5 to 1 mm.

Grains : - Quartz : subrounded to subangular; 0.5 to 1 mm. sphericity about 0.7; margins tend to be serrated; estimated at about 25%.

Feldspar : estimated at 30%; similar in form to quartz, dominantly altered potash feldspar but 1 to 2% of the feldspar is acid plagioclase.

Cement : - Calcite : Optically continuous about grains producing fontainebleau effect.

Origin : - Sedimentary.

5. DEVONIAN SILTSTONE

CL172 : SILTY MUDSTONE

Microslides : - GSQ 2098, 2099 ex Specimen : - GSQ/R 1143

Macro : - A massive, brownish-grey, fine-grained sediment with a brachiopod impression.

Micro :-

Texture : - Clastic; well-sorted, average grain 0.04 mm.

Grains : - Quartz : estimated at 20%; subrounded to subangular; sphericity about 0.5.

Feldspar : dominantly potash, some plagioclase; estimated at about 5%; similar in form to quartz.

Lithic fragments : similar in form to quartz and feldspar; difficult to distinguish from matrix but probably about 5-10%.

Biotite : altered; clastic; estimated at about 10%.

Matrix : - Argillaceous, iron-stained; estimated at 55-60%.

Origin : - Sedimentary.

6. DOUGLAS CREEK LIMESTONE

CL171 : CORALLINE LIMESTONE (slightly silicified)

Microslide : - GSQ 2268 ex Specimen : - GSQ/R 1258

Macro : - A tough, massive, dark grey limestone traversed by a network of irregular, fine white calcite veins. Fossil coral and stromatoporoid remains are abundant.

Micro : - The rock comprises organic remains consisting of crystalline calcite "cemented" by an admixture of crystalline calcite and a minor amount (perhaps as much as 5%) of admixed argillaceous material. The veins cannot be distinguished in thin section.

Alteration : - Spherulitic structures, 0.06 mm. across, composed of chalcedony can be recognised.

Origin : - Autochthonous.

7. DRUMMOND BEDS

CL 188 : TRACHYTE

Microslide : - GSQ 2109 ex Specimen : - GSQ/R 1155

Macro : - A massive, very fine-grained, purplish-grey rock with euhedral crystals of feldspar (up to 3 mm.) and a dark prismatic mineral (up to 5 mm.) with an acute rhombic cross section.

Micro : -

Texture : - Porphyritic; groundmass cryptocrystalline, pilotaxitic.

Phenocrysts : - Feldspar : subhedral or anhedral laths up to 1 mm.; altered; includes potash feldspar and plagioclase. In general, the crystals have been deeply embayed. Hornblende ? : euhedral and subhedral prisms up to 3 mm. in length, of an unknown mineral have been pseudomorphed by opaque material, with or without epidote.

Groundmass : - Microlites of feldspar are disposed in a subparallel manner and the interstices are filled by micro- and cryptocrystalline material.

Origin : - Igneous, extrusive.

Alteration : - Considerable.

CL195 : LITHIC TUFF

Microslide : - GSQ 2113 ex Specimen : - GSQ/R 1160

Macro : - A massive, reddish-brown clastic rock with an abundance of phenoclasts of feldspar (up to 5 mm.) and lithic material (up to 2.5 cms.).

Micro : -

Texture : - clastic

Phenoclasts : - Quartz : broken crystals and anhedra up to 1.5 mm.; most of the crystals are deeply embayed; about 10%.

Plagioclase (acid) : up to 0.5 mm., originally subhedral and euhedral crystals which have been broken; about 5%.

Potash feldspar : altered, broken euhedra and anhedra; about 15%.

Lithic material : includes fragments of crystal tuff, fluidal basic volcanic rock, spherulitic biotite volcanic and spherulitic rhyolite; about 40%.

Matrix : - fine, with a low percentage of devitrified shards; about 30%.

Origin : - Igneous , pyroclastic.

Parent Material : - Acid volcanics.

CL196 : ALTERED DACITE

Microslides : - GSQ 2114, 2115 ex Specimen : - GSQ/R 1162

Four Mile Map : - Galilee

Macro : - A massive, cream-coloured, porphyritic rock with phenocrysts of feldspar and ferromagnesian mineral in a fine grained groundmass.

Micro : -

Texture : - Porphyritic.

Phenocrysts : - Feldspar : subhedral and anhedral, commonly composite; alteration heavy; most of the crystals are of plagioclase but some decomposed potash feldspar is present; up to 2 mm.

Quartz : rare anhedra of quartz occur as phenocrysts.

Ferromagnesian material : anhedra have been torn out during sectioning but some anhedral hematite remains.

Groundmass : - Grain size 0.04 to 0.2 mm.; composed of subhedral and anhedral laths of altered feldspar with lesser amounts of fine interstitial quartz and accessory euhedral (cubic) opaques.

Origin : - Igneous, probably intrusive.

Alteration : - Considerable.

8. UNDIFFERENTIATED

CL189 : ODINITE

Microslide : - GSQ 2110 ex Specimen : - GSQ/R 1157

Macro : - A massive, fine-grained, light grey rock with phenocrysts of feldspar (average 2mm.) and of hornblende (up to 8 mm. in length). Fine pyrite is relatively abundant.

Micro : -

Texture : - Porphyritic; groundmass cryptocrystalline.

Phenocrysts : - Plagioclase(labradorite) : subhedral laths, 0.5 to 1.5 mm.

Hornblende : pleochroic brownish-green to light brown; crystals euhedral to anhedral, 0.2 to 8 mm. Minor pyrite and calcite are associated with the mineral.

Groundmass : - Cryptocrystalline feldspathic with fine needlelike crystals of plagioclase abundant (0.02mm.)

Origin : - Igneous, intrusive.

CL 139 : ODINITE

Microslides : - GSQ 2111, 2112 ex Specimen : - GSQ/R 1156

Macro : - A massive, dark grey, fine-grained rock with irregularly distributed stout phenocrysts of hornblende (up to 1.5 cm. long). Minor "white" phenocrysts occur also.

Micro : -

Texture : - Porphyritic; groundmass fine (about 0.2 mm.) intersertal.

Phenocrysts : - Hornblende : pleochroic brownish-green to light brown; crystals euhedral to anhedral 0.4 mm. to 1 cm.

Augite : 0.4 to 3 mm., euhedral to subhedral crystals which are fractured and partially replaced by green bastite.

Calcite and Penninite : occur together pseudomorphous after anhedral crystals of which the original composition cannot be determined.

Plagioclase (labradorite) : subhedral laths, 0.5 to 1 mm.

Pyrite : subhedral; commonly about 0.2 mm.

Groundmass : - Plagioclase : needlelike crystals with a random orientation.

The angular interstices between the crystals are filled with anhedra of the minerals recognised in the phenocrysts. Pyrite and Penninite are abundant.

Origin : - Igneous; intrusive.

CL160 : BASALT

Microslide : - GSQ 2095 ex Specimen : - GSQ/R 1141

Macro : - A massive, dark-grey porphyritic basic igneous rock.

Micro : -

Texture : - Porphyritic; phenocrysts 1 to 2 mm.; groundmass intersertal, average grain size 0.1 mm.

Groundmass : - Plagioclase : needle-like crystals and anhedra

Chlorite : fine fibres filling the interstices.

Biotite : ragged fibres; brown to green with associated opaques.

Phenocrysts : - Plagioclase (labradorite) : lath-shaped subhedral to anhedral; crystals fractured, with chlorite infilling fractures.

Hypersthene : subhedral to anhedral, fractured.

Diopside : anhedral, fractured; partially pseudomorphed by bastite with associated opaques (pyrite ?).

Origin : - Igneous, possibly intrusive.

APPENDIX 2

PERMIAN MACROFOSSILS FROM COLLINSVILLE AND FROM THE AREA OF THE CLERMONT 4-MILE SHEET

by

J. M. Dickins.

INTRODUCTION.

Some of the fossils considered in this report were collected by the Clermont Field Party (J.J. Veevers, M.A.Randal and R.G. Mollan of the Bureau of Mineral Resources and R. J. Paten of the Geological Survey of Queensland). In addition special collections were made by J.J. Veevers and the author, towards the end of the field season, from localities where fossils were particularly well represented.

Although Collinsville is geographically closer to the Mt. Coolon 4-mile Sheet area, the fossils are more readily comparable with those from the Clermont 4-mile Sheet area and are therefore considered in the present report.

The pelecypods and gastropods are identified, where possible, at the specific level; the brachiopods in many cases are identified only at the generic level. The other fossils are listed without generic or specific identification.

The collections are considered according to the four areas in which they are found - Clermont township area, the main area of Permian outcrop in the Clermont 4-mile Sheet area, the Bundarra Creek area, and the Collinsville area. In the main area of Permian outcrop in the Clermont 4-mile Sheet area, the clarkei-bed is important as a marker bed and the fossils are considered under three headings - those from below the clarkei-bed, This page a resit in wrong order.

on the eastern side of the basin on the Mt. Coolon 4-mile Sheet area (Fauna IV of Dickins in Malone, Corbett and Jensen). Few of the species of pelecypods, gastropods and brachiopods do not occur in both these areas. It seems, in addition, that some of the differences are caused by environment - the environmental differences are discussed later. The same fauna is also found at one locality in the Middle Bowen Beds on the west side of the Basin in the Mt. Coolon 4-mile Sheet area. For the present this fauna is taken as a whole, although further work may show that faunal subdivision is possible. It lies above Faunas I, II and III in the Mt. Coolon area and is apparently no older than the Ingelara Shale of the Springsure area and could be entirely younger.

It is correlable with the fauna of the Flat Top Formation of the Banana area and the upper part of the Maitland Group (Upper Marine) of New South Wales. The Mantuan Productus Bed is equivalent to part of the beds with this fauna but its exact relationship is not clear.

All the identifiable species from the Quarry Hill Shaft are found in the fauna of the main area of outcrop in the Clermont 4-mile Sheet area and the occurrence of Megadesmus sp. and Aviculopecten sp. B seems particularly important. This evidence is consistent with the beds of the shaft being of a similar age to the clarkei-bed.

The Bundarra Creek fauna also contains species of pelecypods and brachiopods similar to the fauna in the main area of outcrop and appears to be of a similar age. Pelecypods however are poorly represented whereas corals (Thamnopora and Cladochonus), fenestellid bryozoans, and crinoid ossicles are abundant, which could indicate deposition in slightly deeper water. It is unlikely those from the clarkei-bed and closely associated beds, and those distinctly above the clarkei-bed. In the north-eastern part of the Clermont 4-mile Sheet area Permian marine sediments are exposed around an intrusion of granodiorite. Marine fossils were collected and these are considered under the heading Bundarra Creek area.

In the Collinsville area the marine beds of the upper part of the Middle Bowen are regarded as equivalent to those found in the main area of Permian outcrop on the Clermont 4-mile Sheet area and the Big Strophalosia Zone as the equivalent of the clarkei-bed. In the Collinsville area the marine beds rest on the Collinsville Coal Measures whereas in the Clermont area they rest on the Upper Devonian to Lower Carboniferous Bulgonunna Volcanics, on the older Anakie Metamorphics and, in the Rugby area, on the presumed equivalents of the Collinsville Coal Measures.

By courtesy of the Geological Survey of Queensland, fossils obtained from the Quarry Hill Shaft by B. Dunstan and R.L. Jack have been borrowed together with other specimens in the Geological Survey of Queensland labelled "Clermont". These are considered under the heading Clermont township area.

Correlation of the Faunas.

Whitehouse (Appendix I in Reid 1928 p. 286) recorded that "the fauna typical of the basal Middle Bowen in the Mt. Britton area and also of the Yatton Limestone has not been found in this area", i.e. the Isaacs River District north of Clermont. The absence of this fauna is confirmed by the present work.

The fauna of the main area of Permian outcrop in the Clermont 4-mile Sheet area is equivalent in age to the fauna found in the top part of the Middle Bowen Beds to be significantly older than Fauna IV and is younger than faunas I, II and III of the Mt. Coolon area.

Both the fauna and general stratigraphical sequence of the marine Middle Bowen Beds of the Collinsville area are strikingly similar to that found in the main area of Permian outcrop in the Clermont 4-mile Sheet area. Few species found in the Collinsville area are absent from the Clermont area. Marine fossils have also been found in the Glendoo Member of the Collinsville Coal Measures (Webb and Crapp, 1960) and I hope to reexamine these for comparison with those identified from the Clermont and Mt. Coolon areas.

Comparison of sequences in the Collinsville and Clermont Areas.

Near Collinsville 2,400 feet of marine sediments overlie the Collinsville Coal Measures. The Big *Strophalosia* Zone, 90 feet thick, is 300 feet above the base of the marine beds (see Isbell, 1960).

In the Clermont area, marine beds are estimated at 1000-1500 feet and marine beds together with "Passage Beds" below definite Upper Bowen Coal Measures at 2000 feet (northern part of main area). The *clarkei*-bed is up to 50 feet thick and at the unconformity is 100 feet above the base. Elsewhere the beds below the *clarkei*-bed may be up to 100 feet thick with no base exposed (see main report). The Big *Strophalosia* Zone and the *clarkei*-bed are of the same order of thickness and occur in a similar position in sequences of comparable thickness. The sedimentary features of the two are also similar. Both have beds with countless *Strophalosia*, especially *S. ovalis* and *S. clarkei*, and *Terrakea* - other species occur in common. Different species are found from place to place as might be expected but *Strophalosia* and *Terrakea* are ubiquitous. Although the fossils may be jumbled up and, in the main, are not in their growth position, their preservation shows they could not have been moved far. Another feature of these beds is the pebbles, cobbles, boulders, leaves and pieces of wood. In both areas no boulders were observed with their long axes at right angles to and cutting the bedding. Their long axes were close to parallel to the bedding with compaction of the bedding below. Successive turbulent currents are postulated bringing in wood, leaves, pebbles, cobbles and boulders together with sediment. These currents tore the fossils away and dumped and buried them along with the debris brought in.

From the evidence outlined above it is concluded the clarkei-bed is equivalent to the Big Strophalosia Zone. Although Reid (1928) was familiar with the Big Strophalosia Zone it is understandable that he did not draw this conclusion as he had observed only a few limited outcrops of the clarkei-bed.

Depth of Deposition of clarkei-bed and Associated Beds.

The general marginal environment is discussed in the main report. The fossils taken together with certain aspects of the lithology give some additional information on the depth of deposition. The evidence discussed in the previous section suggests the clarkei-bed and the Big Strophalosia Zone were deposited on or adjacent to a shelf area with abundant life. It is postulated that Strophalosia, Terrakea and other forms were torn from where they were living and dumped and buried close at hand before valves were separated and most of the spines knocked off. This is confirmed by the number of large thick-shelled pelecypods (up to 8" across) - Megadesmus cf. grandis, Myonia sp. nov. A and Chaenomya sp. - which are found in and associated with the clarkei-bed. In only unusual conditions could these have been carried far by a current. Evidence considered later in this section indicates that pelecypods have been preserved in their living positions in beds at the stratigraphic level of the *clarkei*-bed. These large shelled specimens are also found associated with the "Pelecypod Bed" which is found in places slightly above the *clarkei*-bed. A typical exposure of this bed is found at CL12/1 which is about 20 feet stratigraphically above the *clarkei*-bed. Pebbles and cobbles and boulders are also found but not in the same quantity as in the underlying *clarkei*-bed.

The above interpretation for the origin of these beds is confirmed by evidence from the Mt. Coolon area. At MC423A (see Dickins, in Malone et al.) all the ten identifiable species of pelecypod and gastropod except possibly *Aviculopecten* sp. are found also at CL12/1. The large thick-shelled pelecypods are entirely absent and, overall, the shells are smaller and only pebbles are found. In stratigraphic position this fauna is close to calcareous beds with numerous *Strophalosia* and *Terrakea* belonging to the same or similar species to those found in the *clarkei*-bed and the Big *Strophalosia* Zone. These beds lack boulders, overall the productid shells are smaller and the spines are poorly preserved. It is suggested that in the Mt. Coolon area the shells have travelled further, the cobbles, boulders, and larger shells have been left behind, and the beds have been deposited in deeper water.

In Roper Creek at C 30/1 on a flat bedding plane, 64 specimens of *Chaenomya* sp. were counted by J.J.Veevers and the author in an area of 18 x 18 feet, all with the anterior end of the shell inclined at an angle of about 40° to the bedding plane. In another 30 the inclination was obscure but none were distinctly different. The specimens were in a crossbedded medium to coarse-grained quartz sandstone and the orientation of the specimens, front to back, varied about the dip of 5° to the east.

According to information supplied by J. J. Veevers, the clarkei-bed does not occur here but from stratigraphic reasoning it might be expected at about the level of the rocks in the creek. It seems clear these specimens were overwhelmed and buried while in their burrowing position. Other evidence for burrowing habits in *Chaenomya* and allied forms have been discussed elsewhere (Dickins in manuscript) and Craig (1956) has discussed similar finds of burrowing pelecypods in the Carboniferous of Scotland.

Identifications.

(The localities of the numbers prefixed by CL are shown on the map accompanying the main report)

Clermont Township Area

(a) Quarry Hill Shaft Clermont.

Collected by B. Dunstan - Geological Survey of Queensland Nos. F2277, F2800 - F2803 and F2806.

Pelecypods

Megadesmus ? sp.

Aviculopecten sp. (as at CL225/1)

Gastropods

Warthia sp.

Brachiopods

Terrakea solida (Etheridge and Dun) 1909
Cancrinella or *Terrakea* sp.
Dielasmatid

Collected by R. L. Jack - Geological Survey of Queensland Nos. F2804 and F2805

Megadesmus ? sp.
Chaenomya sp. (one squashed specimen)

The association of *Terrakea solida*, *Megadesmus* ? sp. and *Aviculopecten* sp. is consistent with the fauna being of a similar age to that of the *clarkei*-bed. It is younger than the fauna found at the base of Middle Bowen Beds on the east side of the basin in the Mt. Coolon area and at Homevale.

(b) Clermont.

Geological Survey of Queensland Nos. F2807-
-F2817.

Brachiopods

Cancrinella or Terrakea sp.

The locality of these specimens is not clear. The matrix, however, is similar to some of the specimens from the Quarry Hill Shaft. Fossils of this type have considerable stratigraphic range.

Main Area of Permian Outcrop on the Clermont 4-mile Sheet.

(a) Below clarkei-bed

Represented by a single locality CL122, at the unconformity.

Pelecypods

Astartila sp. nov.

Pyramus or Notomya sp. (probably different from at 12/1).

Merismopteria sp.

Stutchburia cf. costata (Morris) 1845.

Schizodus sp. nov.

Astartidae gen. et sp.nov.

Gastropods

Warthia sp.

Mourlonia (Mourlonopsis) cf. strzeleckiana (Morris) 1845

Peruvispira sp.nov. (whorls acute at slit-band)

Ptychomphalina sp.nov. (rounded whorl cross-section)

(b) "Clarkei" and Associated Beds (including overlying "Pelecypod Bed").

Localities - CL10, CL12/1, CL12/2, CL13, CL14, CL25/1, CL30/1, CL32, CL39/2, CL42/6, CL44/3, CL50/1, CL109, CL111, CL132, CL142, CL221/1, CL225/1, CL228/9, CL237/3, CL233/10, CL316/1, CL318/1a, and CL318/1b.

CL12/1 and CL25/1 are regarded as characteristic for the "Pelecypod Bed" and the fossils from these localities are marked 1 and 2 respectively in the following list. CL132 and CL225/1 are regarded as typical of the clarkei-bed and are shown by 3 and 4 respectively.

Pelecypods

Nuculana sp.[1]

Parallelodon sp. nov.[2] (P. sp. nov. B of Mt. Coolon area)

Megadesmus ? cf. grandis (Dana) 1847.

Megadesmus ? sp.[4]

Astartila sp. nov. [1,2]

Astartila ? sp. nov. [1]

Myonia cf. carinata [1,4] (Morris) 1845

Myonia sp. nov. A [1,3,4] (very large, thick-shelled species)

Myonia sp. nov. B (posterior carina more concave than in M. cf. carinata)

Pyramus sp.[1]

Chaenomya sp.[1,2,3,4] (probably C. carinata) (Etheridge Jnr.) 1892

"Sanguinolites" sp. nov. (elongated cylindrical form)

"Solemya" edelfeldti [1,2] (Etheridge Jnr.) 1892

Modiolus sp.[1]

Atomodesma sp. [1] (has a single anterior groove but this may result from crushing).

Merismopteria sp.[1] (close to M. macoptera) (Morris) 1845.

Aviculopecten sp. A [1] (unspecialized ribbing)

Aviculopecten sp. B [4] (spiny main ribs intermediate ribs of a similar size).

Streblopteria sp. ind.

Stutchburia cf. costata [1] (Morris) 1845.

Stutchburia cf. compressa [1] (Morris) 1845.

Stutchburia cuneata [1] (Dana) 1847

Schizodus sp. nov.[1]

Astartidae gen. et sp. nov. [1]

Gastropods

Warthia sp.

Mourlonia (*Mourlonopsis*) cf. *strzeleckiana* [1] (Morris) 1845

Walnichollsia subcancellata [1] (Morris) 1845

Ptychomphalina sp. nov.
Platyschisma/or *Planikeeneia* sp.

Brachiopods

Productid spines 1,2

Terrakea solida 2,3 (Etheridge and Dun) 1909

Terrakea [4] and *Terrakea* or *Cancrinella* sp.

Strophalosia brittoni var. *gattoni* [3] Maxwell 1954

Strophalosia clarkei (Etheridge Snr.) 1872

Strophalosia ovalis [2,3,4] Maxwell 1954

Neospirifer sp.[3] (form with shallow sulcus)

Trigontreta sp.[2,3,4] (alate form)

Ingelarella [1,2,3].

Pseudosyrinx

Spiriferacea gen. et sp. [2] (form with distinct spine bases)

Plekonella ? [2]

Streptorynchus sp. ind.

Dielasmatids [2]

Bryozoans

Fenestellids [1,3], cylindrical branched forms[1,2,3,4] and encrusting forms [4].

Echinodermata

Blastoid or crinoid plates and stem ossicles

Single Corals[3]

Wood and bone fragments.

(c) Distinctly above *clarkei*-bed

Localities - CL15, CL21/5 and CL325/1

Pelecypods

Pyramus sp.

Brachiopods

Strophalosia clarkei (Etheridge Snr.) 1872

Strophalosia ovalis Maxwell 1954

Ingelarella

Bryozoans

Fenestellids and cylindrical branched forms

Crinoid ossicles.

Bundarra Creek Area.

Localities - CL311/12, CL311/14, and CL311/17

Pelecypods

Parallelodon sp. nov.

Merismopteria ? sp. ind.

"*Modiolus*" cf. *modiomorpha* (Etheridge Jnr.) 1892

Brachiopods

Ingelarella sp.

Plekonella ? sp.

Bryozoans

Fenestellids and cylindrical branched forms

Echinodermata

Crinoid stem ossicles

Blastoid or crinoid plates

Corals

Thamnopora

Cladochonus

Collinsville area.

(a) Below Big *Strophalosia* Zone

Localities - Collinsville 4a (west bank of Corduroy Creek, immediately south of road bridge), Collinsville 4b (west bank of Corduroy Creek, immediately north of road bridge), and Collinsville 3 (Corduroy Creek, 50 yards north of railway viaduct, east bank in entrance of small tributary). 4a and 4b are from the lowest fossil beds close to the boundary with the Collinsville Coal Measures.

Pelecypods

Megadesmus ? sp.
Myonia sp. (juvenile)

Pyramus or Notomya sp.

Merismopteria sp.

Astartidae gen. et sp. nov.

Gastropods

Warthia sp.

Mourlonia (Mourlonopsis) cf. strzeleckiana (Morris)1845

Peruvispira sp. nov. (as at CL122)

Brachiopods

Terrakea

Strophalosia typica (Booker) 1929

Strophalosia brittoni var. gattoni Maxwell 1954

Strophalosia clarkei (Etheridge Snr.) 1872

Neospirifer

Pseudosyrinx ?

Bryozoans

Fenestellids

(b) Big Strophalosia Zone

Collinsville 5 (1¼ miles south-west of Scottsville along main road, in gully about 150 yards north of road, at bottom or immediately below Big Strophalosia Zone.

Pelecypods

Megadesmus ? cf. grandis (Dana) 1847

Pyramus or Notomya sp. (as at CL122)

Chaenomya sp.

Collinsville 2 (Corduroy Creek, 3200 feet south of railway viaduct - top part of Big Strophalosia Zone

Brachiopods

Terrakea solida (Etheridge and Dun) 1909

Strophalosia ovalis Maxwell 1954

(c) Above Big *Strophalosia* Zone

Collinsville 1 (Corduroy Creek 6,400 feet south of railway viaduct: 1a about 15 feet stratigraphically below 1b which is the "*Streptorynchus* Bed")

Collinsville 1a

Pelecypods

Astartila sp. nov.

Myonia sp. nov. A

Chaenomya sp.

Astartidae gen. et sp. nov.

Gastropods

Warthia sp.

Collinsville 1b

Brachiopods

Streptorynchus pelicanensis Fletcher 1932

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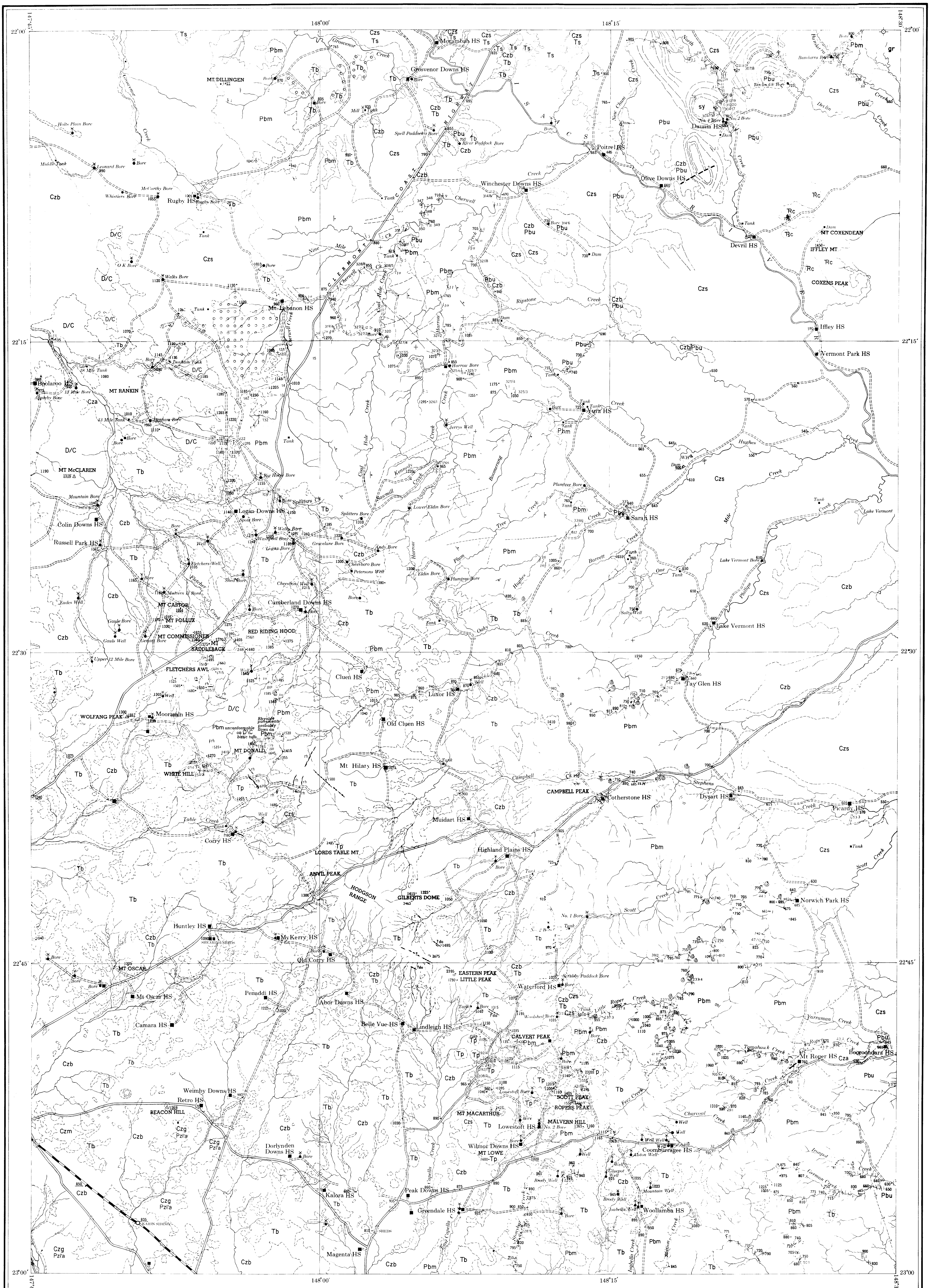
ADDENDUM

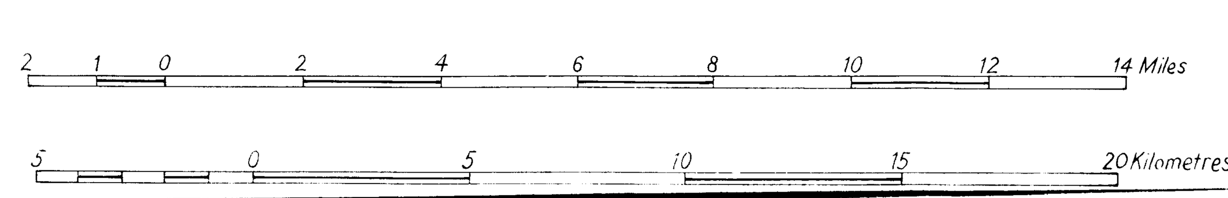
Since this report was written Mary E. White has handed me some specimens which she picked out while examining plants from the Upper Bowen Coal Measures. These specimens are from CL314/6, Clermont 4-mile Sheet, 2.6 miles south-south-west of Winchester Homestead and can be identified as "*Leaia*" sp.. The shell is bicarinate and in a general way is similar to some of the specimens figured by John Mitchell in 1925 ("Description of new species of *Leaia*". *Proc. Linn. Soc. N.S.W.*, 50, 438-447) from the Newcastle Coal Measures at Belmont, near Newcastle, N.S.W.. The material is too limited (two almost complete valves and a number of fragments) to allow satisfactory specific comparison.

CLERMONT EAST
QUEENSLAND

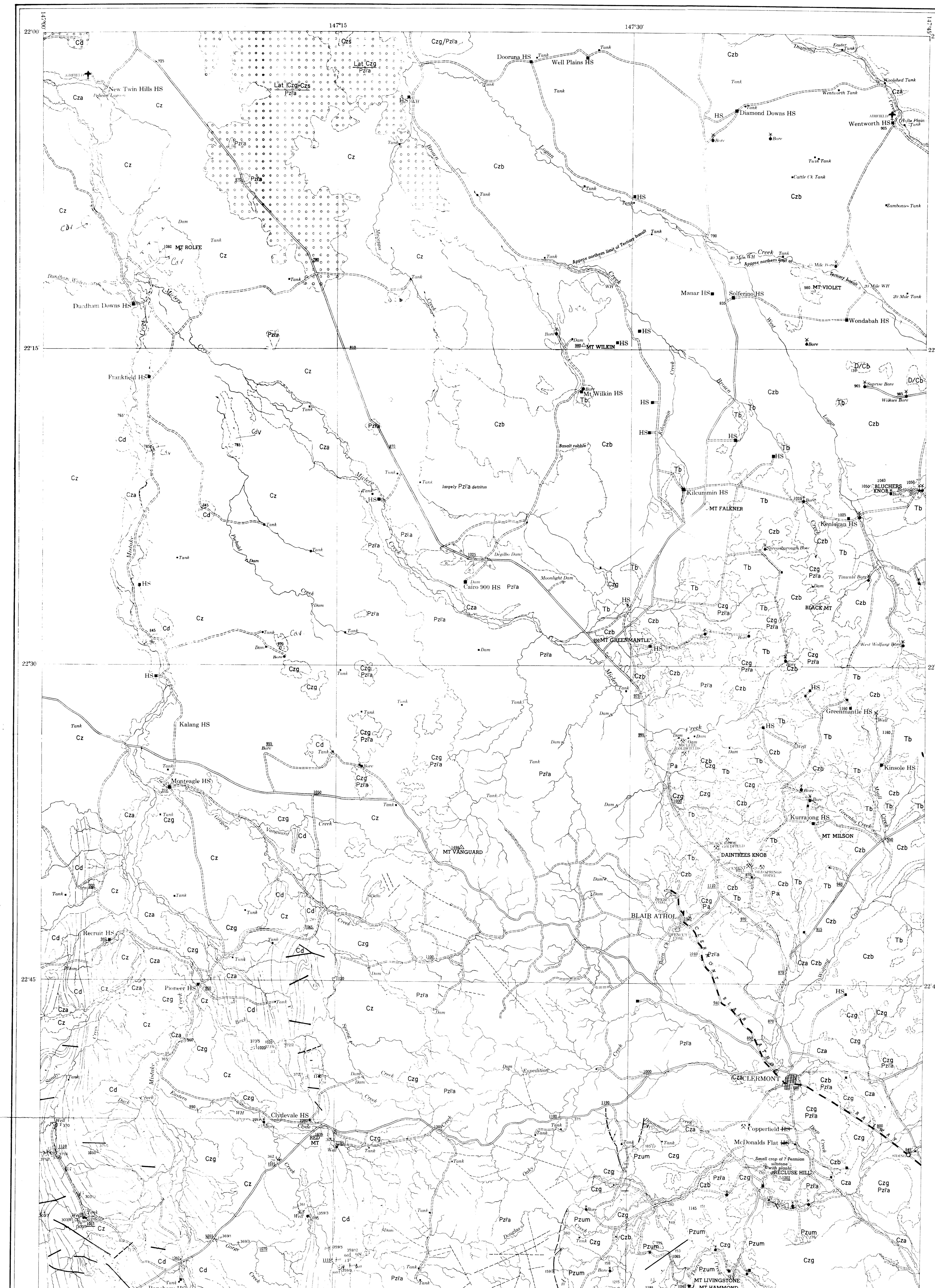
PLATE I



Scale



CLERMONT WEST
QUEENSLAND



Scale

2 1 0 2 4 6 8 10 12 14 Miles

5 0 5 10 15 20 Kilometres

CLERMONT

Reference

CAINOZOIC	Undifferentiated Cainozoic		Cz	*Undifferentiated soil and alluvium*
			Cza	*Alluvium*
			Czb	*Heavy-textured dark soil*
			Czg	*Gravel*
			Czs	*Sand, sandy soil*
			Czm	*Magnesian limestone*
	? Tertiary			*Laterite*
		Peak Range Volcanics	Tp	*Rhyolite, trachyte*
		Suttor Formation	Ts	*Quartz sandstone, siltstone, conglomerate*
			Tb	*Basalt*
MESOZOIC OR TERTIARY	Undifferentiated Post-Triassic		sy	*Syenite*
			gr	*Granite*
MESOZOIC	? Triassic	**Carborough Sandstone**	Rc	*Quartz sandstone, quartz greywacke*
PALAEOZOIC	Undifferentiated		P	*Fine quartz conglomerate, sandstone, shale*
	Permian	**Blair Athol Coal Measures**	Pa	*Sandstone, shale; coal*
		Upper Bowen Coal Measures	Pbu	*Lithic sandstone, greywacke, siltstone, mudstone, coal*
		Middle Bowen Beds	Pbm	*Quartz sandstone, quartz greywacke, siltstone, minor coal*
		clarkei-bed	c	*Sandy coquinite*
	? Upper Palaeozoic		Pzum	*Monzonite porphyry, granodiorite*
	Carboniferous	**Drummond Beds**	Cd	*Conglomerate, quartz sandstone, greywacke, siltstone*
			Cdv	*Flow rhyolite, agglomerate, tuff*
	Devonian-Carboniferous	**Bulgonunna Volcanics**	D/Cb	*Intermediate to acid volcanics, greywacke, siltstone*
	Undifferentiated Palaeozoic		Pzs	*Chocolate pebbly sandstone, shale*
	Middle and Upper Devonian	**Theresa Creek Volcanics**	Dt	*Intermediate to acid volcanics, minor tuff*
	Middle Devonian		Ds	*Micaceous siltstone*
		Douglas Creek Limestone	Dd	*Coralline and stromatoporoid limestone*
PALAEOZOIC OR PRECAMBRIAN	Pre-Devonian	**Anakie Metamorphics**	pDa	*Schist, slate, fine sandstone*

	Geological boundary
	Fault
	Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes.
23	*Strike and dip of strata*
	Prevailing dip
	Horizontal strata
	Very shallow dip
	Dip slope
	Dip < 15°
	Trend of bedding
	Vertical joint
	Marine fossil locality
	Plant fossil locality
× 303/10	*Reference number to specimen locality*
	Dyke (do - dolerite, m - monzonite, ol. b.- olivine basalt)
	Ridges of rhyolite
	Platy flow layering inclined
	Platy flow layering horizontal
	Mine or workings disused
	Bore
	Well
	Spring
	Windpump
WH	*Waterhole*
	Tank
	Dam
	Homestead
	Airfield
	Road
	Vehicle Track
	Railway line
• 885	*Height in feet instrument levelled*
• 758	*Height in feet barometric*