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COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

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1962/72

PROGRESS REPORT ON THE BOWEN BASIN REGIONAL SURVEY, SEASON 1961

GEOLOGY OF THE BOWEN SOUTH AREA

by

E.J. Malone, A.R. Jensen, C.M. Gregory
and V.R. Forbes

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SUMMARY

This report covers the work of a combined Bureau of Mineral Resources and Geological Survey of Queensland field party which mapped the southern half of the Bowen 1:250,000 Sheet area during the three months June to September, 1961. This was part of a continuing programme of regional mapping of the Bowen Basin, commenced in 1960.

The area mapped includes: the northern end of the Bowen Basin, except for an extension to the north occupied by Lower Bowen Volcanics only; the northern end of the Anakie High; upper Devonian to Carboniferous sediments and volcanics dipping east off the Anakie High; the northern end of the Drummond Basin; the Carboniferous Bulgonunna Volcanics forming the western basement to the Bowen Basin; and the Urannah Complex forming the eastern margin of the Bowen Basin.

The oldest rocks in the area are fossiliferous Ukalunda Beds, at least partly Middle Devonian in age. Their relationship to the Anakie Metamorphics is not known. Together with adamellite and granodiorite intrusives, they form the northern end of the Anakie High.

Devonian to Carboniferous sediments and volcanics dip east off the Anakie High. These contain Upper Devonian fossils near the base.

The Carboniferous Drummond Group unconformably overlies the Ukalunda Beds and intrusives. The group crops out in the northern end of the Drummond Basin which displays a north-east trend in this area.

The Bulgonunna Volcanics, of probably Upper Carboniferous age, unconformably overlie the above units. Together with intrusives they form the shallowly east dipping basement to the western shelf zone of the Bowen Basin.

The Urannah Complex forms the eastern margin of the Bowen Basin. It is partly contemporaneous with and partly intrusive into the Lower Bowen Volcanics.

The Lower Bowen Volcanics is the basal unit in the Bowen Basin. It is a thick, heterogeneous pile of volcanics and sediments, extending to the north beyond the Bowen South area.

The Middle Bowen Beds cropping out on the eastern flank of the Bowen Basin were divided into three units on the basis of palaeontological and stratigraphical information. These units are referred to as units A, B and C, A being the oldest; unit B is divided into three sub-units, B1, B2 and B3.

A distinct fauna is associated with each of these units and sub-units. The Collinsville Coal Measures was shown to be equivalent to most of unit B, apart from a few hundred feet at the base. The subdivisions of unit B are visible in the Collinsville Coal Measures which is regarded as a formation in the Middle Bowen Beds. Unit A is not present around the western margin of the Bowen Basin.

The Upper Bowen Coal Measures and the Triassic Carborough Sandstone are conformable on the Middle Bowen Beds. The Bowen Basin sequence was folded and intruded to some extent during the Mesozoic.

Remnants of Tertiary sediments and scattered Tertiary basalt and acid volcanics are widespread in the area.

The Middle Bowen Beds contain potential oil source rocks, cropping out mainly on the east flank, and clean sandstone beds which are potential reservoirs. The unit crops out in the Rosella Creek anticline in the middle of the Bowen Basin. This structure is an attractive drilling prospect, both to test for possible accumulations and to gather stratigraphic information.

INTRODUCTION

The Bowen 1:250,000 Sheet area is located at the northern end of the Bowen Basin. This report refers to the southern half of the Bowen Sheet area, bounded by 20°30' and 21° of south latitude and by 147° and 148°30' of east longitude. The area includes the small coal mining town of Collinsville which is linked by a 3'6" gauge railway line and by a road in process of reconstruction to Bowen on the Queensland coast.

Access within the mapped area is provided by several moderately good gravel roads: one runs west from Collinsville to the Charters Towers-Clermont Highway, with branch roads south to Mount Coolon and north to Glendon and Mount McConnell Homesteads; others are the Collinsville-Bowen road and the road south from Collinsville to Mount Coolon. Graded roads and vehicle tracks branch off the major roads and supply access to much of the area.

In some areas, the country is quite rugged and vehicular traffic is restricted to existing tracks which may be many miles apart. In the east of the area, access is restricted to four tracks which are usable only by four-wheel drive vehicles. In such areas, the mapping consisted of wide spaced traverses.

The area lies within the 20" to 30" annual rainfall region, with most rain falling during the summer months. The rainfall is not reliable and long dry spells are common. Some frosts occur during the winter months.

Coal mining is the main industry in the area. The State Coal Mine at Collinsville and the Bowen Consolidated Coal Mine at Scottville, about 4 miles from Collinsville, are the main supports of a total population of about 2,000 people. The State Coal Mine closed down during 1960, mainly due to industrial trouble, and was sold to a private firm. It is expected that the mine will be reopened shortly.

The pastoral industry is the only other industry of any importance in the area. There are 19 stations in the area, the majority located in the better grazing country developed on the Bowen Basin sequence. In this area, the abundance of station tracks compensated for the many fences and it was possible to drive within walking distance of most outcrop areas.

The Bowen Sheet area is covered by Adastra air-photos at a scale of 1:85,000, photographed in 1960, and of very high quality. The small scale of these photos made it difficult in places to recognise tracks and other cultural features, to locate oneself accurately and to plot complicated geology in sufficient detail. However, in general, they were very suitable for the purpose of the present survey: reconnaissance mapping to produce a final map at a scale of 1:250,000.

The map accompanying this report was produced as follows: transparent overlays of the air-photos were made showing geology, drainage, cultural detail and wing and principal points; the overlays were photographically reduced and corrected and fitted to a slotted template control point plot at 1:250,000 scale.

This report and map are largely based on field work done between June 9 and September 5, 1961, by a combined field party of the Bureau of Mineral Resources and the Geological Survey of Queensland. This was the second field season of a continuing programme of regional mapping of the Bowen Basin and adjacent areas.

The 1961 party consisted of E.J. Malone, A.R. Jensen and C.M. Gregory of the Bureau of Mineral Resources and V.R. Forbes of the Geological Survey of Queensland.

The geology of the area between the Bowen River and Collinsville is largely based on published mapping by geologists of the Bowen Consolidated Coal Mining Company. (Webb and Crapp, 1960). This Company's geologists, are continuing a programme of detailed mapping of the Bowen Basin sediments south of the Bowen River. The mapping of this area is partly based on this unpublished material. The assistance of C. Crapp and the other geologists of the Bowen Consolidated Coal Mining Company in this and other ways is gratefully acknowledged. We are grateful to Bowen Consolidated Coal Mining Company for permission to include the log of their diamond drill hole No. 371.

J.M. Dickins visited the party from August, 24th to September 9th. He collected fossils from various localities in the area and particularly from fossil zones in measured sections in the Middle Bowen Beds.

G. Tweedale, of the Geological Survey of Queensland and W.B. Dallwitz visited the party for one week from the 14th August. Dallwitz gave advice on petrological problems, particularly of the Urannah Complex. Tweedale examined part of the Mount Wyatt Beds and pointed out criteria for differentiating Tertiary acid volcanics from similar Carboniferous volcanics. K. Walker examined thin sections of some of the party's rock specimens.

PREVIOUS INVESTIGATIONS

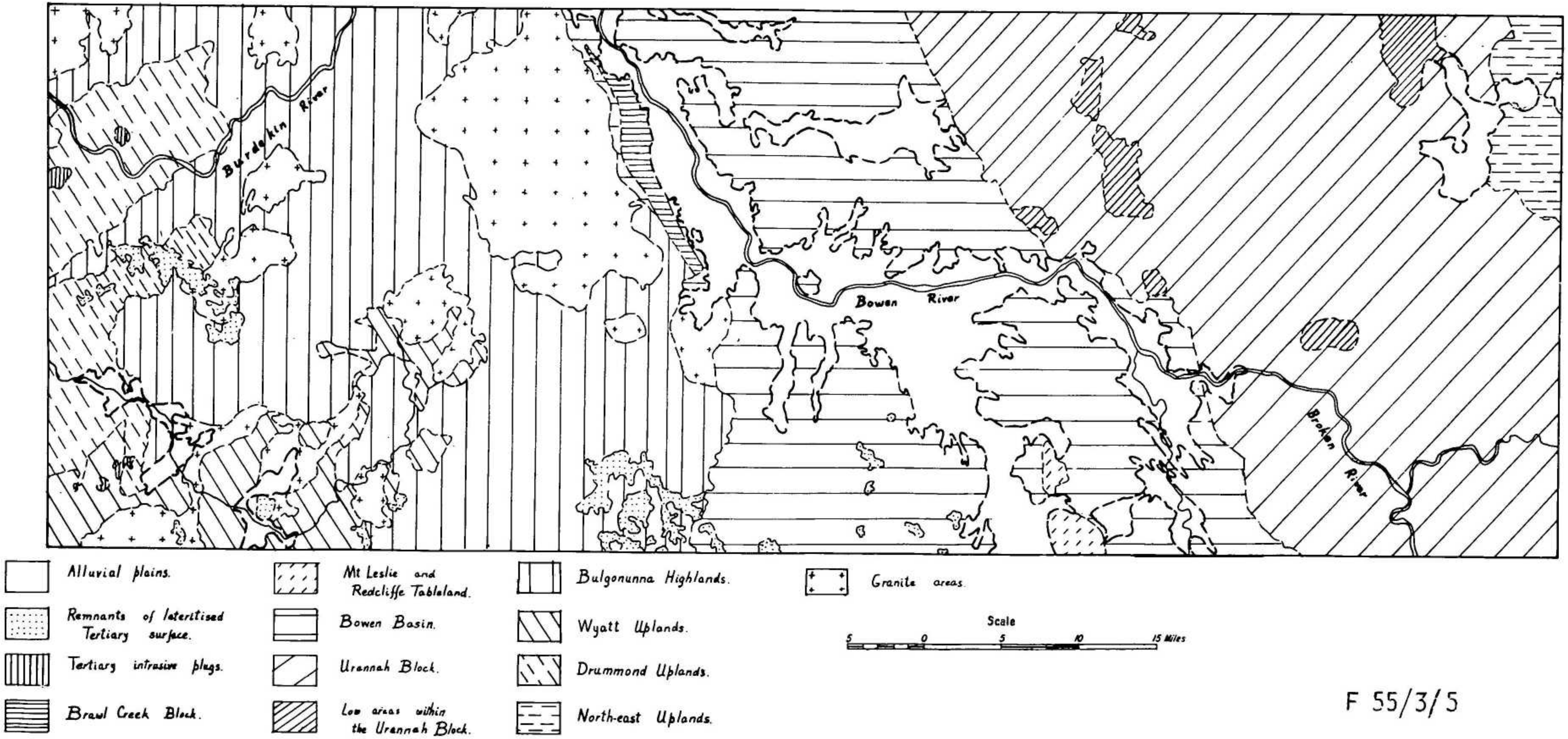
The mineral and coal deposits of the area were known and to some extent exploited during last century. Consequently, many geologists have visited the area. Possibly the first to publish notes on the geology was Daintree (1870). R.L. Jack made many visits to the area between 1879 and 1893. He reported on the coal fields and on a number of mineral prospects. He also made a considerable contribution to the regional geology and palaeontology of the area. Other early workers included Maitland (1889) and Cameron (1903). Morton examined many of the mineral prospects of the area between 1920 and 1946.

Reid made the greatest contribution to the geology of the area. He visited and mapped many parts of the area during the years 1924 to 1931, revising Jack's subdivision of the Bowen Basin sequence and reviewing the Upper Palaeozoic succession in the west of the area.

Isbell (1955) mapped a large part of the northern Bowen Basin in reconnaissance detail, including part of this area. He reviewed the existing literature and contributed some original work. Laing (1959) mapped part of the area, again only in reconnaissance detail. The only detailed mapping in the area is presently being carried out by geologists of Bowen Consolidated Coal Mining Company in the area south of Collinsville. Some results of this mapping have been published. (Webb and Crapp, 1960).

PHYSIOGRAPHIC SKETCH MAP

FIGURE 1.



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PHYSIOGRAPHY

Thirteen physiographic units are recognized in the Bowen South area. Their distribution is shown in the physiographic sketch map, text figure 1. They are briefly described below.

Alluvial flats occupy much of the Bowen Basin, but are rare in other parts of the mapped area. At present, these flats are being eroded. The streams have cut through the alluvium in many places, permitting the underlying rocks to be mapped. For this reason, the alluvium was omitted from the geological map. In places, the alluvial flats grade into the very mature plains of the Bowen Basin. Elsewhere, the flats have sharp boundaries against more prominent topographic features within the Basin. Alluvial flats also occur beside the Sellheim River in the south-west of the area and in the north-east corner of the area.

The Bowen Basin is a broad, mature valley of generally uniform elevation and low relief, bounded to the east and west by highlands. Topography within the Basin includes the following forms: mature, soil covered plains with some low, rubble covered ridges; gently rising, dissected cuestas with relief of about 250 feet, located in the west of the Basin; and long, steep strike ridges generally of less than 100 feet relief. The highest relief in the east of the basin is produced by hills of volcanics, such as Mount Devlin, which rises about 750 feet above the plains. Other high, steep hills are found in circular, metamorphic aureoles in the south-east of the Basin.

Remnants of an extensive, lateritised Tertiary surface occur in the south and west of the Bowen South area. These form mesas in the Bowen Basin, rising to 200 feet above the plains. Further west, they form mesas and plateaus, most of which are lower than the highest peaks of the local topography.

Tertiary intrusive plugs occur in the west of the area mapped. Most of these are small and possess a youthful topography. The largest is Mount McConnell, a very steep sided plug, occupying an area of about 4 square miles and rising about 600 feet above the surrounding countryside.

The Brawl Creek block is elongated and is bounded on most sides by steep, 500' high scarps. The straightness of the scarps suggest that it is a fault block. The top is a dissected plateau area, in places sloping eastward. The block is breached at only two points, Brawl Creek and a smaller creek near the northern end. Brawl Creek has cut a wide, steep-sided valley through the block. This valley is straight for part of its length and may be fault controlled.

Mount Leslie and the Redcliffe Tableland are both tablelands. They are located at the southern edge of the sheet, within the Bowen Basin. Both are steep sided and benched, and rise 400 to 500 feet above the surrounding plains.

The Urannah block occupies the eastern quarter of the mapped area. It is markedly different in topography from the Bowen Basin. The two units are separated by a well defined boundary placed at the foot of a line of hills rising some 300 to 400 feet above the basin. In places, foothills extend west from the hill; these are included in the Bowen Basin.

A number of different topographic forms are displayed by the Urannah block. These include little dissected high plateaus of uniform elevation. These grade into areas of the same elevation but dissected by a close pattern of shallowly incised drainage. This drainage shows a preferred orientation and is structurally controlled. The dissected plateau occupies most of the block. In places, hills and groups of hills rise from the plateau. These higher hills are fairly deeply incised by a close dendritic pattern of steep gullies and creeks. The gradient of these creeks slackens considerably when they descend to the plateau.

In the east and south, the block breaks up into groups of high hills with very youthful, deeply incised drainage systems. In the east, these groups of hills are separated by mature re-entrants from the low coastal strip to the east. In the south, they are separated by the Broken River and its major tributaries. These streams have achieved a near-mature topography throughout most of their length.

A number of low areas occur within the Urannah block. These are geologically controlled; apparently the underlying rocks are prone to chemical weathering. In some cases they form low valleys almost encircled by hills of the Urannah block. Elsewhere, they form areas of lower elevation and subdued topography within the plateau areas. The surrounding regions commonly drain into these areas.

The Bulgonunna highlands are located west of the Bowen Basin. Their elevation is from 400 to 600 feet above that of the Basin. The highlands possess a fairly rugged topography, particularly in the north. The drainage forms a close incised pattern. Many of the creeks have straight or regularly curved courses, controlled by joints or faults. The largest river, the Burdekin River, has carved a large, deeply incised path through the highlands. Despite its size, it is a youthful rather than a mature river. For most of its length, it occupies the full width of its steep sided valley and many rapids and rock bars impede its progress. A dendritic drainage pattern is developed in the headwaters areas of some streams. These areas commonly grade into plateau areas of little relief. Towards the south, near the Tertiary remnants, the topography is a little less rugged. It is still youthful but the drainage is more widely spaced and the local relief is less.

The Wyatt and Drummond uplands are generally similar in topography. They consist of hills and ridges separated by and grading into soil covered plains. The Drummond uplands are characterised by long strike ridges which are absent from the Wyatt uplands. The relief in these uplands is rarely more than 200 feet. An exception is Mount Wyatt, which rises about 600 feet above plain level.

The north-east uplands consist of hills and ridges surrounded by soil covered plains. Drainage is to the east and the unit forms part of the mature coastal strip. Relief is about 150 feet.

The granite areas are located in the west of the area. They all possess a similar topography, consisting of broad valleys and rounded, mainly soil covered rises with some low hills covered with granite tors and boulders.

Pointed, conical hills occur in places, mostly covered with tors but with outcrop in a few places. Some much higher hills occur in the larger granite area. These are geologically controlled. They are due to the presence of roof pendants of volcanics in some places, and to the existence of fine grained differentiates in others.

Most of the area is drained by the Burdekin River and its main tributaries, the Sellheim, Bowen and Broken Rivers. The Sellheim River drains the south-west corner and flows north into the Burdekin, which flows north across the north-west corner of the area. The Bowen and Broken Rivers drain the eastern two thirds of the area. These last two drain away from the coast. The only direct drainage to the coast is seen in the north-east corner of the mapped area.

GEOLOGY

Introduction

The Bowen South area includes parts of the following major geological units: the northern end of the Anakie High, consisting of the Middle Devonian Ukalunda Beds and intrusives; Devonian to Carboniferous sediments, dipping east off the Anakie High; the northern end of the Drummond Basin; the Carboniferous Bulgonunna Volcanics, unconformably overlying the above and forming the western basement to the Bowen Basin; the northern end of the Bowen Basin, except for an extension to the north occupied by the Lower Bowen Volcanics only; and the Urannah Complex, forming the eastern margin of the Bowen Basin.

Remnants of the Tertiary Suttor Formation and scattered Tertiary basalt and acid volcanics are widespread in the area.

The rock units in the area are summarized in Table 1, and are described below.

TABLE 1

ROCK UNITS OF THE BOWEN SOUTH AREA

AGE	PERIOD	ROCK UNIT AND LETTER SYMBOL	THICKNESS	LITHOLOGY	DISTRIBUTION	TOPOGRAPHY	PALAEONTOLOGY AND AGE	RELATIONSHIPS	DEPOSITIONAL ENVIRONMENT
		Czs	Less than 100'	Alluvial deposits, soil and ferruginous gravel	Small areas near Sellheim River. Extensive areas in Bowen Basin not shown on map.	Alluvial flats, soil and gravel covered plains and low rises.			
CAINOZOIC	TERTIARY	Tv	600'+ in Brawl Creek	Contorted, flow banded rhyolite and dacite; trachyte, obsidian and volcanic glass; basalt and dolerite; rhyolite and basaltic agglomerate; quartz feldspar porphyry dykes; trachytic flows, tuffs and agglomerates; siliceous plugs and acid volcanic breccia.	Several small areas about: Brawl Creek; Flagstone Creek; the Pyramids; Mount McConnell.	Generally very rugged topography of high relief.	Unconformably younger than Devonian to Permian rocks in different areas. Assumed to belong to Tertiary epoch of acid volcanism.	Intrusive into, unconformably overlying or faulted against Devonian to Permian rocks.	
		Suttor Formation Ts	About 200', locally up to 400 feet	Quartz sandstone, fine and pebble conglomerate, siltstone, all argillaceous in places; clay and sandy claystone; silicified argillaceous siltstone; oil shale.	In the Parrot Creek area, in the Rutherfords Table area and south-east of Mount McConnell	Isolated mesas and plateaus	Rare dicotyledonous plants.	Unconformably overlies Devonian to Triassic rocks; disconformably overlies Tertiary basalt.	Extensive shallow lakes, swampy in places, on uneven basement of underlying rocks.
		Tb		Basalt flows and plugs.	Small residuals in Bowen Basin; Brawl Creek area; two plugs in Pyramid area.	Forms rounded steep hills, or small mesas; soil covered flats with low rubble covered rises or hills.		Underlies Tertiary volcanics in Brawl Creek area.	
MESOZOIC	TRIASSIC	Carborough Sandstone Rc	Up to 1500'.	Cross-bedded, medium to coarse grained quartz sandstone, feldspathic in places, some fine and pebble conglomerate.	Redcliffe Tableland, Mount Leslie, small area north of Mount Leslie.	Forms steep sided tablelands.	?Triassic	Conformable on Upper Bowen Coal Measures.	Shallow water, possibly deltaic. Intense reworking and sorting of sediments.
PALAEOZOIC	UPPER PERMIAN	Upper Bowen Coal Measures Pbu	10,500'	Cross and festoon bedded, well sorted and bedded, lithic sandstone, calcareous in places; siltstone, carbonaceous shale, coal seams, quartz sandstone, pebble and cobble conglomerate.	Bowen Basin, within outcrop area of Middle Bowen Beds.	Low soil covered plains and rises; some strike ridges; rugged hills where contact metamorphosed.	Upper Permian. Contains abundant plant remains of Permian to Triassic age. Species include <u>Glossopteris indica</u> Sch. <u>G. browniana</u> Brong. <u>G. augustifolia</u> Brong. <u>Phyllotheca australis</u> Brong. <u>Spheropteris lobifolia</u> Morr. <u>Cladophlebis roylei</u> Arker. <u>Samaropsis dawsoni</u> (Shirley)	Conformably overlies Middle Bowen Beds.	Mainly shallow, restricted environment, marine at times. Coarse and fine fractions sorted but deposited in same place.

AGE	PERIOD	ROCK UNIT AND LETTER SYMBOL	THICKNESS	LITHOLOGY	DISTRIBUTION	TOPOGRAPHY	PALAEONTOLOGY AND AGE	RELATIONSHIPS	DEPOSITIONAL ENVIRONMENT
PALAEOZOIC	LOWER TO ?UPPER PERMIAN	Unit C Middle Bowen Beds Pbm	About 1500' on western side of Bowen Basin; about 2600' at Exmoor on east flank of Bowen Basin.	Siltstone, fine to medium grained quartz greywacke, carbonaceous and fossiliferous with pebble bands and scattered cobbles and boulders. Some quartz sandstone beds. Includes Big Strophalosia Zone.	Broad belt around western and northern margins and narrow strip down eastern flank of Bowen Basin.	Mainly subdued topography; some gently sloping cuestas in Parrot Creek area.	Abundant marine fossils of Fauna IV. Age is Lower Permian to lowermost Upper Permian. Contains species of Strophalosia, Terrakea, Ingelarella, Neospirifer, Parallelodon, Myonia, Stutchburia, Schizodus.	Conformably overlies Unit B of the Middle Bowen Beds or the Collinsville Coal Measures in different areas.	Moderately deep to shallow water, transgressive marine phase.
		Big Strophalosia Zone. Pbm	75' to 105'	Medium to fine, quartz greywacke grading into coarse grey blue siltstone in places; calcareous and fossiliferous; containing scattered pebbles, cobbles and angular boulders.	Continuous horizon throughout Bowen Basin in Bowen area; crops out discontinuously around margin of basin; southernmost outcrop is at Exmoor.	Crops out on side of hills in places; elsewhere forms subdued topography.	Richly fossiliferous zone, fauna IV. Contains Strophalosia ovalis, S. clarkei, S. brittoni ver. gattoni, Terrakea solida and other species.	Member in unit C 300' to 450' above base of unit.	Possibly density current deposit.
	LOWER PERMIAN	Unit B Middle Bowen Beds Pbm	1400' at Gebbie Creek and on west of Bowen Basin; 2,000' at Exmoor.	Medium to coarse grained quartz greywacke, carbonaceous in places, mainly semi-friable with some hard, calcareous fossiliferous zones; siltstone; locally some thin coal; thick sandstone units are characteristic.	In narrow strip down eastern flank of Bowen Basin.	Forms prominent strike ridges separated by subdued topography.	Lower Permian. Moderately abundant marine fossils of sub-faunas IIIa and IIIb of Fauna III. Contains species of Glyptoleda, Atomodesma, Stutchburia, Mourlonia, Terrakea, Ingelarella	Middle unit in conformable sequence with Unit A below and Unit C above. Equivalent in part to Collinsville Coal Measures.	Moderately shallow marine transgressive phase with deltaic, coal measure environment in places.
		Sub-unit B3 Pbm	150' to 450'	Quartz greywacke, siltstone, quartz sandstone.	These three sub-units are recognized at Gebbie Creek, Collinsville and on western side of Bowen Basin; less obvious south of Gebbie Creek.		Fauna IIIc	Form conformable sequence	Marine to deltaic coal measures.
		Sub-unit B2 Pbm	180' to 250'	Quartz sandstone and siltstone changing to quartz greywacke and siltstone. Includes Glendoo Sandstone Member in Collinsville area.			Fauna IIIb		Marine transgression
		Sub-unit B1 Pbm	About 650'	Quartz greywacke, siltstone, quartz sandstone. Includes Wall Sandstone Member.			Fauna IIIa		Marine to deltaic coal measures.
		Wall Sandstone Member Pbm	100' maximum	Cross bedded, medium to coarse grained, quartz sandstone.	Eastern flank of Bowen Basin.	Forms prominent strike ridges.		Member in Unit B, about 300' above base of unit.	
		Collinsville Coal Measures Pc	750'	Quartz sandstone to quartz greywacke, siltstone, carbonaceous shale, coal, conglomerate. Contains Glendoo Sandstone Member.	Collinsville area and western edge of Bowen Basin.	Subdued topography with some hills.	Contains Fauna IIIb in Glendoo Sandstone Member.	Grades laterally into marine sediments of Unit B above Wall Sandstone Member.	Deltaic coal measures environment, possibly marine. One fossiliferous marine horizon.
		Glendoo Sandstone Member	80'	Fine grained quartz sandstone.	Recognisable as distinct sandstone unit from Collinsville south-west to Bowen River only.	Low hills	Contains Fauna IIIb	Is included in sub-unit B2.	Marine transgressive phase.

AGE	PERIOD	ROCK UNIT AND LETTER SYMBOL	THICKNESS	LITHOLOGY	DISTRIBUTION	TOPOGRAPHY	PALAEONTOLOGY AND AGE	RELATIONSHIPS	DEPOSITIONAL ENVIRONMENT
PALAEOZOIC	LOWER PERMIAN	Unit A Middle Bowen Beds Pbm	1800' at Exmoor	Semi-friable, fine to medium grained quartz greywacke, hard, calcareous and fossiliferous in places; some siltstone.	Best developed at Exmoor; lenses out to north, and thins little to south. Absent at Gebbie Creek.	Long, low strike ridges and soil covered plains.	Lower Permian. Contains fauna II including species of Eurydesma, Deltopecten, Taeniothaerus, Anidanthus, Parallelodon, Astartila.	Overlies Lower Bowen Volcanics with possible unconformity.	Moderately deep water marine.
	?UPPER CARBONIFEROUS TO LOWER PERMIAN	Lower Bowen Volcanics. Pbl	10,000' to 20,000'	Quartz sandstone, siltstone, greywacke siltstone, tuffaceous sandstone; pebble, cobble and massive boulder conglomerate; basaltic, andesitic, trachytic flows, breccias, tuffs and agglomerates; in places, some acid volcanics.	On eastern flank of Bowen Basin; wedging out down western margin of Bowen Basin; extending north of mapped area.	High, rugged hills and ridges in places; elsewhere scattered high hills in soil covered plains and low rises.	Lower Permian. Contains plants at a few localities, including species of Noeggerathiopsis, Samaropsis, Glossopteris, Cordaites.	Basal unit of Bowen Basin. Unconformably overlies Bulgonunna Volcanics and intrusives on western edge of Bowen Basin. Overlies, faulted against and intruded by partly contemporaneous Urannah Complex.	Restricted, possibly marine, in shore from volcanic island arc.
	?UPPER CARBONIFEROUS	Bulgonunna Volcanics. Cbv	Unknown but probably very thick.	Overlapping and interfingering lenses of rhyolitic to dacitic flows, breccias, tuff, crystal tuff, agglomerate, ignimbrite; tuffaceous lithic sandstone and siltstone; some undifferentiated acid intrusive rocks.	In western half of the Bowen South area.	Rugged topography; some very close drainage patterns in places; some deep, steep sided fault valleys.	Carboniferous, possibly Upper Carboniferous.	Unconformably overlies Drummond Group; is unconformably overlain by Lower Bowen Volcanics.	Possibly terrestrial volcanism.
	LOWER CARBONIFEROUS	Drummond Group Cd	About 10,000'	Tuffaceous sandstone, siltstone, and conglomerate; tuff, agglomerate and minor flows; some shale, chert and limestone.	In west of Bowen South area.	Mainly forms soil covered plains with long strike ridges; in places ridges coalesce to form groups of hills.	Lower Carboniferous. Contains Lower Carboniferous plants including Lepidodendron, Calamites, Rhodea.	Unconformably overlies Ukalunda Beds and intrusives.	Restricted parallic basin, partly marine.
	DEVONIAN-CARBONIFEROUS	Undifferentiated Volcanics. D/Cvu	Unknown.	Siliceous tuff, siliceous crystal and lapilli tuff, porphyritic acid and contaminated flows, volcanic conglomerate, tuffaceous sandstone and siltstone.	Three small areas: south of Hidden Valley; south-west of Hidden Valley; south of the Sellheim River.	Mainly forms low plains with some hills and ridges.	Age indefinite in range Devonian to Carboniferous. Appear to be unconformably older than Bulgonunna Volcanics.	Southern block D/Cvu appears to be conformable on [illegible] att [illegible] others occupy anomalous positions between Ukalunda Beds and Bulgonunna Volcanics.	Partly terrestrial partly waterlain.

AGE	PERIOD	ROCK UNIT AND LETTER SYMBOL	THICKNESS	LITHOLOGY	DISTRIBUTION	TOPOGRAPHY	PALAEONTOLOGY AND AGE	RELATIONSHIPS	DEPOSITIONAL ENVIRONMENT
PALAEOZOIC	UPPER DEVONIAN	Mount Wyatt Beds. Dus	Not known, but more than 1000'.	Tuffaceous lithic sandstone, siltstone and conglomerate; calcareous siltstone.	About the Sellheim River, east of Rutherfords Table, two small areas further east, and a small area north-west of Mount Wyatt.	Low soil covered plains with some hills in the eastern outcrop areas.	Upper Devonian (Famennian). Contains <u>Cyrtospirifer</u> cf. <u>reidi</u> Maxwell. Also plants including <u>Leptophloeum australe</u>, <u>Proto-lepidodendron</u>, psilophyte, and <u>Stigmaria</u>.	Probably unconformable on Ukalunda Beds.	At least partly marine.
	MIDDLE DEVONIAN	Ukalunda Beds Dmw	Not known. 4000'+ was estimated for part of the unit.	Includes several rock units: shale, siltstone, calcareous siltstone, thin bedded limestone, and sandstone sequence, fossiliferous in places; a well-bedded lithic sandstone, siltstone, shale, conglomerate and thick bedded fossiliferous limestone sequence; a poorly bedded siltstone and sandstone sequence; a quartz sandstone and pebble conglomerate sequence, commonly silicified. Locally includes low grade contact metamorphosed sediments and low grade, regionally metamorphosed schistose sediments.	In south-west of Bowen South area. Area of outcrop broken up by intrusions and overlying units.	Produces high rugged hills and ridges in places; moderately high, rounded hills in other places; and low soil covered plains with scattered hills and rises elsewhere.	Middle Devonian. Contains <u>Favosites</u>, <u>Mesophyllum</u>, <u>Keriophyllum</u>, <u>Atrypa</u>, <u>Chonetes</u>, <u>Receptaculites</u>, <u>Calceola</u>, strophomenoids, rhynconellids, straight nautiloids, ostracods, nuculids.	Oldest rocks in area. Relationship with Anakie Metamorphics not known.	Marine, probably different environments in different times and places.

UKALUNDA BEDS

Summary

The Ukalunda Beds crop out in the south-west of the Bowen Sheet area. They are of Middle Devonian age and are the oldest rocks in the Sheet area. They include a wide variety of rock types which could probably be divided into a number of rock units with more detailed mapping.

The Ukalunda Beds include the following: a shale, siltstone, calcareous siltstone, thin bedded limestone and sandstone sequence, generally fossiliferous; a well-bedded lithic sandstone, siltstone, shale, conglomerate and thick-bedded fossiliferous limestone sequence; a poorly bedded siltstone and sandstone sequence; a quartz sandstone and pebble conglomerate sequence, commonly silicified.

The unit also includes a wide variety of generally low grade contact metamorphic rocks cropping out in the vicinity of igneous intrusions, and regionally metamorphosed schistose rocks cropping out in a north trending zone in the south-west of the area.

Volcanic rocks, including uralitized trachy-andesite and porphyritic rhyolite and dacite, are included in or intrude the Ukalunda Beds.

The thickness of the unit is not known.

Fossils collected include corals, strophomenoids, chonetids, rhynconellids, ostracods, gastropods, pelecypods, stromatoporoids, bryozoa, and fish bones. Those identified include <u>Favosites</u> sp. <u>nitidus</u>?, <u>Mesophyllum</u>, <u>Keriophyllum</u>, <u>Atrypa</u> and <u>Receptaculites</u>, which are probably Middle Devonian in age. Some of the fossils may be older.

Nomenclature

The rocks referred to in this report as the Ukalunda Beds were so-named by Jack (1889) who included them in the Star Series (= Star Group). Reid (1930) also included them in the Star Formation (= Star Group). In the Geology of Queensland (Hill and Denmead, 1960) they are regarded as unconformably younger than the Anakie Metamorphics, on the basis of the Devonian fossils they were known to contain, and are included with the Devonian to Carboniferous sediments of the Drummond Basin.

During the 1961 field season, many more fossil collections were made, establishing the Middle Devonian age of these beds. However, it was found to be impossible to separate them from low grade metamorphic rocks of the Mount Coolon and Buchanan areas, mapped in 1960 as Anakie Metamorphics. In addition, they were found to be unconformably older than the Drummond Basin sequence. Their relationship to the Star Group which crops out in the Upper Burdekin River, about 80 miles north-west of the Mount Wyatt area, is not known.

The name, Ukalunda Beds, is proposed for these rocks in this report. The unit is thought to be of group rank. An informal name is chosen because there is insufficient field data, particularly structural information, for valid formations to be defined.

The Ukalunda Beds crop out in the south-west of the Bowen Sheet area. The area of outcrop of the unit is broken up by several igneous intrusions and by unconformably younger units.

Distribution and Topography

No type areas are proposed at this stage. The unit is well exposed at Mount Wyatt, particularly in Wynne Creek and its tributaries draining off Mount Wyatt. A thickness of 4,000 feet is estimated from the available outcrop in this area; this represents only part of the Ukalunda Beds.

The unit is also well exposed in Mary Creek and in the area west of the Pyramid.

The type of topography developed on the unit differs from place to place. In places, the unit forms prominent steep hills, such as Mount Wyatt, with a relief of about 600 feet. It produces moderately rugged topography in places within the contact metamorphic aureoles around the igneous intrusions, with a relief of the order of 200 feet. Similar topography is developed in the area west of Pyramid.

A fairly subdued topography is developed over much of the unit's area of outcrop. This consists of low rises and soil-covered plains, with scattered ridges and groups of hills. Some of these hills are mesas, capped with Tertiary sediments; the highest hills rise above the level of the Tertiary mesas. Relief is rarely more than 150 feet. Most of the outcrop is found in creek sections.

Lithology

The Ukalunda Beds cropping out in the Mount Wyatt area are as follows. At the base are thinly laminated, grey, green and brown siltstone interbedded with medium to thick-bedded, grey to buff, hard lithic sandstone, calcareous in part, and thinly bedded drrk shale. These are well exposed in Wynne Creek. They show slump structures and contemporaneous faulting in some places. A very little graded bedding was observed, which indicated that the sequence is not overturned. Other sedimentary structures observed include mudballs in the sandstone beds and some possible load cast structures.

This sequence is essentially a well bedded alternation of fine to coarse sandstone in beds to 1 foot thick, siltstone in beds about 3 inches thick, and thin shale beds.

Thin section examination of a sandstone specimen showed it to be a feldspatho-lithic quartz sandstone. The lithic fragments include devitrified glass and volcanic flow rocks. The specimen had a calcareous cement.

A little higher up the section, thick lenses of grey-blue, fine to cobble conglomerate are interbedded with lithic sandstone.

Above this point, the sediments are not well exposed. They include contact metamorphosed, poorly bedded fine sandstone intruded by hornblende porphyry sills, flow banded porphyritic rhyolite flows or sills, thinly bedded, buff, fine lithic sandstone, tuffaceous in part, and hard, banded grey-green silicified limestone, biostromal in part. The latter are thick bedded and form massive outcrops on the flanks of Mount Wyatt.

Scree from these outcrops covers much of the lower flanks of the hill. The silicified limestone contains an abundance of poorly preserved fossils of which Receptaculites is the most easily recognized. The fossils are not diagnostic but similar types are found in association with diagnostic fossils at other localities within the unit.

Overlying the silicified limestone are poorly bedded lithic quartz sandstone, grey, red-flecked, pink and buff, very jointed siltstone, tough, white coarse siltstone and micaceous lithic sandstone. This sequence was regarded by Reid (1930) as constituting an upper unit at Mount Wyatt, conformably overlying the sequence described above. No field relations were observed to confirm this, though there does appear to be a significant change in lithology.

The siltstone-sandstone sequence is the most widespread unit in the Ukalunda Beds. It crops out at Mount Wyatt, in the narrow strip south-east of Mount Wyatt, about the Sellheim River between the two granite masses, and in the extreme south-west of the Sheet area. This unit extends south into the Mount Coolon and Buchanan areas. In the 1960 season report (Malone et al., 1961) it is referred to as the siltstone/quartz greywacke assemblage of the Anakie Metamorphics of possibly Lower Palaeozoic age.

This unit consists essentially of siltstone and sandstone, with thin limestone beds in a few places. Bedding was generally obscure. In a few places, the siltstone was thin bedded and colour banded; mostly it was massive or so jointed that all traces of bedding were hidden. The limestone beds were commonly silicified. One such, cropping out about 1 mile south of White's copper show, contained a sparse, poorly preserved fauna. These, and other fossils collected in the associated siltstone, were similar to the larger collections made at other localities in the Ukalunda Beds. This fossil collection established the Middle Devonian age of the siltstone sandstone sequence.

These sediments are metamorphosed in many places. Mainly low grade metamorphosed sediments crop out in the contact zones about the granite intrusives. These include quartz muscovite schist, spotted and lineated siltstone, hornfelds, hardened and silicified sandstone and muscovite, chlorite quartz rock. The latter is a metamorphosed impure sandstone. It consists of large, euhedral plagioclase phenocrysts altered to sericite and clay in a granular aggregate of quartz, muscovite and chlorite. One specimen of lineated siltstone was examined. It consisted of quartz, sericite and needles of hematite; the hematite needles had grown and been aligned during metamorphism, producing the lineation.

They are regionally metamorphosed in a north-trending zone in the extreme south-west of the Bowen Sheet area. This zone extends south into the Mount Coolon and Buchanan areas. There the sediments are very schistose, possessing slatey cleavage in places. Despite the intense schistosity of the hand-specimen, thin sections examined have shown very little reorganisation of minerals or new mineral growth. The schistosity is due to alignment of sericite flakes within the rocks. One specimen consisted of thinly interbedded fine sandstone, apparently unmetamorphosed, and schistose, sericitic siltstone layers. Another specimen collected, with well developed slatey cleavage, has a spotted appearance suggesting development of new minerals during metamorphism.

Some schistose rocks are found throughout the Ukalunda Beds, but the most intense schistosity is confined to this narrow zone and is best developed south of the Bowen area. Within this zone, schistosity and bedding are parallel, dipping steeply and striking north, as does the zone. This trend is roughly parallel to the main axis of folding in the Drummond Basin to the west. It is suggested that the schistosity is related to the orogeny which folded the Drummond Basin sequence, the stresses being released by reorganisation of material, mainly sericite, along the bedding planes in a series of minute bedding plane shears. The confining of this schistosity to a narrow zone may be due to a coincidental parallelism of the bedding in this zone with the direction of release of shear stress. In the Buchanan area, non-schistose sediments crop out between the schistose zone and the Drummond Basin. These are blocky, jointed, spotted or lineated sediments essentially similar to the siltstone-sandstone sequence of the Bowen area. The lack of schistosity in these sediments may be due to their more massive nature. No bedding was observed in these sediments.

It has been suggestdd that the schistose sediments, because of their regional metamorphism, are older than the Ukalunda Beds. However, they can be traced north into the area west of the Pyramid where they are associated, appa rently conformably, with fossiliferous Middle Devonian sediments.

Rock types in the Pyramid area include: poorly bedded to massive, jointed and quartz veined, brown to buff, hardened or silicified, lithic and quartz sandstone and pebbly sandstone; red, silicified quartz pebble conglomerate; and siltstone, commonly quartz veined, schistose or lineated, ferruginized in places and containing rare fossils.

The silicified quartz pebble conglomerate is a very distinctive rock type; it has a reddish, siliceous matrix enclosing mainly white quartz pebbles. Similar rock types were mapped in the Mount Coolon area and further west during 1960 and placed in the Anakie Metamorphics.

Other rock types in the Pyramid area include thinly bedded quartz lithic sandstone with some calcareous nodules; very jointed, yellow, grey and brown siltstone, fossiliferous in places, and containing calcareous beds and limestone pods; and well bedded, interbedded sandstone, pebbly sandstone and coarse siltstone becoming hardened and quartz veined in places. The limestone pods in the fossiliferous siltstone give off a strong, fetid odour when broken.

Quartz veining and silicification of the sediments are common in parts of the Pyramid area, and are absent in others.

The Ukalunda Beds in the Mary Creek area include the following lithologies: very jointed, khaki to dark grey siltstone and silty shale, calcareous and fossiliferous in places and commonly containing rounded, non-jointed cobbles of the same lithology; thin to 6 inches thick beds and lenses of grey, yellow weathering, fossiliferous limestone, generally interbedded with calcareous siltstone and, in places, with calcareous lithic sandstone; thin bedded, micaceous coarse siltstone to fine sandstone; medium bedded, medium to very coarse-grained sandstone; quartz veined, hardened, thick bedded to massive, very jointed in places, grey to buff sandstone, similar to the hardened sandstone of the Pyramid area; laminated, ferruginous, grey-pink siltstone, wavy bedded and slumped in places, interbedded with medium bedded quartz sandstone.

Five miles south of Hidden Valley, near the 7-mile Dam turn-off, the Ukalunda Beds include a few rock types other than those already described. These are soft olive-grey, thin bedded siltstone, interbedded with impure chert. The chert is dense, grey to dark grey and pyritic. In places, it encloses pods of unaltered limestone.

Near the Glendon road, beds of uralitized trachyandesite crop out. These are porphyritic rocks containing amphibole and feldspar phenocrysts, quartz grains and small xenoliths of quartz amphibole rock in a groundmass of fine-grained feldspar and uralitic material. Other volcanics in the Ukalunda Beds include flow banded porphyritic rhyolite and dacite. Some of the rhyolitic rocks may be minor intrusives. One such consisted of subhedral phenocrysts of sodic plagioclase and quartz and books of biotite, to 1 mm. across, in a micro-crystalline groundmass of quartz, feldspar and iron minerals.

Structure and relationships.

The folding of the Ukalunda Beds is not fully understood but is obviously complex. A number of observations have been made outlining local structure in some places but the overall pattern of folding is not apparent. No major fold axes or major structural trends are revealed by the data collected to date. This is due to a number of factors: poor outcrop and obscure bedding in parts of the Ukalunda Beds; the amount of the unit concealed by overlying formations or replaced by intrusions; and insufficient field work.

Dips in the Ukalunda Beds range from 20° to vertical, with the steeper dips more common. No overturning of beds was observed. Faulting is moderately common and is particularly obvious near the boundaries with overlying units.

The Ukalunda Beds are the oldest rocks in the area. They are intruded by three igneous masses of Devonian to Carboniferous age and are unconformably overlain by the Upper Devonian Mount Wyatt Beds and by the Carboniferous Drummond Group and Bulgonunna Volcanics.

The unconformity separating the Ukalunda Beds and the Mount Wyatt Beds is mainly based on fossil evidence. Collection B269F was made from the Ukalunda Beds, and collection B93F from the Mount Wyatt Beds, both fairly close to the boundary between the two units. Collection B269F is of Middle Devonian age. Collection B93F includes a diagnostic fossil indicating a high Upper Devonian Fammenian horizon. These indicate a considerable time break between the two units. The relationship between the two units as seen in the field, suggests that they are separated by an unconformity but the field evidence is not conclusive. The contact between the two units was not seen. This relationship will be discussed further in the chapter describing the Mount Wyatt Beds.

Well marked unconformities separate the Ukalunda Beds from the overlying Drummond Group and Bulgonunna Volcanics. In one place, the Ukalunda Beds reflect the folding of the Drummond Group.

Environment of deposition.

The wide variety of sediments and sedimentary structures in the Ukalunda Beds indicate that the unit had a complicated sedimentary history, with depositional environments varying from place to place and from time to time.

Apparently, most of the sediments are marine. Marine fossils were collected from 10 localities and poorly preserved fossils were seen in metamorphosed rocks in several other places. Bedding and other sedimentary structures in the unit suggest moderately deep water conditions of deposition. No shallow water structures were seen.

Thickness.

It is impossible to estimate the thickness of the Ukalunda Beds as neither the top nor the bottom of the unit is known. The section at Mount Wyatt is at least 4,000 feet thick. It includes some minor intrusives and may be faulted, though there does not seem to be any repetition of section. On top of this sequence is an unknown thickness of the siltstone-sandstone sequence. This, judging by its areal extent and the little information available, may be very thick.

In addition, considerable thicknesses of section are present in the Mary Creek and Pyramid areas.

The Ukalunda Beds consist of a number of rock units having their maximum developments in different areas. The overall thickness of the group is probably very great.

Age.

Fossils were collected at 10 localities in the Ukalunda Beds. Collection B76F was examined by Professor Dorothy Hill who identified Favosites sp. nitidus?, Mesophyllum (atelophyllum)?, Keriophyllum?, and Atrypa sp. of probably Middle Devonian age. Collection B84F is similar to B76F; both were collected near Hidden Valley Homestead.

Collections B220F and B610F were made west of the Pyramid, in the south-west of the Sheet area. These two collections have only 1 or 2 species in common and have none in common with B76F and B84F.

Collection B220F has 2 species of strophomenoids and possibly one species of coelospirid in common with the fauna at the Douglas Creek siltstone locality in the Clermont area (Veevers et al., 1961). The B610F and B220F collections contain some species which may be of Lower to Middle Devonian age. This is not definite, however, as no detailed work has been done on this material as yet. The fossils collected are generally poorly preserved and in many cases more material is required for identification. The collections include straight nautiloids, corals, strophomenoids, chonetids, rhynconellids, ostracods, gastropods, pelecypods, fish bones, bryozoa, and stromatoporoids.

At present, the Ukalunda Beds are regarded as Middle Devonian.

MOUNT WYATT BEDS.

Summary

The name Mount Wyatt Beds was applied by Daintree (1870) to Upper Devonian sediments of the Mount Wyatt district. The unit crops out in the Bowen South area, east of Rutherfords Table, and extending south into the Mount Coolon area. It consists of siltstone, lithic sandstone and minor conglomerate. Much of the clastic material is of volcanic origin.

The unit unconformably overlies the Ukalunda Beds and is overlain, possibly conformably, by undifferentiated Devonian to Carboniferous volcanics. To the north-east, it is unconformably overlain by Bulgonunna Volcanics.

The Mount Wyatt Beds contain marine fossils at a few localities and plant remains at a number of localities. They are of unknown thickness.

Nomenclature

The Mount Wyatt Beds, named by Daintree (1870) consist of a siltstone, sandstone, minor conglomerate sequence cropping out about the Sellheim River, south of Mount Wyatt. The type area is about 3 miles north-east of where the Mount Coolon to Ukalunda road crosses the Sellheim River. In this area, the unit is exposed in a number of small creeks draining south into the Sellheim River. The main marine fossil locality in the unit is about 3 miles from the Mount Coolon road at latitude 20° 57' S., longitude 147° 16' E., beside the track leading from Rutherfords Table to White's copper show. This point is the south-west corner of the type area.

No type sections have been measured.

Distribution and topography.

The unit crops out in the type area and in four other small, separate areas. Two of the latter are in the Bowen Sheet area, a few miles north-east of the type area, The nearer is regarded as Mount Wyatt Beds on lithology. The more distant is somewhat similar lithologically, and, in addition, contains *Leptophlocum australe* which is common in the Mount Wyatt Beds.

The third area is located about 2 miles north-west of Mount Wyatt. The sediments are very similar in lithology to those in the type area and contain Protolepidodendron and ?psilophyte which are common in the unit.

The fourth area is the small area of outcrop at the Rosetta Creek crossing in the Mount Coolon Sheet area. The rock type in that area and the flora they contain are similar to the rock types and flora in the type area of the Mount Wyatt Beds.

The topography developed on most of the formation is very subdued. It consists of soil-covered plains with a few low rises. Outcrop is confined to creeks and gullies. The two northerly outcrop areas are more rugged. There, the sediments are hardened by granite intrusion and by minor intrusions associated with the Bulgonunna Volcanics. They form hills with a relief of 200 feet.

Lithology

The Mount Wyatt Beds consist of siltstone, sandstone and conglomerate. All three rock types, and especially the conglomerate, contain volcanic detritus. For the most part, these sediments are immature and contain a high proportion of labile constituents.

The siltstone is generally a hard, well-sorted rock consisting of quartz grains, minor feldspar and muscovite grains, sericite and clay. Calcite occurs in some specimens as irregularly shaped patches and may constitute up to 25% of the rock. In others, calcite and chlorite have developed due to low-grade metamorphism.

The siltstone is commonly well bedded and thin to medium bedded. It may be brown, grey-green or colour-banded in grey and green. Jointed, poorly bedded purple siltstone showing weak lineation crops out at one place.

Lithic sandstone is most common in the unit, though quartz sandstone crops out in the units most northerly area of outcrop. The lithic sandstone is poorly-sorted with grains ranging in size from fine to very coarse, and grades into pebbly sandstone in places. The sandstone consists of:

quartz grains, subangular to irregular in shape and strained and shattered in some specimens; feldspar grains and acid to intermediate volcanic fragments, all weathered to clay minerals and sericite; and siltstone, igneous and other rock fragments. They generally contain little original matrix material. The colour may be brown, buff or khaki on weathered surfaces and is usually grey to grey-green on fresh surfaces. Purple sandstone, grading into coarse siltstone crops out at one locality.

The lithic sandstone occurs in thin to medium beds, interbedded with siltstone. Lamination is rare within individual beds.

Beds of calcareous lithic sandstone packed with fossils crop out at a few localities in the formation. These are weathered so that only casts and moulds of the fossils remain. The fossils are random in their orientation and were transported into their depositional position.

The quartz sandstone is generally a fine-grained, grey to white, porous rock, superficially silicified in most outcrops. It appears to be thick bedded to massive but this may be an effect of silicification.

Pebble and rare cobble conglomerate crops out in the unit in beds and lenses to 2 feet thick. The pebbles are usually sub-rounded and consist of volcanic rocks, quartz and quartzite. Green tuffaceous conglomerate crops out in a few places; it consists of rounded pebbles and cobbles of volcanic rocks in a tuffaceous matrix.

Sedimentary structures include small scale slumping and clastic dykes. Rapid variation along strike was observed at one locality where thick bedded lithic sandstone grades into interbedded siltstone and sandstone over a strike length of about 15 feet.

Small steep-sided conical structures were seen in the unit near fossil locality B11F and in the area north-west of Mount Wyatt.

Structure and relationships.

The Mount Wyatt Beds in the type area appear to be rather gently folded. Dips are as high as 55° but are generally less. The most obvious structural control is that everywhere they are dipping away from the Ukalunda Beds. This is in agreement with the fossil evidence which indicates that they are considerably younger than the Ukalunda Beds. The Mount Wyatt Beds is less complex structurally than the Ukalunda Beds. It lacks the lineation and schistosity common in the latter, and is thought to be unconformably younger. An important difference between the Mount Wyatt Beds and the Ukalunda Beds is the much greater proportion of volcanic detritus in the former. The Mount Wyatt Beds appear to mark the commencement of a period of dominantly volcanic activity.

The unit is overlain to the south of the type area by undifferentiated Devonian to Carboniferous volcanics. Airphoto trends and the few reliable dip observations made in the volcanics indicate that their structures are similar to those of the Mount Wyatt Beds. The relationship may be conformable. It was thought to be conformable when first seen in the Mount Coolon area in 1960, both units then being included in the Bulgonunna Volcanics.

The Mount Wyatt Beds are unconformably older than the Bulgonunna Volcanics though no contacts between the two were seen in the field. In its most northerly area of outcrop, the Mount Wyatt Beds are intruded by sills and dykes of porphyritic rhyolite. These are almost certainly related to the very extensive rhyolite flows of the Bulgonunna Volcanics cropping out a short distance away. The Bulgonunna Volcanics are considerably younger than the Mount Wyatt Beds as, in other areas, the volcanics unconformably overlie plant-bearing Lower Carboniferous sediments of the Drummond Beds.

Environment of deposition.

The Mount Wyatt Beds were possibly laid down under moderately shallow water, marine conditions. That marine conditions prevailed at least part of the time is shown by the occurrence of marine fossils.

Plant fossils are also very common in the unit. These occur in great abundance on a relatively few bedding plane surfaces and are generally associated with sandstone units. The occurrence of the plant remains is compatible with the postulated marine conditions of deposition.

The sedimentary structures, bedding characteristics and lithologies of the Mount Wyatt Beds suggest deposition in a shallow rather than a deep water environment.

Thickness

More than 1,000 feet of section is present in the Mount Wyatt Beds between fossil locality B11F and the Ukalunda Beds to the north. The total thickness of the unit is not known. It is probably not very great.

Age

Most of the fossils found in the Mount Wyatt Beds belong to one species, very closely allied to Cyrtospirifer cf. reidi, (Maxwell) (pers.comm. D. Hill). This is virtually a diagnostic type and indicates a high Upper Devonian Famennian horizon.

The plants identified in the unit include Leptophloeum australe, Proto-lepidodendron, psilophyte and stigmaria. The L. australe probably commenced in the Upper Devonian; the other forms have a Middle to Upper Devonian range.

UNDIFFERENTIATED DEVONIAN TO CARBONIFEROUS VOLCANICS.

Volcanics cropping out in three areas of the southern half of the Bowen Sheet area are referred to as undifferentiated Devonian to Carboniferous volcanics. The largest area is south-east of Rutherfords Table and extends south into the Mount Coolon area where the unit has its maximum development. The rock types in this area include siliceous tuff, porphyritic rhyolite lavas, volcanic conglomerate and tuffaceous sandstone.

The second area is 3 miles south-west of Hidden Valley homestead, extending west along the 7-mile Dam track. The rock types in this area include dark, intermediate crystal tuff and porphyritic rhyolite.

The third area is near Isabella Creek, about 5 miles south-south-east of Hidden Valley homestead. Here, the rock types include agglomerate, volcanic conglomerate and tuffaceous sandstone, tuff and crystal tuff.

The sequence in the area south-east of Rutherfords Table overlies the Mount Wyatt Beds, possibly conformably. It appears to be unconformably overlain by the Bulgonunna Volcanics. The sequences in the other two areas appear to be unconformable under the Bulgonunna Volcanics also. The three sequences are grouped because they are generally similar in lithology and occupy apparently similar stratigraphic positions.

The topography of the southern area is fairly subdued. It consists of low, soil-covered plains and low rises and a few long, moderately high strike ridges.

In the 7-mile dam area, the unit occupies a level upland valley area between blocks of Bulgonunna Volcanics. The topography is subdued with a few low rocky outcrops rising out of soil-covered plains.

In the third area, the topography consists of low, rounded hills with a close pattern of drainage near the igneous intrusions. Further south the topography is very subdued. Best outcrops are found in creeks, particularly in the headwaters of the Sellheim River. These three areas will be dealt with separately.

THE SOUTHERN AREA

Lithology

The unit in this area consists of porphyritic lavas, acid tuffs, volcanic conglomerate and tuffaceous sandstone. The conglomerate consists of cobbles and boulders to 4 feet long of flow-banded rhyolite, fine tuff and other volcanic rocks in a white, tuffaceous sandstone matrix. Other sediments include well bedded, white, medium-grained feldspathic tuffaceous sandstone overlying interbedded coarse crystal tuff and porphyritic rhyolite flows.

Porphyritic lavas crop out over large areas. These contain a very high proportion of phenocrysts to the fine-grained matrix. One specimen is described as a porphyritic, glassy lava with embayed, corroded phenocrysts of quartz and feldspar in the albite-oligoclase range set in a flow-banded groundmass of partly devitrified glass. The rock is a porphyritic sodic pitchstone. Another specimen was described as a hybrid andesite lava, containing fragmental corroded and altered zenocrysts of quartz and plagioclase. Porphyritic rhyolite crops out in a number of places, either in very large outcrops showing contorted flow banding or in thin, regularly banded flows interbedded with tuffs.

Very fine-grained and dense to very coarse-grained siliceous tuffs are common in the unit. They consist of shards, splinters and angular fragments of partly devitrified glass, quartz grains, oligoclase and other feldspars as grains and aggregates, biotite flakes, and fragments of felsitic lavas set in a very fine-grained matrix of siliceous ash and cryptocrystalline silica. Despite the fragmental nature of most of these, many show some signs of flow banding in the matrix. Some also show vague bedding.

Lapilli tuff occurs in a few places. These consist of lapilli up to 4 cms long by 1 cm. across of very fine devitrified siliceous lava set in a siliceous tuff matrix. Some of the lapilli partly merge into the siliceous matrix of the tuff in which they occur. These rocks show some evidence of flowing prior to final consolidation.

Structure and relationship.

Many of these rock types crop out in the Mount Coolon area where they were mapped during 1960 as part of the Bulgonunna Volcanics. Strikes and dips were measured in the unit in several places and many strike ridges and bedding trends are visible on the airphotos. These indicate that the unit is moderately folded with fold axes trending north-east. This is compatible with the structure of the underlying Mount Wyatt Beds and the two units may be conformable.

The structures appear to be at variance with those in the Bulgonunna Volcanics. The Bulgonunna Volcanics consist essentially of overlapping blocks of volcanics. Each block shows depositional dips related to its particular basin of deposition, the depositional dips being steepened by subsequent movement in some cases. In many places, the Bulgonunna Volcanics are almost flat-lying. They do not show any evidence of folding such as has affected the Mount Wyatt Beds and the undifferentiated Devonian to Carboniferous volcanics of this area.

These structural disparities are the main reason for separating the undifferentiated volcanics from the Bulgonunna Volcanics. Both units contain similar lithologies.

7-MILE DAM AREA

Lithology

Rock types cropping out in this rather small area include crystal tuff, porphyritic rhyolite and conglomeratic tuff. The crystal tuffs are the most abundant. They are dark, hard, medium to coarse-grained rocks, deeply weathered and altered. They consist of phenocrysts of altered plagioclase and chlorite-epidote pseudomorphs after amphibole set in a fine-grained matrix of quartz, feldspar, epidote, chlorite, mica and clay minerals.

Fine-grained, slightly porphyritic, dark, flow-banded rhyolite crops out at a few places. The flow banding was quite regular over the entire outcrop, striking 210° and dipping east at 70°.

The only other rock type seen in this area was well bedded, medium bedded spotted grey tuff containing some rounded boulders of volcanic rocks.

Structure and relationships:

This unit crops out in a narrow, west-trending zone. It is overlain to the north and south by Bulgonunna Volcanics, striking parallel to the zone and dipping away from it. The lithologies of the Bulgonunna Volcanics on either side of this zone are quite different and represent two separate blocks of volcanics, as referred to above. The zone of undifferentiated volcanics is exposed between the two blocks probably because of tectonic movement and erosion. It is unlikely that it formed a barrier separating the two basins of deposition of the Bulgonunna Volcanics.

There appear to be significant differences in lithology and structure which justify separating this unit from the Bulgonunna Volcanics. In particular, the dark, intermediate crystal tuff which is the dominant rock type in this unit is not known in the Bulgonunna Volcanics. The dip and strike measured on the flow-banded rhyolite of the undifferentiated volcanics is not regionally significant, but it is markedly at variance with the structure of interbedded sediments and rhyolite flows of the Bulgonunna Volcanics, cropping out barely 100 yards to the south. These strike at 280° and dip at 40° south, an attitude which is maintained for some miles along strike.

To the east, this unit of undifferentiated volcanics is separated by a fault zone from reddish, partly silicified, jointed and metamorphosed siltstone and sandstone of the Ukalunda Beds. It occupies a similar position, in respect to the Bulgonunna Volcanics, as do the Ukalunda Beds in this area. It is separated from that unit solely on lithological grounds.

ISABELLA CREEK AREA

Lithology.

Rock types in this area include tuff, crystal tuff, rhyolite flows, siltstone, volcanic agglomerate and tuffaceous conglomerate.

Interbedded, green medium-grained tuff and coarse-grained crystal tuff of similar composition crop out at one locality. They consist of very irregularly shaped and sized fragments of quartz, plagioclase, potash feldspar, and fine-grained volcanic rocks and patches of granular epidote replacing an amphibole set in a matrix of finely granular quartz, chlorite and clay material. Grains range up to 2 mm. in diameter.

Thin rhyolite flows, interbedded with grey-green siltstone, tuffaceous sandstone and tuff, crop out near the margin of an igneous intrusion. This has hardened the siltstone and produced some hornfelsing of the sandstone and tuff.

Volcanic agglomerate crops out in Isabella Creek at the road crossing. It consists of rounded cobbles and boulders of acid volcanic rock set in a blue, hard matrix of the same rock type. Some of the cobbles and boulders merged into the matrix. The outcrop is practically unstratified. Despite the hardness of fresh outcrop in the creek, this rock type occupies low ground and apparently weathers fairly easily.

A little way downstream from the crossing several hundred feet of well bedded volcanics crop out. These include thin-bedded fine and coarse siliceous tuff, weathered to a white or buff colour, interbedded with thick units of volcanic conglomerate. The conglomerate includes mainly pebbles and cobbles of volcanic rocks with some of quartz and other rock types.

Structure and relationship.

These rocks are separated from the Ukalunda Beds cropping out to the north on the basis of lithology only. Not enough is known of the structural geology of the area to establish the relationships of the various rock units. In fact, this unit may be part of the Ukalunda Beds.

The undifferentiated volcanics in this area are steeply dipping to vertical in most places seen. In Isabella Creek, where the exposures are best, they dip at 55° to the south-east. These attitudes are sufficiently at variance with the structures of the Bulgonunna Volcanics to warrant separating the unit from the Bulgunurna Volcanics.

Little is known of the environment of deposition or thickness of the undifferentiated Devonian to Carboniferous volcanics. The unit exists merely as a means of describing volcanics which do not seem to fit into already defined units. With further work, the undifferentiated volcanics of the southern area may well be recognised as a valid unit of formation rank and be defined as such. However, the correlation of the rock types in the 7-mile Dam and Isabella Creek areas with those of the southern area may be quite unjustified.

The age of this unit is described as Devonian to Carboniferous. The rock types in the southern area are younger than the Upper Devonian Mount Wyatt Beds and older than the Bulgonunna Volcanics. The ages of the units in the other two areas are less well established. They are probably older than the Bulgonunna Volcanics and may be as old as the Ukalunda Beds.

DRUMMOND GROUP

The Drummond Group crops out in the west of the area. The unit unconformably overlies the Middle Devonian Ukalunda Beds and is unconformably overlain by the Carboniferous Bulgonunna Volcanics. The group is Lower Carboniferous in age.

The formations mapped in the Drummond Group in the Emerald and Springsure areas are not recognized in the Bowen area. The unit in this area is probably equivalent to the Ducabrook Formation. In this area, the group consists of possibly 10,000 feet of sandstone, siltstone, conglomerate, tuff and agglomerate and minor flows, shale, chert and limestone. Much of the clastic material in the sediments is of volcanic origin. The sediments are well bedded and sorted. They are moderately well exposed in the persistent, narrow structures characteristic of the Drummond Basin folding.

In this area, the fold axes trend north-east in contrast to the north trend of the structures in most of the Drummond Basin.

Plant remains of Lower Carboniferous age were collected at one locality. Unidentifiable plant remains and wood were found in the unit at many places.

Nomenclature

The name, Drummond Beds, was introduced by Jack in 1892. Since then Jensen, Reid and others have worked on them. Shell (Queensland) Development Pty Ltd (1952) recognized a number of formations in the Springsure area. Subsequently, Hill introduced the name Drummond Group in the Geological Map of Queensland (1953).

The most recent mapping of the unit has been done during the present programme of regional mapping of the Bowen Basin and environs. In particular, the 1961 Emerald Party have mapped the Shell formations north of their type areas and introduced one new formation.

This report deals with the unit at the northern end of the Drummond Basin. No formations are recognized in the unit which is mapped as undifferentiated Drummond Group.

Distribution and topography.

The Drummond Group crops out in the west of the Bowen South area. The base of the unit is exposed in the south where it overlies the Ukalunda Beds. Its north-eastern margin is concealed by overlapping Bulgonunna Volcanics.

The unit produces a moderately subdued to mature topography consisting of low, soil-covered rises and wide alluvial flats with long strike ridges in places. These ridges may be separated by broad alluvial flats; elsewhere they run together to form groups of hills. The relief in the area is generally less than 100 feet. Higher relief is developed in the unit near cappings of Tertiary sediments and Bulgonunna Volcanics.

Lithology

The Drummond Group in this area consists of clastic sediments, volcanics and minor shale, chert and limestone. The clastics include lithic sandstone, pebble to boulder conglomerate, siltstone and minor quartz sandstone. These consist largely of reworked volcanic detritus. The volcanics include tuff, crystal tuff, agglomerate and some flow rocks and are generally acid to intermediate in composition.

Lithic sandstone is the most abundant rock type. It is generally a hard, well-sorted and bedded rock consisting of quartz and feldspar grains, volcanic and other rock fragments, rare mica flakes and very little matrix. Calcareous cement is present in some specimens and a few others are silicified. The rock grades from quartz lithic to tuffaceous lithic sandstone with changes in the proportions of the various detrital components.

One specimen of tuffaceous lithic sandstone was examined. It is a coarse-grained rock consisting of volcanic quartz grains (15%), angular feldspar crystals and fragments of andesitic volcanics. The matrix constitutes about 15% of the rock and consists of chloritized tuffaceous material. Most of the grains were rounded.

Another specimen examined was a calcareous tuffaceous lithic sandstone. This is a fairly well-sorted, very coarse-grained rock consisting of fragments of devitrified glass and flow rocks and grains of quartz and feldspar set in a calcareous cement.

The lithic sandstone may be khaki, green, brown, grey or white. It is medium to thick bedded, rarely thin bedded, and is current bedded in many places.

A few outcrops of hard, silicified or siliceous cemented, thin bedded, current bedded, coarse quartz sandstone were mapped in the Drummond Group in this area.

Conglomerate is prominent in the unit. The larger fragments are dominantly volcanic, are generally well rounded and range from granules to boulders three feet across. The conglomerate occurs in thick bedded lenses, commonly showing current bedding and torrential cross bedding. It is interbedded with and may grade laterally into tuffaceous lithic sandstone. It is white, grey, brown, green or blue-green and is generally hard and impermeable.

These lenses and beds of conglomerate are in no way comparable with the much thicker and more mature Mount Hall Conglomerate recognized in the Emerald and Springsure areas.

Beds of conglomerate are interbedded with lithic sandstone and siltstone near the base of the group in the Pyramid areas. They contain angular and rounded pebbles of chert, hardened shale, granite, quartzite, thinly laminated siltstone and quartz. These conglomerates are non-volcanic in origin, the pebbles being derived from the Ukalunda Beds and intrusives, and occur in laterally persistent thick bedded units.

Siltstone constitutes a large proportion of the Drummond Group, though it is not very prominent in outcrop. In general, the siltstone is more mature than the coarser clastics, due to greater reworking, but much of the detrital material is of volcanic origin. In places, it is a tuffaceous siltstone containing rare phenocrysts of volcanic quartz, and grading into ashstone. The unit includes a range of rock types grading from silicified siltstone to ashstone or siliceous fine tuff. The silicified siltstone may be the product of diagenetic silicification of a quartz rich siltstone produced by reworking siliceous ash and fine tuff.

The colour of the siltstone is variable and may be quite bright. It includes white, grey, brown, khaki, green, purple, blue and black. Some specimens are colour banded in grey and green. The siltstone is generally thin bedded to thinly laminated, and may show small scale slump structures.

Calcareous siltstone crops out in a few places. One specimen was found to be a calcareous quartz mica siltstone, containing quartz grains up to fine sand size and calcite in a microcrystalline groundmass of mainly quartz and mica. This rock contained some large blebs of brown semi-opaque material elongated in the bedding plane. In one outcrop it contained lenses of limestone.

A purple, coarse friable siltstone crops out at one locality. This tuffaceous siltstone contains lenses and interbeds to 9" thick of purple, hard quartz greywacke. It was associated with a purple, fine-grained acid tuff consisting of angular fragments of quartz and feldspar set in a silicified matrix of clay material and iron oxide.

Tuff, crystal tuff and agglomerate are the most common volcanics in the group, with thinly interbedded flows and tuffs cropping out in a few places. Various outcrops represent nearly every stage of a complete gradation from ashstone, generally siliceous, through fine to very coarse tuff, to agglomerate. In some places, parts of this series are found grading into one another. In particular, a gradation from coarse tuff to agglomerate is common. These volcanics are generally well bedded. They occur interbedded with one another and with tuffaceous sediments, in thin to medium beds or thick beds in the case of the coarser tuffs and agglomerate. The tuffs are of the same range of colours as the tuffaceous sediments. They weather very readily, particularly the crystal tuffs, and are commonly white on the weathered surface.

These volcanics are acid to intermediate in composition. One specimen of tuff was examined and found to be an intermediate feldspathic tuff. It consists of phenocrysts of potash and soda feldspars with fragments of deeply weathered, fine-grained volcanic rocks and patches of chlorite set in a matrix of clay and secondary calcite. Other specimens of tuff were very much altered. They included altered vitric tuff with the glass shards aligned in a common direction.

Several specimens of agglomerate were examined. One of these is a dark, intermediate, fine agglomerate consisting of flow aligned fragments set in a flow aligned lava matrix. Fragments and lava are of the same composition: plagioclase needles set in a microcrystalline groundmass. Another was a deeply altered agglomerate consisting of fragments, up to 5 mm. long, of quartz and massive or flow banded acid to intermediate lavas, partly altered to chlorite and clay, set in an originally igneous matrix altered to quartz and clay.

A 60 foot thick section of thin to medium bedded, grey and buff shale crops out at one locality. The shale shows mud cracks and very small scale graded bedding. It is cut by many calcite veins. At another locality, thinly bedded, well jointed, dark grey shale is interbedded with white to light grey impure chert. Dark green shale, containing fossil wood, crops out at one place interbedded with green friable lithic sandstone and boulder conglomerate.

Limestone was mapped at a few localities in thin beds and lenses to about 9" thick.

The generally well bedded nature of the sediments and extreme heterogeneity are characteristics of the Drummond Group in this area. This heterogeneity is least apparent in the Pyramid area. Elsewhere, almost every outcrop consists of an interbedded sequence of many of the rock types present in the unit.

Beds are laterally very persistent. Most of the structures are outlined by beds which may be traced for many miles though the lithology may vary somewhat along strike.

Cross bedding and torrential cross bedding are common in the Drummond Group. Other sedimentary structures include small slump structures, ripple marks, mud cracks and rare, small scale graded bedding.

Structure.

The Drummond Group is folded into a number of moderately tight folds, all with axes trending north-east. Flank dips of these structures are steeper than 80° in many places but are most commonly between 30° and 60°. Most of these folds are long and parallel sided. They are complicated by minor cross folds in some places, and in such areas the dips are between 10° and 30°.

West of Pyramid Homestead, the unit crops out in a rather gently folded syncline with flanks dipping at 30° or less. Further west, the group crops out in an anticline which has Ukalunda Beds exposed in the core. The unconformably older Ukalunda Beds are involved in both these last two folds.

Many faults cut the Drummond Group. Many of these trend north-east and appear to be related to the folding of the Drummond Group. Some of them cut the Ukalunda Beds also, and in one place the contact between the Drummond Group and the Ukalunda Beds is faulted. Another set of faults trend north; these generally cut the overlying Bulgonunna Volcanics also.

The Drummond Group unconformably overlies the Ukalunda Beds and the igneous mass at Pyramid Homestead. The evidence for this disconformity is mainly regional; the contact with these rocks is faulted or concealed in most places. The group is unconformably overlain by the Bulgonunna Volcanics and is intruded by an igneous mass south of Glendon Homestead.

Environment of deposition:

The Drummond Group is generally regarded as a freshwater deposit. During the 1961 season, plant remains were found in the unit in a number of places. No marine fossils were found.

Sedimentary structures found in the group include cross bedding and torrential cross bedding, indicating the existence of rapid, sediment laden currents in shallow water. Shallow water conditions are supported by the existence of ripple marks and mud cracks. Very small scale graded bedding in shale indicates deposition from turbid water at times.

The environment of deposition of the Drummond Group may have been freshwater. However, the area was invaded by the sea in the preceding Middle and Upper Devonian time. It seems unlikely that the vast downwarp of the Drummond Basin, which accommodated up to 20,000 feet of sediments, would have been completely or permanently cut off from the sea. The environment may well have been a parallic, restricted marine basin. Plant remains would normally be preserved in such a basin under conditions of rapid sedimentation. And in such a restricted basin, the physico-chemical conditions may inhibit marine organisms.

Thickness

Three measurements were made across the limbs of major synclines in the unit. These were based on measured dips and strikes and on the horizontal cross-section of the limb, measured on the airphotos. The three gave results of 5,000 feet, 6,400 feet and 7,000 feet respectively. In no case was the entire unit measured. The total thickness of the unit is probably up to 10,000 feet.

Age.

Determinable plant remains were collected at one locality - B572F. These were identified as Lepidodendron sp., Rhodia sp., and Calamites sp. of Lower Carboniferous age. These are described in "Report on 1961 Collections of Plant Fossils" by Mary E. White.

BULGONUNNA VOLCANICS

Summary.

The Bulgonunna Volcanics crop out over much of the western half of the mapped area. They unconformably overlie the Ukalunda Beds, the Drummond Group, the Mount Wyatt Beds and possibly the undifferentiated volcanics as well as some of the igneous intrusives. They are intruded by several acid igneous masses and are unconformably overlain by the Bowen Basin sequence.

The unit consists of overlapping and interfingering or separate lenses of acid volcanics. Each lens of volcanics represents effusive activity from one or more of a great number of separate centres of activity, the shape of individual lenses being controlled by the individual locus of deposition. The boundaries of these lenses are commonly fault controlled. Rock types cropping out in adjacent lenses may be quite different.

Rock types in the unit include almost the full range of volcanic types: flows, volcanic breccias, tuff, crystal tuff, agglomerates and possibly ignimbrites. The composition of these rocks is usually in the rhyolite to dacite range. Porphyritic rhyolite is the most abundant individual rock type. Sediments occur in the unit in a few places.

The Bulgonunna Volcanics are Carboniferous in age. In the west of the area, they unconformably overlie Drummond Group containing Lower Carboniferous plants. Further east, they are unconformably overlain by fossiliferous Lower Permian.

Nomenclature.

The name Bulgonunna Volcanics was introduced in the Geology of the Mount Coolon area, (Malone et al., 1961). In the present report, the unit is redefined to some extent. As previously defined, the unit included sediments of the Mount Wyatt Beds as well as those volcanics now included in the undifferentiated Devonian to Carboniferous volcanics.

In this report, the name Bulgonunna Volcanics is restricted to acid to intermediate volcanics and minor sediments separated by a major, though not everywhere obvious, unconformity from the Lower Carboniferous and older rocks and structures.

The undifferentiated Devonian to Carboniferous volcanics in the south of the Bowen area and in the Mount Coolon area are separated from the Bulgonunna Volcanics because their structures appear to be related to the folding of the Upper Devonian beds.

Distribution and topography.

The Bulgonunna Volcanics crop out over most of the western half of the area mapped. The unit includes some extremely resistant rock types and these produce the most rugged topography in the area. The topography developed on some of the masses of porphyritic rhyolite is particularly distinctive. It consists of high hills of fairly uniform altitude and practically devoid of vegetation; these are intensely dissected by a close, joint-controlled drainage system.

A fairly sparse vegetative cover is typical of the unit. This facilitates rapid run-off and is reflected in the close pattern of deep, steep-sided gullies. Much of this drainage is fault controlled.

The most spectacular topographic feature in the area is at the north-east margin of the Bulgonunna Volcanics. There, the unit forms a high plateau, the edge of which is a steep scarp rising some 700 feet above a more deeply eroded granite intrusive cropping out to the east. This plateau is cut by some fault controlled valleys with a relief of more than 500 feet.

Outcrop is extremely good in most areas of the Bulgonunna Volcanics. The only area of poor outcrop is in the south, near the Sellheim River. Here, the unit includes some readily weathered agglomerate and breccia. Similar rock types occur in other places within the unit and produce patches of subdued topography in contrast to the more common rugged, dissected uplands.

Lithology

The Bulgonunna Volcanics consist of overlapping, interfingering or separate lenses of volcanics. The lithologies of the volcanics differ markedly from lens to lens. Within individual lenses, they consist of one or a few related lithologies. The lenses were produced during separate episodes of volcanic activity, involving extrusion from one or a few of the great number of volcanic centres which produced the Bulgonunna Volcanics as a whole.

The shape of the lenses was probably controlled by the surface on which they were deposited. In some cases, they were poured out on extensive, more or less level surfaces. This was apparently the case in the west of the area where very extensive rhyolite flows and tuffs overlie the Drummond Group. Elsewhere, the volcanics accumulated in more restricted basins, some of which have faulted margins. This faulting may have been contemporaneous with deposition, possibly as marginal faults to foundering blocks on which the volcanics accumulated.

The Bulgonunna Volcanics were mapped as a single unit. It contains a very wide variety of rock types, most of which have only local significance. In some cases, it is possible to map a lens of a single lithology. More commonly, the lens is known to exist at one point but its full extent is not known.

The most common rock type in the Bulgonunna Volcanics is porphyritic rhyolite which constitutes almost 50% of the entire unit. These are finely to coarsely porphyritic rocks, white, cream, buff or grey-brown in colour, and commonly show regular or contorted flow banding. They always contain quartz phenocrysts generally euhedral but rounded by resorption in many specimens, and commonly contain orthoclase phenocrysts. Other phenocrysts found in some specimens include plagioclase, hornblende, chlorite pseudomorphs after a ferromagnesian mineral, and calcite, possibly pseudomorphing an amphibole. Secondary quartz occurs in many specimens, commonly as vugs of chalcedony. The goundmass is a fine grained to crypto-crystalline mass of quartz, clay, iron oxide, and chloritic material.

The rhyolites are mainly flow rocks but probably include some intrusive components. One dark grey porphyritic rock was described as a rhyolite porphyry. It consists of quartz and feldspar phenocrysts to 3 mms. long in a very fine groundmass of biotite and aphanitic material. It may be an intrusive equivalent of some of the flows.

The second most common porphyritic rock is porphyritic dacite which is the dominant rock type in at least a few of the lenses of volcanics. Other porphyritic rocks include rhyolitic trachy-andesite. One specimen of this rock type was composed of phenocrysts of plagioclase and potash feldspar in a groundmass of rounded patches to 0.3 mms. diameter of microcrystalline feldspar and minor quartz. Another specimen is a porphyritic toscanite consisting of phenocrysts of oligoclase potash feldspar and quartz in an equigranular groundmass of quartz feldspar and minor iron oxide and chloritic material.

One specimen of very porphyritic augite trachy-andesite was examined. It consists of euhedral phenocrysts of plagioclase, potash feldspar, augite, chlorite after a ferromagnesian mineral, iron oxide and a few strained quartz crystals set in a groundmass of feldspar, chlorite, clay minerals, iron oxide and minor quartz. This rock is similar in groundmass and in the presence of chlorite pseudomorphs to some of the porphyritic rhyolites; it differs in being quartz poor and in containing augite phenocrysts.

Examination of these thin sections suggest that the porphyritic rocks in the Bulgonunna Volcanics are a related sequence, ranging in composition from rhyolite to trachy-andesite.

Tuffs constitute a large proportion of the unit. Rhyolitic to dacitic crystal tuffs are the most common. These consist of potash feldspar and plagioclase phenocrysts, quartz grains and patches and fragments of fine grained acid to intermediate volcanics in a matrix of cryptocrystalline quartz and clay. They are commonly medium to coarse grained, ill-sorted rocks and many show close jointing.

A specimen of feldspathic crystal tuff was found to consist of large crystals of zoned plagioclase, quartz and amphiboles and fragments of basaltic and siliceous volcanics in a matrix of micro-crystalline quartz and chlorite and cryptocrystalline clay material. This rock type is thought to be an ignimbrite. Possibly many of the tough, porphyritic fragmental volcanics in the unit are ignimbrites.

Well bedded tuff, tuffaceous conglomerate and lithic lapilli tuff are associated in one outcrop, at the base of a lens of volcanics consisting dominantly of porphyritic rhyolite. The lithic lapilli tuff consists of angular fragments, to 1 cm. long, of recrystallized quartzite and fine grained siliceous volcanics and angular quartz grains to 1 mm. across set in a groundmass of microcrystalline silica, mica and minor feldspar. The tuff is of similar composition but the matrix constitutes 90% of the entire rock. It is medium to coarse grained. In places the tuff and lapilli tuff grade into tuffaceous conglomerate.

Fine grained tuffs occur in places. These are generally grey, bedded or flow aligned, very siliceous rocks, consisting of quartz grains in a matrix of fine quartz, secondary silica, sericite, clay and iron oxide.

Volcanic breccia is common in the unit. In places, the breccia is dark, purple and well-bedded and grades into or is interbedded with tuff. Rhyolitic volcanic breccia also crops out. They are light pink to brown, tough rocks with a very fine groundmass containing fragments to 9" long of flow banded rhyolite.

Rhyolitic agglomerate crops out in a few places. Typically, these form very thick lenses. They consist of rounded fragments ranging from pebble to boulder size of porphyritic rhyolite set in a purple groundmass of porphyritic rhyolite tuff. These are possibly the result of tuffaceous, mud flows in the vicinity of a volcanic centre. The boulders may be bombs which have undergone a moderate amount of transportation.

Sediments were mapped in the Bulgonunna Volcanics in a few places. These include well bedded, fine to coarse grained khaki, brown or white tuffaceous sandstone and, less commonly, white tuffaceous siltstone. A 10' thick bed of conglomerate crops out at the base of the Bulgonunna Volcanics in the west of the area unconformably overlying the Drummond Beds. This conglomerate consists of rounded pebbles of acid volcanics and quartzite set in a hard, siliceous matrix.

Structure

The most important structures in the Bulgonunna Volcanics are the depositional lenses described above. These are essentially synclinal in character. In no place have they been mapped extending over an anticlinal crest.

Some small anticlines were mapped in the Bulgonunna Volcanics during 1960. These were apparently quite local, affecting medium bedded agglomerate, tuff and thin flows. No structures were visible in a mass of porphyritic rhyolite cropping out a few hundred yards to the west. On the whole, reliable dips and strikes are rarely seen in the Bulgonunna Volcanics.

Faulting and jointing are very common in the Bulgonunna Volcanics. Many of the faults mark abrupt lithological and photo-pattern changes. They may have been contemporaneous with deposition. Other faults are associated with the intrusion of igneous masses.

Very close spaced, intersecting, almost concentric and radiating patterns of joints are seen cutting porphyritic rhyolites in some areas. They produce a very distinctive photo-pattern which is diagnostic of the Bulgonunna Volcanics, but unfortunately is not present in all or even most of the lenses of volcanics.

Longer joints are characteristic of most of the unit. These commonly occur in two sets either nearly at right angles or nearly at 45^{o} to one another. The sets trend north-west to north and north-east to east.

The Bulgonunna Volcanics unconformably overly the Mount Wyatt Beds, the Ukalunda Beds, the undifferentiated volcanics, the Drummond Beds and several igneous masses. They are intruded by several large acid intrusions and, in the east of their area of outcrop, are unconformably overlain by Lower Permian sediments.

The environment of deposition of the Bulgonunna Volcanics was probably largely terrestrial. As redefined in this report, the unit includes very few sediments. These are possibly lacustrine. No plant remains, marine fossils or other data relating to their environment of deposition was found within them.

The thickness of the unit is not known. It is thinnest in the west of the area where the underlying rocks are exposed and some areas of volcanics are separated from the main mass. The unit thickens towards the east.

Age

The Bulgonunna Volcanics as mapped may include rocks of different ages. In the east, the unit is unconformably overlain by Lower Permian sediments. In the west, the unit unconformably overlies sediments of the Drummond Group containing Lower Carboniferous plants. This indicates that the unit is probably Upper Carboniferous in age.

However, Tertiary acid volcanics crop out in the west and north of the area of outcrop of the Bulgonunna Volcanics. Where there is no evidence to indicate age, it is difficult to distinguish Tertiary rhyolitic volcanics from Carboniferous rhyolitic volcanics. Consequently some Tertiary volcanics may have been included in the unit. In some cases, volcanics have been mapped as Tertiary because they lack the jointing commonly found in the Bulgonunna Volcanics. In other cases, they are regarded as Tertiary because they contain undevitrified volcanic glass. It is also quite possible that some of the volcanics mapped as Tertiary belong in the Bulgonunna Volcanics.

A few specimens of Tertiary volcanics and Bulgonunna Volcanics were collected for age determination. All the specimens were too deeply weathered to be of any use. However, very careful collection of samples may enable the ages of these volcanics to be determined.

NOMENCLATURE OF THE BOWEN BASIN SUCCESSION

This subject was fully discussed in the Geology of the Mount Coolon Area (Malone et alia, 1961). In that report it was decided to use the established, informal nomenclature, Lower Bowen Volcanics, Middle Bowen Beds and Upper Bowen Coal Measures. This nomenclature will be retained in the present report.

No subdivision of the rock units, Lower Bowen Volcanics and Upper Bowen Coal Measures, is attempted in the present report. The Middle Bowen Beds are divided into a number of units. These are referred to as units A, B and C and are not formally named.

The Collinsville Coal Measures is shown to be equivalent to part of the Middle Bowen Beds and is described as a formation in that unit.

LOWER BOWEN VOLCANICS

Summary

The Lower Bowen Volcanics is the basal unit of the Bowen Basin. It is an extensive, heterogeneous volcanic and sedimentary pile, possibly up to 20,000 feet thick. It was deposited in a broad, north-north-west trending belt, overlain and overlapped to the south-west by the Middle Bowen Beds.

The unit consists of : sandstone, quartz, lithic or tuffaceous in places; siltstone; greywacke and tuffaceous greywacke; bedded to massive pebble to boulder conglomerate, probably tuffaceous; and andesitic, trachytic, basaltic and minor acid flows, tuff, breccia and agglomerate. In places the sediments contain fossil plants and wood.

The boundary with the overlying Middle Bowen Beds is structurally conformable overall; it may be locally unconformable and is certainly disconformable at the northern end of the basin. To the west, the Lower Bowen Volcanics are unconformable on the Bulgonunna Volcanics and intrusives and are faulted against Tertiary Volcanics. To the east, they are faulted against, overlie and are intruded by rocks of the Urannah Complex. Their deposition was essentially contemporaneous with the igneous activity of the Complex, which supplied much of the volcanic detritus in the Lower Bowen Volcanics.

The unit crops out in the south-west dipping flank of the Bowen Basin and in a number of south plunging fold structures north and west of Collinsville. It was deposited in a restricted environment, at least partly marine, and apparently deep water in places.

The unit contains some fossil plants and fairly abundant fossil wood. The plants belong to a Permian flora. The age of the unit is Lower Permian, though deposition may have commenced in the Carboniferous.

Distribution and Topography

The Lower Bowen Volcanics occupy a broad, north-north-west trending belt, bounded by the Urannah Complex to the north-east and by Tertiary Volcanics and the Bulgonunna Volcanics to the west. Area of outcrop is limited by the overlying Middle Bowen Beds to a narrow strip on the eastern flank of the Bowen Basin and a triangular wedge in the north-west of the basin. The Lower Bowen Volcanics extend to the north of the Bowen South area.

The topography developed on the Lower Bowen Volcanics differs from place to place. West of Collinsville, the unit produces mainly deeply soil-covered plains with low, rocky rises and scattered hills and strike ridges. The most prominent topographic feature is Mount Devlin, just north of Collinsville, which is an isolated, 750 feet high hill of volcanics. There are several other hills in that area, some of them very rugged.

In the eastern strip, areas of soil-covered plains with scattered hills and strike ridges are adjacent to dissected, rugged highland areas. The boundaries between these topographic forms are commonly straight. They were probably developed on fault blocks of different lithologies. The most prominent topography in this area is produced by metamorphosed and indurated Lower Bowen Volcanics adjacent to the Urannah Complex.

Lithology

The Lower Bowen Volcanics is a very thick and extensive unit containing different lithologies in different places. The unit will be described area by area.

North-west area

In this area, the Lower Bowen Volcanics consist largely of basalt and purple basaltic agglomerate, which weather readily to produce deep soil cover. Hematitic basalt is the dominant rock type at the southern end of this area. Sediments crop out at a few places, particularly a hill 2 miles north-west of the old Bowen River Hotel. This outcrop is bounded to the west by a fault separating the Lower Bowen Volcanics from Tertiary volcanics. The Lower Bowen Volcanics in this outcrop consist of: deeply weathering, brownish green porphyritic intermediate volcanic, about 10 feet thick; several beds, to 60 feet thick, of poorly sorted cobble to boulder conglomerate; thin bedded, flaggy, brown, fine to very coarse tuffaceous sandstone grading into fine to pebble conglomerate; thinly laminated, cross laminated, white siltstone and fine quartz sandstone, containing plant fossils; and khaki, cross bedded, medium to very coarse-grained pebbly lithic sandstone containing scattered angular pebbles and boulders.

The conglomerates in this area contained mainly angular cobbles and boulders of acid volcanics and igneous rocks, of the types cropping out in the Bulgonunna Volcanics and intrusives to the west. The poor sorting, angularity and number of these boulders suggest that these sediments were deposited fairly close to their source. The cross bedding indicates shallow water conditions of deposition.

Sediments crop out at the bridge over the Bowen River also. These are thin bedded, very well bedded, flaggy, interbedded brown to grey siltstone and lithic sandstone containing plant fossils. Other sediments seen in this area include khaki-brown tuffaceous lithic sandstone and hard pebble conglomerate.

Collinsville area

In this area, the Lower Bowen Volcanics were divided by Reid (1929) into Mount Devlin Volcanics, Mount Devlin Coal Measures and Mount Toussaint Volcanics. This subdivision does not seem to be valid. West of Mount Devlin, there is a structurally conformable succession from the Mount Toussaint Volcanics to the Collinsville Coal Measures. The volcanics forming Mount Devlin are separated from this succession by a series of faults, and are not represented in the succession. The Collinsville Fault appears to pass between Mount Devlin and the Collinsville Coal Measures, though the trace of the fault is not easily identified. It certainly does not run east of Mount Devlin where it would be readily identified cutting the good exposures in Pelican Creek. The volcanics at Mount Devlin are thus part of the uplifted fault slice east of the Collinsville Fault and are separated from the Collinsville Coal Measures by the amount of the uplift, probably about 2000 feet. The fault slice is bounded to the north by a north-east trending fault, which separates the Mount Toussaint Volcanics from the Mount Devlin volcanics. Dropping the fault slice by 2000 feet, the Mount Devlin Volcanics outcrop can be migrated up-dip to the north-east to be approximately on strike with the Toussaint Volcanics. These two groups of volcanics are thought to be equivalent.

The Mount Toussaint Volcanics are north of the Bowen South area. They were mapped and sampled to establish their relationship to the Mount Devlin Volcanics. The structures of the volcanics were mapped with the aid of a dark, friable, tuffaceous feldspathic conglomerate interbedded with the volcanics. This mapping showed that the structures were essentially conformable with those in the Collinsville Coal Measures though the structures tend to die out towards the south in the overlying sediments.

The Mount Toussaint and the Mount Devlin Volcanics are similar in texture and mineralogy, though the Mount Devlin Volcanics may have undergone more hydrothermal alteration.

Petrology of the Mount Toussaint Volcanics

Three specimens from near Mount Toussaint were examined. These are essentially andesitic in composition but contain different amounts of ferromagnesian minerals. Phenocrysts, mainly euhedral plagioclase, are about 1½ mm long by ½ mm across; some form glomeroporphyritic patches. The plagioclase is zoned but probably averages labradorite in composition. Some zones are chloritized. Most of the phenocrysts are turbid in part; they commonly contain many irregular cracks, most of which are filled with hydrous iron oxide.

The modal abundance of ferromagnesian minerals is lower than normal for andesites, and varies from specimen to specimen. In one specimen, pyroxene and its alteration products are entirely absent. The ferromagnesian phenocrysts are euhedral and are either quite fresh or completely pseudomorphed by serpentine-like and chloritic minerals. Where the pyroxene can be identified, it is diopsidic augite. Opaque iron oxide minerals are grouped with ferromagnesian minerals or form individual phenocrysts and small grains that are evenly distributed throughout the rock.

The groundmass is fine-grained and generally affected by turbid alteration. Only plagioclase microlites could be identified in the groundmass. The rocks contained accessory apatite, sphene and calcite and secondary hydrous iron oxide. Another specimen of the Mount Toussaint Volcanics is similar in texture and mineralogy to the above but contains fewer euhedral plagioclase phenocrysts and less ferromagnesian and iron ore minerals. This specimen contains a zenolith of basaltic rock and has undergone considerable hydrothermal alteration.

A fifth specimen examined is much less hydrothermally altered than the above. This rock is also a porphyritic andesite with a fine, turbid groundmass in which plagioclase microlites show crude orientation. However, both plagioclase and pyroxene phenocrysts are smaller than those in the specimens from Mount Toussaint. In this specimen all the phenocrysts are euhedral and unaltered. The plagioclase phenocrysts are zoned from bytownite to andesine, are irregularly cracked and some show corrosion embayments. Brown hornblende phenocrysts are as abundant as diopsidic augite phenocrysts. Iron ore is less abundant than in the other specimens.

Petrology of the Mount Devlin Volcanics

Three specimens from Mount Devlin were examined. They are porphyritic and glomeroporphyritic andesite, very similar to the specimens from Mount Toussaint. In the Mount Devlin specimens, the phenocrysts are up to 3 mm in diameter. They are mainly plagioclase but include some sub-euhedral phenocrysts of diopsidic augite and opaque iron ore. The phenocrysts are set in a turbid, aphanitic groundmass containing some individual relict plagioclase microlites, flecked with alteration products.

The plagioclase phenocrysts have a dense pattern of cracks and show turbid alteration in part. Some are strongly zoned, and may have an individual zone replaced by chlorite.

The diopsidic augite phenocrysts are mostly about 0.5 mm in diameter but range up to 1 mm. Some of them are pseudomorphed by serpentine-like and chloritic material, and others by uralite. A few unaltered diopsidic augite grains remain, some of which are rimmed by opaque iron oxide. Hydrous iron ore may occupy cracks in phenocrysts.

Ilmenite is evenly distributed throughout as phenocrysts up to 0.5 mm in diameter and in some cases, as small grains peppering the groundmass. A few grains are rimmed by sphene; apatite occurs as a few small needles.

This petrological data does not prove that the Mount Toussaint and Mount Devlin Volcanics are the same. However, it shows that they are very similar and therefore, could be the same. Rock types between the Mount Toussaint Volcanics and the Collinsville Coal Measures include massive andesitic agglomerate, containing boulders up to 1 foot in diameter of blue grey, brecciated and mottled andesitic volcanics set in a brown, deeply weathered tuffaceous matrix, with malachite staining in places; well bedded, medium to coarse-grained, green flecked, chocolate basaltic tuff; medium to thick bedded, medium to coarse-grained yellow-brown tuffaceous sandstone;

basalt; interbedded grey sandstone and pebble conglomerate. Near the top of the Lower Bowen Volcanics is a light olive green, vesicular, trachytic volcanic overlying thin bedded tuff, tuffaceous sandstone and agglomerate.

The sediments underlying the Mount Devlin Volcanics were referred to as the Mount Devlin Coal Measures (Reid, 1929). One seam of coal is reported but no coal was seen in outcrop. The sequence consists of interbedded, medium to thin bedded, laminated, fine to coarse-grained quartz sandstone, flaggy in places; pebbly and tuffaceous sandstone; and quartz pebble and cobble conglomerate. This sequence is cut off by the north-east trending fault mapped at the north-west end of Mount Devlin, as no similar lithologies were found west of this fault. Apparently, this sequence is of only local extent, as it could not be recognized above or below the Mount Toussaint Volcanics.

East of the north-east trending fault, between the Urannah Complex and the Mount Devlin Coal Measures the Lower Bowen Volcanics include : unstratified, poorly sorted, cobble to boulder conglomerate with a feldspathic tuffaceous matrix, intruded by thick porphyritic dykes; brown, friable, very fine to medium-grained feldspathic tuff; purplish, weathered, fine-grained volcanic rocks with pink feldspar phenocrysts, brecciated in places; hydrothermally altered, porphyritic ?dacitic flows.

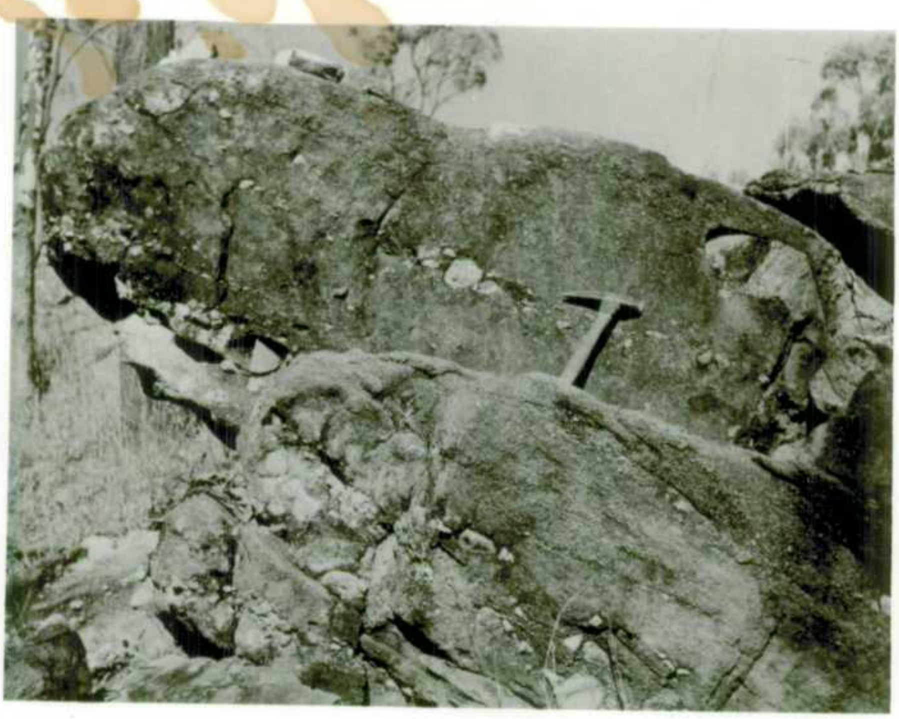
The ?dacitic flows are on strike with the Mount Toussaint Volcanics, though separated from them by a fault. They are petrologically different, in that they are much more hydrothermally altered and that they are more acid. They are porphyritic with mainly oligoclase phenocrysts, commonly showing some or complete turbid alteration. Some oligoclase phenocrysts are unaltered or have a rim of albite. Ferromagnesian minerals are very rare, and are replaced by almost colourless chlorite. Apatite needles are present but not common, and some specimens contain patches of mosaic quartz and calcite. The groundmass contains oriented microlites which are rather indistinct owing to turbid alteration and to the dense distribution of finely divided hydrous iron minerals in the groundmass. Similar iron oxide fill numerous cracks crossing the specimens.

Coral Creek Area

Coral Creek flows through high rugged hills of the Lower Bowen Volcanics between the Urannah Complex and a fault, and then through subdued topography of the volcanics as far as the Collinsville Fault. Between the Collinsville Fault and the fault to the east, the Lower Bowen Volcanics are poorly exposed. Dark green to purplish, weathered volcanics crop out on a rounded hill near the eastern fault. Elsewhere, the volcanics consist of light green, bedded or flow banded, fragmental volcanics interbedded with sandy pebble conglomerate; olive green tuffaceous sandstone and finely laminated siltstone, showing some slump structures; and extensive, altered andesitic lava, tuff and agglomerate.

The hills to the east consist dominantly of indurated, massive, tight packed, green, pebble to boulder conglomerate containing very little matrix. Most fragments are rounded; they are all igneous, ranging from porphyritic volcanics to coarse-grained intrusives. The conglomerate is intruded by green porphyritic dykes similar to those intruding the Urannah Complex. Associated with the conglomerate in places are: fine to very coarse, light green to green tuffaceous lithic sandstone, pebbly in places and grading into tuffaceous pebble conglomerate; green tuffs and lavas; quartz lithic sandstone and pebble conglomerate; tough, hard, light green volcanic breccia; and dacitic crystal tuff or fine agglomerate.

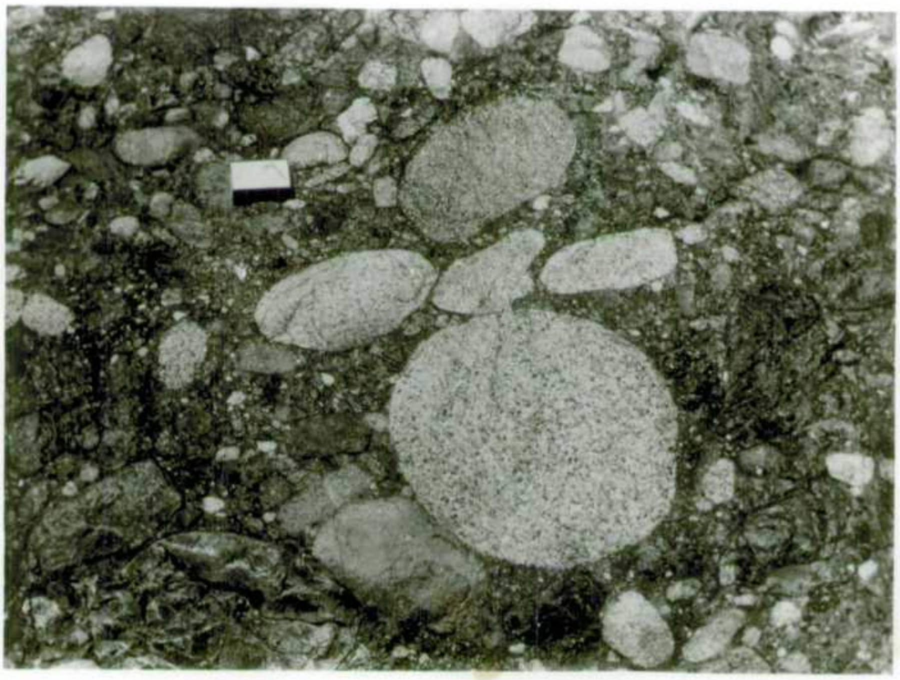
About 2 miles south of Coral Creek, the equivalent of the conglomerate is a green, hard, tuffaceous conglomerate, containing more tuffaceous matrix and fewer boulders. Some fragments are rounded but many are angular. The fragments are mainly of green porphyritic volcanics; some boulders of coarse intrusive rocks were seen. Associated with the conglomerate in this area are: coarse agglomerate, bedded in places, containing angular, porphyritic and amygdaloidal cobbles and boulders of basic to intermediate volcanics; green, medium to coarse-grained tuff; and dark-grey, jointed siltstone.



Lower Bowen
Volcanics.

Current bedded, pebbly sandstone containing scattered cobbles and boulders.

Outcrop near base of unit, on western margin of basin, 2 miles north-west of abandoned Bowen River Hotel.
(Neg.No.G/2463)



Lower Bowen
Volcanics.

Conglomerate in Coral Creek area.

(Neg.No.G/4267)

Lower Bowen
Volcanics.

Conglomerate in Coral Creek area, intruded by micro-diorite dyke similar to those in Urannah Igneous Complex.

(Neg.No.G/4283).

A further 6 miles south, a similar conglomeratic sequence crops out, adjacent to the Urannah Complex. This consists dominantly of a green, very hard, generally well sorted and bedded, polymictic, pebble to cobble conglomerate and tuffaceous conglomerate. Interbedded with the conglomerate were: hard, laminated, fine-grained, green and white tuffaceous siltstone, showing small scale slump structures; medium to thick bedded hard green tuff; and black, hardened, very jointed siltstone.

Gebbie Creek Area

A bed of volcanics form a prominent outcrop near the top of the Lower Bowen Volcanics extending from Gebbie Creek north and west to the Collinsville Fault. The structure of this volcanic bed is similar to that of the Wall Sandstone Member, at the base of the overlying Middle Bowen Beds.

The volcanics consist of white to buff, siliceous volcanic breccia containing angular fragments in a fine-grained, chert-like matrix. Fragments and matrix are of a trachy-rhyolite composition; the groundmass consists of a siliceous quartz feldspar mosaic. Some thin flows are interbedded with the breccia; these are rhyolitic to trachytic, silicified rocks, commonly with a mottled, roughly flow aligned appearance. They contain amygdules of calcite and limonite.

Between the volcanics and the Wall Sandstone Member is the following sequence of Lower Bowen Volcanics: interbedded blue, white and grey, plant-bearing siltstone and khaki tuffaceous sandstone, with some thin flows or sills; a thick unit of polymictic pebble conglomerate and quartz lithic sandstone; and ferruginous siltstone containing wood. This sequence was previously equated to the Collinsville Coal Measures. Work during 1961 has shown that the Collinsville Coal Measures are equivalent to sediments of the Middle Bowen Beds above the Wall Sandstone. This is fully discussed in the next chapter.

Below the prominent volcanic outcrop, the Lower Bowen Volcanics are not well exposed. They include black siltstone, red ferruginous siltstone with some plant fragments, grey green tuffs and flows, and khaki tuffaceous greywacke.

Broken River Area

The Lower Bowen Volcanics are very well exposed at a few places in the Broken and Bowen Rivers. Elsewhere, on this eastern flank of the Bowen Basin, the unit is generally poorly exposed. Some 300 feet of section is exposed near the top of the unit in the Bowen River, near the junction with the Broken River. This consists of a well sorted quartz lithic sandstone containing pebble bands, overlain by rhythmically bedded, siltstone and current-bedded calcilutite to calcarenite, overlain in turn by a thick sequence of spheroidally weathered, closely jointed, purple siltstone, possibly tuffaceous.

About 1 mile to the east, thin to medium bedded, laminated, closely jointed, siltstone and lithic sandstone crops out in the Broken River. These sediments show small scale current lamination. They contain fairly abundant plant remains and fossil wood.

A little way below them, about 500 feet of section is well exposed in the Broken River. This sequence consists of thin to medium bedded, well bedded, thinly laminated, grey siltstone, dark tuffaceous greywacke and greywacke conglomerate. Beds are consistent in thickness and lithology over a considerable distance. Slump structures and graded bedding are common; no current bedding was seen. The greywacke contains an abundance of fine matrix but most of the grains are subrounded. One specimen examined was a basaltic tuff or greywacke. Some large oscillation ripples with an amplitude of 4" and a wave length of 3 feet were seen in this outcrop. The sediments and their sedimentary structures suggest deposition in deep water. They contain rare fossil plants and wood.

South of the Broken River, the Lower Bowen Volcanics include: thick bedded, ill-sorted, green and red agglomerate, possibly andesitic in composition; thinly laminated, greenish-brown siltstone containing plant remains and fossil wood in places; black, well-jointed, semi-friable shale; fine-grained andesite flows; grey, fine lithic sandstone; and medium to coarse-grained tuff. The thinly bedded siltstone-shale and volcanics sequence occurs near the top of the Lower Bowen Volcanics east of Exmoor Homestead and for some miles to the north and south. It contains abundant fossil plants and wood.

Mainly acid volcanics crop out in the Lower Bowen Volcanics adjacent to the Urannah Complex, north and south of the Broken River. These are separated by a fault from the sediments described above. At the southern end of this block, the sediments appear to be conformable on the acid volcanics, though the contact is partly faulted. The volcanics are mostly fawn, brown, khaki or pink porphyritic rhyolite, flow banded in places. They are intruded and metamorphosed by the Urannah Complex.

Structure

The Lower Bowen Volcanics are apparently little folded in the north-west of the Bowen Basin. Some dips of 25° were measured but most were about 15° or less. Outcrop was not good, and it was impossible to delineate structures. North west of Collinsville, the unit is better exposed and some structures were mapped. These are essentially similar to those in the conformably overlying Collinsville Coal Measures. Dips are 25° or less, and the structures plunge south at shallow angles.

North of Collinsville, the Lower Bowen Volcanics are folded into a broad synclinal structure plunging south-west. One dip of 35° was measured near the faulted contact with the Urannah Complex; other dips in the area are less than 20°. The volcanics in this area are part of a fault slice between the Collinsville Fault and the Urannah Complex. North of Collinsville, the volcanics strike parallel to the length of the fault slice. Further south, their strike swings to east-west across the fault slice. At the southern end, between Gebbie and Jacks Creeks, the topmost beds of the Lower Bowen Volcanics crop out in a south plunging flexure, conformably overlain by Middle Bowen Beds. In this structure, the volcanics dip west at 80° near the Collinsville Fault; east along strike, the dip slackens to 15° south; then, on line with the eastern fault, the strike bends sharply and the volcanics again dip at 80° west. The faults die out in this area, the displacement being taken up by the flexuring of the beds.

On the eastern flank of the Bowen Basin, the Lower Bowen Volcanics generally dip south-west, away from the Urannah Complex, at angles of about 40°. The volcanics are affected by several faults and some minor folding. Essentially, the structure of the volcanics reflects the development of the steep eastern flank of the Bowen Basin and is conformable with that of the overlying Middle Bowen Beds. Some minor folds, near the southern edge of the mapped area, are not reflected in the overlying Middle Bowen Beds. These may indicate local unconformity.

The Lower Bowen Volcanics are overlain by the Middle Bowen Beds. The relationship is structurally conformable in most places; it is a disconformable, transgressive overlap in the west of the Bowen Basin.

On their western margin, the Lower Bowen Volcanics are faulted against Tertiary Volcanics in the Brawl Creek area. Further south, the volcanics unconformably overlie the Bulgonunna Volcanics and intrusives. Some outliers of the volcanics were mapped overlying intrusives into the Bulgonunna Volcanics.

The eastern boundary of the Lower Bowen Volcanics is more complicated. In many places the volcanics are faulted against the Urannah Complex. Where the boundary is not faulted, the volcanics generally strike parallel to the contact with the Complex and dip away from it. Some of the sediments in the Lower Bowen Volcanics were apparently derived from the Complex. On the other hand, these same sediments as well as other rocks in the Lower Bowen Volcanics are intruded and metamorphosed by elements of the Complex.

We consider that the Urannah Complex represents a period of igneous activity, which probably commenced before the deposition of the Lower Bowen Volcanics and certainly continued for some time after deposition of the volcanics had ceased. The dominantly andesitic volcanics of the Lower Bowen Volcanics were probably derived from extrusive vents associated with the Urannah Complex.

Environment of Deposition

The Lower Bowen Volcanics were probably deposited in a restricted marine, asymmetrical basin. The western part of this basin consisted of a gently east-dipping shelf of Bulgonunna Volcanics. The eastern margin of the basin was a volcanic island arc. The bulk of the volcanics were deposited in a deep trough, probably under deep-water conditions, west of the island arc. Deposition in deep water is suggested by the bedding and other sedimentary structures in the volcanics cropping out in the Broken River. That the environment was marine at times is shown by the presence of marine fossils near the top of the Volcanics in the Mount Coolon area.

Thickness

The total thickness of the Lower Bowen Volcanics is not known. A thickness of 12,000 feet was estimated east of Gatton Vale Homestead. Locally, the unit was probably much thicker.

Age

The fossils collected from the top of the Lower Bowen Volcanics in the Mount Coolon area, during the 1960 season, are of Lower Permian age. Since a unit like the Lower Bowen Volcanics would accumulate fairly quickly, the entire unit may be Lower Permian. On the other hand, deposition may have commenced in the Carboniferous. At this stage, the unit is regarded as Lower Permian.

Plant remains are contained in the unit in a number of localities in the west of the Bowen Basin and in a few places in the east. These plants include species of Noeggerathiopsis, Samaropsis, Glossopteris, and Cordaites.

MIDDLE BOWEN BEDS

Summary

The Middle Bowen Beds crop out around the margin of the Bowen Basin, between the Lower Bowen Volcanics and the Upper Bowen Coal Measures, and in the Rosella Creek anticline in the middle of the basin. Three units, A, B, and C are recognised in the Middle Bowen Beds, A being the oldest. These three units differ in gross lithological characteristics. Unit A consists of fine to medium quartz greywacke and siltstone, calcareous in part; unit B is characterised by thick quartz sandstone units in a medium to coarse quartz greywacke and siltstone sequence; unit C consists dominantly of siltstone and fine quartz greywacke. In places, unit B can be divided into three sub-units. A distinct fauna is associated with each unit and with the sub-units of unit B.

The Collinsville Coal Measures are regarded as a formation in the Middle Bowen Beds; they are equivalent to most of unit B.

The relationships, distribution and thickness of the units in the Middle Bowen Beds are illustrated by means of text figure 2. The maximum thickness is about 6,500 feet in the Exmoor Homestead area where the entire Middle Bowen Beds are present.

The Middle Bowen Beds are steeply dipping on the eastern margin of the Basin and in the Rosella Creek anticline, and dip shallowly basinwards around the north-west margin. They are intruded by a lacolith and by several hornblende diorite and rhyolite sills. The faunas are mainly Lower Permian; they may range into the lowermost Upper Permian.

Nomenclature

The established informal name, Middle Bowen Beds, is used in this report. During 1961, three subdivisions were recognised in the Middle Bowen Beds, based on lithological and palaeontological data. These are referred to as units A, B and C, unit A being the oldest. The Collinsville Coal Measures is effectively a formation within the Middle Bowen Beds and is equivalent to most of Unit B.

Distribution and Topography

The Middle Bowen Beds form a curving line of outcrop around the margin of the Bowen Basin. The Collinsville Coal Measures and unit C occupy a wide belt of country around the western and northern margin of the Basin. The topography within this belt is fairly subdued; consists of long, low ridges and soil covered rises and plains. The most rugged topography is developed in the headwaters region of Parrot Creek. There, unit C forms a few long cuestas with gentle eastern slopes and steep western scarps. The Parrot Creek drainage is deeply incised west of the cuestas and has produced a modified bad-lands topography. Some outliers of Collinsville Coal Measures overlie the Bulgonunna Volcanics to the west.

Unit C crops out in the Rosella Creek Anticline, surrounded by Upper Bowen Coal Measures. It produces a long low hill over the axis of the structure, but for the most part forms a subdued topography of soil covered rises and plains. Most outcrop occurs in creeks and gullies. Rubble and near-outcrop are found on some of the low rises.

The Middle Bowen Beds crop out in a narrow belt on the eastern side of the basin. All three units, A, B and C, are present in the vicinity of Exmoor Homestead. Unit A diminishes in thickness from this point north and is not seen north of the Bowen River. The narrowness of this belt of outcrop is a reflection of the steep dips along this flank of the basin. The topography also reflects these steeper dips. It is characterised by long, moderately high strike ridges. South of Emu Plains, the Middle Bowen Beds are intruded and metamorphosed, the metamorphic aureole forming a ring of high hills.

Subdivision within the Middle Bowen Beds

In this report, the Middle Bowen Beds are divided into four units, A, B and C and the Collinsville Coal Measures.

Unit C is the youngest of these. It was first recognised as a transgressive unit in the Clermont area during 1960 (Veevers et al. 1961). In that area it unconformably overlies Lower Carboniferous and older rocks. During the 1961 season, this transgressive unit was identified in the Bowen

Styx area, conformably overlying the Collinsville Coal Measures in the west and north of the basin and forming the top unit of the Middle Bowen Beds on the eastern flank of the Basin. In addition, the equivalents of the Collinsville Coal Measures were recognised in the Middle Bowen Beds, immediately below the transgressive upper unit. This has permitted a threefold division of the Middle Bowen Beds. The subdivisions are based on palaeontological and stratigraphical data. Locally, these units may have distinctive lithological characteristics and are effectively rock units. This is the case at the northern end of the basin. In a regional sense, these units are akin to stages. We consider that they are related to major changes of environment affecting the whole Bowen Basin and hence possess a regional significance.

Text figure 2 shows the distribution and thickness of the Middle Bowen Beds, of units A, B and C and of the Collinsville Coal Measures in the Bowen area. Stratigraphic columns 3 and 4 are measured sections. The others were computed using dip and strike information and a plan width measured on the aerial photos where the locations of the top and bottom of the unit were known. The accuracy with which the fossil collections are located on the stratigraphic columns varies somewhat but in no case is the possible error critical.

The time-rock nature of units A, B and C is shown by the fact that a distinct fauna is associated with each. These faunas were first recognised by J.M. Dickins (1961) while studying the fossils collected during the 1960 season. Additional material collected during 1961 has increased the number of species on which the faunas are based and has permitted the sub-division of one fauna into 3 parts. The faunas are:

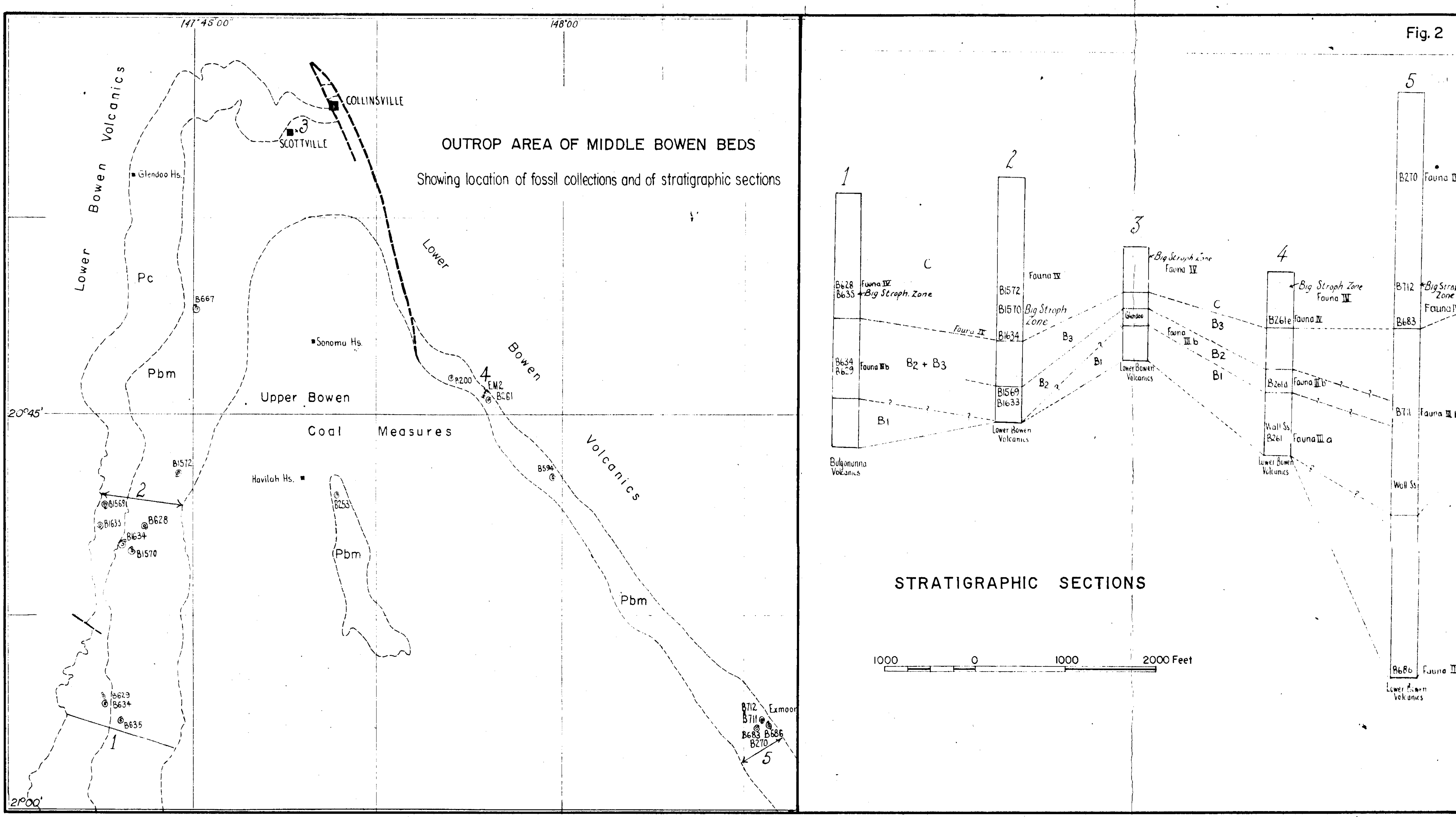
Fauna IV, associated with unit C,

Fauna III, " " " B,

Fauna II, " " " A

Fauna III has been divided into IIIa, IIIb, IIIc, each of which is associated with equivalent subdivisions of unit B. The subdivisions of unit B can be recognised on lithology in the Gebbie Creek and Collinsville areas.

Fig. 2



OUTROP AREA OF MIDDLE BOWEN BEDS
Showing location of fossil collections and of stratigraphic sections
147°45'00"
148°00
20°45'
21°00'
COLLINSVILLE
SCOTTVILLE
Glendoo Hs.
Sonoma Hs.
Havilah Hs.
Lower Bowen Volcanics
Upper Bowen
Coal Measures
Pc
Pbm
Exmoor
STRATIGRAPHIC SECTIONS
Big Stroph. Zone
Fauna IV
Fauna III b
Fauna III a
Fauna II
Lower Bowen Volcanics
Bulgonunna Volcanics
Wall Ss
1000 0 1000 2000 Feet

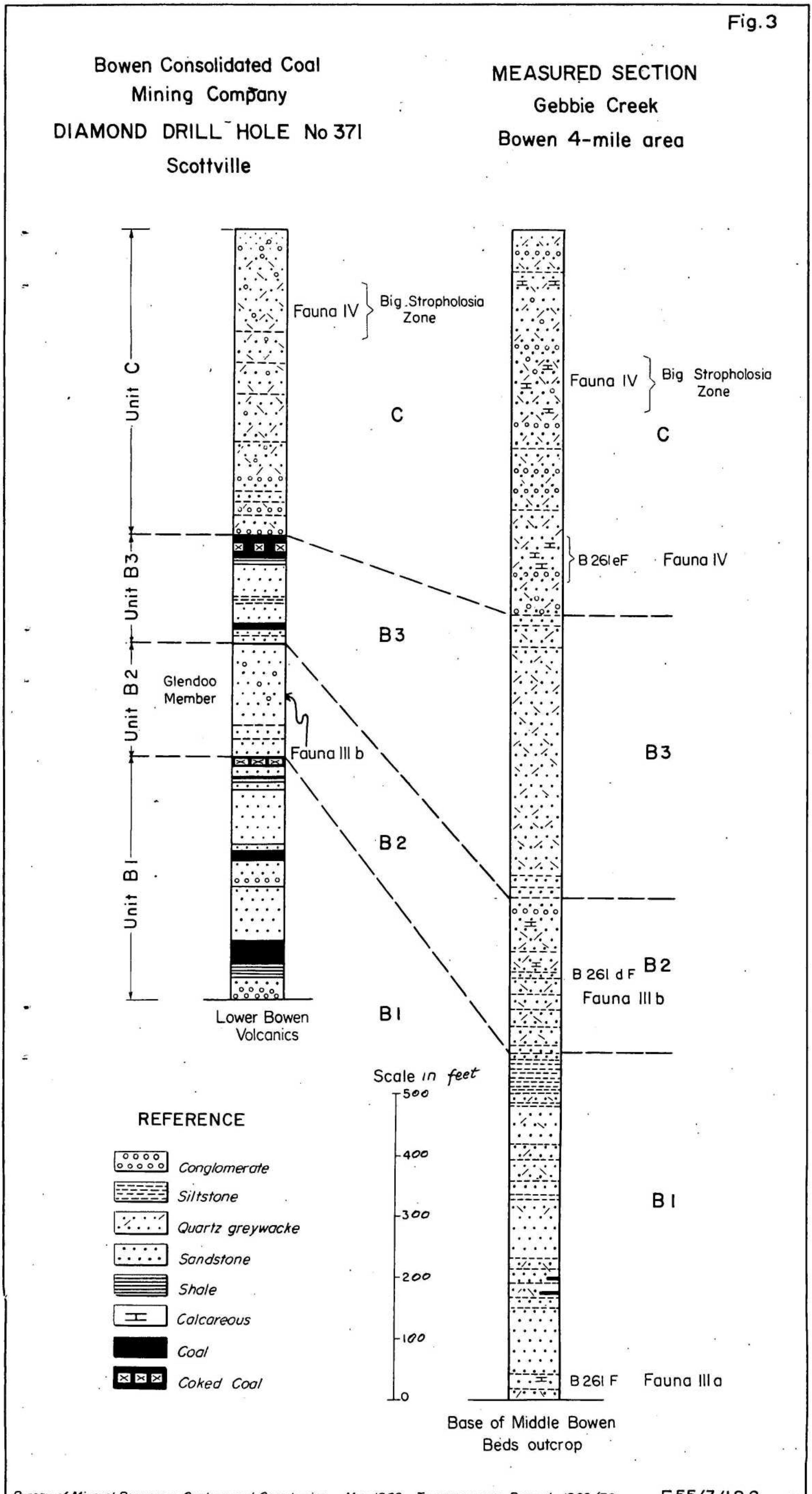


Fig. 3
Bowen Consolidated Coal
Mining Company
DIAMOND DRILL HOLE No 371
Scottville
MEASURED SECTION
Gebbie Creek
Bowen 4-mile area
Unit C
Unit B3
Unit B2
Unit B1
Fauna IV
Big Stropholosia Zone
C
B3
B2
B1
Glendoo Member
Fauna III b
Lower Bowen Volcanics
B 261 eF
B 261 d F
Fauna III a
B 261 F
Scale in feet
500
400
300
200
100
0
Base of Middle Bowen Beds outcrop
REFERENCE
Conglomerate
Siltstone
Quartz greywacke
Sandstone
Shale
Calcareous
Coal
Coked Coal

They can be recognised on fossil content in a few places further south.

The equivalence of the Collinsville Coal Measures with unit B is shown by comparing the log of the Bowen Consolidated Coal Mining Co. diamond drill hole No. 371 with the Gebbie Creek measured section. These are shown on plates 2 and 3, at a scale of 1" to 100' with descriptions of the lithologies. The same sections are directly compared on text figure 3 at a scale of 1:2,000.

The base of unit C is clearly marked on both sections. In the drill hole, it is at the top of the Collinsville Coal Measures. In Gebbie Creek, it is marked by the appearance of a pebble conglomerate band above a monotonous quartz greywacke and siltstone sequence. Fossil collection, B261e, a rich fauna IV collection, helps to locate the base of unit C in Gebbie Creek.

The three subdivisions of unit B are recognized in the diamond drill hole and in Gebbie Creek. The small fossil collection B261d from Gebbie Creek belongs to fauna IIIb and is equivalent to that contained in the Glendoo Sandstone Member. The Glendoo Sandstone Member, as a distinct sandstone bed, can be recognized in the Collinsville to Glendoo Homestead area only. It is included in sub-unit B2, a dominantly sandstone unit with marine fossils. Sub-unit B2 is clearly defined in the drill hole; its boundaries are less sharply defined in Gebbie Creek.

Sub-units B3 above and B1 below are coal measures without marine fossils in the drill-hole and are carbonaceous quartz greywacke and siltstone with few marine fossils in Gebbie Creek. Several thin coal seams were mapped in Gebbie Creek in sub-unit B1.

The base of unit B is not exposed in Gebbie Creek but probably not much more than 100 feet of section is missing. The Collinsville Coal Measures are probably equivalent to most of unit B, above the Wall Sandstone Member. The Wall Sandstone Member lenses out to the north of Gebbie Creek and does not appear to be represented in the Collinsville Coal Measures.

The sub-divisions of unit B are not well defined on the western flank of the Basin, south of the Bowen River. Several collections of fossils were made from richly fossiliferous calcareous quartz greywacke horizons in this area. The collections belong to fauna IIIb and are equivalent to that contained in the Glendoo Sandstone Member. They indicate the presence of sub-unit B2 throughout the area, though here it consists of a quartz greywacke-siltstone lithology, similar to unit C and quite different from its lithology in the Collinsville area. In section 2, west of Havilah Homestead, units B2 and B3 can be distinguished. B3 retains a similar lithology to that which it possessed in the Collinsville area, though no coal seams crop out. Its photo pattern differs from that of unit B2 below and unit C above. In this section, unit B1 appears to be absent. A narrow strip of alluvium separates B2 from Lower Bowen Volcanics. Possibly, B2 has transgressed B1 in this area.

Further south, in the Parrot Creek area, (Section 1) unit B1 crops out displaying the same lithology, complete with coal seams, as it does in the Collinsville area. Here, unit B3 can not be distinguished. Either it has lensed out or has changed its lithology from coal measures to a quartz greywacke siltstone sequence. Comparison of section 1 and section 2 suggest that the latter is correct. The base of unit C is located on palaeontological evidence as there is little difference in the lithologies of units B2, B3 and C in this area. Unit B is well developed in the Exmoor area, section 5. Fossil Collection B711 F is a fauna IIIb collection indicating the presence of sub-unit B2. However, it was not possible to locate accurately the boundaries between units B1, B2 and B3 in this section. The units possess slightly different gross lithological characteristics and more detailed work might enable them to be distinguished.

Units B and C differ in gross lithology, unit B being dominantly an arenite sequence and unit C a siltstone sequence. However, the boundary between the two is not everywhere clearcut. In sections 3 and 4 and to a lesser extent in 2 and 5, the boundary is quite distinct. In these cases, the boundary is commonly marked by pebble conglomerate bands, about 350 to 450 feet below the Big Strophalosia Zone. This zone crops out discontinuously around the northern end of the Bowen Basin. Its most southerly outcrop is found near Exmoor Homestead. The fauna, lithology and thickness of this zone is remarkably consistent, making it a very easily recognized marker in unit C. In section 1, the base of unit C was placed about 300 feet below the Big Strephalosia Zone, there being no lithological or other data on which to locate this boundary.

Units A and B are distinguished on faunal content and on gross lithological characteristics. On lithology alone, the boundary between them would be placed at the base of the Wall Sandstone Member, the first major lithological change. In practice, it is placed about 200 feet below that Member, to include a fossiliferous sequence of siltstone and fine quartz greywacke. These fossils belong to fauna IIIa and are quite different from those of the underlying fauna II.

The Wall Sandstone Member is a prominent marker in unit B. It crops out discontinuously from the Gebbie Creek area south into the Mount Coolan area.

Unit A crops out on the eastern flank of the Bowen Basin, south of Gebbie Creek. It is best developed east of Exmoor Homestead, where it is about 1800 feet thick.

Lithology

The lithologies of the various units in the Middle Bowen Beds are described separately.

Unit A.

This unit is the least well exposed in the Bowen area. It consists dominantly of a grey-green, semi-friable, medium to fine grained quartz greywacke with carbonaceous streaks and laminaes. In places it contains scattered coarse sand grains and calcareous and fossiliferous zones and nodules. Fossiliferous calcareous quartz greywacke crops out at the base of Unit A, east of Exmoor and near the southern margin of the sheet area. These were extensively ferruginized during weathering, with replacement of calcareous material. The fossils weather out as ferruginous casts and steinkerns.

Unit A may include some siltstone but this is not exposed in the Bowen area.

Unit B

The lithology of most of unit B is described in detail in the Gebbie Creek measured section, plate 2. The basal few hundred feet, which are not exposed in Gebbie Creek, consist of yellow-brown siltstone and fine, semi-friable quartz greywacke, commonly calcareous and fossiliferous.

Unit B changes in lithology south from Gebbie Creek. In particular, sub-units B1, B2 and B3 become difficult to distinguish.

The unit consists essentially of medium to coarse grained, interbedded carbonaceous quartz greywacke and siltstone changing southwards into medium to coarse grained dark blue, micaceous greywacke and siltstone. This arenite-siltstone sequence contains medium to thick bedded, medium to coarse-grained quartz sandstone and thin pebble conglomerate beds. The quartz sandstone beds are laterally very persistent, vide the Wall Sandstone Member, and are the most characteristic features of Unit B.

The name, Wall Sandstone Member, is informal as it is not derived from a geographic feature. However, the name is firmly established in the literature and we will continue to use it until the entire Middle Bowen Beds stratigraphic nomenclature is revised.

This member has a maximum thickness of 98 feet in Gebbie Creek. It has thinned to about 20 feet at its last outcrop north of Gebbie Creek, and is approximately 80 feet thick near the southern margin of the Bowen Sheet. The member is a clean, well sorted, medium to coarse grained quartz sandstone. It is medium to thick bedded and shows cross-bedding and cross-lamination. It is moderately to very silicified, and is intensely jointed in some places.

Unit C

The basal 600 feet and 500 feet of unit C are described in detail on plates 2 and 3, respectively. The maximum thickness of the unit is estimated to be 2,600 feet in the Exmoor area. This unit differs from unit B in that siltstone is the dominant lithology. The unit commences with a pebble conglomerate or pebbly sandstone band overlain by medium to fine grained carbonaceous quartz greywacke with some conglomerate bands and scattered pebbles and boulders. This section includes the Big Strophalosia Zone about 350' above the base of unit C. Above this, the quartz greywacke is interbedded with siltstone which becomes the main rock type in the top 2,000 feet of the unit. Outcrop in the upper part of unit C is very poor, probably due to the dominance of siltstone.

The uppermost part of unit C is exposed in the Rosella Creek anticline. The lithologies in this area include: fossiliferous, calcareous grey medium grained quartz greywacke; thin beds of grey-blue, poorly fossiliferous limestone; gypsiferous or micaceous, thin to medium interbedded quartz greywacke and sandy siltstone; vari-coloured siltstone; thick beds of blue-grey to pale-grey, gypsiferous or micaceous siltstone interbedded with medium to 18" thick beds of laminated and cross laminated, fine to medium grained, quartz greywacke with worm tubes or tracks; cross bedded quartz sandstone with rare pebble and fine conglomerate bands. In this area, siltstone constituted more than 60% of the total.

In the Parrot Creek area, unit C includes medium bedded fine to coarse grained, thinly laminated micaceous quartz sandstone. This rock type and the calcareous quartz greywacke of the Big Strophalosia Zone form cuestas in the area. The bulk of the unit does not crop out.

The Big Strophalosia Zone

This name is not formal but is well established in the literature. The zone is 75' thick in drill hole No. 371 (Plate 3), 100' thick in Gebbie Creek and 105' thick near Exmoor Homestead. It was not measured on the western flank of the Bowen Basin but is approximately 60 feet thick in section 1. The zone is a continuous horizon in Unit C of the Middle Bowen Beds throughout the Bowen area. The most southerly outcrop is near Exmoor Homestead. It is not definitely recognised in the Mount Coolon area to the south and, if present, is much thinner.

The lithology of the zone consists of fossiliferous calcareous, medium to fine grained quartz greywacke containing scattered pebbles, cobbles and angular boulders and some thin beds of conglomerate. In the Collinsville area, the dominant rock type is a grey-blue, coarse siltstone. The quartz greywacke is ferruginized to a brownish-red colour in weathered outcrop. It is a grey-green colour when fresh.

The zone is richly fossiliferous as a whole though, in places, it contains poorly fossiliferous sections. The tremendous number of specimens in this zone belong to a relatively small number of species. These include Strophalosia ovalis, S. clarkei, S. brittoni var. gattoni and Terrakea solida.

The Big Strophalosiz Zone was possibly deposited by a series of density currents.

The random orientation of the fossils and the absence of productid spines in many places indicate that the zone was not developed in situ. Density currents are suggested because of the great areal extent of the zone and to explain the presence of angular boulders and cobbles. No graded bedding was observed in the unit.

COLLINSVILLE COAL MEASURES

This unit is described in great detail by Webb and Crapp (1960). The log of diamond drill hole No. 371 is presented on plate 3. This log with a section through the basal 75' of the coal measures describes the whole of the unit in the type area.

The Glendon Sandstone Member (Webb and Crapp 1960) is recognised as a distinct sandstone unit in the Collinsville to Glendoo Homestead area only. South of the Bowen River, this unit is represented by a fossiliferous, calcareous quartz greywacke horizon.

As mentioned above, unit B3 has changed from coal measure lithology to a quartz greywacke and siltstome lithology in the Parrot Creek area. However, the basal part of the Collinsville Coal Measures (unit B1) is easily recognised in this area. It consists of clean, white, current bedded medium to thick bedded quartz sandstone with interbedded siltstone, carbonaceous shale and coal seams. At the base is a locally thick conglomerate grading into breccia, containing pebble to small boulder size fragments of mainly volcanic rocks. This conglomerate is very easily weathered. It contains a few thin siltstone interbeds and is intruded by many small intermediate sills and dykes. The conglomerate overlies a medium grained acid intrusive into the Bulgonunna Volcanics. Further south, in the

Mount Coolon area, a thin to 1' thick bed of pebble conglomerate is at the base of unit B1 of the Collinsville Coal Measures unconformably overlying the Bulgonunna Volcanics.

<u>Structure</u>

The Collinsville Coal Measures and unit C of the Middle Bowen Beds are little folded in their area of outcrop around the north-west margin of the Bowen Basin. A few fairly minor folds are mapped in the Collinsville area; these may result from contemporaneous folding and faulting. Elsewhere, the dips are generally less than 10". A few steeper dips, as high as 30°, were mapped. These are apparently related to monoclinal warps as all dips measured were towards the basin.

Unit C crops out in the Rosella Creek anticline, an elongate narrow structure plunging to north and south and bifurcating at the southern end into a number of anticlines. Flank dips on this structure are fairly steep, up to 45°. On the eastern flank of the basin the Middle Bowen Beds dip basinwards at angles generally between 30° and 50°. Steeper dips up to 80° were measured in Gebbie Creek. North west of Gebbie Creek, the strike of the Middle Bowen Beds bend sharply to the west and then curve back to the north-north-west. This swing in strike and the steeper dips in Gebbie Creek are possibly due to folding associated with two parallel faults. Of these, the Collinsville Fault involves mainly vertical movement, east block up, and has displaced outcrop of the Middle Bowen Beds about 10 miles south. The eastern fault also appears to involve vertical movement, east block up. The movement at its southern end has apparently been taken up by bending of the strike and steepening of the dip of the Middle Bowen Beds.

The Middle Bowen Beds are thought to be disconformably younger than the Lower Bowen Volcanics. There is certainly a disconformity around the margin of the basin west of Gebbie Creek; in that part of the basin, the basal part of the Middle Bowen Beds is missing. This disconformity is supported by the Collinsville Coal Measures transgressively overlapping the Lower Bowen Volcanics.

Above, the Middle Bowen Beds are conformably overlain by the Upper Bowen Coal Measures. At their base, there is no sign of a structural discordance between unit A and the Lower Bowen Volcanics. Palaeontological evidence from the Mount Coolon area suggests a short disconformity between the Middle Bowen Beds and the Lower Bowen Volcanics.

Environment of Deposition

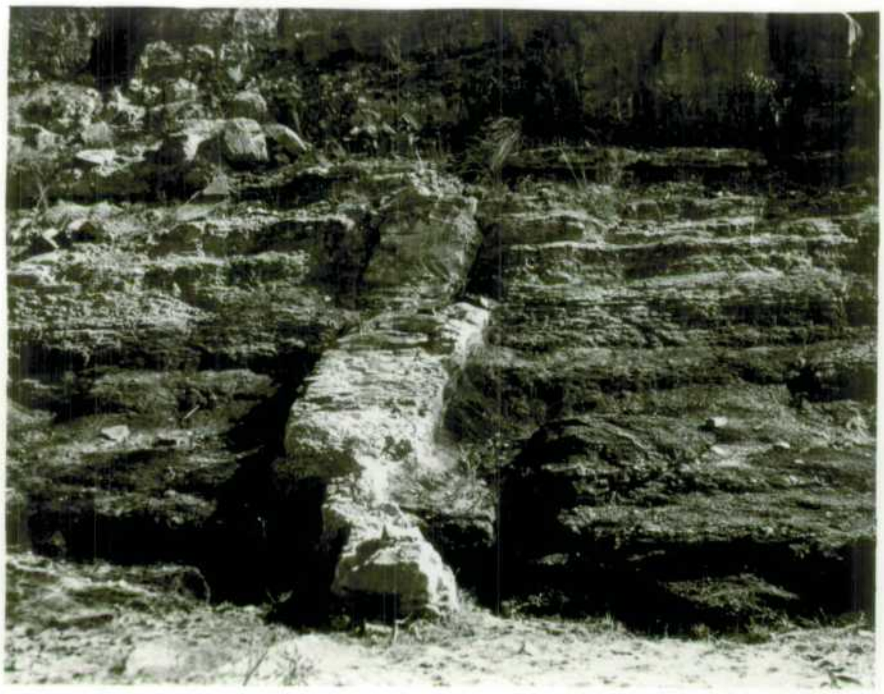
Unit A, the basal unit of the Middle Bowen Beds, was deposited in marine, moderately deepwater conditions, that is, the sediments show no shallow water structures. The area of deposition expanded and shallowed somewhat to receive the sediments of unit B. Some of these, such as the Wall Sandstone Member, are cross bedded. Deltaic or swamp conditions existed around the margins of the basin at this time permitting accumulation of the Collinsville Coal Measures. The area of deposition of unit C was apparently greater than that of unit B. This may have been produced by regional downwarping, rather than by combined expansion and shallowing, as the Unit C sediments in the Bowen area were probably deposited in moderately deep water conditions, similar to those of unit A.

Thickness

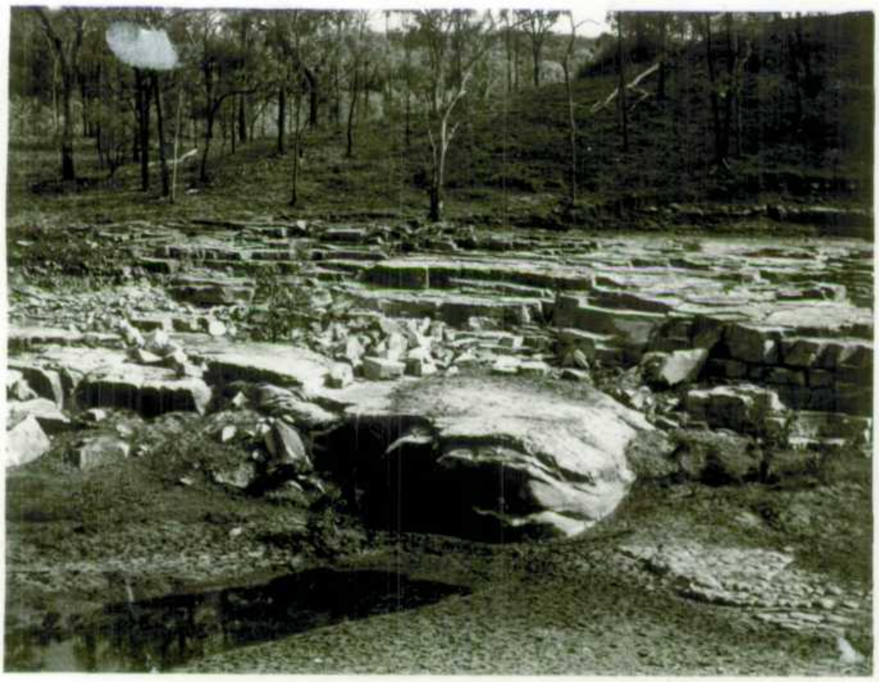
The thickness of the Middle Bowen Beds and its various units are shown on text figure 2. The maximum thickness of the unit is about 6500 feet in the Exmoor Homestead area.

Age

The palaeontology of the Middle Bowen Beds are described in appendix A by J.M. Dickins. The three faunas II, III and IV are closely related to those in the Maitland Group (Upper Marine) of New South Wales although fauna II has some relationships with the fauna in the Dalwood Group (Lower Marine). These faunas are mainly Lower Permian in age, though fauna IV may range up into the lowermost Upper Permian.



Middle Bowen Beds. Unit B1 exposed in Parrot Creek. Photo shows dyke intruding interbedded coal seams, carbonaceous shale and siltstone. (Neg. No. M186)



Middle Bowen Beds. Unit B1. Medium bedded, clean quartz sandstone, locally bulged by sill. This sandstone underlies sequence in photograph above. (Neg. No. M186).

UPPER BOWEN COAL MEASURES

Summary

The Upper Bowen Coal Measures consist of about 10,000 feet of plant bearing sediments, conformably overlying the Middle Bowen Beds and overlain by the Carborough Sandstone. The unit occupies most of the centre of the Bowen Basin but produces very little outcrop.

Rock types in the unit include lithic sandstone, calcareous lithic sandstone, siltstone, carbonaceous shale, coal seams, quartz sandstone, and conglomerate. Lithic sandstone is the dominant rock type in outcrop. It generally occurs as very large, festoon bedded lenses interspersed in thin bedded siltstone and fine arenite. Carbonaceous shale and coal are widespread but constitute only a small proportion of the unit. Conglomerate to poorly sorted conglomeratic sandstone crop out in a few places.

The overall structure of the Upper Bowen Coal Measures is that of the Bowen Basin syncline, modified by monoclinal warping in some places. It is folded into a number of steep flanked structures about the Rosella Creek anticline.

The unit is Upper Permian in age but may range into the Lower Triassic.

Distribution and Topography

The Upper Bowen Coal Measures occupy a triangular area of very poor outcrop, bounded to the west, north and east by the Middle Bowen Beds and extending south into the Mount Coolon area. The topography of this area consists of alluvial and soil covered plains with some low rises. Most of the drainage has cut through this alluvial and soil cover to expose the underlying coal measures. In many places, bedding trends are visible on the air photos, through soil cover.

The only prominent topography on this unit is found east of the Redcliffe Tableland at the southern edge of the sheet-area. There, the metamorphic aureole about an intrusive has produced a line of high, rugged hills.

Lithology

The Upper Bowen Coal Measures are better exposed and were mapped in greater detail in the Mount Coolon area during the 1960 field season. The following brief description of the lithology is based on that season's work. Very few differences in lithology were noted in the Upper Bowen Coal Measures in the Bowen Area. The most important is the presence of quartz sandstone which is not known in the Mount Coolon area.

The unit consists of lithic sandstone, calcareous lithic sandstone, siltstone, conglomerate, quartz sandstone, carbonaceous shale and coal seams.

The lithic sandstone is a semi-friable, khaki to green rock consisting of well sorted, subangular grains of quartz, volcanic rock fragments, feldspar and mica and very little matrix. It commonly contains wood and bark. These rocks occur in thick lenses, showing cross bedding and festoon bedding. They are medium to coarse grained and are pebbly in places. Fine lithic sandstone occurs, commonly interbedded with siltstone.

The calcareous lithic sandstone is a hard, medium to thick bedded rock consisting of angular grains of quartz and volcanic quartz and rock fragments set in a fine grained cryptocrystalline calcite matrix forming up to 40% of the rock. This unit is very abundant in the Bowen South area. Weathered, rounded yellow boulders of this rock are found in the soil cover over very large areas of the Upper Bowen Coal Measures. In places, the calcite content of these rocks is so high that they are almost sandy limestones.

The siltstone is fine to coarse grained, thin to medium bedded or, in places, massive and very jointed, white, grey, blue, black, brown or yellow. It is calcareous in many places, and may be micaceous or gypsiferous.

Beds of fine to cobble conglomerate are an important constituent of the Upper Bowen Coal Measures in a few places. They consist of rounded fragments, mainly of volcanic rocks, set in a hard, brown matrix of quartz, mica and chlorite and some calcite cement.

Elsewhere, conglomerate and poorly sorted conglomeratic sandstone occur in very lenticular bodies. These may be torrentially cross bedded, and commonly contain abundant bark, wood fragments, and even entire tree trunks. These bodies of conglomeratic material may be river channel fillings. A typical example is exposed in the Bowen River crossing near the southern margin of the Bowen Sheet-area.

Quartz sandstone crops out at one locality in the Bowen River, associated with coal seams. It is a white to buff, medium grained, medium to thick bedded rock, containing some worm tubes, quite unlike any rock types seen elsewhere in the Upper Bowen Coal Measures. This lithology is similar to some quartz sandstone in the Collinsville Coal Measures.

Carbonaceous shale and thin coal seams are widespread in the unit. In a few places, the coal seams are quite thick but in every outcrop are intruded by sills.

Structure

Dips in the Upper Bowen Coal Measures are generally towards the centre of the basin at angles of 25° or less. Steeper dips, up to 60°, are noted at the southern end of the Rosella Creek anticline where the unit is folded into several steep flanked, south plunging anticlines and synclines. These structures die out quickly to the south.

The upper and lower boundaries of the Upper Bowen Coal Measures are not exposed in this area. However, the unit appears to be conformable on the Middle Bowen Beds and to be conformably overlain by the Carborough Sandstone.

Environment of Deposition

The presence of coal seams and abundant plant remains and the absence of marine fossils indicate that this unit was not deposited in a normal marine environment. However, the abundance of calcite in many of the sediments suggest that the sea had some access to the basin. The environment was possibly a parallic basin with restricted access, both temporally and spatially, to the open sea. Development of a high area is suggested as a mechanism for the conversion of the marine environment of the Middle Bowen Beds to this restricted basin. The high was located approximately in the present outcrop area of the Urannah Complex. It consisted of the Complex and overlying Lower Bowen Volcanics. The effects of the high were twofold: it restricted the access of the sea to the basin; and it supplied a provenance for the volcanic derived sediments which typify the Upper Bowen Coal Measures. These sediments could be produced by erosion of Lower Bowen Volcanics.

Further evidence of the restriction of the basin during Upper Bowen Coal Measures time is supplied by the sediments themselves. The sediments contain a high proportion of labiles, indicating little reworking. Most beds are moderately well sorted, but different size fractions were dumped in the same area. This implies that there was no regional gradient in the basin permitting the various fractions to be separated.

Thickness

A thickness of 10,500' was computed during the 1960 season in an area of moderately good outcrop, about 6 miles south of the Bowen area.

Age

No marine fossils are known in this unit. The abundant flora includes Glossopteris indica Sch., G. augustifolia Brong., G. conspicua Fm., G. spathulato-cordata Fm., Phyllotheca australis Brong., Nummulo-spermum bowenense Walk., and species of Sphenopteris, Cladophlebis, Samaropsis and Vertebraria. These plants are a Permian to Lower Triassic assemblage and are not suitable for more accurate age determinations. However, the marine fossils in the underlying Middle Bowen Beds indicate that the Upper Bowen Coal Measures are no older than lowermost Upper Permian. They are regarded as Upper Permian but may range into the Lower Triassic.

CARBOROUGH SANDSTONE

Summary

The Carborough Sandstone, of presumably Triassic age, conformably overlies the Upper Bowen Coal Measures. It consists of about 1500 feet of current bedded quartz sandstone with minor bands of quartz pebble conglomerate. It crops out on the Redcliffe Tableland, on Mount Leslie, and on a small hill between the two. The unit occupies the trough of a single syncline with some cross-folds.

Nomenclature

The name Carborough Sandstone was first used by Reid (1928b) to refer to the rocks of the Carborough Range. Later he applied a different name, the Redcliffe Series, to the same unit cropping out in the Redcliffe Tableland. The name Carborough Sandstone has priority.

Distribution and topography

The unit crops out in the Redcliffe Tableland, the northern end of which lies within the Bowen South area, on Mount Leslie, and on a small hill between the two. A small area of rubble and near outcrop north of Mount Leslie is included in the unit.

The formation typically produces tableland topography, rising 400 to 500 feet above the plains developed on the more readily eroded Upper Bowen Coal Measures. The slopes of the tablelands are steep and scree covered. In places, benches are developed on the slopes at the top of massive sandstone units or, in one case, on top of an intrusive sill.

Lithology

The dominant rock type is quartz sandstone containing little or no matrix. Apart from quartz grains, it may contain up to 15% of chert, quartzite and other rock fragments and minor feldspar and mica. The grains are subrounded, medium to coarse grained and well sorted. Larger grains are scattered through the rock or occur in bands. Many of the quartz grains show evidence of solution and movement of silica.

Structure

Dips in the Carborough Sandstone are shallow, generally less than 5°. In the Redcliffe Tableland, the formation is folded into a syncline plunging south at a low angle. The remnant on the small hill between Mount Leslie and the Redcliffe Tableland is flat lying. At Mount Leslie, the formation is folded into a very shallow syncline plunging [illegible]. Thus, an anticlinal crossfold axis is located between Mount Leslie and the Redcliffe Tableland. This may explain erosion of the formation from this area as it is commonly susceptible to erosion over anticlines.

The Carborough Sandstone appears to be conformable on the Upper Bowen Coal Measures. The contact was not exposed, but dips in both units are parallel near the contact.

The Carborough Sandstone is unconformably overlain by Tertiary Basalt. In the Mount Coolon area, it is conformably overlain by the Teviot Formation which contains a small Dicroidium flora of Triassic age.

Environment of Deposition

The marked lithological change from the Upper Bowen Coal Measures to the Carborough Sandstone indicates a change of environment. This change is reversed at the end of deposition of the Carborough Sandstone, as the overlying Teviot Formation is of similar lithology to that of the Upper Bowen Coal Measures.

The lithological change may be due to the basin becoming less restricted, and developing a regional south plunge. The Carborough Sandstone was deposited in a deltaic area, either marine or brackish, under conditions of intense reworking of the sediments. The abundance of cross-bedding, the good sorting and the maturity of the sediments are evidence of the intense reworking. Such reworking would have destroyed the labile constituents of the Upper Bowen Coal Measures. The regional south gradient of the basin is postulated to explain removal of the finer fraction from the area of deposition of the Carborough Sandstone.

Thus, the Carborough Sandstone may have been derived from approximately the same provenance areas as supplied the Upper Bowen Coal Measures. The differences in lithology may be due to more intense reworking and fractionation of the sediments.

These environmental changes are related to downwarping of parts of the Bowen Basin to produce an effective regional gradient within the basin. That massive downwarps affected the Bowen Basin at this time is shown some 300 miles to the south where the basin was downwarped to receive some 20,000 feet of Cabawin Formation.

The effects of the downwarping were only temporary, as the Teviot Formation indicates a return to the depositional environment of the Upper Bowen Coal Measures.

Thickness

The Carborough Sandstone is approximately 1500 feet thick in the Carborough Range, the type area of the formation.

Age

No fossils have been found in the Carborough Sandstone. The overlying Teviot Formation contains Triassic plants; the underlying coal measures contain a Permian-Triassic flora, and are at least Upper Permian in age. The Carborough Sandstone is considered to be Triassic though it may extend down into the Permian.

TERTIARY BASALT

Basalt of presumably Tertiary age crops out in parts of the Bowen South area. Plugs and remnants of flows form hills and mesas in the Bowen Basin; flow basalts underlie Tertiary acid volcanics in the Brawl Creek area; and two basalt plugs were mapped in the south-west of the Sheet-area.

Most of the basalt in the Bowen Basin are plugs intruding the Upper Bowen Coal Measures. These produce steep rounded hills of 100 to 150 feet relief. In some cases remnants of flow basalt sheets are preserved around them, producing mesas. The base level of erosion in the area is lower than the base of the basalt flows which have been almost completely removed. Most of the plugs consist of very fine grained basalt. The flow basalts are mainly olivine-bearing, and differ widely in texture. The most common is a holocrystalline, equigranular rock.

The flow basalts and plugs are part of a basalt province which extends south into the Mount Coolon area. There, larger areas of flow basalts are preserved. In that area, these basalts appear to be disconformably younger than the Suttor Formation.

The basalts cropping out in the Brawl Creek area are mainly flows; one possible plug was noted. They unconformably overlie a large Carboniferous intrusive to the west. The basalts dip east at 5° to 10°, dipping beneath Tertiary acid volcanics in the south; at the northern end of their outcrop area, they are faulted against plant bearing Lower Bowen Volcanics.

The basalt is dark grey, fine grained, and commonly porphyritic. It consists of euhedral phenocrysts of augite and labradorite in a matrix of plagioclase needles, granular pyroxene and iron oxide. The phenocrysts and the plagioclase needles are flow aligned. The basalt may contain some secondary iron minerals but on the whole is very little altered.

The basalt is assumed to be Tertiary, largely because of its freshness.

Two small plugs of basalt were mapped west of Pyramid Homestead. These are regarded as Tertiary because the magnetic effects associated with them are similar to those of known Tertiary basalts. (pers. comm. P.M. Stott).

SUTTOR FORMATION

Remnants of lateritized sub-horizontal sediments crop out in the south and west of the mapped area. These are correlated with the Tertiary Suttor Formation, defined in the report on the 1960 field season. (Malone et alia 1961). The type area is in the Leichhardt Range, east of the Suttor River, in the Mount Coolon 1:250,000 Sheet area.

The Suttor Formation forms mesas some 200 feet above the general level of erosion where it overlies the sediments of the Bowen Basin. Further west, it forms mesas or plateaux, the plateaux being lower than the highest peaks of the underlying rocks.

Lithology

Friable, cross-bedded, coarse grained feldspathic quartz sandstone, containing lenses of pebble to cobble conglomerate, is the dominant lithology in the formation in the Parrot Creek area. This is overlain by argillaceous siltstone containing angular clear quartz grains, and argillaceous sandstone. The pallid or mottled zone of a laterite profile usually forms the upper part of most outcrops.

Further west, the formation is still essentially a sandstone, conglomerate, siltstone sequence but is much more argillaceous. A hard white siliceous rock is prominent in the formation at Rutherford's Table. It is a quartz siltstone with a siliceous, clayey matrix containing angular, clear quartz grains. It usually crops out at the top of the formation or is overlain by the ferruginous zone of a lateritic profile. This rock was produced by partial silicification of argillaceous quartz siltstone in the pallid zone of a laterite profile. The angular clear quartz grains were possibly derived from the Bulgonunna Volcanics, which probably produced the clay minerals also.

At Rutherfords Table, the formation is much thicker than usual. The base of the sequence consists of auriferous river channel deposits, varying from fine sand to polymictic cobble conglomerate, usually somewhat argillaceous. Beds of heavy mineral sands are included in the sequence.

A bed of oil shale, about 19 feet thick is contained in the Suttor Formation at Rutherfords Table, above the auriferous wash. (Levingston, 1956b). The oil shale is of too low a grade (12 gals./ton) to be economic. Its occurrence, coupled with that of pyrite in the sediments, suggests deposition in reducing conditions, possibly a swamp.

Structure and Relationship

The Suttor Formation is effectively flat lying. Some low dips were noted in the formation but these are most probably depositional. Laterite profiles capping Suttor Formation mesas are generally horizontal. However, in the area north of Rutherford's Table, the laterite profiles dip at about 5° away from highs of Ukalunda Beds. The slopes are possibly original features of the laterite profile, developed parallel to the gradient of the water table at the time of lateritisation.

The formation unconformably overlies the Devonian to Triassic rocks of the area. In the Mount Coolon area, the Suttor Formation appeared to be disconformably younger than the Tertiary Basalt.

Environment of Deposition

The Suttor Formation was deposited in an extensive lake system occupying the low-lying parts of an uneven basement of Devonian to Triassic rocks. The oil shale and pyritic sediments at Rutherfords Table suggest the existence of a reducing environment at least part of the time. The abundance of clay in the siltstone and sandstone, west of the Bowen Basin indicate little sorting of the sediments. On the other hand the quartz sandstone in the Parrot Creek area is current bedded and reworked, and contains conglomerate lenses.

Thickness

The thickness of the Suttor Formation varies widely form place to place, depending on the topography of the underlying basement. An average thickness for the entire formation would be about 200 feet. At Rutherford's Table, the unit is about 350' thick; this increased thickness is due to deposition in a basement low, apparently an old river valley.

Age

The Tertiary age of the Suttor Formation is based on one dicotyledonous plant found in the Suttor Formation during 1960.

TERTIARY VOLCANICS

Rocks mapped as Tertiary Volcanics crop out at a number of localities in the mapped area. In no case is the Tertiary age of the volcanics proven. The largest block is in the Brawl Creek area and consists of acid to basic flows and agglomerates. Other Tertiary volcanic localities are: near Flagstone Creek, east of Mount Poole; at the northern-edge of the mapped area, between the Bowen and Burdekin Rivers; at the Pyramid and south-west of there; and in the Mount McConnell area.

Brawl Creek Area

The volcanics crop out in a narrow, elongate block, about 16 miles long by less than 4 miles wide. The boundaries of this block are mainly high, steep, rectilinear scarps, probably fault controlled. The top of the block is a dissected plateau of rather uniform elevation.

Lithology

The rock types in the Brawl Creek block include basalt, dolerite, trachyte, rhyolite, dacite, obsidian and volcanic glass, and rhyolitic and basaltic agglomerate.

The basalt is generally a dark coloured porphyritic rock with flow aligned feldspar phenocrysts and needles. The degree of weathering ranges from intense to almost absent.

The dolerite occurs as near vertical dykes, usually up to 10 feet wide, intersecting the volcanics. The one specimen sectioned was rather weathered.

Very thick beds, from 15 to 20 feet thick, of basaltic agglomerate are included in the sequence. The agglomerate is very little sorted. It consists of angular to rounded fragments of basalt, ranging from pebbles to boulders 2 feet in diameter, in a purplish brown, weathered matrix.

The volcanics include some deeply weathered, pinkish-white, porphyritic volcanics, containing flow aligned pink feldspar phenocrysts. These were called trachytes on the basis of hand specimen examination. No thin sections were made.

The most prominent rock types in this area are acid flows, varying in composition from rhyolite to dacite. They are generally light coloured, porphyritic rocks showing flow banding, commonly contorted. In some places, they are massive. These flow rocks form a thick layer at the top of the Brawl Creek block, and form the sheer cliffs on the western margin of the block. The layer as a whole dips to the east at about 10°; the lavas within it mainly display contorted flow banding.

These acid rocks are generally very weathered. Some samples were collected for age determinations but were too weathered to be of any use.

Acid agglomerate is a major rock type in the unit. It consists of angular to rounded boulders varying widely in size and shape. The agglomerate forms massive beds up to 60 feet thick and contains boulders up to 12 feet in diameter. The boulders are mainly flow-banded and contorted flow banded rhyolite and dacite. The agglomerate contains some very angular fragments of acid volcanic breccia.

The Tertiary volcanics include some black obsidian and red, blue, green and brown volcanic glass. The glass ranges from massive and vitreous to partially devitrified, the latter appearing colloidal in hand specimen. In thin section, the vitreous specimens show turbulent flow texture and perlitic cracking; some contain inclusions of basalt.

<u>Structure</u>

The Tertiary volcanics of the Brawl Creek area overlie basalts of presumably Tertiary age cropping out to the west. In the south, the volcanics are faulted against or unconformably overlie the Bulgonunna Volcanics. The smooth curves bounding the block to the east suggest that the eastern margin is faulted.

<u>Tertiary Volcanics</u>

Near Brawl Creek. Western scarp of thick layer of dacite and rhyolite. Layer dips east at shallow angles. Gentle slope below scarp is developed on agglomerate. (Neg. No. M186).

<u>Tertiary Volcanics</u>

Near Brawl Creek. Showing contorted flow banding in dacite, part of thick layer shown in top photograph. (Neg. No. M186).

<u>Tertiary Volcanics</u>

Brawl Creek gorge. Rhyolitic agglomerate containing mainly flow banded acid volcanics. Wide range in shape and size of boulders. Hammer indicates very large boulder. (Neg. No. M186).

East dipping Lower Bowen Volcanics crop out to the east of the Brawl Creek Block. The attitude of the Lower Bowen Volcanics suggest that they overlie the Tertiary Volcanics and Tertiary basalt in the Brawl Creek area. For this reason, the volcanics shown as Tertiary on the map were first mapped as part of the Bulgonunna Volcanics. The presence of undevitrified volcanic glass and the extreme freshness of some the volcanics suggested a younger age than Carboniferous. They were placed in the Tertiary because of a general similarity to rocks in adjacent areas ascribed to a Tertiary period of extrusive and minor intrusive activity. Accepting a Tertiary age for the Brawl Creek volcanics implied acceptance of a faulted boundary between them and the Lower Bowen Volcanics to the east. It has been suggested that the Tertiary volcanics at Brawl Creek were deposited in a river valley. However, the volcanics extend below the present day base level of erosion and certainly below any Tertiary base level. Thus, the Tertiary volcanics are considered to be down faulted against the Lower Bowen Volcanics.

Thickness

The thickness of the Tertiary Volcanics in Brawl Creek is more than 600 feet.

Flagstone Creek Area

Tertiary volcanics were mapped north and south of Flagstone Creek, about 1 mile east of its junction with the Bowen River. These volcanics are very similar to some of those in the Brawl Creek area. They consist of flow layered rhyolite, dacite and trachyte with minor acid agglomerate. No basic volcanics were seen in the Flagstone Creek area.

They unconformably overlie the Lower Bowen Volcanics to the south-west and the Urannah Complex to the north-east. The Complex is commonly faulted against the Lower Bowen Volcanics, some of which faulting took place in the Tertiary. The occurrence of Tertiary volcanics at the boundary between the two may be related to this faulting.

Northern Area

Volcanics cropping out in a small area at the northern margin of the mapped area, between the Bowen and Burdekin Rivers, are referred to the Tertiary. They consist of pink, flow banded volcanics with phenocrysts of feldspar and mica, associated with dykes of similar composition. The dykes intrude the flows and also the Bulgonunna Volcanics. These rocks crop out in a long, north trending ridge, mainly north of the area mapped. They are mapped as Tertiary because they appear to be somewhat younger than the Bulgonunna Volcanics and are similar to other acid volcanics mapped as Tertiary.

Pyramid Area

Several small plugs and dyke-like masses and associated volcanics crop out at the Pyramid and south-west of there.

At the Pyramid, they consist of quartz feldspar porphyry with some phenocrysts of ferromagnesian minerals. These appear to be dykes radiating from the Pyramid. The Pyramid itself consists of coarse acid agglomerate and acid flow rocks. Its conical shape and the relationship of the dykes suggest that it may be a volcanic centre.

Two elongate areas of acid volcanics crop out near the Mount McConnell Road, about 10 miles south-west of the Pyramid. These are coarsely porphyritic rhyolite porphyries. They are thought to be dykes intruding the Ukalunda Beds.

Greenish, weathered, tuffs, agglomerates and flows of possibly trachytic composition crop out as a high, round hill, about 2 miles south-west of the Pyramid. These rocks overlie Ukalunda Beds, probably unconformably. They are lithologically distinct from other volcanics mapped as Tertiary in the area. The shape of their outcrop suggests they are draped about a volcanic centre.

Rocks cropping out at two other places in this area are referred to the Tertiary because their photo-pattern is similar to that of the rocks described above.

The age of these volcanics and intrusives is not definitely established. Many of them are similar in lithology to rock types in the Bulgonunna Volcanics, and, in fact, they were originally included in that unit. They are mapped as Tertiary for various reasons, none of which is conclusive. The Tertiary volcanics including some rocks which may be flows, were mapped in a few places below the base level of deposition of the Bulgonunna Volcanics. This would indicate that they were younger than the Bulgonunna Volcanics, if they did include extrusives.

The trachytic rocks, described last above, are unlike the lithologies of the Bulgonunna Volcanics. They are like Tertiary volcanics in other parts of Queensland.

The two basalt plugs in the area are almost certainly Tertiary. They indicate that Tertiary intrusion did take place in the area.

Assigning these rocks to the Tertiary is simply a best guess, under the circumstances. Part or all of them may belong to the Carboniferous Bulgonunna Volcanics. These two ages seem to be the only possibilities.

Mount McConnell Area

Mount McConnell is a plug intruding the Drummond Group. The plug consists of a blue-white, porphyritic volcanic consisting of cryptocrystalline quartz and mica. The phenocrysts could not be identified as they were torn out in the making of the thin section. The hill is high, round and steep-sided, and is similar to Tertiary plugs in other areas.

About 4½ miles north-east of Mount McConnell is a breached, crater-shaped hill. The walls of the crater consist of hard, medium grained intermediate volcanics. The low, central area of the feature consists of volcanic breccia and some flow rocks. These volcanics intrude the Drummond Group.

These two areas of volcanics are mapped as Tertiary, but they could as easily be Carboniferous.

CAINOZOIC UNDIFFERENTIATED

Two small areas of undifferentiated Cainozoic sediments are shown on the map. The larger is about the Sellheim River, south of Rutherfords Table. It consists of mainly river alluvial deposits of sufficient thickness to completely mask the underlying rocks. In several other parts of the Bowen South area, particularly the [illegible]n Basin it[illegible]lf, there are extensive, superficial Cainozoic soil and alluvial deposits. These are not shown on the geological map because the drainage has cut through them to reveal the underlying rocks. Their extent is shown on the physiographic sketch map.

The second area of undifferentiated Cainozoic is located near the Sellheim River, due east of Rutherfords Table. This is a thin remnant of ferruginous, poorly consolidated wash, containing pebbles and cobbles to about 2 inches across. It has been worked for gold in the past but the results are not known. The wash is apparently an alluvial gravel and may be equivalent to the auriferous alluvial gravel at the base of the Suttor Formation at Rutherfords Table.

IGNEOUS INTRUSIVES

The intrusive rocks of the Bowen South area are divided into four groups: Devonian-Carboniferous intrusives, Carboniferous intrusives, the Urannah Complex, and the Mesozoic intrusives. The first two groups crop out west of the Bowen Basin. The Devonian-Carboniferous intrusives include all those which are unconformably older than the Bulgonunna Volcanics. The Carboniferous intrusives include those which intrude the Bulgonunna Volcanics. The Urannah Complex forms the eastern margin of the Bowen Basin. It is partly contemporaneous with and partly younger than the Lower Bowen Volcanics. The Mesozoic intrusives crop out in the Bowen Basin. They were intruded during or after the main folding orogeny, probably during the Triassic. Some of these intrusives intrude the presumably Triassic Carborough Sandstone. Thirteen samples of acid igneous intrusives were collected in the Bowen South area for age determination work. No results are available as yet. It is proposed to collect a complete suite of samples for age determination work when the regional mapping of the Bowen Basin is completed.

DEVONIAN-CARBONIFEROUS INTRUSIVES

Distribution and Topography

Four intrusives are included in this group. They crop out in a line trending roughly north-east from the south-west corner of the Sheet area. The two larger masses occupy extremely irregular areas and are probably connected at depth. The intrusive in the Hidden Valley Homestead area is irregular in outcrop due partly to faulted boundaries and to large roof pendants and embayments. The fourth mass, on the Sellheim River, is relatively small and has a fairly regular boundary.

These masses produce a subdued topography of plains and low rises covered by a coarse, sandy "granite" soil, with scattered to numerous tors protruding from soil cover on some low rises. Tors and outcrop are abundant in the narrow band around the margin of the intrusions.

Lithology

The south-western masses are adamellite. They consist of alkali-feldspar, plagioclase and quartz, in approximately equal proportions, with calcite, biotite, iron oxide, chlorite, epidote and opalite as minor constituents. The texture is allotriomorphic to hypidiomorphic granular. Only a few specimens were examined and there may be some variation throughout these masses.

The intrusives cropping out around Hidden Valley Homestead and about the Sellheim River are similar in texture and mineralogy. They are allotriomorphic granular to granophyric in texture, containing patches of micro-pegmatitic intergrowths of quartz and alkali feldspar. They consist of quartz, alkali feldspar, plagioclase, uralite, chlorite, biotite, iron oxide and epidote. Plagioclase occurs as phenocrysts throughout. The phenocrysts are up to 3 mm across and are zoned from andesine to oligoclase.

The alkali feldspar in the micro-pegmatite patches includes both potash feldspar and albite. In some specimens, the granophyric groundmass is fine-grained and the ferromagnesian content is low. Uralite, bright green chlorite and coffee-brown biotite are the main ferromagnesians in one specimen. These rocks are late hydrothermal differentiates. Consequently the feldspars are turbid and flecked with sericite and most of the ferromagnesians are hydrous types such as uralite and chlorite. Opaque iron oxide, some of which is pyritic, prehnite and epidote occur in some specimens.

One specimen from the Hidden Valley intrusive was described as a quartz feldspar porphyry. It contains corroded, euhedral quartz phenocrysts, to 7 mm. diameter, zoned plagioclase phenocrysts to 5 mm. diameter, and alkali feldspar (including perthite) phenocrysts to 3 mm. diameter. Other minerals present include original ferromagnesians replaced by uralite and chlorite, iron oxide and epidote. The groundmass contains numerous roughly circular patches of incipient quartz crystal development. These have a crudely granophyric texture.

Another specimen from near the margin of the Sellheim River mass is dioritic in composition. It is a hypidiomorphic granular rock consisting of plagioclase, uralite, biotite, chlorite, quartz and iron ore and minor epidote and apatite.

Relationships

The two adamellite bodies are intrusive into the Ukalunda Beds of Middle Devonian age. Both are unconformably overlain by the Carboniferous Bulgonunna Volcanics and the most westerly of the two appears to be unconformably overlain by the Drummond Group. These two masses may be Devonian in age.

The other two intrusives are grouped because of textural and mineralogical similarity. The Hidden Valley mass is intrusive into the Ukalunda Beds and is unconformably overlain by the Bulgonunna Volcanics. The relationships of the Sellheim River mass are not known. It probably intrudes the Mount Wyatt Beds and is probably unconformably older than the Bulgonunna Volcanics.

CARBONIFEROUS INTRUSIVES

Ten intrusives are included in this group; eight were seen in the field and the other two, cropping out in the north-west of the area, are based on photo-interpretation. All are thought to intrude the Bulgonunna Volcanics.

Distribution and Topography

Most of these intrusives are located on a north-north-west trend near the western margin of the Bowen Basin. Two others, probably connected at depth, crop out near Glendon Homestead. The two intrusives in the north-west are part of more extensive bodies cropping out beyond the limits of the Bowen South area. The tenth is a small body cropping out near Bobby Dazzler Creek.

Most of these intrusives crop out in broad valleys surrounded by high country of the Bulgonunna Volcanics. Within these valleys, the topography is mainly soil covered plains and low rises, with some tors protruding from the soil cover. In places, the intrusives produce high rocky hills, some of them conical, with some outcrop and many tors. Some of the intrusive masses just north of the mapped area produce high, deeply dissected, rugged country similar to that developed in the Urannah Complex.

Lithology

The small outcrop near Bobby Dazzler Creek is a granodiorite with a hypidiomorphic granular texture, consisting of plagioclase, quartz, alkali feldspar, biotite, hornblende and iron oxide. It is cut by veins of granophyric differentiates, containing micropegmatitic intergrowths of quartz and alkali feldspar. This intrusive is somewhat similar to two of the Devonian-Carboniferous intrusives, the Sellheim River and the Hidden Valley masses; the three may be related. This small intrusive body is surrounded by Bulgonunna Volcanics and was thought to be intrusive into them. However, it may be older than the Bulgonunna Volcanics.

The largest of the Carboniferous intrusives occupies a roughly rectangular area, about 16 miles long by about 8 miles wide, drained by Brawl Creek and its tributaries. This mass is allotriomorphic to hypidiomorphic granular in texture. In composition it ranges from granodiorite to adamellite, with the latter possibly more common. The adamellite consists of quartz, turbid plagioclase probably in the albite-oligoclase range, alkali feldspar, mainly perthite, sericite and iron ore. The Brawl Creek mass commonly shows some deformation, such as brecciated patches containing angular and fragmental, granulated quartz grains. Large perthite grains are associated with these brecciated patches.

Two specimens of granodiorite were examined. Both were composite rocks, one containing a basic xenolith and the other cut by a leucocratic vein. The specimen containing the basic xenolith consists of quartz, plagioclase, alkali feldspar, biotite, hornblende, ilmenite and prehnite. Biotite 4% and hornblende 6% of the whole, are more abundant than in other specimens from this area because of contamination from the xenolith, originally a dolerite or coarse basalt. The plagioclase is in the andesine-oligoclase range. It is strongly zoned, and partly turbid, particularly specific zones. The alkali feldspar is mainly perthite, containing inclusions of biotite and plagioclase.

The second specimen is essentially similar in composition. It shows the effect of some hydrothermal alteration; in particular, the plagioclase is turbid and sericitized, making determination impossible. The alkali feldspar is perthite which is abundant in the leucocratic vein. The latter is a low temperature, granitic vein consisting of large anhedral perthite grains, less common sodic plagioclase grains, and small granulated quartz grains set in a turbid matrix.

A third specimen of granodiorite belongs to the Brawl Creek intrusive. It was collected close to the contact with Bulgonunna Volcanics and shows some signs of hydrothermal alteration and deformation. The rock is cut by hydrothermal veins filled with uralite, turbid material and in some cases opaque iron oxide. Brecciated zones are common. Its composition is generally similar to the above.

Fine-grained, hypidiomorphic granular, late sodic veins intrude the Bulgonunna Volcanics a little distance north of the Brawl Creek mass. These are aplitic in composition, though lacking an aplitic texture. They consist of fresh, uncracked quartz grains, turbid plagioclase in the albite-oligoclase range, bright green chlorite and some iron oxide and sphene. The plagioclase grains are patchy due to partial replacement of calcic plagioclase by sodic feldspar.

Another Carboniferous intrusive crops out at the northern margin of the Bowen South area, north-west of the Brawl Creek mass. This has an allotriomorphic granular texture. It approaches granodiorite in composition, though its ferromagnesian content is rather low. The main constituents are quartz, plagioclase and alkali feldspar. The plagioclase is zoned, and has sodic rims to some grains. It shows turbid alteration in part. The alkali feldspar is microcline and some perthite, and shows less turbid alteration than the plagioclase. Biotite is the main ferromagnesian mineral in the rock which also contains a few small grains of amphibole.

The other Carboniferous intrusives have not been examined petrologically. They are mainly acid rocks, showing a considerable range in texture and grainsize.

Relationships

The Carboniferous intrusives intrude the Bulgonunna Volcanics. Two of the intrusives are unconformably overlain by Lower Permian rocks of the Bowen Basin succession. This indicates a post-Bulgonunna Volcanic, pre-Lower Permian intrusive epoch. There is no direct evidence showing that all these intrusives are the same age. However, they are generally similar in lithology, have a common lower age limit and probably belong to the same intrusive epoch.

URANNAH COMPLEX

Summary

The Urannah Complex is a granite-granodiorite-diorite mass, abundantly veined by acid and intermediate dykes and including some basic and ultrabasic components. At least twenty-eight rock types are present in the unit, belonging to several different ages of emplacement.

The complex occupies the rugged eastern quarter of the area mapped and extends into the Proserpine, Mackay and Mount Coolon Sheet areas.

The topography is rough, making large areas of the unit inaccessible. Streams are generally quite youthful.

The complex is faulted against or intrudes the Lower Bowen Volcanics. Some elements in the complex may be older than the Lower Bowen Volcanics.

Nomenclature

Urannah Complex is a new name proposed in this report. The name is derived from Urannah Homestead, located at Lat. 20°57'S, Long. 148°21'E, near the junction of Urannah Creek and the Broken River. The complex is very well exposed in the Broken River and its tributaries in the vicinity of Urannah Homestead. The complex was referred to informally as the Eungella-Broken River Igneous Complex in the unpublished 1960 season report. The name Broken River is not available and the Eungella area is not well exposed nor typical.

Distribution and Topography

The Urannah Complex crops out in the east of the mapped area. Its western limit is located about three miles east of Collinsville and extends roughly south-east to the southern edge of the sheet area. The eastern margin of the complex lies just within the north-east corner of the mapped area.

The topography varies from place to place. It is generally rugged but includes some dissected to mature, high plateaus. Streams are generally wide, swift flowing and shallow and occupy the full width of their steep-sided valley bottoms; locally, the streams approach maturity. Large, flat, waterworn surfaces are common in the Broken River and its larger tributaries.

Basic masses within the complex weather more rapidly, producing low, undulating surfaces of low relief. These areas are mainly soil covered with little or no outcrop.

River flats and soil covered plains have developed in a few places within the complex. One such is along Dart Creek, near the Dart Yard, and extending east for ½ mile. Other small river flats exist along the Broken River and Urannah Creek. These flats represent local base levels of erosion; their development does not seem to be related to the underlying geology.

Access is poor within the complex. One track runs from Emu Plains Homestead, along the Broken River to Urannah Homestead, then south to Eungella Homestead. A side track from this follows Dart Creek to a stock yard about three miles south of Normanby. There are two other usable tracks into the complex: one runs east from Collinsville along Coral Creek; the second follows the north bank of the Don River (north of the area mapped), ending at Normanby. All these tracks are suitable for 4-wheel-drive vehicles only.

Outcrops are abundant but are often so deeply weathered and so incomplete as to conceal the relationships of the many rock types. These relationships are best displayed in the large, fresh water worn surfaces found in the Broken River and its larger tributaries, particularly Urannah Creek below its junction with Ernest Creek. Several of these water worn surfaces were mapped and sampled in detail to unravel the complicated history of the complex.

Lithology

Twenty-eight different rock types were recognised in the Urannah Complex. These are listed below.

1. Basalt
2. Dolerite
3. Porphyritic leucocratic dolerite
4. Gabbro
5. Hornblendite

6. Hornblende diorite
7. Diorite
8. Leucocratic diorite
9. Foliated diorite
10. Tonalite
11. Micro-diorite
12. Andesite
13. Porphyritic andesite
14. Granophyric micro-adamellite
15. Granite
16. Leucocratic granite
17. Pegmatite.
18. Aplite
19. Granodiorite
20. Gneiss
21. Leucocratic granodiorite
22. Foliated granodiorite
23. Amphibolite
24. Quartz-feldspar-porphyry
25. Feldspar porphyry
26. Rhyolite porphyry
27. Dacite
28. Porphyritic dacite.

The rocks described as porphyry range from porphyritic micro-granite to porphyritic micro-granodiorite. The degree of alteration of these specimens makes recognition difficult, hence the less accurate name porphyry is used. These rock types are divided into nine broad groups for ease of description and are described below.

1. Basalt and Dolerite. This group includes basalt and dolerite dykes intruding the complex. They appear to be of at least two different ages. They are all partially altered to secondary material such as calcite, epidote, chlorite and hydrated iron oxides; some are very deeply epidotized. Slight metamorphism of the older dolerite dykes has dehydrated some of the secondary hydrated iron minerals. Some of these rocks are notably leucocratic. Their texture may be intergranular or flow-aligned; many are porphyritic. The dykes range in width from about one inch to 20 feet; bifurcations are common.

2. Gabbro and Hornblendite. These rocks intrude the complex. They crop out in subrounded topographic lows which may be up to one square mile in area. The gabbro is hornblende-rich and grades through hornblende gabbro to hornblendite. The hornblendite contains large poikioblasts of green-brown hornblende enclosing anhedral crystals of labradorite (An_{60}). No inclusions were seen in these poorly exposed gabbro and hornblendite intrusions.

3. Diorite and Tonalite. Diorite is the most abundant rock type in the complex. It may be massive or foliated, almost gneissic and ranges widely in grain size from fine to very coarse. In some patches it contains hornblende crystals up to two inches across. In some areas xenoliths are very abundant; in others, they are apparently absent. The mineral assemblage is normal: plagioclase (An_{50-60}, average An_{52}), hornblende, minor quartz and accessory iron oxide. Epidotization is common in some areas, and has developed prominently on joints striking 100 degrees. This diorite is not uniform in composition and includes tonalite, the latter apparently being more gneissic. The colour ranges from leucocratic to melanocratic.

In places, the massive diorite includes xenoliths of melanocratic diorite. In other places, dykes of porphyritic leucocratic diorite intrude the massive diorite. This suggests several ages of intrusion of diorite.

There are a large number of different joint directions; the most persistent joints trend 335 degrees.

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4. Andesite, Porphyritic Andesite and Micro-Diorite

Micro-diorite, grading into andesite, are the most abundant dyke rocks in the Complex and intrude all the main rock types. Identical dykes invade conglomerates of the Lower Bowen Volcanics in Coral Creek, west of the Complex. In outcrop they are dark to light green. In thin section this colour is seen to be due to the degree of epidotization and chloritization that has taken place. The dyk ..ve the same range of thickness as the basaltic dykes. In texture, they range from fine grained to medium grained, strongly porphyritic rocks. Chilled margins against the diorites and granites are usual.

All these dykes are quite deeply weathered making accurate mineral determinations impossible. Epidotization is developed in patches in the dykes; sericitization and saussuritization are very common throughout. All the mafic minerals are more or less chloritized. Pyrite is a notable accessory mineral in the dykes throughout the whole area.

There are at least two ages for these dykes and a number of directions of emplacement. The most common and most persistent direction of emplacement is 335 degrees. This direction is seen throughout the complex and has in part caused the very obvious photo lineation. Other directions of emplacement appear to be random.

A xenolith of andesite was noted in a granodiorite mass. This andesite is not thought to be comparable genetically with the dykes.

Micro-diorite was noted as separate subrounded masses, 100 to 300 yards in diameter, within the Complex. The larger micro-diorite masses are not as common as the gabbro-hornblendite masses. Two groups are noted in the porphyritic micro-diorite of the Complex: the first contains brown hornblende and a characteristically distributed iron ore; the second contains green hornblende.

One specimen from a sub-round mass was found to be a very dark coloured, hornblende-rich micro-diorite. It is similar in colour to the hornblendite. It differs in containing primary quartz and in the mode of development of the hornblende crystals.

5. <u>Granite, Pegmatite and Aplite</u>. As with the other rocks already described, the granite includes a wide variety of rock types. These include porphyritic, graphic and leucocratic granite. The granite ranges in texture from massive to foliated. Some specimens were identified as porphyritic, granophyric micro-adamellite.

Pegmatite and aplite, containing the normal mineral assemblages, occur as fairly narrow, often wispy, dykes, up t ... feet wide. They are not abundant in the Complex. Granite also occurs as dykes within the diorite.

Granite is not an abundant rock type in the complex, and is subordinate to diorite and granodiorite.

6. <u>Granodiorite.</u> These rocks range from massive to foliated and appear to grade into gneiss in places. The granodiorite and diorite groups are the major rock types of the complex with the granodiorite being the less abundant of the two in the area examined. The granodiorite contains many xenoliths of melanocratic hornblende granodiorite, as well as of diorite and amphibolite. It is intruded by pegmatite and granitic dykes.

There is a very noticeable trend in the granodiorite to become progressively more foliated from the south-west and south towards the north-east, and finally to become gneissic around Normanby. This trend is accompanied by a progressive increase in the number of quartz veins and blows. Many costeans and small mine workings are associated with the quartz veins. The direction of foliation is generally close to 240 degrees. Locally, the strike of the foliation may be different.

7. <u>Amphibolite</u>. These rocks generally occur as xenoliths or roof pendants in diorite and granodiorite. The amphibolite consists of a medium grained, equigranular mass of green hornblende, plagioclase and quartz approximately in the proportions 3 to 4 to 3, together with accessory iron oxide. The xenoliths range from an inch or two to 20 yards in length. They are generally very elongate and narrow. They are abundant in some areas and absent in others.

8. Porphyries. Porphyries occur as non-foliated dykes intersecting granite, diorite and granodiorite. They are intersected by the younger andesitic and basaltic dykes.

The porphyries may be feldspar porphyries with a groundmass of dacitic material, or quartz-feldspar porphyries with a micro-granitic to dacitic groundmass. Phenocrysts are up to 1 cm. in diameter.

These dykes are deeply weathered. This has largely altered the feldspar phenocrysts to saussurite or sericite, depending on their original composition.

These dykes differ from the andesitic and basaltic dykes in that they neither bifurcate nor possess a preferred orientation. They are quite narrow, ranging up to about two feet wide.

Joints have developed cutting these dykes. Secondary alteration has affected the dykes along and in from the edges of these joints. Round patches of epidote, up to four inches in diameter, have developed along these joints in places.

9. Dacite. Dacite and porphyry dacite occur as dyke rocks throughout the complex, intruding all of the acid and intermediate plutonic rocks. One specimen of these is similar to the tonalite of group 3; the others may be compared with the porphyries and may be genetically related to them.

Mineralogically, the dacite is normal. It is quite deeply weathered as are most other rocks of this complex. It is not a major rock type in the Complex.

Outcrop Relationships

The Urannah Complex is particularly well exposed in an outcrop located in a small tributary of the Broken River, about two miles north-west of Urannah Homestead (Grid ref. 657393 Bowen, F55/3). This outcrop was studied in considerable detail. It consists of a fresh, waterworn surface extending over an area of 60 yards by 30 yards. The inter-relationships of seven of the nine groups described above are revealed in this outcrop.

The oldest rocks here are the amphibolite xenoliths which are abundant in the diorite and granodiorite and also are found in the dacite and porphyry dykes. None were seen in the andesitic and basaltic dykes.

Next in the sequence is a melanocratic diorite which occurs as large xenoliths in the diorite and granodiorite. It contains small xenoliths of amphibolite.

Diorite and tonalite are the oldest intrusives in the area and may represent the parent magma for the complex. They were followed by the emplacement of granodiorite which may be an acid differentiate of the dioritic magma.

Granite is next in the sequence. In this area it does not contain xenoliths. From the time of granodiorite emplacement to this stage, shearing took place producing a foliation in the rocks.

Next in the sequence came the dykes. Firstly came the aplite and pegmatite associated with the granite. These invade all earlier phases of the Complex. Then came the dacite followed by the porphyries. Finally came the andesite and dolerite dykes cutting all other rocks and structures. These also cut each other, there apparently being different ages of both andesite and dolerite emplacement.

The genetic relationship between the granite and the other plutonics is not known. The andesite and dolerite do not appear to be related mineralogically to each other nor to any other rock type of the Complex.

A similar sequence of events is seen in other less complete outcrops.

Structure and Relationships

The western edge of the Complex is in contact with the Lower Bowen Volcanics. This contact appears to be intrusive along part of its length and faulted elsewhere.

The evidence for an intrusive contact is strong. There has been low grade thermal metamorphism at a number of points along the contact. The conglomerates in Coral Creek have been silicified and indurated.

Further south, near the junctions of Flagstone Creek, East and Dart Creeks and the Bowen River, there are more indurated and metamorphosed Lower Bowen Volcanics adjacent to the Complex.

Dykes of andesite and basalt cut the conglomerate in Coral Creek where it is in contact with the Complex. These dykes are identical with those of the Complex.

There is no regional, structural discordance between the Lower Bowen Volcanics and the Complex. The strike of the volcanics is roughly parallel to the contact and the dips are away from the Complex. Thus, the Complex as a whole is not obviously younger than the Lower Bowen Volcanics. In fact, it may be, in part, older than the volcanics. The conglomerate in Coral Creek contains boulders up to 10 feet across. These boulders are rounded but have not travelled far. They are all acid igneous rocks, including granite, granodiorite and diorite, and were derived from the Complex.

The complicated intrusive relationships of the rock types within the Complex indicate that igneous activity continued over a considerable period of time. We think it possible that the Lower Bowen Volcanics were deposited within that space of time, and were partly derived from the extrusive volcanic phase of that igneous activity. The Urannah Complex may be the roots of an island arc system which supplied the Lower Bowen Volcanics.

The Urannah Complex is faulted against the Lower Bowen Volcanics in many places. The faulting occurred during uplift of the complex. The north-east margin of the Complex was not studied in any detail. It appears to be a fault contact.

<u>Urannah Complex</u>

Foliated diorite with pegmatite dykes.
(Neg. No. g/4266)

<u>Urannah Complex</u>

Foliated diorite, intruded by pegmatite dyke, and both cut by acid porphyry dyke.
(Neg. No. G4268)

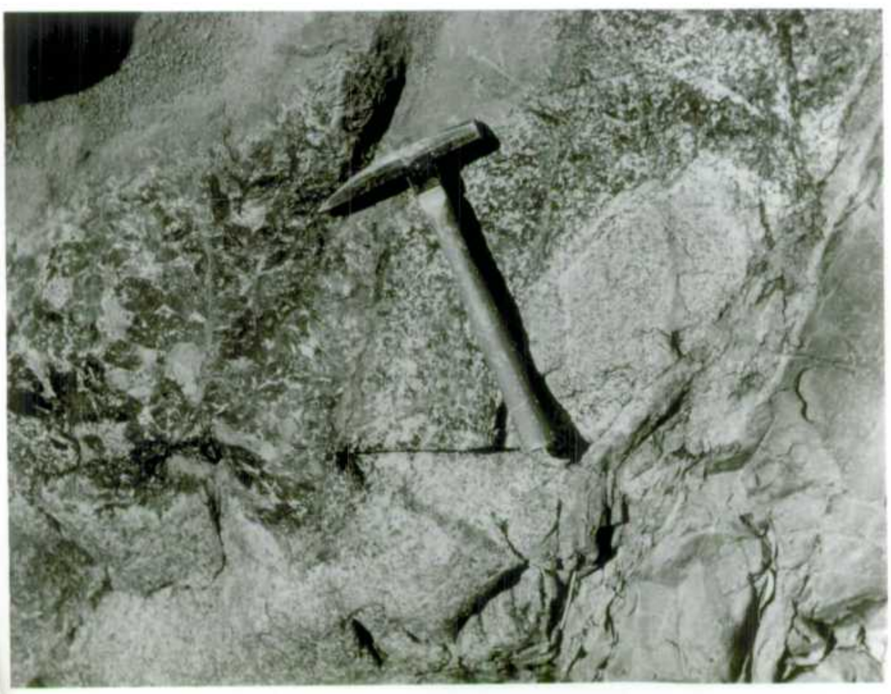
<u>Urannah Complex</u>

Diorite cut by acid porphyry dyke (foreground), then by micro-diorite (left hand side), then by dolerite (right hand side).
(Neg. No. g/4278).

Urannah Complex.

Foliated diorite intruded by a dyke of acid porphyry containing biotite-rich gneissic xenolith.

(Neg.No.G/4281)



Urannah Complex.

Three phases in diorite with acid porphyry dyke in top left hand corner.

(Neg.No.G/4282)

Urannah Complex.

An amphibolite xenolith in the foliated diorite cut by acid porphyry dykes.

(Neg.No.G/4286).

Urannah Complex

Gneissic inclusion in dolerite dyke.

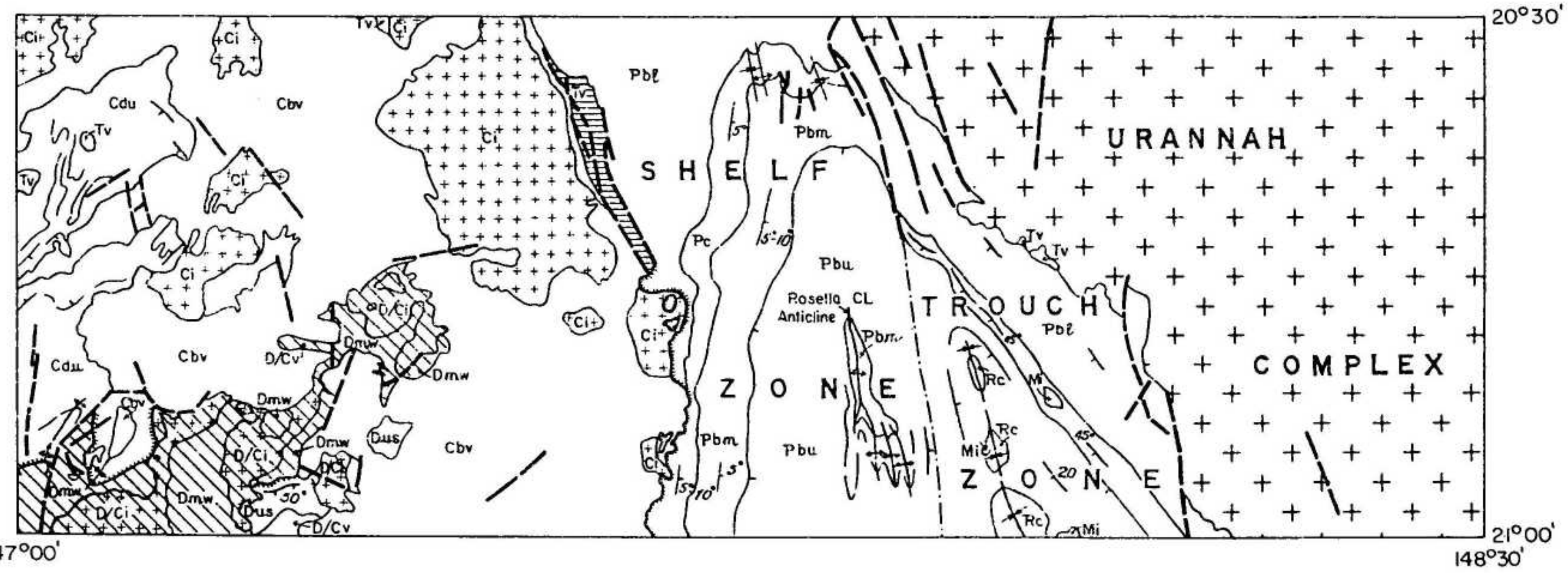
(Neg. No. g/4269)

The above seven photographs are of waterworn outcrops in the Broken River and Grants Creek, near the Broken River. They illustrate some of the relationships discussed in the text.

Fig. 4.

STRUCTURAL SKETCH MAP

BOWEN SOUTH



SCALE

10 0 10 20 30 40 Miles

REFERENCE

North-east trending block of Ukalunda Beds and Devonian-Carboniferons Intrusives

Brawl Creek Fault Block

Approximate boundary between postulated trough zone and shelf zone of Bowen Basin

MESOZOIC INTRUSIVES

This group includes two lacoliths and a number of sills intruding the Permian to Triassic succession of the Bowen Basin. The lacoliths occupy low, fairly mature valleys surrounded by high hills. The sills crop out mainly as long, narrow low rises with some outcrop and rubble. In places, where the dips are shallow, they crop out over more extensive areas.

Lithology

One lacolith crops out at the southern margin of the area. It is a leucocratic anorthite gabbro containing anorthite and augite and accessory biotite and hornblende. Associated with this gabbro are basalt dykes, some of which intrude the Carborough Sandstone.

The second lacolith intrudes the Middle Bowen Beds and the Lower Bowen Volcanics south of Emu Plains Homestead. It is a grey leucocratic, holocrystalline acid rock, probably granodioritic.

The sills include micro-diorite, hornblende micro-diorite, feldspar porphyry, trachyte and rhyolite porphyry. Some of the sills are very rich in hornblende, which occurs as very large laths in a generally fine-grained groundmass.

Many sills intrude the Collinsville Coal Measures. According to Webb and Crapp (1960) they intrude up fault planes and spread out as sills preferentially intruding the coal seams. The sills are very irregular in size and extent; in places they are more than 100 feet thick.

STRUCTURAL GEOLOGY

Detailed structural geology is described in the chapters dealing with the various rock units. The major structural features are shown on the structural sketch map, Text Figure 4, and are discussed below.

The Ukalunda Beds, the Devonian-Carboniferous intrusives and the two northerly blocks of Devonian-Carboniferous volcanics constitute the northern end of the Anakie High. The High trends north-east, in the Bowen South area, separating the Mount Wyatt Beds from the Drummond Group.

The north-east trend of the High is parallel to the axial trend of the Drummond Group folds in this area and to the main structural trend of the Mount Wyatt Beds and the southern block of Devonian Carboniferous volcanics. These three trends are parallel south of the Bowen area also. This parallelism probably reflects the control of the Mount Wyatt Beds and Drummond Group depositional areas exercised by the Anakie High. The Drummond Group was folded during a late Lower Carboniferous orogeny which probably produced the Mount Wyatt Beds structures also. This orogeny affected the Anakie High also, accentuating its structurally high position and producing some shearing of the Ukalunda Beds.

Several tongues of Bulgonunna Volcanics extend onto the Drummond Group. These also trend roughly north-east. Two of them are located in the axial regions of Drummond Group synclines. Probably, they are preserved in these positions because at the time of deposition of the Bulgonunna Volcanics these areas were topographic lows in which a greater thickness of volcanics accumulated.

The Bulgonunna Volcanics, as a whole, seem to trend north-north-west. This direction becomes more important and is the dominant structural trend during the Permian. The oldest, obvious example of the north-north-west structural trend is the long axis of the large Carboniferous intrusive cropping out near the western margin of the Bowen Basin.

The western margin of the Lower Bowen Volcanics appears to follow the same trend. It is overlapped by Collinsville Coal Measures to the south and is bordered, in the north-west, by Tertiary volcanics which exist in a fault block elongated in a north-north-west direction. The faults and the elongation probably reflect older structural trends.

The Lower Bowen Volcanics and the Urannah Complex are regarded as constituting an inter-related depositional and structural unit. The igneous complex is thought to be the exhumed base of an island arc volcanic and intrusive pile. The Lower Bowen Volcanics consist of contemporaneously deposited volcanics and sediments derived from the crest of that island arc. The contact between the two units trends north-north-west. The trend of this contact reflects in part the folding of the Bowen Basin; it is faulted, in places, due partly to late Tertiary uplift of a block largely composed of the Urannah Complex.

The limits of the Bowen Basin are partly structural. Its western margin is probably close to the original limit of deposition; the western area is one of shelf deposition, little affected by subsequent folding. In the east, adjacent to the igneous complex, the sediments were deposited in moderately deep to shallow water in a basin which subsided to accommodate 30,000 to 40,000 feet of sediments. At times, during the deposition of the Lower Bowen Volcanics and the Middle Bowen Beds, the eastern margin of this basin was further east than the present outcrop limits of these units. However, the conglomerate in Coral Creek was deposited near the margin. During deposition of the Upper Bowen Coal Measures, the eastern limit was close to the present limit of the basin.

The most obvious structure within the Bowen Basin is the steeply dipping eastern flank. It is outlined by the Middle Bowen Beds which dip south-west at angles of 40° or more. The main synclinal axis of the basin is occupied by discontinuous outcrops of the Carborough Sandstone. The axis trends north-north-west and is located east of the centre of the basin. This structure is probably related to the folding of the eastern trough of the basin, hence the asymmetrical relationship it bears to the Basin as a whole.

The Rosella Creek Anticline is one of the few structures west of the main syncline. It is an elongate dome, bifurcating at the southern end into a number of minor anticlines. Dips in this structure are quite steep in places, but the structure dies out rapidly to north and south. It probably does not persist to very great depth. This anticline may have an intrusive core. However, its elongate shape and steep flank dips seem to indicate that this is not so.

Faulting

Faulting is particularly prominent along the eastern limb of the Bowen Basin. Near Collinsville, a series of parallel north-north-west trending faults were mapped. The most important of these is the Collinsville Fault. (Webb and Crapp, 1960). This is a high angle reverse fault, east block up, which forms the eastern margin of the Collinsville Coal Measures. The throw on this fault has brought Lower Bowen Volcanics adjacent to the lowest beds of Unit C of the Middle Bowen Beds, cutting out the 700 feet of the Collinsville Coal Measures. The throw is greater than, probably much greater than, 700 feet. At the southern end, the fault probably had less throw and dies out in steeply dipping sediments. At its northern end, the fault plane is not easy to trace. It apparently passes in front Mount Devlin and may abut against a north-east trending fault. This latter fault separates the uplifted block of Lower Bowen Volcanics from a sequence of Lower Bowen Volcanics which is structurally conformable under the Collinsville Coal Measures.

The Collinsville Fault, and the parallel fault just west of Collinsville are the boundary faults of a graben. The throw on the western fault is not known but is about 200 feet. Other north trending faults affect the Collinsville Coal Measures. These are important in mining but are not of any regional significance. Most are high angle reverse faults, west block down. To the east, a series of faults parallel the Collinsville Fault. The first of these is partly the faulted contact between the Urannah Complex and the Lower Bowen Volcanics. This fault dies out to the south where its displacement is taken up by folding of the sediments.

Near the southern margin of the mapped area, a number of north trending faults separate the Urannah Complex and parts of the Lower Bowen Volcanics from the overlying Lower Bowen Volcanics and Middle Bowen Beds. These faults are generally similar to the Collinsville Fault and other faults east of it. The displacement on most of these faults is east block up. Possibly, they are related to uplift of a block consisting of the Urannah Complex and part of the Lower Bowen Volcanics, during the Tertiary.

TABLE 2

SUMMARY OF GEOLOGICAL HISTORY

	PERIOD	DEPOSITIONAL UNIT	INTRUSIVE UNIT	DESCRIPTION OF EVENTS
CAINOZOIC	Undifferentiated			Uplift of Urannah Complex. Regional uplift producing dissection of Tertiary sediments. Lateritisation during period of slow erosion.
	TERTIARY	Tv u-u-u-u	Tv	Extrusion of acid to basic volcanics; intrusion of plugs) Each of the three Tertiary units unconformably overlies pre-Tertiary rocks in different places.
		Suttor Formation Ts u-u-u-u		Widespread, thin veneer of lake sediments, encircling local topography.)
		Tb -u-u-u-u	Tb	Basalt flows and plugs.)
		u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u		Main period of uplift and erosion.
	Triassic to Upper Permian	Carborough Sandstone Rc	Mi	Main Bowen Basin folding and intrusive episode. Deposition of mature, well sorted Carborough Sandstone in ?deltaic environment.
		Upper Bowen Coal Measures Pbu		Reduction in size of Bowen Basin and change to restricted marine or brackish environment due to uplift of Lower Bowen Volcanics/Urannah Complex block. Latter are eroded and supply sediment for Upper Bowen Coal Measures.
	LOWER PERMIAN	Middle Bowen Beds Unit C		Major extension of basin as shallow transgressive sea in which Unit C is deposited.
		Collinsville Coal Measures; Middle Bowen Beds Unit B -D-D-D-D-D Wall...Sandstone Member		Basin extends to east and north and becomes shallower. Deltaic conditions around margin in places e.g. where Collinsville Coal Measures deposited. Elsewhere, unit B deposited in marine environment, at times shallow.
		Middle Bowen Beds Unit A D?D?D?D?D?D-		Island arc activity ceases. Unit A deposited in moderately deep marine basin. Lower Bowen Volcanics/Urannah Complex not a source of sediments.
		Lower Bowen Volcanics. Pbl	Urannah Complex 3/Mi	Development of Bowen Basin commences. Island arc activity: volcanics and sediments derived from island arc deposited as Lower Bowen Volcanics; contemporaneously, multiple intrusion and differentiation in base of island arc volcanic pile produces Urannah Complex.
		u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u		
	Carboniferous	Bulgonunna Volcanics Cbv u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u	Ci	Terrestrial volcanism and sedimentation. Intrusion into Cbv and older rocks.
				Main compressive folding of Drummond Group, Mount Wyatt Beds; and undifferentiated volcanics. Possibly some intrusive activity. Some regional metamorphism and folding of Ukalunda Beds.
		Drummond Group Cd; Undifferentiated Devonian-Carboniferous Volcanics D/C vu		Intrusia and volcanism in area of Ukalunda Beds high, supplying volcanics and sediments to sinking Drummond Basin west and north-west of Ukalunda Beds.
		-u-u-u-u-u-	D/Ci -u-u-u-u-	Drummond Group is unconformable on Ukalunda Beds and some of Devonian-Carboniferous intrusives.
	Upper Devonian	Mount Wyatt Beds Dus -u-u-u-u-u-u-u-?u?u?u?u?u?u?u? u-u	D/Ci	Marine deposition of Mount Wyatt Beds, ?unconformable on Ukalunda Beds, followed by terrestrial volcanism.
				Folding, uplift and intrusion of Ukalunda Beds with contact and low grade regional metamorphism.
	Middle Devonian	Ukalunda Beds Dmw		Deposition of Ukalunda Beds in marine environment. Possibly isolated basin or geosyncline of unknown extent.

The Bowen South area has produced moderate quantities of gold, silver, lead and other minerals from many small workings, mainly in the Normanby and Mount Wyatt areas. The Ukalunda-Mount Wyatt-Sellheim River area is extensively mineralised with many small deposits of silver, lead, gold, copper, bismuth and arsenic ores. Many of these ores are complex and difficult to treat.

Apart from coal, the present mineral production of the area consists of a little gold from Tertiary auriferous gravel at Rutherfords Table. A small copper prospect on the Sellheim River is being developed and has produced some small parcels of ore.

Metalliferous

Gold

Most gold production has come from Rutherfords Table, from the Mount Wyatt area and from Normanby.

The Mount Wyatt Goldfield was one of the earliest known fields in Queensland. The occurrence of alluvial gold was known in 1868 and was reported on by Daintree in that year. Metalliferous deposits of the district are found in granite intrusives or in the metamorphosed sediments around the margins of the intrusives. Small silver and copper lodes are known in the district but are uneconomic. Mines in the area included the Southern Cross, Golden Ridge, Big Hope, Middle Camp, Top of the Hill and Big Lode.

The Southern Cross Mine was the largest. It was opened in 1893 and a battery was erected the following year. Average recovery was reported to be 10.7 dwt. per ton. However, the mine proved a failure; the reef pinched out completely within a few months and the mine workings collapsed. The other mines produced only negligible quantities of gold.

Rutherford's Table is a mesa of Tertiary Suttor Formation overlying granite. Auriferous river channel deposits occur at the base of the Suttor Formation, in a depression in the granite basement. The gold occurs as small rounded flakes, scales and in wire form. In general, the grains vary from microscopic size up to 1-2 mm. in diameter. Larger pieces are uncommon but have been found to ½ dwt in size. Rounding and pitting of the grains suggest they have travelled a considerable distance.

(Levingston, 1953b). Production during the past ten years totals approximately 900 ozs.

Gold was discovered at Normanby in 1872. The field reached its peak in 1891 when there were about 300 miners working there, but most work had ceased by 1908. The field is located in the Urannah Complex. The gold is associated with pyrite and chalcopyrite in siliceous reefs which intrude the andesite dykes, the youngest component in the igneous complex. The reefs are generally 6" to 12 inches wide with local bulges to two or three feet wide.

In 1922, 34 oz of gold were produced from the Mount Poole Goldfield located 14 miles south-east of Collinsville.

No subsequent production is recorded.

Silver Lead

The bulk of the silver produced in the area has come from the Sellheim Silver Mines, located about Two-mile Creek, north of the Sellheim River. The first production was in 1883 and several mines operated during the years 1883-1893; after 1893, most production came from the Sunbeam Mine. Total production for the period 1883-1934 is estimated at 681,000 oz of silver.

The Sunbeam Mine, the major producer of the area, yielded some extremely rich ore, assaying as high as 1200 ozs of silver to the ton, as well as some gold, copper and bismuth. Other mines in the area include the Pyramid, Venture, Rob Roy, General Gordon, Bonny Dundee, Silver King and Stackpool.

The deposits took the form of fissure lodes in the Ukalunda Beds and in doleritic intrusives into them. Ore minerals included galena, the most abundant, sphalerite, tetrahedrite, cerussite and pyrite.

Small silver-lead deposits have been worked in the Emu Plains area. In 1889-1890, some rich tetrahedrite ore was mined at the King Solomon Mine. In 1889, some shafts were sunk to mine a silver-lead lode in the Flagstone Creek area. Some parcels of ore were sent to the smelter but, in 1891, the workings were abandoned.

TABLE 3

TABLE OF MINERAL PRODUCTION

COAL

Period		State Coal Mine	Bowen Consolidated Coal Mine	Total
1920-31		965,572 tons	379,169 tons	1,344,741 tons
1931-41		1,617,589 "	557,254 "	2,174,843 "
1941-51		1,933,113 "	778,026 "	2,711,139 "
1951-61	(Prod'n.(	1,352,150 "	2,184,8[illegible] "	3,536,954 "
	(Value (	£3,778,656	£6,779,250	£10,557,906
Total Prod'n.		5,868,424 tons	3,899,253 tons	9,767,677 tons

GOLD

Period	Production (Oz.)	Main Producers
1878-1900	7,696	Normanby, Mount Wyatt
1901-1920	2,648	" " "
1921-1940	391	Normanby, Mount Poole, Urannah
1941-1960	1,176	Mount Wyatt, Rutherfords Table
Total	11,911 oz.	

SILVER

Period	Production (Oz.)	Value (£)	Tons Ore
1883-1900	289,871	£36,135	811
1901-1920	88,481	£11,459	376
1921-1940	7,207	£ 840	56
1941-1960	323	£ 100	
Total	385,882	£48,534	1,243

Main producers were Sunbeam Mine and Pyramid Mine.

LEAD, COPPER AND BISMUTH

	Lead	Copper	Bismuth
Total Production	30	9	1

GRAPHITE

Period	Production Tons	Production Value	Main Producer
1935-1950	1,587	£15,765	Jacks Creek Mine
1951-1961	243	£ 3,564	Jacks Creek Mine

Bismuth-Arsenic-Gold

Bismuth, arsenic and gold ores are contained in fissures in granite of the Ukalunda District. The Daisy Bismuth Mine, the Walhalla Workings and the Carrington Workings have worked these fissure lodes. The Daisy is located 2 miles north-east of Ukalunda, and the other two are respectively ½ mile south and east of the Daisy.

The Daisy fissure was almost vertical. It was worked over a length of 620 feet and contained two ore-shoots, 250 feet apart. The mine was working during 1889 and 1890 producing ores of gold, copper, silver and bismuth. The sulphides include chalcopyrite, pyrite and bismuthinite; quartz and siderite are the main gangue minerals. Morton (1945b) considers that sulphide ores containing high aggregate values of gold, copper, silver and bismuth remain in the ground. However, economic development is dependent on the existence of a market for such complex ores, on which payment could be obtained for all the minerals present.

Walhalla Workings opened in 1893 but no production was recorded. In 1936-1938 a shaft was sunk to 125 feet and some lode material was mined and sold for its gold content. The work to date indicates the existence of a further tonnage of gold-bismuth ore. But the ore is complex and successful operation is dependent on the ability to treat the ore locally and recover both the gold and bismuth content. (Morton, 1945a).

Arsenic-gold ore was mined at the Salopia workings 1½ miles south-east. The auriferous arseno-pyrite occurs sparingly in small quartz veins and as minor disseminations in highly altered Ukalunda Beds close to their contact with an intrusive granite.

Copper

At present, one copper prospect is being developed in the Bowen South area. It is located north of the Sellheim River, about 6 miles south of Mount Wyatt. The ore occurs in Ukalunda Beds, close to their contact with a granite intrusive. It consists of malachite, azurite, chrysocolla, chalcopyrite and pyrite in an epidote rich country rock.

Some 250 tons of high grade ore had been stock-piled at the end of 1960, and further development work was done in 1961, but no production is known to date.

Iron

Connah (1953) and Brooks (1957) noted a magnetite deposit about 1½ miles east of Mount Wyatt. This is a small, contact metamorphic deposit of disseminated magnetite associated wi[illegible] [illegible]rnet, epidote and hornblende. It is not an economic iron ore deposit.

Non-metals

Coal

The existence of coal in the Bowen Basin was known in 1845. The coal deposits of the Collinsville area were reported on first by Jack in 1879. They were subsequently reported on by Reid (1929) and the Powell Duffryn Report (1949).

The most recent and the most important report on the Collinsville Coal Measures is that by Webb and Crapp (1960). The following summary is based on that report.

The Collinsville Coal Measures include eleven named seams, of which the Bowen and the Blake Seams are being worked. These two seams are about 20 feet thick where mined. They are of medium volatile bituminous rank. The Blake Seam is a non-coking, steaming coal; the Bowen Seam produces high grade metallurgical coke. Bowen Consolidated Coal Mines Ltd. works the Blake Seam by open cut methods and the Bowen Seam by underground methods at Scottville. The former State Mine, Collinsville (now owned by Davis Contractors) was working the Bowen Seam by underground methods and may resume production in the near future.

In general, the other seams are not thick enough to work. The Garrick Seam has an average thickness of seven feet in the Collinsville area but the upper part of the seam contains a high concentration of marcasite.

Extensive feldspar porphyry intrusions have greatly reduced the reserves of workable coal. These intruded along fault planes and spread out as sills, selectively intruding the coal seams. One such sill attains a thickness of 115 feet. Coal near such intrusions is low in volatile matter and loses its coking properties.

The eastern margin of the Collinsville Coal Measures is a high angle, reverse fault, called the Collinsville Fault by Webb and Crapp (1960). This fault has a throw of more than 700 feet, east block up, which has resulted in erosion of the eastern extension of the Collinsville Coal Measures.

Webb and Crapp (1960) give 80 million tons of coking coal and 36 million tons of steam raising coal as established reserves of workable coal as at 1/1/59 for the Bowen Consolidated Coal Mining Ltd. leases and State Reserve No. 1.

Graphite

The Jacks Creek graphite mine was first reported on by Morton in 1934. It has produced 1830 tons of graphite since 1935 but recent production has been spasmodic. At present the mine is idle but is being kept in readiness to resume production should orders be received.

The Jacks Creek Graphite mine is located about eleven miles south-east of Collinsville. The workings are in the Upper Bowen Coal Measures close to the Collinsville Fault. Graphite, formed by metamorphism of coal, is distributed through 15 feet and 9 feet thick bands of sediments separated by 14 feet of non-graphitic sediments, dipping west at about 80°. Total reserves of graphite are not known; developed reserves are small and not all of them may be recoverable.

Clay

A search for fire-clay deposits in the Collinsville Coal Measures was made in 1945. It was concluded (East, 1945) that reasonably large quantities of shale suitable for the manufacture of fire-bricks are available in the clay-pit near the Collinsville Coal Mine.

TABLE 4

TABLE OF WATER BORE AND WELL DATA

Name of Bore or Well	Reference on geological map	Station	Depth	Water Level	Depth Water Struck	Depth to which water rose	Supply	Quality
Twelve-Mile Mill	1	Birralie	200 ft.	80 ft.			Permanent	Good but hard
Bottom Jacks Creek Mill	2	"	150	50			"	Brackish
Bottom Burn Tree	3	"	80	40			"	Good
Top Burn Tree	4	"	200				Semi-permanent	Brackish
Bottom Stone Humpy	5	"	250			100 ft.	Permanent	Good
Emu Plains No. 1	6	Emu Plains	72	52			400 gals/hour	Brackish
Emu Plains No. 2	7	" "	64		56	27 ft.	2000 gals/hour	Slightly brackish
Stone Wall No. 1	8	" "	52		48	23	8000 gals/hour	Good
Goanna Gully	9	Glendoo	80		40		1400 gals/hour	Good
Goldbeetle No. 1 Mill	10	Heidelberg	50		37		Permanent	"
Desmond's Mill	11	"	50		20		"	"
Bell Creek Well	12	Mt. McConnell	80		40		"	"
Five Mile Paddock Well	13	Old Hidden Valley	45				"	"
Mount Wyatt Mill	14	" " "	15				"	"
Southern Cross Mill	15	" " "	50				"	"
Sunbeam Mill	16	" " "	400				"	Sulphurous Smell (H_2S)
Oakey Creek	17	Sonoma	51	25	47	25	1600 gals/hour	Good
Coral Creek Bore	18	"	71	28	65	57	2000 gals/hour	"
Coral Creek Well	19	"	40	14			Permanent, less than 2500 g/hour	"
Charlie's Well	20	"	30	20			Semi-permanent	Good but slightly limey
Henry Run Well	21	"	40				Permanent	Slightly limey
Pelican Bore No. 2	22	Strathmore	80	45	50	45	2000 gal/hour	Hard
Lower Crush Bore, No. 4	23	"	75	60	50	50	" " "	"
Top Paddock Bore, No. 5	24	"	80	50	50	50	" " "	"
Umina Bore, No. 9	25	"	90	60	60	60	" " "	Good
Bella Vista No. 10	26	"	90	40	40	40	" " "	Good

Water

Sub-artesian water is produced from a number of bores and wells, many of which are old mine shafts, in the Bowen South area. Most of these bores are less than 100 feet deep, and most struck water at about 50 feet. Records of the water bores in this area are incomplete. Available information is given in the following table of water bore and well data.

Rainfall in the area is between 20 and [illegible] inches per year, sufficient to reduce the dependence of the pastoral industry on ground water. Many landowners construct dams and earth tanks to collect water for stock purposes. Many also obtain good drinking water from spears sunk in the sandy beds of the larger watercourses. This method supplies the town water supply of Collinsville.

OIL PROSPECTS AND RECOMMENDATIONS

Bowen Basin

The marine Middle Bowen Beds include some possible oil source beds, particularly in Unit C. Potential reservoir beds are the thick, clean quartz sandstone beds in Unit B, and less commonly in Unit C. Igneous intrusives into the sequence reduce its attractiveness as an oil prospect. However, the larger intrusives are confined to the eastern flank of the basin. Elsewhere, the intrusives are less common, are smaller and cause little metamorphism. The Rosella Creek Anticline is a possible drilling site. Since the Middle Bowen Beds crop out on this structure, a relatively shallow hole, to 4,000' or less, would test almost the entire unit present in this area. Such a hole would supply information on a number of points:

(1) It would test for possible accumulations of oil in this structure.

(2) It would supply stratigraphic information on the Middle Bowen Beds, including part of Unit C, all of Unit B and any part of Unit A present in the area.

(3) Coring of all sandstone units would enable porosity and permeability of all potential reservoirs to be determined.

(4) Anticlines were mapped during 1960 in the Upper Bowen Coal Measures west of the Redcliffe Tableland, in the Mount Coolon area. Middle Bowen Beds are probably involved in these structures below about 4,000 feet of Upper Bowen Coal Measures. The results of a bore on the Rosella Creek structure could be used to evaluate the potential of these buried anticlines.

The Middle Bowen Beds sequence below the Rosella Creek structure will almost certainly include some reservoir beds. Clean quartz sandstone crops out at several horizons in unit B, the equivalent of the Collinsville Coal Measures, about twelve miles to the west. Some sand development was noted in unit C in this area also. Unit C becomes sandier to the south on this western flank of the Bowen Basin.

Igneous intrusives occur in the vicinity of the Rosella Creek Anticline and, in fact, crop out on the east flank of the anticline. These seem to be thin sills with only very limited metamorphic effects.

As an initial step, detailed geological mapping is required to outline the structure and to select a drilling site. This structure is steep flanked in outcrop but dies out fairly rapidly down plunge. It probably becomes broader and gentler at depth. In this area, the Middle Bowen Beds are underlain by basaltic rocks of the Lower Bowen Volcanics, which would be much denser than the sediments. Thus, a detailed gravity and magnetometer survey would give some idea of the shape of the structure if, as is likely, it persisted to sufficient depth to involve the Lower Bowen Volcanics. It could also indicate the presence of major intrusives.

The following is a postulated stratigraphic column for the sequence in the Rosella Creek Anticline, based on outcrop information around the margin of the northern Bowen Basin.

The Rosella Creek Anticline may have grown during deposition, with some thinning of the section over the crest. The section may be much thinner than is suggested in the following column.

0'	Top of outcropping Unit C. Possibly 200' to 500' of Unit C eroded.
1400'-1500'	Big Strophalosia Zone. A calcareous quartz greywacke zone, probably a good seismic reflector.
1800'	Base of Unit C = Top of Unit B.
2600'	Calcareous, fossiliferous zone, equivalent to Glendoo Sandstone. Probably a good se... reflector.
3600'	Base of Unit B = Top of Unit A.
4,000' ∓	Lower Bowen Volcanics. The thickness of Unit A, if present, is unknown.

Devonian

The Middle Devonian Ukalunda Beds include thick sequences of fossiliferous, dark fine siltstone and shale containing lenses and nodules of limestone which yield a foetid odour when broken. The Ukalunda Beds also include thick quartz sandstone beds. In the Bowen South area, these rocks are intensively intruded and metamorphosed and are unprospective for oil. These rocks are thought to be part of an extensive Lower and Middle Devonian sedimentary sequence, which includes most of the Anakie Metamorphics. This sequence probably extends to the west of the Drummond Basin and underlies the Mesozoic sequence of the Great Artesian Basin. The latter area is possibly less affected by intrusives. It may well be prospective for oil since the Ukalunda Beds, cropping out about 60 miles to the east, i.e., in the Bowen South area, contain source and reservoir lithologies. The only possible prospecting tool in this case is seismic work to locate structures in Devonian sediments below the Great Artesian Basin sequence, west of the Drummond Basin.

BIBLIOGRAPHY

BROOKS, J.H., 1957 - Summary Report Iron Ore Resources of Queensland. Qld. geol. Surv. Publ. 283, 7.

CAMERON, W.E., 1903 - Additions to the Geology of the Mackay and Bowen Districts. Qld. geol. Surv. Publ. 181.

CONNAH, T.H., 1953 - Iron Occurrence, Mount Wyatt. Geol. Surv. Qld. Unpubl. Rept. 1953. Qld. geol. Surv.

CRIBB, H.G.S., 1940 - Graphite Mine, Col ...ville. Geol. Surv. Qld. Unpubl. Rept. 19/1/40.

DAINTREE, R., 1870 - General Report upon the Northern District. Parlt. Paper 1870.

EAST, J.D., 1945 - Brick Clay, Collinsville. Geol. Surv. Qld. Unpubl. Rept. 15/11/45.

HANLON, F.N., 1955a - Geological Report on Bowen Basin region covering oil prospecting area held by Kimberley Oil Exploration. Geol. Surv. Qld. Libr. No. 54.

HILL, D., and DENMEAD, A.K., 1960 - The Geology of Queensland. Jour. Geol. Soc. Aust. Vol. 7.

ISBELL, R.F., 1955 - The Geology of the Northern Section of the Bowen Basin. Univ. Qld. Dep. Geol. Pap. 4(ii).

JACK, R.L., 1879a - On the Bowen River Coalfield. Qld. geol. Surv. Publ. 4.

________, 1879b - On the Normanby and Marengo Goldfields. Qld. geol. Surv. Publ. 5.

________, 1889 - On the Sellheim Silver mines and surrounding District. Qld. geol. Surv. Publ. 57.

________, 1893 - Second report on the Normanby Goldfield. Qld. geol. Surv. Publ. 88.

LAING, A.C.M., 1959 - Reconnaissance Geology of the Northern Section of the Bowen Basin and Styx Basin. Mines Adm. Pty Ltd, Rep. Q/56P/63. Unpub. rept. Geol. Surv. Qld. Libr.

LEVINGSTON, K.R., 1953a - "Graphite Consolidated" Mine, Collinsville.
Qld. Govt. Min. J., 54, p.50.

______________, 1953b - Ukalunda Gold Mining Syndicate, Ukalunda.
Qld. Govt. Min. J. 54, p.819.

______________, 1956a - Ukalunda Gold Mining Syndicate, Ukalunda.
Qld. Govt. Min. J, 57, p.137.

______________, 1956b - Oil Shale Occurrence, Ukalunda.
Qld. Govt. Min. J, p.137.

______________, 1961 - Ukalunda Development Ltd, Rutherford's Table, Ukalunda. Geol. Surv. Qld. Unpubl. Rept. 12/5/61.

LONGMAN, H.A., 1929 - New Records Diprotodon australis from Urannah.
Mem. Qld. Mus. Vol. 9, p.250.

MAITLAND, A.G., 1889 - Geological Observations at the heads of the Isaacs, the Suttor, and the Bowen Rivers.
Geol. Surv. Qld. Publ. 54, p.5.

MALONE, E.J., CORBETT, D.W.P., and JENSEN, A.R., 1961 - Geology of the Mount Coolon 4-mile area. Bur. Min. Resour. Aust. Rec. 1961/69 (Unpubl.).

MORTON, C.C., 1920 - The Normanby Goldfield. Qld. Govt. Min. J., 21, p.268.

__________, 1921 - Recent notes on Normanby Goldfield.
Qld. Govt. Min. J., 22, pp. 271-274
pp. 316-320.

__________, 1922 - New Gold Discovery near Bowen Coalfield.
Geol. Surv. Qld. Unpubl. Rept. 1922.

__________, 1927 - Mineral Discovery - Birralee Holding.
Geol. Surv. Qld. Unpubl. Rept. 10/4/27.

__________, 1934 - Graphite at Collinsville.
Qld. Govt. Min. J., 35, p.404.

__________, 1935a - Middle Camp, Ukalunda.
Qld. Govt. Min. J., 36, p.415.

__________, 1935b - Mount Wyatt-Middle Camp-Ukalunda Prospects.
Geol. Surv. Qld. Unpubl. Rept. 17/10/35.

MORTON, C.C., 1945a - Walhalla Workings, Ukalunda. _Qld. Govt. Min. J._, 46, p.143.

_____________, 1945b - Daisy Workings, Ukalunda. _Qld. Govt. Min. J._ 46, p.143.

_____________, 1946 - Salopia Gold-Arsenic Prospect, Ukalunda. _Qld. Govt. Min. J._, 47, 76.

POWELL DUFFRYN TECHNICAL SERVICES, 1949 - First Report on the Coal Industry of Queensland. 3 Vols. Parl. Pap. A, 16-1949. Brisbane.

REID, J.H., 1924 - Geology of the Bowen River Coalfield. _Geol. Surv. Qld. Publ._ 276, pp. 1-107.

_____________, 1928a - The Mount Wyatt Goldfield. _Qld. Govt. Min. J._, 29, p.344.

_____________, 1928b - The Isaacs River Permo-Carboniferous Coal Basin. _Qld. Govt. Min. J._, 29, pp. 239-40.

_____________, 1929 - Mount Wyatt and Ukalunda Geological Notes. _Qld. Govt. Min. J._, 30, p.158.

_____________, 1930 - The Queensland Upper Palaeozoic Succession. _Geol. Surv. Qld. Publ._ 278.

_____________, 1931 - Correlations of Queensland Permo-Carboniferous Basin. _Proc. Roy. Soc. Qld._ 43, 56-65.

REID, J.H. and MORTON, C.C., 1928 - Central Queensland Geological Section. _Qld. Govt. Min. J._, 29, 384.

RIDGWAY, J.E., 1941 - re Collinsville Prospecting Syndicate. Geol. Surv. Qld. Unpubl. Rept. 9/6/41.

SHELL (QLD.) DEVPT PTY LTD, 1952 - General Report on Investigations and operations carried out by Shell in Queensland 1940-1951. Unpubl. report.

VEEVERS, J.J., RANDAL, M.A., MOLLAN, R. G., and PATEN, R.J., 1961 - Geology of the Clermont 4-mile Sheet area. _Bur. Min. Resour. Aust. Rec._ 1961/75. (Unpubl.).

VEEVERS, J.J., MOLLAN, R.G., OLGERS, F., and KIRKEGAARD, A.G., 1962 - Geology of the Emerald 1:250,000 Sheet area. Bur. Min. Resour. Aust. Rec. 1962/50. (Unpubl.).

WEBB, E.A., and CRAPP, C.E., 1960 - The Geology of the Collinsville Coal Measures. Proc. Aust. Inst. Min. Met. No. 193.

WHITE, M.E., 1962 - Report on the 1961 collections of fossil plants. Bur. Min. Resour. Aust. Record 1962/ . (Unpubl).

WHITEHOUSE, F.W., 1929 - Preliminary report on Devonian fossils from the districts of Mount Wyatt and Ukalunda. Qld. Govt. Min. J., 30, p.158.

WYATT, P.H., 1958 - Geological Reconnaissance-Broken River Area. Qld. Govt. Min. J., 59, pp. 121-125.

APPENDIX A

PERMIAN MARINE MACROFOSSILS FROM THE BOWEN AND MACKAY SHEET AREAS

by

J.M. Dickins

SUMMARY

More than 120 species, mainly pelecypods, gastropods and brachiopods are identified and referred to Faunas I, II, III and IV, which characterize successive stratigraphic subdivisions. Fauna III is further subdivided stratigraphically into III a, b, and c.

Faunas I and II, from the top part of the Lower Bowen Volcanics and the lower part of the Middle Bowen Beds, are similar and are characterized by the pelecypods *Deltopecten* and *Eurydesma*. Fauna II has in addition the brachiopods *Anidanthus*, *Taeniothaerus* and *Neospirifer* (*Grantonia*). Fauna III differs distinctly and lacks the five genera or subgenera characterizing Fauna II. The pelecypod *Glyptoleda* and the gastropod *Platyteichum* and many new species appear. The changes seem to indicate a hiatus or a marked change in environment. Fauna IIIb is found in the Glendoo Sandstone Member of the Collinsville Coal Measures in the northern part of the basin. To the south, where the coal measure environment is poorly developed or absent and marine conditions predominate, Fauna IIIb is an important marker.

Fauna IV is characterized mainly by the incoming of new species and may reflect a relatively rapid deepening of the basin without a distinct hiatus in most places.

The marine faunas range in age from Lower Permian (lower Artinskian or possibly Upper Sakmarian) to lower Upper Permian.

SPECIES DISTRIBUTION CHART

Table I

BOWEN MT COOLON AND MACKAY SHEET AREAS

SPECIES	Fauna I.	Fauna II.	Fauna III A.	Fauna III B. (Glendoo Member)	Fauna III B. (Glendoo equivalent, Gebbie Crk. and Exmoor)	Fauna III C.	Fauna IV. (Below Big Strophalosia Zone)	Fauna IV. (Big Strophalosia Zone)	Fauna IV. (Above Big Strophalosia Zone)
Pachymyonia cf. etheridgei	●								
Aviculopecten sp.	●								
Notospirifer sp. A.	●								
Eurydesma hobartense	●	●							
Deltopecten limaeformis	●	●							
Chaenomya sp. nov. A.	●	●							
Myonia cf. davidis	●	●							
Ingelarella profunda	●	●							
Notospirifer hillae plicata	●	●							
Astartila cf. gryphoides	●	●	●	●	●	?			
Merismopteria sp.	●	●		●	●		●		●
Warthia sp.	●	●	●	●	●	●			●
Aviculopecten cf. leniusculus		●							
Aviculopecten cf. comptus		●							
Astartella sp. nov.		●							
M. (Mourlonia) sp. nov.		●							
Bembexia sp. nov. A.		●							
Terrakea pollex		●							
Anidanthus springsurensis		●							
Strophalosia preovalis		●							
Taenicthaerus sp.		●							
Lissochonetes sp.		●							
Ingelarella ovata		●							
Notospirifer hillae		●							
Schizodus nov. sp. A.		●							
Pseudomyalina cf. mingenewensis		●							
Deltopecten sp.		●							
Streblopteria cf. englehardti		●							
Stutchburia cf. randsi		●							
Cypricardinia sp. cf. C. gregarius		●							
Parallelodon sp. nov. B.		●							
Cancrinella farleyensis		●							
Trigontreta sp. A.		●							
Gilledia cf. cymbaeformis		●							
Gilledia sp. nov.		●							
Deltopecten squamuliferus		●							
Aviculopecten tenuicollis		●							
Strophalosia brittoni		●							
Neospirifer (Grantonia) cf. hobartense		●							
Modiolus sp.		●							
Aviculopecten sp. nov.		●							
Aviculopecten cf. fittoni		●							
Streblochondria? sp.		●							
Palaeosolen? sp. nov.		●							
Pseudosyrinx sp. nov.		●							
Megadesmus? cf. nobilissimus		●							
Terrakea sp.		●	●				●		
Streblopteria sp.		●				●			
Dielasmatids		●		●		●	●	●	
Cancrinella sp.		●	●					●	
Neospirifer sp.		●		●			●	●	●
Glyptoleda sp. nov.			●						
Chaenomya sp. nov. B.			●						
Schizodus sp.			●						
Ingelarella sp.			●						
Megadesmus sp. nov.			●						
Pachymyonia sp. nov.			●						
Atomodesma cf. mytiloides			●						
Wilkingia? sp. nov.			●						
Pseudomonotis? sp. nov.			●						
Mourlonia (Platyteichum) cf. costatum			●			●			
Gyptoleda cf. reidi			●						●
Ingelarella cf. ingelarensis			●			●	●	●	
Stutchburia cf. costata			●	●		●	●	●	●
Notospirifer extensus				●					
Walnichollsia? sp. nov.				●					
Parallelodon or Cypricardinia? sp.				●					
Volsellina? sp.?				●	●				
Pelecypoda gen. et sp. nov.				●	●	?			
Bembexia sp. nov. B				●	●				
Cypricardinia? sp.				●	●	●			
Aviculopecten cf. subquinquelineatus				●		●			
Schizodus sp. nov. B.				●		?			
Notomya or Pyramus sp.				●	●		●	●	
Nuculana sp.				●			●		●
Notospirifer sp. B.				?		●			
Notomya? sp. nov.						●			
Streblopteria sp.						●			
Astartidae gen. et sp. nov. A.						●			
Megadesmus? sp.					?	●	●		
Ingelarella undulosa						●			
M. (Mourlonia) cf. strzeleckiana						●	●		●
Peruvispira sp. nov.						●	●		●
Stutchburia cuneata						●			●
Stutchburia cf. compressa						●			●
Aviculopecten sp. A							●		
Ingelarella magna							●		
I. cf. magna or mantuanensus							●		
Strophalosia sp.							●		
Notospirifer cf. minutus							●	●	
Megadesmus grandis							●	●	
Strophalosia cf. typica							●	●	
S. clarkei							●	●	?
Terrakea solida							●	●	?
Myonia cf. carinata							●	●	●
Pseudosyrinx sp.							●	●	●
Strophalosia cf. brittoni var. gattoni							●	●	●
Astartidae gen. et sp. nov. B.							●		●
Schizodus sp. nov. C.							●	●	●
"Solemya" edelfelti								●	●
Trigonotreta sp. B.								●	
Cancellospirifer sp.								●	
Conocardium sp.								●	
Strophalosia ovalis								●	●
Myonia cf. corrugata								●	●
Chaenomya sp.								●	●
Ingelarella ingelarensis								●	●
Streptorhynchus pelicanensis								?	●
Ingelarella angulata									●
Astartila cf. cytheria									●
Ingelarella havilensis									●
Notospirifer minutus									●
Cleiothyridina sp.									●
Plekonella? sp.									●
Walnichollsia subcancellata									●
Mourlonia (Platyteichum) coniforme									●
Nuculopsis (Nuculopsis) sp. nov.									●
N. (Nuculanella) sp.									●
Parallelodon sp. nov. B									●

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JK

INTRODUCTION

The study of the Permian macrofossils from the Bowen Basin and their use for the stratigraphy initiated in 1961 (Dickins, 1961c; 1961d.) is continued in the present report. Fossils from some parts of the sequence from which none were previously collected are now available and a comprehensive account is possible for the northern part of the basin.

As well as the pelecypods and gastropods the brachiopods are identified where practicable, at the specific level. In making these identifications the latest publications have been used, but in the absence of detailed descriptive work for so many of the species, these must be regarded at least partly, as tentative. A special effort, however, has been made by comparing actual specimens, to ensure that the identifications are internally consistent.

I am grateful to Dr.K.S.W. Campbell of the Department of Geology at the Australian National University, for discussion on these faunas and for checking some of my identifications. I am, however, fully responsible for the identifications given. I would also like to thank Professor Dorothy Hill, of the Department of Geology of the University of Queensland for making the collections of the University available for examination. These collections arranged in stratigraphical sequence have proved a firm basis for further work. I am grateful also, to Mr.A.K.Denmead, Chief Government Geologist, and Mr.J.T.Wood, Superintending Palaeontologist, for making the collections of the Geological Survey of Queensland available to me.

The ranges of the species of pelecypods, gastropods and brachiopods according to the faunal subdivisions are shown in Table 1. In constructing this table, information has been used from Dickins (1961c) and from the identifications given later in this report.

The Middle Bowen Beds range in age from lower Artinskian or possibly uppermost Sakmarian, (see Dickins 1961c.), to Kungurian (late Lower Permian) and probably lower Upper Permian (Campbell, 1959; Dickins 1961a).

FAUNAL SUBDIVISIONS AND CORRELATIONS

The divisions I, II, III and IV, proposed in Dickins (1961c), are retained and further extended. Collections have now been made in the interval of 1,500 feet which previously separated Fauna IV from Fauna III and Fauna III has been subdivided into III a, b, and c, which occur at three different stratigraphical levels. This method of naming has been used to indicate that although the subdivisions of III differ from each other, they have species in common which distinguish them from Fauna II below and Fauna IV above.

Faunas I, II, III a, b and c, and IV are found in successive, stratigraphical units - the Lower Bowen Volcanics and Units A, B1, B2, B3, and C, of the Middle Bowen Beds. These units and the positions of the faunas are shown in Dickins, Malone and Jensen (1962, Plate 1), and the nature of the stratigraphical units and the relationship of the faunas to them is discussed.

Fauna I.

During 1961 no additional localities of Fauna I were found so that this fauna is represented by a single collection from the Lower Bowen Volcanics. As shown in Table I, it differs from Fauna II in having possibly three species which are not known from Fauna II and in lacking many species from the beds above.

Recent examination of the faunas of the Permian of the Hunter Valley, New South Wales, has added further evidence that this fauna is younger than that of the Allandale of the Dalwood Group (Lower Marine Beds). The differences between Faunas I and II are similar to those between III a, b, and c, but for consistency with previous work, the designations I and II are retained in preference to I a and b.

Fauna II.

Forty-nine species are positively identified, most of which do not range into Fauna III above. Genera or subgenera which do not occur above are Deltopecten, Eurydesma, Anidanthus, Taeniothaerus, and Neospirifer (Grantonia). The fauna contains characteristic species of many other genera.

Campbell (1961 p.168) has recently discussed the correlation of the Cattle Creek Shale of the Springsure area and considers it slightly younger than the beds at Homevale, which are at the base of the unit with Fauna II. The fauna of the

Cattle Creek Shale can be referred to Fauna II. It contains Eurydesma, Anidanthus and Taeniothaerus as well as Terrakea pollex Hill 1950, Strophalosia preovalis Maxwell 1954 and Notospirifer hillae Campbell 1961. On the other hand, forms characteristic of Fauna III are absent.

In New South Wales this fauna appears to be closest to that of the lower part of the Branxton Beds of the Maitland Group (Upper Marine Beds) between the Great Coal Measures and the Fenestella Zone. In part however, it may be equivalent in age to the Farley Beds, underlying the Greta Coal Measures.

The relationship of the fauna of the Dilly Beds and the Stanleigh Shale to Fauna II is not clear.

Fauna III.

Fauna III lacks most of the species found in Fauna II. Altogether forty-two species are identified, of these eight occur in Fauna II and sixteen in Fauna IV. On the whole brachiopods are poorly represented compared with Faunas II and IV, whereas the pelecypods and gastropods are relatively plentiful. This together with the sandy character of the rocks suggests that in the northern part of the Bowen Basin this fauna accumulated in a relatively shallow-water environment. (see Dickins,in press.). In the Collinsville area the Collinsville Coal Measures belong to the unit containing Fauna III.

New genera which appear in Fauna III are Glyptoleda and Platyteichum. Ingelarellas of the I.ingelarensis type first appear,and characteristic species of Schizodus, Megadesmus, Pachymyonia and Walnichollsia.

The differences between Faunas II and III are striking and represent the most marked faunal change in the Middle Bowen Beds. Two explanations of this change seem possible - a hiatus or a rapid change in environment or a combination of these. The absence of Eurydesma and Deltopecten from Fauna III, genera which are known to be associated with cool-water conditions may indicate the change was in fact caused by climate. The basin certainly became shallower.

Fauna III a contains seventeen species, of which four are found in Fauna II and nine in the overlying beds. Fauna III b also contains seventeen species, of which three are found in IIIa and eight in the overlying beds. Fauna III c has eighteen species identified definitely, of which four are found in III b and nine in Fauna IV.

In the Table the faunas from the Glendoo Member itself and the Glendoo Member equivalent (B2) in Gebbie Creek and near Exmoor Homestead, south along the eastern flank of the syncline, are considered separately. The Glendoo Member equivalent has a lesser number of species, but with one possible exception, all the species are found in the Glendoo Member. It lacks species found in IIIa or IIIb. Both are characterized by abundant representatives of a new species which appears to represent a new genus of pelecypod. This pelecypod externally resembles Eurydesma or Atomodesma, the right valve however, is considerably flatter than the left which precludes reference of the shell to the biconvex Eurydesma. The main shell structure in microscopic cross-section appears to be complex and not prismatic as in Atomodesma (or Aphanaia). A well preserved hinge is not available but in the examples on hand it could resemble that either of Eurydesma or Atomodesma.

In New South Wales the boundary between Faunas II and III appears to be close to the Fenestella zone which separates the lower and upper parts of the Branxton. The boundary between Faunas III and IV seems close to the Muree.

Correlation of Faunas III with the sequence in the Springsure area is not clear. It is younger than the Cattle Creek Formation and older than the Mantuan Productus Bed which has species characteristic of Fauna IV.

Fauna IV.

Fifty species are identified in this fauna, sixteen of which carry over from the beds below. It is especially marked by the incoming of many new species both of brachiopods and molluscs. This change may have been caused by a relatively rapid deepening of the basin, probably with uplift in the hinterland which brought in a different environment, rather than by a hiatus of any length. The fauna is not distinguished by entry of new genera, but many of the genera found in underlying beds are represented by different species.

No distinct faunal changes are apparent at any particular horizon. Within Fauna IV. The gradual change is shown for example by the Big Strophslodia Zone, most of the species of which occur below and above. The Big Strophalosia Zone appears to be a member of a larger unit and lacks sharp upper and lower limits.

In New South Wales, Fauna IV resembles closely that from the Mulbring Shale, the marine beds at Rylestone and Bundanoon, and the Gerringong Volcanics. The close relationship suggests a direct sea connection between the Bowen and Sydney Basins at the time. In both basins this appears to have been the time of most widespread western marine transgression during the Permian.

Correlation of Fauna IV with the Springsure sequence is not altogether clear. The fossils below the Big Strophalosia Zone are not older than the Ingelara Shale. The occurrence of Terrakea solida, Strophalosia brittoni var. gattoni, Notospirifer cf. minutus, Ingelarella magna and species of pelecypods such as Megadesmus grandis, and Schizodus sp. nov. C. in Fauna IV may indicate it is entirely younger. Unfortunately molluscs except Glyptoleda and Platyteichum are poorly represented in collections from the Ingelara Shale. Forms similar to Glyptoleda reidi, Ingelarella ingelarensis and I. angulata appear to be too long-ranged to establish the exact position of the Ingelara Shale. In Fauna IV, however, Platyteichum coniforme may replace P. costatum of Fauna III[1].

1 Recently Dickins (1961b, p.132) concluded that P.coniforme (Etheridge Jnr.) 1872 appeared to be a synonym of P.costatum Campbell 1953, although it had a slightly lower spire. I have since examined specimens collected by Isbell from the "Streptorhynchus Bed" which are referable to P.coniforme. These are younger than any known specimens of P.costatum, as probably are those from the type locality of P.coniforme in the Flat Top Formation of the Banana Area (south-east Bowen Basin). Therefore, P.coniforme may be a distinct morphological group at a stratigraphical level different to that of P.costatum.

On the other hand, the base of Fauna IV is unlikely to be younger than the base of the Mantuan Productus Bed which contains Strophalosia ovalis Maxwell 1954, as well as Terrakea solida, Trigonotreta sp.B, Parallelodon sp.nov.B, Myonia cf. carinata, M.cf. corrugata, and Chaenomya sp. S.ovalis has not so far been found below the Big Strophalosia Zone in the north-eastern part of the Bowen Basin and the last six species are characteristic of Fauna IV as a whole.

No faunal evidence seems to preclude the equivalence of the Big Strophalosia Zone and the Mantuan Productus Bed which resemble each other closely in lithological appearance and in their association of fossils.

IDENTIFICATIONS

Locality numbers from the Bowen 1:250,000 sheet have the prefix B, and those from the Mackay sheet the prefix M.

Fauna II

B 686 - Lat. ~~21°11'~~ 20°55' 45" S., Long. 148°08'30" E.

Pelecypods

Astartila cf. gryphoides (de Koninck) 1877

Chaenomya sp. nov. A (same species as in MC 479 - Dickins, 1961c)

Palaeosolen? sp. nov.

Modiolus sp. (has a rather distinct umbonal ridge and is rather convex)

Deltopecten limaeformis (Morris) 1845 (some of ribbing is more complicated than in type specimen and some approaches that of D. squamuliferus)

Aviculopecten sp. nov.

Aviculopecten cf. leniusculus (Dana) 1847

Aviculopecten cf. comptus (Dana) 1847 (has rather broad main ribs)

Astartella sp. nov.

Gastropods

Warthia sp.

Mourlonia (Mourlonia) sp. nov.? (may be higher spired than M. strzeleckiana)

Bembexia sp. nov. A

Brachiopods

Terrakea cf. pollex Hill 1950 (rather larger than Hill's specimens)

Cancrinella sp. (rather flat pedicle valve and concentric ornament poorly developed)

Anidanthus springsurensis (Booker) 1932

Strophalosia preovalis Maxwell 1954

Taeniothaerus sp.

Lissochonetes sp.

Neospirifer sp.

Ingelarella ovata Campbell 1961

Ingelarella profunda Campbell 1961

Dielasmatids

Crinoids

Part of a cup

Ossicles

M 411 - Lat. 21°29'15" S., Long. 148°32'00" E.

Pelecypods

Merismopteria sp.

Brachiopods

Ingelarella profunda Campbell 1961

Dielasmatid

M 412a - Lat. 21°29'30" S., Long. 148°32'45"E.

Pelecypods

Astartila cf. *gryphoides* (de Koninck) 1877

Deltopecten limaeformis (Morris) 1845

Aviculopecten cf. *fittoni* (Morris) 1845 (Outline of shell wavy)

Schizodus sp. nov. A.

Brachiopods

Terrakea pollex Hill 1950

Cancrinella sp. (rather flat pedicle valve and ornament not well developed)

Cancrinella farleyensis (Etheridge & Dun) 1909

Anidanthus springsurensis (Booker) 1932

Strophalosia preovalis Maxwell 1954

Taeniothaerus sp.

Lissochonetes sp.

Neospirifer sp. ind.

Trigonotreta sp. A (close to *T. stokesii* of Brown, 1953)

Ingelarella ovata Campbell 1961

Ingelarella profunda Campbell 1961

Notospirifer sp. ind.

Pseudosyrinx sp. nov.

Gilledia cf. cymbaeformis (Morris) 1845

Gilledia sp. nov.

M 412b - Latitude and Longitude as for M 412a.

Pelecypods

Astartila cf. gryphoides

Pachymyonia sp. ind. (one specimen similar to but may not be identical with P. cf. etheridgei Dun from MC 479 of Dickins, 1961c)

Modiolus sp.

Deltopecten squamuliferus (Morris) 1845

Aviculopecten tenuicollis (Dana) 1847

Streblopteria sp.

Cypricardinia ? sp. ind.

Brachiopods

Cancrinella farleyensis (Etheridge & Dun) 1909

Anidanthus springsurensis (Booker) 1932

Strophalosia preovalis Maxwell 1954

Strophalosia brittoni Maxwell 1954

Taeniothaerus sp.

Neospirifer (Grantonia) cf. hobartense (Brown) 1953

Trigonotreta sp. A.

Ingelarella ovata Campbell 1961

Ingelarella profunda Campbell 1961

Notospirifer hillae Campbell 1961

Fauna II ?

M 414 - Lat. 21°28'15" S., Long. 148°31'30" E. (lies stratigraphically between definite Fauna II and Fauna III)

Brachiopods

Terrakea sp. (a large form but seems wider at the umbo than T. solida and apparently lacks well developed umbonal thickening)

Fauna III a

B 261 - Lat. 20°44'30" S., Long. 147°57'00"E.

Pelecypods

Glyptoleda cf. reidi Fletcher 1945

Gastropods

Warthia sp.

Ammonites

To be identified by Dr. B.F. Glenister.

Brachiopods

Cancrinella sp. (as at MC 420, see Dickins 1961c, but may be long ranging).

M 413 - Lat. 21°28'15" S., Long. 148°31'15" E.

Pelecypods

Glyptoleda cf. reidi Fletcher 1945

Glyptoleda sp. nov. ? (squat form upturned at the back, also found in MC 420, Dickins 1961c)

Astartila cf. gryphoides (de Koninck) 1877

Chaenomya sp. nov. B?

Stutchburia cf. costata (Morris) 1845

Schizodus sp. (possibly similar to that from Glendoo Member)

Gastropods

Mourlonia (Platyteichum) cf. costatum Campbell 1953

Glossopteris leaf.

M 415 - Lat. 21°28'00" S., Long. 148°31'15" E.

Pelecypods

Glyptoleda sp.?

Megadesmus sp. nov.?

Astartila cf. gryphoides (de Koninck) 1877

Pachymyonia sp. nov.

Chaenomya sp. nov. B

Wilkingia ? sp. nov.

Gastropods

Warthia sp.

Mourlonia (Platyteichum) cf. costatum Campbell 1953

Brachiopods

Ingelarella cf. ingelarensis Campbell 1960

Wood.

Probable Fauna IIIa

M 21 - Lat. 21°31'00" S., Long. 148°33'30" E.

Pelecypods

Wilkingia? sp. nov.?

Atomodesma cf. mytiloides Beyrich 1864

Pseudomonotis? sp. nov. (gryphoid spiny shell)

Gastropods

Mourlonia (Platyteichum) cf. costatum Campbell 1953

Brachiopods

Cancrinella sp.

Ingelarella cf. ingelarensis Campbell 1960

Crinoids

Separate plates.

Fauna IIIb

Glendoo Member

B 634 - Lat. 20°56'30" S., Long. 147°41'15" E.

Pelecypods

Volsellina ? sp.?

Cypricardinia ? sp. (as at B 1633 - relationship to form in Fauna II not clear)

Brachiopods

Notospirifer cf. *extensus* Campbell 1961

Large dielasmatid

Bryozoans

Branching stenoporids

B 629 - Lat. 20°55'30" S., Long. 147°41'15" E.

Pelecypods

Gen. et sp. nov. (very plentiful)

Gastropods

Bembexia sp. nov. B

B 1569 - Lat. 20°48'15" S., Long. 147°41'15" E.

Pelecypods

Gen. et sp. nov. (very plentiful)

Gastropods

Indet.

B 1633 - Lat. 20°49'00" S., Long. 147°41'00" E.

Pelecypods

Nuculana sp. (two species may be present - an elongated and a short one)

Astartila cf. *gryphoides* (de Koninck) 1877

Merismopteria sp.

Notomya or *Pyramus* sp. (could be species in Glendoo Member north of Bowen River and probably species at B 261d)

Gen. et sp. nov.

Aviculopecten cf. *subquinquelineatus* (McCoy) 1847 (simple ribbed type)

Stutchburia cf. *costata* (Morris) 1845

Cypricardinia ? sp. (seems similar to species in Fauna II)

Parallelodon or *Cypricardinia* ? sp. (with radiating ornament at rear)

Schizodus sp. nov. B (as in Glendoo Member north of Bowen River)

Gastropods

Warthia sp.

Mourlonia (*Mourlonia*) sp. ind.

Bembexia sp. nov. B (one specimen similar to *B.* sp. nov. A. from Fauna II but most specimens are higher spired).

Walnichollsia? sp. nov. (distinct keel on upper whorl surface)

Capulid gastropod with radiating ornament.

Brachiopods

Neospirifer sp.

Notospirifer cf. *extensus* Campbell 1961 (in *N. minutus* Campbell the posterior sweeps back more quickly and dental plates are closer and more parallel, has some resemblance to *N. darwini* (Morris) 1845).

Dielasmatid (flat species as in Glendoo Member to north of Bowen River)

Bryozoans

Stenoporids or batostomellids

Fenestellids

Crinoids

Plates

Bones

Glendoo Member (Gebbie Creek and Exmoor Sections)

B261d - Lat. 20°44'30" S., Long. 147°57'00" E.

Pelecypods

Megadesmus? sp.? (like a small _M. grandis_ but perhaps more like _M. nobilissimus_, not clear whether same as species in Collinsville 3).

Astartila cf. _gryphoides_ (de Koninck) 1877

Notomya or _Pyramus_ sp. (apparently not the same species as at CL. 122, CL 12/1 or Collinsville 5)

Merismopteria sp.

Volsellina ? sp.?

Gen. et. sp. nov. (very plentiful)

Aviculopecten sp. ind.

Gastropods

Warthia sp.

Bembexia sp. nov. B

Worm Burrows

B 711 - Lat. 20°56'30" S., Long. 148°08'15" E.

Pelecypods

Merismopteria sp.

Gen. et sp. nov.

Fauna III c

M 416 - Lat. 21°27'45" S., Long. 148°30'00" E.

Pelecypods

Megadesmus? sp. (appears to be same as at Collinsville 3 - Dickins 1961d)

Astartila? cf. _gryphoides_ (de Koninck) 1877? (one incomplete specimen)

Notomya? sp. nov. (may be same as species of CL 122 - Dickins 1961d)

Gen. et sp. nov.?

Streblopteria sp.

Stutchburia cf. compressa (Morris) 1845

Schizodus ? sp. nov. B?

Gastropods

Warthia sp.

Mourlonia (Mourlonia) cf. strzeleckiana (Morris) 1845

Mourlonia (Platyteichum) cf. costatum Campbell 1953

Peruvispira sp. nov. (as at B 270b and CL 122 - Dickins 1961d)

Brachiopods

Notospirifer sp. B (like a large N. cf. extensus. Appears less cut back from umbo than N. minutus Campbell. However, has a fold in sulcus and therefore differs from N. cf. extensus)

M 417 - Lat. 21°27'00" S., Long. 148°30'45" E.

Pelecypods

Aviculopecten cf. subquinquelineatus (McCoy) 1847

Stutchburia cf. costata (Morris) 1845

Stutchburia cf. compressa (Morris) 1845

Stutchburia cuneata (Dana) 1847

Cypricardinia? sp.

Astartidae gen. et nov. A (seems more transversely elongated than species in Fauna IV)

Brachiopods

Ingelarella cf. ingelarensis Campbell 1960

Ingelarella undulosa Campbell 1961

Notospirifer sp.? (may be N. minutus or N. cf. extensus)

Flattish dielasmatid

Wood.

Fauna IV

Below Big Strophalosia Zone

B 261e - Lat. 20°44'30" S., Long. 147°57'00" E.

Pelecypods

Megadesmus grandis (Dana) 1847

Merismopteria sp. (very large specimens)

Aviculopecten sp. A (species with large irregular ribs more or less of one order - same as A. sp. B in Clermont shaft and CL 225/1 - see Dickins 1961d)

Schizodus sp. nov. C.

Gastropods

Mourlonia (Mourlonia) cf. strzeleckiana (Morris) 1845

Brachiopods

Terrakea solida (Etheridge and Dun) 1909

Strophalosia cf. typica (Booker) 1929 (same as in Collinsville 4. Poorly developed ventral sulcus, which may distinguish it from S. typica)

Ingelarella cf. magna or mantuanensis Campbell 1960

Bryozoans

Branching stenoporids

B 683 - Lat. 20°56'45" S., Long. 148°08'00" E.

Pelecypods

Myonia cf. carinata (Morris) 1845

Aviculopecten sp. A.

Stutchburia cf. costata (Morris) 1845

Schizodus sp. nov. C.

Astartidae gen. et sp. nov. B.

Brachiopods

Terrakea sp. (may be small T. solida)

Neospirifer sp.

Ingelarella cf. ingelarensis Campbell 1960

<u>Ingelarella magna</u> Campbell 1960

<u>Notospirifer</u> cf. <u>minutus</u> Campbell 1960

<u>Pseudosyrinx</u> sp.

Biplicate dielasmatids (same species as at B 1510)

Blastoid or crinoid plates

B 1634 - Lat. 20°50'00" S., Long. 147°42'00" E.

Brachiopods

<u>Strophalosia</u> sp.

<u>Ingelarella</u> cf. <u>ingelarensis</u> Campbell 1960

Crinoid Cup.

M 418 - Lat. 21°27'00" S., Long. 148°30'30" E.

Pelecypods

<u>Megadesmus grandis</u> (Dana) 1847
<u>Megadesmus</u>? sp. (similar to species in Collinsville 3)
<u>Stutchburia</u> sp. ind.

<u>Schizodus</u> sp. nov. C.

Big <u>Strophalosia</u> Zone

B 1570 (undifferentiated) - Lat. 20°50'00" S., Long. 147°42'30" E.

Brachiopods

<u>Terrakea solida</u> (Etheridge & Dun) 1909

<u>Strophalosia brittoni</u> var. <u>gattoni</u> Maxwell 1954

<u>Strophalosia clarkei</u> (Etheridge Snr.) 1872

<u>Strophalosia ovalis</u> Maxwell 1954

<u>Neospirifer</u> sp.

<u>Ingelarella ingelarensis</u> Campbell 1960

Biplicate dielasmatid

Branching and Encrushing Bryozoans

Single Coral

B 1570c - as for B 1570, 0 to 16 feet above base; fine to medium-grained calcareous sandstone with some siltstone.

Pelecypods

Myonia cf. *carinata* (Morris) 1845

Aviculopecten sp. ind.

Brachiopods

Terrakea solida (Etheridge & Dun) 1909

Strophalosia cf. *brittoni* var. *gattoni* Maxwell 1954

Strophalosia clarkei (Etheridge Snr.) 1872

Neospirifer sp.

Trigonotreta sp. B.

Pseudosyrinx sp.

Encrusting Bryozoans

(including incrustations on pebbles up to 1 inch across)

B 1570b - as for B 1570, 32 to 43 feet above base; mainly fine to medium-grained calcareous sand.

Brachiopods

Terrakea solida

Cancrinella sp. (simple type)

Strophalosia clarkei

Strophalosia ovalis

Neospirifer sp.

Ingelarella cf. *ingelarensis*

Encrusting Bryozoans

Single coral

B 1570a - as for B 1570, 101 to 117 feet above the base; calcareous siltstone or limestone with some fine-grained sandstone.

Pelecypods

Myonia cf. *corrugata* Fletcher 1932

Jnr.

"*Solemya*" *edelfeldti* (Etheridge Snr.)

Brachiopods

Terrakea solida

Strophalosia cf. *typica*

S. cf. *brittoni* var. *gattoni*

S. clarkei

Neospirifer sp.

Trigonotreta sp. B.

Ingelarella cf. *ingelarensis*

Cancellospirifer sp.

Encrusting Bryozoans

Single Corals

B 712 - Lat. 20°56'30" S., Long. 148°08'00" E., top 20 feet of zone.

Brachiopods

Strophalosia cf. *brittoni* var. *gattoni*

S. clarkei

S. ovalis

Neospirifer sp.

Trigonotreta sp. B.

Ingelarella ingelarensis

Encrusting Bryozoans

Big *Strophalosia* Zone or Close to Zone

B 594 - Lat. 20°49'15" S., Long. 147°59'30" E.

Pelecypods

Chaenomya sp. (species in Fauna IV)

Brachiopods

Terrakea or *Cancrinella* sp.

Strophalosia cf. *clarkei*

Notospirifer cf. *minutus*

B 628 - Lat. 20°49'15" S., Long. 147°43'00"E.

Pelecypods

Conocardium sp.

Brachiopods

Terrakea solida

Strophalosia ovalis

Bryozoa

Encrusting and fenestellid forms.

Single Coral

B 635 - Lat. 20°56'30" S., Long. 147°42'00" E.

Brachiopods

Terrakea solida

Strophalosia cf. clarkei

B 667 - Lat. 20°26'00" S., Long. 147°45'15" E.

Brachiopods

Terrakea solida

Neospirifer sp.

M 85 - Lat. 21°34'45" S., Long. 148°34'00" E.

Pelecypods

Myonia cf. carinata (Morris) 1845

Myonia cf. corrugata Fletcher 1932

"Solemya" edelfeldti (Etheridge Jnr.) 1892

"Modiolus" cf. mytiliformis (Etheridge Jnr.) 1892

Stutchburia cf. costata (Morris) 1845

Astartidae gen., sp. ind.

Brachiopods

Strophalosia cf. clarkei (very numerous as in Big Strophalosia Zone)

Strophalosia cf. ovalis

Ingelarella cf. ingelarensis

Notospirifer cf. minutus

Streptorynchus cf. pelicanensis Fletcher 1952

Bryozoans

Probably above Big Strophalosia Zone

M 86 - Lat. 21°34'45" S., Long. 148°33'15" E.

Pelecypods

"Modiolus" cf. mytiliformis (Etheridge Jnr.) 1892

Astartidae gen., sp. ind.

Brachiopods

Cancrinella or Terrakea sp.

Strophalosia cf. ovalis

Neospirifer sp.

Fenestellid bryozoans

Corals

Cladochonus sp.

Single corals.

Crinoid step ossicles

Above Big Strophalosia Zone

B 270a - Lat. 20°57'00" S., Long. 148°08'00" E., close to "Streptorynchus-bed"

Pelecypods

Nuculana sp.

Astartila cf. cytheria Dana 1847

Chaenomya sp.

Aviculopecten sp. ind.

Stutchburia cf. costata (Morris) 1845

Stutchburia cuneata (Dana) 1847

Schizodus sp. nov. C

Astartidae gen. et. sp. nov. B

Gastropods

Warthia sp.

Mourlonia (Mourlonia) cf. strzeleckiana (Morris) 1845

Brachiopods

Strophalosia ovalis Maxwell 1954

Notospirifer minutus Campbell 1960

Wood

B 270b - as for B 270a, slightly higher stratigraphically.

Pelecypods

<u>Merismopteria</u> sp. (very large specimens)

<u>Aviculopecten</u> sp.? (a large specimen with distinct concentric rugae)

Gastropods

<u>Peruvispira</u> sp. nov. (same species as at CL 122 and M 416 and similar to <u>P. trifilata</u> (Dana))

B 1572 - Lat. 20°47'15" S., Long. 147°44'45" E., "<u>Martiniopsis</u>-bed"

Brachiopods

<u>Ingelarella</u> <u>havilensis</u> Campbell 1960.

REFERENCES

CAMPBELL, K.S.W., 1959 - The <u>Martiniopsis</u>-like spiriferids of the Queensland Permian. <u>Palaeontology</u>, 1, 333-350.

CAMPBELL, K.S.W., 1961 - New species of the Permian spiriferoids <u>Ingelarella</u> and <u>Notospirifer</u> from Queensland and their stratigraphic implications. <u>Palaeontographica</u>, 117(A), 159-192.

DICKINS, J.M., 1961a - Permian pelecypods newly recorded from Eastern Australia. <u>Palaeontology</u>, 4(1), 119-130.

DICKINS, J.M., 1961b - The gastropod <u>Platyteichum</u> in the Permian of Western Australia. <u>Ibid</u>., 131-137.

DICKINS, J.M., 1961c - Appendix <u>in</u> Malone, E.J., Corbett, D.W.P., and Jensen, A.R., Geology of the Mount Coolon 4-mile area. <u>Bur. Min. Resour. Aust. Rec</u>. 1961/69 (unpubl.).

DICKINS, J.M., 1961d - Appendix <u>in</u> Veevers, J.J., Randal, M.A., Mollan, R.G., and Paten, R.J., The geology of the Clermont 4-mile Sheet area, Queensland. <u>Bur. Min. Resour. Aust. Rec</u>., 1961/75 (unpubl.).

DICKINS, J.M., in press - Permian pelecypods and gastropods from Western Australia. <u>Bur. Min. Resour. Aust. Bull</u>. 63.

DICKINS, J.M., MALONE, E.J., and JENSEN, A.R., 1962 - Subdivision and correlation of the Middle Bowen Beds. <u>Bur. Min. Resour. Aust. Rec</u>., 1962/87 (unpubl.).

AUSTRALIA 1 : 250,000

BOWEN SOUTH

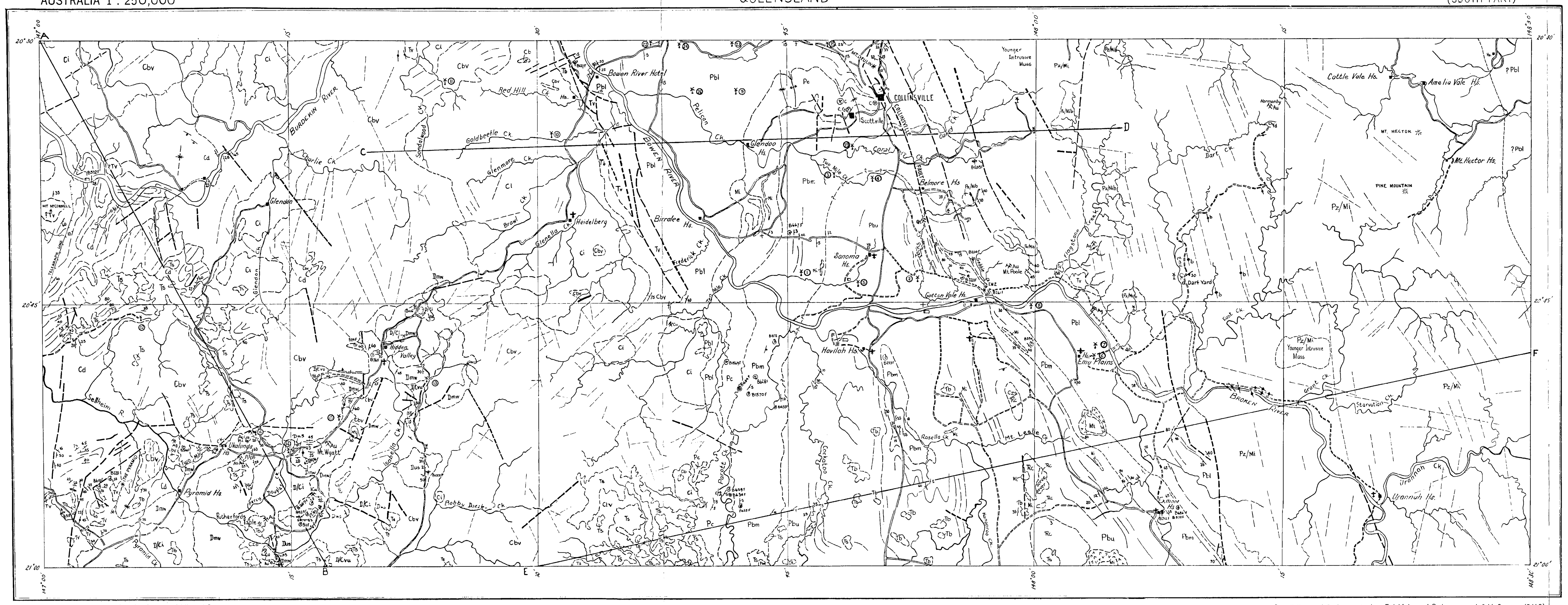
QUEENSLAND

1 : 250,000 GEOLOGICAL SERIES SHEET SF 55-3 (SOUTH PART)

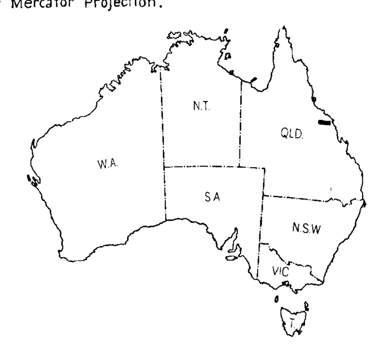
PRELIMINARY EDITION 1962
SUBJECT TO AMENDMENT

Reference

- *Geological boundary*
- *Synclinal axis*
- *Anticlinal axis*
- *Fault*
- *Where location of boundaries, faults and folds is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes.*
- *Strike and dip of strata*
- *Prevailing dip*
- *Vertical strata*
- *Horizontal strata*
- *Dip < 15° - air-photo interpretation*
- *Strike and dip of foliation*
- *Vertical foliation*
- *Joint pattern, air-photo interpretation*
- *Marine fossil locality*
- *Plant fossil locality*
- *Wood fossil*
- *Measured stratigraphic section*
- *Dyke: b - Andesite and basalt; q - quartz*
- *Contact metamorphic aureole*
- *Large mine*
- *Old workings, closed mine*
- Au *Gold*
- Ag *Silver*
- As *Arsenic*
- Bi *Bismuth*
- C *Coal*
- Cu *Copper*
- Cy *Clay - use not specified*
- *Road*
- *Vehicle track*
- *Railway line*
- *Telegraph or powerline*
- Hs. *Homestead*
- *Yard*
- *Landing Ground*
- *Bore with wind pump and reference number to water bore data in report*
- *Wind pump.*

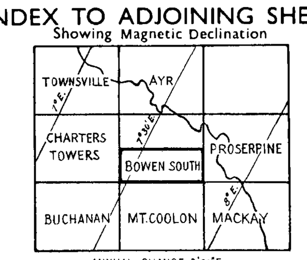


Compiled and published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Aerial photography by Adastra Aerial Surveys; complete vertical coverage at 1:85000 scale. Transverse Mercator Projection.



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination



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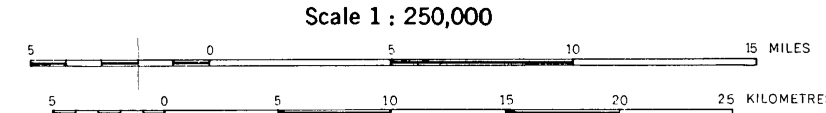
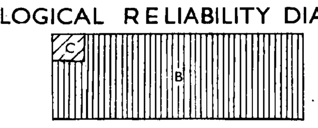
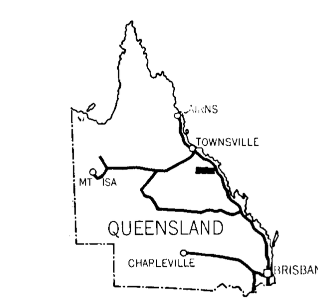


GEOLOGICAL RELIABILITY DIAGRAM



B Detailed reconnaissance — numerous traverses
C Sketchy - air-photo interpretation

Compilation and Geology, 1961, by: E.J. Malone, A.R. Jensen, and C.M. Gregory, (B.M.R.); V.R. Forbes, (Q.G.S.)

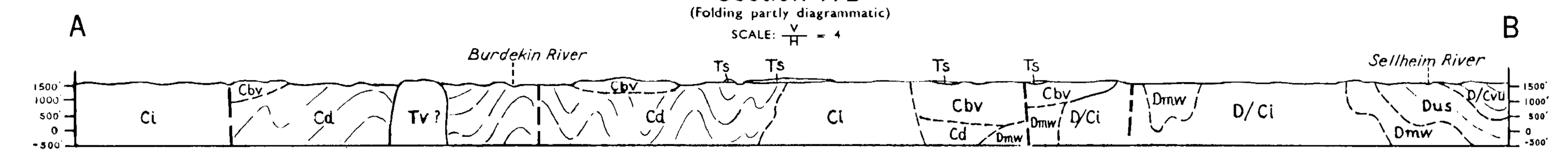


Reference

CAINOZOIC			Czs	*Alluvial deposits, soil, ferruginous gravel.*
	TERTIARY	Suttor Formation	Tv	*Contorted flow-banded rhyolite and dacite, trachyte, obsidian and volcanic glass, rhyolitic and basaltic agglomerate, basalt and dolerite dykes, quartz-feldspar porphyry; trachytic volcanics; siliceous plugs.*
			Ts	*Sandstone, fine and pebble conglomerate, siltstone, clay, sandy clay, silicified argillaceous siltstone, oil shale.*
			Tb	*Basalt flows; rare plugs.*
MESOZOIC			Mi	*Sills, dykes and laccoliths of granodiorite, diorite rhyolite, porphyry, gabbro, hornblende diorite.*
	TRIASSIC	Carborough Sandstone	Rc	*Cross-bedded quartz sandstone, feldspathic in places, some fine and pebble conglomerate.*
PALAEOZOIC OR MESOZOIC			Pz/Mi	*Granite-granodiorite-diorite complex with some basic to ultrabasic components and intruded by several generations of acid to basic dyke rocks.*
			Pz/Mib	*Basic igneous intrusions.*
PALAEOZOIC	PERMIAN	Upper Bowen Coal Measures	Pbu	*Cross-bedded, well-sorted lithic sandstone, siltstone, quartz sandstone carbonaceous shale, some coal seams, pebble and cobble conglomerate beds, dolomitic and calcareous sandstone.*
		Middle Bowen Beds Undifferentiated	Pbm	*Quartz greywacke, hard, fossiliferous, calcareous and ferruginous in places, containing pebbles and cobbles in places; quartz sandstone, siltstone, carbonaceous shale, coal.*
		Collinsville Coal Measures	Pc	*Quartz sandstone, conglomerate, siltstone, fossiliferous, calcareous quartz greywacke, coal seams, carbonaceous shale.*
		Lower Bowen Volcanics	Pbl	*Sandstone, siltstone, greywacke siltstone and tuffaceous sandstone; pebble to massive boulder conglomerate; basaltic, andesitic trachytic flows, breccias, tuffs and agglomerates.*
	CARBONIFEROUS		Ci	*Granite and granodiorite, with aplite and other fine-grained acid components.*
		Bulgonunna Volcanics	Cbv	*Dominantly rhyolitic volcanics, including porphyritic flows, crystal tuffs, agglomerates and auto-breccias; minor lithic sandstone and siltstone.*
		Drummond Group	Cd	*Sandstone, tuffaceous sandstone, siltstone, conglomerate, siliceous siltstone and impure chert, acid flows and tuffs, agglomerate, rare algal limestone lenses.*
	CARBONIFEROUS - DEVONIAN		D/Ci	*Grey-blue granodiorite, jointed in places, with numerous roof pendants.*
		Undifferentiated Volcanics	D/Cvu	*Siliceous tuff, crystal tuff, porphyritic rhyolite, volcanic conglomerate.*
	UPPER DEVONIAN		Dus	*Lithic sandstone, siltstone, conglomerate.*
	MIDDLE DEVONIAN		Dmw	*Lithic sandstone, shale, conglomerate, siltstone, fossiliferous and calcareous in places; silicified limestone, chert, thin fossiliferous limestone beds and lenses, quartz sandstone and quartz pebble conglomerate. Quartz veining, silicification, and low grade contact and regional metamorphism in places.*

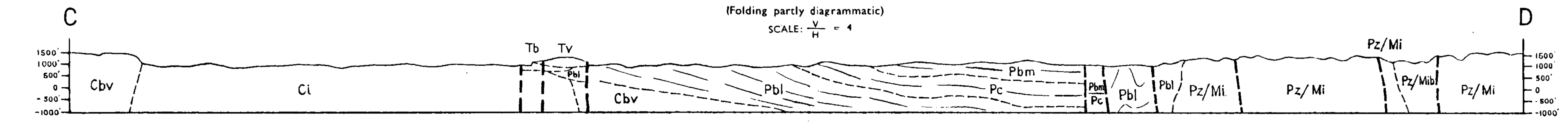
Section A-B

(Folding partly diagrammatic)



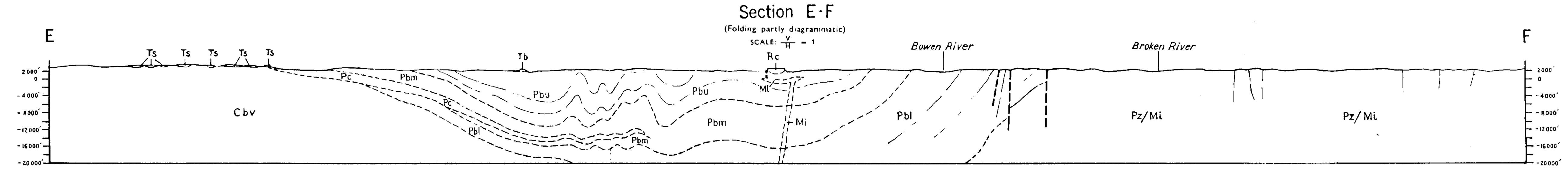
Section C-D

(Folding partly diagrammatic)



Section E-F

(Folding partly diagrammatic)

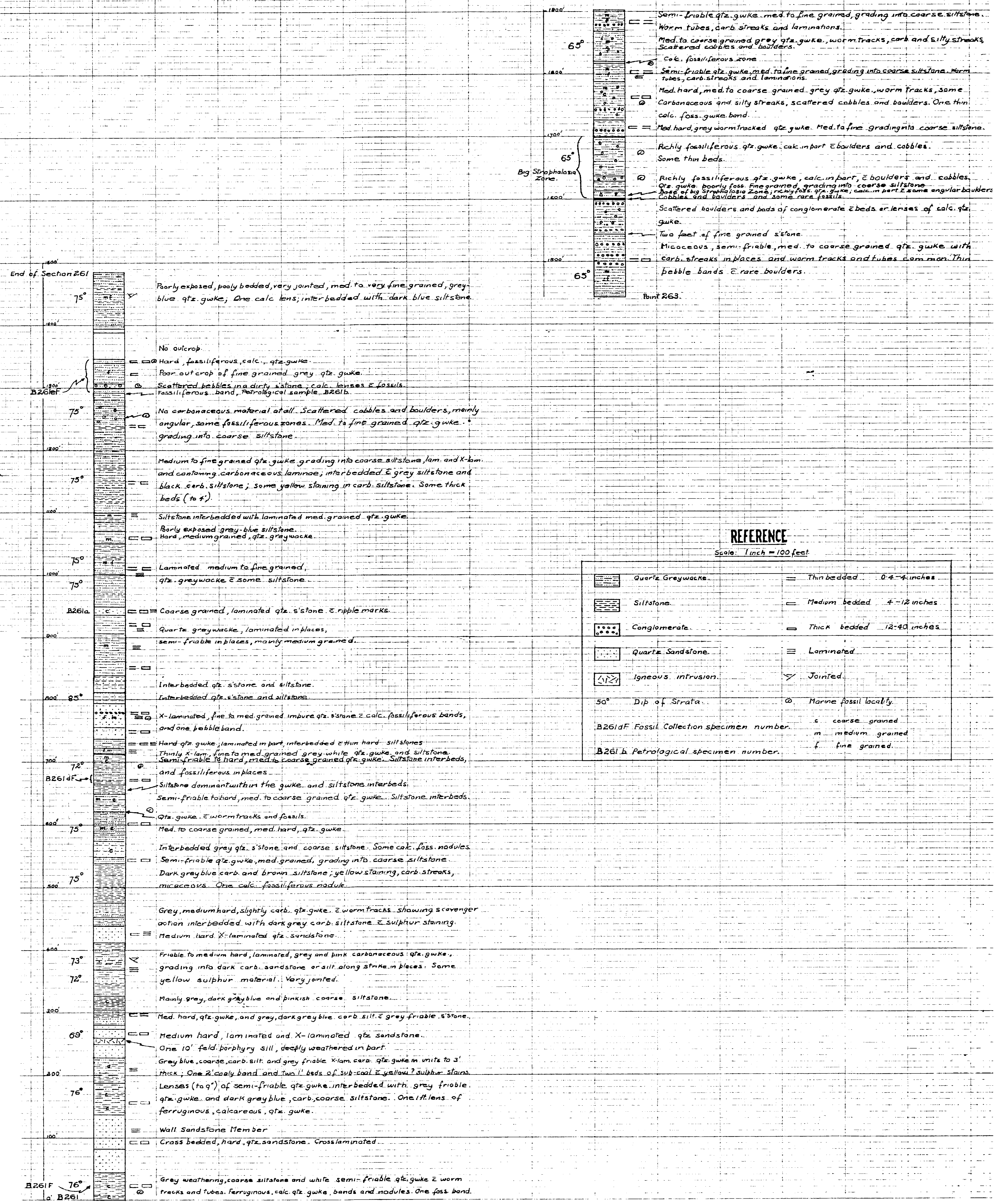


BOWEN SOUTH
SHEET SF 55-3
(SOUTH PART)

Plate 2.

MIDDLE BOWEN STRATIGRAPHIC SECTION MEASURED IN GEBBIE CREEK.

15 ml. SOUTH EAST OF COLLINSVILLE. BOWEN 4 ml. AREA.



Bureau of Mineral Resources, Geology and Geophysics   March 1962   To accompany Record No 1962/72

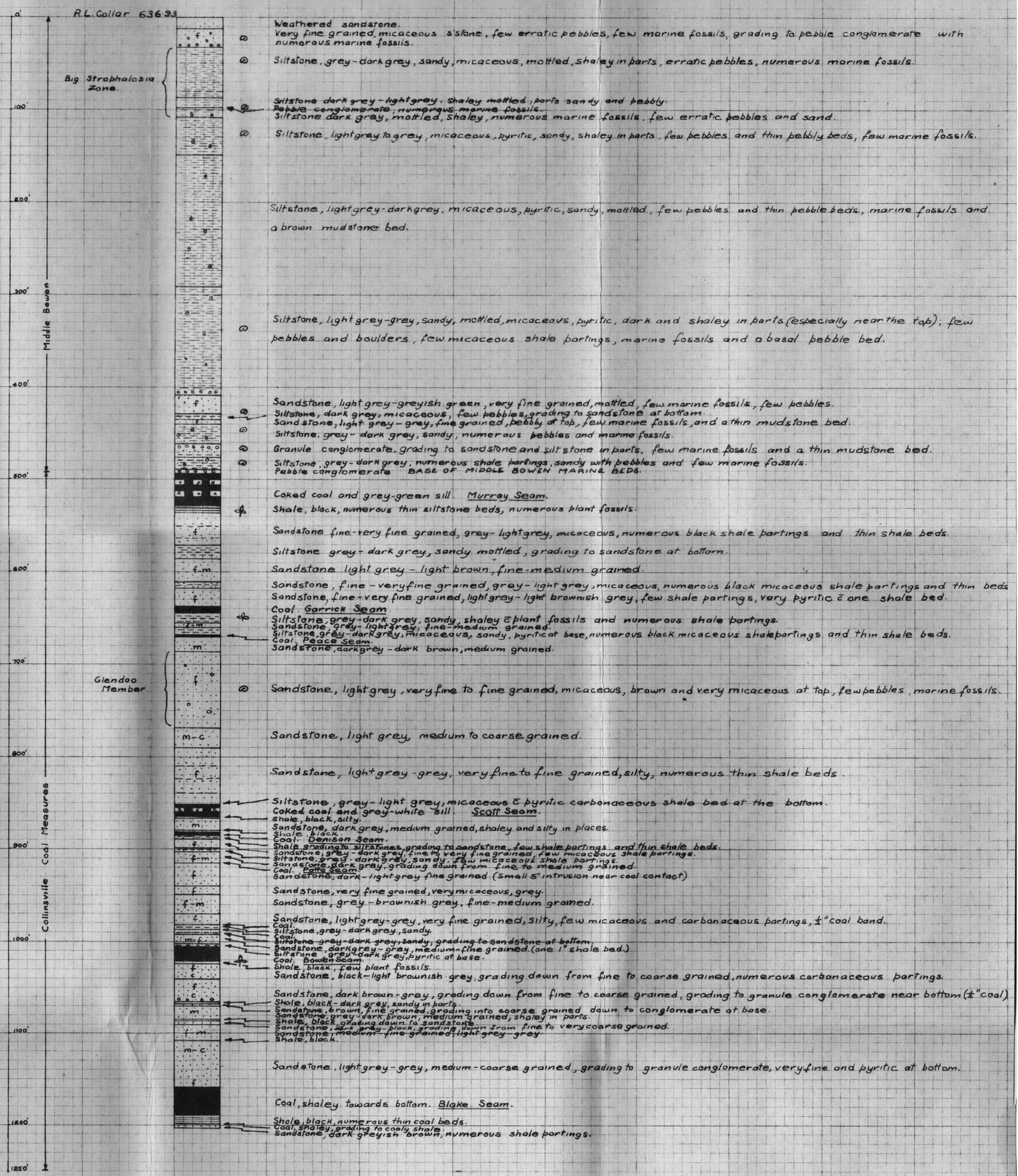
F 55/3/1

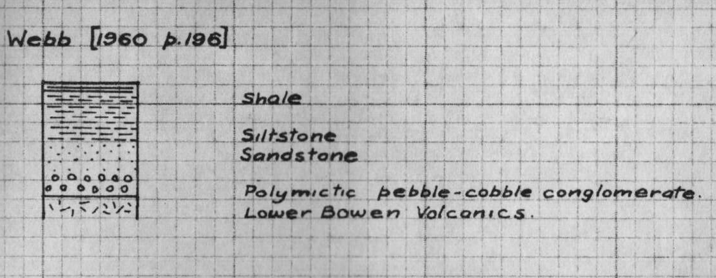
Plate 3.

Bowen Consolidated Coal Mines Bore

About ¼ ml. east of watertank Scottville.

NS371.





REFERENCE

Scale 1" = 100'.