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COMMONWEALTH OF AUSTRALIA.

**DEPARTMENT OF NATIONAL DEVELOPMENT.**

# BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

**RECORDS.**

1962/50

# THE GEOLOGY OF THE EMERALD 1:250,000 SHEET AREA, QUEENSLAND.

by

J.J. Veevers, R.G. Mollan, F. Olgers
and A.G. Kirkegaard (Q.G.S.)

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## SUMMARY

Three major tectonic units are exposed in the Emerald 1:250,000 Sheet area. They are:

a. The southern part of the Anakie Inlier, consisting of the Anakie Metamorphics and intrusions of granite, all probably older than Devonian.

b. The eastern part of the Drummond Basin, consisting of 15,000 feet of rhyolite and trachyte, tuff, quartz sandstone, shale, and greywacke, of Middle Devonian to Lower Carboniferous age.

c. The western part of the Bowen Basin, consisting of 300 feet of Permian freshwater quartz pebbly sandstone at the western margin of the basin, thickening to a probable 8000 feet of marine pebbly quartz sandstone and quartz greywacke. The marine sequence is overlain by an unknown thickness of coal measures.

The Permian rocks unconformably overlie the Devonian-Carboniferous rocks, and the Permian and Devonian-Carboniferous rocks unconformably overlie the Anakie Inlier.

Granite intrudes the eastern margin of the Drummond Basin and the western margin of the Bowen Basin; spinel-bearing basalt intrudes the Anakie Inlier and the eastern margin of the Drummond Basin. Basalt flows rest unconformably on the eastern margin of the Drummond Basin and, interlayered with freshwater sediments, on the Bowen Basin, the Springsure Volcanics, consisting of trachyte and rhyolite intrusions, extend to within 25 miles of Emerald.

Quartz gravel covers part of the area, and at Rubyvale contains sapphires.

## INTRODUCTION

### General

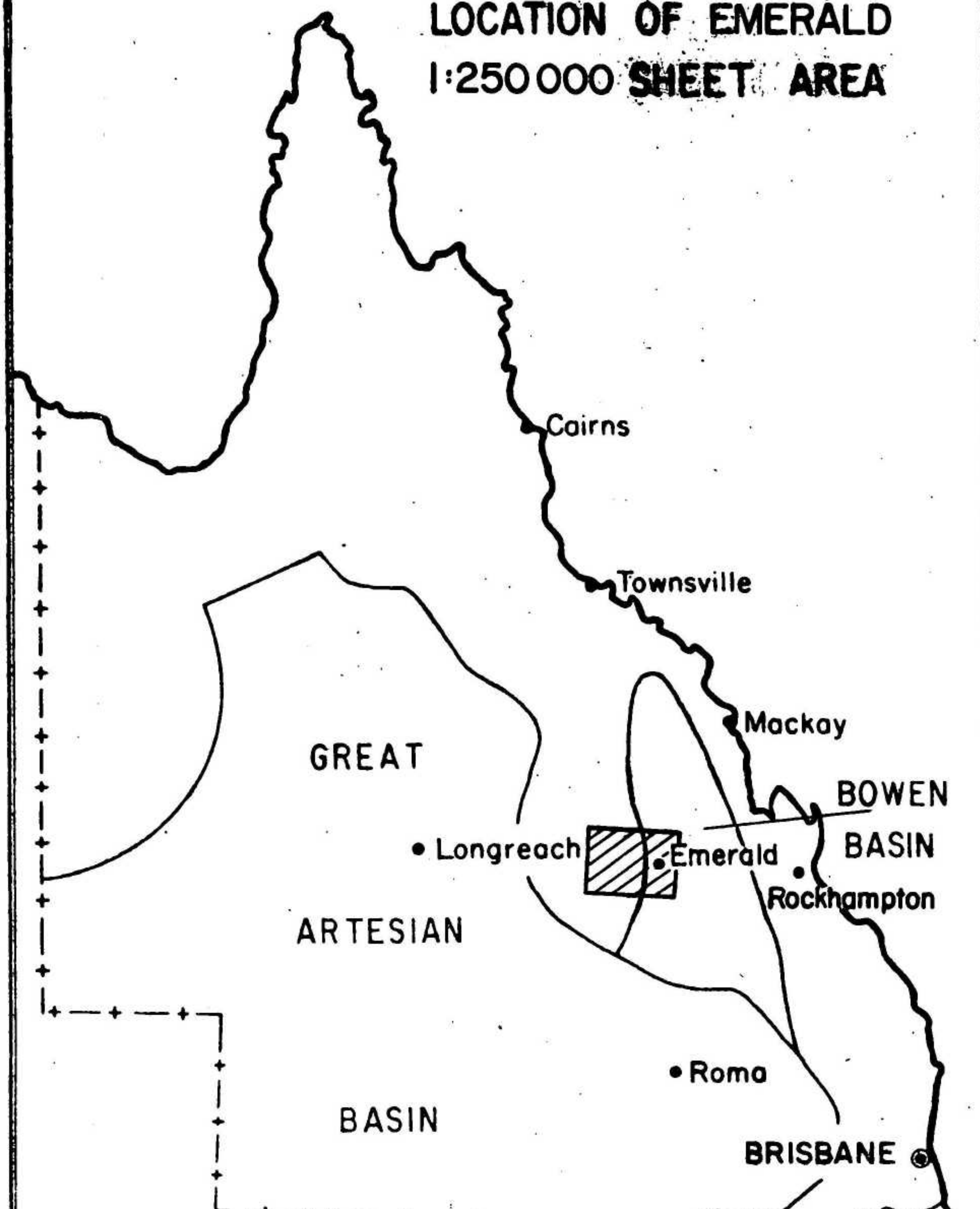
The Emerald Sheet area was mapped by a joint Bureau of Mineral Resources - Queensland Geological Survey party as part of a systematic plan to map the Bowen Basin in the search for oil.

Field work was done between June 8th and September 8th, 1961. The areas mapped and reported on by individual geologists are as follows:

Veevers: Mt Beaufort Anticline and the Permian rocks in the Nogoa River/Fork Lagoons/Capella area.

Fig. 1

# LOCATION OF EMERALD 1:250 000 SHEET AREA

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Mollan: Tertiary volcanics in the Springsure area, all basalt plugs and the Permian rocks of the Caroa/Burn Meadow area.

Olgers: Permian rocks in the Springsure/Kammel area, eastern margin of the Drummond Basin, and the Pebbly Creek Anticline.

Kirkegaard: Anakie Inlier, Permian rocks of Nutholm area, and the Medway Anticline in the Drummond Basin.

The Emerald Sheet area lies in central Queensland, east of the Great Dividing Range and 160 miles inland from Rockhampton. Emerald, Capella, Anakie and Botantungan are the only towns. The main road and railway line from Rockhampton to Longreach cross the area and pass through Emerald; major branch roads and lines run from Emerald to Springsure and to Clermont. Emerald is served by Queensland Airlines.

A large number of properties in the area are devoted mainly to grazing cattle and sheep, and the growing of crops, mainly wheat and sorghum.

The area has a sub-humid climate with an annual rainfall of 20-30 inches. Most rain is received during the summer months.

Most of the country is open woodland; dense brigalow scrub occurs in places. The downs country is virtually treeless and thickly covered with grass.

Eighty percent of the region is drained by the east-flowing Nogoa River system. The far western portion of the Sheet area is drained by the west-flowing tributaries of the Belyando River. The main watercourses flow a few months of the year only. The divide between these river systems is the Drummond Range, which has a relief of over 1000 feet in places.

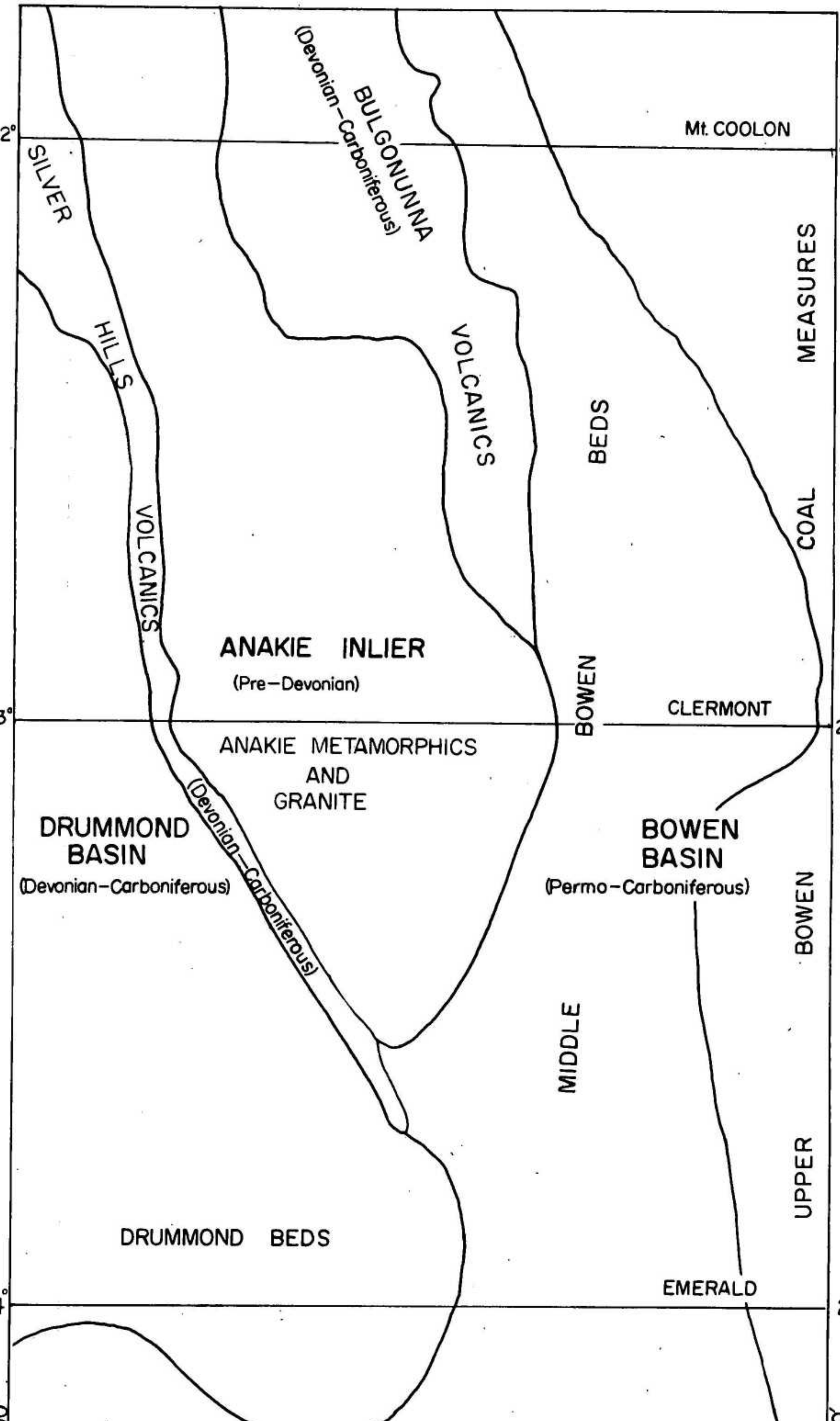
The eastern portion of the area, over the Bowen Basin, is gently undulating plain country with scattered mesas and buttes of Tertiary rocks. In the west, over the Drummond Basin, the country has more relief and numerous small ranges are present. The country over the Anakie Inlier is rough with a dense dendritic drainage pattern (Figure 15).

Relief in the area is 2200 feet, from 2700 feet at Mount Tabletop in the Drummond Range, to 500 feet in the Comet River near the east margin of the Sheet area. Mount Tabletop rises approximately 1300 feet above the surrounding country.

Aerial photographs, taken by Adastra in 1960 at a scale

Fig. 2

# SOLID GEOLOGY OF EMERALD, CLERMONT AND PARTS OF Mt.COOLON AND SPRINGSURE 1:250,000 SHEET AREAS

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of 1:82,000 were used. A photo-interpretation map was prepared by the Institut Francais du Petrole in Paris.

Previous Investigations.

The earliest published work on the area appears to be by Jack (1882) in which he described gold and silver mines near Withersfield and also sapphire fields north of Anakie. In 1883 Tenison-Woods wrote on "A Fossil Plant Formation in Central Queensland", viz. the plant-bearing sediments around Bogantungan, describing Lepidodendron veltheimianum and other plant fossils from this locality. Jack and Etheridge (1892) also described the sediments of the Drummond Range, including the well-known section containing fossil fish at Hannam's Gap. Maitland (1895) described the geology from Emerald to Capella and Dunstan (1902), the sapphire fields, incorporating the geology of the southern part of the Anakie Inlier. Further descriptions of the sediments of the Drummond Basin were made by Jensen (1926) and Reid (1930). Reid and Moreton (1928) show a section across the Sheet area in their Central Queensland Section and also describe the Tertiary rocks in the vicinity of Emerald. Hawthorne (1950), in an unpublished thesis, described the geology of the lower part of the Nogoa River valley including descriptions of the Drummond sediments south of the central railway and adjacent rocks, but the major contribution in this respect was by Shell (Queensland) Development Pty Ltd (1952) who divided the Drummond sediments into formations and mapped and described the major structures of the southern part of the Drummond Basin. Recent geophysical work in the area includes a gravity survey by Mines Administration for the Papuan Apinaipi Petroleum Company and a seismic refraction survey by the Bureau of Mineral Resources from Anakie to Comet (Robertson, 1961).

Various other reports are referred to in the text.

## PRE-DEVONIAN

Anakie Inlier (Anakie Metamorphics and Retreat Granite).

The Anakie Inlier, which has the oldest rocks exposed in the Emerald area, is a sequence of folded and regionally metamorphosed rocks intruded by granitic rocks; it separates the folded Devonian and Carboniferous sediments of the Drummond Basin in the west from those of Permian age in the Bowen Basin in the east.

The inlier crops out from west of Anakie, and extends north for about 180 miles, reaching a maximum width of 45 miles. Only the southern part is on the Emerald Sheet; the northern extension on the Clermont and Mount Coolon Sheets was mapped by the Bureau of Mineral Resources in 1960 (Veevers et al. 1961 and Malone et al., 1961).

In the Emerald Sheet area, the Anakie Inlier forms a central tongue projecting from the northern boundary of the Sheet to the Central Railway. It consists of small isolated outcrops of metasediments, the Anakie Metamorphics, and a large area of granitic rocks, the Retreat Granite, a large part of which is covered by sand derived from the granite.

The Anakie Inlier is mapped easily by photogeology because it has a distinctive photo pattern; the granitic rocks can be readily distinguished from the metamorphic rocks (Fig.15). The metamorphics are etched into high rounded hills and deep gullies with a closely spaced dendritic drainage pattern. In the southern part strike ridges are pronounced. The granite generally forms lower, undulating country with a much more open drainage pattern. Several conical hills of granite, similar morphologically to the conical Hoy Basalt peaks, occur towards the northern boundary of the Sheet.

The Anakie Metamorphics consist mainly of quartz-mica schist, knotted schist, banded phyllite, quartzite and slate. Lenses of unfossiliferous crystalline limestone, twenty feet thick and up to 500 feet long, occur in the slate at Mount Clifford. Quartz reefs, generally concordant with the foliation are common. A probable metamorphosed pillow lava occurs where the Rubyvale - Capella road crosses Kettle Creek. Although gneiss has been described from the area by previous workers, it was not found during the present survey.

Dunstan (1902) divided the metamorphics in the southern part into two distict formations: high grade metamorphic rocks (undescribed, but schists and gneisses are mentioned in the text), and slates, stated to be argillaceous, talcose, micaceous and quartzose.

Structurally, the metamorphics are complex; more than one lineation is present but no detailed analysis of the lineations has been attempted. Relationships between the different rocks are difficult to determine but where strike ridges are prominent, broad structures can be discerned.

Retreat Granite is the name proposed for the complex composite body of mainly granitic intrusions in the Anakie Inlier within the Emerald Sheet area. The intrusions make up the greater part of the inlier in this area, and consist mainly of rocks ranging in composition from granodiorite to adamellite (variations in modal composition are shown in the table at the end of this section). The rocks are notably sheared in the areas between Borilla and Silver Hills Homestead and south-west of Rubyvale, and they are foliated near Silver Hills Homestead. Xenoliths of probable sedimentary rock occur commonly in a biotite adamellite east of Peak Vale Homestead. Small outcrops of gabbro (west of Fork Lagoons Homestead), diorite (Mount Clifford), quartz diorite (Karmoo Homestead and south of Etonvale Homestead), andesite (west of Etonvale Homestead) and tonalite (near Rubyvale) occur. The relationships of these more basic rocks to the main granitic mass and their ages are unknown but they are tentatively mapped with the Retreat Granite. Dunstan (1902) reported syenite in the area but no similar rock was found during the present survey.

Two small masses of granite occur east of the main outcrop of the Retreat Granite, one west of Fork Lagoons Homestead, the other west of Capella (Figure 22). It is not known whether these intrude the Permian rocks or are inliers of Retreat Granite. Maitland (1895) reported that Permian rocks overlie the granite near Capella but this was not observed during the present survey.

The metamorphic and granitic rocks are locally mineralised. Ferruginous lodes with low gold and silver contents and commonly secondary copper occur in the metamorphics in the southern part of the inlier.

The contact between Retreat Granite and Anakie Metamorphics was seen three and a half miles north-east of Silver Hills Homestead. The granite tongues into schist and in detail the contact is ragged and sharp, and not gradational as suggested by Dunstan (1902) who assumed the granite to be of metamorphic origin. The contact appears to dip steeply. As there seems to be no apparent thermal metamorphism of the Anakie Metamorphics and the contact between the granite and metamorphics is sharp, it is suggested that the granite is a high level body.

The Silver Hills Volcanics, the basal member of the Drummond Basin, rests unconformably on the Retreat Granite. West of Peak Vale Homestead, Drummond Basin sediments are faulted against rocks of the inlier. Permian sediments lie on the inlier along the eastern margin, but north-west of Capella the contact is faulted.

The age of the Anakie Inlier is unknown. Hill (1951), Shell (Shell (Queensland) Development Pty Ltd, 1952) and Hill and Denmead (1960) consider the metamorphics to be Precambrian. In the Clermont and Emerald Sheet areas, Middle Devonian limestone is probably unconformable on the inlier. In the south-west of the Bowen Sheet area the Devonian Selheim Formation is possibly equivalent to part of the Anakie Metamorphics (Malone et al., 1962). In the Emerald Sheet area the rocks of the Anakie Inlier are mapped as pre-Devonian.

In the Emerald Sheet area the inlier was folded, regionally metamorphosed and intruded by granite before the Middle Devonian and was the source of much of the sediment in the Drummond Basin. Hawthorne (1950) considers that the inlier was uplifted in the Lower or Middle Devonian, and probably continues to the south-west under the Great Artesian Basin as the Nebine Ridge.

.......

MODAL ANALYSES OF SPECIMENS OF THE RETREAT GRANITE

| LOCALITY | Potash Feldspar (Microcline microperthite) | Plagioclase | Myremekite | Quartz | Biotite | Hornblende | Pyroxene | Opaques | Sphene |
|---|---|---|---|---|---|---|---|---|---|
| EM301/1 3 miles east of Mt Leura Hs. | - | An 58 50.4 | - | 18.6 | 14.3 | 15.2 | - | 1.5 | - |
| EM304/1 3.5 miles E.N.E. Florence Vale Hs. | 7.9 | An 40 43.9 | - | 32.2 | 7.5 (partly chloritised) | 6.8 | - | 0.9 | 0.8 |
| EM305/1 6.5 miles N.E. of Florence Vale Hs. | 21.4 | An 48 48.5 | - | 10.8 | 9.4 | 5.8 | 2.8 (hornblende cores) | 1.3 | - |
| EM320/2 2 miles S.E. of Old Silver Hills Hs. | 31.6 | An 35 zoned to An 15 36.1 | 1.1 | 25.3 | 5.4 (partly chloritised) | - | - | 0.5 | - |
| EM327/1 25 miles E.N.E. of Mt Zigzag | 14.8 | An 42 43.1 | 0.9 | 26.8 | 10.8 | 3.0 | - | 0.6 | - |
| EM344/5 3 miles north of Ridon Hs. | 15.0 | An 42 40.5 | 0.4 | 23.5 | 10.3 | 9.9 | - | 0.4 | - |
| EM361/7 8 miles north of Ridon Hs. | 27.2 | An 40 35.8 | 0.8 | 20.4 | 3.7 | 10.8 | - | 0.9 | 0.4 |

## DEVONIAN - CARBONIFEROUS

### Introduction

The Devonian-Carboniferous rocks occur in the Drummond Basin west of the Anakie Inlier and in an isolated exposure near Glendarriwell Homestead.

In the Drummond Basin, a maximum thickness of 15,000 feet of Devonian-Carboniferous Volcanics and freshwater sediments is present. The formations represented, from the base upwards, are : Silver Hills Volcanics (new name), Telemon Formation, Mount Hall Conglomerate, Raymond Sandstone and Ducabrook Formation. The whole sequence is generally conformable and unconformably overlies the Anakie Inlier. The sediments in the Drummond Basin have been folded into large north-north-west and east-north-east trending anticlines and synclines. Exposures are generally good. In a few areas, rocks have been intruded by granite and Tertiary basalt.

A small outcrop of fossiliferous Middle Devonian limestone associated with volcanic rocks occurs near Glendarriwell Homestead (Figure 6). These rocks are correlated with limestones in the Dunstable Formation (Hill, 1957) and with the limestone at Douglas Creek Homestead in the Clermont Sheet area to the north (Veevers *et al.*, 1961). The Nogoa and Telemon anticlines in the Springsure Sheet area, south of the Emerald area, were visited to examine the type areas of the Devonian-Carboniferous formations (Shell (Queensland) Development Pty Ltd, 1952 and Hill, 1957) and the Mount Beaufort Anticline, most of which lies outside the western boundary of the Emerald Sheet area, was also mapped (Figures 3 and 4).

The Devonian-Carboniferous formations and the Nogoa, Telemon and Mount Beaufort Anticlines will be discussed separately in the following pages.

### Nogoa Anticline

The Nogoa Anticline lies in the north of the Springsure Sheet area, 22 miles west of Springsure. The structure was mapped and described by Shell (Shell (Queensland) Development Pty Ltd, 1952) and by Hill (1957). The anticline was briefly visited to examine the type areas of the Devonian-Carboniferous Dunstable and Telemon Formations in order to compare the type lithologies with those of equivalent units west of the Anakie Inlier in the Emerald Sheet area, 10 miles west of Anakie.

The Nogoa Anticline is an asymmetrical fold with a sinuous axis and a north-north-east plunge. The western limb is fairly well exposed, and dips ranging from 20° to 45° were measured. The east limb is poorly exposed, and contains near vertical beds east of Telemon Homestead on the eastern bank of the Nogoa River. Only the core of the structure was examined in any detail.

The Dunstable Formation is the oldest formation exposed in the Nogoa Anticline. It is best exposed north and west of Telemon Homestead and consists of tuffs, gritty tuffaceous sandstone, conglomerate and coralline limestones (Appendix 4) with a minor development of trachyte, porphyritic andesite and basalt. The Dunstable Formation is unconformably overlain by the Telemon Formation in the Nogoa Anticline (Hill, 1957). Only the basal portion of the Telemon Formation is well exposed, and there the unit consists of conglomerate, tuffaceous sandstone and siltstone and pebbly sandstone with an interbedded flow of porphyritic basalt (Appendix 1, pp 73 ). The Telemon Formation is overlain by the Mount Hall Conglomerate, Raymond Sandstone and Ducabrook Formation. The Mount Hall Conglomerate and Ducabrook Formation are poorly exposed; on the aerial photographs, the Raymond Sandstone can be traced for some distance. A small plant fossil collection was made in the formation (White, 1962).

The work in the Nogoa Anticline showed that the lithologies of the Dunstable Formation and the probably equivalent volcanic unit in the Emerald Sheet area are very different and a new name is proposed for the volcanic unit. The lithologies in the Telemon Formation in the Nogoa Anticline were found to differ from those in the equivalent unit in the Emerald Sheet area, but because considerable lateral variation occurs within the unit in the Emerald Sheet area, no new name is proposed for the unit in the Emerald area.

Telemon Anticline

The Telemon Anticline was visited briefly to compare the lithologies of the Drummond beds described by Shell (Shell (Queensland) Development Pty Ltd, 1952) with those in the Emerald Sheet area whose southern boundary cuts across the northern nose of the anticline. The Telemon Anticline is an asymmetrical anticline closed at both ends, with a slightly sinuous, northerly-trending axis. The structure is morphologically well expressed by cuestas of the Mount Hall Conglomerate and Raymond Sandstone. The culmination is marked in the south by outcrops of sheared granite and andesite which are possibly part of the Anakie Inlier (Shell (Queensland) Development Pty Ltd, 1952, p.18), and in the north by horizontal Mount Hall Conglomerate and Telemon Formation. The eroded central part of the structure is covered by probable Tertiary lavas and the Telemon Formation is largely obscured.

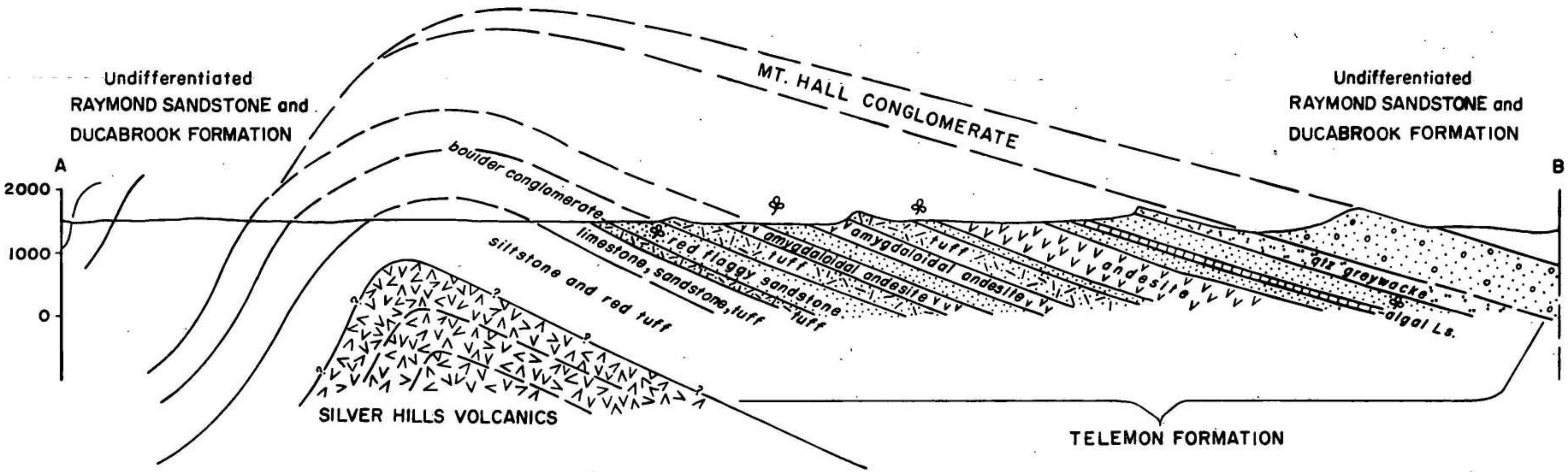
Rocks equivalent to the Dunstable Formation of Shell (Shell (Queensland) Development Pty Ltd, p.19) appear to be absent. The Telemon Formation is divided into a lower Conglomerate Group and an upper Multicoloured Group by Shell (Shell (Queensland) Development Pty Ltd, 1952, pp. 20-21) in this area but along the north-east margin of the Drummond Basin, in the Emerald area, the Conglomerate Group is poorly developed with only a few pebbly and gritty sandstones in a sequence that consists dominantly of mudstone, siltstone, and feldspathic and lithic sandstone (tuffaceous in part). The Mount Hall Conglomerate is very similar to the outcrops in the Emerald Sheet area, and lenses noticeably. Although Shell have mapped it along the central part of the western flank of the Telemon Anticline it was not found there in the present survey. Intense cross-faulting and strike faulting along this limb may have obscured it in places. The Roymond Sandstone consists mainly of flaggy subgreywacke and siltstone (Appendix 1, p. 75 ) forming prominent cuestas. The lithology along the north-east margin of the basin in the Emerald area is more varied with a higher proportion of softer siltstone and mudstone.

Mount Beaufort Anticline

The north-eastern flank of the Mount Beaufort Anticline lies within the Emerald Sheet area - the rest lies in the Jericho, Springsure, and Tambo Sheet areas - but because the Mount Hall Conglomerate, most of the Telemon Formation, and part of the Silver Hills Volcanics are well exposed, the anticline was mapped in some detail. This mapping also served to correct Shell's (Shell (Queensland) Development Pty Ltd, 1952, p. 51) belief that the anticline is closed in volcanics contemporaneous with the Ducabrook Formation.

The anticline, which is 25 miles long and 10 miles wide, is asymmetrical; its western limb is steep, and its eastern limb dips 15° to 20°. The northern part plunges up to 10° to the north and its southern part, which was not visited, possibly the same amount to the south. The Telemon Formation and Mount Hall Conglomerate together are estimated to be 6,000 feet thick on the eastern limb; on the western limb, due to

# Section EM 25
## North of Mount Beaufort




Vertical and Horizontal Scales, 1" = 2000'

0 2000 4000 6000

*Bureau of Mineral Resources, Geology and Geophysics. October 1961.* *To accompany Record Nº 1962/50.*

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relative upward movement along the axis during deposition, the Mount Hall Conglomerate is missing altogether, and the Telemon Formation is probably less than 2,000 feet thick.

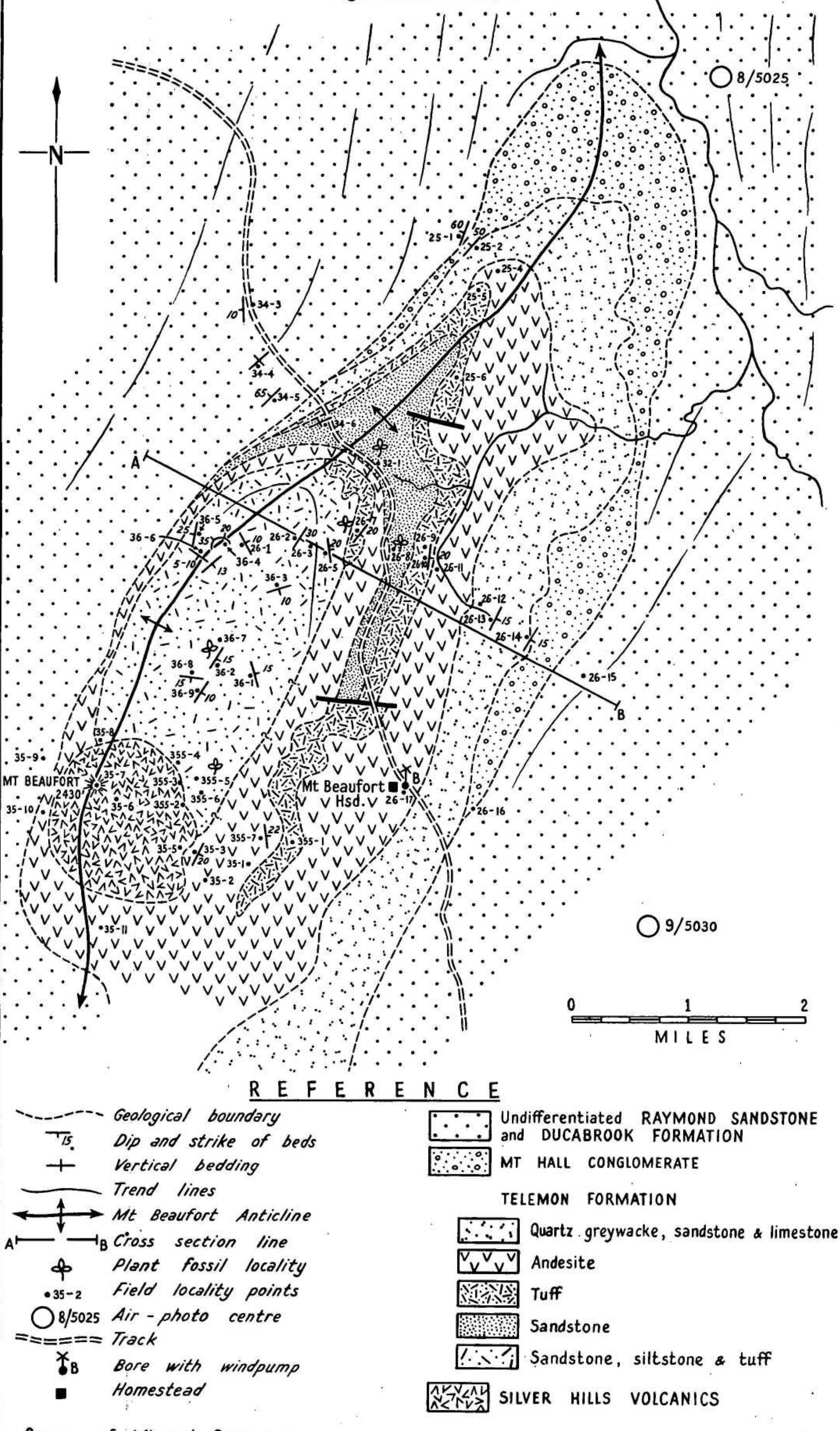
The exposed part of the Silver Hills Volcanics forms Mount Beaufort itself, which rises 1000 feet above the surrounding country. The main rock is a coarsely banded trachyte (Appendix 1, 355/2(b) ) and spherulitic chalcedonic rhyolite; finely banded rhyolite and rhyolitic agglomerate are minor. The rhyolite shows no gross layering in the field but in the air photographs (Figure 5) crude layering is visible, and indicates that the Silver Hills Volcanics are more or less concordant with the anticline, with a short steep western flank, and a long gentle slope eastward.

The Silver Hills Volcanics are the oldest beds exposed in the Anticline. The next oldest are the siltstone and red tuff of the Telemon Formation. The base of the Telemon Formation is not exposed, but because the Silver Hills Volcanics lie close by at Mount Beaufort, we project the Volcanics at shallow depth beneath the surface in section AB (Figure 4). The Telemon Formation contains roughly equal thicknesses of volcanic and sedimentary rocks; the volcanics include amygdaloidal basalt and tuff, and the sedimentary rocks algal limestone, plant-bearing sandstone, and quartz greywacke (Appendix 1, p.79 ). A boulder conglomerate at locality EM26/4, 10 feet thick, includes boulders up to 2 feet across of agglomerate, trachyte, tuff and mudstone, all well rounded, and possibly indicates contemporaneous uplift and erosion of the nearby Silver Hills Volcanics.

According to our mapping, the oldest Telemon rocks at the junction with the Silver Hills Volcanics lie at least several hundred feet above the base of the exposed section of the formation, and, with the evidence from locality EM26/4, this suggests that Mount Beaufort was a low volcanic hill during deposition of the lower part of the Telemon Formation. Individual beds in the Telemon Formation are readily mapped from the air photographs - the tuffs stand up as scarps, the quartz greywacke at the top forms cliffs, and the basalt underlies lightly wooded brown-soil plains; - the pinch out of the greater part of the Telemon Formation and the entire Mount Hall Conglomerate is mappable from the photographs. Beds on the western flank visibly thin southwards, and strike faulting is inadequate to explain the thinning.

FIG. 3.

# MOUNT BEAUFORT ANTICLINE
## QUEENSLAND




*Bureau of Mineral Resources, Geology and Geophysics. October, 1961.* *To accompany Record No 1962/50*

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Figure 5: Airphoto mosaic of Mount Beaufort Anticline. (Adastraphoto 1960, Emerald F55/15, run 9/5031 and run 8/5026.)

The Mount Hall Conglomerate on the east flank is 1000 feet of pebbly sandstone and milky quartz conglomerate. In the rocks overlying the Mount Hall Conglomerate, the Raymond Sandstone is not distinguishable in the air photos, and all these rocks are mapped as Raymond Sandstone/Ducabrook Formation. The air-photograph trends of the Raymond Sandstone/Ducabrook Formation on the western flank of the anticline strike into the Telemon Formation, and probably the lower part of the Roymond Sandstone/Ducabrook Formation is also missing here.

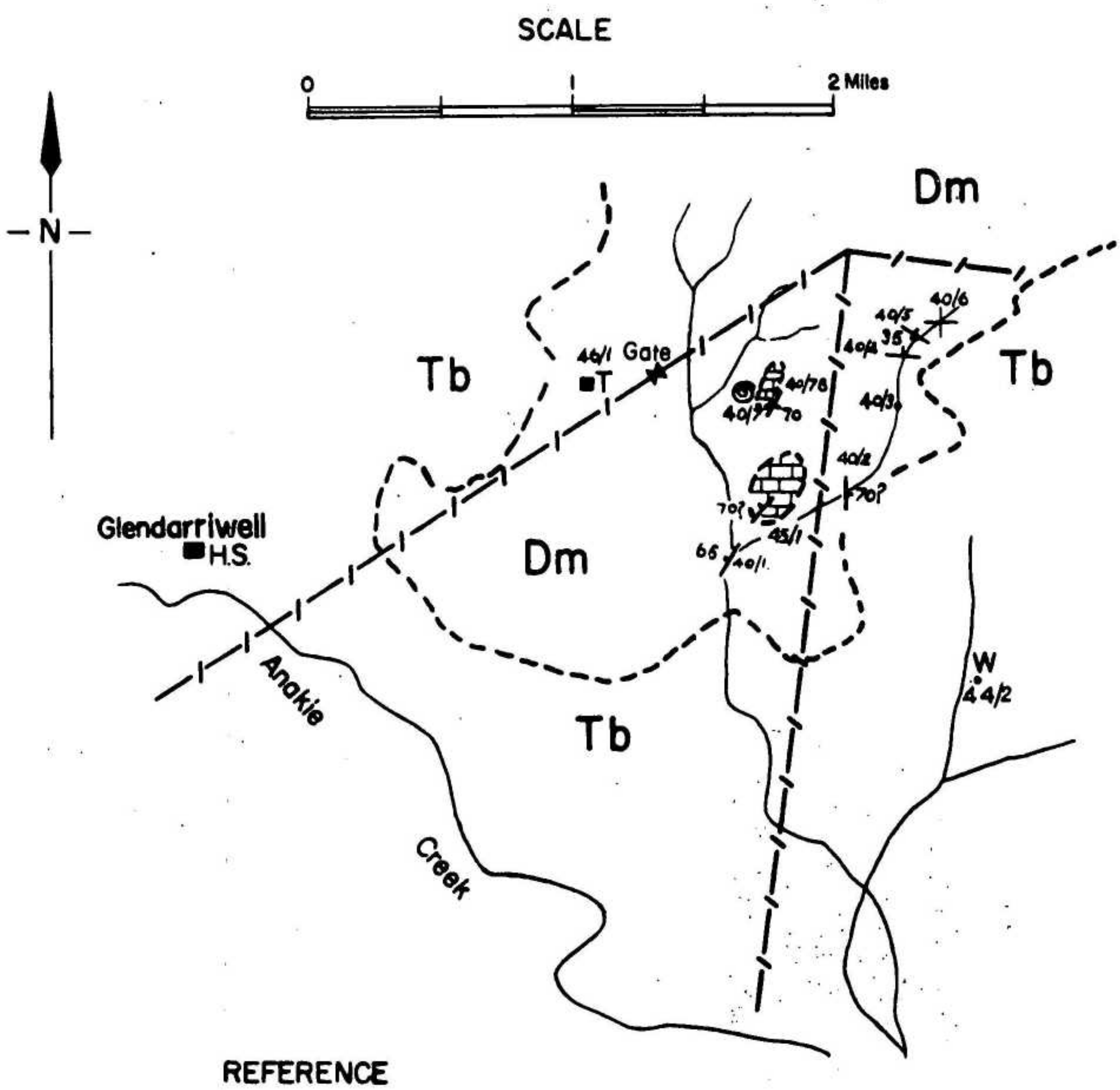
Undifferentiated Middle Devonian

The only Middle Devonian in the Emerald Sheet area whose age is directly indicated by fossils is the outcropping limestone two miles east of Glendarriwell Homestead (Figure 6). The limestone at locality EM40/7 is massive, grey, and superficially silicified, and contains crinoid stems and corals which, according to Professor D. Hill (Appendix 4), indicate a Middle Devonian age. This Devonian inlier is an area of complex geology, and outcrops are too poor to reveal the structure. A north to northeast strike is indicated by outcrops at EM40/1, EM40/2, EM40/7B, and EM45/1 but this is not general because at
EM40/4 and EM40/5 the strike is west to northwest. We interpret the structure as a syncline with limestone (EM40/7, EM45/1) and rhyolite (EM40/7B) in the trough; the limestone is underlain by shale (EM40/2), tuff (EM40/4), pebbly quartz grit and siltstone (EM40/5) (Appendix 1, p.71 ), which lie on the east and northeast flanks of an anticline. These rocks, which are all regarded as Middle Devonian, are overlain unconformably by subhorizontal ?Permian quartz sandstone (EM40/6, EM46/1), which in turn is overlain unconformably by Tertiary basalt.

The Glendarriwell Middle Devonian rocks provide a link between coeval rocks near Telemon Homestead (Dunstable Formation) and Douglas Creek Homestead (Veevers et al., 1961), and points out that marine Middle Devonian rocks crossed at least part of the Anakie Inlier. Fossiliferous marine Middle Devonian rocks have not been found west of the Anakie Inlier, and these three areas of limestone were probably deposited near the Middle Devonian shoreline.

FIG.6.

# DEVONIAN LIMESTONE & ASSOCIATED ROCKS IN THE GLENDARRIWELL AREA




**REFERENCE**

| | |
|---|---|
| Tb | Tertiary Basalt |
| Dm | Undifferentiated Middle Devonian |
| | Fossiliferous Limestone |
| | Fence |
| •W | Well |
| ■T | Tank |
| •44/2 | Field locality number |

Silver Hills Volcanics

Silver Hills Volcanics is the new name proposed for the dominantly acid volcanic complex which lies west of the Anakie Inlier. The unit was previously called Dunstable Formation (Shell (Queensland Development) Pty Ltd, 1952), but a new name is proposed because the rocks in the Emerald Sheet area differ markedly from the Dunstable Formation.

The Silver Hills Volcanics are well exposed, and occur in a northwest-trending belt 10 miles west of Anakie, at Mount Beaufort, and in the north of the Sheet area, north-west of Peak Vale Homestead, extending northward into the Clermont Sheet area (Figure 16). The unit is essentially volcanic extrusive with interbedded pyroclastics and minor sediments. It unconformably overlies the Anakie Metamorphics and Retreat Granite, and is overlain by the Telemon Formation. It has been assigned to the Devonian-Carboniferous on its stratigraphic position only. The Silver Hills Volcanics are named after Silver Hills Homestead, 9 miles west-north-west of Anakie. The type area lies 1 mile west-south-west of the homestead in a gap through which Spring Creek traverses the range formed by the volcanics.

The new name is proposed because field work revealed a marked difference in lithology between the type Dunstable Formation in the Nogoa Anticline and the rocks in the area along the edge of the Drummond Basin. In the Nogoa Anticline, the Dunstable Formation consists of tuffs, gritty tuffaceous sandstone, conglomerate and limestone with a minor development of amygdaloidal rhyolite and porphyritic andesite, in contrast to the predominance of volcanics in the Emerald area. The Dunstable Formation cannot be traced from the Springsure Sheet area into the Emerald Sheet area, and is thus restricted to the core of the Nogoa Anticline. A large sheet of Permian Colinlea Formation and alluvial deposits in Borilla Creek obscure the southern limit of the Silver Hills Volcanics in the Emerald area.

The Volcanics consist of hard resistant rocks that form a prominent range along parts of the edge of the Drummond Basin; they also occur in the core of the Mount Beaufort Anticline, 29 miles to the south-west of Bogantungan, just outside the western boundary of the Emerald Sheet area (Figures 3,4, and 5).

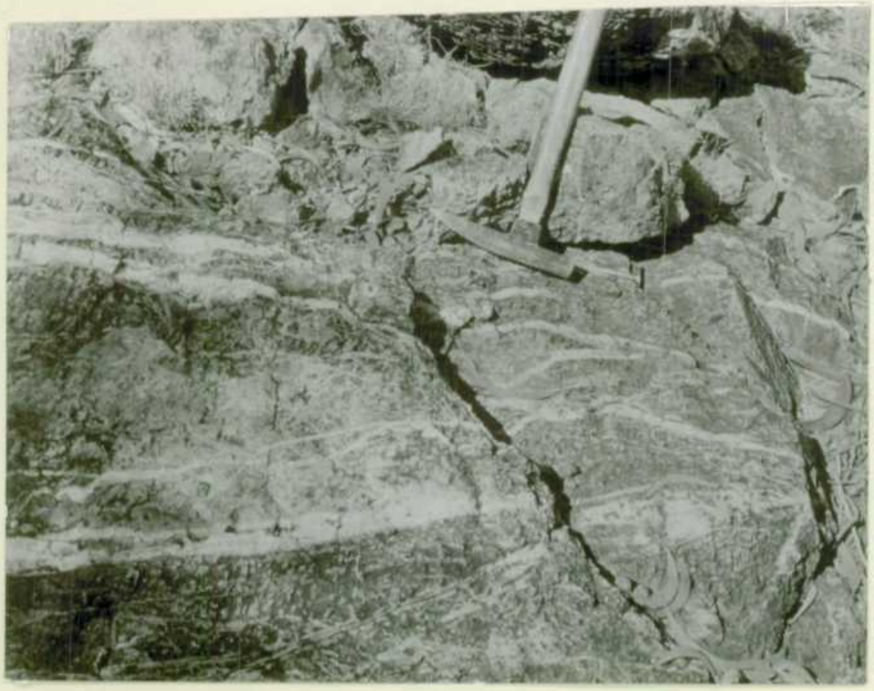


Figure 7: Banded, chalcedonic rhyolite of the Silver Hills Volcanics.

Figure 8: Flow banded, spherulitic rhyolite of the Silver Hills Volcanics.

Thick developments of the unit occur in the Clermont Sheet area, where it forms prominent topographical features as Mount Rolfe and Red Mountain.

Aerial mapping of the unit was simplified by the fact that it forms fairly rugged hills. Moreover, the Anakie Metamorphics and Retreat Granite to the east have a characteristic dendritic photo pattern, and, to the west, the bedded sediments of the Telemon Formation have been eroded to a considerably lower level and occur mainly as low strike ridges.

Trachyte and rhyolite predominate with basalt, tuff, agglomerate and minor micaceous mudstone and sandstone (Appendix 1, p. 81 ). The rhyolites are commonly banded, spherulitic and chalcedonic (Figures 7 and 8).

The volcanics are, in general, dark purplish or reddish-brown, extremely altered with abundant secondary silica/zeolite and/or calcite. The abundance of altered iron sulphides (especially in 231/3), the textures of the trachytes and rhyolites and the presence of pyroxene in most of the trachytes are characteristic of this unit in contrast to the Telemon Formation.

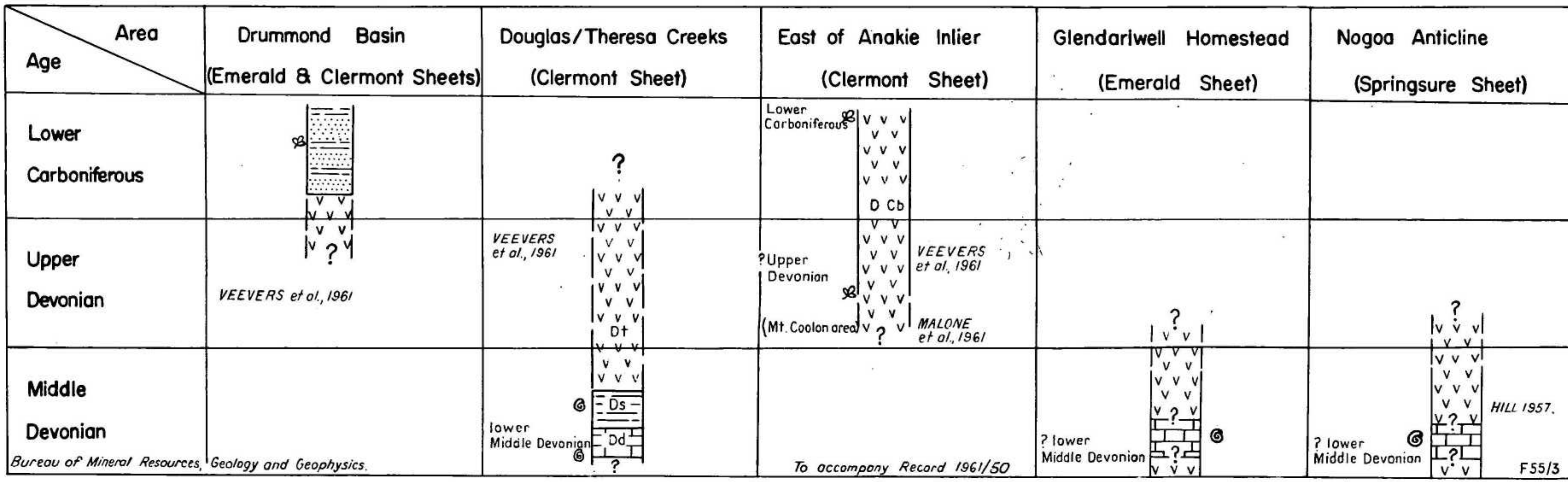
The formation is essentially a massive unit; layering trends can, however, be observed in the outcrops west of Peak Vale homestead and south of Silver Hills homestead, and consistent dips could be measured.

The Silver Hills Volcanics unconformably overlie the metamorphic rocks and granite of the Anakie Inlier. The volcanic rocks dip west at angles ranging from $10^{\circ}$ to $60^{\circ}$. The rocks underlying the volcanics at Mount Beaufort are not exposed.

The Telemon Formation overlies the Silver Hills Volcanics. A continuous section measured across the contact at 251/1-15 (Figure 16) shows that the dips in the upper portion of the Silver Hills Volcanics and basal part of the Telemon Formation are concordant. The boundary between the formations can easily be recognized on the aerial photos, and in the field it is marked by a change from flow rocks and coarse-grained pyroclastics to fine-grained pyroclastic material and sedimentary rocks.

Fig 9

Correlation chart of Devonian - Carboniferous rocks in Emerald, Clermont and Springsure sheets



Steeply dipping felsitic and trachytic dykes occur near the boundary between the Silver Hills Volcanics and the Anakie Inlier and may have been the feeders to the volcanic complex. The dykes are well exposed in the Mount Leura area. They are sinuous east-west trending bodies up to 2 miles long. Deposition probably took place under water as suggested by the spherulitic nature of some of the rhyolites and the presence of coralline limestone in association with the volcanics at Glendarriwell and in the Nogoa Anticline.

The thickness of the formation varies considerably. The type section contains 1600 feet of volcanic rocks and the same thickness was measured two miles south of Silver Hills homestead at EM227/3-6 (Figure 16). A great thickness occurs in the volcanic mass north-west of Peak Vale homestead, and an estimated 7000 feet is present in the Eastern Creek area just north of the Emerald Sheet area (Veevers et al, 1961). The complete thickness of the formation in the Mount Beaufort Anticline is not exposed.

The Silver Hills Volcanics extend northwards into the Clermont Sheet area. These rocks were dated as possibly Upper Devonian to Lower Carboniferous on account of Carboniferous plant fossils found at least 6000 feet above the exposed base of the volcanics (Veevers et al., 1961, pp. 16-18). The basal portion of the Silver Hills Volcanics in the Clermont Sheet area was correlated (Veevers et al., 1961) with the acid volcanic rocks that occur in the upper parts of the Bulgonunna Volcanics east of the Anakie Inlier, and the Theresa Creek Volcanics in the south of the Clermont Sheet area were correlated with the lower part of the Bulgonunna Volcanics (Figure 9). The limestone in the Dunstable Formation in the Nogoa Anticline contains corals and stromatoporoids indicative of a lower Middle Devonian age (Hill, 1957), and the overlying rhyolites and andesites probably have their equivalents in the Silver Hills Volcanics. A similar limestone with associated volcanics occurs in the Emerald area near Glendarriwell homestead (Figures 6 and 9).

No direct links occur between these five volcanic units; the undetermined age of the Anakie metamorphics and the scarcity of useful fossils in overlying beds makes correlation extremely difficult. However, our scanty knowledge indicates that the Silver Hills Volcanics, or part of them, are probably equivalent to parts of the Bulgonunna Volcanics, Theresa Creek Volcanics, Dunstable Formation and the volcanics at Glendarriwell homestead.

Telemon Formation

The Telemon Formation is named after the Telemon Holding in the Nogoa Anticline in the Springsure Sheet area (Shell (Queensland) Development Pty Ltd, 1952). The formation was described from the Nogoa and Telemon Anticlines in the Springsure area, where it reaches a thickness of about 7000 feet. The dominant lithologies there are conglomerate, conglomeratic sandstone, flaggy and ashy sandstone and claystone with thin bands of grey algal limestone. In the Springsure area, the formation unconformably overlies the Dunstable Formation and is unconformably overlain by the Mount Hall Conglomerate (Shell (Queensland) Development Pty Ltd, 1952).

In the Emerald area, the Telemon Formation crops out along the eastern margin of the Drummond Basin between Mount Borilla and the northern edge of the Sheet area (Figure 16). The formation was also mapped in the Mount Beaufort anticline (Figures 3 and 4), west of the Emerald Sheet area.

Along the eastern edge of the Drummond Basin, the formation occurs in low strike ridges, formed by the differential weathering of the interbedded sandstones and softer shales and siltstones. The formation can in most places easily be distinguished on the aerial photographs (Figure 15); it occupies a relatively low area between the rugged range formed by the Silver Hills Volcanics to the east and the steep strike ridges of the Mount Hall Conglomerate to the west.

The outcrop of the Telemon Formation along the edge of the Drummond Basin is not continuous, due to faulting in the north and probable overlap in the south (Figure 16).

The unit is predominantly volcanic in origin; pyroclastics and sediments (tuffaceous, in part) are each more abundant than flows (Appendix 1, p.93 ). The tuffs are essentially primary but, in part, contain fragments of pre-Devonian rocks and erratic volcanic material mainly ... derived from the Silver Hills Volcanics, sandstones, greywackes and conglomerates, predominantly lithic, were derived primarily from the pre-Devonian rocks; some contain volcanic fragments, some of which are identifiable as Silver Hills Volcanics. Calcareous sediments and limestones, organic in part, occur also. The extrusives are dominantly andesitic, with minor basalt and rhyolite; all the rocks are extremely altered.

The relationship between the Silver Hills Volcanics and the Telemon Formation is variable. In the Old Silver Hills area (Figure 16), the Telemon Formation overlies the Silver Hills Volcanics with apparent unconformity. At EM143/6, five miles south-south-east of Silver Hills Homestead, the contact between the formations is a faulted one; west of Peak Vale homestead, the sequence seems to be conformable. Shell reported an angular unconformity between the Telemon Formation and underlying Dunstable Formation (probably partly equivalent to the Silver Hills Volcanics) in the Springsure area. The Telemon Formation is disconformably overlain by the Mount Hall Conglomerate.

The Telemon Formation reaches a thickness of 5000 feet in the Mount Beaufort area (Figure 4). A maximum thickness of 5000 feet occurs in Argyll Creek west of Old Silver Hills homestead.

Plant fossils indicate a probable Upper-Devonian age for at least part of the formation (White, 1962).

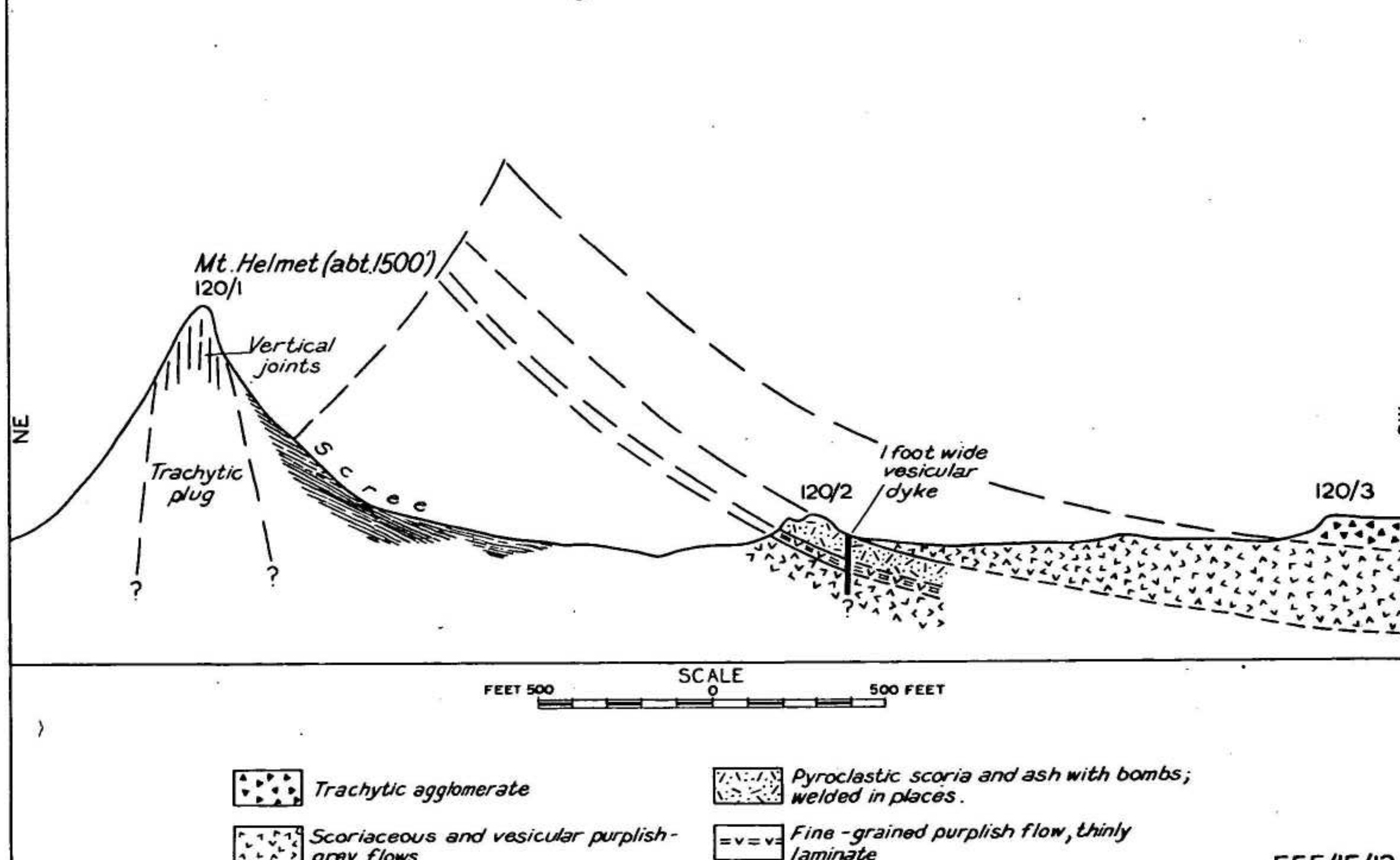
Mount Hall Conglomerate

The Mount Hall Conglomerate is mainly an orthoquartzitic conglomerate (Pettijohn, 1957, p.256) with a maximum thickness of 2600 feet and lensing out completely in places. Its physiography and airphoto pattern are prominent and distinct. Within the Sheet area it crops out in the Pebbly Creek, Telemon and Mount Beaufort Anticlines and along the north-east margin of the Drummond Basin. It overlies, disconformably in places, the Telemon Formation and passes up into the Raymond Sandstone with no apparent break. Its marked lithological contrast to the underlying and overlying beds makes it a useful mapping horizon (Appendix I, p.111).

The formation was named by Shell (Shell (Queensland) Development Pty Ltd, 1952) from the type area of Mount Hall in the Springsure Sheet area. The three areas of outcrop are characterised by prominent timbered ridges and cuestas which form a dark, prominent airphoto pattern. At EM130 and EM131 (Figures 10 and 16) the Mount Hall Conglomerate consists of thick pebbly siliceous quartz conglomerate with minor cobble conglomerate beds and pockets, interbedded with medium-grained to gritty kaolinitic quartz sandstone and other minor sediments.

Cross section through Mt. Helmet and environs and through hypothetical reconstruction of south-west wall of probable original volcanic cone.

FIG. 35.

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At Mount Hall it consists of similar conglomerate and sandstone with flaggy micaceous sandstone. The conglomerates are characterised by rounded milky quartz, quartzite, commonly banded, and hard black siliceous pebbles. Cross-bedding is common and cross-bed units are thick. Minor slump or load cast structures are occasionally found in some of the finer-grained sediments. Indeterminable fossil wood impressions occur in places.

The formation varies in thickness and lithology along strike, with pronounced lensing of beds. Along the eastern margin of the Drummond Basin, where it reaches its maximum thickness of 2600 feet at EM130, the formation lenses out about 10 miles south of Chinaman Peak (Figures 15 and 16) and, similarly, is not present on the west limb of the Mount Beaufort Anticline (Figures 3 and 4) although it is 800 feet thick on the east flank.

Shell (Shell (Queensland) Development Pty Ltd, 1952, p.21) report 'a slight angular unconformity at the base of the Mount Hall Conglomerate' which is 'stronger on the southwest flank of the Anakie Uplift where it overlaps the volcanics of the Dunstable Series'. No evidence was found to support overlap or angular unconformity, except at Mount Borilla where the Mount Hall Conglomerate probably overlaps the Silver Hills Volcanics and Telemon Formation (Figure 14). However, at the north end of the Telemon Anticline, a basal pebble conglomerate lies with sharp contact on a sheared white claystone and contains fragments of this rock at the base. No angular discordance is visible and the relationship is disconformable. At Mount Hall on the south-east limb of the Telemon Anticline the conglomerate lies on purple mudstone with no apparent break. Similarly there appears to be no angular unconformity at the base of the formation along the eastern margin of the Drummond Basin, and the base of the Mount Hall Conglomerate is the first conglomerate bed above the Telemon Formation. The Mount Hall Conglomerate is conformably overlain by the Raymond Sandstone, the boundary being transitional in places.

The formation dips up to $70^{\circ}$ to the south-west on the eastern flank of the basin and small faults and slickensides are common. It forms prominent cuestas and scarps in the Pebbly Creek and Telemon Anticlines with dip slopes of $15^{\circ}$ to $30^{\circ}$.

The Mount Hall Conglomerate indicates a change in provenance and probably depositional environment from Telemon times. The disconformity at the base in places indicates a short depositional break in these areas with a low erosion surface. Probably slight vertical movements continued in the Drummond Basin throughout the deposition of the Mount Hall Conglomerate and the areas that did not receive any sediment were probably land until Raymond Sandstone times when renewed general subsidence took place. Insufficient current direction structures were measured to indicate from where the sediment was derived. The pebbles of milky quartz, quartzite and indurated argillites suggest a source in the pre-Devonian Anakie Metamorphics which are characterised by these rocks. Similarly, the kaolinitic feldspar, the dominant interstitial mineral, may have been derived from the Retreat Granite, also to the east. Pebbles at the base of the formation along the north-eastern margin of the basin were probably derived from the Silver Hills Volcanics. The Mount Hall Conglomerate represents a change from a volcanic to a sedimentary provenance.

The formation is tentatively regarded as Lower Carboniferous (Shell (Queensland) Development Pty Ltd, 1952).

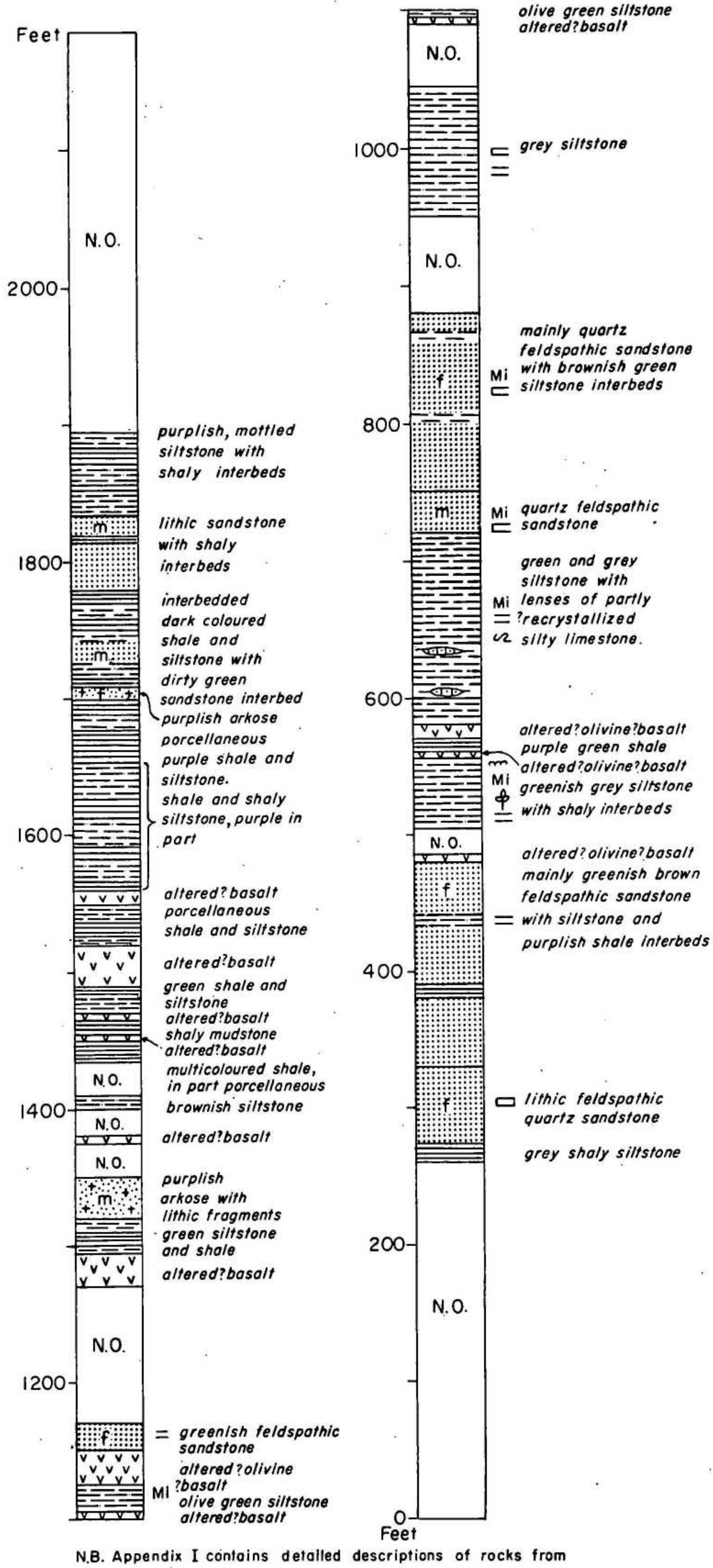
THE RAYMOND SANDSTONE

This formation was originally named 'The Flaggy Sandstone Group' by Shell (Shell (Queensland) Development Pty Ltd, 1952) and subsequently changed to 'The Raymond Flaggy Sandstone' by Hill (1957). In accordance with the Australian Code of Stratigraphic Nomenclature (3rd Ed., 1959) the name is now amended to 'The Raymond Sandstone'.

The type area is loosely referred to by Shell (Shell Queensland (Development) Pty Ltd, 1952, p.21) and Hill (1957) as 'the Telemon Area'. The Raymond Sandstone lies above the Mount Hall Conglomerate and crops out at the same localities. In the Telemon and Pebbly Creek Anticlines it forms prominent cuestas with a lighter, smoother airphoto pattern than the Mount Hall Conglomerate. Along the north-east margin of the basin the Raymond Sandstone occupies low ground between the upstanding Mount Hall Conglomerate and the Ducabrook Formation. Low strike ridges in this area form prominent lines on the air photos.

Fig II.

# MEASURED SECTION IN THE RAYMOND SANDSTONE IN ARGYLL CREEK




N.B. Appendix I contains detailed descriptions of rocks from this section field numbers 167/1-9

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Along the north-east margin of the basin the Raymond Sandstone consists of interbedded mudstone, siltstone and subordinate sandstone and arkose with several basalt flows (Figure 11). The medium to caorse-grained sandstones are feldspathic and/or lithic, occasionally flaggy, and partly silicified or zeolitized. The mudstones and siltstones are olive green, purplish, and shades of brown and, commonly, shaly and porcellanous. Occasional thin lenses of limestone also occur in the sequence. The sandstone and siltstone are derived primarily from the pre-Devonian rocks but contain some volcanic fragments including material derived from the Silver Hills Volcanics (Appendix I, p.114). In the Telemon Anticline the Raymond Sandstone is typically a sequence of medium-grained, micaceous, light coloured flaggy sandstones. The sandstones are partly fine-grained, siliceous and green or brown. Several basalt dykes, up to several feet wide, intrude the Argyll Creek section (Figure 11), and suggest that the concordant igneous layers, usually about five feet thick, are sills or laccoliths, possibly fed by the dykes which have hardened zones only a few inches wide.

Bedding in the micaceous sandstones is commonly thin to laminate and often flaggy, and the finer-grained sediments are commonly shaly. Ripple marking and cross bedding occur commonly throughout the sequence. Indeterminable plant remains were found.

The Sandstone in Argyll Creek (Figure 11) is about 2200 feet thick and from aerial photographs it appears to lens slightly. In the areas where the Mount Hall Conglomerate lenses out the Raymond Sandstone presumably lies disconformably on the Telemon Formation. Elsewhere it lies conformably on the Mount Hall Conglomerate. It is overlain conformably by the Ducabrook Formation.

<u>Ducabrook Formation.</u>

The Ducabrook Formation conformably overlies the Raymond Sandstone and is mainly a sequence of interbedded sandstones and mudstones, about 7000 feet thick. They are probably of estuarine origin and contain fish and plant remains that indicate Lower Carboniferous age. The sediments are folded into a series of broad simple anticlines and synclines.

The name Ducabrook Formation was originally applied to these sediments by Shell (Queensland) Development (Shell (Queensland) Development Pty Ltd, 1952), the type locality being in the Ducabrook Pastoral Holding.

The Ducabrook Formation crops out over most of the Drummond Basin in the Emerald Sheet area. The southern limit of outcrop is 12 miles south of the Sheet boundary on the Springsure Sheet. North of the Emerald Sheet, Gough (1961) has mapped 10,000 feet of sediments assigned to this formation. West of the Sheet boundary the sediments disappear under Cainozoic sand and alluvium. West of Peak Vale, the Ducabrook Formation directly overlies the Anakie Inlier, and the older formations appear to have been faulted out.

The harder beds of the formation stand out as pronounced strike ridges, and structural mapping of the unit is made easy by prominent strike patterns on the aerial photographs.

The topographic expression of the formation varies, depending on the proportion of sandstone to mudstone. In the southern part of the outcrop, especially the area between Kotri and Ducabrook Homesteads, mudstones predominate in the sequence, and the formation occupies relatively featureless country, the harder sandstones forming low strike ridges. The mudstones are soft and easily eroded, leading to the development of deep gullies.

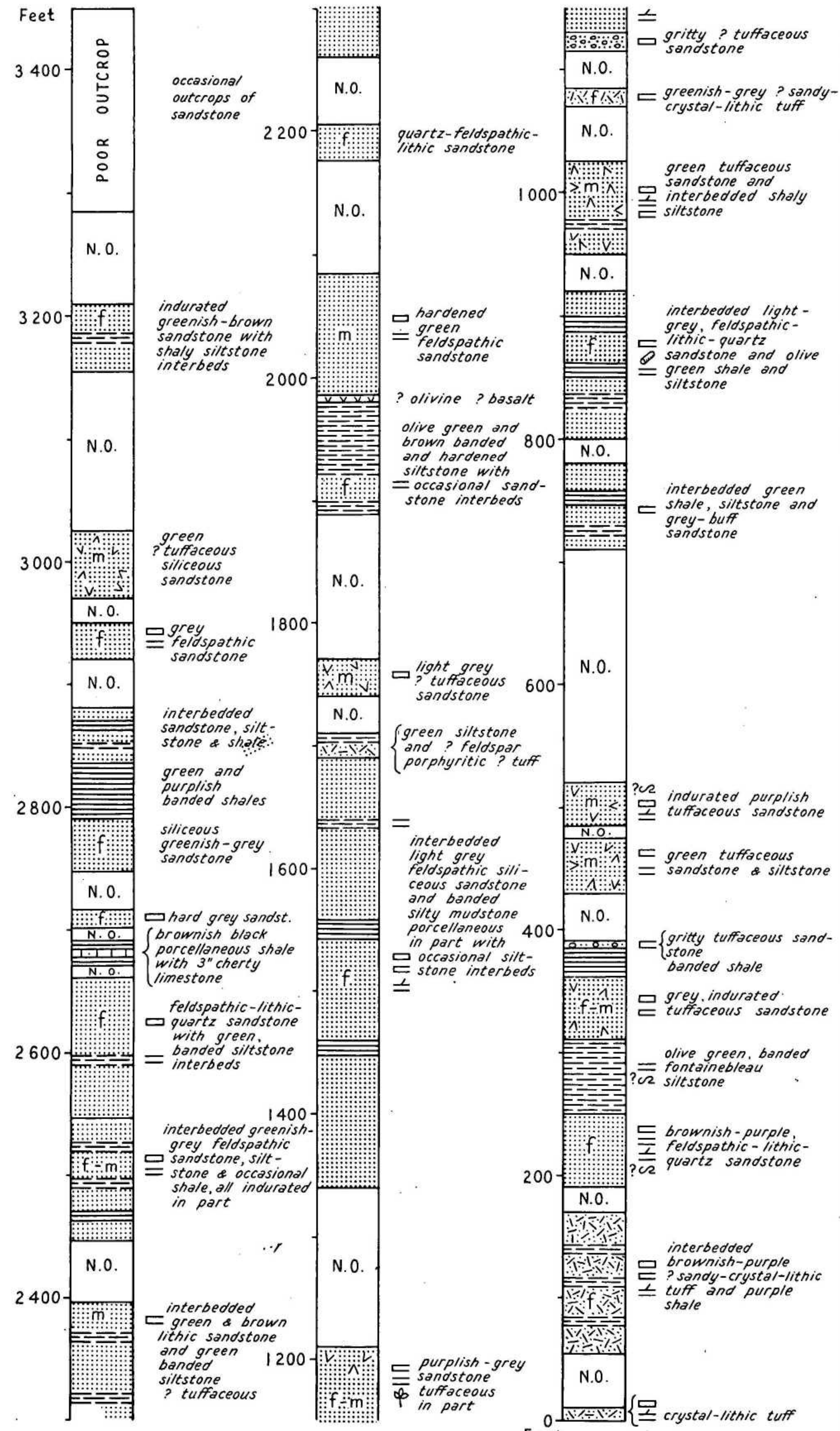
Where the beds are horizontal to very slightly dipping, they form flat-topped ridges with stepped profiles, 800-1000 feet above the general level of the surrounding country (Figure 12). The stepped profiles are due to the collapse of sandstone beds where they overlie soft mudstones.

North-east of Bogantungan, sandstone is the dominant lithology, mudstone being only minor, and the more or less flat-lying sediments form very rugged country with a relief of nearly 2000 feet, Mount Pisgah, north-west of Bogantungan, is 2660 feet high.

The formation was divided by Shell into lower and upper units. According to their report (Shell Queensland) Development Pty Ltd, 1952, pp. 21-23) the lower Ducabrook consists of an alternation of greenish feldspathic sandstone and green, purple and brown mudstones with some hard siltstones, the suggested provenance being granitic, while the upper Ducabrook consists of

Fig 13

# MEASURED SECTION IN THE DUCABROOK FORMATION AT THE HEAD OF NORTH CREEK




N.B. Appendix I contains detailed descriptions of rocks from this section, field N^os^ 165/1-10

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Figure 12: View of horizontal beds of Ducabrook Formation, north of Bogantungan.

green and purple claystone, siltstone and massive sandstone in rapid alternation, with five to ten feet thick intercalations of pink to red siltstones and rhyolitic vitric tuff.

This two-fold subdivision of the Ducabrook Formation applies only to the type area and cannot be applied over the whole areal extent of the formation. North of the Central Railway the sediments are largely arenaceous whilst in the south mudstones are dominant. Locally several units can be distinguished in the formation, but none of these local sub-divisions can be extrapolated over wide areas. In their geological reports, Shell state they were able to distinguish five lighological groups in the Ducabrook Formation in the Zamia I Anticline.

During the present investigation the Medway Anticline was mapped in some detail. In the field three units were distinguished, based largely on the physical appearance of the rocks. Petrographically there appears to be no great difference in the composition of the sandstones through the sequence.

The lowest unit, as exposed in the core of the main structural axis, is characterised by coarse lithic sandstones and pink and pale green tuffs. These tuffs consist of fine grains of quartz, feldspar and lithic material set in a fine tuffaceous matrix.

Above this the rocks which form most of the steeply dipping east flank mainly consist of light green and light brown fine-grained sandstones, often flaggy, interbedded with similarly coloured mudstones, shales and some siltstones.

The third unit at the top of the sequence consists mainly of soft, massive, light brown, green and pinkish-brown mottled sandstones, interbedded with coloured mudstones. Thin beds of dark oolitic limestone also occur, commonly containing fish remains. Thin beds of dense pink siltstone and pink vitric tuffs are rare.

Throughout the sequence the sandy beds are mostly lithic sandstones or subgreywackes. In some, quartz or feldspar form the greater proportion of grains. Up to 10% matrix is present in some rocks but in others a high percentage of grains are in contact. Volcanic fragments are similar to the Silver Hills Volcanics while the most obvious source for the schist and granite fragments is the Anakie Inlier. For further detail refer to the petrography of the Ducabrook Formation (Appendix I, p.118).

Tabular fragments of mudstone occur in the base of some sandstone beds which are underlain by mudstone. The fragments probably represent mudstone broken up by dessication, and subsequently incorporated in the overlying sandstone.

The mudstones commonly contain nodules up to 4" in size. These are more resistant to weathering than the enclosing rock and in places are scattered on the surface. The nodules are generally similar to the enclosing mudstone but are more calcareous and traversed by a network of veins of calcite, tending to concentric and radial patterns.

Conglomerates are rare in the Ducabrook Formation. In the Zamia I and Pebbly Creek Anticlines some conglomerate was observed, the rounded pebbles being mainly of mudstone and siltstone. A few beds of conglomerate with angular pebbles occur near the base of the formation in the west flank of the Telemon Anticline.

Because the mudstones weather easily and the overlying sandstones consequently collapse, it is often difficult to estimate the relative proportions of mudstone and sandstone in the sequence.

Shell (Queensland) Development considered 5000 feet of volcanics in the Mount Beaufort Anticline to be contemporaneous with the Upper Ducabrook, but on present mapping these volcanics belong to the Silver Hills Volcanics and Telemon Formation.

The Ducabrook Formation is about 9000 feet thick in the Zamia I Anticline but appears to vary in thickness elsewhere. 3450 feet of Ducabrook Formation along North Creek in the Withersfield Syncline consists dominantly of fine to medium-grained tough, siliceous, grey and green feldspathic sandstone, interbedded with shaly coloured mudstones and siltstones which are more common in the lower part of the section (Figure 13). Sills or flows of altered basalt occur throughout the sequence. Lepidodendron veltheimianum occurs in places and also in the beds a few miles north along Retreat Creek where lithic sandstones and white tuffaceous siltstones also occur in the sequence.

The Ducabrook beds are mainly massive, particularly towards the top of the sequence. Individual sandstone beds are rarely more than 20 feet thick. Oscillation ripple marks are common. In one instance oscillation ripple marks on two successive bedding planes are at rightangles to each other.

Other irregular markings are probably interference ripple marks caused by the interference of currents from different directions. Some other less well-defined bedding-plane structures are possibly drag marks and flute casts. Lumps of calcareous subgreywacke 2 feet across were observed in places with the overlying bed dipping radially off them. These are considered to be wave or current piled masses of sediments cemented by calcareous material, incurring slight depositional dips in the overlying bed.

Fish remains occur in the Ducabrook Formation, particularly near the top. They are mostly in the oolitic limestones, but some scales also occur in sandstones. Several pieces of oolitic limestone with fish remains were submitted to J.T. Woods ( Appendix 3). The remains compare closely with similarly preserved material in the Geological Survey collections from Hannam's Gap (Jack & Etheridge, 1892). E.S. Hills(in Shell (Queensland) Development Pty Ltd, 1952) determined an acanthodian fish Gyracanthides murrayi and skeletal fragments of palaeoniscoid fish applied to Elonichthys.

The formation is folded into a series of broad relatively simple anticlines and synclines, dips generally being low to about 20°. In a few places as the core of the Zamia I Anticline and the eastern flank of the Medway Anticline, dips of 50° to 65° occur.

The Ducabrook Formation appears to have been deposited in shallow water. The plant remains Lepidodendron sp. Stigmaria ficoides and the fish Gyracanthides murrayi indicate Lower Carboniferous (Shell (Queensland) Development Pty Ltd, 1952 and White, 1962).

On the Emerald Sheet area Shell have mapped certain areas in some of the synclines as Joe Joe Creek Formation which they considered to be Permian and to unconformably overlie the Ducabrook Formation. The present survey could not distinguish the Joe Joe Creek Formation from the Ducabrook Formation either on lithological or structural grounds. The sediments assigned by Shell to the Joe Joe Formation are lithologically similar to the upper part of the Ducabrook and conformable with it.
No evidence of any break in deposition was found. However, the status of the Joe Joe Creek Formation depends on future mapping in the Springsure area, where at the type area it is glacial in character. Tweedale (in Hill & Denmead, 1960), has summarised the present knowledge of the age of the Joe Joe Creek Formation.

Structure

The structure of the Drummond Basin has been described by Shell (Shell (Queensland Development) Pty Ltd, 1952).

The main structural trend in the Emerald area is north-westerly but in the extreme south the trend becomes north-easterly which is the axial trend of the Nogoa and Telemon Anticlines in the Springsure area. Cross-folding has occurred in the zone where these two trends merge and structure axes are sinuous. Shell (Queensland) Development suggest the north-easterly trend is controlled by basement structural trends and the north-westerly trend is the trend of the basin axis.

The Drummond Basin sediments have been folded into a series of relatively simple structures, most of which are closed in sediments of the Ducabrook Formation. Some of the structures are large regional features, such as the Bogantungan and Withersfield Synclines, each about 50 miles long but most are smaller plunging anticlines and synclines, domes, and monoclines. Flank dips are commonly about 15° but dips up to 60° are not uncommon.

Apart from the fault along the north-east margin of the basin major faults are not common. Most faulting is normal and is usually confined to the tighter structures as crestal, and transverse faults. Minor faulting is common in the Rutland-Ducabrook area. The faults are short and are clearly seen on the air photographs by the displacement of bedding trends.

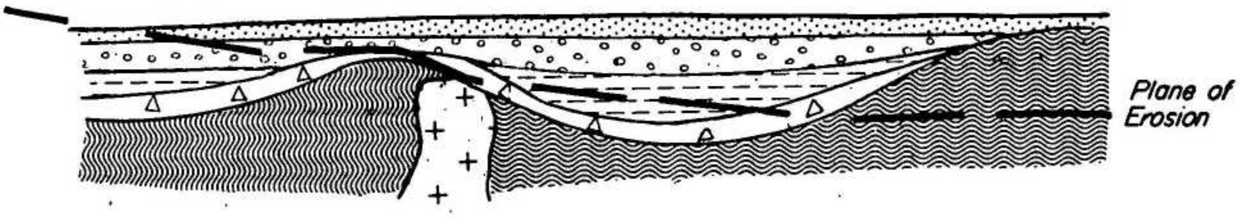
Some of the structures in the Drummond Basin were investigated in detail and these are described here. The eastern margin of the basin is structurally complex and reference is made to the present interpretation in Figure 16.

Immediately north of Old Silver Hills homestead the Silver Hills Volcanics rest unconformably on the Anakie Metamorphics. To the south the Volcanics rest on the Retreat Granite and dip steeply south-westward as do the overlying formations. In this marginal belt dips up to 70° are found in the Telemon Formation and Mount Hall Conglomerate, 10 miles north of Mount Hoy the basin margin is marked by a fault that has cut out the Telemon Formation and Raymond Sandstone northward. The Silver Hills Volcanics do not crop out between Mount Hoy and Chinaman Peak and have probably been faulted out also. The fault line is marked by reversals in dip in the Telemon Formation immediately north of Mount Hoy and a long, thin wedge of Anakie Metamorphics that forms a small, but marked, ridge in

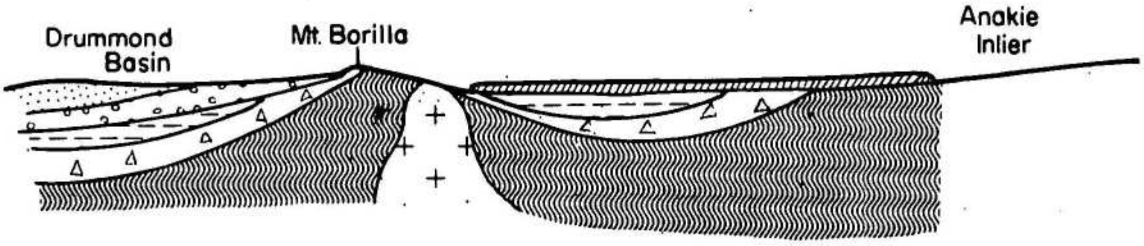
FIG.14.

# DIAGRAMMATIC SKETCH SECTIONS ILLUSTRATING THE HISTORY OF THE MOUNT BORILLA AREA

## A. BEFORE TILTING




## B. AFTER TILTING, EROSION AND PERMIAN SEDIMENTATION




LEGEND

- *Permian sediments and alluvium*
- Raymond Sandstone and Ducabrook Formation
- Mt. Hall Conglomerate
- Telemon Formation
- Silver Hills Volcanics
- *Granite intrusion*
- Anakie Metamorphics

*To accompany Record No 1962/50*

*Bureau of Mineral Resources, Geology and Geophysics* *October 1961*

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places. North of Chinaman Peak occasional outcrops of Silver Hills Volcanics have been preserved east of the fault which terminates near the Sheet boundary.

The structure at Mount Borilla, on the eastern margin of the basin, is probably complex and an interpretation is illustrated in Figure 14. The distribution of the Silver Hills Volcanics, Telemon Formation and Mount Hall Conglomerate in the Mount Borilla area suggests that before deposition commenced a ridge of Anakie rocks existed at Mount Borilla. Sedimentation started with the laying down of the Silver Hills Volcanics along and over the edge of the Anakie Inlier, covering the ridge at Mount Borilla (Figure 14). This volcanic phase was followed by the deposition of the sediments of the Telemon Formation, during which time the Mount Borilla ridge was not submerged and did not receive any sediments. The Mount Borilla ridge was then submerged and the Mount Hall Conglomerate, Raymond Sandstone and Ducabrook Formation were then laid down in a continuous sheet. Sagging of the central portion of the Drummond Basin, subsequent erosion and deposition of Permian sediments east of Mount Borilla probably produced the present relationship between the formations at Mount Borilla.

The Pebbly Creek Anticline is about 25 miles long and 12 miles wide between the adjacent synclinal axes. Mount Hall Conglomerate is exposed in the core. At its northern end the structure is complicated by a tightly compressed subsidiary fold on its west flank. This fold is associated with longitudinal faults which have fractured and sheared the rocks. The northern part of the anticline is probably further complicated by transverse faulting. Flank dips up to 35° are common in the main structure and up to 60° in the subsidiary fold.

The Medway Anticlinorium has a north-east trend and is markedly asymmetric. In the southern part it consists of a steeply dipping, narrow east flank and a very gently dipping west flank and approximates to a monocline. Northward another asymmetric anticline occurs immediately east of the other axis to produce a structural terrace about three miles wide. The terrace is in fact a very shallow syncline which Shell called the Medway Syncline. A northward plunge is maintained throughout the length of these structures.

The Zamia I Anticline is a large structure in which the core has been deeply eroded to produce a topographic basin. The core is tightly folded with dips up to $60^{\circ}$ and the rocks are deeply fractured. Flank dips are about $15^{\circ}$. A longitudinal fault approximately marks the axis of the fold.

## Intrusions

Intrusions into the Devonian-Carboniferous rocks of the Drummond Basin are rare. The largest is an adamellite stock with an elliptical outcrop about 4 miles long which occurs two miles west of Silver Hills Homestead. It is essentially a hornblende-biotite adamellite. Potash feldspar is perthitic and varies in form from anhedral pools to larger masses of three or four intergrown pools. It poikilitically includes most of the other constituents of the rock. Plagioclase ($An_{30}$) occurs as euhedral laths but shows slight marginal zoning to composition $An_{20}$. In places myrmekite is developed at the junction of the two feldspars. Quartz varies in form from being interstitial to forming anhedral grains. Hornblende and biotite are present in about equal proportions while iron oxides and allanite are present as accessory minerals. The rock contains xenoliths of the enclosing volcanic rocks. These show a xenoblastic texture, but with poikiloblastic pools of quartz and potash feldspar added from the adamellite. The stock intrudes steeply dipping rocks of the Telemon Formation, the Mount Hall Conglomerate and the Raymond Sandstone. The intrusion has displaced the north-westerly strike of these rocks within half a mile from its north and south margins. The beds dip steeply toward the stock within a few hundred yards, a fact not readily explained. The Telemon rocks have been hornfelsed near the intrusion (Appendix I, p.93 ).

Small intrusions of andesite occur immediately south of the stock and west of Mount Borilla; both intrude the Raymond Sandstone (Appendix I, p.139 ).

Narrow dykes of altered basalt with a south-westerly trend intrude the Raymond Sandstone in Argyll Creek. The intruded rocks are not noticeably altered. The dykes were probably feeders to the numerous interbedded altered basalt flows or sills in the Raymond Sandstone.

Intrusions of augite-porphyry were observed by Shell (Shell(Queensland)Development Pty Ltd, 1952, p.22) in the Drummond Anticline but were not observed in outcrop by the present survey although loose boulders were found.

Olivine basalt plugs, probably of Tertiary age, intrude the Drummond Basin beds at Black Peak and immediately to the west and also at Chinaman Peak which lies on the faulted margin of the basin. Olivine gabbro intrusions, also probably of Tertiary age, occur at Mount Scholfield and Wilford homestead. Nowhere are the intruded rocks seen in contact with the plugs and only on the lower east slopes of Mount Scholfield are steep dips seen that are probably a result of the intrusion.

## Geological History

The Drummond Basin extends from the Springsure Sheet area in the south to the Burdekin River in the north, a distance of about 250 miles. Its southward extent under Permain and Triassic rocks and its westward extent under Triassic, Cretaceous and Cainozoid rocks beyond the Belyando River are unknown. Its eastward extent is marked by the boundary with rocks of the older Anakie Inlier. The north-westerly strike of the Drummond basin parallels the main axis of the Bowen Basin and is the regional strike in this part of Queensland. The basin contains about 16,000 feet of folded sediments and volcanics, predominantly of shallow water origin and ranging in age from lower Middle Devonian to Lower Carboniferous.

Deposition at the start of and throughout the history of the basin was not contemporaneous or of the same type in all parts of the basin. In the Nogoa Anticline area deposition began with an arenaceous phase and sporadic vulcanism; lenses of lower Middle Devonian coralline limestone indicate at least temporary marine conditions. North, in the Emerald Sheet area, the basal unit consists dominantly of volcanic flows and pyroclastics and the presence of minor interbedded sediments and the siliceous nature of the volcanics suggest the sequence was deposited in water. This dominant volcanic sequence occurs in the core of the Mount Beaufort Anticline and extends north into the Clermont Sheet area suggesting a very wide extent. Similar volcanics occur in a small outcrop about 20 miles west of Emerald at Glendarriwell. Coralline limestone of probable lower Middle Devonian age occurs at the same locality and is probably interbedded with the volcanics. These rocks lie roughly on the axis of the Anakie Inlier and suggest that this structure acted as a shallow submarine platform at least in the early stages of deposition and the present faulted western margin of the Inlier was probably an active hinge-line during the life of the basin. The coralline limestones at Glendarriwell, Nogoa Anticline and Douglas Creek, in the Clermont Sheet area, are all of lower Middle Devonian age and possibly represent reef deposits near the margin of the basin.

Shell (Shell (Queensland) Development Pty Ltd, 1952) suggest a period of folding followed this volcanic activity based on an unconformity at the base of the Telemon Formation in the Nogoa Anticline. In the Emerald area this angular discordance was not seen, the break being a disconformity. The beds of the Telemon Formation indicate a continuance of recurrent volcanic activity although pyroclastics and tuffaceous sediments are more dominant than extrusives. Lithic sandstones and algal limestones are interspersed in the sequence. The volcanic ejecta and sediments were probably deposited in shallow water and much of the lithic material was derived from rocks of the Anakie Inlier and earlier volcanic extrusives. The Telemon rocks probably overlapped the basal volcanics in places along the eastern margin of the basin. According to Shell the Telemon Formation in the Springsure Sheet area is dominantly sedimentary and a partly estuarine environment is interpreted on the basis of some small branchiopod and mollusc fossils.

A disconformity locally occurs at the top of the Telemon Formation and this break was accompanied by an abrupt change in depositional environment and provenance. The Mount Hall Conglomerate is dominantly a quartz pebble conglomerate and although widespread, is not continuous throughout the basin although it may have lateral equivalents. The quartz pebbles are apparently derived from the rocks of the Anakie Inlier and despite the absence of an angular unconformity at the base of the conglomerate it is clear that some uplift of at least part of the Inlier took place, to account for the sudden change in provenance from the Telemon Formation. The pronounced lensing of the conglomerate and large cross-bed units suggest it was deposited rapidly in isolated areas. The marked 'unconformity' between the Telemon and Raymond-Ducabrook rocks, notably along the eastern margin of the basin and the western flank of the Mount Beaufort Anticline, merely expresses local contemporaneous elevation of the basin floor in Mount Hall Conglomerate times and not a regional diastrophism. The direction from which the pebbles were derived is uncertain; they possibly had several sources. Fragments of the basal volcanics are found only at the base of the conglomerate which suggests the higher parts of the formation overlapped the lower formations. The ages of both the Mount Hall Conglomerate and the Telemon Formation are uncertain. Shell regard the Telemon Formation as Upper Devonian and the Mount Hall Conglomerate as Lower Carboniferous mainly on the basis of the depositional breaks and because the Mount Hall Conglomerate belongs to a conformable sequence which is Lower Carboniferous at the top (Shell (Queensland) Development Pty Ltd, 1952, p. 20). After the Mount Hall Conglomerate, sedimentation continued in shallow water conditions without a break, to form a predominantly sandstone and shale sequence with derived volcanic material (Raymond Sandstone). Sporadic volcanic activity occured; tuff beds and dykes feeding flows or sills occur in this sequence which changes lithologically and in thickness, along the strike.

The overlying Ducabrook Formation is essentially similar, although volcanic activity was far less intense than during the earlier life of the basin. Fossil fish remains of Lower Carboniferous age occur in these sediments.

After Mount Hall Conglomerate times, sedimentation and basin subsidence was continuous and a thickness of about 10,000 feet of sediments and volcanics was deposited in the Emerald area.

The age and structural relationship to the Ducabrook Formation of the overlying Joe Joe Creek Formation in the Springsure Sheet area are in doubt but according to Tweedale (in Hill and Denmead, 1960, pp.175-177, 213-214) the major folding of the Drummond Basin sediments is post- Joe Joe times.

The Permian Colinlea Formation was laid down on the folded and eroded Drummond Basin sediments with angular unconformity.

According to Shell (Shell Queensland Development Pty Ltd, 1952) the sediments in the Drummond Basin were in part laid down in a shallow freshwater environment. Marine incursions occurred at least in the Devonian on the evidence of coralline limestone and algal limestone. The presence of fish fossils in the Ducabrook Formation and the reported occurrence of branchiopods by Shell in the Telemon Formation suggest a probable estuarine environment.

There seems to be no positive proof that the Drummond Basin sediments and volcanics were deposited entirely in freshwater. In the Emerald area a near-shore to estuarine marginal environment was probably dominant during deposition.

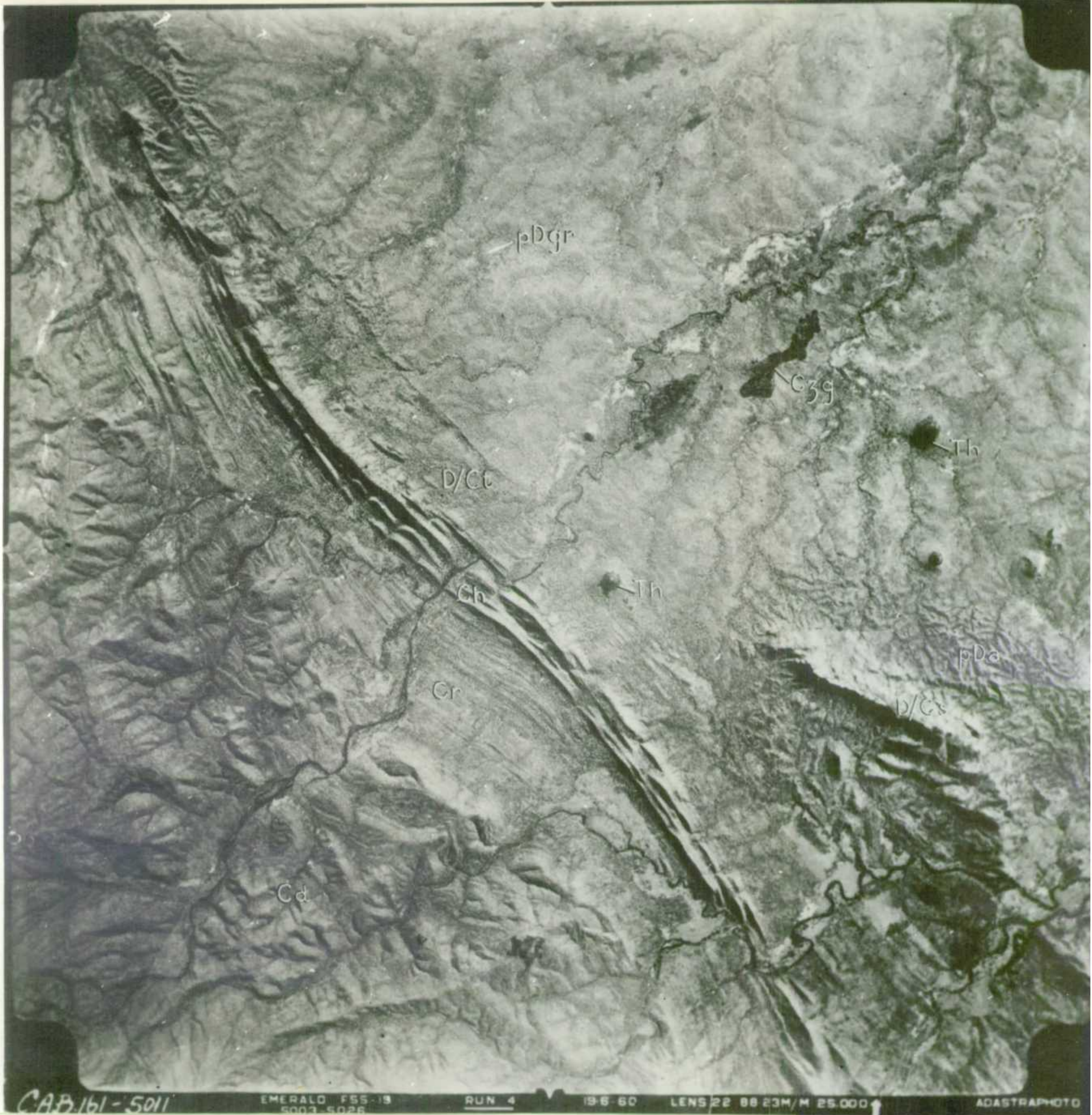



Figure 15: Air photograph of part of the eastern edge of the Drummond Basin showing the patterns of some of the units in the Emerald Sheet area. (The creek flowing diagonally across the photograph is Tomahawk Creek.)


Fig.16
GEOLOGICAL MAP
of the
EASTERN MARGIN OF THE
DRUMMOND BASIN
in the
EMERALD SHEET AREA
SCALE
1 0 1 2 3 4 5
Miles
N
REFERENCE
CAINOZOIC
Cza Alluvium
Czg Gravels
TERTIARY
Th Hoy Basalt
Tb Basalt
PERMIAN
Pc Colinlea Formation
? POST-CARBONIFEROUS
gr Granite
CARBONIFEROUS
Cd Ducabrook Formation
Cr Raymond Sandstone
Ch Mt Hall Conglomerate
DEVONIAN-CARBONIFEROUS
D/Ct Telemon Formation
D/Cs Silver Hills Volcanics
PRE-DEVONIAN
pDgr Retreat Granite
pDa Anakie Metamorphics
Geological boundary
Inferred geological boundary
Strike and dip
Low dip
Horizontal strata
Dip slope
Trend of bedding
Syncline
Fault
Inferred fault
Dyke
Cross section
Town
Homestead, hut
Road
Track
Railway line
Photo centre
Field locality number
Bore with windpump
REFERENCE
to Australian 1:250,000 Series
CLERMONT F55-11
EMERALD F55-15
Eastern Creek
Peak Vale H.S.
Chinaman Peak
Mt Zig Zag
Theresa Creek
Hut
Tomahawk Creek
Mt Newsome
Many felsite dykes in this area
Mt Hoy
Mt Leura
Black Peak
Old Silver Hills H.S.
Retreat Creek
Argyll Creek
Silver Hills H.S.
North Creek
WITHERSFIELD
Tadcaster Outstation
Mt Borilla
Tadcaster H.S.
ANAKIE
Emerald
Czg & Pc
Borilla Creek
SKETCH SECTIONS
A B
C D
E F
G H
feet
Mt Borilla
To accompany Record No. 1962 - 50
Bureau of Mineral Resources, Geology & Geophysics. November, 1961.
F55-5
G.M.

# PERMIAN

## Introduction

Two areas of Permian sedimentary rocks are found in the Emerald Sheet area : (1) a strip of barren pebbly quartz sandstone (the Colinlea Formation) extends from the Springsure Sheet area northward to Anakie, and is separated by part of the Anakie Inlier from (2) the western part of the Bowen Basin which contains at least 8,000 feet of marine and freshwater (paralic) pebbly sandstone and shale overlain by an unknown thickness of Coal Measures. These rocks are not continuously exposed, and their sequence, thickness, and structure have been estimated by piecing together information from scattered outcrops and from regional seismic and gravity surveys. Owing to poor outcrop, only limited results are expected to stem from further geological field work, and detailed geophysical surveys and drilling will be required to advance our knowledge of these rocks.

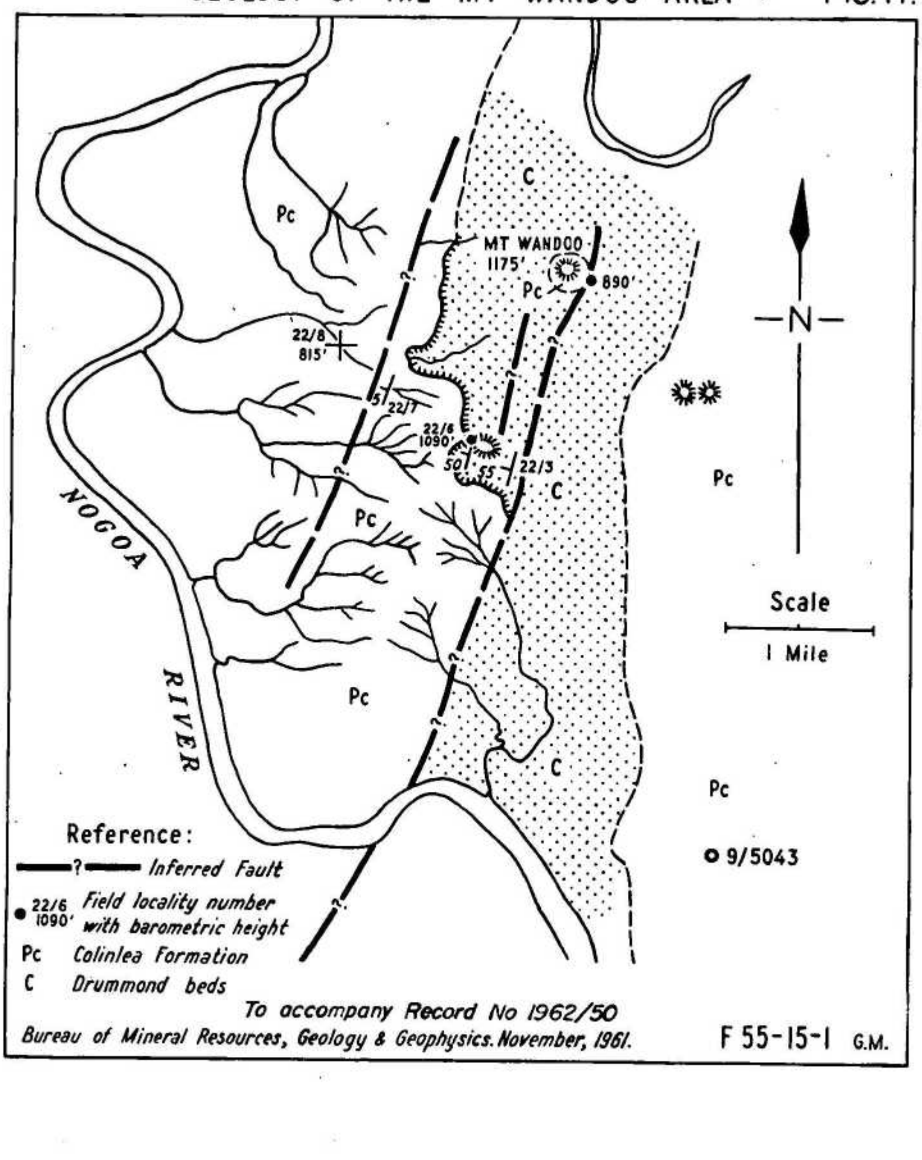
Outcrops on the Emerald Sheet provide the first link, albeit tentative, between formations in previously mapped areas on the western side of the Bowen Basin (Springsure and Clermont Sheet areas), and consequently, through the work of Malone et al. (1961) in the Mount Coolon Sheet area, with formations on the eastern side of the basin.

## Colinlea Formation

The Colinlea Formation extends in discontinuous outcrop 4 to 10 miles wide from the type locality in the Springsure Sheet area to the Central Railway west of Anakie. It overlies unconformably the Anakie Inlier and the eastern margin of the Drummond Basin, and is overlain unconformably along its eastern boundary by Tertiary basalt. At its type locality, 10 miles south of the Emerald Sheet area, the Colinlea Formation consists of a gently east-dipping sequence, 4500 feet thick, of 'quartz conglomerate, overlain by markedly cross-bedded siliceous grit with bands and pockets of pebbles, and white micaceous flaggy or gritty sandstone with intercalations of white micaceous kaolinic clay' (Hill, 1957, p.7). This sequence is overlain unconformably by Tertiary basalt.

The Colinlea Formation is indicated on the air photographs by two types of pattern: (1) low-standing outcrops (type locality and between Southernwood and Anakie) are smudgy in the photographs due to dense vegetation on low ridges which are finely dissected by short watercourses which drain normal to the ridges and produce a herring-bone pattern; (2) lightly vegetated sandy country which lies between the ridges. Where the relief

GEOLOGY OF THE MT WANDOO AREA FIG. 17.



is greater, as in the area east of Rutland Homestead, and in the Mantuan Downs area of the Springsure Sheet area, the Colinlea Formation has a more distinctive morphology of vegetated ridges separated by broad sandy flats.

In the area east of Rutland Homestead, about 300 feet of subhorizontal cross-bedded grey, fine to medium-grained quartz greywacke and coarse quartz sandstone with pebbles of milky quartz overlie folded siltstone and sandstone of the Drummond Basin. The unconformity is exposed on the western edge of the outcrop, and in the Mount Wandoo area (figure 17). At EM22/6, at an elevation of 1090 feet, 20 feet of horizontal pebbly quartz sandstone overlie steeply dipping green tuffaceous sandstone of the Drummond Basin. The unconformity has an elevation of 890 feet on the eastern side of Mount Wandoo. The surface of the Carboniferous rocks on which the Colinlea Formation was deposited was uneven, as indicated by sharp relief along the unconformity near EM22/6; and faults, probably initiated before deposition of the Colinlea, and reactivated later, have increased the relief.

A probable fault, 1 mile west of Mount Wandoo, is indicated by a marked change in vegetation, from dense on the east to lighter on the west. This change in the density of vegetation is not obviously related to the lithology of the outcropping rocks, which, on either side of the probable fault, are cross-bedded pebbly quartz sandstone, but does, however, correspond with a change from horizontal to gently dipping sandstone. These are the only inclined beds known in the Colinlea Formation in the Emerald Sheet area. Northward, outcrops of the Colinlea have low relief, and most outcrops consist of loosely cemented rubbly sandstone detritus or billy quartzite.

No fossils were found in this formation in the Emerald Sheet area. From its field relations and its flora in the Springsure Sheet area, the Colinlea Formation is regarded as Permian.

## Undifferentiated Middle Bowen Beds

Undifferentiated Middle Bowen Beds occur in a north-north-west trending belt in the eastern portion of the Emerald Sheet area. The structure is poorly defined in the Emerald area except in the south-eastern corner, where the rocks have been folded into a well-defined anticline, part of the Springsure Anticline. For the position of all locality numbers mentioned in this section, refer to figure 24.

Minerva/Kammel area

In the Springsure area, the rocks in the anticline were mapped as Dilly Beds overlain by the Aldebaran Creek Group (Hill, 1957). The Aldebaran Creek Group was subdivided into five units in the Serecold and Consuelo Anticlines, south of the Springsure Anticline; these subdivisions were not carried through to the Springsure Anticline.

On the basis of detailed work in the Springsure area, Phillips (1959) subdivided the Permian rocks in the Springsure Anticline - from the Kammel/Fernlees area, 14 miles south of Emerald, to Aldebaran Creek, 24 miles south of Springsure - into nine formations. The type areas of all of these lie in the Aldebaran Creek/Staircase Range area, south-east of Springsure. Identification of these previously recognized units is difficult in the Emerald Sheet area because of monotonous lithology, poor outcrop, and the absence of fossils. On field work alone, the units could not be distinguished, and the rocks were mapped as undifferentiated Middle Bowen Beds.

In the Minerva/Kammel area, the Springsure Anticline is an asymmetrical anticline with a shallow (up to $15^{\circ}$) east limb and steep (up to $50^{\circ}$) west limb. The anticline plunges north-north-west, and disappears under Tertiary basalt at Kammel.

On the air photographs, the Permian rocks are distinguished by a dark, banded vegetation pattern. In the Emerald Sheet area, the anticline is surrounded by Tertiary basalt, which has a contrasting light uniform air photo pattern.

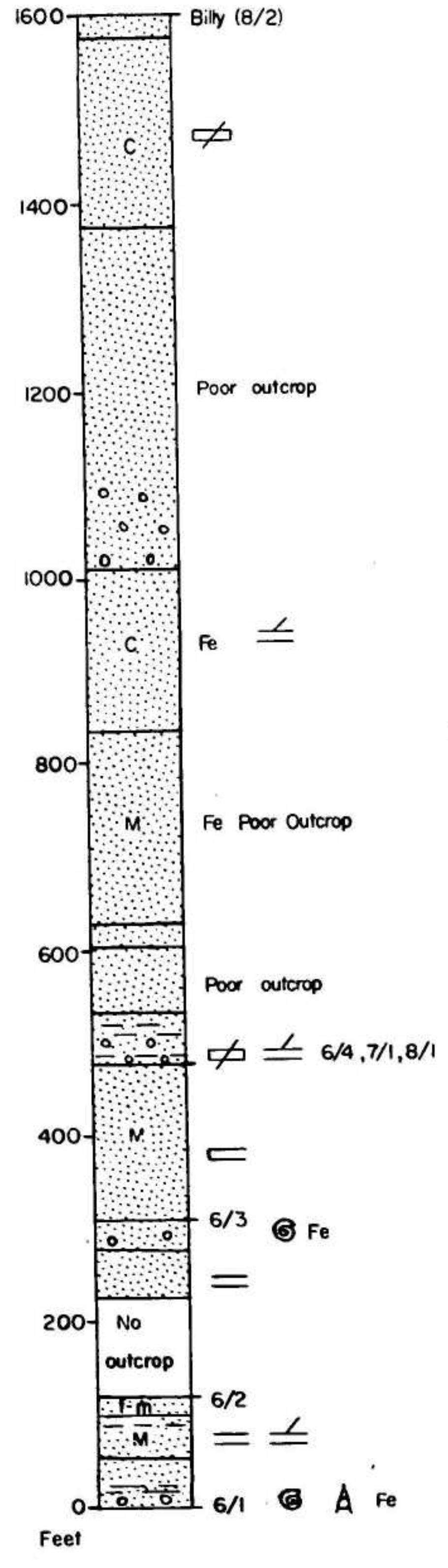
The rocks crop out in low north-north-west trending strike ridges. The bulk of the anticline consists of grey, white and multicoloured sandstone. Most sandstones are medium-grained and well cemented. Crossbedding is common, and milky quartz pebbles and pebble bands are scattered throughout the section. At least 1800 feet of these rocks are exposed in the Fernlees area. A probable strike fault near Fernlees separates south-westerly trending rocks from north-north-east trending strike ridges of the western limb of the anticline.

Nogoa River/Fork Lagoons area

The continuous outcrop of Permian sandstone is broken between Kammel and the Nogoa River by overlying basalt. Between the Nogoa River and a point four miles north of Fork Lagoons Homestead, rocks similar to those in the Minerva/Kammel area re-appear.

Fig.18

# PERMIAN SANDSTONE 10 MILES SOUTH-WEST OF EMERALD



1500 feet of medium to coarse white quartz sandstone and pebbly quartz sandstone are exposed in low strike ridges on the bank of the Nogoa River, 12 miles south-west of Emerald (localities EM 6, 7, 8) (Figure 18). Pelecypods and brachiopods (Dickins, Appendix 2) in pebbly sandstone, and arenaceous foraminifera (Dr I. Crespin, pers. comm.) in grey siltstone, were found at the exposed base, and pelecypods at 300 feet above the base. No other fossils were found in this section. The brachiopods are *Notospirifer*, the pelecypods *Pseudomyalina*, *Merismopteria*, *Aviculopecten*, and a form similar to *Megadesmus nobilissimus*, and the foraminifera *Ammodiscus multicinctus* and *Hyperammina* sp.. Dickins correlates these rocks with the Cattle Creek Formation or as slightly younger. The rest of the section is medium to coarse white quartz sandstone with scattered interbeds of pebbly sandstone. The top of the exposed section is capped with billy quartzite, which has a smudgy pattern on the air photographs.

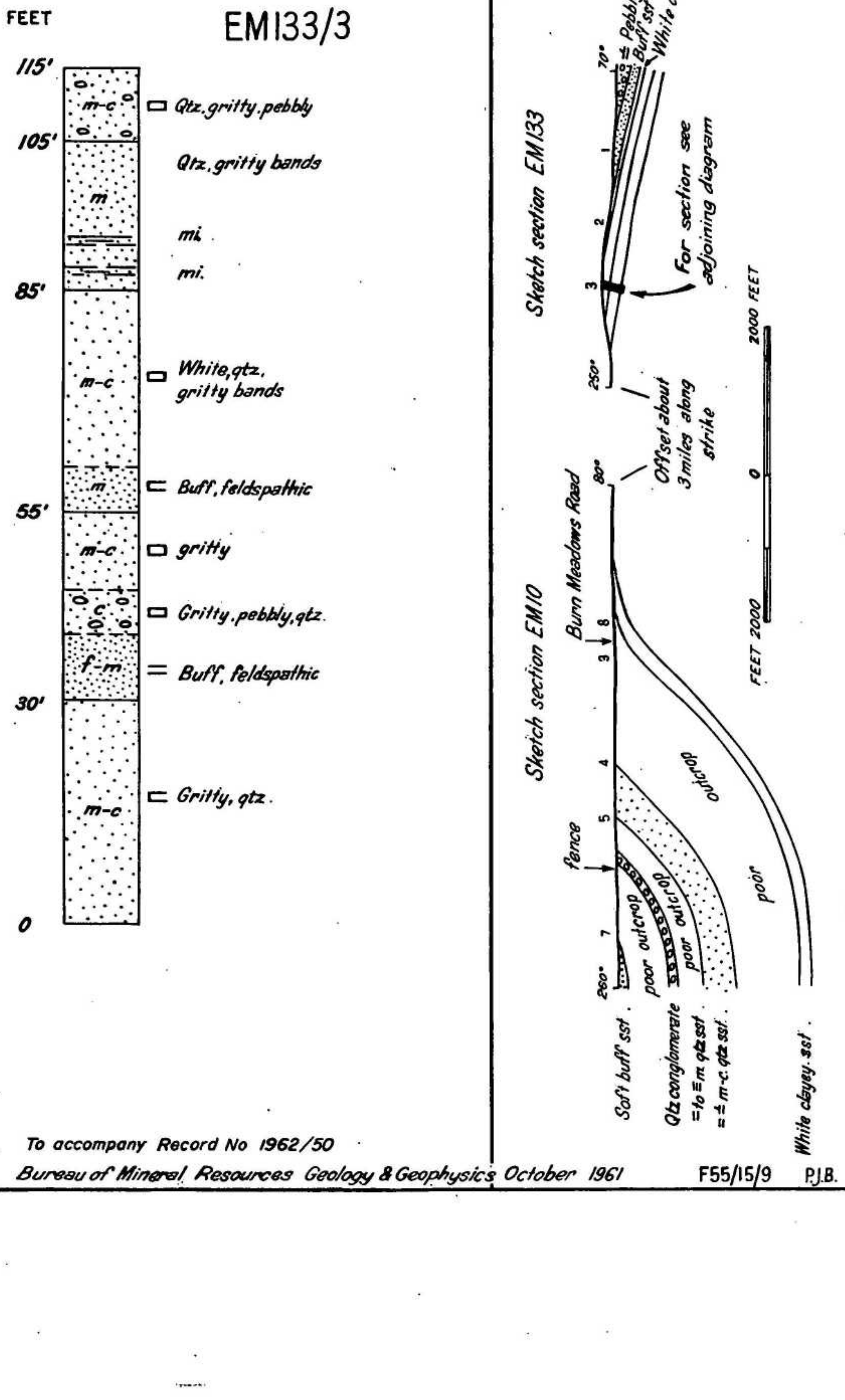
Along St Helens Creek (EM 4), sandstone similar to that shown in Figure 18 dips at low angles in various directions. In Nogoa Downs 87 Bore, 2 miles south-west of Selma, Morton (1922) reported 235 feet of strata, including 10 feet of coal from 115 to 125 feet, and 5 feet of coal from 233 to 238 feet. The rest of the section consists of pebbly white siliceous sandstone, fine grey feldspathic and micaceous sandstone, and shale. One mile from the bore, near Selma, Norton found *Glossopteris*, *Noeggerathiopsis*, and *Cladophlebis*.

At EM 10 (Figure 19), sandstone, estimated to be 2500 feet thick, is intermittently exposed in the western limb of an anticline. These rocks have a uniform smudgy airphoto pattern in which trends are barely visible. No fossils were found in these rocks, but 2 miles east of Fork Lagoons Homestead (EM14), a measured section of 550 feet of medium-bedded, medium to coarse cross-bedded quartz sandstone contains indeterminate pectenid pelecypods. These beds dip 10 degrees east-north-east, and appear in the air photographs as a band of lightly timbered country. Four miles north of Fork Lagoons Homestead (EM16), pebbly quartz sandstone and quartz greywacke dip steeply away from granite, which we assume to be part of the Retreat Granite. The sandstone and granite are covered with dense vegetation, and no distinctive pattern, of either the steeply dipping beds or of the granite, is visible in the air photographs.

FIG.19.

## Permian sst. 1 mile NE of Burn Meadows Homestead

## EM133/3

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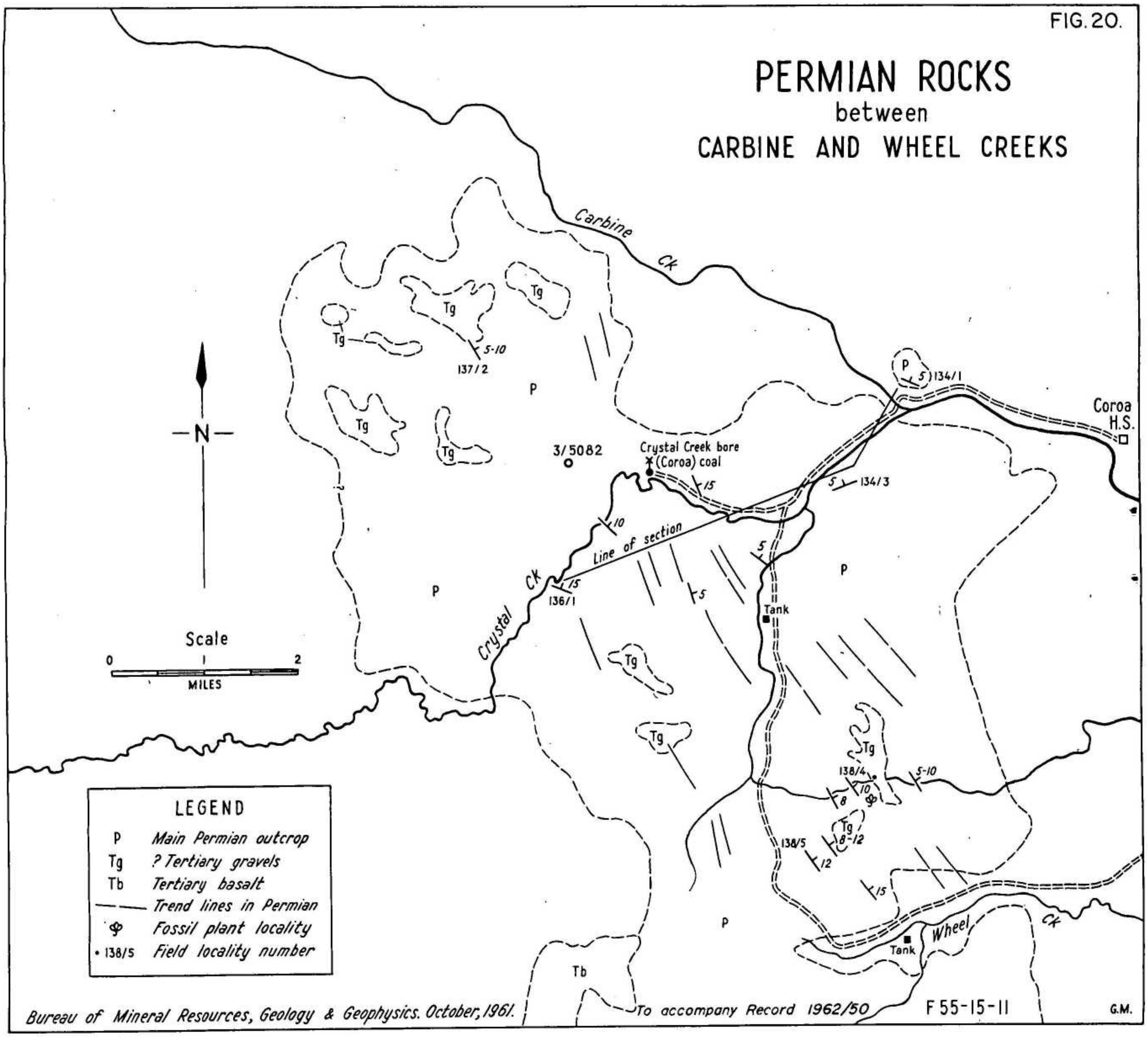

FIG. 20.
PERMIAN ROCKS
between
CARBINE AND WHEEL CREEKS
Carbine Ck
Tg
5-10
137/2
P
N
3/5082
Crystal Creek bore
(Coroa) coal
15
10
Line of section
Crystal Ck
136/1
5
134/1
Coroa
H.S.
134/3
Tank
Scale
0
1
2
MILES
138/4
5-10
8
138/5
8-12
12
Tb
Wheel Ck
LEGEND
P Main Permian outcrop
Tg ? Tertiary gravels
Tb Tertiary basalt
Trend lines in Permian
Fossil plant locality
138/5 Field locality number
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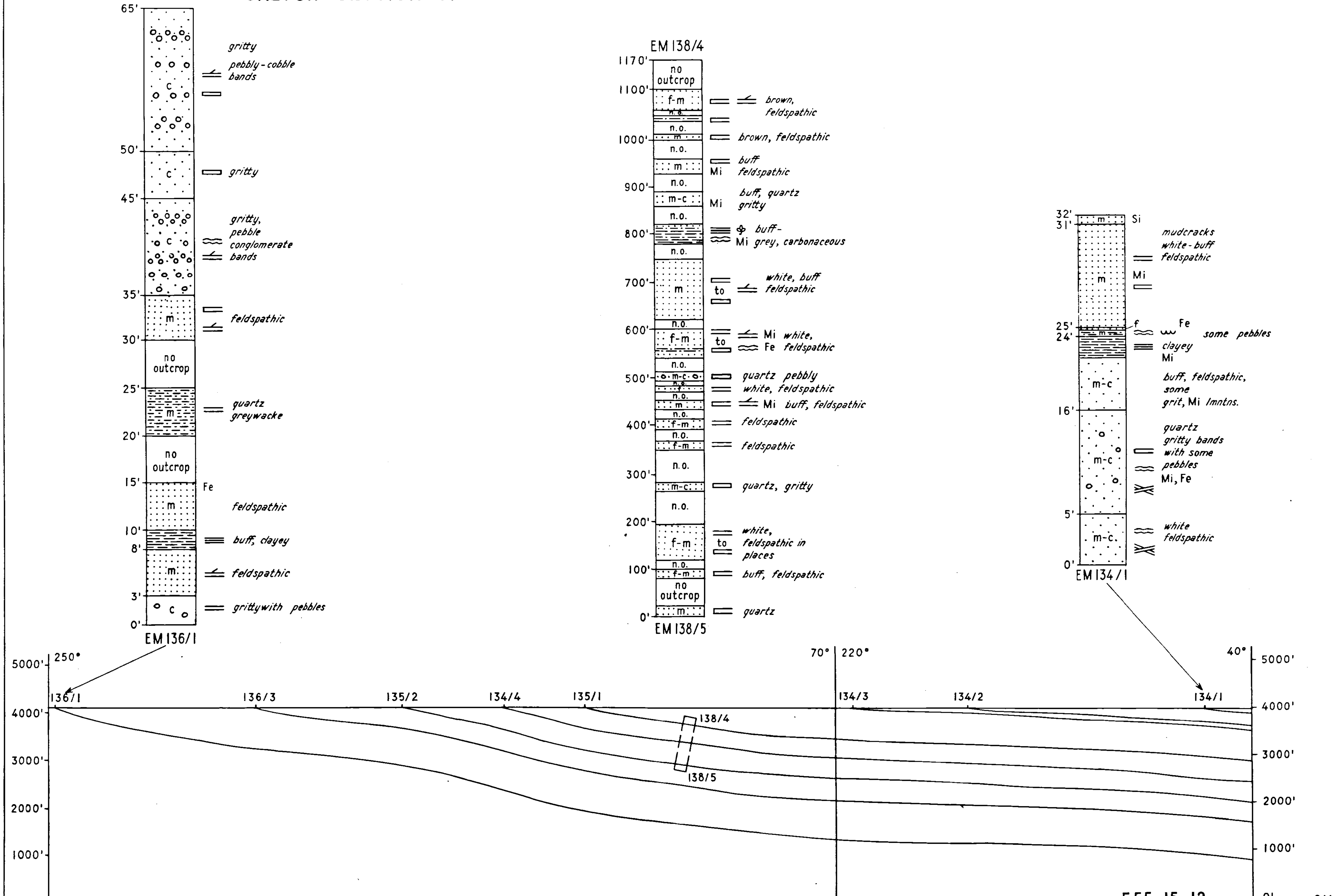
FIG. 21.

# SKETCH SECTION OF PERMIAN ROCKS IN THE AREA BETWEEN CARBINE AND WHEEL CREEKS

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F55-15-12

G.M.

60 feet of coal is reported by Mr. A. Mundt in a dry bore (14,000-acres Bore) on Fork Lagoons Holding. The coal occurs between depths of 80 and 140 feet, is overlain by white clay, and underlain by shale. 400 yards away, a second dry bore passed through 130 feet of white clay and 300 feet of 'sand rock and white kaolin' without striking coal.

Carbine/Wheel Creeks area

Between Carbine and Wheel Creeks, Permian rocks crop out in a discontinuous, north-west trending belt about five miles wide (figures 20 and 21). Poor outcrops were found in areas of low, densely timbered ridges separated by wide sandy valleys with no outcrop. A composite section (figures 20 and 21) indicates a thickness of over 3000 feet in the area. The rocks dip regionally to the north-east at $5^{\circ}$ to $15^{\circ}$; faint north-west trending strike lines can be seen on the air photographs.

The lower part of this sequence consists of interbedded quartz and feldspathic sandstone, pebbly and gritty in places, and shale and siltstone. The pebbly sandstone is cross-bedded, and the rounded pebbles consist mainly of milky quartz, with fewer pebbles of indurated fine quartz sandstone, sandy schist, and volcanic rocks. The middle part of the sequence consists of interbedded sandstone, commonly cross-bedded, and micaceous and carbonaceous siltstone and shale with rare plant remains. Two thin (3 and 23 feet) coal seams occur just below a depth of 100 feet in Caroa's Crystal Creek Bore. Pebbly quartz sandstone occurs in the area at EM 134/3 (figure 21). These belong to the upper part of the sequence and are overlain by interbedded feldspathic and micaceous sandstone and minor siltstone, well exposed at EM 134/1. These beds are unevenly bedded and laminated, and contain numerous worm tubes and casts.

Area west of Capella

West of Capella a superficial cover of Cainozoic gravels has largely obscured deeply weathered Permian rocks. Outcrops are isolated, and a reliable section cannot be compiled. Also the direction of dip throughout the area is variable, and the structure is not determinable. Because outcrops were so hard to find in the area, they are described below in some detail. Areas of shale have weathered to a clayey soil which supports a dense brigalow scrub which shows up as a characteristic dark pattern on the air photographs. Flat-lying Permian sandstone and Cainozoic gravel form gently rounded hills that have similar light airphoto patterns.

On Nutholm Holding, most observed outcrops are shale with a few thin interbeds of sandstone and calcareous siltstone. Eighty feet of shale with a thin fine-grained sandstone interbed crop out in a creek at EM347/1. The shales are light grey to light brown, micaceous, and contain some sand. They are rich in plant fossils including Glossopteris and Gangamopteris (White, 1962). In a gully north of EM347/1, pink feldspathic sandstone and calcareous siltstone, in places containing ferruginous concretions, are interbedded with weathered plant-bearing shales which dip $10^{\circ}$ to $15^{\circ}$ in various directions. Southward at EM347/5, flat-lying sandy micaceous shale with Glossopteris forms a pavement in Carbine Creek. At EM347/4, a deeply weathered biotite granite appears to intrude this shale. The shale at the probable contact has weathered to clay and it is impossible to determine if the rock was hornfelsed. However, the granite contains xenoliths of hornfelsed pelite, which was possibly derived from the Anakie Metamorphics.

Fewer outcrops are seen east of these localities. At EM339/1, light-brown and grey carbonaceous shale fragments were found in clay unearthed during the construction of an earth tank. To the east of EM339/1, three thin beds of medium-grained quartz greywacke with calcarous siltstone were found; the rest of the area is presumably underlain by weathered shale. Further east the sediments are concealed by gravel in places at least 40 feet thick. Bore information from Forest Home and Valeria Holdings shows that sandy shale and dark shale are the dominant rocks to a depth of 200 feet. Coal is recorded from one of these bores.

South of this area, on Pine Creek Holding, the rocks are mainly sandstone. The relation between the sandstone and the shale is not known; they are possibly in part lateral equivalents. Fifty feet of flat-lying Permain sediments are exposed a few hundred yards east of Pine Creek Homestead. These are mainly sandstone, pebbly sandstone and grit, with two thin beds of micaceous siltstone interbedded with friable porous chalky material. The sandstone is quartzose and in part clayey. The chalky material contains fragments of probable productid spines. Porous pebbly scour-and-fill sandstone and grit were found to the west.

One mile north of Pine Creek Homestead, a white fine-grained sandstone contains a few tests of the Permian foraminiferal species Glomospirella nyei Crespin (Crespin, pers. comm.). This species is common at a locality at the Scottsville end of the Collinsville-Scottsville railway line, 20 feet above basal conglomerate of the "Middle Bowen Marine Series".

Between Pine Creek Homestead and the eastern margin of the Anakie Inlier, the surface is covered by gravel and sand, except for small outcrops of pebbly fine quartz sandstone, with clear and glassy grains, and pebbles of milky quartz.

At EM367/3, Theresa Creek has cut through the Cainozoic gravels and exposed an outcrop of Permian rocks, which are flexured to indicate a fault. The oldest exposed rocks are medium-grained brown sandstone, in part ferruginous, with a thin interbed of white siltstone with poorly preserved Permian plant fossils; above this, thin shales are interbedded with the sandstone, and towards the top of the exposed section pebbly sandstone contains a 2-foot conglomerate bed with pebbles of volcanic rocks - rhyolite, trachyte and andesite. Farther south a similar thin conglomerate bed with volcanic pebbles is interbedded with flat-lying massive to thin-bedded sandstone. There is no obvious source for these volcanic pebbles in the vicinity. Devonian-Carboniferous volcanics in the Clermont Sheet area or a now eroded southern extension of these could be the source.

West of Crescendo Homestead, 30 feet of flat-lying Permian sediments are exposed in a creek. These are mainly sandstones, locally pebbly, grading into coarse sandstone, and thin beds of white micaceous thin-bedded sandstone and shale, and thin beds of ferruginous shale. To the west, an isolated outcrop of tough arkosic sandstone crops out. Pebble bands in this sandstone are cross-bedded.

On the northern boundary of the Sheet area, near Westlake Homestead, Permian sediments overlie the Anakie Metamorphics, and the contact is exposed. These rocks dip to the north, and to the south and east they disappear under Cainozoic gravels. At EM308/1 the sediments are flat-lying, but west towards the metamorphics easterly dips of $10^{\circ}$ to $15^{\circ}$ are common, and some westerly dips were also observed.

At EM308/8 and EM307/4, almost vertical dips probably indicate that a fault separates the Anakie Metamorphics and the Permian sediments. The sediments are mainly dirty sandstone, pebbly sandstone and conglomerate which have angular to sub-rounded fragments of milky quartz, schist and volcanic material, with soft interbeds of fine micaceous sandstone and light grey shale. The shales contain poorly preserved Gangamopteris and other indeterminate plants. Cone-in-cone limestone and ferruginous concretions form rubble in nearby creeks.

Capella area

The Middle Bowen Beds exposed in the southern part of the Clermont Sheet area (Veevers et al., 1961) are probably marine throughout. The oldest exposed Permian rocks in this area are those in the core of the Norwich Park Dome, 100 feet below the clarkei-bed, which is a sandy coquinite, up to 50 feet thick, of brachiopods and pelecypods. Outcrops of the clarkei-bed and contiguous strata extend southward only a short distance into the Emerald Sheet area, and farther south they are covered by Tertiary basalt and interbedded lake deposits. The only fossils referable to the clarkei-bed were found 5 miles north-east of Capella (figure 22) at a locality (EM209) first found by Gibb Maitland (unpublished map) in 1895. Locality EM209 is merely an isolated gully exposure of pebbly billy sandstone, 10 feet square, containing brachiopods and pelecypods, which, according to J.M. Dickins, indicate the clarkei-bed.

Half-a-mile south-west of EM209, at locality EM200/1, 10 feet of multi-coloured thin-bedded to laminated medium sandstone with some indeterminate worm tracks are overlain by billy sandstone. Maitland's (1895, p.4) Productus fossil locality, $1\frac{1}{2}$ miles south-south-west of Capella, was not found, but loose pieces of productid brachiopods were found nearby in a poorly exposed creek section (EM2/1-6), estimated to be 600 feet thick; the dip ranges from 3 to 8 degrees southeastward, and the upper beds (EM2/1) contain erratics of quartz schist up to 1 foot across, like those in the clarkei-bed in the Clermont Sheet area. Half-a-mile eastward, a well in Portion 17v, Parish of Capella (Maitland, 1895, p.4) contains coal 7'6" thick, at a depth of about 60 feet;

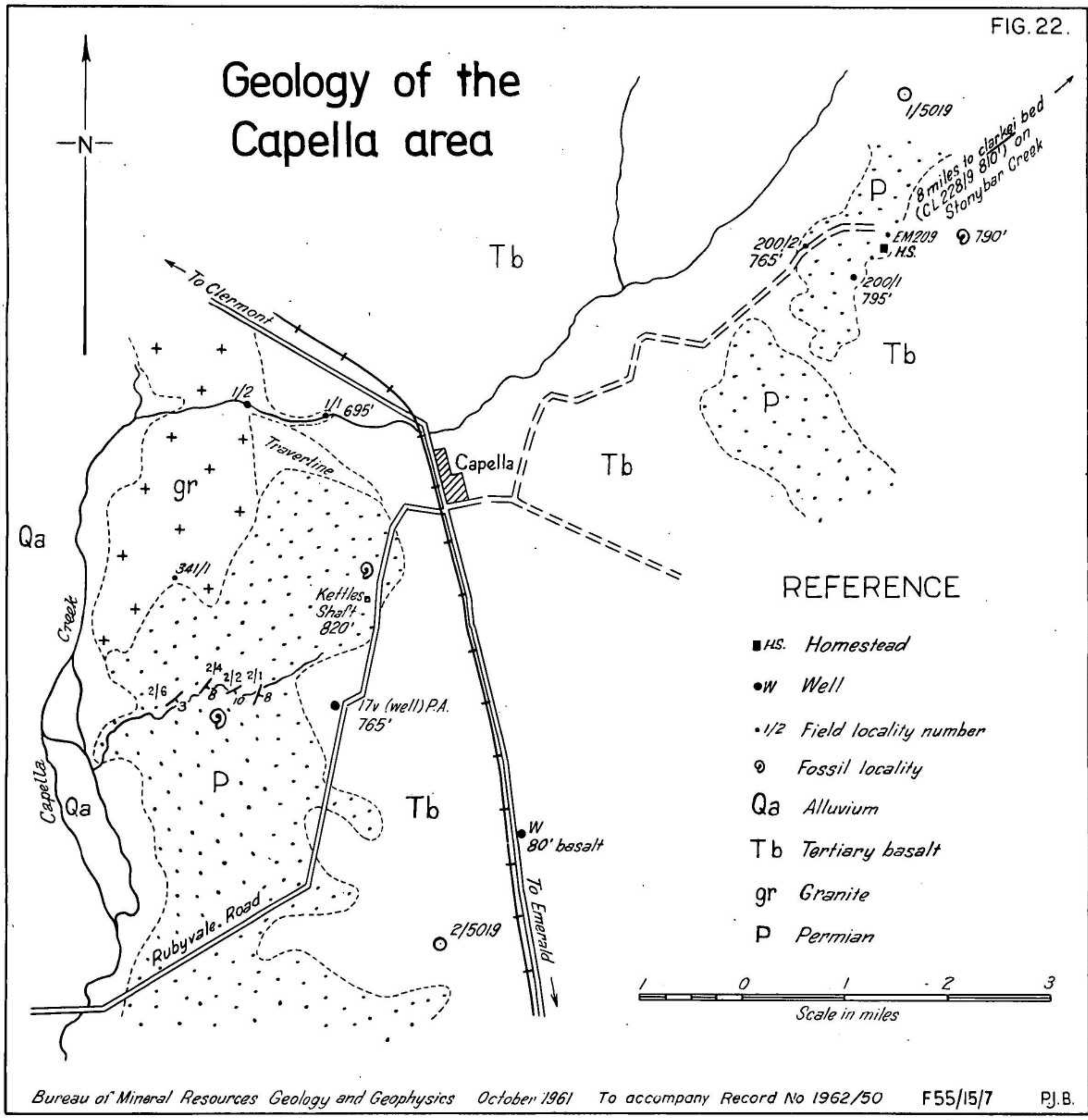


FIG. 22.
Geology of the Capella area
N
To Clermont
Tb
1/5019
8 miles to clarkei bed (CL 228/9 810') on Stonybar Creek
P
200/2 765'
EM209
H.S.
790'
200/1 795'
1/2
1/1 695'
Travertine
Capella
gr
Qa
341/1
Kettles Shaft 820'
Creek
2/6
2/4
2/2
2/1
17v (well) P.A. 765'
Capella
W 80' basalt
Rubyvale Road
To Emerald
2/5019
REFERENCE
H.S. Homestead
W Well
1/2 Field locality number
Fossil locality
Qa Alluvium
Tb Tertiary basalt
gr Granite
P Permian
Scale in miles
Bureau of Mineral Resources Geology and Geophysics October 1961 To accompany Record No 1962/50 F55/15/7 P.J.B.

its analysis is :

| | | % |
|---|---|---|
| | Moisture | 0.82 |
| | Volatile hydrocarbons | 57.52 |
| | Fixed carbon | 32.38 |
| | Ash | 9.28 |

If the southeastward dip is maintained across to the well, the coal lies about 1000 feet above the base (EM2/6) of the measured section, and probably belongs to the Upper Bowen Coal Measures. The granite (EM1/1) immediately west of this section is tentatively identified as Retreat Granite because there is no evidence to show that it has intruded the Permian sandstone, and because Anakie Metamorphics are exposed nearby. W.B. Dallwitz has examined this rock, which is a normal granite aplite similar to a granite aplite from EM16/1 4 miles north of Fork Lagoons Homestead.

Upper Bowen Coal Measures

The history of the name of the unit has been dealt with by Veevers et al. (1961).

The Upper Bowen Coal Measures crop out in the eastern part of the Emerald Sheet area, east of the north-north-west trending outcrop belt of the undifferentiated Middle Bowen Beds (figure 24), and underlie gently undulating country which has a considerable soil cover.

Outcrops are poor, and are confined to creek beds. They consist mainly of thin-bedded, often cross-bedded and ripple-marked sandstone, siltstone and calcareous siltstone. Numerous bores have been sunk in the north-eastern portion of the area, and the driller's logs indicate that sandstone and shale are the dominant lithologies. Coal seams were encountered in many of the bores (see under Economic Geology, "Coal"). Petrified wood is abundant and some poorly preserved plant fossils were found near Ensham Homestead outside the eastern boundary of the Sheet area. Mesas of deeply weathered, probable Tertiary rocks occur in this area over the Coal Measures. On the air photographs, the Coal Measures can readily be distinguished from the overlying basalt by their dark pattern due to dense vegetation; the basalt country is nearly treeless, is covered by thick grass, and has a light photo-pattern. Numerous small structures can be detected on the aerial photographs, but are not discernible on the ground.

The Upper Bowen Coal Measures conformably overlie the Middle Bowen Beds (Veevers et al., 1961) and are unconformably overlain by Tertiary basalt and Cainozoic soil and gravel.

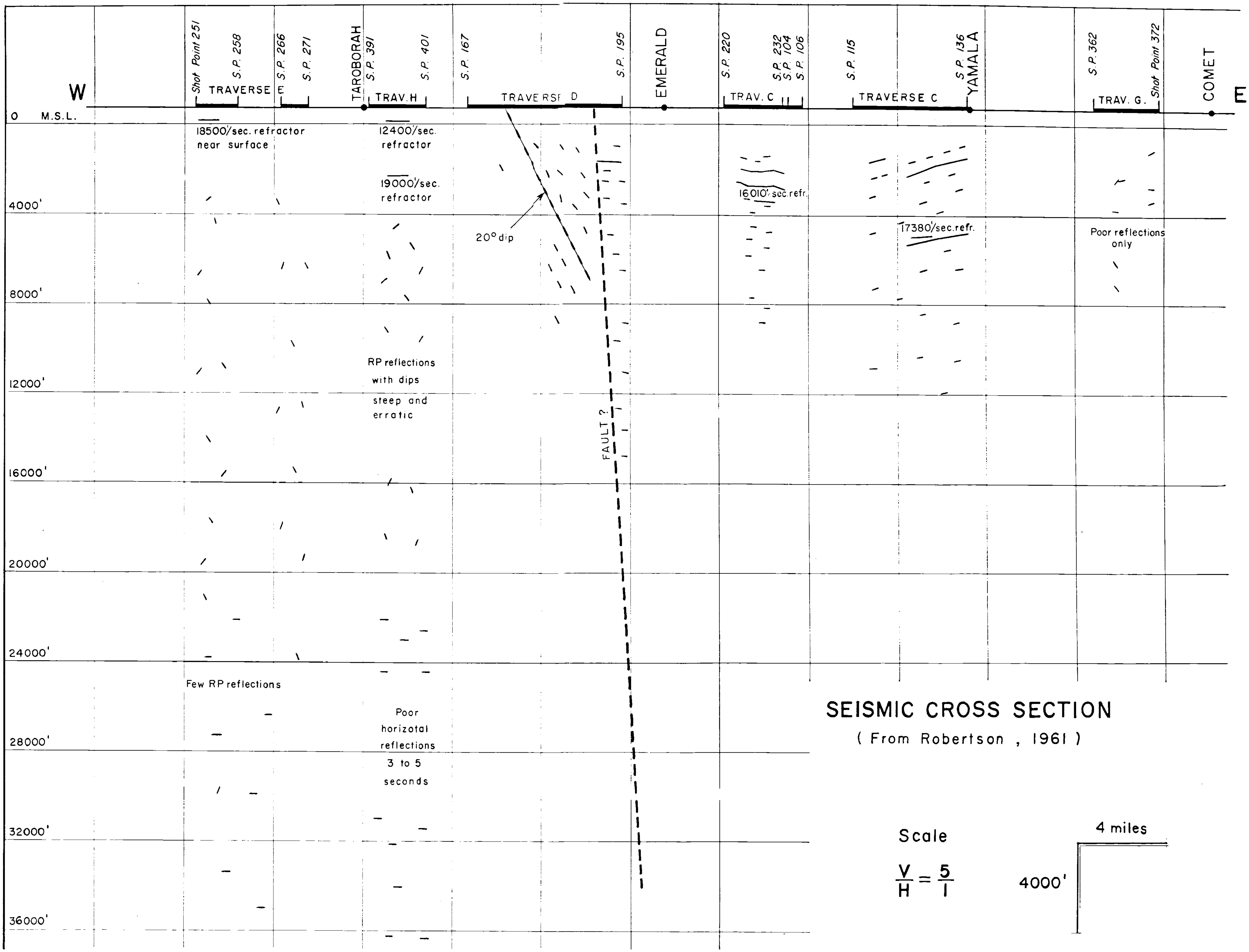
Due to poor outcrop, the thickness of the Upper Bowen Coal Measures in the Emerald Sheet area cannot be directly measured. From the seismic section (figure 23), it may be inferred that the Measures are at least several thousand feet thick.

Structure, and identification of formations

The structure of the Permian rocks of the Emerald Sheet area is dominated by the north-north-west continuation of the Springsure Anticline. The Springsure Anticline is traceable along continuous outcrop to Kammel, and thence for 8 miles is obscured by basalt and alluvium. The next clear expression of the anticline is 4 miles north-north-west of Selma (figure 19, EM10 and EM13); farther north in the Fork Lagoons area, Permian sandstone dips to the south-west at $40^\circ$ to $60^\circ$ (EM16) off a presumed core of pre-Devonian granite and at EM14 the sandstone dips 10 degrees northeastward. The axis of the anticline north of EM16 has been drawn with reference to a prevailing north-east dip in the Caroa area, and to the occurrence of stratigraphically high fossils at EM346/3.

The axis is drawn northward from the Caroa area through the middle of the inlier of pre-Devonian rocks 6 miles west of Capella. This postulated northeastern swing in the axis is confirmed by the swing in strike of the rocks near Caroa from north-north-west to north-north-east at Capella. The strike at Capella (figure 22) is shown by measured strikes at EM2, and by the strike of the clarkei-bed. On Stonybar Creek, in the Clermont Sheet area (Veevers et al., 1961), the clarkei-bed, at an elevation of 810 feet above sea-level, strikes east-south-east; at EM209, 8 miles southwestward, the clarkei-bed has approximately the same elevation (790 feet), so that the regional strike is north-east. If EM2/1 is the clarkei-bed or its equivalent - as is suggested by the erratics of quartz schist, by the occurrence of loose productids downstream from EM2/1, and by the occurrence of productids in Kettles Shaft - then the north-east strike is continued at least as far south as EM2. This change in strike probably parallels the margin of a 'promontory' of pre-Devonian rocks that lies between Capella and Clermont; a possible indication of this 'promontory' is the Bouguer gravity positive anomaly in this area (Starkey, 1959) (figure 24).

The structure south of Selma is not clear. A steep east to north-east dip was found at EM6,7,8 and a low east dip near the headwaters of St Helens Creek. Downstream,




## SEISMIC CROSS SECTION

( From Robertson , 1961 )

*Bureau of Mineral Resources, Geology and Geophysics. October 1961.*

*To accompany Record No 1962/50*

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sandstone dips 5 degrees in different directions. The only recorded dips in this area that may indicate the anticlinal axis are those at EM234/4. We interpret the east and north-east dipping sandstone at EM6,7,8 as the limb of a monocline whose axis passes through St Helens Homestead.

Seismic geophysical work has been carried out along the Central Railway east of Glendarriwell (Robertson, 1961) (figure 23). Near Glendarriwell, an 18,500 feet/sec. refractor, interpreted as pre-Devonian rocks, lies near the surface, and a mile east of Taroborah, a 19,000 feet/sec. refractor, also interpreted as pre-Devonian rocks, lies at a depth of 3,000 feet, and a 12,400 feet/sec. refractor (Permian rocks) at 600 feet. Three to five miles west of Emerald, reflections between 1600 and 8000 feet dip eastward at 20°, and at a discontinuity, probably a fault, 3 miles west of Emerald, reflections are horizontal. The absence of recorded seismic and surface westward dips along the railway probably indicates that the structure here is a monocline. Near Emerald, reflections were received from a depth of 8000 feet.

The eastern edge of shallow Anakie Inlier (figure 24) is indicated by :

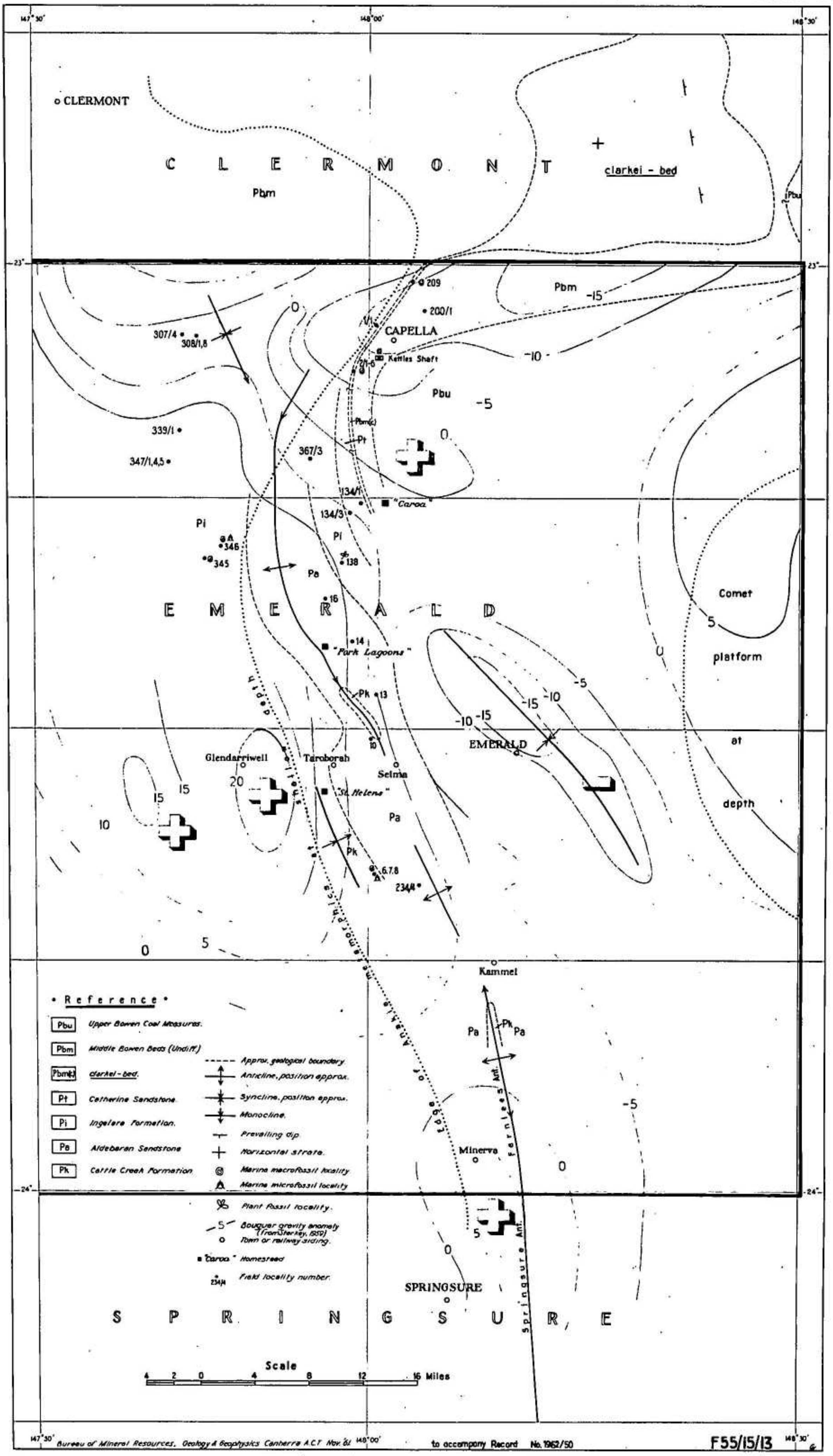
1. an outcrop of presumed Retreat Granite west of Capella, and the positive Bouguer anomaly (Starkey, 1959) in this area;
2. the change from shallow to deeper basement near Taroborah (Robertson, 1961), which lies 8 miles west of the postulated position of the axis of the Springsure Anticline;
3. the positive Bouguer anomaly in the Kammel-Minerva area.

From Carbine Creek south to Minerva, the postulated eastern edge of shallow Anakie Inlier corresponds to the western flank of the Springsure Anticline; north of Carbine Creek, the edge of the Inlier swings north-north-east; shallow Permian rocks fill a shallow embayment in the Inlier 12 miles west of Capella. North of Capella, the edge probably swings back westward around a negative Bouguer anomaly south-east of Clermont.

The Springsure Anticline probably plunges south in the Emerald Sheet area. The Permian rocks thus thicken when traced south from the area west of Capella.

Fig 24

# STRUCTURE AND IDENTIFICATION OF FORMATIONS IN THE PERMIAN



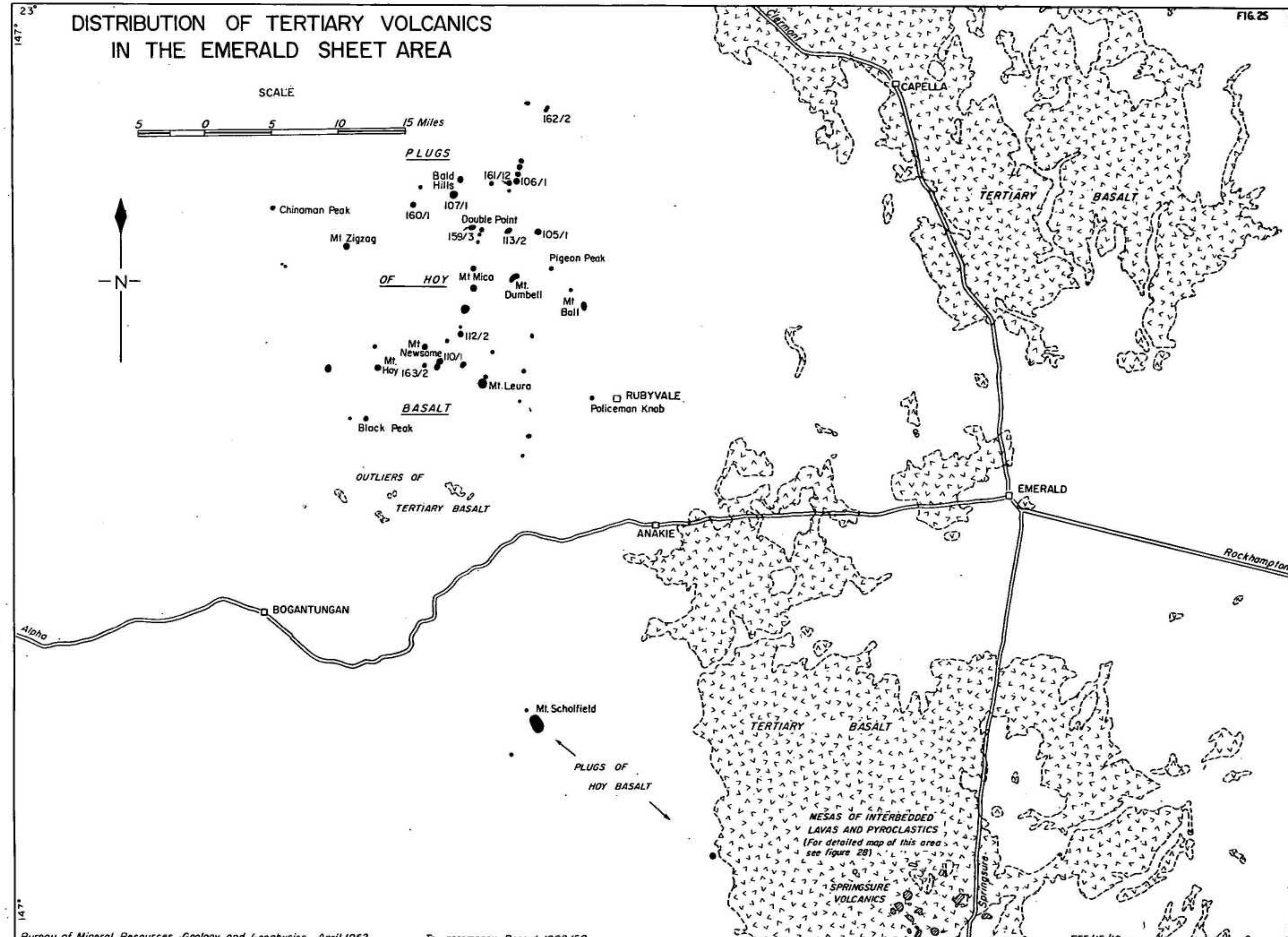

Bureau of Mineral Resources, Geology & Geophysics Canberra A.C.T. Nov. 61 — to accompany Record No. 1962/50 — F55/15/13

Due to poor outcrop, the identification of most Permian formations in the Emerald Sheet area is tentative, and in some cases, speculative. For this reason, we map these rocks as undifferentiated Middle Bowen Beds. The only unit that can be identified with certainty is the clarkei-bed in the Capella area, 8 miles from the nearest outcropping clarkei-bed in the Clermont Sheet area.

According to Dickins (Appendix 2), the macro-fossils at EM6,7,8 probably indicate correlation with the Cattle Creek Formation or slightly younger. These are the oldest recorded Permian fossils in the Sheet area, and, lying at the exposed base of the section, indicate that this western edge of the outcrop is structurally high. The rock above the fossil beds is white pebbly sandstone which we identify as Aldebaran Sandstone. An inlier of finer-grained sandstone in the core of the anticline north-east of Taroborah is identified as Cattle Creek Formation. The pebbly sandstone (Aldebaran Sandstone) is traced northward to EM10. At EM138 and at EM345, EM346, it is overlain by finer-grained rocks, identified as Ingelara Formation. Dr I. Crespin found fragments of ?productid spines in a sample from EM345/7, and, from EM346/3, the foraminifera Glomospirella nyei Crespin, common at Collinsville near the base of the "Middle Bowen Marine Series". The (?)Ingelara Formation at EM138 is overlain by coarse sandstone which we identify as Catherine Sandstone. By interpolating the strike between EM134 and EM2, we conclude that the clarkei-bed rests on Catherine Sandstone, and thus lies in the same stratigraphical position as the Mantuan Productus Bed, with which Dickins (in Veevers et al., 1961) correlates it. The rest of the Middle Bowen Beds and the Upper Bowen Coal Measures are consequently identified as the Bandanna Formation.

FIG. 25

# DISTRIBUTION OF TERTIARY VOLCANICS IN THE EMERALD SHEET AREA




Bureau of Mineral Resources, Geology and Geophysics. April 1962. To accompany Record 1962/50

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Figure 26: View of Springsure Volcanics and mesas of interbedded lavas and pyroclastics in the Minerva Hills area at the boundary of the Springsure and Emerald Sheet areas.

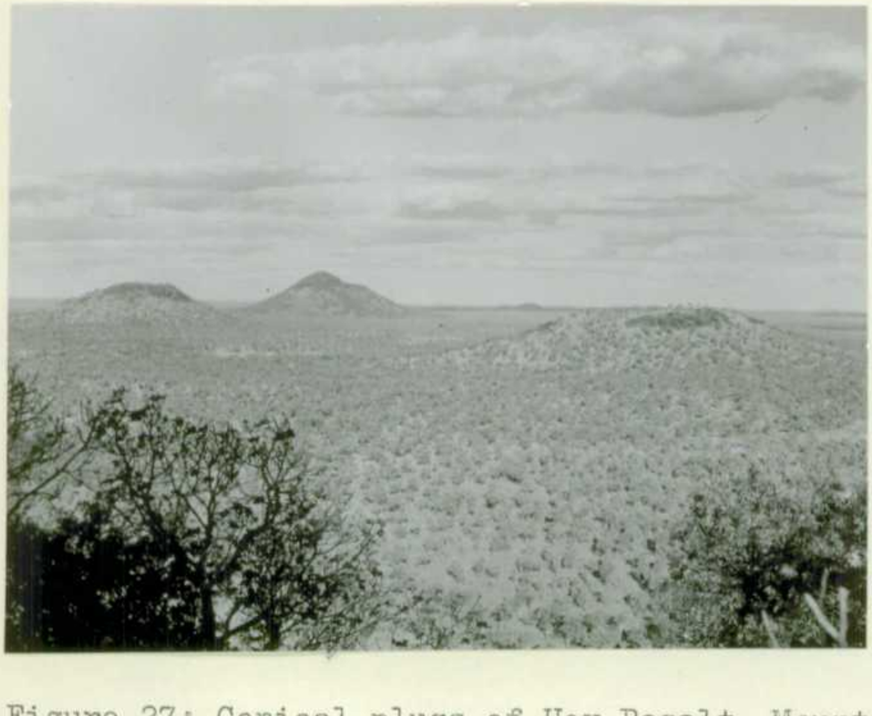


Figure 27: Conical plugs of Hoy Basalt, Mount Leura in the middle, from the summit of Mount Newsome.

# TERTIARY

## Introduction

Igneous rocks of probable Tertiary age occur extensively in the Emerald Sheet area (fig. 25). Three distinct petrographic units are recognised: undifferentiated lavas, Springsure Volcanics (new name), and Hoy Basalt (new name).

The undifferentiated lavas consist of basaltic and trachytic lavas and subordinate pyroclastics, which cover large areas in the eastern half of the Sheet area; the pyroclastics are confined to the south-eastern part of this region. The Springsure Volcanics comprise shallow and hypabyssal intrusions of peralkaline trachyte and rhyolite, genetically related to the undifferentiated lavas and pyroclastics. These intrusions are also confined to the south-eastern region of the Sheet area (figs. 25 and 28). The Hoy Basalt occurs as volcanic plugs of porphyritic olivine basalt containing, typically, xenoliths of medium to coarse grained basic and ultrabasic rocks and xenocrysts including corundum and poor-quality sapphire. Most of the plugs occur in the north-west region of the Sheet area, immediately east of the Drummond basin margin where they form prominent conical hills (fig. 27).

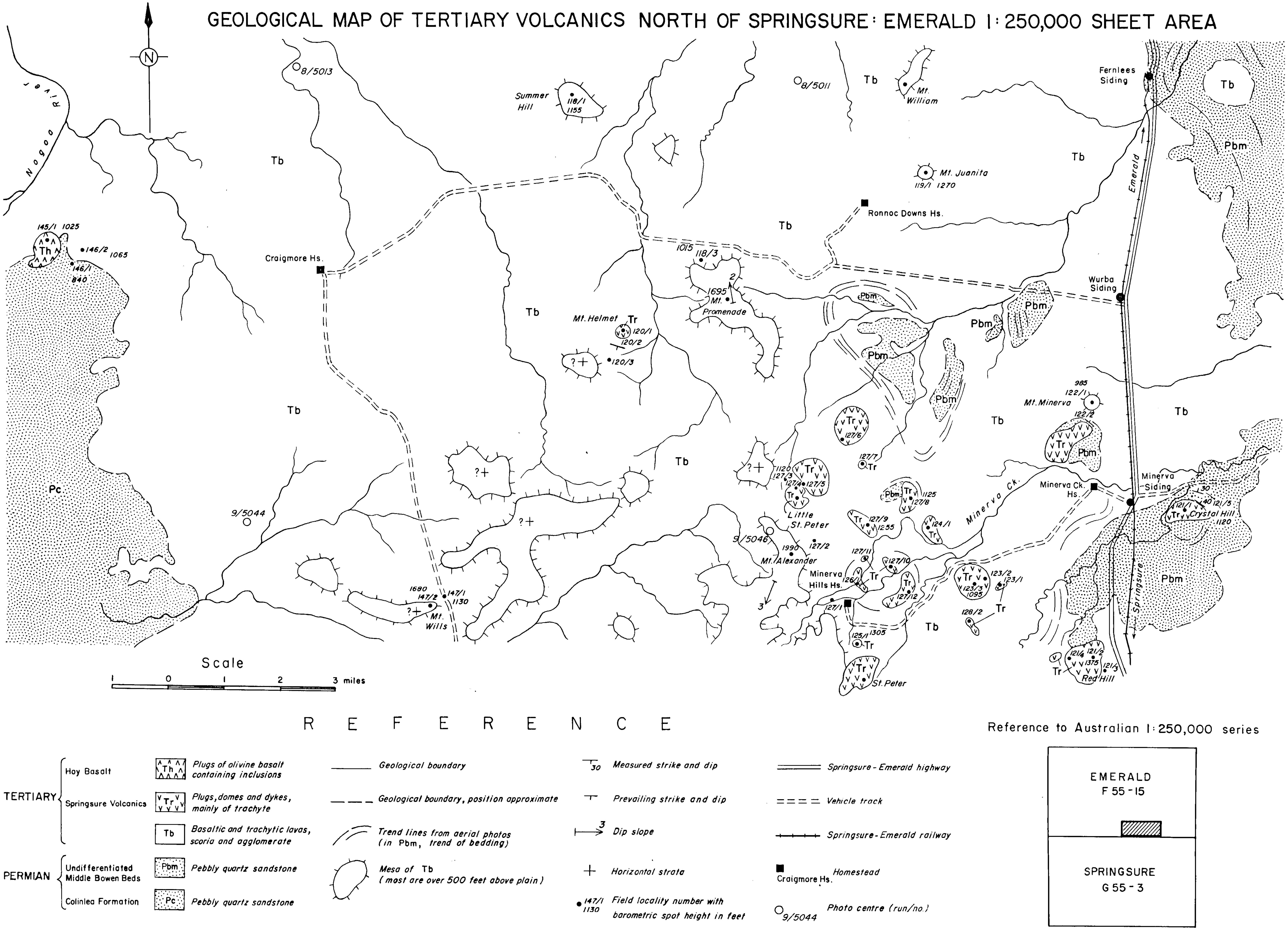
The undifferentiated lavas contain interbedded lacustrine deposits in places and were noted by Reid & Morton (1928). Richards (1918) deals with occurrences of the Springsure Volcanics at Springsure immediately south of the Emerald Sheet area. Dunstan (1902) made a brief investigation of the Hoy Basalt in connection with the origin of the sapphires in the Anakie-Rubyvale-Tomahawk Creek areas.

## Undifferentiated Lavas and Pyroclastics

A sheet of basic lavas and subordinate interbedded pyroclastics covers most of the eastern half of the Emerald Sheet area (fig. 25). The sheet is probably no more than a few hundred feet thick, except in the area shown in figure 28 where mesas of nearly level bedded volcanics rise to over 800 feet above the surrounding plain. Large areas of the lava sheet are covered by a veneer of heavy-textured dark soil which characteristically forms gently rolling grassy downs country with occasional clumps of trees, especially along watercourses. Outcrop is good on the steep slopes of the

Fig 28

# GEOLOGICAL MAP OF TERTIARY VOLCANICS NORTH OF SPRINGSURE: EMERALD 1:250,000 SHEET AREA




Bureau of Mineral Resources, Geology and Geophysics. December 1961. To accompany Record No 1962/50. F55/15/15 EJ mesas in the Minerva Hills area (fig. 28) whereas, over the main basalt sheet it is limited to rubbly patches along creek banks or slopes along the edges of the sheet.

Distribution and Thickness

The sheet of lava is part of a much larger sheet that extends from the Mt. Coolon area to south of the Springsure area and which extends over much of the Clermont area (Veevers et al., 1961). The eastern boundary of the Emerald area more or less coincides with the eastern boundary of the lava sheet. The lavas have been denuded in places exposing the underlying Permian rocks, especially in the north-east region of the Sheet area. Outliers of the lavas occur as far west as the eastern edge of the Drummond Basin but the main outcrop is roughly terminated to the west by a line from Retro Siding, through Capella, Anakie and then south to where the Nogoa River enters the Sheet area (fig. 25).

The lavas were extruded on an uneven surface of rocks of pre-Devonian to Permian age. From water bore logs (Hydrology Table in Economic section) the lavas are known to be less than 200 feet thick especially in the area north of the Rockhampton-Longreach highway where the lava sheet is generally more dissected than to the south of the highway. The edge of the lava sheet a few miles west of Craigmore Homestead forms a scarp, 200 feet high with Permian rocks of the Colinlea Formation at the base (fig. 28, EM146/1,2). Mesas up to 800 feet high comprised of nearly horizontal interbedded flows and pyroclastics, occur in the Minerva Hills area (fig. 28) where the extrusives are over 1,000 feet thick. This area was one of intense volcanic activity and the extrusives are closely associated with the acidic intrusions of the Springsure Volcanics. Erosion has dissected the thick sheet of extrusives and exposed many of the intrusions.

In the north-east of the Sheet area and also in the Fork Lagoons Homestead, Taroborah, and Iona Homestead areas sinuous outcrops of basalt probably represent pre-existing valleys filled with lava (cf. Veevers et al., 1961, p. 53).

Rock Types

Insufficient petrography has been done to make a detailed analysis of the rock-types and their relative amounts in both the main lava sheet and the lavas and interbedded pyroclastics in the Minerva Hills area.

## Lavas

Porphyritic olivine basalt is the dominant rock-type of the main sheet and is characteristically a hard dark bluish rock, massive or platy-jointed. When weathered or hydrothermally altered the rock is a lighter colour, commonly a greyish-brown, and the olivine phenocrysts are replaced by brown iddingsite or serpophite and antigorite. Vesicular rock occurs in places, probably representing the upper part of flows. Outcrops in the localities visited in the main sheet were too poor to note any relations between individual flows.

The lavas in the Minerva Hills area, with interbedded pyroclastics, are better exposed. The mesas in this area, immediately inside the Emerald Sheet boundary, are outliers of a volcanic plateau which extends to Springsure. Richards (1918) worked briefly in the vicinity of Springsure on the same volcanics at the southern end of the plateau. He distinguished a basaltic-trachytic-basaltic sequence in that area. In the Emerald area the sequence is more complicated with a repetition of basalt and trachyte. The basal olivine basalt sheet is present everywhere and it is the repeated sequence of trachytic and basaltic lavas and interbedded pyroclastics that form the mesas on the main sheet.

Most of the flows interbedded with the pyroclastics are greyish-purple or reddish trachybasalts and trachyandesites, commonly extremely vesicular with amygdales of secondary minerals. Fayalite-bearing trachyte is also present, the probable porphyritic fayalite commonly occurring as pseudomorphic iddingsite. Analcite basalt and mugearite also occur.

## Pyroclastics

The pyroclastics in the Minerva Hills mesas (fig. 28) are closely associated with the many eruptive centres in this area and contemporaneous alkaline intrusions of the Springsure Volcanics. The pyroclastic deposits consist of ash, pumice, scoria and agglomerate. They fall into two groups, one consisting of primary, fairly basic ejecta and the other, secondary, acidic and angular material, the agglomerates.

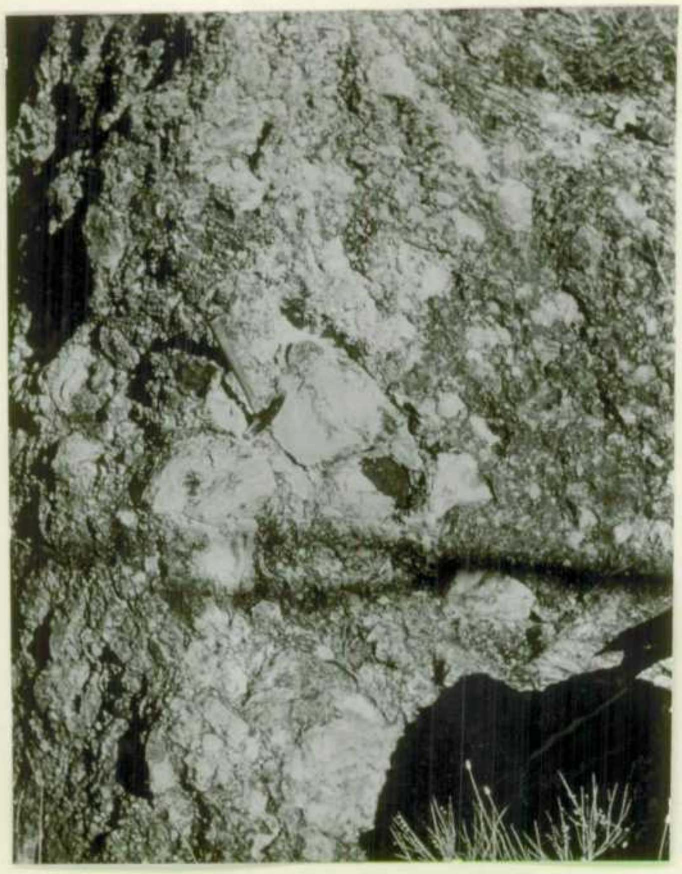


Figure 29: Bed of agglomerate consisting of banded rhyolite and trachyte fragments and angular boulders near Mount Helmet.

Figure 30: A volcanic bed of uncertain origin at Summer Hill.

The rocks of the first, commoner, group are typically a deep reddish-purple. They consist of tuffy, finely scoriaceous ash with fragments of lapilli size and 'bombs' of pumice and scoria up to several feet across. The 'bombs' have 'swirl' structures, especially prominent because of their scoriaceous character, and are rounded, although the finer ejecta are commonly sub-angular. These deposits, which are locally over 100 feet thick, are mainly massive although thick bedding is found in places. Crystals of dark, glassy, fractured minerals up to half an inch across are common and include feldspar and probable spinel. Pyroclastic rocks of this kind are well exposed to the north-west of Little Saint Peter at EM.127/3 where 'bombs' of non-vesicular fine-grained bluish basalt occur in the finer matrix. Contorted flow lines are also prominent in these. Other outcrops are found below Mount Alexander and near Mount Helmet.

The agglomerates are mainly light coloured rocks interbedded with other extrusives near Mount Helmet (EM.120/3, fig. 29), near the top of Mount Alexander, on the south-east flanks of Red Hill (EM.121/3), and on the north side of Little Saint Peter (EM.127/4). The agglomerate near Mount Helmet consists of large angular boulders of pink and light grey flow-banded rhyolite and trachyte set in a variable grain size matrix of similar fragments and purplish, scoriaceous material. The 50 feet thick fine agglomerate bed near the top of Mount Alexander is thinly bedded. A few fragments are several inches across but the average grain size is between $\frac{1}{4}$ and $\frac{1}{2}$ an inch. The angular grains consist of greenish pitchstone, white rhyolite and minor purplish pumice set in an ashy white matrix. The other agglomerates are similar although at Red Hill the rock is purplish grey and brown due to a higher proportion of darker fragments, which are commonly glassy and less than pebble size. The Little Saint Peter agglomerate is a well-bedded fine rhyolitic agglomerate and contains occasional large boulders of grey trachyte.

Some features in a bed at Summer Hill (fig. 30), are not easily explained. The bed appears to consist mainly of a reddish, finely scoriaceous ash with distinct bands up to a foot deep and several feet long, consisting of unconnected horizontally lensoid fragments of fine bluish basalt.

The basaltic fragments occur only in the top five feet of the twenty feet thick bed and increase in size and frequency upward. Some of the lensoid basalt fragments contain 'eyes' of the fine reddish material (fig. 30) and in places lose their lenticularity which suggests the bed is possibly a deeply altered flow of basalt rather than a welded pyroclastic. Also, lapilli-sized grains of basaltic rock in the matrix appear to 'merge' into the reddish matrix rather than having distinct margins.

A fine-grained reddish welded pyroclast with scoriaceous pockets occurs in the Mount Alexander mesa and contains in part small fragments of dark basalt, commonly irregular, but with a rough horizontal alignment. However, the Summer Hill rock has features which cannot be convincingly explained by a simple pyroclastic origin and it is possibly the result of combined laval, pyroclastic and deuteric activity.

Interbedded Sediments

Reid and Morton (1928), Reid (1930), and Dunstan (1902a) deal with probable Tertiary sediments below and interbedded with the basalt sheet in the Emerald area and areas mainly to the east and south. Veevers *et al.* (1961) refers to interbedded lacustrine deposits in the basalt sheet in the northern part of the Clermont area.

The sediments are not well exposed and are mainly known from bore records. On the air photographs areas of dense dark vegetation interspersed between areas of basalt downs probably indicate sediments. These areas have been mapped as Cainozoic cover on the Emerald Sheet to distinguish them from the areas of basalt outcrop. Reid and Morton named the formation the Emerald-Duaringa Series because of thick development at these places, and other authors have used either these or other place names for the formation because of its widespread development and, possibly, lack of continuity.

The sediments are up to several hundreds of feet thick and consist of freshwater gravels, sands, sandstone and partly diatomaceous clays; the gravels and sands are good aquifers. Bores on Gordon Downs property (Hydrology Table, Economic Geology section) also cut hard banded siliceous rock, possibly chert. At Selma a well was sunk into lignite containing Tertiary fossil plants.

Figure 31: Mount Helmet.

Figure 32: Little Saint Peter from the air.

The basaltic flows interfinger with the sediments toward the top and probably spread over them when volcanic activity intensified. The sediments were probably formed in lakes on the eroded Permian rocks, or in basins dammed by lava flows."

Springsure Volcanics

Springsure Volcanics is the new name proposed for a group of shallow alkaline trachytic and rhyolitic intrusions of probable Tertiary age exposed north of Springsure town and, in the Emerald Sheet area, in the Minerva Hills region (fig. 28). All twenty intrusions occurring within the Emerald Sheet area were investigated during the present survey together with two intrusions immediately outside the Sheet area. They are petrogenetically related to the interbedded lavas and pyroclastics which they intrude. They also intrude Permian sandstone. The intrusions consist of plugs, domes and dykes, the plugs especially forming prominent peaks, notably Mount Helmet and Little Saint Peter (figs. 31 and 32) and Saint Peter and Dilly Pinnacle immediately south of the Emerald Sheet boundary (fig. 33). The domes commonly form low, rounded hills.

Many features seen in the Springsure Volcanics are comparable to those of the Peak Range Volcanics (Veevers et al., 1961).

Volcanic Plugs

Mount Helmet and Little Saint Peter are two prominent plugs. Mount Helmet (fig. 31), a conical hill with a roughly circular base about a hundred yards in diameter, consists of light grey, fine grained porphyritic soda-rhyolite with rough flow banding in places. Subhedral sanidine, anhedral anorthoclase and rare albite phenocrysts, commonly glomeroporphyritic, are set in a trachytic textured groundmass of alkali feldspar with interstitial quartz patches and accessory opaque minerals. The albite is usually rimmed with sanidine. A small ridge, probably a dyke, of similar rock trends in a north-easterly direction from the summit. Rough columnar jointing can be seen where the dyke is exposed. Steep pavements of autobrecciated rock are found on the south-east slopes. The plug was probably intruded into a previously active vent and cone which is reconstructed in figure 35. To the south-west, pyroclastic beds and lava flows dip away from the plug and a rhyolitic boulder agglomerate bed, already described, occurring at EM.120/3 (fig.29) was probably formed by shattering of an earlier plug in the same vent.

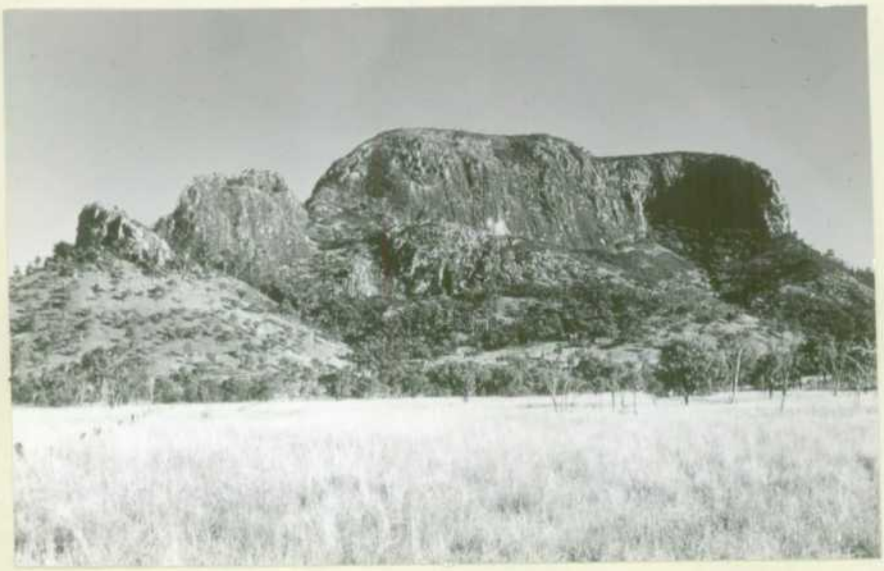


Figure 33: Saint Peter.

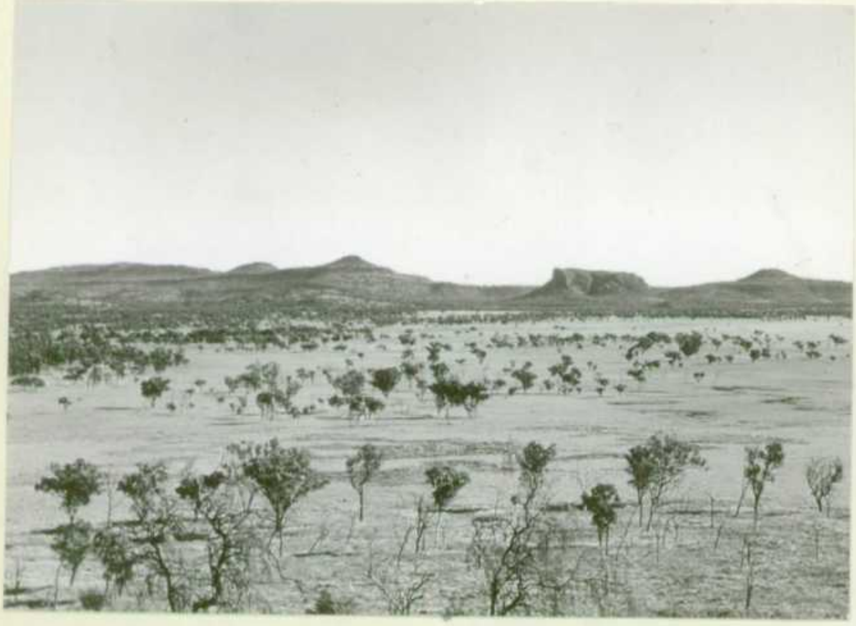


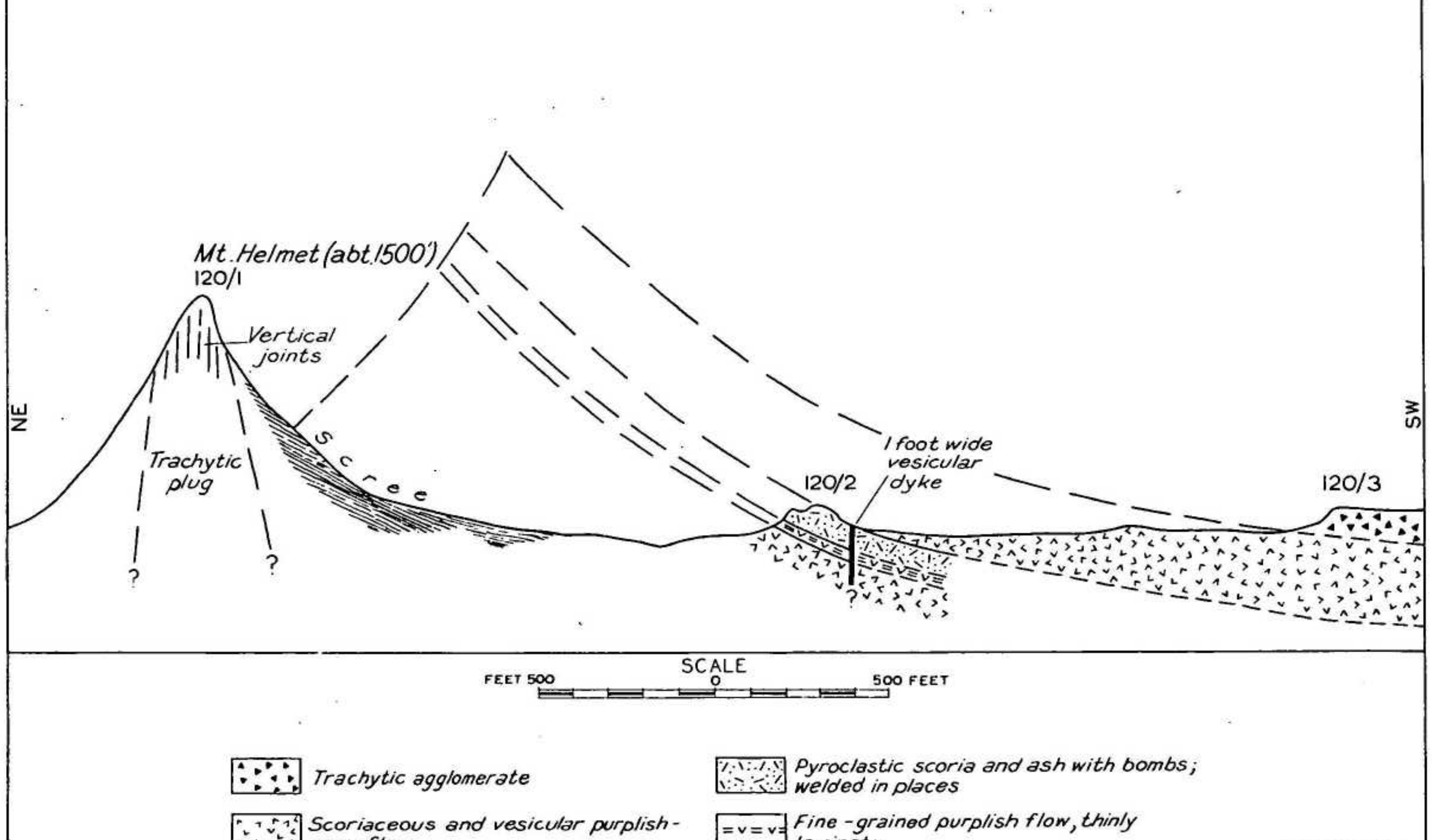
Figure 34: Interbedded lavas and pyroclastics of Mount Alexander (centre, left) showing dip away from Little Saint Peter (centre, right.)

Little Saint Peter is a flat-topped, circular-based plug about a quarter of a mile in diameter (figs. 32 and 34). The almost vertical flanks are breached on the east side to form entry to a large amphitheatre that is possibly the result of incipient explosive activity. The plug consists of a similar rhyolite to that at Mount Helmet. On the lower slopes fragments of a flow-banded, iron-stained glass containing sanidine phenocrysts and very fine feldspar laths were found. Rough columnar jointing and autobrecciated rock are common peripheral features and suggest quick cooling of the magma and movement after solidification. Bedded fine-white rhyolitic agglomerate and pyroclastics containing occasional large sub-angular boulders of trachytic lava outcrop on the lower northern slopes of the peak. The beds dip into the wall of the intrusion and probably represent ejecta from the vent that fell on the inner flanks of a volcanic cone built around the same vent. The bedded extrusives of the Mount Promenade and Mount Alexander mesas dip shallowly away from Little Saint Peter (fig. 34) and the plug now occupies a vent that extruded a large volume of volcanic material and was comparable to a shield volcano in size and structure. A quartz-trachyte dome adjacent to Little Saint Peter on the north-east probably grew within the same vent as the plug.

Saint Peter, which occurs immediately south of the Emerald Sheet boundary, is the highest and largest single intrusion of the Springsure Volcanics (figs. 26 and 33). It is irregular in plan, roughly elongate in a north-easterly direction and about half a mile long by a few hundred yards wide at its widest central part. Shear rocky flanks rise to a flat summit, over 1000 feet above the general plain level to the north. The rock is a light grey, fine grained porphyritic quartz trachyte. Porphyritic sanidine anhedra with rims of differing composition clouded with fine inclusions, and rare porphyritic anorthoclase euhedra are set in a flow textured groundmass of alkali feldspar laths with interstitial quartz and accessory opaque irregular microlites. The form of the intrusion suggests it was emplaced along a vent with radial fissues. Rough vertical columnar jointing and autobreccia are found on the flanks and green pitchstone fragments occur in the scree. A small conical hill, immediately north of Saint Peter, consists of a boulder agglomerate at the summit. Large angular boulders of pink and grey porphyritic rhyolite and minor amounts of green pitchstone and purplish trachyte boulders are cemented by finer fragments. Intensely

Cross section through Mt. Helmet and environs and through hypothetical reconstruction of south-west wall of probable original volcanic cone.

FIG. 35.




Bureau of Mineral Resources, Geology and Geophysics, Nov. 1961. To accompany Record No. 1962/50

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sheared and autobrecciated green porphyritic pitchstone on the flanks of the hill consists of porphyritic sanidine euhedra and minor amounts of porphyritic brown hornblende and green aegirine-augite set in a perlitic glass with flow textured microlitic laths of alkali feldspar and opaque dust. A flow-banded fragment from the agglomerate is a porphyritic quartz-trachyte with phenocrysts of sanidine. The hill is probably the remnant of a vent agglomerate.

A small plug of flow-banded alkaline rhyolite occurs about a mile north-east of Little Saint Peter at EM.127/7.

Volcanic Domes

Volcanic domes are typified by three similar intrusions, EM.123/3, EM.127/5 and EM.127/6 (fig. 28). Roughly circular in plan, they form low rounded hills about 200 feet high, and consist of porphyritic sanidine-quartz-trachyte commonly deeply altered to a brownish or reddish rock which is grey when fresh. Subhedra of sanidine, possible minor albite and anorthoclase are set in a trachytic textured groundmass of alkali feldspar laths with up to 20% interstitial quartz and accessory fine opaques. Platy jointing is common, roughly parallel to the flanks and was formed by the incipient pressure pattern during intrusion within the viscid magma which was crystallising while the domes were being emplaced in previously eruptive vents.

Domal intrusions of similar trachyte, roughly crescentic in plan occur at EM.124/1 and EM.127/8 (fig. 28). Rough flow banding and autobrecciated rock occur on the flanks at EM.124/1. Immediately west of EM.127/8 outcrops of dipping sandstone and siltstone are probably updomed Permian sediments.

A low rounded hill south of Mount Minerva consists of a deeply altered trachyte that possibly contains altered fayalite. Aegirine, possible aegirine-augite and plagioclase feldspar occur in minor amounts with trachytic textured laths of sanidine and possible soda-orthoclase and accessory magnetite and quartz. The plagioclases are commonly rimmed by alkali feldspar. The hill is probably an elongate dome that has arched Permian sediments exposed in places near the east flank.

A domal form of emplacement probably occurred at Crystal Hill and Red Hill. Crystal Hill is crescentic in plan about half a mile long and quarter of a mile wide. Its summit is about 300 feet above the general level and the general shape of the intrusion is comparable to a barchan. It consists of a markedly porphyritic, light grey soda-rhyolite in which glomeroporphyritic anorthoclase subhedra, minor sanidine phenocrysts and irregular to rounded quartz phenocrysts are set in a pilotaxitic textured groundmass of alkali feldspar laths with irregular interstitial patches of quartz which also occurs in aggregates of rounded grains 0.1 to 0.2 mm. across. The intrusion is intensely jointed with major vertical and horizontal sets and peripheral platy pressure jointing. Updoming of intruded Permian sandstone has occurred and although no intrusive contacts were visible dips up to 40° occur near the intrusion wall.

Red hill is roughly circular in plan about half a mile across. It is a roughly bowl-shaped structure consisting of porphyritic alkaline rhyolite characterised by sanidine and anorthoclase phenocrysts with patches of granular quartz in a trachytic textured groundmass. Close radial jointing is a common feature on the rim and within the 'bowl', the eastern rim of which forms a prominent hill. Platy pressure layering dips into the 'bowl'. The intrusion is probably a collapsed dome; the central, unsolidified part of the original dome collapsed due to decrease in pressure in the vent after the walls had solidified sufficiently to remain rigid.

Dykes and Other Intrusions

Three small intrusions immediately north-east of Minerva Hills Homestead lie in a circular plan over a mile in diameter. The circular plan is prominent on air photographs because of distinct trend lines reflected in overburden. The three intrusions, each arcuate in plan, are poorly exposed and lack prominent topographic expression. The intrusion at EM.126/1 consists of alkaline rhyolite with porphyritic sanidine, minor sodic plagioclase and irregular patches of quartz in a fine intergranular groundmass. Contorted flow banding, autobrecciation and irregular joint patterns characterise the intrusion. The third intrusion, at EM.127/12, consists of deeply weathered trachyte, vesicular in places. The intrusions were probably emplaced along a ring fracture.

Two stumpy dykes occur at EM.127/10 and EM.127/9. The dyke at EM.127/10 occurs within the ring fracture and is about 200 yards long and twenty yards wide forming a small ridge trending north-west. It consists of a light grey quartz trachyte with probable soda-orthoclase and sanidine phenocrysts. The dyke dips to the north-east at about 75° and shows columnar jointing, one to two feet across, normal to the hade. Flow banding is, in turn, normal to the columns.

The dyke at EM.127/9 forms a prominent ridge about 200 feet high with a north-westerly trend. It is about half a mile long and 200 yards across in the middle with a lenticular plan. It consists of fine grained porphyritic alkaline rhyolite. The intrusion is possibly a composite dyke. A ridge with rough vertical columnar joints passes through the long axis of the main body, and is autobrecciated along its flanks. Close pressure jointing and other joint sets form a complex pattern in the main structure, adjacent to the ridge to suggest auto-intrusion.

Other small intrusions whose structural form is not clear occur at EM.123/1 and EM.128/2. The former is probably a stumpy dyke of glomeroporphyritic alkaline rhyolite.

A north-east trending basaltic dyke occurs on the east flank of Mount Alexander, intruding flows and pyroclastics.

No other intrusions were found in this part of the Emerald Sheet.

Immediately south of the Emerald Sheet boundary numerous intrusions occur along north-west trending lines. A similar, although not as prominent, alignment of intrusions occurs in the Minerva Hills area described. This alignment is probably controlled by lines of weakness in the basement.

Hoy Basalt

Hoy Basalt is the new name proposed for a group of about sixty probable Tertiary volcanic plugs of porphyritic olivine basalt that characteristically contains foreign rock and mineral inclusions. The unit is named after its occurrence at Mount Hoy. Most of the plugs are circular or elliptical in plan and form prominent conical hills. They crop out in an area that is roughly a twenty-mile square, north of a line between Rubyvale and Black Peak.

About sixty plugs are easily identified on air photographs and all but a few were briefly investigated during the present survey. Others probably occur in the area but lack prominent topographic form. A thin section examination of some of the rock inclusions has been made and a few of the foreign mineral inclusions were identified by W.M.B. Roberts by X-Ray diffraction and X-Ray spectrochemical analysis.

Dunstan (1902) visited the area briefly and tentatively suggested that the sapphires in detrital gravels of the Anakie gem field were derived from inclusions in the basalt. Evidence found during the present survey proves this conclusively.

General Features of the Plugs

Dunstan (1902) concluded that the outcrops of basalt are flow remnants although he tentatively suggested a possible intrusive origin. The basalt outcrops are now regarded as remnants of vent plug intrusions, based mainly on the following observations:

1) The consistent shape and form of the outcrops. They are ridged, conical or rounded hills, never flat-topped as would be expected if they were flow remnants. The hills are regularly circular or elliptical in plan, commonly only a few hundred yards across, a feature more consistent with an intrusive origin.

2) The outcrops are uniform in composition. All the peaks consist of similar porphyritic olivine basalt and olivine dolerite and no variation in rock-type occurs within any one of them. In some cases a vertical thickness of over 500 feet of the same rock occurs; single flows of this thickness are probably rare. Stratification, consistent with flow remnants, is absent.

3) Columnar jointing is commonly found in the peaks. Near the summits the columns are thick, regular, and vertical while on the flanks they are smaller, irregular and inclined or horizontal.

4) The peaks occur noticeably along mainly north-north-east trending lines, suggesting tectonic control over a volcanic intrusive phase rather than the accidental effect of erosion.

Figure 36: Black Peak.

Figure 37: Boulder scree - Mount Leura.

The conical form of most of the plugs is prominent at Mounts Leura (fig. 27), Hoy, Newsome, Mica and Black Peak (fig. 36). Dome-shaped plugs occur at the two Bald Hills and EM.105/1 (fig. 25) and are the second commonest form. The domal and conical hills are circular in plan. Cigar-shaped and ridged plugs, elliptical in plan, are the least common and occur typically at Mount Dumbell, EM.113/2 and Double Point. The plugs vary in basal diameter from less than 100 feet to several hundred yards, and in height from a maximum of nearly 1,000 feet above the surrounding level at Mount Leura to mounds only tens of feet high.

Flank slopes are commonly concave and commonly steepen in their upper parts to near vertical. Outcrop occurs mainly in the upper half of the peaks, thick scree occurring on the lower half. Boulder screes are particularly well developed on the lower slopes of Mount Leura (fig. 37) and Black Peak.

Columnar jointing is common to most of the plugs (fig. 38). The columns are generally hexagonal, up to two feet across and twenty feet long, and transversely jointed (fig. 38). The largest columns occur in the central part of the plugs and commonly dip away from or toward the plugs' central vertical axes at small angles. Vertical columns appear to occur less frequently and are usually confined to the plug summits. However, the wide vertical joints between the columns, combined with the transverse jointing make them unstable and many of the angled columns have moved under the influence of gravity and erosion. This is clearly seen at Mounts Leura and Hoy and at EM.112/2 where heaps of jumbled, broken columns occur at the foot of unstable columns leaning out from the flanks. Horizontal and near-horizontal roughly hexagonal columns, only a few inches in diameter, occur on the lower flanks of plugs at EM.106/1, Black Peak and other localities. Small, irregularly aligned columns occur commonly on peripheral parts of plugs and are well exposed at Bald Hills, EM.160/1 and EM.159/3.

Sets of vertical platy pressure joints, producing rough columns, occur at Mounts Newsome and Mica and at EM.163/2.

No attempt was made to map the attitudes of joint sets in detail but such a study would probably provide a clearer picture of the original forms of the plugs and vents.

Figure 38: Near vertical columns of olivine basalt on flanks of a plug two miles north-west of Mount Leura.

Figure 39: Mount Ball.

Weathered surfaces of the basalt are characterised by:

1) A 'breadcrust' texture which consists of a dense irregular network of cracks, commonly less than half an inch and up to several inches deep.

2) A densely pitted texture which consists of regularly spaced shallow, roughly circular pits, commonly less than half an inch across, and joined by an inter-network of very fine radiating cracks.

3) A 'knobbly' texture apparently formed of small, irregular columns, about an inch across.

The first two features are commonly found on columnar joint surfaces and the third feature on the peripheral parts of the plugs.

Foreign rock and mineral inclusions and 'olivine nodules' are commonly found set in the basalt. The fragments are rounded to sub-angular and range from microscopic size to a foot across. Weathered surfaces of basalt are commonly studded with cavities where inclusions have been removed. The cavities are frequently found with a lining of the included rock.

## Petrography of Host Rock and Inclusions

A brief thin section study has been made of the Hoy Basalt and its inclusions.

The Hoy Basalt is a dark bluish, porphyritic olivine basalt consisting characteristically of olivine euhedra (15-20%), anhedral augite phenocrysts (5-10%, and minor subhedral plagioclase (mainly labradorite) phenocrysts in a groundmass of flow aligned plagioclase laths with interstitial equant grains of augite, probable minor olivine and magnetite (5%). Interstitial patches of isotropic minerals occur in places. The olivine phenocrysts are up to five millimetres across and are commonly hexagonal in section. The augite anhedra, up to two millimetres across, are commonly clouded with fine inclusions and zoned with iron-rich outer rims. Weathered surfaces are purplish-brown but form only a thin veneer on the fresh rock.

All but three of the plugs consist of porphyritic olivine basalt, containing inclusions, very similar to that described above. Plugs at Mount Ball, Mount Scholfield and Wilford Homestead differ in that the rock is coarser than basalt and does not contain inclusions. Mount Ball (fig. 39) consists of olivine dolerite with only minor porphyritic olivine some of which is iron-rich. Andesine labradorite zoned plagioclase laths are ophitically enclosed by augite which is also intergranular and occasionally twinned.

The plug at Mount Scholfield, tentatively allied to the Hoy Basalt, is oval in plan, about a mile long by half a mile wide, with almost vertical flanks and a flat top. It consists of medium to coarse grained olivine gabbro in the centre and olivine dolerite in the peripheral parts. The gabbro and dolerite appear to have an irregular junction with 'veins' of gabbro extending into the dolerite. The gabbro consists of large laths (up to 5 mm. long) of zoned plagioclase (andesine labradorite) and zoned alkali feldspar (microcline and possible anorthoclase) set sub-ophitically in ferro-augite, titanaugite, and optically concurrent patches of olivine. Aegirine-augite commonly rims the augite and magnetite forms skeletal intergrowths with minor biotite. Fibrous zeolites occur interstitially.

The small plug at Wilford Homestead consists of a similar gabbro.

The inclusions in the basalt consist mainly of basic plutonic rocks and minerals probably segregated from these rocks. The following rock-types are identified:

(1) Anorthosite

A specimen from Black Peak consists of 90% plagioclase anhedra of probable labradoritic composition with highly irregular sutures made prominent by fine grained intergranular secondary alteration minerals. The feldspars are strained. The rest of the rock comprises hypersthene, clino-pyroxene (probably augite) and olivine. The hypersthene occurs commonly in grains up to 0.8 mm. long fringed by fine aggregates of clino-pyroxene and olivine which also occur in fine grained patches between the feldspars. Olivine is commonly altered to iddingsite. Similar rock inclusions are widely spread throughout the basalt.

(2) Peridotite

This is the most common rock-type of the inclusions and is frequently found associated with olivine basalts elsewhere. The rock consists of coarse grained anhedra of olivine and pyroxene (mainly augite, possibly some enstatite) with minor interstitial, rounded and embayed brown spinel (picotite). Reaction rims of possible actinolite surround the pyroxenes where they come into contact with the host olivine basalt.

(3) Gabbros

A specimen from Mount Leura consists of plagioclase (labradorite) (50%), augite (25%), probable hypersthene (5%), olivine (10%), and magnetite and secondary minerals (10%). The plagioclase, augite and hypersthene are rimmed by irregular shells of differing composition. The texture of the rock is hypidiomorphic granular but elongate patches of granular olivine occur in places. Foliation banding can be seen in the hand specimen.

Other gabbroic inclusions are common, but their exact variety, depending on the composition of the pyroxenes and plagioclases, has not been accurately determined. Some may be eucritic.

(4) Pyroxenite

Rocks consisting of up to 90% pyroxene occur commonly among the inclusions. At EM.161/1 an inclusion consists mainly of augite and hypersthene anhedra. Oriented exsolution products cloud the pyroxenes which also contain micrographic skeletal frameworks of magnetite. Granular patches of olivine, pyroxene and plagioclase occur interstitially. Other pyroxenites contain ferro-augite, titanaugite and a green spinel, probably pleonaste.

(5) Acidic Plutonic Rocks

An inclusion at EM.160/1 appears to be a quartz-porphyry 'invaded' by the host olivine basalt. Quartz occurs as deeply embayed anhedra and in fine grained, granular patches. Wide fractures in alkali feldspar and plagioclase phenocrysts contain brownish volcanic glass which was probably forced along cracks in the crystals. Patches of fine grained olivine basalt occur toward the periphery of the inclusion and reaction rims are common where the feldspars are in contact with this rock.

A similar 'invasion' has occurred in an inclusion from the small plug at EM.162/2. In this case the original rock had a monzonitic composition. The pyroxene grains have been deeply altered and replaced in part by magnetite. Plagioclase, commonly rimmed by alkali feldspar contains volcanic glass along wide fractures.

The following mineral inclusions have been identified by X-Ray diffraction and X-Ray spectrochemical analyses:

(1) Corundum

Green specimens occur notably at Mount Leura and other small grains, including a yellow variety, were found in the basalt of other plugs.

(2) Spinel (containing high iron content and is therefore either hercynite or a mixture of hercynite and pleonaste)

The specimen analysed was collected at Mount Leura but this black metallic lustred, conchoidal mineral occurs commonly in the basalt.

(3) Pyroxene

Pyroxene inclusions occur abundantly at Black Peak and notably at EM.161/1 and EM.107/1 although they appear to be widely distributed elsewhere. In thin section the pyroxene at Black Peak appears to be augite where it is noticeably rimmed by a fibrous reaction intergrowth with the basalt.

Feldspar crystal inclusions also occur commonly in the basalt.

<u>Origin of the Plugs</u>

The Hoy Basalt represents the remnants of volcanic vent intrusions. Extrusive phases probably preceded the final plugging of the active vents by basaltic magma. Outliers of olivine basalt flows occur at the head of North Creek and nearby (fig. 25) and it is suggested that some or all of the basalt sheet in the eastern half of the Emerald area was derived from these vents. Some of the plugs are probably multiple intrusions, plugs emplaced along vents in previously plugged vents, a probable feature of Mount Leura. A small plug immediately to the north of this locality probably represents a parasitic conduit off the larger vent. Twin and triple conduits in the one vent occurred notably at EM.110/1 and Mount Dumbell.

In many cases the well-formed columnar jointing and its general attitude of normality to the faces of the plugs suggests the lava was allowed to cool slowly within the vents. In others the following evidence probably indicates a quicker freezing of the magma and movement during cooling:

1) The contorted attitude of some of the smaller, irregularly-shaped columns.

2) Flow textures in the basalt.

3) 'Breadcrust' surface textures which may be the result of sudden contraction in a partially cooled, plastic surface.

Most of the plugs intrude Retreat Granite which is commonly found in outcrop on their flanks. Others intrude the Anakie Metamorphics and the Drummond Basin beds (fig. 16) although no intrusive contacts are seen. At depth the plugs intrude ultrabasic and other plutonic rocks. No attempt is made here to suggest the relations of these rocks, seen in the inclusions, their origin, or the depth from which they were derived. Much more detailed sampling and analysing are required than has already been done to elucidate the problem.

The sapphires in old stream gravel wash in the Tomahawk Creek - Rubyvale - Anakie area are suggested to have originated in the Hoy Basalt and allied extrusive rocks. Dunstan (1902) tentatively suggested a similar origin and the discovery, during the present survey, of poor gem quality corundum, especially in the basalt at Mount Leura, is strong evidence in favour of this theory. Many of the sapphires were probably eroded out of inclusions in flows and pyroclastics extruded from the vents.

The plugs are noticeably aligned along north-north-easterly trending lines and most of the long axes of the elliptically-based plugs are common to this direction. A less pronounced alignment occurs in a north-easterly direction. These trends are possibly the regional structural trends in the basement.

Petrogenesis of the Volcanics

The Springsure Volcanics are almost certainly petrogenetically related to the undifferentiated lavas and pyroclastics. The association of olivine basalt with such rocks as trachybasalt and mugearite, as found in the Minerva Hills -

Springsure area, is common in other parts of the world and differentiation processes are generally regarded as being important in producing these less basic rocks from an olivine basalt magma. Small volumes of trachyte and undersaturated feldspathoidal rocks, such as phonolite, occur commonly in the same association but, similarly, peralkaline trachyte and rhyolite are rare. It seems that the derivation of these oversaturated rocks results from a rarely attained combination of magmatic conditions. Volatiles, acting both mechanically (aiding differentiation) and chemically, are probably important in addition to the action of normal differentiation processes. The presence of volatiles during volcanic activity in the Minerva Hills - Springsure region is borne out by scoriaceous and vesicular pyroclastics and lavas, and probably by agglomerate which suggests release of volatile pressure. Richards (1918) reported a nosean-bearing phonolite flow from near Springsure and the coexistence of this undersaturated rock with peralkaline rhyolite in the same petrographic province is difficult to explain. Possibly volatiles carried away a high proportion of alkalis during eruption, leaving an oversaturated fraction (rhyolite) and producing an alkali-enriched undersaturated (phonolite) lava. However, the petrogenetic origin of the Springsure Volcanics from an olivine basalt magma, on present evidence, is not clear. The successive appearance of rhyolite agglomerate, trachytic pyroclastics and olivine basalt flows in the volcanic pile in the Minerva Hills area suggests the original magma was successively differentiated and regenerated, at least twice, with accompanying phases of explosive activity.

The large sheet of olivine basalt covering much of the eastern part of the Emerald area is possibly also related to the Hoy Basalt, a similar olivine basalt. It is postulated that the olivine basalt was erupted from the vents now filled with Hoy Basalt. At the time of extrusion the Retreat Granite and sediments of the Drummond Basin probably formed high land and the basalt flowed mainly eastward where probable Tertiary sediments had already accumulated in a shallow basin. Outliers of basalt occur high up on the Drummond Basin sediments and support the idea that a steep eastward land surface gradient existed during the eruption of the basalt. Contemporaneous extrusion of the same lava may have occurred from vents in the Minerva Hills region, although activity probably began here at a later stage with the formation of alkaline-enriched differentiates in cupolas, rising from the main magma chamber. Further detailed petrography may prove the

Hoy Basalt and the olivine basalt sheet to be petrogenetically unconnected. On present evidence, however, the undifferentiated lavas and pyroclastics, the Springsure Volcanics and the Hoy Basalt would seem to have a common magmatic origin.

Age of the Volcanics

The undifferentiated lavas and pyroclastics are regarded as probable Tertiary because they overlie and are interbedded with sediments which have yielded probable Tertiary fossil plants obtained from bores (Reid and Morton, 1928). The Springsure Volcanics are slightly younger in age.

The plugs of Hoy Basalt are at least post-Lower Carboniferous on the evidence that they intrude the Ducabrook Formation. Although no intensive contacts are seen, steep dips in beds of the Ducabrook Formation occur immediately east of the plug at Mount Scholfield. However, a much younger age, probably Tertiary, is suggested on the following evidence:

1) The possible petrogenetic relationship to the probable Tertiary olivine basalt flows to the east.

2) The youthful morphology of the plugs allied to the apparent fast rate of mechanical destruction as seen in the young 'active' screes.

3) The plugs have fairly strong magnetic fields.

## UNDIFFERENTIATED CAINOZOIC

### Gravels

A large part of the Emerald Sheet area is covered by Cainozoic gravels. In the Rubyvale-Tomahawk Creek area sapphire-bearing gravels consist mainly of sandstone and pebbly sandstone similar to the Mount Hall Conglomerate. They vary considerably in thickness and in places are covered by soil. Similar gravels occur near Mount Hoy and probably represent outwash fans from the range formed by the Mount Hall Conglomerate. Longman (1932) describes a jawbone of a giant marsupial of the Nototherium type from the gravels near Rubyvale which indicates a probable Pleistocene age.

The sediments of the Drummond Basin are covered in places by 'billy' boulder and pebble gravels which contain sapphires at The Willows.

A large part of the Permian rocks north of the Central Railway are covered by gravels, consisting of quartz pebbles set in a silty or loamy matrix. In places, especially west of Carea Homestead, consolidated gravels form horizontal caps to Permian outcrops. The gravels are probably fluviatile in origin.

### Other Deposits

Large areas mapped as undifferentiated Cainozoic (Cz) on the Emerald 1:250,000 map in the eastern half of the region include soils, sands and lacustrine Tertiary sediments.

Small mesas north of Rubyvale are probably partly lateritised silt and gravel.

Dark, heavy-textured soil forms downs country in the east of the Sheet area and is usually underlain by basalt. Thin sandy soil and sand covers much of the Retreat Granite outcrop.

Alluvium is thick along the Nogoa River in the east of the Sheet area and also along the lower courses of Medway and Borilla Creeks. Creeks flowing west to the Belyando River off the Drummond Range are accompanied by spreads of alluvium where they reach the plain which extends west of the Sheet area.

## ECONOMIC GEOLOGY

### Oil.

Permian rocks in the Bowen Basin have been drilled for oil immediately south and east of the Emerald Sheet area. Dry gas was encountered in a few wells, notably A.O.E. No.1 Reid's Dome and Morella.

The Middle Bowen Beds in the Emerald Sheet area consist of about 8000 feet of poorly outcropping pebbly quartz sandstone and shale. A few marine fossil horizons occur in the sequence which is probably wholly marine, being deposited in a marginal environment. Insufficient detailed evidence is available to say whether the Middle Bowen Beds contain good source and reservoir rocks. No bore samples were available and only surface rocks were examined during the present survey. The shales, which rarely occur in outcrop are possible source beds and the sandstone possible reservoir rock. The deepest bores into the Middle Bowen Beds are the Cullin-la-Ringo Homestead bore (800 feet) and Deep (745 feet) and Dip (680 feet) bores on Theresa Downs property. The logs of these bores are poor (Hydrology Table); the dominant lithologies appear to be shale and sandstone. The Middle Bowen Beds have been folded along the eastern margin of the Anakie Inlier, forming a structural extension of the Springsure Anticline. The folds, notably the Fernlees Anticline and the anticline north-west of Emerald, form possible oil traps (Figure 24). To the east of this folded belt the rocks thicken and dip regionally eastward (Robertson, 1961) beneath the Upper Bowen Coal Measures, Tertiary basalt and Cainozoic deposits. The Middle Bowen Beds have been intruded and arched up by volcanic plugs, domes and dykes of the probable Tertiary Springsure Volcanics.

The Upper Bowen Coal Measures are mainly a poorly outcropping sequence of pebbly sandstone, shale and coal, probably deposited mainly in shallow freshwater. Abundant worm tracks indicate the basin floor was aerated.

The Devonian-Carboniferous rocks of the Drummond Basin consist of about 16,000 feet of volcanics (up to 2000 feet) and sediments. Coralline limestone occurs in the basal, dominantly volcanic, sequence at Glendarriwell, in the Emerald Sheet area, and in the Nogoa Anticline, in the Springsure Sheet area, indicating a marine environment. However, no marine fossils occur in the sequence above this basal unit and, mainly for this reason, the Drummond Basin has been regarded previously as primarily a freshwater basin. The sediments consist of quartz conglomerate, sandstone, siltstone and shale, containing derived and primary volcanic material. The presence of branchiopods (Shell (Queensland) Development Pty Ltd, 1952) and algal limestones, both in the Telemon Formation, and fish remains in the Ducabrook Formation suggest an estuarine, rather than freshwater, depositional environment. The presence of abundant plant remains does not necessarily infer a freshwater environment. Cross bedding, lensing of beds and disconformities throughout the sequence suggest shallow water conditions. Possible source beds and reservoir rocks occur in the sequence; dark shales are rare and multicoloured shales common; sandstones are common. The rocks are folded into broad anticlines and, where they are not deeply eroded or faulted, provide good traps. The rocks have not been intruded by large igneous bodies; a granitic stock near Silver Hills Homestead is the largest intrusion. Plugs of Hoy Basalt occur at Black Peak and Mount Scholfield and dykes and possible sills of basalt occur notably along the eastern margin of the Drummond Basin.

The part of the Drummond Basin in the Emerald Sheet area lies within the 'mobile' marginal belt of the basin which is faulted and intruded. The oil prospects in this area are therefore regarded as slight. However, to the west, where the Drummond Basin is covered by Mesozoic and Cainozoic sediments, conditions may have been more favorable for the formation of oil because of quieter, deeper water, and for the accumulation of oil because of probable gentler folding and a later cover of Mesozoic rocks.

Underground water

All details concerning the available bore records have been set out in the hydrology table.

A large number of bores have been sunk in the Emerald area, most of them in the eastern half, in Permian rocks, in Tertiary basalt with interbedded lake deposits, and in superficial deposits. Some bores are present in the western region in the Drummond sediments and in the granite and metamorphics of the Anakie Inlier, but no records are available for these bores.

Most bores sunk in the basalt were successful water producers. On Gordon Downs property, in the north-east corner of the area, 25 bores were sunk between 1923 and 1960, and most draw good supplies of excellent water from the basalt. Tertiary lacustrine gravels penetrated by some of the bores, and others in the Emerald area, are good aquifers also.

HYDROLOGY TABLE

| Name of Bore | Property | Date | Depth (in feet) | Water struck (in feet) | Water level (in feet) | Supply (in g.p.h.) | Quality | Strata |
|---|---|---|---|---|---|---|---|---|
| Balcombe | Gordon Downs | 1926 | 170 | | 70 | 650 | excellent | no record |
| Bottom | Montrose | 1942 | 272 | | 110 | 640 | good | 0-52' brown basalt; -105' greasy back; -150' limestone & clay; -205' blue rock; -215' dry greasy back; -240' grey & red marl; -248' blue shale; -251' red marl; -272' coarse sandstone with waterworn pebbles. |
| Bottom | The Glen | 1942 | 272 | 110 | | 640 | | 0-52' brown basalt; -105' greasy back; -150' limestone & clay; -205' blue rock; -215' dry greasy back; -240' grey & red marl; -248' blue shale; -251' red marl; -272' coarse sandstone and waterworn gravel. |
| Burn Meadow Hs. | Burn Meadow | | 90 | | | large | poor | 0-70' clay and stone; -90' sandrock. |
| Central Creek Hs. | Central Creek | | 52 | 14, 29, 46 | | 600 | | 0-52' clay and sandrock. |
| Champion | Gordon Downs | 1959 | 250 | 72, 132, 247. | 33 | 1000 | | 0-55' sand, gravel, clay; -107' basalt; -250' sand and clay. |
| Comet | Burn Meadow | | 280 | | | large | good stock | 0-2' soil; -10' coloured rock; -104' coloured sandrock and clay; -240' shale and sandrock; -250' sandrock; -280' shale and sandrock. |
| Cottage | Caroa | 1959 | 329 | 303, 315 | | 500 | good stock | 0-1' soil; -30' gravel; -40' sandrock; -75' clays; -160' coloured shale; -329' clay with bands of sandrock. |
| Crystal Creek | Caroa | 1959 | | 90, 102, 125 | 30 | 525 | salt | 0-16' red clay; -24' soft sandrock; -56' soft sandrock; -90' dark shale; -102' coal; -112' sandrock & shale; -115' coal; -125' sandrock & shale. |
| Cullin-la-Ringo Hs. | Cullin-la-Ringo | | about 800 | | | | | At 225' coal; below this sand, gritty rock, clay and sandstone. |
| Deep | Theresa Downs | 1961 | 745 | 160, 648 | 200 | 425 | | 0-289' coloured clays; -745' sandrock with small bands of shale and thin coal seams. |
| Dip | Theresa Downs | 1961 | 680 | | 60 | 330 | | 0-3' soil; -40' gravelly clay; -63' sandrock, sandy clay; -90' green shale; -140' coloured clay; -680' shale and sandrock. |
| Druces | Cullin-la-Ringo | | 183 | | | | | 0-183' basalt |
| Oakhole | Caroa | 1958 | 261 | 100, 105, 213, 245 | 168 | 540 | good stock | 0-12' clay; -62' sandrock and clay; -72' coloured clays; -145' sandrock; -210' sandy shale; -251' sandrock; -261' dark shale with sandrock at bottom of bore. |

## HYDROLOGY TABLE (contd)

| Name of Bore | Property | Date | Depth (in feet) | Water struck (in feet) | Water level (in feet) | Supply (in g.p.h.) | Quality | Strata |
|---|---|---|---|---|---|---|---|---|
| Gordon Downs No.1 | Gordon Downs | 1923 | 72 | 56 | 40 | 1700 | excellent | 0-56' soil and sandstone; -72' basalt. |
| " "No.2 | " " | 1923 | 54 | 33 | 20 | 1000 | " | 0-3' soil; -54' basalt. |
| " "No.3 | " " | 1959 | 126 | 90 | 67 | 720 | " | 0-23' clay and boulders; -126' basalt. |
| " "No.4 | " " | 1923 | 212 | 202 | 115 | 1500 | good stock | 0-42' basalt; -190' clay; -212' fine and coarse sandstone. |
| " "No.5 | " " | 1955 | 271 | 200,217 | | 300 | excellent | 0-5' soil<br>-271' basalt with some limestone boulders. |
| " "No.6 | " " | 1923 | | | | 450 | | soil, clay & honeycomb rock. |
| " "No.7 | " " | 1949 | 376 | | 147 | | | 0-150' basalt; 253'-322' black mud;<br>-376' hard sandstone. |
| " "No.8 | " " | 1945 | 191 | | | | | 0-35' basalt; -191' clay and sand. |
| " "No.9 | " " | 1960 | 327 | 28, 148 (salty) 214,240, 253 | 93 | 485 | good stock | 0-15' soil, clay & boulders;<br>-95' coloured clays; -118' hard sand rock;<br>-144' shale;<br>-206' white rock, slate and shale;<br>-211' white boulders;<br>-219' shale, rock bars and coal;<br>-240' dark shale; -246' coal;<br>-288' sand rock; -291' coal;<br>-296' white stone and coal; -302' coal;<br>-318' shale and coal; -324' coal;<br>-327' white slag. |
| " "No.10 | " " | 1937 | 193 | 192 | 90 | 840 | excellent | 0-20' basalt; -193 clay, limestone, grit and slippery back. |
| " "No.11 | " " | 1924 | 185 | 141 | 140 | 720 | " | 0-23' limestone and gravel;<br>-185' basalt & some clay with quartz. |
| " "No.12 | " " | 1925 | 193 | | 73 | 300 | " | 0-4' sandy loam; -60' clay;<br>-170' soft sandstone;<br>-177' oily sandstone; -180' dark shale;<br>-191' coal; -193' dark shale. |
| " "No.13 | " " | 1959 | 651 | 173, 522 | | 290 | | 0-135' basalt; -522' shale and coal;<br>-523' conglomerate and coal;<br>-651' shale and coal. |
| " "No.14 | " " | 1939 | 387 | 375 | 350 | 300 | " | 0-170' clay; -190' fine quartz sandstone;<br>-260' black slate;<br>-325' fine white sandstone; -375' shale;<br>-378' coal and water; -387' clay. |
| " "No.15 | " " | 1925 | 181 | | 90 | 300 | good stock | 0-34' basalt; -48' clay;<br>-106' limestor boulders; -127' basalt;<br>-141' sandstone; -166' limestone;<br>-175' sandy limestone; -181' pipe clay. |
| " "No.16 | " " | 1926 | 135 | 116 | | 400 | good stock | basalt |
| " "No.17 | " " | 1959 | 263 | 136,256 | | 320 | | 0-167' basalt, limestone & clay;<br>-248' clay, limestone and slippery back;<br>-256' soft sandstone; -263' sandy clay. |

# HYDROLOGY TABLE (contd)

| Name of Bore | Property | Date | Depth (in feet) | Water struck (in feet) | Water level (in feet) | Supply (in g.p.h.) | Quality | Strata |
|---|---|---|---|---|---|---|---|---|
| Gordon Downs No.19 | Gordon Downs | 1937 | 281 | 272 | 90 | 720 | stock | 0-258' clay, limestone, some basalt & grit; -275' sandstone; -281' clay. |
| " " No.20 | " " | 1938 | 288 | 192 | 90 | 960 | good stock | 0-192' clay and grit; -288' slaty basalt and clay. |
| " " No.21 | " " | | 594 | 492,585 | 150 | 400 | excellent | 0-180' sandstone and clay; -343' black slate; -365' black shale and coal; -390' sandstone; -465' slate; -594' sandstone. |
| Montrose No.1 | Montrose | | 101 | 75,85 | | 240 | good | 0-3' soil; -8' gravel and boulders; -25' brown basalt; -35' clay; -55' soft basalt; -63' slippery back; -68' clay; -91' blue green basalt; -101' basalt. |
| " No.2 | " | | 250 | | 65 | 420 | | 0-3' soil; -11' blue basalt; -15' blue metal; -22' soft basalt; -26' blue metal; -51' soft basalt; -55' clay; -65' brown basalt; -71' black basalt; -250' clay. |
| Mt Macdonald | Cullin-la-Ringo | | 146 | | | | | 0-146' basalt |
| Pelican | Theresa Downs | | 190 | 142,149, 180. | | 500 | | 0-2' white stone; -20' basalt; -91' soapstone; -137' green shale; -177' basalt; -190' red clay. |
| Prince's | Cullin-la-Ringo | | 226 | | | | | 0-226' mostly basalt. (petrified wood?). |
| Rowley's Well | Caroa | | 425 | | | | | 0-80' gravel; -425' shale and sandrock. |
| Ronnoc Downs Hs. | Ronnoc Downs | | 295 | | | | | 0-295' probably all volcanics |
| Salt | Gordon Downs | 1958 | 227 | 95 | | 350 | salty | no record |
| Stapleton | " " | 1950 | 295 | | | 720 | | 0-106' basalt; -295' sandstone, clay & chalk. |
| Taroborah | St Helens | | | 180 | | | | 0-180' sandstone with coal seam at the base. |
| The Glen Hs. No.1 | The Glen | 1944 | 330 | | | 240 | | 0-64' brown basalt and clay; -130' limestone, clay and loose sand. 236-300' sandstone and gravel; -330' black shale. |
| " " No.2 | " " | | 315 | | | | | 0-60' basalt; 60-150' dry marl; -315' black shale and sandstone. |
| Theresa Downs Hs. No.1 | Theresa Downs | | 326 | 114,180 | | 320 | | 0-129' clay; -180' soft basalt; -326' clay and soft rubble. |
| " " No.2 | " " | | | 27,134, 150 | | 480 | good | 0-26' rock; -35' gravelly clay; -102' soapstone; -125' green shale; -179' bands of basalt. |
| Wyoming Hs. | Wyoming | | 407 | | 185 | | good | 0-3'6" black soil; -11' yellow basalt; -25' orange basalt; -85' grey rock; -112' blue rock. A gravel bed at 153', and the hole bottomed in blue soft rock at 407'. |

The deeper bores penetrate Permian rocks. The water is often found in coal measures and is of a poorer quality, but nevertheless is suitable for stock.

The sediments in the Drummond Basin and the metamorphic rocks of the Anakie Inlier have little water potential, and property owners in those areas prefer to build earth tanks and dams. The rainfall in the area ranges from 20 to 30 inches per annum, and is sufficient to keep the reservoirs filled.

Several bores have been sunk in the granite of the Anakie Inlier and small quantities of good water are obtained from some of these.

Coal

Coal seams do not crop out in the Emerald area and bore and well records (Hydrology Table) are the only indications of the presence of coal. A 7'6" seam was recorded from a well in Portion 17v, Parish of Capella (Maitland, 1895). The analysis is: Moisture 0.82%, Volatile hydrocarbons 57.52%, Fixed carbon 32.38% and Ash 9.28%.

Details of the coal in bores in the Emerald area have been set out in the following table:

| BORE | PROPERTY | DEPTH OF COAL in feet | FORMATION |
|---|---|---|---|
| Crystal Ck | Caroa | 90-102<br>112-115 | Middle Bowen Beds |
| Cullin-la-Ringo Homestead | Cullin-la-Ringo | at 225 | Middle Bowen Beds |
| Deep | Theresa Downs | thin seams between 289 and 745 | Middle Bowen Beds |
| Gordon Downs No.9 | Gordon Downs | 211-219 some coal<br>240-246 coal<br>288-291 coal<br>291-296 some coal<br>296-302 some coal<br>302-318 coal<br>318-324 coal | Upper Bowen Coal Measures |
| Gordon Downs No.12 | " | 180-191 coal | Upper Bowen Coal Measures |
| Gordon Downs No.13 | " | 135-522 some coal<br>522-523 some coal<br>523-651 some coal | Upper Bowen Coal Measures |
| Gordon Downs No.14 | " | 375-378 coal | Upper Bowen Coal Measures |
| Gordon Downs No.21 | " | 343-365 some coal | |
| Taroborah | St Helens | ?-180 coal | Middle Bowen Beds |

Gemstones

The Emerald Sheet area has not been a notable producer of minerals, the gemstones of the Anakie Field, principally sapphires, being the only production of any value. The field was first described by Jack (1882) while the most detailed description has been by Dunstan (1902). Sapphires were first recorded from the district in 1870, the deposits being opened up in 190C. The most productive period was from 1906 to 1925, in 1920 reported production from the field being £65,831. Since 1925 production from the field has declined, apparently because the richer deposits have been worked out, and recorded sales have rarely exceeded £3000 per annum and in a few years have not exceeded £1000 per annum. Records of the Department of Mines show that the value of gems produced to 1960 was £692,635. However as many sales are made of which no record is kept, the actual value of gems produced is probably much higher.

The main sapphire producing area has been in the vicinity of Sapphire and Rubyvale, with the Willows Field some 25 miles south-west being a later subsidiary field. Most production of latter years appears to have come from this field. Sapphires have also been found near Tomahawk Creek, but results from here have generally been poor.

The sapphires occur as water-worn fragments in the deposits of old watercourses which are mainly found on low ridges above the alluvium of the present streams. The actual sapphire wash is generally from 2 to 5 feet thick and varies from being a near surface deposit to being 40 feet or more deep. It is worked either by shallow open cuts or by sinking shafts.

Other minerals are found with the sapphires and include zircon, pleonaste, garnet, topaz and tourmaline, but only the zircons are important as gems. Some diamonds have also been recorded from the wash.

Other Minerals

Slight mineralisation has been recorded from many places on the Anakie Inlier, but none of these has ever proved to be an economic proposition.

(i) Gold. Some alluvial gold has been found in the sapphire wash and also in the present streams. At Basalt Hill gravelly and sandy wash, below a thin basalt flow, was worked for gold.

At Mount Clifford, described by Dunstan (1898) and Morton (1932), gold was mined intermittently from 1896 to 1902 and again intermittently for a few years after 1926, but it appears that very little gold has been produced. The gold occurred in hydrothermally altered slates caught up in a diorite intrusion and also in veins in the diorite. This area was first worked for silver in lodes associated with bornite, hematite, azurite and malachite (Jack, 1882). The oxidised ores are in all cases highly ferruginous.

(ii) Copper. Some copper mineralization, mainly secondary carbonates, has been observed in several places in the southern part of the Anakie Inlier. Malachite and azurite are common in several lodes at Mount Clifford. Copper deposits at Kettle Creek, north-east of Rubyvale, were described by Morton (1931). The ore consisted mainly of carbonates, probably associated with a nearby diorite intrusion.

Copper mineralization has also been described from granite of the Anakie Inlier near the northern Sheet boundary. Morton (1931) described the mineralization, ores containing gold, silver, copper and lead (the latter two as carbonates) being found in siliceous chlorite lodes in granite, generally greisenised in the immediate vicinity of the lodes. From the same area Reid (1945) described copper mineralization at the junction of granite and greisen. The granite is not mineralised, but the greisen is impregnated with copper carbonate and copper silicate.

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# APPENDIX I

## PETROGRAPHY OF DEVONIAN - CARBONIFEROUS ROCKS

by

Beverley R. Houston (Q.G.S.)

### Undifferentiated Volcanics from Glendarriwell

Microslide:- GSQ 2802 ex Specimen:- GSQ/R 1809 Field No.:- 40/3(a)

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5083 Run:- 6

Location:- Glendarriwell

Formation:- Undifferentiated Age:- Middle Devonian

Macro:- A massive, ironstained (yellow), medium-grained, granitic rock.

Micro:-

Texture:- Porphyritic; phenocrysts (about 65% of rock) anhedral, embayed, 0.5 to 3 mm. Groundmass consists of anhedra (commonly about 0.04 mm.) and abundant areas (commonly about 0.2 mm.) of graphic and myrmekitic intergrowths.

Phenocrysts:- Potash Feldspar: about 30% of rock; altered to clay minerals.

Plagioclase:

Quartz: about 20% of rock; slightly strained.

Groundmass:- Quartz:

Feldspar: altered.

Epidote: yellow.

Clinozoisite: minor.

Mica: colourless to pale yellow; minor.

Origin:- Igneous; ?intrusive.

Name:- Altered QUARTZ-FELDSPAR PORPHYRY.

Microslide:- GSQ 2797 ex Specimen:- GSQ/R 1804 Field No.:- 40/4

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5083 Run:- 6

Location:- Glendarriwell

Formation:- Undifferentiated Age:- Middle Devonian

Macro:- A massive, extremely altered, clastic rock containing rounded fragments up to 6 mm.

Micro:- This rock is extremely altered but an abundance of fragments of volcanic rock (dominantly rhyolite) and broken crystals of quartz and feldspar occur. The matrix appears to be tuffaceous, and is rich in chlorite.

Origin:- Volcanic, pyroclastic; probably primary.

Name:- CRYSTAL-LITHIC LAPILLI TUFF.

Microslide:- GSQ 2798 ex Specimen GSQ/R 1805 Field No.:- 40/5

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5083 Run:- 6

Location:- Glendarriwell

Formation:- Undifferentiated Age:-Middle Devonian

Macro:- An extremely altered, irregularly layered and ironstained, fine - to coarse-grained rock.

Micro:- This rock could not be sectioned satisfactorily.

The following characteristics are evident:-

(1) The rock is clastic.

(2) The clasts are (at least) 0.01 to 1.5 mm.

(3) Fragments of pre-Devonian "granite" and of spherulitic rhyolite can be recognised.

Name:- ?SILTSTONE.

Microslide:- GSQ 2799 ex Specimen:- GSQ/R 1806 Field No.:- 40/7B

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5083 Run:- 6

Location:- Glendarriwell

Formation:- Undifferentiated Age:- Middle Devonian

Macro:- Essentially similar to 168/5.

Micro:- similar to 168/5 except in the following details:-

(1) Phenocrysts make up $<$ 10% of 40/7B

(2) The phenocrysts in 40/7B are 0.2 to 5 mm.

(3) The groundmass of 40/7B has a grain size of about 0.02 mm.

(4) Intergrowths are rare in 40/7B.

Name:- RHYOLITE.

Microslide:- GSQ 2801 ex Specimen:- GSQ/R 1808 Field No.:- 168/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5083 Run:- 6

Location:- Glendarriwell

Formation:- Undifferentiated Age:-Middle Devonian

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

Micro:- Esentially similar to 168/5 except in the following details:-

(1) 168/3 is not porphyritic or amygdaloidal.

(2) Spherulitic and graphic structures are much more abundant in 168/3 than in 168/5.

(3) Minor opaques occur in 168/3.

Name:- Spherulitic RHYOLITE.

Microslide:- GSQ 2803 ex Specimen:- GSQ/R 1810 Field No.:- 168/5

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5083 Run:- 6

Location:- Glendarriwell

Formation:- Undifferentiated Age:- Middle Devonian

Macro:- A massive, fine-grained, light grey porphyritic rock.

Micro:-

Texture:- Porphyritic; phenocrysts ( > 5% of rock) are anhedral and subhedral lath-shaped or anhedral equant crystals, commonly about 1 mm.; some of the crystals are surrounded by a "reaction rim" (up to 0.25 mm.) of radiating fibres and graphic intergrowths. The groundmass has a grain size of about 0.08 mm. and consists of equant anhedral and subhedral acicular crystals. Spherulitic and graphic structures are common. Amygdules ( < 5% of rock) are 0.5 to 1 mm. across and surrounded by an irregular fringe.

Phenocrysts:- Feldspar: dominant; oligoclase and potash feldspar; somewhat altered to lightly ironstained clay minerals.

Quartz: anhedral.

Groundmass:- Quartz:

Potash Feldspar

Oligoclase

Chlorite

Amygdules:- Quartz, fringed with chlorite.

Origin:- Volcanic, extrusive.

Name:- RHYOLITE.

Nogoa Anticline

Microslide:- GSQ 2829 ex Specimen:- GSQ/R 1844 Field No.:- SP53/7

Four Mile Map:- Springsure

Air Photo (B.M.R.):- Springsure North. No.:- 5018 Run:- 2

Location:- Nogoa Anticline

Formation:- Dunstable Age:- Middle Devonian

Macro:- A massive, fine-grained, purplish-grey rock irregularly streaked with buff-coloured material.

Micro:- The original rock consists of somewhat cloudy crystalline calcite which has been irregularly invaded by chalcedony. Subsequent partial recrystallisation has taken place.

Origin:- Alteration of a sedimentary rock.

Name:- SILICIFIED LIMESTONE.

Microslide:- GSQ 2704 ex Specimen:- 1[illegible]7 Field No.:- 26/5

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5025 Run:- 8

Location:- Mt. Beaufort Anticline.

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, pink rock.

Micro:-

Texture:- Clastic; consisting of about 40% phenoclasts, 30% shards and 30% very fine-grained matrix. The phenoclasts are 0.02 to 0.15 mm., of low to moderate sphericity; some are broken and/or corroded crystals; many are fringed by an extremely fine zone of mica.

Phenoclasts:- Feldspar: oligoclase and potash.
Quartz
Biotite
Muscovite
Volcanic rock (fine-grained)
Epidote

Shards:- Hematitic.

Matrix:- Tuffaceous

Origin:- Essentially volcanic, pyroclastic but containing a significant fraction of redeposited grains.

Name:- SANDY - VITRIC TUFF

Microslide:- GSQ 2705 ex Specimen:- GSQ/R 1661 Field No.:- 26/11 (a)

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5025 Run:- 8

Location:- Mt. Beaufort Anticline.

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, dark brown rock.

Micro:-

Texture:- Porphyritic; phenocrysts (about 10% of rock), acicular, 0.2 to 1 mm. Groundmass intergranular, fluidal, about 0.11 mm.

Phenocrysts:- Labradorite.

Groundmass:- Labradorite: about 50% of rock; acicular.
Pyroxene: granular, hematite-stained.
Opaques: oxidised.
Serpentine: minor; secondary.

Origin:- Igneous, extrusive.

Name:- BASALT.

Microslide:- GSQ 2707 ex Specimen:- 1663 Field No:- 26/12

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5025 Run:- 8

Location:- Mt. Beaufort Anticline

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- Dark grey limestone displaying a concentric and radiating structure.

Micro:- The rock consists of partly recrystallised calcite. The structure may be algal.

Name:- Partially recrystallised ? ALGAL LIMESTONE.

Microslide:- GSQ 2697 ex Specimen:- GSQ/R 1636 Field No:- 355/5

Four Mile Map:- Jericho

Air Photo (B.M.R.):- Emerald No:- 5032 Run:- 9

Location:- Mt. Beaufort Anticline.

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, dark red-brown rock.

Micro:-

Texture:- Clastic; consisting of about 60% phenoclasts, 20% matrix and 20% secondary material. The phenoclasts are 0.05 to 0.1 mm., commonly sutured, of low to moderate sphericity.

Phenoclasts:- Quartz

Lithic Material: fine-grained volcanic and mica schist.

Feldspar

Mica

Matrix:- Tuffaceous: hematite-stained.

Secondary Material:- Calcite: heavily limonite-stained, in part.

Origin:- Essentially sedimentary.

Name:- Altered TUFFACEOUS SANDSTONE.

## Silver Hills Volcanics.

Microslide:- GSQ 2692 ex Specimen:- GSQ/R 1673 Field No.:- 141/17A

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5012 Run:- 4

Location:- N.W. Old Silver Hills Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

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

Micro:- The rock is extremely altered and consists essentially of irregular "patches" (up to 1 mm.) of cryptocrystalline mosaic interspersed at random with a coarser (about 0.15 mm.) mosaic. Up to 5% opaque dust is fairly evenly distributed.

The rock consists essentially of feldspar (apparently potash), altered to lightly ironstained clay minerals, with minor altered zeolite.

Origin:- Igneous, extrusive.

Name:- Altered TRACHYTE.

Microslide:- GSQ 2693 ex Specimen:- GSQ/R 1674 Field No.:- 143/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5099 Run:- 5A

Location:- N. of Withersfield

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, dark grey rock traversed by irregular, roughly parallel "layers" a greenish material.

Micro:-

Texture:- Porphyritic; phenocrysts ( $<$ 5% of rock) 0.6 to 1 mm., subhedral to anhedral. Groundmass pilotaxitic, about 0.04 mm.

Phenocrysts:- Plagioclase: extremely altered.

Groundmass:- Labradorite: dominant; altered.

Serpentine: secondary.

Chlorite: secondary.

Calcite: secondary.

Opaques: granular; commonly oxidised.

"Green Layers":- consist essentially of a zeolite mosaic (about 0.07 mm.) enveloped in serpentine and chlorite.

Origin:- Volcanic, extrusive; altered.

Name:- Altered BASALT.

Microslide:- GSQ 2656 ex Specimen:- GSQ/R 1575 Field No:- 225/4B

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- N.W. of Silver Hills Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

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

Micro:-

Texture:- Extremely altered; porphyritic; phenocrysts ( 10% of rock) are mostly subhedral (0.5 to 2.0 mm.); groundmass pilotaxitic, grain size about 0.08 mm.

Phenocrysts:- Oligoclase: about 5% of rock; altered, being replaced, in part, by chlorite, antigorite, calcite or sericite.

? Pyroxene: < 5% of rock; completely replaced by aggregates of antigorite with abundant associated opaques and minor pyrophyllite.

Groundmass:- The following minerals can be recognised:-

Feldspar: acicular crystals, altered.

Opaques: about 10% of rock; granular; tends to be concentrated about the phenocrysts.

Antigorite: secondary.

Veins:- Rock is cut by fine opaque veins, with associated hematite and by calcite veins.

Origin:- Alteration of volcanic extrusive rock.

Name:- Altered fluidal ?PYROXENE TRACHYTE.

Microslide:- GSQ 2657 ex Specimen:- GSQ/R 1576 Field No.:- 225/40

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- N.W. of Silver Hills Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, off-white, bedded sediment.

Micro:-

Texture:- Clastic; phenoclasts (about 30% of rock) 0.04 to 0.1 mm., mostly subrounded and of moderate sphericity. The bedding can be seen vaguely, by slight increases and decreases in the percentage of phenoclasts. The matrix is very fine-grained with an abundance of micaceous flakes. The coarser flakes tend to be aligned parallel to the bedding.

Phenoclasts:- Quartz: about 25% of rock; occurs as discrete grains and a composite clasts of quartz mosaic.

Feldspar: about 5% of rock; altered.

Matrix:- Argillaceous: about 70% of rock; muscovite and sericite are abundant.

Origin:- Sedimentary; probably derived from low grade (quartz mica) metamorphic rocks.

Name:- SANDY MICACEOUS MUDSTONE.

Microslide:- GSQ 2664 ex Specimen:- 1582 Field No:- 227/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- S.W. of Silver Hills Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, very fine-grained dark reddish-brown fluidal rock; phenocrysts up to 2 mm. occur. The rock contains abundant fine ( < 1 mm.) white "spots".

Micro:-

Texture:- Extremely altered; porphyritic-subhedral to euhedral phenocrysts (0.2 to 0.9 mm.) make up about 10% of rock. Groundmass microcrystalline and cryptocrystalline; the microcrystalline areas tend to be concentrated about the phenocrysts and display a fluidal structure. The "spotting" seen in hand specimen appears to be due to the variations in grain size.

Phenocrysts:- Feldspar: (?Oligoclase): > 5% of rock; calcitised and/or zeolitised, with minor pyrophyllite.

Pyrophyllite: < 5% of rock; ragged flakes, greenish in part, with minor associated opaques; possibly replacing pyroxene.

Groundmass:- Feldspar: > 80%; microlites.

? Bastite: < 5% of rock; filling interstices.

Apatite: ≪ 5% of rock; euhedral, very fine crystals.

Opaques: < 5% of rock; fine dust distributed at random. Secondary hematite is concentrated in part.

Origin:- Extremely alteration of a volcanic extrusive.

Name:- Altered, fluidal ?PYROXENE ?TRACHYTE.

Microslide:- GSQ 2665 ex Specimen:- GSQ/R 1584 Field No.:- 227/5

Four Mile Map:- Emerald.

Air Photo (B.M.R.):- Emerald No.:- 5087 Run:- 6

Location:- S.W. of Silver Hills Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, reddish-brown clastic rock with an abundance of volcanic fragments, up to 2 cm. There is a predominance of fluidal material.

Micro:-

Texture:- Clastic; fragments mostly rounded.

Phenoclasts:- About 95% of rock; volcanic material including vitric tuff and silicified spherulitic rhyolite.

Matrix:- Extremely fine-grained ( < 0.0005 mm.), tuffaceous; limonite-stained.

Origin:- Volcanic, pyroclastic; whether any of the phenoclasts are redeposited cannot be determined.

Name:- ?AGGLOMERATE

Microslide:- GSQ 2666 ex Specimen:- GSQ/R 1585 Field No:- 228/5

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5087 Run:- 6

Location:- S.E. of Tadcaster Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, biscuit-coloured, very fine-grained fluidal rock containing rare pink crystals up to 2 mm.

Micro:-

Texture:- Extremely altered; glomeroporphyritic; phenocryst clusters up to 2 mm. make up 5% of rock. Groundmass cryptocrystalline, apparently crudely pilotaxitic. About 15% of the rock is of irregular patches of secondary material, dominantly about 0.1 mm. across.

Phenocrysts:- Plagioclase & ? Sanidine: < 5% of rock; clusters of euhedral to subhedral lath-shaped crystals, extremely altered to clay minerals.

Biotite: rare flakes; extremely altered.

Groundmass:- Feldspar: about 75% of rock; unidentifiable altered microlites.

Biotite: > 5% of rock; very fine flakes, extremely altered.

Secondary Minerals:- ?Zeolite: about 15% of rock; irregular "patches" with serrated margins. Centres contain abundant minute unidentifiable inclusions.

Limonite: Light staining of entire rock.

Origin:- Alteration of volcanic extrusive.

Name:- ?Zeolitised fluidal BIOTITE TRACHYTE.

Microslide:- GSQ 2668 ex Specimen:- GSQ/R 1591 Field No:- 231/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- N.N.E. of Withersfield.

Formation:- Silver Hills Formation Age:- Devonian-Carboniferous

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

Micro:- On overall appearance, the rock seems to have a "swirling" flow structure. About 60% is of very fine opaque dust identified mineragraphically as "probably ilmenite with some hematite" (N.A.H. Simmonds, Geologist).

About 20% feldspar microlites are distributed at random but display a tendency towards parallel alignment. About 20% of the rock is irregular transparent "eyes" filled with secondary antigorite and minor pyrophyllite.

Origin:- Alteration of volcanic extrusive rock. The abundance of ?ilmenite and antigorite suggests that the rock was a fairly basic one.

Name:- Altered fluidal ?ILMENITE - FELDSPAR - ANTIGORITE ROCK.

Microslide:- GSQ 2669 ex Specimen:- GSQ/R 1597 Field No.:- 246/2

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- Mt. Borilla Area

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, very fine-grained, pinkish-buff porphyritic rock containing feldspar phenocrysts, up to 4 mm. in length.

Micro:-

Texture:- Extremely altered, porphyritic; phenocrysts (about 5%) subhedral to anhedral, lath-shaped, altered. Groundmass cryptocrystalline to 0.08 mm. anhedra; minor crude spherulitic structure occurs.

Phenocrysts:- Feldspar (potash feldspar and albite): about 5% of rock; mostly altered to ironstained clay minerals.

Groundmass:- Feldspar: about 55% of rock; heavily sericitised.

Quartz: about 40% of rock.

Origin: Alteration of volcanic extrusive rock.

Name:- Altered Spherulitic RHYOLITE.

Microslide:- GSQ 2670 ex Specimen: 1598 Field No.:- 246/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- Mt. Borilla Area

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, very fine-grained, pinkish-brown fluidal rock with feldspar phenocrysts up to 3 mm.

Micro:-

Texture:- Porphyritic; phenocrysts subhedral to anhedral, lath shaped, mostly about 1.2 mm. in length; about 5% of rock; Groundmass pilotaxitic, microcrystalline. The rock is extremely altered.

Phenocrysts:- Feldspar: $<$ 5% of rock; completely replaced by secondary minerals.

?Pyroxene: $<$ 5% of rock; replaced by antigorite with associated hematite.

Groundmass:- Plagioclase: about 50% of rock; acicular crystals; extremely altered to clay minerals; appears to be more basic than oligoclase.

?Antigorite and ?Clay Minerals: about 40% of rock; secondary.

Opaques: about 5% of rock; fine, granular.

Origin:- Fluidal volcanic extrusive which has been extremely altered.

Name:- Altered fluidal ?BASALT.

Microslide:- GSQ 2671 ex Specimen:- GSQ/R 1602 Field No.:- 248/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- N.E. of Withersfield

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

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

Micro:-

Texture:- Extremely altered; essentially basaltic; cryptocrystalline to 0.05 mm. with rare crystals up to 0.15 mm.

Constituents:- Plagioclase (andesine or labradorite): about 65% of rock; acicular crystals.

Antigorite: about 15% of rock; filling interstices.

?Magnetite: about 10% of rock; euhedral to subhedral; with associated secondary hematite, in part.

Calcite: about 10% of rock; secondary, dispersed at random.

Veining:- The rock is cut by fine veins of chlorite and of quartz and chalcedony.

Origin:- Alteration of an igneous extrusive rock.

Name:- Altered BASALT.

Microslide:- GSQ 2672 ex Specimen:- GSQ/R 1605 Field No.:- 249/12b.

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- Silver Hills, 1 mile west of Silver Hills Homestead.

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, pinkish-grey fluidal rock with about 60% secondary vein and cavity filling.

Micro:-

Texture:- Host rock cryptocrystalline, allotriomorphic-granular with some acicular crystals (up to 0.07 mm.). The secondary material is distributed at random in extremely irregular cavities and occurs as a fine mosaic, with a grain size up to 0.3 mm, dominantly 0.05 mm.

Host Rock:- Acid Feldspar (acid oligoclase, albite or potash feldspar): predominant; anhedra.

Oligoclase: acicular crystals; rare.

?Mafic Mineral: Rare crystals, the largest being about 3 mm. x 0.25 mm; replaced by pyrophyllite and opaque material (?pyrite).

Secondary Material:- Zeolite (?chabazite), quartz and minor ?potash feldspar. The quartz fills the cores of the cavities and is, in general, surrounded by a fringe of zeolite.

Origin:- The rock is somewhat altered. A volcanic extrusive in which late volatiles were abundant.

Name:- Amygdaloidal fluidal TRACHYTE.

Microslide:- GSQ 2675 ex Specimen:- GSQ/R 1608 Field No.:- 250/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- Old Silver Hills, near homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, very pale grey bedded sediment.

Micro:- Essentially similar to 225/4C except in the following detail:-

250/1 comprises about 80% phenoclasts in a matrix composed almost entirely of sericite.

Name:- MICACEOUS QUARTZ SANDSTONE.

Microslide:- GSQ 2677 ex Specimen:- GSQ/R 1610 Field No.:- 251/9

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 1

Location:- Saltwater Ck., N.W. of Peak Vale Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, purplish, banded and spherulitic rock.

Micro:-

Texture:-

Extremely altered. Very thinly-banded, alternating 0.5 and 0.1 mm. bands. Thicker bands are spherulitic, individual structures having a diameter of about 0.5 mm. Thinner bands comprise, essentially, finely dendritic opaques. Fine veins occur and are roughly conformable with the bedding.

Spherulites:- Siliceo - feldspathic; altered.

Veins:- Siliceous mosaic.

Origin:- Alteration of a volcanic extrusive rock.

Name:- Altered banded spherulitic RHYOLITE.

Microslide:- GSQ 2680 ex Specimen:- GSQ/R 1615 Field No.:- 251/15

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 1

Location:- Saltwater Ck., N.W. of Peak Vale Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, pinkish-grey, fine-grained sediment

Micro:- Essentially similar to 225/4C except in the following details:-

(1) Phenoclasts:- make up about 35% of rock.

Quartz: about 20%

Feldspar: about 10%

Muscovite: and Biotite: < 5%

Zircon: minor

? Hornblende: minor

Opaques: minor

(2) Origin:- Sedimentary; derived from low grade (quartz, mica) metamorphic rocks and from granite.

Name:- SANDY MICACEOUS MUDSTONE.

Microslide:- GSQ 2681 | ex Specimen:- GSQ/R 1616 | Field No.:- 252/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald | No.:- 5008 | Run:- 1

Location:- S. of Saltwater Ck., N.W. of Peak Vale Homestead.

Formation:- Silver Hills Volcanics | Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, pink, irregularly fluidal rock with pink feldspar phenocrysts, many of which are aligned, up to 2 mm.

Micro:-

Texture:- Extremely altered. Porphyritic; phenocrysts ( $< 10\%$) euhedral to subhedral, mostly 0.7 to 0.9 mm. Groundmass microcrystalline, mostly crudely spherulitic; in part, microfluidal, devitrified glass, heavily ironstained. Irregular secondary, fine mosaics are common ( $< 10\%$).

Phenocrysts:- Feldspar (oligoclase and ? potash feldspar): $< 10\%$ of rock; mostly very altered to ironstained clay minerals. Some of the lamellar twins have been replaced, in part, by zeolite.

Groundmass:- Quartzofeldspathic: altered; ironstained, in general; opaque dust abundant.

Secondary Minerals:- Intergrowths of quarts and zeolite fill cavities in the rock.

Origin:- Alteration of a volcanic extrusive.

Name:- Altered fluidal RHYOLITE.

Microslide:- GSQ 2682 | ex Specimen:- GSQ/R 1617 | Field No.:- 252/2

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald | No.:- 5008 | Run:- 1

Location:- S. of Saltwater Ck., N.W. of Peak Vale Homestead.

Formation:- Silver Hills Volcanics | Age:- Devonian-Carboniferous

Macro:- A massive, dark yellowish-brown, fine-grained, rock displaying a marked "swirling" pattern and traversed by numerous veins.

Micro:-

Texture:- Extremely altered. Clastic; phenoclasts (about 30%) 0.2 to 2.0 mm. of two types:- (a) crystals, commonly broken and corroded and (b) rock fragments, commonly distorted. Matrix extremely fine-grained with a very fine "swirled" structure. Secondary veins are very fine and irregular.

Phenoclasts:-

(a) Crystals:-

Feldspar (oligoclase): $< 20\%$ of rock; altered, calcitised in part with or without minor clay minerals and chlorite; commonly fringed by a narrow zone of iron oxide concentration.

Quartz: $< 1\%$ of rock; strained.

Bastite: about 1 to 2%; with minor associated calcite and opaques.

(b) Lithic Materials:- about 10% of rock; fragments fringed by a zone of concentration of iron oxides.

Porphyritic trachyte: predominant.

Bastite Andesite: minor, grain size about 0.1 mm.

Matrix:- Tuffaceous: almost translucent due to the concentration of limonite.

Veins:- Quartz mosaic, fringed with iron oxides.

Zeolite occurs, apparently filling a cavity in the rock.

Origin:- Volcanic, pyroclastic; phenoclasts probably, in part, redeposited volcanic material.

Name:- Altered LITHIC CRYSTAL TUFF.

Microslide:- GSQ 2683 ex Specimen:- GSQ/R 1618 Field No.:- 252/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 1

Location:- S. of Saltwater Ck., N.W. of Peak Vale Homestead

Formation:- Silver Hills Formation Age:- Devonian-Carboniferous

Macro:- A massive, purplish-brown, very fine-grained rock.

Micro:-

Texture:- Altered, intersertal, fluidal; grain size about 0.08 60 0.03 mm.

Constituents:- Plagioclase (? andesine): about 55% of rock; altered acicular crystals.

Clinopyroxene: about 15% of rock; granular.

Opaques: about 10% of rock; euhedral to anhedral.

Antigorite & Zeolite: about 20%; filling interstices.

Apatite: accessory; euhedral.

Origin:- Alteration of a volcanic extrusive.

Name:- Altered fluidal BASALT.

Microslide:- GSQ 2684 ex Specimen:- GSQ/R 1620 Field No.:-252/5

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No:- 5008 Run:-1

Location:- S. of Saltwater Ck., N.W. of Peak Vale Homestead.

Formation: Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, very fine-grained, dark pinkish-brown rock. Seen macroscopically, the thin section displays a marked banding.

Micro:-

Texture:- Extremely altered. Porphyritic; phenocrysts (about 5%) are subhedral to anhedral, mostly about 0.4 mm. Groundmass spherulitic, the structures being, in general 0.3 mm. Extremely irregular "patches" of secondary mosaic make up about 20% of rock. Fine dendritic opaques are relatively abundant.

Phenocrysts:- Feldspar: about 5% of rock; crystals altered to ironstained clay minerals and minor sericite.

Groundmass:- Essentially silicco-feldspathic.

Secondary Minerals:- Quartz and zeolite, commonly intergrown.

Origin:- Alteration of a volcanic extrusive.

Name:- Altered banded spherulitic RHYOLITE.

Microslide:- GSQ 2685 ex Specimen:- GSQ/R 1621 Field No.:- 252/6

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 1

Location:- S. of Saltwater Ck., N.W. of Peak Vale Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, leached, whitish, fine-grained, spherulitic rock with approximately 40% cavities lined with fine crystals.

Micro:-

Texture:- Altered; spherulitic and amygdaloidal. Spherules commonly round, 0.3 mm. across. Amygdules commonly, ellipsoidal, about 1 mm. by 0.5 mm.

Spherules:- Silicco-feldspathic; altered with minor limonite-staining.

Amygdules:- Quartz crystals.

Origin:- Alteration of a volcanic extrusive rock.

Name:- Altered amygdaloidal spherulitic RHYOLITE.

Microslide:- GSQ 2686 ex Specimen:- GSQ/R 1622 Field No.:- 255/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 1

Location:- Saltwater Ck., N.W. of Peak Vale Homestead.

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, dark reddish-brown porphyritic rock with a very irregular "swirled" fluidal texture. Phenocrysts are up to 4 mm. The rock is traversed by a network of very fine veins.

Micro:-

Texture:- Extremely altered and ironstained. Porphyritic; phenocrysts (about 5%) subhedral to anhedral, somewhat broken and corroded in part. Groundmass comprises irregular extremely thinly-banded altered material which has "swirled" about the phenocrysts and about coarser-grained (about 0.02 mm.) allotriomorphic-granular "nodules" which tend to be ellipsoidal in shape, commonly about 1 mm. x 0.5 mm. Fine veins of fine-grained secondary mosaic traverse the rock at all angles.

Phenocrysts:- Plagioclase (?Oligoclase or ?Albite): about 10% of rock; crystals poorly-twinned, altered to clay minerals. Commonly broken and displaced by partial infilling by secondary quartz-?zeolite mosaic. Commonly rimmed by a fine fringe of hematite or limonite.

Groundmass:- "Nodules"; about 15% of rock; feldspathic, altered and ironstained; ?devitrified glass.

Thinly-banded material:- about 45% of rock; feldspathic with minor sericite and clouded by clay minerals and ironstaining.

Veins:- Quartz-zeolite intergrowth.

Origin:- Volcanic extrusive, subsequently altered. The "nodules" probably represent xenoliths or autoliths, picked up by the main mass of the flow prior to flow and subsequent cooling. The mica appears to be primary.

Name:- Altered fluidal RHYOLITE.

Microslide:- GSQ 2688 ex Specimen:- GSQ/R 1626 Field No.:- 257/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 1

Location:- Gorge Ck., N.W. of Peak Vale Homestead.

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, pinkish-coloured clastic rock with fragments dominantly 1 to 2 mm. One fragment of spherulitic rock, 2 cm. across occurs.

Micro:-

Texture:- Extremely altered. Clastic; phenoclasts (about 70% of a sizes; of two types - (a) rock material (b) crystals commonly broken and corroded. Matrix extremely fine-grained. A network of very fine veins traverses the rock.

Phenoclasts:-

(a) Lithic material: about 45% of rock; dominantly spherulitic rhyolite and broken spherules, with associated secondary clacite.

(b) Crystals: about 25% of rock; dominantly oligoclase.

Matrix:- Tuffaceous: feldspathic, somewhat altered.

Veins:- Quartz, with minor intergrown zeolite.

Origin:- Alteration of a volcanic, pyroclastic. The rock fragments may or may not be redeposited. The lack of variety in the fragments suggests that they are not redeposited.

Name:- Altered CRYSTAL LITHIC TUFF.

Microslide:- GSQ 2689 ex Specimen:- GSQ/R 1627 Field No.:- 257/6

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 1

Location:- Gorge Ck., N.W. of Peak Vale Homestead.

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, purplish-brown, porphyritic (up to 2 mm.) rock which has a marked flow-banding.

Micro:-

Texture:- Extremely altered and ironstained. Porphyritic (about 10%); phenocrysts subhedral to anhedral, somewhat broken and corroded, dominantly 1.0 to 2.0 mm. Groundmass banded; dominantly an intricate mosaic with a grain size of about 0.05 mm. Interbanded are very fine bands of very fine-grained material. Roughly conformable veins of secondary mosaic are quite abundant.

Phenocrysts:- Plagioclase (?Oligoclase): < 10% of rock; altered to clay minerals and ironstained.

Bastite (after ?Augite): < 5% of rock with abundant associated opaques.

Groundmass:- Mosaic: feldspathic; clouded by alteration and opaque dust.

Fine bands: cryptocrystalline feldspathic and micaceous.

Veins:- Quartz with or without zeolite and/or calcite and/or feldspar.

Origin:- Alteration of volcanic extrusive. Bands possibly represent individual flows.

Name:- Altered PYROXENE TRACHYTE.

Microslide:- GSQ 2690 ex Specimen:- GSQ/R 1629 Field No.:- 261/6

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 1

Location:- Snake Ck., N.W. of Peak Vale Homestead

Formation:- Silver Hills Volcanics Age:- Devonian-Carboniferous

Macro:- A massive, dark red, fine-grained rock.

Micro:- Basically similar to 252/2 but with the following differences:-

(a) 261/6 contains phenoclasts of spherulitic rhyolite as well as trachyte and andesite.

(b) The matrix of 261/6 contains numerous devitrified shards.

(c) The matrix of 261/6 is denser than that of 252/2 and stained with hematite, not limonite.

Name:- Altered LITHIC CRYSTAL TUFF.

Telomon Formation

Microslide:- GSQ 2650 ex Specimen:- GSQ/R 1567 Field No.:- 140/7A

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- S. of Old Silver Hills Homestead.

Formation:- Telomon Age:- Devonian-Carboniferous

Macro:- A massive, pinkish-grey rock, rich in feldspar.

Micro:-

Texture:- Porphyritic; phenocrysts (about 60% of rock) subhedral to euhedral, 0.25 to 4 mm.; groundmass cryptocrystalline.

Phenocrysts:- Plagioclase (andesine): originally about 55% of rock; extremely altered to sericite and/or chlorite and epidote.

?Hornblende: about 5% of rock; pseudomorphed by secondary chlorite, epidote and opaque material.

Groundmass:- Comprises acicular feldspar, chlorite and minor epidote.

Origin:- Hydrothermal alteration of a volcanic extrusive rock.

Name:- Altered ANDESITE.

Microslide:- GSQ 2651 ex Specimen:- GSQ/R 1568 Field No.:- 140/7B

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- S. of Old Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, light-grey, fine-grained rock.

Micro:-

Texture:- Porphyritic; phenocrysts (about 10% of rock) anhedral to subhedral about 0.5 to 1 mm.; groundmass intersertal, about 0.1 mm.

Phenocrysts:- Andesine: saussuritised.

Groundmass:- Andesine: about 45% of rock; lath-shaped crystals.

Pennine chlorite: about 30% of rock; filling interstices.

Epidote and Clinozoisite: about 10% of rock; granular.

Calcite: about 5% of rock; anhedral.

Origin:- Hydrothermal alteration of volcanic extrusive.

Name:- Altered ANDESITE.

Microslide:- GSQ 2652 ex Specimen:- GSQ/R 1569 Field No.:- 140/8

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- S. of Old Silver Hills Homestead.

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, purplish-brown thinly-bedded clastic rock.

Micro:-

Texture:- Clastic; phenoclasts about 95% of rock; these fragments are angular to subrounded, of moderate sphericity, 0.05 to 0.1 mm.

Phenoclasts:- Lithic Material: about 65% of rock; very fine-grained micaceous material (? schist) and ? tuff.

Quartz: about 30% of rock; grains commonly composite.

Matrix:- about 5% of rock; represented by reddish-brown opaque dust filling the interstices of the rock. Possibly concentrated by slight metamorphism.

Origin:- Very low grade ? metamorphism of sedimentary rock.

Name:- ? Metamorphosed LITHIC SANDSTONE.

Microslide:- GSQ 2654 ex Specimen:- GSQ/R 1571 Field No.:- 140/12C

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- S. of Old Silver Hills Homestead.

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, purplish-brown clastic rock.

Micro:-

Texture:- Clastic; about 90% phenoclasts. Grains 0.2 to 0.5 mm., rounded to subrounded, of moderate sphericity, somewhat corroded.

Phenoclasts:- Granitic Material: about 40% of rock; quartz, altered feldspar (including oligoclase), mica, graphic intergrowths and rare composite quartzofeldspathic grains.

Lithic Material: about 50% of rock; quartzite, very fine-grained micaceous material, tuff, metasiltstone and fine-grained material very rich in opaques.

Matrix:- About 10% of rock; very fine-grained ? tuff; mostly replaced by calcite.

Origin:- Alteration of a clastic rock formed by the contemporaneous deposition of ? pyroclastic ejecta and fragments derived from a granitic, volcanic and metamorphic terrain.

Name:- Altered ? TUFFACEOUS LITHIC SANDSTONE.

Microslide:- GSQ 2612 ex Specimen:- GSQ/R 1514 Field No.:- 225/9A

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- N.W. of Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, purplish brown, clastic rock with fragments up to 5 mm.

Micro:-

Texture:- Clastic; phenoclasts make up at least 85% of rock. These fragments are commonly corroded and distorted; in general, their sphericity is very low and the grain size up to 5 mm, dominantly 2-4 mm. The matrix (about 5% of rock) is extremely fine-grained and appears to have flowed around the fragments. Random secondary silicification makes up about 10% of rock.

Phenoclasts:- Lithic material: about 80% of rock; only some of the fragments could be identified:-
vitric tuff (with abundant hematite dust) fluidal feldspathic volcanic spherulitic rhyolite

Crystals: feldspar; about 5% of rock; extremely corroded.

Matrix:- Tuffaceous: about 5% of rock. Extremely fine-grained

Alteration:- Secondary silicification (see above).

Origin:- Volcanic; pyroclastic.

Name:- LITHIC TUFF.

Microslide:- GSQ 2614 | ex Specimen:- GSQ/R 1516 | Field No.:- 225/9C

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald | No.:- 5075 | Run:- 5

Location:- N.W. of Silver Hills Homestead

Formation:- Telemon | Age:- Devonian-Carboniferous

Macro:- A massive, very fine-grained, purplish rock.

Micro:-

Texture:- Clastic; about 30% of rock is phenoclasts which are angular to subrounded (corroded in part), of moderate to low sphericity, 0.01 to 0.07 mm. Matrix is extremely fine-grained and makes up about 60% of rock. Mica flakes, produced by very low grade metamorphism, make up about 10% of rock and show no preferred orientation.

Phenoclasts:- Quartz and Feldspar:- about 20% of rock.

Lithic material (? tuff): about 10% of rock - more rounded and equant than the quartz and feldspar.

Matrix:- Tuffaceous: about 60% of rock; extremely fine-grained and masked by an abundance of fine hematite dust which tends to be concentrated in irregular bands.

Mica: (sericite and minor muscovite) about 10% of rock.

Alteration:- The rock is traversed by fine siliceous veins and chlorite veins.

Origin:- Very low grade metamorphism of a rock produced by the contemporaneous deposition of pyroclastic ejecta and debris derived from the erosion of a ? granitic and volcanic terrain. Very low grade metamorphism has caused mica to grow, probably from argillaceous elements in the matrix, and hematite to be concentrated.

Name:- Metamorphosed SILTY TUFF.

Microslide:- GSQ 2615 | ex Specimen:- GSQ/R 1517 | Field No.:- 225/10

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald | No.:- 5075 | Run:- 5

Location:- N.W. of Silver Hills Homestead

Formation:- Telemon | Age:- Devonian-Carboniferous

Macro:- A massive, light grey porphyritic rock with phenocrysts up to 2 mm. and with a few xenoliths of very fine-grained dark grey material (4 to 8 mm.)

Micro:-

Texture:- Rock decomposed almost beyond recognition. Porphyritic; phenocrysts subhedral to anhedral up to 2 mm. Groundmass probably intersertal, very fine-grained.

Phenocrysts:- Plagioclase (? andesine): about 35% of rock; extremely altered to clay minerals and/or sericite and/or epidote, and/or pennine chlorite, and/or calcite.

?Mafic Mineral: about 15% of rock; completely replaced by a mixture of pennine chlorite, epidote (commonly relatively coarse prismatic crystals) and calcite.

Groundmass:- About 40% of rock; comprises laths of feldspar, fine chlorite, granular epidote, fine calcite and sericite. Minor biotite occurs.

Xenoliths:- A fine-grained granular mass of epidote, pennine chlorite, minor calcite and secondary quartz.

Alteration:- Secondary silicification has taken place and produced a discontinuous quartz mosaic which makes up about 10% of the rock.

Origin:- low grade metamorphism (mica) followed by hydrothermal alteration of a porphyritic volcanic rock.

Name:- Metamorphosed Altered ? ANDESITE.

Microslide:- GSQ 2616 ex Specimen:- GSQ/R 1518 Field No.:- 225/11

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- N.W. of Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, light grey calcareous rock.

Micro:-

Texture:- Clastic in part; dominantly microcrystalline; rock contains about 80% equant to oblong bodies, about 0.2 to 0.08 mm. of ? organic material (possibly algal).

Phenoclasts:- Quartz: < 5% of rock; angular to subrounded grains, about 0.02 mm.

Biotite: < 2% of rock; altered fine flakes.

Cement/Matrix:- Calcite: about 15% of rock; fresh microcrystalline.

? Organic Remains: about 80% of rock; microcrystalline calcite, somewhat cloudy.

Origin:- Partial recrystallisation of a silty ? organic limestone.

Name:- ? ORGANIC LIMESTONE.

Microslide:- GSQ 2617 ex Specimen:- GSQ/R 1519 Field No.:- 226/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- N.W. of Silver Hills Homestead

Formation:- Telemon Formation Age:-Devonian-Carboniferous

Macro:- A massive, irregularly-banded, light brown, tough rock.

Micro:-

Texture:- Hornfelsic ex clastic; the banding represents interlensing of sedimentary material of varying composition and grain size. The lenses appear to have been of mudstone, silty (average 0.04 mm.) mudstone and sandy (average 0.2 mm.) mudstone. The rock now comprises a siliceous mosaic (0.04 to 0.2 mm.) interspersed with varying amounts of micaceous minerals.

Constituents:- Quartz:- estimated at about 25% of rock; allotriomorphic-granular, 0.04 to 0.2 mm.

Sericite:- estimated at about 35% of rock; fine flakes, faintly greenish in colour.

Chlorite:- estimated at about 20% rock; yellowish-green in colour.

Muscovite: estimated at about 10% of rock; colourless.

Biotite: estimated at $>$ 5% of rock; pleochroic from green to almost colourless (probably variety stilpnomelane).

? Magnetite: estimated at $<$ 5% of rock; fine, euhedra and anhedra.

Origin:- Contact metamorphism of an argillaceous-quartz sediment.

Name:- MICA HORNFELS.

Microslide:- GSQ 2618 ex Specimen:- GSQ/R 1520 Field No.:- 227/6

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- S.W. of Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, dark reddish brown clastic rock, comprising beds, 5 to 10 mm. thick, of fine-grained and very fine-grained and very fine-grained material.

Micro:-

(A) Fine-grained beds :-

Texture:- Clastic; phenoclasts and matrix difficult to distinguish, ratio estimated at 9:1; phenoclasts subrounded to subangular, somewhat embayed and corroded; sphericity low, grain size 1.2 to 0.05 mm., dominantly about 0.3 mm.

Phenoclasts:- Originated from 3 source rock types.

(I) Granitic :- about 50% of rock.

(a) Feldspar: predominant; extremely altered potash feldspar slightly predominates over fresh acid plagioclase.

(b) Quartz: mostly discrete crystals, some composite grains; minute inclusions abundant.

(c) Biotite: chloritised;

(c) Composite Grains:

(i) Quartz and potash feldspar
(ii) Quartz, feldspar and mica
(iii) Graphic intergrowths

(II) Volcanic:- about 35% of rock.

(a) Vitric tuff: shards heavily ironstained, matrix slightly chloritic.

(b) ?Intermediate extrusive material: very fine-grained, altered.

(c) ?Rhyolite: altered

(d) Tuff: similar to the matrix of the vitric tuff.

(III) Metamorphic:- about 5% of rock.

(a) Quartzite. } very fine-grained about 0.01 mm.
(b) Sericite-quartz hornfels }

Matrix:- Ashy; fairly rich in green chlorite; ironstained in part.

(B) Very fine-grained beds:-

Essentially similar to (A) except in the following ways:-

(i) phenoclasts make up about 20% of the rock instead of 90%.

(ii) sorting is better; the phenoclasts have a grain size of 0.02 to 0.05 mm. with rare ones to 0.1 mm.

Origin:- Contemporaneous deposition of pyroclastic ash and material derived from the erosion of granitic, volcanic and metamorphic rocks. The corrosion and embayment of the phenoclasts indicates that the two fragments were mixed while the ash was still hot, thus suggesting aeolian deposition.

Name:- Bedded TUFFACEOUS LITHIC SANDSTONE.

| | | |
|---|---|---|
| Microslide:- GSQ 2619 | ex Specimen:- GSQ/R 1521 | Field No.:- 227/7 |

Four Mile Map:- Emerald

| | | |
|---|---|---|
| Air Photo (B.M.R.):- Emerald | No.:- 5100 | Run:- 5A |

Location:- S.W. of Silver Hills Homestead

Formation:- Telemon    Age:- Devonian-Carboniferous

Macro:- A massive, dark purplish-brown, fine-grained, thinly-bedded, tough rock.

Micro:-

Texture:- Clastic; phenoclasts, mostly subrounded with a moderate sphericity and a grain size of about 0.08 mm; phenoclasts about 75%, matrix about 25%.

Phenoclasts:- Quartz: (with minor associated feldspar): about 25% of rock; minute inclusions quite abundant in quartz.

Biotite: about 10% of rock; extremely altered.

Zircon: about 5% of rock; round grains surrounded by a heavy fringe of translucent reddish brown material, ? hematite.

Lithic Material: 30% of rock; extremely altered and thus difficult to identify; three types can be recognised :-

(i) Mica ? Schist
(ii) Very fine-grained material, tuff or mudstone.
(iii) Chloritic material, possibly altered intermediate volcanic extrusive.

Opaque Material: $<$ 5% of rock.

Muscovite: $<$ 5% of rock; fresh flakes.

Matrix:- Argillaceous; small amounts of fresh sericite occur; heavily ironstained.

Origin:- Original rock was a sediment, probably derived from a dominantly granitic and metamorphic terrain. Subsequently, very low-grade metamorphism has resulted in the growth of the sericite and muscovite.

Name:- Metamorphosed GREYWACKE.

| | | |
|---|---|---|
| Microslide:- GSQ 2621 | ex Specimen:- GSQ/R 1523 | Field No.:-227/7B |

Four Mile Map:- Emerald

| | | |
|---|---|---|
| Air Photo (B.M.R.):- Emerald | No.:- 5100 | Run:- 5A |

Location:- S.W. of Silver Hills Homestead

Formation:- Telemon    Age:- Devonian-Carboniferous

Macro:- A massive, light grey, clastic rock with an abundance of fragments about 3 mm. and rare ones to 25 mm.

Micro:- Clastic; comprising about 85% phenoclasts in about 15% extremely fine-grained matrix; phenoclasts 0.5 to 3 mm., subrounded to rounded, of moderate to high sphericity, with some of their margins embayed.

Phenoclasts:- Originated from three distinct types of source rock:-

I. Volcanic:- about 40% of rock; of two varieties.

(i) Authigenic (about 10% of rock) crystal tuff: margins distorted as if the fragments were hot when picked up.

(ii) Allogenic: altered porphyritic intermediate, extrusive material, altered crystals tuff and rhyolite; some of these fragments were silicified prior to deposition in this environment.

II. Granitic:- about 35% of rock: found as discrete grains of quartz, discrete grains of quartz, feldspar or mica or as fragments of fine-grained granitic rock.

III. Metamorphic:- about 10% of rock; mica schist and quartzite.

Matrix: Extremely fine-grained ash.

Alteration: Minor secondary silicification has taken place.

Origin:- Contemporaneous deposition of pyroclastic ejecta and debris derived from the erosion of granitic, volcanic and metamorphic rocks.

Name:- TUFFACEOUS CONGLOMERATE.

Microslide:- GSQ 2622 ex Specimen:- GSQ/R 1524 Field No.:- 227/8

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No:- 5100 Run:- 5A

Location:- S.W. of Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, pale pinkish-brown, very fine-grained banded rock, with abundant dendrites.

Micro:-

Texture:- Fluidal; about 35% acicular crystals showing a preferred orientation; about 30% dendritic iron oxide, dominantly hematite; about 35% very fine-grained argillaceous material.

Constituents:- Feldspar: about 35%; acicular crystals, very altered; most, if not all, is plagioclase.

Hematite; about 30%; dendritic.

Groundmass: about 35%; cryptocrystalline, dominantly feldspathic.

Sericite: a small amount of fine, pale green sericite has grown in the rock after solidification due to very low grade metamorphism.

Alteration:- A few amygdules occur; they comprise calcite surrounded by a rim of hematite.

Origin:- Very low grade contact metamorphism of an acid to intermediate extrusive rock.

Name:- Metamorphosed ? DACITE

Microslide:- GSQ 2623 ex Specimen:- GSQ/R 1525 Field No.:- 227/10

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- S.W. of Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, pinkish-brown, porphyritic rock.

Micro:-

Texture:- ?Porphyritic; "groundmass" crudely fluidal. The "groundmass" makes up about 65% of the rock and envelops crystals of plagioclase (dominantly oligoclase), potash feldspar and hornblende (pseudomorphed by calcite and opaques), and composite grains consisting essentially of feldspar with minor quartz and opaques. The crystals are subhedral to anhedral, 0.2 to 2.2 mm.; some have corroded by the groundmass. The grains are up to 4 mm. and have an internal grain size of 0.1 to 1.5 mm.

Some of the crystals may be phenocrysts but most are undoubtedly xenocrysts.

"Groundmass":-

Constituents:- Plagioclase (?acid andesine): about 65% of material; acicular crystals, somewhat altered.

Chlorite: about 30% of material; filling interstices between feldspars.

Mica: about 5%; granular.

Alteration: Rock is hydrothermally altered and has undergone very low grade contact metamorphism.

Origin:- Very low grade metamorphism of extrusive volcanic rock containing abundant allothigenous material.

Name:- Metamorphosed ANDESITE.

Microslide:- GSQ 2626 ex Specimen:- GSQ/R 1528 Field No.:- 230/2

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- N.W. of Tadcaster Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, light brown, lustrous rock.

Micro:-

Texture:- Clastic; phenoclasts make up about 80% of rock. They are of two types:- corroded crystals, 0.1 to 0.4 mm. of low to moderate sphericity and lithic fragments, similar in size and sphericity. The matrix is very fine-grained, cloudy; devitrified shards are quite abundant.

Phenoclasts:- Feldspar (potash and andesine): about 25% of rock; altered.

Quartz: about 10% of rock.

Lithic Material: about 45% of rock; of two types:

(a) Volcanic (predominant);

Tuff
Vitric tuff
Feldspathic extrusives
Fluidal rhyolite

(b) Metamorphic

Quartzite
Mica Schist.

Matrix:- Tuffaceous: about 20% of rock; rich in chlorite. Opaque dust abundant.

Alteration:- Considerable; including minor pyritisation.

Origin:- Essentially pyroclastic; the shards, some of the crystals and some of the lithic material are essential constituents. The remainder of the material is derived from erosion of older rocks.

Name:- SANDY VITRIC-CRYSTAL-LITHIC TUFF.

Microslide:- GSQ 2627 ex Specimen: 1529 Field No. 230/2b

Four Mile Map:- Emerald

Air Photo (B.MR.):- Emerald No.:- 5088 Run:- 6

Location:- N.W. of Tadcaster Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A tough, massive, pinkish-brown, very fine-grained, banded rock cut by a conformable siliceous vein, about 3 cm. wide.

Micro:-

Texture:- Clastic; with rare phenoclasts ( $< 1\%$) which are embayed. About 5% mica occurs which is granular or flaky, the flakes having a preferred orientation.

Phenoclasts:- Quartz

Matrix:- Tuffaceous: chloritic and feldspathic; extremely fine-grained.
Mica: granular brown biotite and flakes of greenish biotite.

Vein:- Quartz: fine mosaic with a grain size of about 0.02 mm.
Chalcedony: developed, in part, as fine veins displaying a spherulitic structure.

Origin:- Silicification and very low grade metamorphism of volcanic pyroclastic rock.

Name:- Metamorphosed and silicified TUFF

Microslide:- GSQ 2713 ex Specimen:- GSQ/R 1679 Field No.:- 232/6

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- E. of Withersfield

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, medium- to fine-grained, light brown clastic rock with rare fragments up to 8 mm.

Micro:-

Texture:- Clastic; consisting of about 85% phenoclasts and 5% matrix together with about 10% ironstained secondary calcite. The phenoclasts are 0.08 to $> 6$ mm., angular to rounded, of low to moderate sphericity.

Phenoclasts:- Dominantly granitic and volcanic rock fragments with some strained quartz (with abundant minute inclusions) and altered feldspar and minor mica schist.

Matrix:- Argillaceous.

Origin:- Sedimentary; derived, predominantly, from the pre-Devonian "granites" and Silver Hills Volcanics.

Name:- LITHIC SANDSTONE.

Microslide:- GSQ 2629 ex Specimen:- GSQ/R 1531 Field No.:- 232/6(i)

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- E. of Withersfield

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive mauve-coloured rock traversed by networks of veins.

Micro:-

Texture:- Clastic; extremely fine-grained with an abundance of devitrified glassy material distributed at random. One fragment of quartzite occurs.

Constituents:- Tuff

Devitrified Glass: siliceous.

Opaque Dust: abundant.

Calcite: secondary; distributed at random

Veins:- Siliceous.

Origin:- Alteration of a pyroclastic rock which has been slightly contaminated by detrital material.

Name:- Altered VITRIC TUFF.

Microslide:- GSQ 2630 ex Specimen:- GSQ/R 1539 Field No.:- 248/4

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- N.E. of Withersfield

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A tough, massive, dark grey, clastic rock with fragments up to 4 mm.

Micro:-

Texture:- Clastic; phenoclasts up to 4 mm., with distorted outlines and of very low sphericity. The rock is extremely altered with the dominant feature being the presence of about 30% secondary calcite. No matrix can be distinguished.

Phenoclasts:- Lithic Material: mostly extremely altered. The following types can be recognised:-

Vitric tuff
Tuff
Rhyolite
Intermediate extrusive (rich in chlorite).

Origin:- Alteration of a volcanic pyroclastic rock.

Name:- Altered LITHIC TUFF.

Microslide:- GSQ 2631 ex Specimen:- GSQ/R 1541 Field No.:- 248/5(a)

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- N.E. of Withersfield

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, pinkish-brown, fine-grained, altered rock.

Micro:-

Texture:- Intersertal; grain size about 0.1 to 0.3 mm. Rock very heavily limonite-stained and altered.

Constituents:- Plagioclase: about 40%; subhedral to anhedral, lath-shaped crystals; pinkish in colour and altered to clay minerals.

Pennine Chlorite: green.
Biotite: green and brown, very altered and ragged.
Calcite: minor.
Opaques: ?magnetite.
} together fill the interstices of the rock.

Origin:- Extreme alteration of volcanic extrusive rock.

Name:- Altered BIOTITE ?ANDESITE.

Microslide:- GSQ 2633 ex Specimen:- GSQ/R 1544 Field No:- 249/11a

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- Silver Hills, 1 mile west of Silver Hills Homestead.

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, pinkish-brown, clastic rock, with an abundance of rock fragments 3 to 10 mm, and one fragment more than 6 cm. across.

Micro:-

Texture:- Clastic; Rock fragments make up about 80% of rock; they are dominantly of low sphericity with distorted outlines and about 3 mm. across. Broken and corroded crystals make up 5% of the rock.

Phenoclasts:- Lithic Material: about 80% of rock: the following types can be identified:-

spherulitic rhyolite
fluidal rhyolite
rhyolite
porphyritic volcanic (? andesite)
tuff
vitric tuff
mica hornfels

Crystals: Feldspar: about 5% of rock; broken and corroded.

Groundmass: Tuffaceous: about 15% of the rock; very fine-grained.

Metamorphism:- Fine flakes of sericite and biotite are developed throughout due to low grade metamorphism. Secondary quartz veins and chlorite veins are fairly common.

Origin:- Low grade metamorphism of an essentially volcanic pyroclastic rock.

Name:- Metamorphosed LITHIC TUFF.

Microslide:- GSQ 2635 ex Specimen:- GSQ/R 1546 Field No.:- 249/11c

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- Silver Hills, 1 mile west of Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, dark grey, fine-grained rock with phenocrysts of feldspar up to 8 mm. in length.

Micro:-

Texture:- Porphyritic; phenocrysts, mostly anhedral, 2 to 0.3 mm., make up about 60% of the rock; groundmass intersertal, grain size about 0.05 to 0.1 mm.

Phenocrysts:- Labradorite (about $An_{54}$): about 30% of rock; sericitised in part.

Mafic mineral: about 30% of rock; extremely altered and represented by actinolite, chlorite, calcite and sphene - possibly originally pyroxene.

Groundmass:- Plagioclase: about 10% of rock; acicular crystals, extremely altered.

Chlorite, actinolite and minor sphene and calcite: about 25% of rock; filling the interstices of the rock.

Opaques (?magnetite): about 5% of rock; fine euhedra.

Origin: Extreme alteration (probably very low grade metamorphism) of a volcanic extrusive.

Name:- Altered BASALT.

Microslide:- GSQ 2636 ex Specimen:- GSQ/R 1547 Field No:- 249/11d

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- Silver Hills, 1 mile west of Silver Hills Homestead.

Formation:- Telemon Age:- Devonian-Carboniferous

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

Micro:-

Texture:- Clastic; phenoclasts make up about 55% of rock. Phenoclasts of 2 types :-

(a) Rock fragments - elongate, distorted fragments, about 0.2 mm; about 70%; fragments aligned with their long axis roughly parallel.

(b) Crystals - broken and corroded; about 30%.

Matrix very fine-grained, about 40% of rock. Secondary quartz is distributed at random and makes up about 5% of rock.

Phenoclasts:- Lithic material: about 35% of rock; very fine-grained chloritic volcanic.

Crystals: about 20%; quartz and feldspar.

Matrix:- Tuffaceous: about 35% of rock; rich in chlorite and opaque dust.

Mica: (sericite and muscovite) about 5% of rock; showing no preferred orientation; concentrated especially about the margins of lithic fragments.

Metamorphism:- very low grade; evidenced by the mica.

Microslide:- GSQ 2642 ex Specimen:- GSQ/R 1553 Field No.:- 251/6B

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 1

Location:- Saltwater Ck., S.E. of Banchory Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, pinkish brown, altered crystalline rock.

Micro:-

Texture:- Basaltic; grain size about 0.5 mm. Rock is extremely altered. Amygdules are quite common.

Constituents:- Plagioclase: about 55% of rock; anhedral to subhedral, lath-shaped crystals which are extremely sericitised.

Clinopyroxene: about 25% of rock; prismatic crystals, altered.

Olivine: about 15% of rock; heavily iddingsitised.

Opaques and limonite: < 5% of rock.

Calcite: < 5% of rock; secondary.

Amygdules:- Irregular in shape. Filled with chalcedony which has, in part, developed a spherulitic structure. About these structures is a fine fringe of green material, possibly stained chalcedony.

Origin:- Alteration of a volcanic extrusive.

Name:- Altered OLIVINE BASALT.

Microslide:- GSQ 2643 ex Specimen:- GSQ/R 1558 Field No.:- 272/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- S.W. of Silver Hills Homestead.

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive dark greenish-grey medijm-grained sediment with some fine-grained green fragments up to 15 mm.

Micro:-

Texture:- Clastic; about 90% phenoclasts, subrounded to subangular, of moderate to low sphericity, 0.1 to 0.6 mm., in a fine-grained matrix.

Phenoclasts:- Of three types:-

(i) Granitic: about 60% of rock; quartz, plagioclase, perthite and altered biotite.

(ii) Volcanic: > 20% of rock; fine-grained tuff and hematite-stained devitrified glass.

(iii) Metamorphic: < 10% of rock; quartzite, sericite hornfels and ? mica schist.

Matrix:- about 10% of rock; appears to have been quartzo-argillaceous originally; now represented by very fine, partial quartz mosaic; heavily hematite-stained.

Origin:- Very low grade contact metamorphism of a sediment derived from a granitic, volcanic and metamorphic terrain.

Name:- Metamorphosed LITHIC SANDSTONE.

Microslide:- GSQ 2644 ex Specimen:- GSQ/R 1559 Field No.:- 272/4

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- S.W. of Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, light brown, clastic rock.

Micro:-

Texture:- Clastic; about 90% phenoclasts, subrounded to subangular, moderate to low sphericity, grain size about 0.2 mm.

Phenoclasts:- Quartz (with minor ? feldspar): about 50% of rock; grains somewhat embayed, in part.

Lithic Material: about 40% of rock; fine-grained volcanics (mainly tuff), metasediment, quartzite, ? mica schist can be recognised.

Mica: < 2% of rock; pleochroic from colourless to pale yellow; zircon euhedra, surrounded by pleochroic haloes (bluish-grey to colourless) are commonly included.

Matrix:- About 10% of rock; fine tuff, chloritic in part

Alteration:- Minor mineralisation (? pyrite) has occurred; the ?pyrite has been altered, in part, to hematite.

Origin:- Alteration of a rock formed by contemporaneous erosion of a granitic, volcanic and metamorphic terrain and pyroclastic activity.

Name:- TUFFACEOUS LITHIC SANDSTONE.

Microslide:- GSQ 2646 ex Specimen:- GSQ/R 1561 Field No.:- 272/6

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- S.W. of Silver Hills Homestead

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, light brown, fine-grained, thinly-bedded clastic rock.

Micro:-

Texture:- Clastic; about 95% phenoclasts -subangular to subrounded, corroded in part, moderate to low sphericity, grain size 0.04 to 0.5 mm.

Phenoclasts:-

(i) Granitic Material: about 20% of rock; quartz, acid plagioclase, potash feldspar, biotite (light to dark brown), muscovite and composite quartzo-feldspathic grains.

(ii) Rock Material (unidentified): about 75% of rock; very fine-grained argillaceous materialcomparatively rich in fine sericite (? metamorphic in origin).

Matrix:- About 5% of rock; almost impossible to distinguish from the "rock material" above.

Origin:- Very low grade ?metamorphism of clastic rock.

Name:- ?Metamorphosed LITHIC SANDSTONE.

Microslide:- GSQ 2647 ex Specimen:- 1562 Field No.:- 334/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5012 Run:- 4

Location:- S. of Mt. Hoy

Formation:- Telemon Age:- Devonian-carboniferous

Macro:- A massive, light brown, fine-grained clastic rock.

Micro:-

Texture:- Clastic; sorting good, grain size about 0.2 mm. Phenoclasts make up > 95% of the rock and matrix < 5%. The phenoclasts are mostly subrounded and of moderate sphericity; a major part of the outline of each is in contact with other grains. The matrix tends to occur as fine strings.

Phenoclasts:- Quartz (with minor feldspar): about 85% of rock.

Lithic Material: < 10% of rock; dominantly very fine-grained sericitic schistose material. Rare fragments of graphic intergrowth occur also.

Mica: < 5%; altered, unidentifiable.

Hornblende: rare grains; green.

Matrix:- Essentially sericitic.

Origin:- Sedimentary; derived from a dominantly granitic and low grade metamorphic terrain. The relationship of the phenoclasts, one to another, suggests that the rock has undergone stronger compaction than usual.

Name:- LITHIC-QUARTZ SANDSTONE.

Microslide:- GSQ 2648 ex Specimen:- GSQ/R Field No.:- 334/2

Four Mile Map:- Emerald

Air Photo (B.M.R.) : Emerald No.:- 5012 Run:- 4

Location:- S. of Mt. Hoy

Formation:- Telemon Age:- Devonian-Carboniferous

Macro:- A massive, fine-grained, light grey rock.

Micro:-

Texture:- Clastic; sorting good, grain size about 0.1 mm. Phenoclasts make up about 95% of the rock; they are mostly subrounded and of moderate sphericity. Matrix makes up about 5% of the rock and tends to occur as very fine strings; a major part of the outline of each phenoclast is in contact with other grains.

Phenoclasts:- Quartz (with minor ?feldspar): about 35% of rock.

Lithic Material: about 55% of rock; extremely fine-grained chloritic and sericitic material. Some mica schist can be recognised.

Sericite and Muscovite: about 5% of rock.

Matrix:- Essentially sericitic.

Origin:- Sedimentary; derived from a dominantly low grade metamorphic terrain. The relationship of the phenoclasts, one to another, suggests that the rock has undergone stronger compaction than usual.

Name:- LITHIC SANDSTONE.

Microslide:- GSQ 2649 ex Specimen:- GSQ/R 1565 Field No.:-336B

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5011 Run:- 4

Location:- N.W. Of Mt. Hoy

Formation:- Telemon Age:- Devonian-Carboniferous

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

Micro:-

Texture:- Clastic, in part; texture dominated by the presence of about 80% concretionary structures, dominantly round to ovoid, 0.5 to 0.1 mm. Many of these structures have an isotropic nucleus and display a concentric zoning. Minor amounts of formless calcite are distributed at random. The remainder of the rock is made up of > 15% phenoclasts and < 5% matrix. The phenoclasts are mostly subangular, and of low sphericity, about 0.04 mm.

Phenoclasts:-

Lithic Material (volcanic)
Quartz
Feldspar (dominantly plagioclase)
} in order of decreasing abundance.

Matrix:- Argillaceous.

Concretions:- Appear to be secondary; consist essentially of calcite which is very cloudy, thus suggesting the admixture of a small percentage of argillaceous material.

Origin:- Segregation by unknown means of original calcareous ? cement of host rock which must then have been a silty limestone.

Name:- CONCRETIONARY (Calcite) SILTSTONE.

Microslide:- GSQ 2836 ex Specimen:- GSQ/R 1857 Field No.:- 336C

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5011 Run:- 4

Location:- N.W. of Mt. Hoy

Formation:- Telemon Age:- Devonian-Carboniferous

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

Micro:- Individual laminae cannot be distinguished.

Texture:- Clastic; consisting of about 90% phenoclasts and 10% detrital matrix. The phenoclasts are 0.04 to 0.15 mm., dominantly about 0.1 mm., and of moderate to low sphericity. Duturing of the grains is common thus masking the original roundness. The matrix occurs as fine stringers about some of the grain boundaries.

Phenoclasts:- Lithic Material: 30 to 35% of rock; dominantly mica schist with minor pre-Devonian granitic material.

Feldspar (potash feldspar and oligoclase): 25 to 30% of rock; commonly altered to ironstained clay minerals.

Quartz: 20 to 25% of rock; strained.

Mica: about 5% of rock; altered.

Tourmaline: minor.

Matrix:- Micaceous: about 10% of rock.

Origin:- Sedimentary; derived essentially from pre-Devonian schists and granitic rocks.

Name:- QUARTZ-FELDSPATHIC-LITHIC SANDSTONE

Mount Hall Conglomerate

Microslide:- GSQ 2710 ex Specimen:- GSQ/R 1676 Field No.:- 131/2

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5011 Run:- 4

Location:- N.W. of Mt. Hoy

Formation:- Mt. Hall Conglomerate Age:- Carboniferous

Macro:- A massive, fine-grained white clastic rock containing rare siliceous, rounded pebbles up to 10 mm.

Micro:-

Texture:- Clastic; the grains are 0.5 to 1 mm., with sutured margins and, thus, the rock has negligible pore space. Sphericity is, in general, moderate.

Constituents:- Quartz: about 60% of rock; strained; minute inclusions abundant.

Feldspar: about 25% of rock; slightly altered.

Granitic Material: > 10% of rock; characteristic of the pre-Devonian "granites" in the area.

Mica Schist: < 5% of rock.

Muscovite: minor; fine flakes.

Origin:- Sedimentary; derived essentially from the pre-Devonian Anakie Metamorphics and associated "granites".

Name:- FELDSPATHIC-QUARTZ SANDSTONE.

Microslide:- GSQ 2712 ex Specimen:- GSQ/R 1678 Field No.:- 227/12

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- S.W. of Silver Hills Homestead

Formation:- Mt. Hall Conglomerate Age:- Carboniferous

Macro:- A massive, fine-grained, white clastic rock.

Micro:- Essentially similar to 131/2 except in the following details:-

(1) The grain size of 227/12 is 0.17 to 0.3 mm.

(2) 227/12 contains about 25% "rock" fragments and about 10% feldspar.

(3) 227/12 contains rare grains of zircon.

Name:- QUARTZ SANDSTONE.

Microslide:- GSQ 2714 ex Specimen:- GSQ/R 1680 Field No.:- 232/6(a)

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- E. of Withersfield

Formation:- Fragment in Mt. Hall Conglomerate Age:- Carboniferous

Macro:- A massive, fine-grained, dark red-brown porphyritic rock; a pebble in conglomerate.

Micro:-

Texture:- Glomeroporphyritic, crystal clusters 0.5 to 2 mm. Groundmass extremely altered and ironstained with a grain size of about 0.04 mm.

Phenocrysts:- Acid Labradorite: about 20% of rock; extremely altered.

Groundmass:- Feldspar, hematite and limonite can be recognised.

Origin:- Volcanic, extrusive (Silver Hills Volcanics).

Name:- Altered ?BASALT.

Microslide:- GSQ 2715 ex Specimen:- GSQ/R 1682 Field No.:- 232/6(d)

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- E. of Withersfield

Formation:- Mt. Hall, Conglomerate Age:- Carboniferous

Macro:- A reddish-brown conglomerate containing approximately 70% rounded pebbles of low to moderate sphericity, 3 to 30 mm. Limonite-staining is abundant.

Micro:-

Texture:- Clastic; see above.

Phenoclasts:- The following occur in the thin section:-

Granitic material (pre-Devonian)
Mica Schist (Anakie Metamorphics)
Volcanic rock (Silver Hills Volcanics)

Matrix:- Tuffaceous: very fine-grained.

Origin:- Sedimentary; from the hand specimen, volcanic rock fragments appear to predominate.

Name:- CONGLOMERATE.

Microslide:- GSQ 2716 ex Specimen:- GSQ/R 1683 Field No.:- 233/1(c)

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- N.E. of Withersfield

Formation:- Mt. Hall Conglomerate Age:- Carboniferous

Macro:- A massive, fine-grained, light brown clastic rock.

Micro:-

Texture:- Clastic; the grains are 0.08 to 1 mm., commonly about 0.5 mm., subangular to subrounded, of moderate sphericity. No detrital matrix can be recognised.

Constituents:- Lithic Material: about 60% of rock. The following, in decreasing order of abundance, can be recognised:-

Volcanics (fine-grained) of Silver Hills Volcanics.

Granitic material of pre-Devonian "granites".

Mica Schist of Anakie Metamorphics.

Much of this material is heavily-ironstained.

Quartz: about 30% of rock; commonly strained; minute inclusions abundant.

Feldspar: about 10% of rock; altered.

Muscovite: minor; altered.

Origin:- Sedimentary; approximately half of the detritus was derived from the Anakie Metamorphics and associated pre-Devonian "granites" and the remainder from the Silver Hills Volcanics.

Name:- QUARTZ-LITHIC SANDSTONE.

Microslide:- GSQ 2717 ex Specimen:- GSQ/R 1685 Field No.:- 233/2A

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- N.E. of Withersfield.

Formation:- Mt. Hall Conglomerate Age:- Carboniferous

Macro:- A massive, very fine-grained, light grey, "flaggy" clastic rock.

Micro:-

Texture:- Clastic; the grains are 0.1 to 0.04 mm. with sutured margins and, thus, negligible pore space. No detrital matrix can be recognised.

Constituents:- Lithic Material: about 60% of rock; dominantly mica schist with minor granitic material.

Quartz: about 30% of rock; commonly strained; minor overgrowths are evident.

Feldspar: < 10% of rock; altered, commonly replaced by calcite.

Muscovite: about 2% of rock; somewhat altered.

Tourmaline: minor; brown to colourless.

Origin:- Sedimentary; derived essentially from the pre-Devonian Anakie Metamorphics and associated "granites".

Name:- QUARTZ-LITHIC SANDSTONE.

Raymond Sandstone

Microslide:- GSQ 2787 ex Specimen:- GSQ/R 1794 Field No.:- 167/2

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5074 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Raymond Sandstone Age:- Carboniferous

Macro:- A massive, fine-grained, greenish-grey, laminated rock.

Micro:-

Texture:- Clastic; consisting of about 85% phenoclasts and 15% fine-grained matrix. The phenoclasts are about 0.03 mm., angular to subrounded of low sphericity. The rock is heavily ironstained, in part. Individual beds cannot be distinguished in thin section.

Phenoclasts:- Quartz (with minor ? feldspar): about 50% of rock.

Mica: about 25% of rock; altered.

Lithic Material: about 10% of rock; fine-grained, chloritic; unidentifiable.

Epidote: minor

Matrix:- Micaceous; dominantly ?chloritic material.

Origin:- Sedimentary; derived predominantly from a granitic/low grade metamorphic terrain.

Name:- MICACEOUS SILTSTONE.

Microslide:- GSQ 2788 ex Specimen:- GSQ/R 1795 Field No.:- 167/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5074 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Raymond Sandstone Age:- Carboniferous

Macro:- A massive, fine-grained, greenish-grey porphyritic rock.

Micro:- Essentially similar to 165/8 except in the following details:-

(1) 167/3 is more altered than 165/8

(2) The mafic minerals in 167/3 have been replaced by serpentine and calcite.

Name:- Altered ?OLIVINE ?BASALT.

Microslide:- GSQ 2790 ex Specimen:- GSQ/R 1797 Field No.:- 167/4B

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5074 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Raymond Sandstone Age:- Carboniferous

Macro:- A massive, fine-grained, grey rock containing irregular, light brown bands, about 2 mm. thick.

Micro:- The rock is essentially a silty limestone. The bands consist essentially of calcite displaying a crude spherulitic structure, possibly resultant from differential recrystallisation.

Name:- Partly ?Recrystallised SILTY LIMESTONE.

Microslide:- GSQ 2791 ex Specimen:- GSQ/R 1798 Field No.:- 167/5A

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5074 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Raymond Sandstone Age:- Carboniferous

Macro:- A massive, fine-grained, thinly-bedded, light grey clastic rock.

Micro:-

Texture:- Clastic; consisting of about 80% of phenoclasts and 20% fine-grained matrix. The phenoclasts are 0.03 to 0.05 mm., subrounded, irregular in shape.

Phenoclasts:- Feldspar: about 30% of rock; altered, over-growths of quartz are common.

Quartz: about 40% of rock.

Lithic Material: about 10% of rock; minor mica schist with extremely fine-grained micaceous material, possibly mudstone.

Hornblende:- minor.

Muscovite: minor

Matrix:- Essentially sericitic.

Origin:- Sedimentary; derived, in part, from granitic/metamorphic and (probably) sedimentary terrain.

Name:- SILTSTONE.

Microslide:- GSQ 2793 ex Specimen:- GSQ/R 1800 Field No.:- 167/6

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5074 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Raymond Sandstone Age:- Carboniferous

Macro:- A massive, medium-grained, purplish-brown clastic rock.

Micro:-

Texture:- Clastic; consisting of about 80% phenoclasts and 20% cement. The phenoclasts are 0.2 to 1 mm., mostly subrounded of low to moderate sphericity. The cement is a very fine-grained (about 0.04 mm.) mosaic.

Phenoclasts:- Feldspar (dominantly potash with some plagioclase): about 45% of rock; mostly extremely altered to ironstained clay minerals. Most of the crystals are typical of those in a crystal tuff.

Lithic Material: about 25% of rock;

Volcanic rocks (typical of Silver Hills Volcanics).

Granitic material (minor).

Quartz: about 10% of rock; similar in form to feldspar.

Cement:- Zeolite.

Origin:- Sedimentary; derived from volcanic (Silver Hills Volcanics)/granitic terrain.

Name:- ARKOSE.

Microslide:- GSQ 2794 ex Specimen:- GSQ/R 1801 Field No.:- 167/7

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5074 Run:- 5

Location:- west of Silver Hills Homestead.

Formation:- Raymond Sandstone Age:- Carboniferous

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

Micro:-

Texture:- Essentially pilotaxitic consisting of roughly aligned acicular feldspar crystals and intersertal serpentine together with secondary calcite. About 5% of rock consists of fairly equant "pools" (about 0.08 mm.) of very fine quartz, quartz/feldspar or quartz/feldspar/apatite mosaic occur and these have been somewhat corroded by the enclosing rock. The rock is extremely altered.

Constituents:- Plagioclase

Serpentine

Calcite

"Pools"

Origin:- The rock is essentially a volcanic, extrusive. The "pools" are believed to represent xenoliths of older rock (probably granitic in origin) which have been somewhat invaded by the host rock.

Name:- Altered ?BASALT.

Microslide:- GSQ 2796 ex Specimen:- GSQ/R 1803 Field No.:- 167/9

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5074 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Raymond Sandstone Age:- Carboniferous

Macro:- A massive, medium-grained, pinkish-brown clastic rock.

Micro:-

Texture:- Clastic; consisting of about 85% phenoclasts and 15% fine-grained cement. The phenoclasts are 0.5 to 3 mm., mostly rounded to subangular, of moderate of low sphericity, commonly extremely irregular in shape. The cement is a very fine (about 0.04 mm.) mosaic.

The rock is heavily ironstained.

Phenoclasts:- Lithic Material: essentially volcanic fragments (mostly typical of the Silver Hills Volcanics).

Cement:- Zeolite: about 10% of rock; filling pore spaces.

Calcite: about 5% of rock; infilling.

Origin:- Essentially sedimentary, derived from a volcanic (Silver Hills Volcanics) terrain.

Name:- Altered LITHIC SANDSTONE.

Microslide:- GSQ 2782 ex Specimen:- GSQ/R 1778 Field No.:- 230/7

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- Withersfield Syncline - east of Tadcaster Homestead

Formation: Raymond Sandstone Age:- Carboniferous

Macro:- A massive, fine-grained, light grey, thinly-bedded clastic rock.

Micro:-

Texture:- Clastic; consisting of about 70% phenoclasts and 30% fine-grained matrix. The phenoclasts are subangular to subrounded, of low to moderate sphericity, 0.05 to 0.07 mm. Minor secondary limonite-staining occurs.

Phenoclasts:- Quartz (and minor Feldspar): about 45% of rock; strained. Composite grains are common.

Lithic Material: about 20% of rock; mica schist and "granite".

Muscovite: about 5% of rock; unoriented flakes.

Matrix:- Argillaceous (dominantly chloritic): about 30% of rock.

Origin:- Sedimentary; derived essentially from the Anakie Metamorphics and pre-Devonian "granites".

Name:- ARGILLACEOUS-LITHIC-QUARTZ SANDSTONE.

Microslide:- GSQ 2783 ex Specimen:- GSQ/R 1779 Field No.:- 232/9

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- Withersfield Syncline - south-east of Withersfield

Formation:- Raymond Sandstone Age:- Carboniferous

Macro:- A massive, very fine-grained, yellowish-brown, thinly-bedded rock.

Micro:-

Texture:- Clastic; consisting of about 80% phenoclasts and 20% fine-grained matrix. The phenoclasts are mostly subrounded, of low to moderate sphericity, 0.02 to 0.09 mm. The matrix occurs as very fine (0.004 mm.) stringers separating individual grains.

Phenoclasts:- Quartz (with minor ? feldspar): about 40% of rock; commonly strained; composite grains common.

Lithic Material: about 20% of rock; dominantly mica schist with minor extremely fine-grained ?volcanics.

Mica: about 25% of rock; muscovite, biotite and minor chlorite.

Zircon: minor

Matrix:- Micaceous: about 20% of rock; limonite-stained.

Origin:- Sedimentary, altered; derived predominantly from the Anakie Metamorphics and pre-Devonian "granites."

Name:- LITHIC-MICA-QUARTZ SILTSTONE.

Ducabrook Formation

Microslide:- GSQ 2769 ex Specimen:- GSQ/R 1765 Field No.:- 139/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5012 Run:- 4

Location:- West of Silver Hills Homestead.

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, banded, pale pinkish-coloured rock. Some of the bands are separated by greenish-coloured siliceous material.

Micro:-

Texture:- Essentially clastic; extremely fine-grained and cloudy due to alteration. Phenoclasts occur and are 0.02 to 0.5 mm., extremely corroded by the matrix. These tend to be concentrated in layers. About 15% extremely fine-grained micaceous material occurs, with the long axes roughly parallel.

Phenoclasts:- ?Feldspar: dominant.

Quartz: minor

Mica:

Matrix:- Tuffaceous: chloritic.

"Siliceous Bands":- Zeolite surrounded by a very fine zone of siliceous mineral.

Origin:- Alteration of a volcanic, pyroclastic.

Name:- Altered ?CRYSTAL TUFF.

Microslide:- GSQ 2773 ex Specimen:- GSQ/R 1769 Field No.:- 165/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5073 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, extremely weathered, purplish-coloured clastic rock.

Micro:- This rock could not be sectioned satisfactorily.

Texture:- Clastic; grain size 0.3 to 1 mm.

Constituents:- Broken crystals feldspar (altered) and quartz and an abundance of volcanic rock fragments. Opaque material is abundant. The matrix is heavily ironstained.

Origin:- Volcanic, pyroclastic; appears to be essentially primary.

Name:- Altered CRYSTAL-LITHIC TUFF.

Microslide:- GSQ 2775 ex Specimen:- GSQ/R 1771 Field No.:- 165/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5073 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, thinly-bedded, brownish-purple clastic rock.

Micro:-

Texture:- Clastic; consisting of about 95% phenoclasts and 5% fine-grained matrix. The phenoclasts are about 0.07 mm., rounded to angular, of moderate to low sphericity, commonly very irregular in shape. The percentage of grain boundary contacts is very high.

Phenoclasts:- Quartz: about 50% of rock.

Feldspar: about 10% of rock; mostly somewhat altered to ironstained clay minerals.

Muscovite:
Biotite: altered
Epidote:
Clinozoisite:
} minor

Lithic Material: about 35% of rock; dominantly mica schist with less volcanic material, commonly very heavily ironstained.

Matrix:- Sericitic: about 5% of rock; very heavily ironstained, in part.

Origin:- Sedimentary; derived from low grade (mica) metamorphic/granitic/volcanic (Silver Hills Volcanics) terrain.

Name:- FELDSPATHIC-LITHIC-QUARTZ SANDSTONE.

Microslide:- GSQ 2778 ex Specimen:- GSQ/R 1774 Field No.:- 165/7

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5073 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Ducabrook Age:- Carboniferous

Macro:- A somewhat fissile, very fine-grained, thinly-bedded, dark grey, clastic rock.

Micro:-

Texture:- Clastic; graded bedding is clearly-defined; each rhythm is about 0.8 mm. and they are, in general, separated by heavily limonite-stained laminae. Overall, the rock consists of about 10% phenoclasts in a very fine-grained matrix. The phenoclasts are angular to subrounded, mostly of low sphericity, about 0.02 mm.

Phenoclasts:- Quartz, feldspar and biotite (colourless to greenish.)

Matrix:- Argillaceous.

Origin:- Sedimentary.

Name:- SILTY MUDSTONE.

Microslide:- GS 2779 ex Specimen GS/R 1775 Field No.:- 165/8

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5073 Run:- 5

Location:- West of Silver Hills Homestead

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, greenish-grey porphyritic rock containing phenocrysts up to 4 mm. and irregular "clots" of secondary calcite.

Micro:-

Texture:- Porphyritic; phenocrysts (about 40% of rock) are subhedral to anhedral, mostly 0.5 to 1.5 mm. Groundmass intersertal, grain size about 0.1 mm. Secondary calcite makes up about 10% of rock.

Phenocrysts:- Plagioclase (? acid andesine): about 25% of rock; lath-shaped crystals; extremely altered, replaced by calcite and/or green chlorite and/or ironstained clay minerals.

Mafic minerals: about 15% of rock;

?Olivine: extremely altered to fine, dark brown, almost opaque mineral.

?Pyroxene: completely replaced by green chlorite with minor calcite and opaques.

Groundmass:- Plagioclase: about 35% of rock; acicular crystals, displaying a crude flow texture.

Chlorite: about 15% of rock; filling interstices

Secondary Minerals:- Calcite: about 10% secondary; the larger "clots" (up to 3 mm.) are believed to be, in part, at least, replacing phenocrysts.

Origin:- Volcanic; probably extrusive.

Name:- Altered ?OLIVINE ?BASALT

Microslide:- GS 2780 ex Specimen:- GS/R 1776 Field No.:- 165/9

Four Mile Map:- Emerald

Air Photo (B.M.R.O:- Emerald No.:- 5073 Run:- 5

Location:- West of Silver Hills Homestead.

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, greenish-grey clastic rock.

Micro:-

Texture:- Clastic; consisting of about 95% phenoclasts and about 5% fine-grained matrix and minor amounts of secondary calcite. The phenoclasts are 0.17 to 0.25 mm., angular to subrounded, of moderate to low sphericity.

Phenoclasts:- Lithic Material: about 60% of rock.

Volcanic rock fragments: commonly heavily ironstained.

Mica Schist
Micaceous Siltstone

Feldspar: about 25% of rock; commonly altered to ironstained clay minerals.

Quartz: about 10% of rock; commonly strained.

Composite grains of quartz or quartz and feldspar occur.

Clinozoisite: minor

Epidote: minor

Matrix:- Chloritic/sericitic

Secondary Material:- Calcite: minor

Origin:- Sedimentary; derived from a volcanic (Silver Hills Volcanics)/low grade metamorphic/granitic/sedimentary terrain.

Name:- QUARTZ-FELDSPATHIC-LITHIC SANDSTONE.

Microslide:- GSQ 2772 ex Specimen:- GSQ/R 1768 Field No.:- 151/4

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5018 Run:- 8

Location:- Bogantungan Syncline - Nine Mile Holding.

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, brownish-red rock.

Micro:- Essentially similar to 351/7 except in the following details:-

(1) Phenoclasts make up about 65% of rock - 35% "crystals" and 30% shards.

(2) The "crystals" include quartz, feldspar, mica, epidote and lithic fragments. Minor redeposited fragments of pre-Devonian "granite" and mica schist occur.

Origin:- Essentially volcanic, pyroclastic (primary) with minor admixed terrigenous material.

Name:- Altered SANDY VITRIC TUFF.

Microslide:- GSQ 2753 ex Specimen:- GSQ/R 1735 Field No.:- 349/4(a)

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5043 Run:- 7A

Location:- Bogantungan Syncline

Formation:- Ducabrook Age:- Carboniferous

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

Micro:-

Texture:- Clastic; consisting of about 90% phenoclasts and 10% very fine-grained matrix. The phenoclasts are about 0.1 mm., subangular to subrounded, of moderate to low sphericity.

Phenoclasts:- Quartz: about 40% of rock; strained.

Feldspar (dominantly potash with plagioclase): about 5% of rock; altered, in general, to limonite-stained clay minerals.

Composite grains of quartz or quartz and feldspar occur.

Mica Schist: about 30% of rock; commonly greenish in colour, probably due to the presence of secondary chlorite.

Biotite: about 10% of rock; X = yellowish, Z = reddish-brown; altered.

Muscovite: about 5% of rock.

Epidote: minor

Matrix:- Argillaceous with abundant micaceous material.

Origin:- Sedimentary; derived from a granitic/low grade (mica) metamorphic terrain. The colour variation in hand specimen is probably due to local concentrations of limonite-stained material and altered (chlorite) mica.

Name:- LITHIC-QUARTZ SANDSTONE.

Microslide:- GSQ 2754 ex Specimen:- 1736 Field No.:- 370/2

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5091 Run:- 6

Location:- Zamia Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, thinly-bedded, dark purplish-grey rock.

Micro:-

Texture:- Clastic; about 95% phenoclasts in a very fine-grained, heavily limonite-hematite-stained matrix. Phenoclasts (0.4 to 0.06 mm.) mostly angular to subangular (commonly broken) of low sphericity, more rarely rounded to subrounded of moderate to high sphericity. The long axes of the less equant grains are roughly parallel to the bedding as are fine stringers of limonite/hematite which occur at random.

Phenoclasts:- Feldspar (dominantly potash, with minor plagioclase): about 20% of rock; mostly angular, broken, partly corroded crystals with rare more rounded and equant grains.

Quartz: about 5% of rock; similar in form to feldspar.

Lithic Material: about 70% of rock; rounded grains of moderate sphericity fairly rare.

The following rock types can be recognised:-

Rhyolite, spherulitic in part.
Fine-grained fluidal feldspathic volcanic, sometimes porphyritic, heavily ironstained - ?altered trachyte.
?Tuff, rich in green chlorite.

Biotite: minor; colourless to pale green, altered in part.

Matrix:- Tuffaceous; heavily ironstained.

Origin:- Essentially primary volcanic, pyroclastic; up to 20% of the material may be redeposited - most of this material is believed to be derived from the Silver Hills Volcanics.

Name:- Altered SANDY CRYSTAL-LITHIC TUFF.

Microslide:- GSQ 2757 ex Specimen:- GSQ/R 1741 Field No.:- 370/4

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5091 Run:- 6

Location:- Zamia Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, medium-grained (2 mm.) purplish-grey clastic rock.

Micro:-

Texture:- Clastic; about 90% phenoclasts in about 10% fine-grained (about 0.04 mm.) crystalline cement. Phenoclasts are mostly subrounded, of moderate sphericity, 1 to 3 mm.

Phenoclasts:- Lithic Material: about 90% of rock; the following rock types can be recognised:-

Rhyolite, spherulitic in part.
Trachyte, commonly ironstained.
Tuff and crystal tuff.
Granite.

Cement:- Essentially zeolite; about 10% of rock; a crystalline mosaic with individual anhedra about 0.02 to 0.04 mm.; minor corrosion of some of the phenoclasts by the cement has taken place.

Origin:- Essentially sedimentary; the phenoclasts appear to represent redeposited rocks, dominantly from the Silver Hills Volcanics. The cement appears to be secondary.

Name:- Coarse Zeolitic LITHIC SANDSTONE.

Microslide:- GSQ 2758 ex Specimen:- GSQ/R 1742 Field No.:- 370/5

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5091 Run:- 6

Location:- Zamia Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, dark reddish-brown, clastic rock containing coarse fragments (up to 6 cm.) of volcanic rock material.

Micro:-

Texture:- The rock is too heavily ironstained to allow very detailed identification. Clastic; phenoclasts mostly of low sphericity, commonly distorted.

Phenoclasts:- Volcanic.

Matrix:- Tuffaceous.

Origin:- Volcanic, pyroclastic; essentially primary.

Name:- Altered AGGLOMERATE.

Microslide:- GSQ 2760 ex Specimen:- GSQ/R 1744 Field No.:- 370/9

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5091 Run:- 6

Location:- Zamia Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, greenish-grey to pinkish-grey, clastic rock.

Micro:-

Texture:- Clastic; about 90% of rock consists of phenoclasts (0.04 to 1 mm.) angular to subrounded, of low to moderate sphericity. Numerous "grains" are broken and/or corroded crystals. The matrix (about 10%) is very fine-grained.

Phenoclasts:- Lithic Material: about 55% of rock; the following rock types can be recognised:-

Ironstained feldspathic fluidal volcanic
Rhyolite, commonly spherulitic.
Chloritic tuff.
Mica Schist: > 5% of rock.
Granite: < 5% of rock.
?Sediment: < 5% of rock.

Feldspar (dominantly potash with minor oligoclase): about 25% of rock; commonly altered to ironstained clay minerals.

Quartz: about 10% of rock.

Matrix: Tuffaceous: chloritic.

Origin:- Essentially sedimentary; the fragments are believed to be redeposited rocks derived from a volcanic (Silver Hills Volcanics)/granitic/low grade (mica/?sedimentary terrain.

Name:- TUFFACEOUS-QUARTZ-FELDSPATHIC-LITHIC SANDSTONE

Microslide:- GSQ 2761 ex Specimen:- GSQ/R 1749 Field No.:- 370/17

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5091 Run:- 6

Location:- Zamia Anticline

Formation:- Ducabrook Age:- Carboniferous

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

Micro:-

Texture:- Clastic; consisting of about 90% phenoclasts, about 5% fine-grained matrix (which occurs as fine stringers between grains) and about 5% secondary calcite. The phenoclasts are 0.1 to 0.02 mm., angular to subrounded, of low to moderate sphericity. The percentage of grain boundary contacts is high.

Phenoclasts:- Quartz: about 55% of rock; extremely fine inclusions are abundant.

Feldspar (dominantly potash): about 20% of rock; altered, commonly somewhat ironstained.

Lithic Material: about 10% of rock; dominantly mica-chlorite schist and chloritic ?tuff.

Mica: about 5% of rock; biotite, altered flakes, light to dark brown and muscovite.

Matrix:- Sericite/chlorite: about 5%

Secondary Material:- Calcite: about 5% of rock; secondary.

Origin:- Alteration of a sedimentary rock; detritus derived from dominantly granitic/metamorphic terrain.

Name:- Altered MICACEOUS-LITHIC-FELDSPATHIC SANDSTONE.

Microslide:- GSQ 2762 ex Specimen:- GSQ/R 1753 Field No.:- 370/20

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5091 Run:- 6

Location:- Zamia Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, brownish-pink, bedded clastic rock.

Micro:-

Texture:- Clastic; consisting of about 95% phenoclasts in about 5% very fine-grained matrix. The phenoclasts are about 0.3 mm., angular to subangular (commonly broken), of moderate to low sphericity; many have been somewhat corroded by the matrix.

Phenoclasts:- Lithic Material: about 55% of rock; the following rock types can be recognised:-

Fluidal feldspathic volcanic: heavily ironstained.

Spherulitic rhyolite; somewhat ironstained.

Micaceous siltstone: somewhat ironstained.

Mica schist: extremely ironstained.

Granite (one fragment).

Feldspar (dominantly potash): about 25% of rock; altered to iron-stained clay minerals.

Quartz: about 15% of rock.

Matrix:- Tuffaceous: siliceo-feldspathic

Origin:- The rock appears to be, in part, a primary volcanic pyroclastic (crystal tuff); the percentage of redeposited material (derived from metamorphic/granitic/volcanic (Silver Hills Volcanics)/sedimentary terrain) cannot be determined.

Name:- TUFFACEOUS-QUARTZ-FELDSPATHIC-LITHIC SANDSTONE.

Microslide:- GSQ 2763 ex Specimen:- GSQ/R 1754 Field No.:- 370/21

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5091 Run:- 6

Location:- Zamia Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, coarse-grained, pinkish-brown clastic rock containing fragments up to 4 mm.

Micro:-

Texture:- Clastic; consisting of about 65% phenoclasts in about 20% very fine-grained matrix. Phenoclasts are 1 to 4 mm., dominantly about 3 mm., mostly rounded, of low sphericity.

Phenoclasts:- Lithic Material:- about 65% of rock; the following rock types can be recognised:-

Rhyolite, spherulitic in part.
Trachyte.
?Basalt, heavily ironstained.
Crystal Tuff.

Matrix:- Crystal Tuff: about 35% of rock; contains about 15% broken and/or embayed crystals of feldspar, with minor quartz and minor fragments of volcanic rock (mostly about 0.5 mm.) in a chloritic tuffaceous ~~matrix, heavily~~ ironstained.

Origin:- The matrix is primary volcanic pyroclastic; the phenoclasts are derived (predominantly, at least) from the Silver Hills Volcanics.

Name:- TUFFACEOUS-LITHIC-CONGLOMERATE.

Microslide:- GS 2771 ex Specimen:- GS/R 1767 Field No.:- 151/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5018 Run:- 8

Location:- Ducabrook Anticline - Nine Mile Holding.

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, pinkish-brown, bedded clastic rock. Some of the beds appear to consist entirely of opaques - these beds are 0.5 to 2 mm. and display a crude current-bedding.

Micro:-

Texture:- Clastic; the light-coloured beds consist of about 90% subangular to angular fragments of low to moderate sphericity and about 10% secondary material. The dark bands are essentially similar except that about 75% of the clasts are opaque.

Light-coloured Bands:- Quartz: about 40% of rock; strained.

Potash Feldspar: about 25% of rock; extremely altered to ironstained (reddish) clay minerals.

Oligoclase: about 15% of rock; altered (as for potash feldspar)

Lithic Material: about 10% of rock;

Mica schist
"Granite" (pre-Devonian)
Fine-grained volcanics

Epidote: minor

Opaques: minor

Secondary Material:- consists of aggregations of heavily limonite-stained chlorite spherulites with a diameter of about 0.04 mm.; this material occupies the interstices of the rock and replaces, in part, some of the grains.

Dark Bands:- The opaque clasts are almost totally of magnetite, some of which has altered to hematite.

Origin:- Sedimentary

Name:- Altered SANDSTONE.

Microslide:- GS 2718 ex Specimen:- GS/R 1686 Field No.:- 351/7

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5036 Run:- 9

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, thinly-bedded bright pink rock.

Micro:-

Texture:- Extremely altered. Clastic; phenoclasts (about 35% of rock) of two types:- (a) grains angular to subrounded, embayed, 0.1 to 0.5 mm. (b) shards commonly about 0.1 to 0.2 mm. The long axes of the phenoclasts have a roughly parallel alignment. Matrix, very fine-grained.

Phenoclasts:- (a) Crystals: < 5% of rock; quartz, plagioclase (?oligoclase) and flakes of altered biotite.

(b) Shards: > 30% of rock; shapes extremely variable; all of the structures are composed essentially of dense hematite.

Matrix:- Tuffaceous: green chlorite (only) can be recognised.

Origin:- Volcanic, pyroclastic; the presence of minor amounts of terrigenous material suggests that the material may have been water-laid.

Name:- Altered VITRIC TUFF.

Microslide:- GSQ 2721 ex Specimen:- GSQ/R 1689 Field No.:- 351/14

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5036 Run:- 9

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, very thinly-bedded, greenish-brown rock which is ripple-marked.

Micro:-

Texture:- Clastic; about 95% phenoclasts, dominantly 0.04 mm., subrounded, of moderate sphericity. The percentage of grain boundary contacts is very high. About 5% matrix occurs, as fine stringers separating some of the grains.

Phenoclasts:- Quartz: about 30% of rock.

Feldspar (dominantly potash): about 25% of rock.

Mica: about 20% of rock; altered biotite and muscovite and minor pennine chlorite.

Lithic Material: about 20% of rock; dominantly mica schist.

Matrix:- Essentially sericitic.

Origin:- Sedimentary; derived from a granitic/low grade (mica) metamorphic terrain.

Name:- SILTSTONE.

Microslide:- GSQ 2722 ex Specimen:- GSQ/R 1690 Field No.:- 357/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5022 Run:- 8

Location:- Medway Anticline.

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, light grey, fine-grained rock which is somewhat ironstained, in part.

Micro:-

Texture:- Clastic; phenoclasts (about 95% of rock) 0.07 to 0.3 mm., rounded to subrounded, of moderate go low sphericity. Matrix very fine-grained.

Phenoclasts:- Quartz: about 25% of rock; some grains contain inclusions of apatite.

Feldspar (potash and oligoclase): about 15% of rock.

Composite grains of quartz mosaic or quartz and feldspar are relatively abundant.

Miscellaneous Grains: < 10% of rock;

mica
?glauconite-heterogeneous green pellets
hematite-strained ? rock fragments.

Matrix:- Argillaceous: about 5% of rock.

Secondary Minerals:- Secondary calcite with admixed limonite is distributed at random ( < 5%)

Origin:- Alteration of a sediment derived from an essentially granitic/low grade metamorphic terrain.

Name:- Altered LITHIC SANDSTONE.

Microslide:- GSQ 2727 ex Specimen:- GSQ/R 1697 Field No.:- 358/21

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

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

Micro:- Essentially similar to 336B (Telemon Formation) except in the following details:-

(1) The phenoclasts are mostly 0.1 to 0.3 mm.

(2) Of the phenoclasts, quartz is the most abundant, followed by feldspar, lithic material (very fine-grained ? volcanic) and altered green biotite and hornblende.

(3) Original matrix is negligible.

Origin:- Segregation by unknown means of original calcareous ? cement of host rock which must then have been a sandy limestone. The sandy fraction was derived, in part, from a granitic terrain.

Name:- CONCRETIONARY (Calcite) SANDSTONE.

Microslide:- GSQ 2729 ex Specimen:- GSQ/R 1699 Field No.:- 358/23

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

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

Micro:-

Texture:- Originally clastic; now dominated by about 80% concretionary structures, mostly rounded 0.5 to 1 mm., with a radiating and concentric structure. Original phenoclasts (about 5% of rock) mostly about 0.1 mm., of moderate sphericity and slightly corroded. About 5% devitrified shards are present also. The matrix (about 10% of rock) is very fine-grained.

Phenoclasts:- Quartz with minor feldspar and altered biotite.

Shards: hematitic.

Matrix:- Tuffaceous

Origin:- The host rock was a water-laid vitric tuff containing phenoclasts derived from a granitic terrain. The concretions represent segregation by unknown means of calcite of unknown origin, possibly calcareous phenoclasts deposited with the other terrigenous material.

Name:- CONCRETIONARY (calcite) SANDY VITRIC TUFF.

Microslide:- GSQ 2732 ex Specimen:- GSQ/R 1702 Field No.:- 372/5

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, thinly-bedded, fine-grained rock with alternating greenish-grey and buff-coloured beds.

Micro:- This rock could not be sectioned properly but appears to be essentially similar to 372/1 except in the following details:

(1) The phenoclasts are dominantly about 0.4 mm.

(2) The lithic fragments are mica schist, micaceous siltstone (derived from low grade metamorphics)

(3) Minor amounts of heterogeneous green pellets of ? glauconite occur.

The bedding does not show up in the thin section but the alternations of colour are undoubtedly due to concentrations of ? glauconite in the green material and of ironstained feldspar in the buff-coloured beds.

Origin:- Sedimentary; derived from a dominantly low grade metamorphic/granitic terrain with minor volcanics and sediments.

Name:- LITHIC SANDSTONE.

Microslide:- GSQ 2733 ex Specimen:- GSQ/R 1704 Field No.:- 372/8

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, pinkish-brown sediment.

Micro:-

Texture:- Clastic; comprises about 95% phenoclasts in a very fine-grained matrix. Phenoclasts are 0.1 to 0.5 mm., mostly subrounded, of moderate to high sphericity, commonly somewhat embayed. The percentage of grain boundary contacts is very high.

Phenoclasts:- Lithic Material: about 55% of rock; the following (in approximate order of decreasing abundance) can be recognised:-

Volcanics: spherulitic rhyolite
rhyolite
?intermediate extrusives
Mica schist
Micaceous Siltstone

Feldspar (potash : oligoclase = about 3:1): about 20% of rock; mostly altered to ironstained clay minerals.

Quartz: about 15% of rock; composite grains of quartz and/or feldspar are comparatively common.

Biotite: < 5% of rock, brown.

Epidote: colourless; minor

Tourmaline: blue to colourless; minor.

Opaques: minor

Matrix:- Argillaceous

Origin:- Sedimentary; derived from a volcanic (Silver Hills Volcanics), granitic/low grade (mica) metamorphic and sedimentary (Ducabrook Formation) terrain.

Name:- LITHIC SANDSTONE.

Microslide:- GSQ 2734 ex Specimen:- GSQ/R 1705 Field No.:- 372/9

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A very fine-grained, khaki-coloured, thinly-bedded rock.

Micro:- Essentially similar to 372/13C except in the following details:-

(1) Phenoclasts are 0.05 to 0.1 mm.

(2) Quartz and feldspar make up about 45% of the rock.

(3) Plagioclase is more abundant than potash feldspar.

(4) Mica makes up < 10% of rock

(5) Green hornblende makes up < 5% of rock.

(6) Mica schist makes up about 35% of rock.

(7) No volcanic fragments can be recognised.

(8) Matrix is essentially sericitic.

Origin:- As for 372/13C except that volcanic rocks do not appear to have contributed to the accumulating debris.

Name:- LITHIC SANDSTONE.

Microslide:- GSQ 2736 ex Specimen:- GSQ/R 1709 Field No.:- 372/13B

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, dark-grey, clastic rock containing an abundance of greenish-fragments, up to 5 mm.

Micro:-

Texture:- Clastic, altered; 4 main elements:-

(1) Secondary concretionary structures: mostly rounded to ovoid, 0.25 to 0.5 mm., about 30% of rock; commonly structureless, though a few of the bodies display a radiating growth in concentric zones.

(2) Lithic fragments (about 40% of rock) of two types:-

(a) fresh, micaceous.

(b) replaced totally or in part by calcite.

(3) Calcareous rod-like bodies: about 20% of rock; extremely cloudy; some of these bodies have, along one side of fringe growth of fresh calcite some of which has a suggestion of cellular structure (identified by J.T. Woods, Geologist, as inorganic).

(4) Calcareous cement: about 10% of rock; fresh.

Concretions: calcite.

Lithic fragments: clastic; about 40% fragments of quartz (about 0.03 mm.) and 30% fine flakes of mica in an argillaceous matrix - ARGILLACEOUS-MICACEOUS-QUARTZ SILTSTONE.

Origin:- The original rock appears to have been a lithic conglomerate, with the lithic fragments being siltstone, formed by the deposition and consolidation of debris derived from low grade (mica) metamorphics. The rod-like bodies may be fragments of limestone. The secondary calcite (concretions, cement, fringe growths and replacement of some of the lithic fragments) is of unknown origin, possibly redeposition of original cement.

Name:- CONCRETIONARY (calcite) LITHIC CONGLOMERATE

Microslide:- GSQ 2737 ex Specimen:- GSQ/R 1710 Field No.:- 372/13C

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, thinly-bedded, brownish-grey rock.

Micro:-

Texture:- Clastic; phenoclasts make up about 95% of rock; phenoclasts 0.05 to 0.2 mm., of low sphericity, mostly subrounded. The long axes are roughly parallel. The percentage of grain boundary contacts is very high. The matrix is very fine-grained, difficult to distinguish.

Phenoclasts:- Quartz and feldspar (dominantly potash):- about 35% of rock; mostly strained fragments but some composite quartz or quartz and feldspar fragments occur.

Mica: about 10% of rock; altered green biotite and muscovite; flakes

Mica Schist: about 30% of rock.

Volcanic Rock: about 15% of rock; fine-grained extrusive tuff and broken spherulites.

Opaques: about 5% of rock; commonly concentrated as dust about fragments.

Epidote: minor

Matrix:- Argillaceous.

Origin:- Sedimentary; derived from a predominantly low-grade (mica) metamorphic/granitic terrain with minor volcanics.

Name:- LITHIC SANDSTONE.

Microslide:- GSQ 2738 ex Specimen:- GSQ/R 1711 Field No.:- 373/1

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:-- A massive rock composed of irregular alternations of very fine-grained pink material and slightly coarser off-white material.

Micro:-

Texture:- Altered. The different bands cannot be seen clearly but appear to be presented by slight variations in the percentage of phenoclasts. Clastic; phenoclasts (5 to 10% of rock) about 0.02 mm., of moderate to low sphericity, corroded. Matrix extremely fine-grained, about 70% of rock. Secondary material makes up about 20% of rock.

Phenoclasts:- Quartz: predominant.

Feldspar:

Biotite: extremely altered flakes.

Lithic Material: very fine-grained volcanics, similar in composition to the matrix.

Tourmaline: rare, euhedra.

Matrix:- Tuffaceous: about 70% of rock; very fine-grained. Green chlorite can be recognised as well as opaque dust.

Secondary Minerals:- Calcite, heavily ironstained: about 20% of rock; distributed at random.

Origin:- Volcanic, pyroclastic; the presence of terrigenous material (granitic) suggests that the rock was water-laid. The lithic material appears to be essential.

Name:- Altered LITHIC TUFF.

Microslide:- GSQ 2739 ex Specimen:- GSQ/R 1712 Field No.:- 373/1A

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, thinly-bedded, very fine-grained, purplish rock containing fairly regular, rounded ellipsoidal bodies, up to 17 mm. of fine-grained greenish material.

Micro:-

Green Material:- There is an inner core of very fine-grained material, masked by a concentration of anhedral opaque material and associated limonite.

About this core is a clastic rock with a grain size of about 0.04 mm. The dominant constituent is mica (estimated at about 50% of rock), dominantly muscovite and sericite. This tends to mask the remainder of the rock which consists of about 10% quartz (subrounded to subangular grains of moderate sphericity) and about 40% argillaceous material, some of which is believed to be lithic fragments and the remainder, matrix, both being similar in composition.

Purple Rock:- Similar in composition to the green material but heavily stained with secondary limonite with minor associated calcite.

Origin:- Sedimentary; the detritus appears to have been derived from an essentially low grade (mica) metamorphic terrain. The colour change is believed to be a mottling effect resulting from differential alteration and is a common phenomenon in such rocks.

Name:- SILTSTONE.

Microslide:- GSQ 2740 ex Specimen:- GSQ/R 1714 Field No.:- 373/2A

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, pinkish-brown and off-white rock.

Micro:-

Texture:- Clastic; comprises about 90% phenoclasts in a fine-grained matrix. Phenoclasts are 1.2 to 0.3 mm., angular to subrounded, of very low to moderate sphericity, embayed in part.

Phenoclasts:- Lithic material: about 60% of rock; the following types (in approximate order of decreasing abundance) can be recognised:-

Volcanic rocks: tuff, commonly hematitic, rhyolite, ?intermediate extrusives.
Mica schist
Micaceous siltstone
Limestone

Quartz: about 20% of rock.

Feldspar (dominantly potash): < 10% of rock; commonly altered.

Composite grains of quartz and feldspar, commonly in graphic intergrowth, are relatively abundant.

Mica: minor; extremely altered.

Matrix:- Tuffaceous: hematite-stained, in part.

Alteration:- Many of the fragments of lithic material are very heavily ironstained and some are surrounded by a fine fringe of limonite. Some of these fragments have been replaced, in part, by calcite as have many of the feldspar crystals.

Origin:- Sedimentary and volcanic pyroclastic; phenoclasts derived from a volcanic (Silver Hills Volcanics), granitic/low grade (mica) metamorphic and sedimentary (Ducabrook Formation) terrain. The corrosion of some of the phenoclasts suggests that the tuff is primary (water-laid), not redeposited.

Name:- Altered TUFFACEOUS LITHIC SANDSTONE.

Microslide:- GSQ 2770 ex Specimen:- GSQ/R 1766 Field No.:- 150/6

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5017 Run:- 8

Location:- 3 miles north-east of Lockington Homestead.

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, greenish-grey altered rock.

Micro:- No satisfactory thin section could be made.

The rock contains angular to subrounded clasts (about 0.08 mm.) of quartz and feldspar in cloudy calcite.

Name:- SANDY LIMESTONE.

Microslide:- GSQ 2741 ex Specimen:- GSQ/R 1716 Field No.:- 373/4

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5021 Run:- 8

Location:- Medway Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A brownish-coloured bedded clastic rock. Individual beds vary, at random, from fine-grained to coarse-grained, with rounded pebbles of quartz and lithic material, up to 2.5 cm.

Micro:- A thin section of some of the finer-grained material was made.

Texture:- Clastic; uneven-grained, consisting of about 85% phenoclasts and 15% zeolitic cement. The phenoclasts are 0.5 to 6 mm., rounded to angular to rounded, of low to high sphericity. The cement is an allotriomorphic-granular mosaic (grain size about 0.02 mm.) which occurs as fine "stringers" between grains. The margins of the crystal phenoclasts against the cement are finely "frayed".

Phenoclasts:- Of two types - "crystals" and lithic material. The individual fragments are difficult to distinguish and it is impossible to estimate the percentage of "crystals" which are discrete grains and the percentage which are clasts in fragments of tuff. All of this material is counted together (below).

Lithic Material: about 55% of rock:

Crystal tuff
Acid volcanic extrusive rock (Silver Hills Volcanics)
Low grade metamorphic rocks (Anakie Metamorphics)
Composite quartz grains (Pre-Devonian "granite")

Feldspar (potash and oligoclase): about 20% of rock; altered.

Quartz: about 10% of rock; mostly unstrained.

Cement:- Zeolite; secondary.

Origin:- Sedimentary; derived from volcanic (Silver Hills Volcanics)/low grade metamorphic/granite terrain.

Name:- LITHIC SANDSTONE/CONGLOMERATE.

Microslide:- GSQ 2764 ex Specimen:- GSQ/R 1756 Field No.:- 371/1A

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5094 Run:- 6

Location:- Drummond Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, extremely fine-grained, buff-coloured rock.

Micro:-

Texture:- Clastic; about 65% of rock consists of extremely fine-grained (0.01 to 0.001 mm.) essentially siliceo-feldspathic material. About 15% comprises original phenoclasts (commonly about 0.05 mm.) which are, in general, extremely corroded and difficult to distinguish from the matrix. These phenoclasts appear to have been angular to rounded (some to have been broken) of low to moderate sphericity. About 20% secondary calcite is distributed at random.

Phenoclasts:- Spherulitic ?rhyolite: 5% of rock; grain boundaries very difficult to distinguish.

Quartz: < 5% of rock.

Feldspar: plagioclase, in part, at least; mostly crystals, many of which have been partially replaced by calcite.

Mica Schist: minor.

Biotite: minor; colourless to pale green.

Muscovite: minor.

Zircon: one fine euhedral crystal.

Matrix:- Siliceo-feldspathic.

Secondary Material:- Calcite: clots, up to 0.6 mm.; suspected of being secondary after comparatively coarse plagioclase crystals.

Origin:- Essentially volcanic, pyroclastic (primary); there has been a certain amount of contamination from terriginous material.

Name:- Altered ?SILTY-CRYSTAL TUFF.

Microslide:- GSQ 2765 ex Specimen:- GSQ/R 1757 Field No.:- 371/1B

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5094 Run:- 6

Location:- Drummond Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, pinkish-brown clastic rock.

Micro:-

Texture:- Clastic; consisting of about 85% phenoclasts in about 5% extremely heavily ironstained, fine-grained matrix with about 10% calcite cement, associated, in general, with limonite. The phenoclasts are mostly subrounded, of low to moderate sphericity, 0.02 to 0.2 mm.

Phenoclasts:- Lithic Material: about 40% of rock; the following rock types can be recognised:-

Mica schist: greenish in colour due to alteration to chlorite.
Fine-grained volcanic rock, heavily ironstained.

Quartz: about 25% of rock.

Feldspar (dominantly potash): about 20% of rock; commonly altered to ironstained clay minerals.

Mica: minor muscovite.

Tourmaline: minor; bluish-green.

Matrix:- Micaceous; ironstained.

Cement:- Calcite, with associated limonite.

Origin:- Alteration of sediment derived from a metamorphic/volcanic/granitic terrain.

Name:- CALCAREOUS-FELDSPATHIC-QUARTZ-LITHIC SANDSTONE.

Microslide:- GSQ 2767 ex Specimen:- GSQ/R 1762 Field No.:- 371/10

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5094 Run:- 6

Location:- Drummond Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, brownish-pink clastic rock.

Micro:-

Texture:- Clastic; about 95% phenoclasts in about 5% very fine-grained matrix. Phenoclasts mostly 0.03 to 0.1 mm., rarely up to 1 mm.; in general subrounded, of low to moderate sphericity. The percentage of grain boundary contacts is very high.

Phenoclasts:- Feldspar (dominantly potash with minor plagioclase): about 40% of rock; commonly altered to ironstained clay minerals.

Quartz: about 20% of rock.

Lithic Material: > 30% of rock; the following rock types can be recognised:-

Fine-grained micaceous rock, dominantly schistose; commonly ironstained.
Chloritic tuff (green).
Rhyolite, commonly spherulitic.
Granite.

Mica: < 5% of rock; muscovite and biotite, commonly altered.

Matrix:- Tuffaceous: chloritic.

Origin:- Sedimentary; derived from a low grade metamorphic/granitic/volcanic terrain.

Name:- TUFFACEOUS-QUARTZ-LITHIC-FELDSPATHIC SANDSTONE.

Microslide:- GSQ 2768 ex Specimen: GSQ/R 1764 Field No.:- 371/11

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5094 Run:- 6

Location:- Drummond Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, light grey (almost white) clastic rock.

Micro:-

Texture:- Clastic; about 95% of rock consists of phenoclasts (0.08 to 1 mm.), angular to subrounded, of low to moderate sphericity. The matrix (about 5%) is extremely fine-grained. The percentage of grain boundary contacts is very high. The matrix appears to have slightly corroded many of the phenoclasts.

Phenoclasts:- Lithic Material: about 55% of rock; the following rock types can be recognised:-

Micaceous siltstone
Mica schist
Fine-grained, ironstained, volcanics.

Quartz: about 20% of rock; commonly strained.

Feldspar (potash and oligoclase): about 15% of rock; commonly grains with some lath-shaped crystals.

Composite grains of quartz or quartz and feldspar are common.

Muscovite: about 5% of rock; flakes.

Matrix:- Essentially sericitic; about 5% of rock.

Origin:- Sedimentary; derived from low grade (mica metamorphic/granitic/sedimentary/volcanic terrain.

Name:- FELDSPATHIC-QUARTZ-LITHIC SANDSTONE.

Microslide:- GSQ 2785 ex Specimen:- 1783 Field No.:- 241/1b

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5008 Run:- 4

Location:- North-east limb of Pebbly Creek Anticline

Formation:- Ducabrook Age:- Carboniferous

Macro:- A massive, fine-grained, dark grey rock, finely specked with white and with irregular "patches" of calcite.

Micro:-

Texture:- Clastic; consisting of about 5% phenoclasts in about 85% very fine-grained matrix. The phenoclasts are about 0.02, commonly corroded. Irregular "patches" of secondary calcite and others of zeolite are dispersed at random.

Phenoclasts:- Quartz and feldspar (plagioclase, in part, at least).

Mica: minor; pleochroic from colourless to pale green.

Matrix:- Tuffaceous; containing abundant fine (0.01 mm.) granular ? zoisite.

Secondary Minerals:- Calcite: dominant.

Zeolite.

Origin:- Altered, possibly slightly metamorphosed, volcanic pyroclastic.

Name:- Altered, TUFF

Microslide:- GSQ 2747 ex Specimen:- GSQ/R 1727 Field No.:- 356/4

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5023 Run:- 8

Location:- Mt. Mudge Syncline

Formation:- Ducabrook Age:- Carboniferous

Macro:- Essentially similar to 349/4(a). The "pink" and "green" material appears to be somewhat irregularly interbedded.

Micro:-

Texture:- Clastic; phenoclasts make up about 95% of rock and fine-grained matrix about 5%. Phenoclasts rounded to subangular, of moderate to low sphericity, 0.05 to 0.2 mm. The percentage of grain boundary contacts is very high.

Individual beds are not clearly defined but the proportions of quartz/feldspar and lithic material vary inversely throughout the rock probably from "pink" to "green" beds.

Phenoclasts:- Quartz: about 20% of rock; strained.

Feldspar (dominantly potash with minor plagioclase): about 15% of rock; commonly altered to limonite-stained clay minerals.

Composite grains of quartz or quartz and feldspar are common.

Lithic Material: about 50% of rock.

(a) Volcanic: about 35% of rock fine-grained acidic extrusives, commonly very rich in iron oxides.

(b) Mica Schist: about 15% of rock; commonly altered to pale greenish chloritic material.

Mica: about 5% of rock; biotite (light brown to brownish-green) and muscovite.

? Glauconite: 5% of rock; heterogeneous green pellets.

Epidote: minor.

Opaques: minor; somewhat oxidised.

Matrix:- Argillaceous: dominantly micaceous.

Origin:- Sedimentary; derived from a granitic/low grade (mica) metamorphic/volcanic (Silver Hills Volcanics) terrain.

Name:- FELDSPATHIC-QUARTZ-LITHIC SANDSTONE.

Microslide:- GSQ 2749 ex Specimen:- GSQ/R 1730 Field No.:- 356/7

Four Mile Map:- Emerald

Air Photo (B.MR.):- Emerald No.:- 5023 Run:- 8

Location:- Mt. Mudge Syncline

Formation:- Ducabrook Age:- Carboniferous

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

Micro:-

Texture:- Clastic; consisting of approximately 55% phenoclasts and 45% calcareous cement, exhibiting "fontainbleu" texture. The phenoclasts are 0.2 to 0.5 mm., rounded to subangular, mostly of moderate sphericity.

Phenoclasts:- Quartz: about 20% of rock; strained.

Feldspar: about 5% of rock.

Composite grains of quartz or quartz and feldspar occur.

Lithic Material: about 30% of rock; fine-grained volcanics, sediments and mica schist.

Muscovite: minor.

Cement:- Calcite.

Origin:- Sedimentary; clasts derived from a granitic/low grade (mica) metamorphic/volcanic/sedimentary terrain.

Name:- QUARTZ-LITHIC-CALCAREOUS SANDSTONE.

## Intrusives

Microslide:- GSQ 2804 ex Specimen:- GSQ/R 1782 Field No.:- 227/14

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5100 Run:- 5A

Location:- North-west of Withersfield

Formation:- Intrusive in Raymond Sandstone Age:- Unknown

Macro:- A massive, greenish-grey, medium-grained rock.

Micro:-

Texture:- Extremely altered. Porphyritic, phenocrysts (about 70% of rock) 1 to 2 mm. Groundmass ? intersertal, about 0.1 mm.

Phenocrysts:- Plagioclase (? Andesine): about 45% of rock; extremely saussuritised.

Mafic Minerals: about 25% of rock; one crystal of pyroxene; the remainder of the crystals (pyroxene, ?amphibole) have been entirely replaced by serpentine, with or without chlorite.

Groundmass:- Feldspar

Clinopyroxene

Biotite

Serpentine

Chlorite

Calcite

Epidote

Origin:- Igneous; intrusive.

Name:- Altered ANDESITE.

Microslide:- GSQ 2655 ex Specimen:- GSQ/R 1573 Field No.:- 225/3

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5075 Run:- 5

Location:- N.W. of Silver Hills Homestead

Formation:- ?Intrusive in Silver Hills Volcanics Age:- Unknown

Macro:- A massive, reddish-brown and white mottled rock with feldspar crystals up to 4 mm. in length.

Micro:-

Texture:- Extremely altered; porphyritic and glomeroporphyritic, with phenocrysts making up about 30% of rock; crystal clusters (mostly of subhedral to euhedral crystals), mostly about 2 mm.; individual phenocrysts subhedral to anhedral dominantly about 1 mm. Groundmass, intersertal, dominantly about 0.05 mm.

Phenocrysts:- Plagioclase (labradorite to andesine): about 30% of rock; strongly zoned, in general concentric, alternate; crystals slightly to extremely sericitised.

Hornblende: about 10% of rock; pleochroic from pale yellow to bright green; minor secondary calcite, epidote and opaques are associated with some of the crystals.

Groundmass:- Extremely altered; feldspar and hornblende with minor opaques and accessory apatite can be recognised.

Origin:- Alteration of an igneous ?intrusive rock.

Name:- Altered HORNBLENDE ANDESITE.

Microslide:- GSQ 2667 ex Specimen:- GSQ/R 1588 Field No.:- 230/5a

Four Mile Map:- Emerald

Air Photo (B.M.R.):- Emerald No.:- 5088 Run:- 6

Location:- E.N.E. of Tadcaster Homestead.

Formation:- Intrusive in Silver Hills Volcanics Age:- Unknown

Macro:-

Texture:- Porphyritic; phenocrysts anhedral, 0.5 to 4 mm.; many of the crystals are corroded; about 80% of rock; groundmass intersertal, about 0.2 mm. Rock extremely altered.

Phenocrysts:- Labradorite (intermediate): about 40% of rock; lath-shaped, corroded crystals; in general extremely altered being replaced, in part, by sericite and/or chlorite with minor calcite. Inclusions of apatite relatively abundant.

?Pyroxene: about 30% of rock; completely replaced by calcite and chlorite. Mostly anhedral but some display a suggested 8-sided shape.

Biotite: about 10% of rock; extremely altered, ragged flakes pleochroic from pale yellowish-brown to dark brown.

Groundmass:- Plagioclase: predominant; crystals tending to acicular, anhedral.

Chlorite: fibrous, green and brown.

Quartz: anhedral.

Biotite: ragged, altered flakes.

Apatite: comparatively abundant; euhedral.

Pyrite: accessory; anhedral.

Origin:- Igneous, ?intrusive.

Name:- Altered ANDESITE.

# APPENDIX II

## PERMIAN MARINE MACROFOSSILS FROM THE EMERALD SHEET AREA.

by
J.M. Dickins

Four collections were made during the field survey, two samples (EM 6/1 and 6/3) came from low in the Middle Bowen Beds and two (EM 208 and 209) came from high in these beds. EM 6/3 is 300 feet stratigraphically above EM 6/1, EM 208 is stratigraphically close to EM 204, but the exact relationship is not clear. EM 6/1 and EM 6/3 are referable to Fauna II of Dickins found in the basal part of the Middle Bowen Beds in the north-east part of the Bowen Basin and can be correlated with the Cattle Creek Formation in outcrop in the Springsure area. EM 209 is referable to Fauna IV in the upper part of the Middle Bowen Beds. EM 208 is younger than Fauna II but, other than this, its stratigraphical position cannot be determined from the fossils at present available.

### Identifications

EM 6/1 - About 12 miles south-west of Emerald on the Nogoa River.

Pelecypods

- *Megadesmus*? cf. *nobilissimus* (de Koninck) 1877
- *Merismopteria* sp.
- *Pseudomyalina* cf. *mingenewensis* (Etheridge Jnr ) 1907
- *Modiolus* sp.
- *Aviculopecten* sp. nov.

Brachiopods

- *Trigonotreta*? sp.
- *Notospirifer hillae hillae* Campbell 1961

EM 6/3 - As for EM 6/1 but 300 feet stratigraphically higher.

Pelecypods

- *Myonia* or *Pachymyonia* sp. ind.
- *Aviculopecten* sp. nov. (species with large coarse primary ribs)

Brachiopods

- *Ingelarella* cf. *plana* Campbell 1960
- *Notospirifer hillae hillae* Campbell 1961

EM 208 - About 15 miles north-east of Capella.

Gastropods

*Platyteichum costatum* Campbell 1953

Brachiopods

*Strophalosia* sp. ind.

EM 209 - About 4 miles north of Capella.

Pelecypods

*Astartila sp?*

*Stutchburia* cf. *costata* (Morris) 1845

Brachiopods

*Terrakea* sp. ind.

*Strophalosia clarkei* (Etheridge Snr ) 1872

*Strophalosia brittoni var. gattoni* Maxwell 1954

*Strophalosia ovalis* Maxwell 1954

## Conclusions

*Megadesmus*? cf. *nobilissimus*, *Pseudomyalina* cf. *mingenewensis*, *Aviculopecten* sp. nov. and *Notospirifer hillae hillae* indicate that the faunules at EM 6/1 and 6/3 are to be referred to Fauna II of Dickins (1961; 1962). *Notospirifer hillae hillae* and *Ingelarella plana* are known in the Cattle Creek Formation in its area of outcrop. It is shown elsewhere (Dickins, 1962) that the fauna of the Cattle Creek Formation is also to be referred to Fauna II.

The three species of *Strophalosia* identified from EM 209 indicate that Fauna IV from the northern part of the Bowen Basin can be recognized on the Emerald 1:250,000 Sheet. *Stropholasia brittoni* var. *gattoni* is not definitely known below the *clarkei*-bed of the Clermont area or the Big *Stropholasia* Zone to the north and east of this area. *Strophalosia ovalis* is not known below the Mantuan *Productus* Bed, the *clarkei*-bed or the *Big Strophalosia* Zone.

This fauna is compatible with EM 209 representing a continuation of the *clarkei*-bed, as suggested by the field evidence. From the fossil ranges alone, however, it could be also slightly younger.

EM 208 is not older than Fauna III of the north-eastern part of the Bowen Basin, because the lowest occurrence of this fauna is marked, inter alia, by the incoming of Platyteichum costatum. It may be, but not necessarily, slightly older than EM 209, as Platyteichum costatum has not been definitely recorded from beds as young as the clarkei-bed and its equivalents.

References

DICKINS, J.M., 1961 - Appendix in Malone, E.J., Corbett, D.W.P. and Jensen, A.R., Geology of the Mt Coolon 4-mile area. Bur.Min.Resour.Aust.Rec.1961/69 (unpubl.)

__________ 1962 - Appendix in Malone, E.J., Jensen, A.R., Gregory, C.M. and Forbes, V.R., Geology of the southern half of the Bowen Sheet. Bur.Min.Resour.Aust.Rec. 1962/72 (unpubl.)

## APPENDIX III.

### REPORT ON FOSSIL FISH REMAINS FROM TWO LOCALITIES IN THE EMERALD SHEET AREA.

by
J.T. Woods (Geological Survey of Queensland).

Locality : EM 349/5 reference 557032
Emerald 4-mile Sheet

Collected by : Bureau of Mineral Resources/ Geological Survey of Queensland field party, 1961.

Determination: Indeterminate palaeoniscoid fish.

Remarks : The single specimen from this locality shows a single dorsal ridge scale. Its ornament of fine discontinuous grooves differs in detail from similar elements in collections from EM 350/1 and Hannam's Gap.

........

Locality : EM 350/1 reference 553028
Emerald 4-mile Sheet.

Collected by : Bureau of Mineral Resources/Geological Survey of Queensland field party, 1961.

Determination: Indeterminate palaeoniscoid fish (?*Elonichthys* sp.)

Age : Upper Devonian or Lower Carboniferous.

Remarks : Fifteen pieces of matrix exhibit numerous low rhomboidal ventral body scales, several more rhombic flank scales, one dorsal ridge scale, very fragmental skull bones, and a nearly complete cleithrum, from palaeoniscoid fishes. In ornament the scales exhibit a transition from a well developed system of bifurcating furrows, initially parallel to the anterior and ventral margins, to one where it becomes posteriorly obsolete - nearly smooth, with punctae and discontinuous grooves.

On the whole, the scales and the cleithrum compare closely with similarly preserved material, from sediments of the Ducabrook Formation at Hannam's Gap, in the Geological Survey collections (obtained by J. Smith in 1891, and B. Dunstan in 1921). On that basis, a tentative correlation of the sediments at the present locality with part of the Ducabrook Formation, of Upper Devonian or Lower Carboniferous age, is suggested.

Since only dissociated skeletal elements are present, no definite generic determination can be made. The scales are within the range of variation of those referable to the form genus Elonichthys (Upper Devonian-Permian); but they differ from those of species of this genus described by Woodward (1906) from ?Lower Carboniferous sediments in the Mansfield district, Victoria. Hill (in Shell (Queensland) Development Pty Ltd, 1952) recorded Elonichthys scales from sediments of the Ducabrook Formation in the Springsure region.

References

SHELL (QUEENSLAND) DEVELOPMENT PTY LTD, 1952 : General report on investigations and operations carried out by the company in the search for oil in Queensland 1940-1951 with appendices A-H. Unpub. rep. Geol.Surv.Qld library.

WOODWARD, A.S., 1906 : On a Carboniferous fish fauna from the Mansfield district, Victoria. Mem. Nat. Mus.Vict., 1, 1-32.

# APPENDIX IV.

## REPORT ON FOSSILS FROM NEAR GLENDARRIWELL HOMESTEAD (EMERALD SHEET AREA) AND NEAR TELEMON HOMESTEAD (SPRINGSURE SHEET AREA)

by
Professor Dorothy Hill.

Preliminary report on specimens EM 40/7 collected by Bureau of Mineral Resources/Geological Survey of Queensland Emerald field party, 1961.

Locality EM 40/7 is about 10 miles east of Anakie Hill on the Emerald Sheet area, Queensland.

| | | |
|---|---|---|
| 1 and 3 | - | Eddastraea grandis (Dun) |
| 11,12,15,17 | - | Stringophyllum bipartitum Hill |
| 19 | | (Yabeia salmoni Hill)? |
| 2,5,14 | - | Thamnopora sp.cf. helenae Chudinova |
| 6 | - | Thamnopora sp. (cf. Parastriatopora) |
| 7, 20 | - | Romingeria? sp.nov. (not foordi Eth.) |
| 9 | - | Aulopora? sp.nov. |
| 10,18 | - | Alveolites sp. |
| 8, 13 | - | Chaetetes sp. |
| 9, 16 (and on 18) | - | Alveolites (or Coenites) sp. |

The assemblage is Middle Devonian.
To determine whether it is lower Middle or upper Middle Devonian will require research.

Eddastraea grandis (Dun) occurs in a limestone (Shell Co. M.233) near Telemon Homestead on the Springsure-Tambo road, and also in the Loomberah Limestone in New South Wales. Both these limestones, because of their associated faunas, had been regarded as lower Middle Devonian.

Stringophyllum bipartitum Hill has previously been regarded as upper Middle Devonian, since it occurs with Givetian faunas at Burdekin Downs in Queensland and at Moore Creek in New South Wales.

The association of these two species possibly indicates a high lower Middle Devonian age for EM 40/7, but I wish to investigate the Tabulata accompanying them in much more detail before I commit myself.

Preliminary palaeontological report on specimens from near Telemon Homestead, Springsure-Tambo road, Queensland collected by Bureau of Mineral Resources/Geological Survey of Queensland Emerald field party, 1961.

Specimens: 51/2/1,5,7 - *Hexaganaria* sp.
/2,3 - *Heliolites* aff. *porosa*
/4,8, and several unnumbered - *Alveolites* sp.
/9, - Solitary Rugose Coral, new to be determined.
/10 - *Favosites* sp. aff. *goldfussi*
/11 - Polyzoan.
/12,13 - *Thamnopora* and Polyzoan
/14,15 - Stromatoporoid.

Age: This is a Devonian assemblage, older than Upper Devonian, and probably Middle rather than Lower Devonian.

Specimens: 50/2a/1 & 2c and
unnumbered specimens - *Eddastrea grandis* (Dun).
/2b - *Heliolites* aff. *porosa*
/2a - *Favosites*
/3 - Tabulatan genus, new? cf. *Thecia*.
/4 - *Alveolites*, 2 species, one very fine celled.

Age: Probably lower Middle Devonian.

Specimens: 50/2b/1,3 - *Favosites* aff. *goldfussi*
/2,4,5,9 - *Heliolites* aff. *porosa*
/6,7 - Stromatoporoid
/8 - Stromatoporoid and Heliolitid

Age: Probably Devonian.

Specimens: 50/2c/1,5 - *Eddastrea grandis*
/2 - *Heliolites* aff. *porosa*
/3,4 - Stromatoporoid

Age: Probably Devonian.

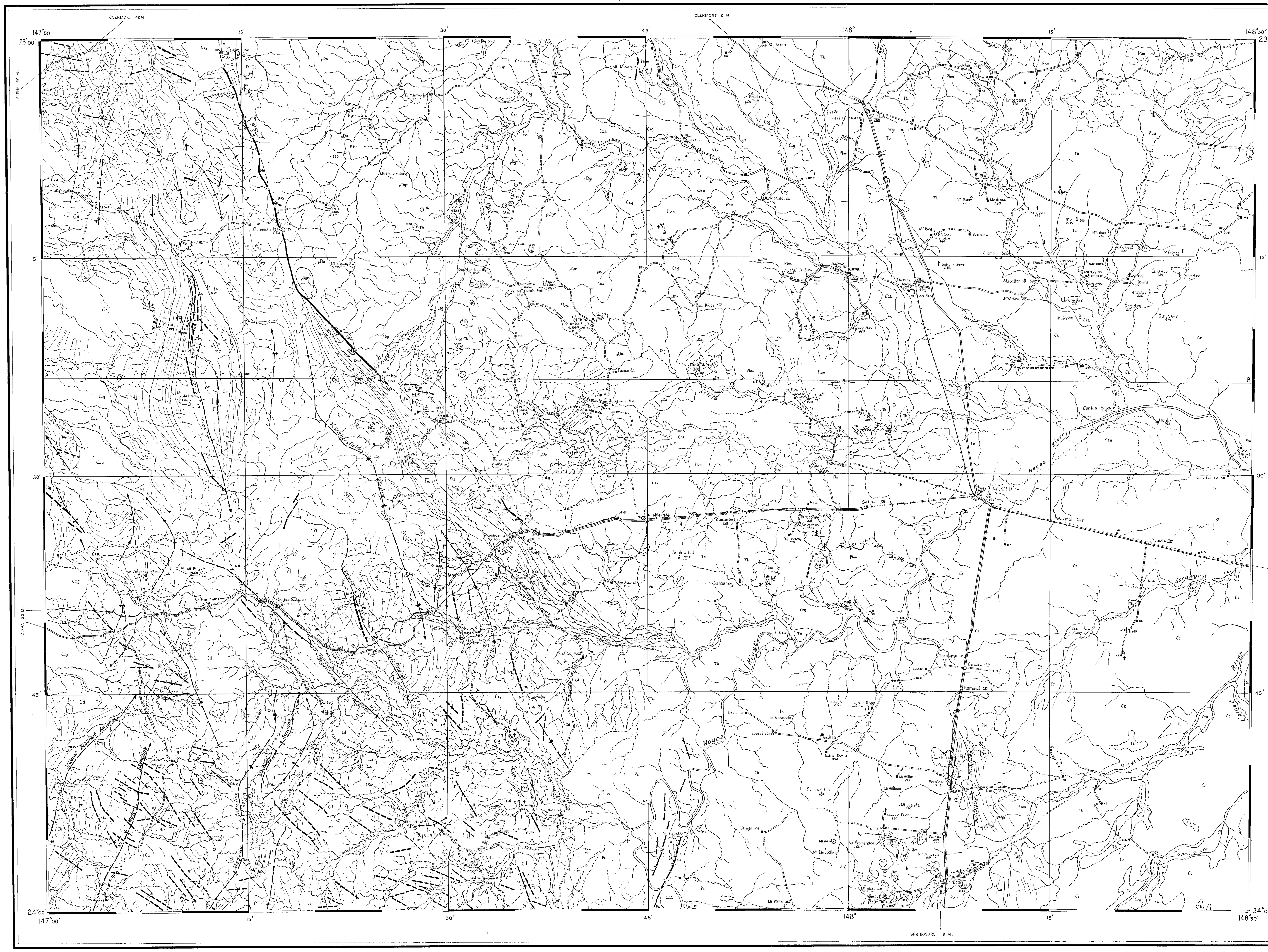
AUSTRALIA 1 : 250,000

# EMERALD

QUEENSLAND

1 : 250,000 GEOLOGICAL SERIES SHEET SF 55-15



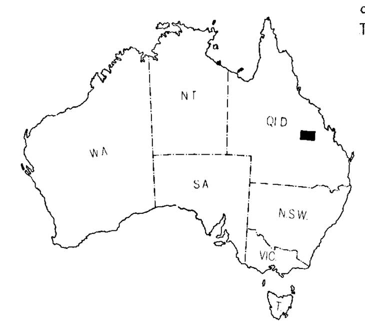



## Reference

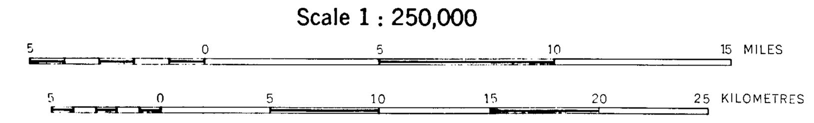
| | | | | |
|---|---|---|---|---|
| CAINOZOIC | UNDIFFERENTIATED | | Cza | Alluvium |
| | | | Czg | Gravel |
| | | | Cz | Soil, sand, clay and gravel |
| | TERTIARY | | Tr | Alkaline trachyte and rhyolite, plugs, domes and dykes |
| | | Undifferentiated | Tb | Flows of olivine basalt, interbedded in places with trachytic pyroclastics and sediments |
| | | Hoy Basalt | Th | Plugs of olivine basalt with inclusions |
| PALAEOZOIC | | Undifferentiated | Pzg | Granite |
| | PERMIAN | Upper Bowen Coal Measures | Pbu | Sandstone, shale and coal |
| | | Middle Bowen Beds | Pbm | Pebbly sandstone, sandstone and shale |
| | | Colinlea Formation | Pc | Pebbly sandstone |
| | CARBONIFEROUS | Ducabrook Formation | Cd | Sandstone, shale and minor tuff |
| | | Raymond Sandstone | Cr | Sandstone, shale and minor tuff |
| | | Mount Hall Conglomerate | Ch | Quartz pebble conglomerate |
| | CARBONIFEROUS – DEVONIAN | Telemon Formation | D-Cl | Sandstone and siltstone, tuffaceous in part, tuff and conglomerate |
| | | Silver Hills Volcanics | D-Cs | Rhyolite, trachyte and andesite flows and agglomerate |
| | MIDDLE DEVONIAN | Undifferentiated | Dm | Coralline limestone and volcanics |
| | PRE-DEVONIAN | Retreat Granite | pDgr | Granite, granodiorite and adamellite |
| | | Anakie Metamorphics | pDa | Schist and slate |

- Geological boundary
- Fault
- Anticline
- Syncline
- Monocline
- Where location of boundaries faults and fold axes is approximate, line is broken; where inferred, queried; where concealed, folds are dotted
- Strike and dip of strata
- Horizontal strata
- Dip < 15° (Air-photo interpretation)
- Dip 15° - 45° (Air-photo interpretation)
- Dip > 45° (Air-photo interpretation)
- Horizontal strata (Air-photo interpretation)
- Dip slope (Air-photo interpretation)
- Trend of bedding (Air-photo interpretation)
- Dyke
- Macrofossil locality
- Microfossil locality
- Plant fossil locality
- Bore with wind pump
- Trigonometrical station
- Height in feet, instrument levelled (datum: mean sea level)
- Height in feet, barometric (datum: mean sea level)
- Road
- Vehicle track
- Railway line with siding
- Homestead
- Landing ground
- Town
- Old river channel
- Dam

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Slotted templates supplied by Division of National Mapping, Department of National Development. Aerial photography by Adastra Aerial Surveys; complete vertical coverage at 1:80,000 scale.
Transverse Mercator Projection.

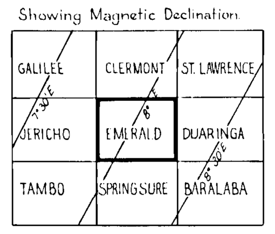



### Scale 1 : 250,000



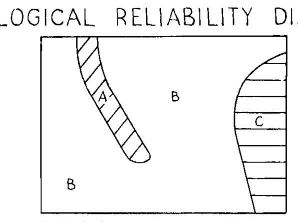

### INDEX TO ADJOINING SHEETS

Showing Magnetic Declination



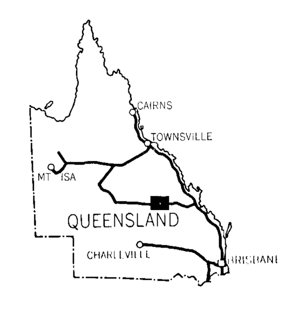

ANNUAL VARIATION 2'30"E

### GEOLOGICAL RELIABILITY DIAGRAM



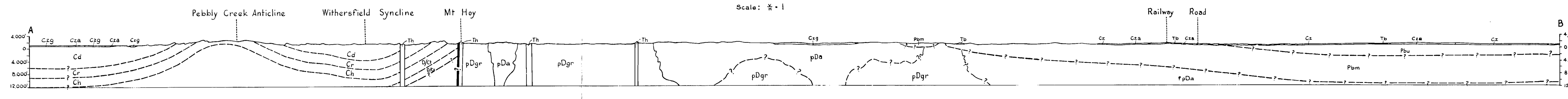

A. Detailed reconnaissance, numerous traverses.
B. Numerous traverses and air-photo interpretation.
C. Air-photo interpretation, few traverses.

Geology, 1961, by: J.J. Veevers, R.G. Mollan and F. Olgers. (B.M.R.) and A.G. Kirkegaard. (Q.G.S.)
Compiled, 1961, by: R.G. Mollan, F. Olgers and A.G. Kirkegaard.
Drawn by: Ruskin Publishing Pty. Ltd.




### Section A - B

Scale: ⅛ : 1




EMERALD
SF 55-15