COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

REPORT No. 100

Geology of the Southern Half of the Bowen 1:250,000 Sheet Area, Queensland

BY

E. J. MALONE, A. R. JENSEN, C. M. GREGORY
Bureau of Mineral Resources

and

V. R. FORBES
Geological Survey of Queensland

Issued under the Authority of the Hon. David Fairbairn,
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MINISTER: THE HON. DAVID FAIRBAIRN, D.F.C., M.P.

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SUMMARY

A combined field party from the Bureau of Mineral Resources and the Geological Survey of Queensland mapped the southern half of the Bowen 1:250,000 Sheet area in 1961, as part of the programme of regional geological mapping of the Bowen Basin which was begun in 1960. The area mapped is referred to as Bowen South, and can be divided into three parts. The western part consists of Palaeozoic sediments, volcanics, and intrusives of several ages and complex inter-relations. The central part is occupied by the Permian-Triassic sediments, volcanics, and associated intrusives of the Bowen Basin, and was mapped in more detail than the western part. The eastern part consists partly of pre-Permian intrusive rocks and volcanics.

In the west the oldest rocks are the fossiliferous Ukalunda Beds, which are at least partly Middle Devonian. Their relationship to the Anakie Metamorphics is unknown. The Ukalunda Beds, and the associated adamellite and granodiorite intrusions, form the northern end of the 'Anakie High', which extends north-east for 30 miles from the south-west corner of Bowen South and separates the Drummond Basin to the north-west from the Mount Wyatt Beds to the south-east. The Upper Devonian Mount Wyatt Beds probably rest unconformably on the Ukalunda Beds. They dip south to south-east off the High and are overlain, apparently conformably, by Devonian to Carboniferous volcanics. Several other isolated blocks of volcanics of uncertain age have been included with the Devonian to Carboniferous group. The Lower Carboniferous Drummond Group rests unconformably on the Ukalunda Beds. The group occupies the northern end of the Drummond Basin, which trends north-east, parallel to the Anakie High.

The Upper Carboniferous Bulgonunna Volcanics are an extensive body of mainly acid volcanics, which wedge out to the west, where they rest unconformably on the Drummond Group, the Devonian to Carboniferous volcanics, the Mount Wyatt Beds, and the Ukalunda Beds. To the east, the Bulgonunna Volcanics and associated Upper Carboniferous intrusives are unconformably overlain by the Bowen Basin sequence.

The Connors Arch, in the eastern part of the area, consists of Carboniferous to Mesozoic intrusive rocks (Urannah Complex) and remnants of pre-Permian volcanics (Connors Volcanics), which are faulted against or overlain by the Bowen Basin sequence. Some of the intrusives are Permian or younger and intrude the Bowen Basin sequence.

The succession in the Bowen Basin began with the eruption of a large volume of andesitic lava and pyroclastics interbedded with thick clastic sediments (Lower Bowen Volcanics) in the rapidly subsiding trough zone of the basin. The great thickness of sediments was mainly derived from volcanics, and towards the end of the volcanic cycle the environment was marine. The Lower Bowen Volcanics also form the basal part of the succession in the shelf zone to the west, where they consist of basaltic lavas and pyroclastics and freshwater sediments resting unconformably on the Bulgonunna Volcanics.

The Lower Bowen Volcanics were succeeded by the marine fossiliferous Tiverton Formation, at the base of the Middle Bowen Beds. The formation was deposited mainly in the trough zone of the Bowen Basin. The area of deposition then expanded to the north and west: the Gebbie Formation was deposited in a fairly shallow sea in the trough zone, and at the same time the Collinsville Coal Measures were formed in a deltaic environment on the western shelf, partly overlapping the Lower Bowen Volcanics. Subsequently, the sea transgressed farther to the west, and the Blenheim Formation was deposited in moderately deep water in the trough zone and in shallower water on the western shelf.

The Upper Bowen Coal Measures rest conformably on the Middle Bowen Beds, but were deposited in a lacustrine, fluvial, or paludal environment. They are restricted to the shelf zone and the western part of the trough zone, possibly as a result of uplift of the Connors Arch, which also supplied the volcanic-derived sediments characteristic of the Upper Bowen Coal Measures. The Carborough Sandstone is conformable on the Upper Bowen Coal Measures and possibly represents fluviatile sedimentation with considerable reworking in a slowly subsiding basin.

The Bowen Basin succession was folded and, to some extent, intruded during the Mesozoic. The most prominent structure is the Bowen Syncline. The western limb consists of shallow-dipping sediments of the shelf zone, but the eastern limb, adjacent to the Connors Arch, is steeply dipping. The arch is a major anticline trending parallel to the Bowen Syncline.

Remnants of Tertiary sediments and basalt and scattered blocks of Tertiary acid volcanics are widely distributed in the Bowen South area.

The Middle Bowen Beds contain possible oil source rocks, and some of the quartz sandstone beds may be suitable as reservoir rocks. The oil prospects are reduced by the presence of numerous igneous intrusions, although the larger intrusions are confined to the trough zone. The high ratio of fixed carbon and volatiles in the coals is also an unfavourable factor. The Rosella Creek Anticline, on the western limb of the Bowen Syncline, is a possible drilling prospect which could be tested for the presence of hydrocarbons. The borehole would also provide stratigraphic information and data on porosity and permeability.

INTRODUCTION

This Report describes the geology of the southern half of the Bowen 1:250,000 Sheet area, between latitude 20°30'S. and 21°S., and longitude 147°E. and 148°30'E. The area is referred to as Bowen South throughout this Report. It includes the small coal-mining town of Collinsville, which is linked by a 3 foot 6 inch gauge railway line to Bowen on the Queensland coast. A formed road is also being constructed.

Gravel roads run from Collinsville to the Charters Towers/Clermont Highway, to Bowen, Nebo, and Mount Coolon. These and minor roads and vehicle tracks that branch off them give access to much of the country. In the more rugged areas, tracks are many miles apart; and the eastern section is served only by four tracks suitable for four-wheel-drive vehicles.

The annual rainfall is generally between 20 and 30 inches, most of which falls during the summer. Some frosts occur during the winter.

Coal mining is the main industry. The State Coal Mine at Collinsville and the Bowen Consolidated Coal Mine at Scottville, about 4 miles from Collinsville, support the population of about 2000. In 1960 the State Coal Mine was sold to a private firm. The pastoral industry is the only other industry of importance: there are 19 stations in the area, most of which are located in the better grazing country on the Bowen Basin sequence.

The Bowen Sheet area is covered by high-quality air-photographs on a scale of 1:85,000, taken by Adastra Airways Pty Ltd in 1960. The geology was plotted on transparent overlays, and these were photographically reduced to fit the slotted templet assembly at a scale of 1:250,000.

This Report and the accompanying map are largely based on field work done between 9th June and 5th September 1961, by a combined field party which included 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 based on the maps published by the geologists of the Bowen Consolidated Coal Mining Company (Webb & Crapp, 1960). Our map also incorporates unpublished material provided by the Company's geologists on the Bowen Basin sediments south of the Bowen River. The assistance of Mr C.E. Crapp and the other geologists of the Bowen Consolidated Coal Mining Company is gratefully acknowledged, and we are also grateful to Bowen Consolidated Coal Mining Company for permission to publish the log of their diamond drill hole No. 371.

Previous Investigations

The mineral and coal deposits of the Bowen South area were exploited to some extent during last century. The first notes on the geology of the area were published by R. Daintree in 1870. R.L. Jack made many visits between 1879 and 1893, and reported on the coalfields and on a number of mineral prospects. He also made a considerable contribution to the regional geology and palaeontology. Other early workers included Maitland (1889) and Cameron (1903). Morton examined many of the mineral prospects between 1920 and 1946. Reid made important contributions to the geology of the area. He mapped many parts of the area between 1924 and 1931, revised Jack's subdivision of the Bowen Basin sequence, and reviewed the Upper Palaeozoic succession in the west.

Traves (1951, 1953) produced a geological map and report on the Townsville-Bowen region, based on reconnaissance mapping and photo-geological interpretation, which included part of Bowen South. He suggested that the Upper Devonian volcanics were possibly unconformable beneath the Permian Lower Bowen Volcanics east of the Bowen Syncline. Isbell (1955) made a reconnaissance map of much of the northern Bowen Basin, including part of the Bowen South area. Laing (1959) also mapped part of the area on a reconnaissance basis. Detailed mapping is being carried out south of Collinsville by geologists of the Bowen Consolidated Coal Mining Company (Webb & Crapp, 1960).

Physiography

Thirteen physiographic units can be distinguished in Bowen South. Their distribution is shown in Figure 1.

The Bowen River valley is a broad mature valley bounded to the east and west by highlands. The plains are covered with soil, and the minor topographic features include some low ridges covered with rubble, dissected cuestas with a relief of about 250 feet in the west, and long steep strike ridges with a relief of less than 100 feet. In the east, volcanic hills such as Mount Devlin rise about 750 feet above the plains. Other high hills are found in circular metamorphic aureoles in the south-east.

Alluvial flats are common in the Bowen River valley. The flats are being eroded, and in many places the underlying rocks are exposed. In places, the alluvial flats grade into mature plains, but elsewhere they abut against prominent topographic features. Alluvial flats also occur along the Sellheim River in the south-west, and in the north-east corner of the area.

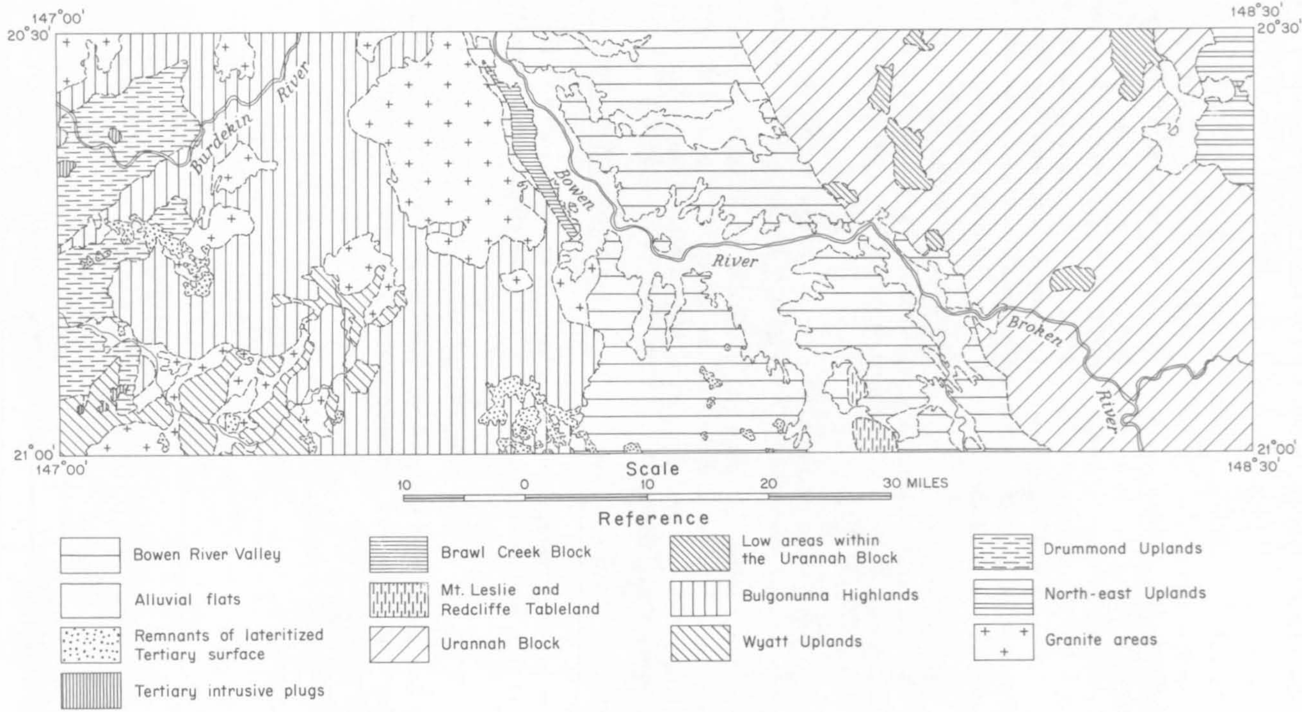
Remnants of an extensive lateritized Tertiary surface occur in the south and west. In the Bowen River valley they form mesas rising up to 200 feet above the plains. Farther west, the elevation of the mesas and plateaux is generally less than the highest peaks of the highlands and uplands.

The Tertiary intrusive plugs in the west are mostly small and youthful landforms. The largest is Mount McConnell. It is a steep-sided plug, which occupies an area of about 4 square miles, rising about 600 feet above the surrounding countryside.

The elongated Brawl Creek block is bounded mainly by steep scarps about 500 feet high, and is probably an uplifted fault block. The plateau top is dissected, and in places slopes eastward. The block is breached by Brawl Creek and by a smaller creek near the northern end. Brawl Creek has cut a wide steep-sided valley, which is straight for part of its length and may be controlled by faulting.

Mount Leslie and the Redcliffe Tableland are located in the Bowen River valley at the southern edge of the Bowen Sheet area. 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. The boundary with the Bowen River valley lies at the foot of a line of hills rising 300 to 400 feet above the valley. Most of the block forms a high dissected plateau with a structurally controlled drainage pattern. Occasional hills rise above the plateau. They are deeply incised by gullies and creeks with a close dendritic pattern.



Bureau of Mineral Resources, Geology and Geophysics. April, 1965.

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Fig. 1 Physiographic sketch map, Bowen South.

In the east and south, the block is broken up into groups of high hills with deeply incised drainage systems. In the east, the hills are separated by re-entrants of the lower coastal strip to the east, and in the south they are separated by the Broken River and its tributaries.

The low areas within the Urannah block have apparently been formed by chemical weathering.

The Bulgonunna highlands to the west of the Bowen River Valley rise 400 to 600 feet above the valley. The drainage forms a close incised pattern, and many of the creeks are controlled by joints or faults. The largest river, the Burdekin River, has incised a broad deep valley through the highlands. For most of its length, it occupies the full width of its steep-sided valley, and many rapids and rock bars impede its progress. The drainage pattern on the plateaux at the head of some of the streams is dendritic. Towards the south, the topography is less rugged, the drainage pattern is more widely spaced, and the relief is less.

The Wyatt uplands and Drummond uplands consist of hills and ridges which grade into the plains. The Drummond uplands are characterized by long strike ridges, which are absent in the Wyatt uplands. The relief is rarely more than 200 feet, though Mount Wyatt rises about 600 feet above the level of the plain.

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

The granite areas, in the west, consist of broad valleys and some low hills covered with tors and boulders. Some of the hills are conical. The hills in the larger granite area are much higher; some of them are formed of roof pendants of volcanic rocks; others represent fine-grained differentiates.

Most of the Bowen South area is drained by the Burdekin River and its tributaries, the Sellheim, Bowen, and Broken Rivers. The Sellheim River drains the south-west corner, and the Bowen and Broken Rivers, flowing away from the coast, drain the eastern two-thirds of the area. In the north-east corner of the area, the streams flow towards the coast.

STRATIGRAPHY

The relationships of the principal rock units are illustrated in Figure 2. The oldest unit is the Middle Devonian Ukalunda Beds. This unit and the associated intrusions

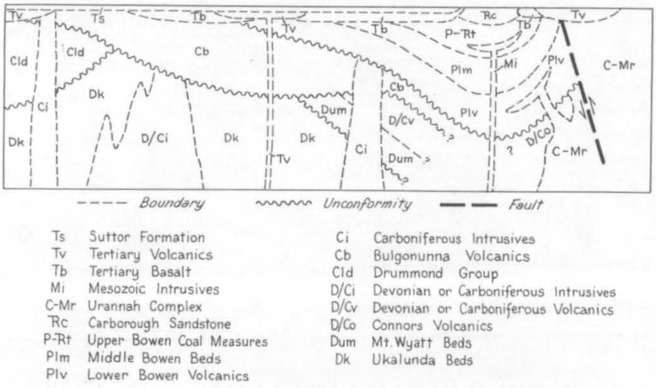


Fig. 2 Rock relationship diagram, Bowen South

form the northern end of the Anakie High. The northern end of the Drummond Basin lies to the north-west of the High. The Upper Devonian Mount Wyatt Beds and Devonian-Carboniferous volcanics overlap the Anakie High to the east and north. These formations are unconformably overlain by the Carboniferous Bulgonunna Volcanics, which are in turn unconformably overlain by the Permian-Triassic sequence of the Bowen Basin. The Urannah Complex and the Connors Volcanics constitute the Connors Arch which is overlain by or faulted against the steeply dipping Bowen Basin sequence. Remnants of the Tertiary Suttor Formation and scattered Tertiary basalt and acid volcanics are widespread.

The principal rock units are summarized in Table 1.

Ukalunda Beds

Nomenclature

The Ukalunda Beds were named by Jack (1889), who included them in the Star Series (=Star Group); Reid (1930) also included them in the Star Formation (=Star Group). As they contain Devonian fossils Hill & Denmead (1960) regarded them as unconformable on the Anakie Metamorphics, and they included them with the Devonian to Carboniferous sediments of the Drummond Basin.

Fossil collections made in 1961 established the Middle Devonian age of the beds, but they could not be separated from low-grade metamorphic rocks of the Mount Coolon and Buchanan 1:250,000 Sheet areas, which were mapped in 1960 as the Anakie Metamorphics. It was found that they are unconformable below 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 Ukalunda Beds, is not known.

The Ukalunda Beds are thought to be of group rank, but the component formations cannot be defined on the field data available. No type localities have been designated.

Distribution and Topography

The Ukalunda Beds crop out in the south-west part of the Bowen South area. The various outcrops are separated by several igneous intrusions and other younger rocks. The unit is well exposed at Mount Wyatt, particularly in Wynne Creek and its tributaries. The estimated thickness in this outcrop is 4000 feet, but it represents only part of the Ukalunda Beds. They are also well exposed in Mary Creek and west of the Pyramid.

The Ukalunda Beds generally form low rises and scattered ridges up to 150 feet high. The prominent hills, such as Mount Wyatt, have a relief of about 600 feet and the hills in the contact metamorphic aureoles around the igneous intrusions have a relief of about 200 feet. Some of the mesas are capped with Tertiary sediments but the highest hills rise above them. The best exposures are found in creeks.

Lithology

The Ukalunda Beds have been tentatively subdivided into a siltstone-sandstone sequence and a sandstone-limestone sequence. The former is the more widespread.

The siltstone-sandstone sequence forms most of the outcrop from Mount Wyatt south and west to the boundaries of Bowen South. The sequence consists of poorly bedded lithic sandstone, quartz greywacke, and siltstone. The lithic sandstone is mainly fine to medium-grained, and is commonly feldspathic. It contains a high proportion of matrix, and grades into quartz greywacke. The siltstone is closely jointed, deeply weathered, and grey, pink, or buff. Thinly colour-banded siltstone and thin beds of silicified limestone crop out in a few places. Poorly preserved fossils were found in silicified limestone and associated siltstone about a mile south of White's copper show, which is 3 miles south of Mount Wyatt. The fossils are similar to some of the species in the sandstone-limestone sequence, and are thought to be Middle Devonian.

In the contact zones around the granite intrusions the lithic sandstone and siltstone are metamorphosed to quartz-muscovite schist, spotted and lineated siltstone, hornfels, hardened and silicified sandstone, and a muscovite-chlorite-quartz rock composed of large euhedral phenocrysts of sericitized plagioclase set in a granular aggregate of quartz, muscovite, and chlorite. The lineated siltstone consists of quartz, sericite, and parallel needles of hematite.

Thinly interbedded siltstone and fine-grained sandstone crop out in a north-south zone in the south-western corner of Bowen South area. The rock has a schistose appearance due to shearing along the bedding planes: the sericite flakes are aligned in the silt layers, but the sandy layers are not affected. The schistosity, parallel to the bedding, has a northerly trend and steep dip, and is parallel to the main axis of folding in the Drummond Basin to the west. It may be related to the folding of the Drummond Basin sequence. The schistose sediments can be traced northwards into the area west of the Pyramid, where they are interbedded with the sandstone-limestone sequence.

The sandstone-limestone sequence is well exposed in Wynne Creek and on the north-east slope of Mount Wyatt. It forms most of the outcrops of Ukalunda Beds to the north-east of Mount Wyatt, near Hidden Valley homestead, and west of the Pyramid. In the Mount Wyatt area, the base of the unit consists of a well-bedded and alternating sequence of fine to coarse hard lithic sandstone, which is calcareous in part, in beds up to 1 foot thick, with thinly laminated grey, green, and brown siltstone in beds up to about 3 inches thick, and with thin dark shale beds. In thin section, the rock was found to be feldspathic lithic quartz sandstone with a calcareous cement. The lithic fragments include devitrified glass and flow-banded volcanics.

The upper part of the unit is not so well exposed. It includes thick lenses of blue-grey pebble to cobble conglomerate interbedded with lithic sandstone, fine lithic sandstone, tuffaceous in part, and banded grey-green thick-bedded silicified limestone, biostromal in part. The limestone forms massive outcrops on the flanks of Mount Wyatt, and contains abundant poorly preserved fossils, of which Receptaculites is the most easily recognized. The siltstone-sandstone sequence overlies the silicified limestone.

In the Pyramid area, the sandstone-limestone sequence includes lithic sandstone, quartz sandstone, quartz pebble conglomerate, siltstone, and minor limestone. These sediments are commonly veined with quartz and silicified. The distinctive quartz pebble conglomerate consists mainly of white quartz pebbles in a red siliceous matrix. The siltstone is closely jointed, yellow-brown or grey, fossiliferous and calcareous in places, and contains pods of foetid limestone.

TABLE 1

ROCK UNITS OF THE BOWEN SOUTH AREA

Age	Rock Unit and Letter Symbol	Thickness (feet)	Lithology	Distribution	Topography	Palaeontology and Age	Relationships	Depositional Environment
CAINOZOIC	Czs	Less than 100	Alluvial deposits, soil and ferruginous gravel	Near Sellheim River. Extensive in Bowen River Valley, not shown on map.	Alluvial flats, soil and gravel covered plains and low rises.			
CAINOZOIC — TERTIARY	Tertiary volcanics Tv	600 + in Brawl Creek	Contorted, flow banded rhyolite and dacite; trachyte, obsidian and volcanic glass; basalt and dolerite; rhyolitic and basaltic agglomerate quartz feldspar porphyry dykes; trachytic tuff and agglomerate; siliceous plugs and acid volcanic breccia.	Small outcrops about Brawl Creek, Flagstone Creek, The Pyramid, Mount McConnell.	Generally very rugged, high relief.	Presumably Tertiary epoch of acid volcanism	Intrusive into, unconformable on, or faulted against Devonian to Permian rocks.	
	Suttor Formation Ts	About 200, locally up to 400	Quartz sandstone, fine conglomerate, siltstone, all argillaceous in places; clay and sandy claystone; silicified argillaceous siltstone; oil shale.	Near Parrot Creek near Rutherfords Table, and southeast of Mount McConnell.	Isolated mesas and plateaux.	Few dicotyledonous plants	Unconformable on Devonian to Triassic rocks; disconformable on Tertiary basalt.	Extensive shallow lakes, swampy in places on uneven basement.
	Tertiary basalt Tb		Basalt flows and plugs	Small residuals in Bowen Basin; Brawl Creek Block; two plugs near The Pyramid	Rounded steep hills or small mesas; soil-covered flats with low rubble-covered hills.		Underlies Tertiary volcanics in Brawl Creek area.	
TRIASSIC	Carborough Sandstone Rc	up to 1500	Cross-bedded medium to coarse quartz sandstone, feldspathic in places, some fine conglomerate	Redcliffe Tableland, Mount Leslie, and small outlier between.	Steep-sided tablelands	Triassic	Conformable on Upper Bowen Coal Measures.	Fluviatile deposition in slowly subsiding Bowen Basin.
UPPER PERMIAN - LOWER TRIASSIC	Upper Bowen Coal Measures P-Rt	10,500	Cross and festoon bedded well sorted lithic sandstone, calcareous in places siltstone, carbonaceous shale, red mudstone, coal quartz sandstone, pebble and cobble conglomerate.	Within Bowen Syncline only.	Soil-covered plains and rises; some strike ridges; rugged hills where contact metamorphosed.	Abundant plants of Permian to Triassic age include Glossopteris indica Sch. G. Browniana Brong. G. angustifolia Brong. Phyllotheca australia Brong. Sphenopteris lobifolia Morr. Cladophlebis royei Arker. Samaropsis dawsoni (Shirley)	Conformable on Middle Bowen Beds.	Lacustrine, fluviatile, paludal. Possibly some access to the sea at times.
UPPER PERMIAN	Blenheim Formation Pue	About 1500 on western side of Bowen Basin; about 2600 at Exmoor on east flank of basin.	Siltstone, fine to medium quartz greywacke, carbonaceous, fossiliferous, with pebble bands, scattered cobbles, boulders, Some quartz sandstone beds.	Broad belt around western flank and northern end and narrow strip down eastern flank of basin.	Subdued cuestas near Parrot Creek.	Abundant marine fossils, Fauna IV. Upper Permian Strophalosia, Terrakea, Ingelarella, Neospirifer, Parallelodon, Myonia, Stutchburia, Schizodus.	Conformable on Gebbie Formation or on the Collinsville Coal Measures.	Moderately deep to shallow water; transgressive marine phase.
LOWER TO UPPER PERMIAN — MIDDLE BOWEN BEDS	Big Strophalosia Zone	75 to 105	Medium to fine quartz greywacke grading into coarse grey blue siltstone in places; calcareous fossiliferous; scattered pebbles, cobbles and angular boulders	Continuous horizon throughout Bowen South; crops out discontinuously around basin; Southernmost outcrop is at Exmoor.	Crops out on sides of hills and as low ridges in places; elsewhere covered by alluvium.	Richly fossiliferous fauna IV. Stophalosia ovalis, S. clarkei, S. brittoni var. gattoni, Terrakea solida and others.	Member in Blenheim Formation 300' to 450' above base.	
LOWER TO UPPER PERMIAN — MIDDLE BOWEN BEDS	Gebbie Formation Plb	1250 at Gebbie Creek 2000 at Exmoor	Medium to coarse quartz greywacke, carbonaceous in places mainly semi-friable with some hard, calcareous fossiliferous zones; siltstone; thin coal locally; thick sandstones characteristic.	Narrow strip down eastern flank of basin.	Prominent strike ridges separated by subdued topography.	Lower Permian. Marine fossils of sub-faunas IIIa and IIIb of Fauna III. Glyptoleda, Atomodesma, Stutchburia, Mourlonia, Terrakea, Ingelarella.	In conformable sequence with Tiverton Formation and Blenheim Formation.	Moderately shallow marine, transgressive in parts.
LOWER TO UPPER PERMIAN — MIDDLE BOWEN BEDS	Wall Sandstone Member	100 maximum	Cross bedded, medium to coarse quartz sandstone.	Eastern flank of Basin.	Prominent strike ridges.		Member in Gebbie Formation, about 300' above base.	
LOWER TO UPPER PERMIAN — MIDDLE BOWEN BEDS	Collinsville Coal Measures Plc	750 near Collinsville 1400 near Parrot Creek.	Quartz sandstone to quartz greywacke, siltstone, carbonaceous shale, coal, conglomerate.	Collinsville and western flank of Basin.	Subdued, some hills.	Fauna IIIb in Glendoo Sandstone Member.	Grades laterally into marine sediments of Gebbie Formation above Wall Sandstone Member.	Daltaic coal measures environment, marine at times. One fossiliferous marine horizon.
LOWER TO UPPER PERMIAN — MIDDLE BOWEN BEDS	Glendoo Sandstone Member.	80	Fine quartz sandstone.	Distinct unit from Collinsville southwest to Bowen River.	Low hills.	Fauna IIIb.	Member near middle of Collinsville Coal Measures.	Marine transgression in coal measures.
LOWER TO UPPER PERMIAN — MIDDLE BOWEN BEDS	Tiverton Formation Plp	1800 at Exmoor	Semi-friable, fine to medium quartz greywacke, hard, calcareous and fossiliferous in places; siltstone.	Thickest at Exmoor; lenses out to north, absent at Gebbie Creek, and thins to southern margin.	Long, low strike ridges and soil-covered plains.	Lower Permian. Fauna II, Eurydesma, Deltopecten, Taeniothaerus, Anidanthus, Parallelodon, Astartila.	Overlies Lower Bowen Volcanics with possible unconformity.	Moderately deep water marine.

Age	Rock Unit and Letter Symbol	Thickness (feet)	Lithology	Distribution	Topography	Palaeontology and Age	Relationships	Depositional Environment
LOWER PERMIAN	Lower Bowen Volcanics Plv	10,000 to 20,000	Quartz sandstone, siltstone, greywacke siltstone, tuffaceous sandstone; pebble to boulder conglomerate; basaltic, andesitic, trachytic flows, breccias, tuffs and agglomerates.	East flank and north end of Bowen Basin. Wedges out down west flank.	High, rugged hills and ridges in places; elsewhere scattered high hills in soil covered plains and low rises.	Lower Permian. Plants at a few localities. *Neoggerathiopsis*, *Samaropsis*, *Glossopteris*, *Cordaites*.	Basal Unit of Bowen Basin. Unconformable on Bulgonunna Volcanics and intrusives on western edge of Bowen Basin. Overlying faulted against, and intruded by Urannah Complex and unconformable on Connors Volcanics on eastern edge.	Mainly non-marine volcanism and sedimentation.
?UPPER CARBONIFEROUS	Bulgonunna Volcanics Cb	Probably very thick.	Overlapping and interfingering lenses of rhyolitic to dacitic flows, breccia, tuff, agglomerate, ignimbrite; tuffaceous lithic sandstone and siltstone; some acid intrusives.	Western half of Bowen South.	Rugged; very close drainage pattern in places; some deep, steep-sided fault valleys.	Carboniferous, possibly Upper Carboniferous.	Unconformable on Drummond Group; unconformably overlain by Lower Bowen Volcanics.	Possibly terrestrial volcanism.
LOWER CARBONIFEROUS	Drummond Group Cld	About 10,000	Sandstone, tuffaceous sandstone, siltstone, conglomerate, siliceous siltstone and impure chert, acid flows and tuffs, agglomerate, rare algal limestone lenses.	Western margin	Soil-covered plains with long strike ridges; in places ridges coalesce to form groups of hills.	Lower Carboniferous. Plants include *Lepidodendron*, *Calamites*, *Rhodea*.	Unconformable on Ukalunda Beds and intrusives.	Mainly non-marine basin.
DEVONIAN - CARBONIFEROUS	Devonian to Carboniferous D/Cv	?	Siliceous tuff, porphyritic acid flows, volcanic conglomerate, tuffaceous sandstone and siltstone.	In south-west, near "Hidden Valley" and south of Sellheim River.	Plains with some hills and ridges.	Indefinite, Devonian to Carboniferous.	Southern outcrop apparently conformable on Mount Wyatt Beds. Others lie against Ukalunda Beds and apparently unconformable below Bulgonunna Volcanics.	Possibly terrestrial volcanism and non-marine sedimentation.
	Connors Volcanics D/Co	?	Porphyritic rhyolite and dacite flows and autobreccia; andesitic and dacitic agglomerate.	Two small areas east of Emu Plains Hs. and south-east of Exmoor Hs.	Mainly high, rugged hills and ridges.	No fossils; Devonian-Carboniferous based on lithologic correlation beyond Sheet boundary.	Intruded by Urannah Complex; unconformably overlain by Lower Bowen Volcanics.	
UPPER DEVONIAN	Mount Wyatt Beds Dus	1000	Tuffaceous lithic sandstone, siltstone and conglomerate; calcareous siltstone.	About the Sellheim River, east of Rutherfords Table; two small areas farther east, and a small area north-west of Mount Wyatt.	Soil-covered plains with hills in the eastern outcrop areas.	Upper Devonian (Fammennian). *Cyrtospirifer* cf. *reidi* Maxwell. Plants include *Leptophleum australa*, *Proto lepidodendron*, a psilophyte, and *Stigmaria*.	Probably unconformable on Ukalunda beds.	At least partly marine.
MIDDLE DEVONIAN	Ukalunda Beds Dk	4000+ in part	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.	In south-west; area of outcrop broken by intrusions and overlying units.	High rugged hills and ridges in places; moderately high, rounded hills in others; plains with scattered hills and rises elsewhere.	Middle Devonian. *Favosites*, *Mesophyllum*, *Keriophyllum*, *Atrya*, *Chonetes*, *Receptaculites*, *Calceola*, strophomenoids, rhynconellids, straight nautiloids, ostracods, nuculids.	Oldest rocks. Relationship with Anakie Metamorphics to south not known.	Marine.

The sandstone-limestone sequence in the Hidden Valley homestead area includes closely jointed khaki to dark grey siltstone, which is calcareous and fossiliferous in places and commonly contains rounded non-jointed cobbles of siltstone; beds and lenses, up to 6 inches thick, of grey fossiliferous limestone, which is generally interbedded with calcareous siltstone and, in places, with calcareous lithic sandstone; thin-bedded micaceous coarse siltstone to fine sandstone; soft olive-grey thin-bedded siltstone interbedded with dense grey to dark grey pyritic impure chert, which in places encloses pods of unaltered limestone; and medium to coarse lithic sandstone, hardened and veined by quartz in places.

In a few places the Ukalunda Beds contain volcanics and minor intrusions. They include a uralitized trachyandesite which contains phenocrysts of amphibole and feldspar, quartz grains, and small xenoliths of quartz-amphibole rock, set in a groundmass of fine-grained feldspar and uralitic material. One flow-banded porphyritic rhyolite cropping out at Mount Wyatt may be intrusive. It consists of subhedral phenocrysts of sodic plagioclase, quartz, and biotite, up to 1 mm across, set in a microcrystalline groundmass of quartz, feldspar, and iron oxide.

In the metamorphic aureoles around the igneous intrusions, the Ukalunda Beds have been converted into a wide variety of low-grade contact metamorphic rocks. Minor gold, bismuth, arsenic, silver, lead, and copper mineralization is common in the contact zones in places. The Ukalunda Beds have not been greatly affected by regional metamorphism except in the meridional zone of schistose rocks in the south-west. Elsewhere, the close jointing of the siltstone and widespread silicification of the coarser clastic rocks are the only regional metamorphic effects.

Environment of Deposition

Most of the sediments are marine. Marine fossils were collected from 10 localities and poorly preserved fossils were noted in the metamorphosed rocks. Bedding and other sedimentary structures in the Ukalunda Beds suggest that they were laid down in moderately deep water; no shallow-water structures were seen except for the thick beds of silicified limestone, which may have formed as reef limestones.

Thickness

The top and bottom of the Ukalunda Beds are not exposed and the thickness is unknown. The section at Mount Wyatt is at least 4000 feet thick: it includes some minor intrusives and may be faulted. The overlying siltstone-sandstone sequence has a wide areal extent, and may be very thick. The thickness of the Ukalunda Beds in the Hidden Valley homestead and the Pyramid areas is unknown.

Age

Collection B76F was examined by Professor Dorothy Hill, who identified Favosites sp. cf. nitidus?, Mesophyllum (Atelophyllum)?, Keriophyllum?, and Atrypa sp., probably of Middle Devonian age. Collection B84F is similar to B76F; both were collected near Hidden Valley homestead.

Collections B220F and B610F, from west of the Pyramid, have only one or two species in common, and none of the species in collections B76F and B84F are present.

Collection B220F has two 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., 1964). The B610F and B220F collections contain some species which may be of Lower to Middle Devonian age, but examination of the material has not yet been completed. The fossils are generally poorly preserved and include straight nautiloids, corals, strophomenoids, chonetids, rhynchonellids, ostracodes, gastropods, pelecypods, fish bones, bryozoa, and stromatoporoids.

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

Mount Wyatt Beds

Nomenclature

The Mount Wyatt Beds were named by Daintree (1870). The type area is about Ukalunda, where the unit is exposed in small creeks draining south into the Sellheim River. The main marine fossil locality is at the south-east corner of the type area, about 3 miles from the Mount Coolon road at latitude $20^{o}57'$S., longitude $147^{o}16'$E., beside the track leading from Rutherfords Table to White's copper show. No type sections have been measured.

Distribution and Topography

In addition to the type area four other small outcrops of the Mount Wyatt Beds are known, three of which are in the Bowen South area. Two of them are situated a few miles north-east of the type area. The nearer is correlated on lithology; the other is similar in lithology, and contains Leptophloeum australe, which is common in the Mount Wyatt Beds. The third is 2 miles north-west of Mount Wyatt; the sediments are similar to those in the type area and contain Protolepidodendron and psilophytes, which are common in this unit.

The type area consists of soil-covered plains with a few low rises, and exposures are confined to creeks and gullies. The topography in the two outcrops north-east of the type area is more rugged. The sediments have been hardened by granite intrusions and minor intrusions associated with the Bulgonunna Volcanics, and form hills with a relief of 200 feet.

Lithology

The Mount Wyatt Beds comprise siltstone, sandstone, and conglomerate, all of which contain volcanic detritus, especially the conglomerate. For the most part, the sediments are immature and contain a high proportion of labile constituents.

The siltstone is generally a hard well-sorted rock composed of quartz, minor feldspar, muscovite, sericite, and clay. In some specimens irregular patches of calcite may form up to 25 percent of the rock; in others, chlorite has developed as a result of 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.

The sandstone is most commonly lithic, but quartz sandstone crops out in the most northerly outcrop. The lithic sandstone is poorly sorted, with grains ranging from fine to very coarse, and grades into pebbly sandstone in places. The quartz grains are subangular or irregular, and are strained and shattered in some specimens. The feldspar grains and fragments of acid to intermediate volcanic rocks are weathered to clay minerals and sericite. Fragments of siltstone and igneous rocks are also present. The sandstone may be brown, buff, or khaki on weathered surfaces and is usually grey to grey-green when fresh. 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 weathered calcareous lithic sandstone packed with fossil casts and moulds crop out at a few localities. The random orientation of the fossils indicates that they have been transported into their present 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 effect may be due to silicification.

Pebble and rarely cobble conglomerate crops out in beds and lenses up to 2 feet thick. The pebbles are usually subrounded and consist of volcanic rocks, quartz, and quartzite. Green tuffaceous conglomerate, composed of rounded pebbles and cobbles of volcanic rocks in a tuffaceous matrix, crops out in a few places.

The beds contain small slump structures 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 distance of about 15 feet.

Small steep-sided conical structures, up to 2 inches high, were seen in the unit near fossil locality B11F, and in the area north-west of Mount Wyatt.

Structure and Relationships

In the type area the Mount Wyatt Beds are gently folded; dips range up to 55^{o} but are generally less. The Mount Wyatt Beds dip away from the Ukalunda Beds, and the fossils indicate that they are considerably younger. They have a less complex structure and lack the lineation and schistosity found in the Ukalunda Beds. The Mount Wyatt Beds probably rest unconformably on the Ukalunda Beds. They contain a much greater proportion of volcanic detritus than the Ukalunda Beds and mark the beginning of a period of volcanic activity.

To the south of the type area the Mount Wyatt Beds are overlain by Devonian to Carboniferous volcanics. Photogeological evidence and a few reliable dip observations indicate that the structure of the volcanics is similar to that of the Mount Wyatt Beds, and they are probably conformable, as in the Mount Coolon 1:250,000 Sheet area.

The Mount Wyatt Beds are unconformable with the overlying Bulgonunna Volcanics, although the contacts are not exposed. In the most northerly outcrop, the Mount Wyatt Beds are intruded by sills and dykes of porphyritic rhyolite, which are almost certainly related to the extensive rhyolite flows in the Bulgonunna Volcanics. The Bulgonunna Volcanics are considerably younger than the Mount Wyatt Beds, and in other areas the volcanics rest unconformably on the Lower Carboniferous Drummond Beds.

Environment and Deposition

The Mount Wyatt Beds were possibly laid down in a moderately shallow sea and the presence of marine fossils shows that marine conditions prevailed for at least part of the time. Plant fossils, mainly wood and bark, occur in great abundance in certain horizons in the sandstone units. The plant remains may have been deposited in the sea, but their presence suggests that the environment may have been freshwater at times. The sedimentary structures and the lithology of the Mount Wyatt Beds suggest that they were deposited in shallow rather than deep water.

Thickness

In the section between fossil locality B11F and the Ukalunda Beds to the north, the Mount Wyatt Beds are over 1000 feet thick, but the total thickness is not known.

Age

Most of the fossils in the Mount Wyatt Beds belong to a species closely allied to *Cyrtospirifer* cf. *reidi* (Maxwell) (D. Hill, pers. comm.), which indicates a horizon high in the Famennian. The plants include *Leptophloeum australe*, *Protolepidodendron*, psilophytes, and stigmaria. *L. australe* probably originated in the Upper Devonian; the other forms range from Middle to Upper Devonian.

Devonian to Carboniferous Volcanics

The volcanics cropping out in three areas in the south-western part of Bowen South are referred to as 'Devonian to Carboniferous volcanics'.

Distribution and Topography

In the largest area, south-east of Rutherfords Table, the volcanics form plains, low rises, and a few long strike ridges. They extend south into the Mount Coolon Sheet area, where the unit has its maximum development. The second area is 3 miles south-west of Hidden Valley homestead and extends west along the 7-mile Dam track. The volcanics occupy a level upland valley between blocks of Bulgonunna Volcanics, with a few low rocky outcrops. The third area is along Isabella Creek, about 5 miles south-south-east of Hidden Valley homestead, where the volcanics form low rounded hills with a close pattern of drainage near the igneous intrusions.

Lithology, Structure, and Relationships

Largest Area: The volcanics comprise porphyritic lava, acid tuff, volcanic conglomerate, and tuffaceous sandstone. The conglomerate consists of cobbles and boulders, up to 4 feet long, of flow-banded rhyolite, fine tuff, and other volcanic rocks, set in a white tuffaceous sandstone, overlying interbedded coarse crystal tuff and porphyritic rhyolite flows.

Many of the lavas are porphyritic and contain a high proportion of phenocrysts in a fine-grained matrix. One specimen is a porphyritic glassy pitchstone with embayed and corroded phenocrysts of quartz and albite-oligoclase set in a flow-banded groundmass of partly devitrified glass. Another specimen is a hybrid andesite lava with corroded and altered xenocrysts of quartz and plagioclase. Porphyritic rhyolite crops out in a number of places. They form large exposures showing contorted flow banding, or thin regularly banded flows interbedded with tuffs.

Fine to coarse-grained acid tuffs are common. They are composed of shards, splinters, and angular fragments of partly devitrified glass, quartz grains, grains and aggregates of oligoclase and other feldspars, biotite flakes, and fragments of felsitic lavas set in a very fine-grained matrix of siliceous ash and cryptocrystalline silica. Many show some signs of eutaxitic texture in the matrix, and are possibly ash-flow tuffs; some also show vague bedding.

Lapilli tuff occurs in a few places. It consists of lapilli up to 4 cm long of fine devitrified acid lava set in a tuffaceous matrix. Some of the lapilli partly merge into the matrix, and the rocks show some evidence of flow structure.

In the Mount Coolon 1:250,000 Sheet area, the lavas and tuffs were mapped in 1960 as part of the Bulgonunna Volcanics. The measured strikes and dips and the general trends of the bedding on the air-photographs indicate that the volcanics are moderately folded, with axes trending north-east. The structure is similar to that of the underlying Mount Wyatt Beds, and the two units may be conformable. The Bulgonunna Volcanics, however, generally consist of flat-lying blocks of volcanics, and the marked difference in structure of the Devonian to Carboniferous volcanics is the main reason for separating them from the Bulgonunna Volcanics. Similar rock types are present in both units.

Second Area: In the second area, the principal rock type is crystal tuff, with subordinate porphyritic rhyolite, and conglomeratic tuff. The crystal tuff is a dark hard medium to coarse-grained deeply weathered and altered rock. It is composed of phenocrysts of altered plagioclase and pseudomorphs of chlorite and epidote 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 is regular and strikes at 210^{o} and dips east at 70^{o}. Well-bedded spotted grey tuff, containing a few rounded boulders of lava, is also present.

The second area forms a narrow zone trending east-west. To the north and south, the Devonian to Carboniferous volcanics are overlain by Bulgonunna Volcanics striking parallel to the zone and dipping away from it. As the lithology of the Bulgonunna Volcanics to the north and south is quite different it appears that they represent two separate blocks. The exposure of the zone of Devonian to Carboniferous volcanics between the two blocks is probably due to tectonic movements and erosion.

The structure and lithology of the Devonian to Carboniferous volcanics are markedly different from the Bulgonunna Volcanics. The dark intermediate crystal tuff, which is predominant in the Devonian to Carboniferous volcanics, does not occur in the Bulgonunna Volcanics. The dip and strike of the flow-banded rhyolite is markedly at variance with the structure of the interbedded sediments and rhyolite flows in the Bulgonunna Volcanics which crop out about 100 yards to the south. The Bulgonunna Volcanics strike at 280^{o} and dip at 40^{o} south for a distance of several miles.

To the east, the Devonian to Carboniferous volcanics are separated by a fault from metamorphosed siltstone and sandstone of the Ukalunda Beds.

Third Area: Rock types in the third area include tuff, crystal tuff, rhyolite flows, siltstone, volcanic agglomerate, and tuffaceous conglomerate.

At one locality interbedded green medium-grained tuff and coarse-grained crystal tuff crop out. They consist of poorly sorted irregular fragments of quartz, plagioclaase, potash feldspar, fine-grained volcanic rocks, and aggregates of granular epidote replacing an amphibole, set in a matrix of fine granular quartz, chlorite, and clay. The grains range up to 2 mm in diameter.

Thin rhyolite flows, interbedded with grey-green siltstone, tuffaceous sandstone, and tuff, crop out near an igneous intrusion. The siltstone has been hardened and the sandstone and tuff have been partly converted to hornfels.

Volcanic agglomerate crops out in Isabella Creek at the road crossing. It consists of rounded cobbles and boulders of an acid volcanic rock set in hard blue matrix of the same rock. The agglomerate is poorly stratified. The fresh rock in the creek is hard, but it apparently weathers readily. A short distance downstream from the crossing several hundred feet of well-bedded volcanics crop out. They include thin-bedded fine and coarse acid tuff, weathered to a white or buff colour, interbedded with thick units of volcanic conglomerate. The conglomerate includes pebbles and cobbles of volcanic rocks, with some quartz and other rock types.

These rocks have been separated from the Ukalunda Beds to the north on the basis of their lithology, but their structural relationships are unknown, and they may form part of the Ukalunda Beds.

The Devonian to Carboniferous volcanics in the third area are generally steeply dipping and in Isabella Creek, where the exposures are best, they dip at 55^{o} to the south-east. They are separated from the Bulgonunna Volcanics because of the difference in structure.

Environment of Deposition and Thickness

Little is known of the environment of deposition or thickness of the Devonian to Carboniferous volcanics. The unit includes miscellaneous volcanic rocks which do not appear to belong to other established units. The volcanics in the largest area may represent a unit of formation rank, and the correlation with the volcanics in the second and third areas may not be valid.

Age

The rocks in the largest area are younger than the Upper Devonian Mount Wyatt Beds and older than the Bulgonunna Volcanics. The age of the rocks in the other two areas is less certain. They are probably older than the Bulgonunna Volcanics and may be as old as the Ukalunda Beds.

Connors Volcanics (new name)

The Connors Volcanics were first recognized in the St Lawrence 1:250,000 Sheet area (Malone, Olgers, & Kirkegaard, in prep.) where the type area is located.

Definition

Derivation of name: The name is derived from Connors Range.

*The Connors Volcanics are intruded by granodiorite near Burwood homestead in the St Lawrence Sheet area. Biotite from the intrusion has been dated at 307 m.y. and hornblende at 318 m.y. (A.W. Webb, pers. comm.). Though the dates are not yet confirmed, they suggest that the Connors Volcanics are, at youngest, Lower Carboniferous.

Type section: The type section is along the road from Croydon homestead to Killarney homestead in the southern Connors Range, St Lawrence 1:250,000 Sheet area, from coordinates 19391975 to coordinates 20402036.

Distribution: The Connors Volcanics crop out almost continuously throughout the Broad Sound Range and Connors Range in the Duaringa and St Lawrence Sheet areas, and extend north-north-west across the Mackay and Mount Coolon 1:250,000 Sheet areas into the south-eastern part of the Bowen 1:250,000 Sheet area. There are also some isolated outcrops to the east and south-east of the Broad Sound Range in the St Lawrence and Duaringa Sheet areas.

Lithology: The principal rock types are rhyolitic, dacitic, and andesitic flows, autobreccias, agglomerates, and other pyroclastics. Close jointing, silicification, and quartz veining are common. The volcanics are intruded, metamorphosed, and silicified in many places.

Thickness: The thickness is unknown. The consistent easterly dips in Markwell Creek indicate that the thickness is possibly about 10,000 feet or more, but the massive nature of the volcanics makes it difficult to estimate the thickness.

Palaeontology: No fossils have been found in this unit.

Age: The Connors Volcanics are pre-Permian, possibly Devonian-Carboniferous*

Relationships: The Connors Volcanics are tentatively correlated with the Devonian-Carboniferous Campwyn Beds. The units are lithologically similar and both occupy similar structural positions relative to the Carmila Syncline. The Connors Volcanics are unconformably overlain by the Carmila Beds to the east and by the Lower Bowen Volcanics or Middle Bowen Beds to the west. The base of the unit is not exposed.

Distribution and Topography

The Connors Volcanics crop out in two areas to the west of the Urannah Complex, in the south-eastern part of Bowen South area. The larger area extends to the north and south of the Broken River and the smaller lies on the southern margin of the Bowen South area. The volcanics form high rugged hills.

Lithology

The Connors Volcanics comprise pink, buff, or brown rhyolite and dacite flows, which are commonly porphyritic. Near the Urannah Complex they are intruded, metamorphosed, and silicified by numerous microdiorite and aplite veins. In the southern outcrop, the Connors Volcanics include purple and green andesitic and dacitic agglomerates in addition to acid lavas.

The unit was not mapped in detail, and its pre-Permian age was established as a result of later work in the St Lawrence Sheet area.

Structure and Relationships

The Connors Volcanics are intruded by the oldest members of the Urannah Complex, as well as by the younger suites of intrusions and dykes. In places the Connors Volcanics are overlain by the Lower Bowen Volcanics, and the contact is presumably unconformable; elsewhere the contact is faulted.

Thickness

The thickness of the Connors Volcanics in Bowen South is unknown.

Age

The Connors Volcanics in the Bowen South area are nearly continuous with the outcrops in the type area, where the regional geological relationships suggest that they may be Devonian-Carboniferous. Their lithology is similar to that of the fossiliferous Devonian-Carboniferous Campwyn Beds. Both units occupy structurally high positions on opposite sides of the Carmila Syncline, and both are unconformably overlain by the Lower Permian Carmila Beds; they may be stratigraphically equivalent.

Drummond Group

Nomenclature

The name 'Drummond Beds' was introduced by Jack in 1892; Jensen, Reid, and others have also studied them. Shell (Queensland) Development Pty Ltd (1952) distinguished a number of formations in the Springsure 1:250,000 Sheet area, and Hill subsequently introduced the name Drummond Group on the geological map of Queensland (1953). In 1961 Veevers et al. (1964) mapped the formations named by Shell to the north of their type areas and introduced one new formation.

This Report deals with the group at the northern end of the Drummond Basin; no formations have been differentiated.

Distribution and Topography

The Drummond Group crops out in the western part of the Bowen South area. The base of the unit is exposed in the south, where it overlies the Ukalunda Beds, but the north-eastern boundary is concealed by overlapping Bulgonunna Volcanics.

The Drummond Group forms low soil-covered rises and wide alluvial flats, with some long strike ridges, which in places coalesce to form groups of hills. The relief is generally less than 100 feet, with occasional hills capped by Tertiary sediments and Bulgonunna Volcanics.

Lithology

In the Bowen South area the Drummond Group comprises clastic sediments, volcanics, chert, and limestone. The clastics consist largely of reworked volcanic detritus, and include lithic sandstone, pebble to boulder conglomerate, siltstone, and minor quartz sandstone. The volcanics include tuff, crystal tuff, agglomerate, and some lava flows, and are generally acid to intermediate in composition.

Lithic sandstone is the most abundant rock type. It is generally a hard well-sorted bedded rock composed of quartz and feldspar, and fragments of volcanic and other rocks. Occasional flakes of mica are also present. In places the sandstone has a calcareous cement and occasionally it is silicified. The rock grades from quartz lithic sandstone to tuffaceous lithic sandstone.

The typical tuffaceous lithic sandstone is a coarse-grained rock containing about 15 percent of volcanic quartz grains, feldspar crystals, and fragments of andesitic volcanics. The matrix, which forms about 15 percent of the rock, consists of chloritized tuffaceous material. Most of the grains are partly rounded.

The calcareous tuffaceous lithic sandstone is a fairly well sorted coarse-grained rock composed of fragments of devitrified glass and other volcanic 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-bedded to thick-bedded and current-bedding is a common feature.

The Drummond Group includes a few outcrops of hard silicified thin-bedded, current-bedded coarse quartz sandstone.

Conglomerate is common. The larger fragments are mainly volcanic, and are generally well rounded. They range from granules to boulders up to 3 feet across. The conglomerate occurs in thick-bedded lenses, commonly showing current-bedding and torrential cross-bedding, interbedded with, and grading laterally into, tuffaceous lithic sandstone. It is white, grey, brown, green, or blue-green, and is generally hard and impermeable. These lenses of conglomerate can be readily distinguished from the much thicker and more mature Mount Hall Conglomerate in the Emerald and Springsure areas.

Beds of conglomerate are interbedded with lithic sandstone and siltstone near the base of the group near the Pyramid. They contain angular and rounded pebbles of chert, hardened shale, granite, quartzite, thinly laminated siltstone, and quartz. These conglomerates are thick-bedded rocks with a considerable lateral extent. They are not volcanic in origin, and the pebbles have been derived from the Ukalunda Beds and intrusives.

The Drummond Group includes a large proportion of siltstone, although it is not prominent in outcrop. The siltstone has been formed largely from reworked volcanic material and is more mature than the coarser clastics. In places, it is tuffaceous and contains rare grains of volcanic quartz, and grades into ashstone. The silicified siltstone may be the product of diagenetic silicification of quartz-rich siltstone produced by reworking siliceous ash and fine tuff.

The siltstone may be white to grey, brown, khaki, green, purple, blue, or black. Some specimens are colour-banded in grey and green. The siltstone is generally thin-bedded to thinly laminated, and may contain small-scale slump structures.

Calcareous siltstone crops out in a few places. It contains fine grains of quartz and calcite set in a microcrystalline matrix of quartz and mica. In one outcrop the calcareous siltstone contains lenses of limestone.

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

The most common volcanic rocks are tuff, crystal tuff, volcanic conglomerate, breccia, and agglomerate, with some interbedded thin lava flows. They range from acid to intermediate in composition, are generally well bedded, and are interbedded with tuffaceous sediments. The pyroclastic rocks grade from siliceous ashstone through fine to very coarse tuff to conglomerate; beds grading from coarse tuff to conglomerate are particularly common.

The tuffs have the same range of colours as the tuffaceous sediments. They weather readily, particularly the crystal tuffs, and are commonly white on weathered surfaces. They include altered vitric tuff with the glass shards aligned parallel to the bedding. Less common is intermediate felspathic tuff containing crystals of potash and soda felspar, fragments of deeply weathered fine-grained volcanic rocks, and patches of chlorite set in a matrix of clay and secondary calcite.

The volcanic breccia is generally a dark intermediate fine-grained rock with the fragments aligned parallel to bedding in the matrix. In some specimens, both the fragments and matrix are composed of plagioclase laths set in a microcrystalline groundmass. Agglomerate is less common and is generally extensively altered.

Less common rock types in the Drummond Group are shale, chert, and limestone. The shale is dark grey or green, thin to medium-bedded and well jointed, and in places is interbedded with white to light grey impure chert. The shale crops out in sequences up to 60 feet thick; it contains mud cracks and small-scale graded bedding, and in places is cut by many calcite veins. Less commonly, the shale contains fossil wood and is interbedded with green friable lithic sandstone and boulder conglomerate.

Limestone occurs at a few localities in thin beds and lenses up to about 9 inches thick.

The sediments of the Drummond Group are generally well bedded and heterogeneous; near the Pyramid the group is less heterogeneous. Most of the beds are laterally persistent, and most of the structures are delineated by beds which can be traced for many miles, although the lithology may vary along strike. Cross-bedding and torrential cross-bedding are common. 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, with axes trending north-east. In many places the dips on the flanks of the folds are over 80°, but generally they are between 30° and 60°. Most of the folds can be traced for several miles. West of Pyramid homestead, the unconformity between the Drummond Group and Ukalunda Beds delineates a gentle syncline, with flanks dipping at 30° or less, and a complementary anticline in the core of which the Ukalunda Beds are exposed.

The north-easterly faults that cut the group appear to be related to the folding, and some of them also cut the Ukalunda Beds. In one place they have displaced the contact between the Drummond Group and the Ukalunda Beds. A second, possibly younger, set of faults trends north, and generally cuts the overlying Bulgonunna Volcanics also.

The Drummond Group rests unconformably on the Ukalunda Beds and the igneous rocks at Pyramid homestead, but the contact 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, and plant remains were found in several places. The cross-bedding and torrential cross-bedding suggest that the beds were deposited by rapid sediment-laden currents in shallow water. The presence of ripple marks and mud cracks also suggest shallow water, and the small-scale graded bedding in the shale indicates that the water was turbid at times.

Thickness

The thickness has been estimated across the limbs of three major synclines. The estimates are based on measured dips and strikes and on the width of the limbs on the air-photographs. The results obtained were 5000 feet, 6400 feet, and 7000 feet, but the total thickness of the unit is probably about 10,000 feet.

Age

Plant remains collected at locality B572F were identified as *Lepidodendron* sp., *Rhodia* sp., and *Calamites* sp., of Lower Carboniferous age, by Mary White (1962).

Bulgonunna Volcanics

Nomenclature

The name 'Bulgonunna Volcanics' was introduced by Malone et al. (1964). The type area is along Bulgonunna Creek in the Mount Coolon Sheet area, 20 miles south of Bowen South. Outcrop is continuous from the type area into Bowen South.

The formation comprises acid to intermediate volcanics and minor sediments and is probably of Upper Carboniferous age. It is separated from the Lower Carboniferous and older rocks by a major unconformity. The Devonian to Carboniferous volcanics in the southern part of Bowen South have been separated from the Bulgonunna Volcanics because of the similarity of their structure to the Upper Devonian rocks.

Distribution and Topography

The Bulgonunna Volcanics crop out over most of the western half of the area mapped. They include resistant rocks which produce the most rugged topography in the area. The topography on some of the porphyritic rhyolite is distinctive, and consists of high hills which are almost devoid of vegetation and deeply dissected by a close joint-controlled drainage system. In the north-east, the Bulgonunna Volcanics form a high plateau, with a steep scarp rising some 700 feet above the granite to the east. This plateau is dissected by fault-controlled valleys about 500 feet deep.

The Bulgonunna Volcanics are well exposed, except in the south near the Sellheim River, where they include some readily weathered agglomerate and breccia.

Lithology

The Bulgonunna Volcanics consist of overlapping, inter-fingering, or separate lenses of volcanics up to 10 miles across. The lithology differs markedly from lens to lens, but individual lenses consist of one or several related rock types. The lenses represent separate episodes of volcanic activity from one or more of the numerous volcanic centres.

The shape of each lens was probably controlled by the surface on which it was deposited. In the west the volcanics were erupted on more or less level surfaces, and extensive rhyolite flows and tuffs overlie the Drummond Group. Elsewhere, the volcanics accumulated in small basins, some of which are bounded by faults which may represent the marginal fractures of the foundering blocks.

The Bulgonunna Volcanics contain a wide variety of rock types, most of which are of local extent only. The most common is porphyritic rhyolite, which is white, cream, buff, or grey-brown, and commonly shows regular or contorted flow banding. The porphyritic rhyolite always contains quartz phenocrysts which are generally euhedral but corroded, and many of the rhyolites contain orthoclase phenocrysts. Some specimens also contain phenocrysts of plagioclase and hornblende, and pseudomorphs of chlorite and calcite after amphibole. Vugs filled with chalcedony are common. The groundmass is a fine-grained to crypto-crystalline aggregate of quartz, clay, iron oxide, and chloritic material.

The rhyolites are mainly extrusive but some of them are probably intrusive. A dark grey rhyolite porphyry, which may be intrusive, consists of phenocrysts of quartz and feldspar, up to 3 mm long, set in a fine groundmass of biotite and aphanitic material.

Porphyritic dacite is common and is the predominant rock type in several of the volcanic lenses. Other porphyritic rocks include trachyandesite, typically composed of phenocrysts of plagioclase and potash feldspar set in a groundmass composed of rounded patches, up to 0.3 mm across, of microcrystalline feldspar and minor quartz. Also present are porphyritic toscanites consisting of phenocrysts of oligoclase, potash feldspar, and quartz in an equigranular groundmass of quartz and feldspar, with subordinate iron oxide and chloritic material.

One specimen of porphyritic augite trachyandesite contains euhedral phenocrysts of plagioclase, potash feldspar, augite, chlorite pseudomorphs, 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 to some of the porphyritic rhyolites, but is distinguished by the presence of augite phenocrysts and the low proportion of quartz.

The porphyritic rocks in the Bulgonunna Volcanics appear to belong to a related sequence which ranges in composition from rhyolite to trachyandesite.

The Bulgonunna Volcanics include a large proportion of tuffs, of which rhyolitic and dacitic crystal tuffs are the most common. They consist of potash feldspar, plagioclase, quartz, and fragments of fine-grained acid to intermediate volcanics in a matrix of crypto-crystalline quartz and clay. They are commonly medium to coarse-grained and poorly sorted, and many of them are closely jointed.

One of the feldspathic crystal tuffs consists of large crystals of zoned plagioclase, quartz, and amphibole, and fragments of basaltic and acid volcanics in a microcrystalline matrix of quartz, chlorite, and clay. This rock is thought to be a variety of ash-flow tuff, and many of the tough porphyritic pyroclastics are possibly also ash-flow deposits.

Well-bedded tuff, tuffaceous conglomerate, and lithic lapilli tuff are associated in one outcrop, at the base of a lens of volcanics consisting predominantly of porphyritic rhyolite. The lapilli tuff consists of angular fragments, up to 1 cm long, of recrystallized quartzite and fine-grained acid volcanics, and angular quartz grains up to 1 mm across, set in a matrix of microcrystalline silica, mica, and minor feldspar. The medium to coarse-grained tuff is of similar composition, but the matrix forms 90 percent of the rock. In places the tuff and lapilli tuff grade into tuffaceous conglomerate. Fine-grained tuffs occur in places. They are generally grey bedded siliceous rocks, composed of quartz grains in a fine matrix of quartz, secondary silica, sericite, clay, and iron oxide.

Volcanic breccia is common. In places, it is dark purple and well bedded and grades into or is interbedded with tuff. The rhyolitic volcanic breccia is a light pink to brown tough rock with a very fine matrix, and contains fragments of flow-banded rhyolite up to 9 inches long.

Thick lenses of rhyolite agglomerate crop out in a few places. It consists of rounded pebbles and boulders of porphyritic rhyolite set in a purple matrix of rhyolitic tuff.

The sediments interbedded with the Bulgonunna Volcanics in a few places include well-bedded fine to coarse-grained khaki, brown, or white tuffaceous sandstone and, less commonly, white tuffaceous siltstone. A 10-foot bed of conglomerate crops out at the base of the Bulgonunna Volcanics, unconformably overlying the Drummond Beds. The conglomerate consists of rounded pebbles of acid volcanics and quartzite in a hard siliceous matrix.

Structure

The Bulgonunna Volcanics are little folded. They were deposited in separate lenses which have the synclinal shape of the original basin of deposition. The Volcanics were folded into anticlines in very few places. Some small local anticlines have been mapped in the Mount Coolon Sheet area, but no structures are visible in the porphyritic rhyolite a few hundred yards to the west. Reliable dips and strikes are rarely seen. Faulting and jointing are common, and many of the faults are marked by abrupt changes in lithology. Other faults are associated with the igneous intrusions. Closely spaced sub-concentric and radiating joints can be seen in the porphyritic rhyolites, and in some areas they form a distinctive pattern on the air-photographs which is characteristic of the Bulgonunna Volcanics. Some of the joints extend for several miles, and they commonly occur in two sets trending north-west to north, and north-east to east.

The Bulgonunna Volcanics rest unconformably on the Mount Wyatt Beds, Ukalunda Beds, Devonian to Carboniferous volcanics, Drummond Group, and several igneous intrusions. They are cut by several large acid intrusions. In the east, they are unconformably overlain by Lower Permian sediments.

Environment of Deposition

The Bulgonunna Volcanics were probably largely terrestrial. The formation includes a few sediments, which are possibly lacustrine, but no plant remains or marine fossils were found.

Thickness

The thickness of the Bulgonunna Volcanics is not known. They are thinnest in the west, where the underlying rocks are exposed, and thicken towards the east.

Age

The Bulgonunna Volcanics may include rocks of different ages. In the east, the unit is unconformably overlain by Lower Permian sediments, and in the west the formation rests unconformably on sediments of the Drummond Group which contain Lower Carboniferous plants. This suggests that the formation is probably Upper Carboniferous.

The Tertiary acid volcanics cropping out to the west and north of the Bulgonunna Volcanics are difficult to distinguish from the Carboniferous rhyolites. Some Tertiary volcanics may have been included in the Bulgonunna Volcanics; and some mapped as Tertiary may belong to the Bulgonunna. Some of them have been mapped as Tertiary only because they lack the jointing commonly found in the Bulgonunna Volcanics, and other are regarded as Tertiary because they contain undevitrified volcanic glass.

Permian-Triassic

The Bowen Basin is occupied by a thick sequence of Permian-Triassic rocks comprising terrestrial and marine volcanics, and marine, paralic, lacustrine, paludal, and fluviatile sediments. In the Bowen South area, they crop out mainly in the Bowen Syncline (Allan, in Hill & Denmead, 1960, p.282), which is bounded by the Bulgonunna Volcanics to the west and by the Connors Arch to the east; but the Bowen Basin originally extended considerably farther east. The steeply dipping eastern flank of the Bowen Syncline is a structural feature produced by mainly post-Permian uplift of the Connors Arch.

Stratigraphic Nomenclature of the Bowen Basin Succession

The history of the stratigraphic nomenclature of the Bowen Basin succession has been discussed by Malone et al. (1964). In that Report, the established informal nomenclature - Upper Bowen Coal Measures, Middle Bowen Beds, and Lower Bowen Volcanics - was used because the nomenclature cannot be revised satisfactorily until the regional mapping of the Bowen Basin has been completed. The nomenclature used in this Report is as tabulated below:

Age	Bowen South Area		Mount Coolon 1:250,000 Sheet Area	
Triassic	Teviot Formation		Teviot Formation	
	Carborough Sandstone		Carborough Sandstone	
Upper Permian to Lower Triassic	Upper Bowen Coal Measures		Upper Bowen Coal Measures	
		(Blenheim		(
	Middle	(Formation	Middle	(
		(		(
		(Collinsville		(Collinsville
Lower Permian		(Coal Measures		(Coal Measures
to	Bowen	(	Bowen	(
Upper Permian		(Gebbie Formation		(
		(		(
	Beds	(Tiverton	Beds	(
		(Formation		(
Lower Permian	Lower Bowen Volcanics		Lower Bowen Volcanics	

The names 'Redcliffe Series' (Reid, 1925) and 'Carborough Sandstone' (Reid, 1928) were applied to different areas of outcrop of the same unit. There appears to be no advantage in reverting to the name 'Redcliffe', which has priority, since Reid himself abandoned the name in favour of Carborough Sandstone in later publications.

Lower Bowen Volcanics

The Lower Bowen Volcanics form the basal unit of the Bowen Basin succession. The volcanics mainly occupy the Bowen Syncline which trends north-west, and which is bounded to the west by Upper Carboniferous rocks and to the east by the Urannah Complex and Connors Volcanics, exposed in the Connors Arch. The unit also crops out east of the Connors Arch in the north-east corner of Bowen South. In the Bowen Syncline, the Lower Bowen Volcanics are overlain and overlapped by the Middle Bowen Beds.

Topography and Distribution

The volcanics mainly form plains with low rocky rises, scattered hills, and ridges. Mount Devlin, north of Collinsville, is an isolated hill of volcanics about 750 feet high. Several other rugged hills of volcanics also occur in the same area. The rugged highland areas of Lower Bowen Volcanics south-south-east of Collinsville probably represent uplifted and dissected fault blocks.

Lithology

The distribution of the Lower Bowen Volcanics is shown in Figure 3.

North-west area: In the north-west the Lower Bowen Volcanics consist largely of basalt and purple basaltic agglomerate. They are covered by deep soil and are poorly exposed. In the south, basalt is the predominant rock type, but sediments crop out at a few places, particularly in a hill 2 miles north-west of the old Bowen River Hotel. The sequence is as follows:

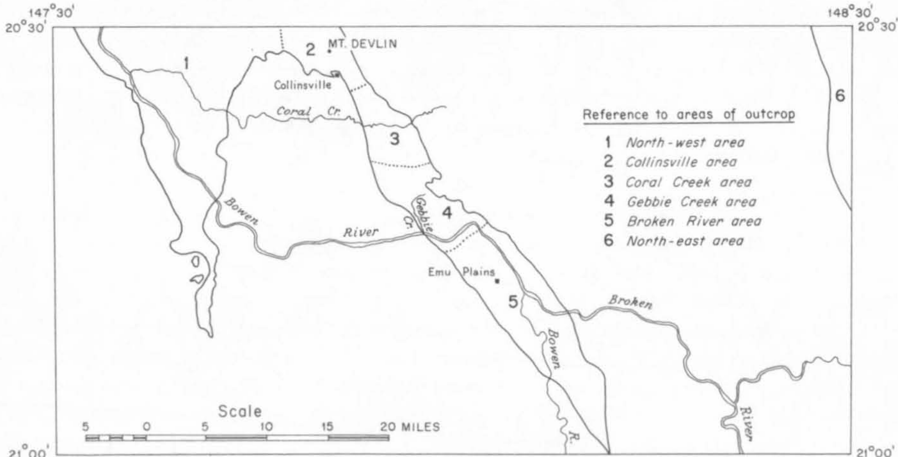


Fig. 3 Distribution of Lower Bowen Volcanics, Bowen South.

deeply weathered brownish green porphyritic intermediate volcanics, about 10 feet thick; several beds, up to 60 feet thick, of poorly sorted cobble to boulder conglomerate; brown thin-bedded flaggy fine to very coarse tuffaceous sandstone grading into fine pebble conglomerate; white thinly laminated cross-laminated 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 conglomerate contains angular cobbles and boulders of acid volcanic and other igneous rocks similar to the Bulgonunna Volcanics and the intrusions to the west. The poor sorting, angularity, and abundance of boulders suggest that the sediments were deposited close to their source, and the presence of cross-bedding indicates that the beds were deposited in shallow water.

The thin-bedded flaggy sediments cropping out at the bridge over the Bowen River consist of interbedded brown to grey siltstone and lithic sandstone containing fossil plants. Other sediments in this area include khaki-brown tuffaceous lithic sandstone and hard pebble conglomerate.

Collinsville area: Reid (1929) divided the Lower Bowen Volcanics in the Collinsville area into the Mount Devlin Volcanics, Mount Devlin Coal Measures, and Mount Toussaint Volcanics (in descending order). The volcanics at Mount Toussaint, 2 miles to the north of the Bowen South area (Fig. 3), were mapped and sampled to establish their relationship to the volcanics at Mount Devlin. The mapping of the folds in the Mount Toussaint Volcanics was facilitated by the presence of a dark friable tuffaceous feldspathic conglomerate which is interbedded with the volcanics. The structures were found to be conformable with those in the Collinsville Coal Measures. To the west of Mount Devlin there is a conformable succession from the volcanics at Mount Toussaint to the Collinsville Coal Measures. The Mount Devlin Volcanics are not present, and it appears that they may be equivalent to the Mount Toussaint Volcanics, which have been separated and displaced by faulting.

The Collinsville Fault apparently passes between Mount Devlin and the Collinsville Coal Measures, but the fault is difficult to locate. It does not pass east of Mount Devlin as it would be clearly visible in the good exposures in Pelican Creek. The volcanics at Mount Devlin form part of the uplifted block to the east of the Collinsville Fault and they do not lie directly under the Collinsville Coal Measures. If the fault blocks were restored to their original positions, by dropping the uplifted east block about 2000 feet the outcrop of the volcanics at Mount Devlin would fall roughly in line with the volcanics at Mount Toussaint. Thus, the Mount Devlin and Mount Toussaint Volcanics may be equivalent. They are similar in texture and mineralogical composition, though the Mount Devlin Volcanics may have undergone some hydrothermal alteration.

The five specimens collected from near Mount Toussaint are andesitic, but they contain different proportions of pyroxene. The phenocrysts are mainly euhedral plagioclase up to about 1 1/2 mm long, and in some specimens they form glomeroporphyritic aggregates. The plagioclase is zoned, but the average composition is probably labradorite. Some of the plagioclase is chloritized, and most of the phenocrysts are partly turbid, and commonly contain irregular cracks filled with hydrous iron oxide. The proportion of pyroxene is lower than in normal andesites, and in some specimens pyroxene is absent. The pyroxene phenocrysts consist of diopsidic augite. They are euhedral, and may be completely replaced by pseudomorphs of serpentine and chlorite. Iron oxides occur in association with the pyroxene, as individual phenocrysts, and as small scattered grains. Only plagioclase microlites can be identified in the fine-grained turbid groundmass. The accessories include apatite and sphene. Calcite and secondary hydrous iron oxide are also present. One specimen of the

Mount Toussaint Volcanics contains fewer plagioclase phenocrysts and less mafic minerals than average, and another contains a basaltic xenolith and has undergone considerable hydrothermal alteration.

Another less altered specimen is a porphyritic andesite with a fine turbid groundmass with plagioclase microlites showing crude orientation. The plagioclase and pyroxene phenocrysts are smaller than usual and the phenocrysts include equal proportions of brown hornblende and diopsidic augite. All the phenocrysts are euhedral and unaltered. The plagioclase phenocrysts are zoned from bytownite to andesine. Iron oxide is less abundant.

The porphyritic andesites from Mount Devlin are similar to the andesites from Mount Toussaint. At Mount Devlin the phenocrysts range up to 3 mm in diameter. They consist mainly of plagioclase, with some subhedral diopsidic augite and opaque iron oxide. The turbid aphanitic groundmass contains some altered microlites of plagioclase. The plagioclase phenocrysts contain numerous cracks and are partly turbid. Some crystals are strongly zoned, and some of the zones may be chloritized. The diopsidic augite phenocrysts average about 0.5 mm in diameter, but range up to 1 mm. Some of them are pseudomorphed by serpentine and chlorite, and others by uralite. A few unaltered diopsidic augite grains remain, some of which are rimmed by opaque iron oxide. Hydrous iron oxide occurs in cracks in the phenocrysts. Ilmenite is evenly distributed as phenocrysts up to 0.5 mm in diameter, or as small grains in the groundmass. Occasionally, the ilmenite is rimmed by sphene and a few small needles of apatite are also present.

The conformable succession between the Mount Toussaint Volcanics and the Collinsville Coal Measures west of Mount Devlin includes massive andesite agglomerate, containing boulders up to 1 foot in diameter of blue-grey brecciated and mottled andesite, set in a brown deeply weathered tuffaceous matrix which is stained with malachite in places; well-bedded medium to coarse-grained green-flecked red-brown basalt tuff; medium to thick-bedded medium to coarse-grained yellow-brown tuffaceous sandstone; basalt; and interbedded grey sandstone and pebble conglomerate. A light olive-green vesicular trachyte, overlying thin-bedded tuff, tuffaceous sandstone, and agglomerate, crops out near the top of the succession.

The sediments underlying the Mount Devlin Volcanics were referred to as the Mount Devlin Coal Measures (Reid, 1929). One seam of coal has been 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-easterly fault at the north-west end of Mount Devlin.

East of the fault, between the Urannah Complex and the Mount Devlin Coal Measures, the 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; and hydrothermally altered porphyritic dacite(?) flows.

The dacite(?) flows lie on the same line of strike as the Mount Toussaint Volcanics, but are separated from them by the north-east fault. The dacites are hydrothermally altered, and contain phenocrysts of turbid oligoclase, but some of the crystals are unaltered and have a rim of albite. Ferromagnesian minerals are rare, and are generally altered to pale green chlorite. A little apatite is present, and some specimens contain patches of mosaic quartz and calcite. The groundmass contains altered microlites of feldspar and abundant finely divided hydrous iron oxides. Iron oxides also occur in numerous cracks.

Coral Creek area: Coral Creek flows through rugged hills of Lower Bowen Volcanics adjacent to the Urannah Complex, and then across the plains on the volcanics as far as the Collinsville Fault. East of the Collinsville Fault, the volcanics are poorly exposed. They consist of light green pyroclastics interbedded with sandy pebble conglomerate; olive-green tuffaceous sandstone and finely laminated siltstone, showing some slump structures; extensive altered andesitic lava, tuff, and agglomerate; and dark green to purple weathered volcanics.

The hills to the east consist predominantly of indurated massive green pebble to boulder conglomerate containing very little matrix. The phenoclasts consist entirely of igneous rocks ranging from porphyritic volcanics to coarse-grained intrusives, and most of them are rounded. The conglomerate is intruded by green porphyritic dykes similar to those in 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 conglomerate contains more tuffaceous matrix and fewer boulders. Some of the fragments are rounded but many are angular. The fragments consist of green porphyritic volcanics with some boulders of coarse intrusive rocks. The beds associated with the conglomerate include coarse agglomerate, bedded in places, containing angular cobbles and boulders of porphyritic and amygdaloidal basic to intermediate volcanics; green medium to coarse-grained tuff; and dark grey jointed siltstone.

Six miles farther south, a similar conglomeratic sequence crops out adjacent to the Urannah Complex. It consists predominantly of a green very hard generally well sorted and bedded polymictic pebble to cobble conglomerate and tuffaceous conglomerate. Interbedded with the conglomerate are hard laminated fine-grained green and white tuffaceous siltstone, showing small slump structures; medium to thick-bedded hard green tuff; and black hardened closely jointed siltstone.

Gebbie Creek Area: A prominent bed of volcanics, near the top of the Lower Bowen Volcanics, crops out to the north and west of Gebbie Creek as far as the Collinsville Fault. The structure of the Bed is similar to that of the Wall Sandstone Member at the base of the overlying Gebbie Formation.

The bed consists of white to buff acid volcanic breccia composed of angular fragments in a fine-grained cherty matrix. The fragments and matrix are rhyolitic and the matrix consists of a quartz-feldspar mosaic. Some thin rhyolitic to trachytic flows are interbedded with the breccia. They are silicified and commonly have a mottled appearance and crude flow structure. They contain amygdales of calcite and limonite.

Between the volcanic breccia and the Wall Sandstone Member the sequence is as follows: interbedded blue, white, and grey siltstone, with plant remains, 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 fossil wood.

The sequence below the volcanics is not well exposed. It includes black siltstone, red ferruginous siltstone with some plant fragments, grey-green tuffs and flows, and khaki tuffaceous greywacke.

Broken River area: On the eastern flank of the Bowen Basin the Lower Bowen Volcanics are well exposed at a few places in the Broken and Bowen Rivers; but elsewhere the formation is 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. The sequence consists of a well-sorted quartz lithic sandstone with pebble bands, overlain by rhythmically bedded siltstone and current-bedded calcilutite and calcarenite, which are succeeded 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 crop out in the Broken River. The sediments show small-scale current lamination, and contain fairly abundant plant remains and fossil wood. Stratigraphically below them, another 500 feet of section, well exposed in the Broken River, consists of thin to medium-bedded well-bedded thinly laminated grey siltstone, dark tuffaceous greywacke or basaltic tuff, and greywacke conglomerate. The greywacke contains an abundant fine matrix, but most of the grains are subrounded. The beds are consistent in thickness and lithology over considerable distances. Slump structures and graded bedding are common, and some large oscillation ripples with an amplitude of 4 inches and a wave length of 3 feet were seen in this outcrop. The nature of the sediments suggests that they were deposited 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. This sequence crops out near the top of the volcanics east of Exmoor homestead and for some miles to the north and south. It contains abundant fossil plants and wood.

The basal beds of the Lower Bowen Volcanics are poorly exposed. East of Emu Plains homestead, they include massive basalt overlain by interbedded basaltic agglomerate, tuff, and tuffaceous conglomerate and basalt.

North-east area: The Lower Bowen Volcanics in the north-east area were not examined in detail. They are predominantly volcanic and include green andesitic agglomerate containing fragments up to half an inch in diameter, tuff, flows, and tuffaceous conglomerate containing quartz pebbles.

Structure

In the north-west, the Lower Bowen Volcanics are only slightly folded. Dips of 25^{o} were measured, but the dip is generally about 15^{o} or less to the east or south east into the Bowen Syncline. Near Collinsville, the unit is better exposed and the structures are similar to those in the conformably overlying Collinsville Coal Measures. Dips are 25^{o} or less, and the structures plunge south at shallow angles.

North of Collinsville, the Mount Devlin Volcanics and underlying rocks are folded into a broad syncline plunging south-west. One dip of 35^{o} was measured near the faulted contact with the Urannah Complex, but elsewhere the dip is less than 20^{o}. The volcanics are part of a fault block, between the Collinsville Fault and the Urannah Complex, and generally strike parallel to the long axis of the block. At the southern end of the block, between Gebbie and Jacks Creeks, the topmost beds of the volcanics crop out in a south-plunging flexure, conformably overlain by Middle Bowen Beds. In this structure, the volcanics dip west at 80^{o} near the Collinsville Fault; along the strike the dip flattens to 15^{o} south; and along the line of the eastern fault the strike bends sharply with a dip of 80^{o} to the west. In this area the faults die out and the displacement is taken up by the flexuring of the beds.

On the eastern flank of the Bowen Syncline the Lower Bowen Volcanics generally dip south-west, away from the Urannah Complex, at angles of about 40^{o}. The volcanics are affected by several faults and some minor folding. Their structure reflects the development of the steep eastern flank of the Bowen Syncline. The boundary between the Lower Bowen Volcanics and Middle Bowen Beds is structurally conformable in most places, but there is a disconformable transgressive overlap north of Emu Plains and in the west of the Bowen Syncline. Some minor folds near the southern edge of the mapped area do not continue into the overlying Middle Bowen Beds and there may be local unconformities.

The western margin of the Lower Bowen Volcanics is faulted against Tertiary volcanics in the Brawl Creek area. Farther south, they rest unconformably on the Bulgonunna Volcanics. Some of the outliers rest unconformably on igneous rocks which are intrusive into the Bulgonunna Volcanics.

The boundary of the Lower Bowen Volcanics with the underlying Urannah Complex and Connors Volcanics is more complicated, and is faulted in many places. Where the boundary is not faulted, the volcanics generally strike parallel to the contact with an outward dip from the underlying unit. Some of the sediments in the Lower Bowen Volcanics were possibly derived from the Urannah Complex, but the sediments and volcanics are intruded and metamorphosed by intrusions of the Urannah Complex, which includes several episodes of igneous activity. The first episode preceded the deposition of the Lower Bowen Volcanics and the last took place some time after deposition had ceased. The andesites of the Lower Bowen Volcanics were probably derived from vents which penetrated the older rocks of the Urannah Complex.

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, but in some places the formation is probably much thicker.

Age

Lower Permian fossils have been collected from the top of the Lower Bowen Volcanics in the Mount Coolon 1:250,000 Sheet area. The volcanics may all be Lower Permian, but it is possible that the vulcanism commenced in the Carboniferous.

Plant remains from a number of localities in the western part of the Bowen Basin, and from a few places in the east, include species of *Noeggerathiopsis*, *Samaropsis*, *Glossopteris*, and *Cordaites*.

Environment of Deposition

The Lower Bowen Volcanics were deposited in an asymmetrical basin. In the west, the Bulgonunna Volcanics formed a shelf dipping gently to the east on which sediments and basaltic volcanics accumulated. The environment of deposition was probably mainly freshwater, though some of the vulcanism may have been terrestrial. In the east, there may have been a line of volcanic islands trending north-north-west, flanked by a trough to the west. The type of sediments suggested that the trough was moderately deep.

The presence of marine fossils in the upper part of the Lower Bowen Volcanics in the Mount Coolon 1:250,000 Sheet area shows that the trough was invaded by the sea towards the end of deposition of the formation. The volcanics accumulated partly under terrestrial conditions on the islands and partly in the trough adjacent to the islands. The terrestrial volcanics were probably the source of most of the sediments in the unit.

Middle Bowen Beds

In Bowen South, the Middle Bowen Beds comprise the Blenheim, Gebbie, and Tiverton Formations, and the Collinsville Coal Measures. The three formations, of which Tiverton is the oldest and Blenheim the youngest, are new names defined in this Report. The Collinsville Coal Measures are equivalent to the upper part of the Gebbie Formation.

The Middle Bowen Beds crop out in a narrow strip along the steeply dipping eastern flank of the Bowen Syncline. Around the northern nose and western flank of the syncline, they crop out over a much greater area, but are represented only by the Collinsville Coal Measures and the Blenheim Formation.

The Middle Bowen Beds overlie the Lower Bowen Volcanics. Initially, the Tiverton Formation was deposited in a fairly restricted marine trough, but later the area of deposition included shallow seas to the east and west. The Collinsville Coal Measures were deposited under deltaic conditions along the northern and western margins of the basin. The Gebbie Formation was deposited at the same time, over a slightly more extensive area than the Tiverton Formation. Subsequently, the sea transgressed farther to the west and the Blenheim Formation was deposited over a much greater area. The distribution, thickness, and relationships of the formations in the Middle Bowen Beds are illustrated in Plate 6.

Tiverton Formation (new name)

Definition

The name is derived from Tiverton holding in the Mount Coolon 1:250,000 Sheet area.

Type Section: The type section is in a small creek 2 miles north-north-west of Blenheim homestead. The grid references are: top - 6518 3669, bottom 6521 3672, in the Mount Coolon 1:250,000 Sheet area.

Type area: The type area is a narrow strip trending north-north-east across Tiverton holding, east of Blenheim homestead, and extending from 2 miles north to 10 miles south of Blenheim Homestead. The formation is well but not completely exposed in a small creek 2 miles north of Blenheim homestead. Other good exposures in the type area are in small gullies about 1 3/4 miles south-east of Blenheim homestead. The basal part of the unit is well exposed in Hazelwood Creek.

Distribution: The Tiverton Formation forms a narrow strip extending north and north-west from near Mount Landsborough on the Mackay 1:250,000 Sheet area to about 5 miles north-west of Emu Plains homestead on the Bowen 1:250,000 Sheet area.

Lithology: The principal rock types are medium-grained to fine grained quartz greywacke, with carbonaceous streaks and laminae, and coarse sand grains in places; calcareous fossiliferous quartz greywacke beds, lenses, and nodules; and some limestone, coquinite, and sandy limestone. The upper part of the unit consists mainly of siltstone and is poorly exposed.

Thickness: The thickness near Blenheim homestead is 750 feet, but it increases to about 2100 feet at the southern end of the type area.

Fossils: Fauna II of J.M. Dickins (Appendix) includes Eurydesma hobartense, Deltopecten limaeformis, Anidanthus springsurensis, Strophalosia preovalis, Notospirifer hillae, Cancrinella farleyensis, Taeniothaerus sp., Neospirifer (Grantonia) cf. hobartensis.

Age: The age is Lower Permian.

Relationships: The Tiverton Formation overlies the Lower Bowen Volcanics with possible slight disconformity or unconformity, and is conformably overlain by the Gebbie Formation.

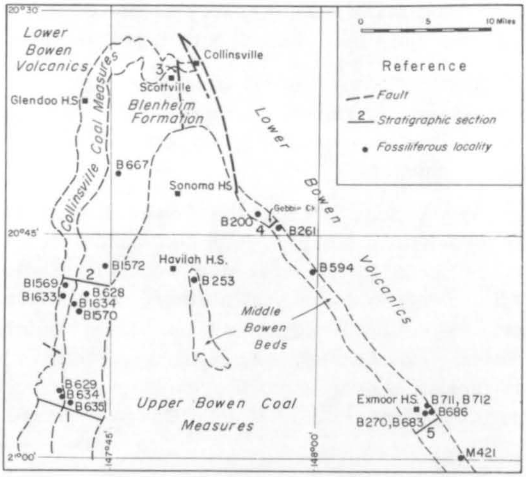


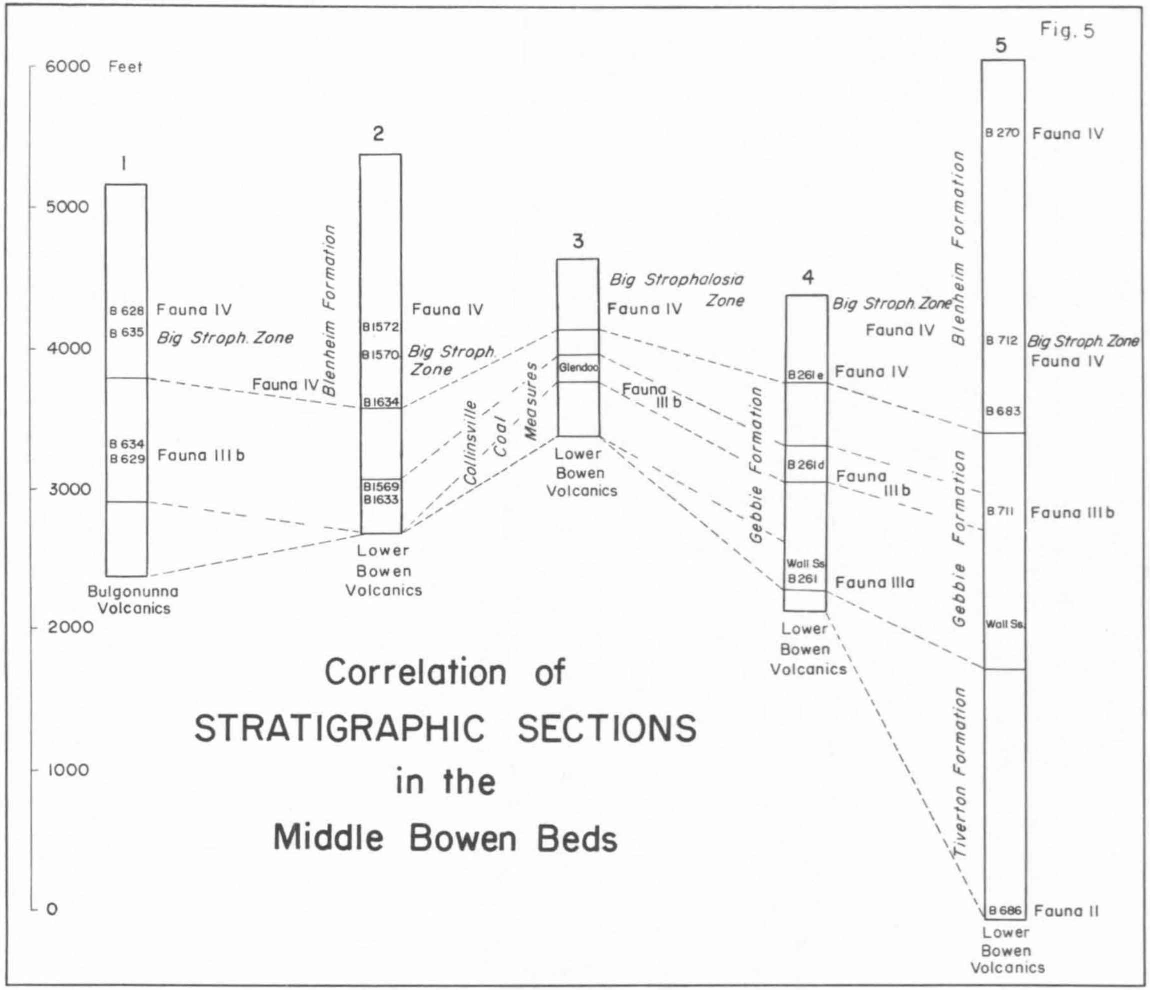
Fig. 4 BOWEN SOUTH, OUTCROP AREA, Middle Bowen Beds
Showing fossiliferous localities and stratigraphic sections

Description

In Bowen South, the formation crops out in a narrow strip extending south-southeast from near the Bowen River to the southern boundary of the mapped area. The formation forms soil-covered plains with some long low strike ridges covered with ferruginous gravel and soil. The unit forms more prominent hills where it is metamorphosed by an intrusion south of Emu Plains.

The Tiverton Formation is poorly exposed in Bowen South. It consists mainly of a grey-green semi-friable medium-grained to fine-grained quartz greywacke with irregular carbonaceous streaks and laminae, apparently the result of scavenger action during sedimentation. In places, it contains scattered grains of coarse sand and calcareous and fossiliferous beds and nodules. Fossiliferous calcareous quartz greywacke crops out at the base of the Tiverton Formation east of Exmoor and near the southern margin of Bowen South. The greywacke has been extensively ferruginized during weathering, and the calcareous material has been partly replaced. The fossils weather out as ferruginous casts and steinkerns. The upper part of the formation probably includes some siltstone or shale, which is invariably covered by soil.

The Tiverton Formation overlies the Lower Bowen Volcanics, but the contact is not exposed in Bowen South. Near the southern boundary of Bowen South, the minor folds and faults in the Lower Bowen Volcanics do not continue into the overlying Tiverton Formation,



Correlation of STRATIGRAPHIC SECTIONS in the Middle Bowen Beds which suggests that they may be separated by an unconformity. In general the Tiverton Formation is structurally conformable with the volcanics, and any unconformity between them is probably slight. Similar relationships obtain in the Mount Coolon Sheet area to the south.

The Gebbie Formation rests conformably on the Tiverton Formation, but near the Bowen River it overlaps it and to the north it directly overlies the Lower Bowen Volcanics.

The Tiverton Formation contains a rich marine fauna, called Fauna II by Dickins (Appendix). It indicates that the formation is Lower Permian and can be correlated with the Cattle Creek Formation (equivalent to the Sirius Formation, Staircase Sandstone, and Stanleigh Formation) of Reids Dome in the Springsure 1:250,000 Sheet area.

The formation is 1800 feet thick east of Exmoor and thins to 1400 feet near the southern boundary of the area mapped.

The Tiverton Formation was deposited in a marine environment and the absence of shallow-water structures suggests moderately deep water.

Gebbie Formation (new name)

Definition

Derivation: The name is derived from Gebbie Creek, a tributary of the Bowen River on the Bowen 1:250,000 Sheet area.

Type section: The type section is in Gebbie Creek, and the base of the section is approximately 1 mile upstream from Bowen River at latitude 20°44'S., longitude 147°57'E.

Distribution: The Gebbie Formation forms a narrow strip extending north and north-west from near Mount Landsborough in the Mackay 1:250,000 Sheet area to 6 miles north-west of Gebbie Creek on the Bowen 1:250,000 Sheet area.

Lithology: The principal rock types include quartz sandstone, quartz greywacke, carbonaceous in part, fossiliferous calcareous quartz greywacke, siltstone, carbonaceous shale, and minor coal.

Thickness: The thickness is 1450 feet in Gebbie Creek.

Fossils: Fauna III of J.M. Dickins (Appendix) includes *Chaenomya* sp.nov., *Megadesmus* sp.nov., *Pachymyonia* sp.nov., *Mourlonia* (*Platyteichum*) cf. *costatum*, *Walnichollsia*? sp.nov., pelecypoda gen.et sp.nov., *Schizodus* sp.nov. A.

Age: The age is Lower Permian.

Relationships: The Gebbie Formation is conformable with the Tiverton Formation below and the Blenheim Formation above. It overlaps the Tiverton Formation north of Emu Plains homestead on the Bowen 1:250,000 Sheet area, and disconformably overlies the Lower Bowen Volcanics. The Collinsville Coal Measures are equivalent to that part of the Gebbie Formation above the Wall Sandstone Member. The formation differs from the Tiverton Formation in containing disseminated carbonaceous material and minor coal, and thick quartz sandstone units. The base of the formation is taken below the 200-foot sequence of calcareous quartz greywacke, sandstone, and siltstone below the Wall Sandstone Member. This boundary marks the transgression beyond the limits of the Tiverton Formation.

Description

In Bowen South, the Gebbie Formation crops out on the eastern flank of the Bowen Syncline; it extends from the southern boundary of the area to the Collinsville Fault, about 5 miles north-north-west of the type section. The formation crops out as long prominent strike ridges separated by valleys or alluvial flats. It forms high hills on the flank of the intrusion south of Emu Plains homestead.

Lithology

The Gebbie Formation comprises carbonaceous quartz greywacke and siltstone interbedded with thick beds of quartz sandstone and thin beds of pebble conglomerate. The persistent quartz sandstone beds, such as the Wall Sandstone Member, are characteristic of the Gebbie Formation. They are commonly cross-bedded and, in places, ripple-marked.

The lithology of most of the Gebbie Formation is described in the Gebbie Creek and Exmoor homestead measured section on Plate 2. The basal few hundred feet of the unit, which are not exposed in either section, include yellow-brown siltstone and fine semi-friable quartz greywacke, in part calcareous and fossiliferous. Similar calcareous and fossiliferous quartz greywacke and siltstone beds and lenses occur throughout the unit.

In the type section the Gebbie Formation contains some thin interbeds of coal as well as carbonaceous shale. These are absent farther south, but the quartz greywacke still contains irregular carbonaceous streaks and laminae.

The Gebbie Formation differs from the Tiverton Formation mainly in containing quartz sandstone. The other rock types are similar, although the arenites are coarser than those in the Tiverton Formation. The sediments at the base of the formation, below the Wall Sandstone Member, are similar to the basal part of the Tiverton Formation. They have been included in the Gebbie Formation because they overlap the Tiverton Formation, and because they rest directly on the Lower Bowen Volcanics to the north of the Bowen River. They are separated from the outcrop of the basal part of the Tiverton Formation by an unexposed area which is presumably underlain by a siltstone/shale sequence.

Structure and Relationships

The Gebbie Formation crops out on the eastern limb of the Bowen Syncline, and rests conformably on the Tiverton Formation. The dip is generally south-west at 30° to 50°, but it steepens to 70° or more near faults such as the Collinsville Fault. The formation is structurally conformable, though disconformable, on the Lower Bowen Volcanics north of the Bowen River. The structural conformity is shown by the parallelism of two prominent strike ridges formed by the Wall Sandstone Member near the base of the Gebbie Formation and a trachytic volcanic breccia near the top of the Lower Bowen Volcanics.

The relationship of the Gebbie Formation to the Collinsville Coal Measures is discussed on p. 36.

Thickness

The unit is about 1450 feet thick in Gebbie Creek and thickens southward to 1600 feet near Exmoor homestead Fig. 5, sections 4 and 5.

Palaeontology and Age

The Gebbie Formation contains a distinct marine fauna (Fauna III), which is described by J.M. Dickins (see Appendix). The fauna is distinct from that in the underlying Tiverton Formation. This is probably the result of a change in environment and possibly a slight break in deposition. The fauna indicates that the Gebbie Formation is Lower Permian.

Environment of Deposition

The Gebbie Formation was deposited in a marine environment, and the presence of the quartz sandstone beds and the cross-bedding and rare ripple-marking indicate that the water was fairly shallow. The presence of carbonaceous shreds and thin seams of drift coal in the type section suggests that the beds were deposited near the shore. The proportion of carbonaceous material decreases to the south, away from the shore.

Wall Sandstone Member

The Wall Sandstone Member is a sandstone unit near the base of the Gebbie Formation which is too thin to show on the map.

The name was introduced by Reid (1924), and was derived from a sandstone cliff, known locally as 'the Wall', near the Bowen River, 1 mile east of Gatton Vale homestead. The member extends for about 4 miles to the north of the Bowen River and to the south of the Bowen 1:250,000 Sheet area. It generally forms a high rocky strike ridge, breached at the Bowen River and at a few other places.

The member is a clean well-sorted medium-grained to coarse-grained quartz sandstone, slightly to strongly silicified, and closely jointed in places. It is medium to thick-bedded, cross-bedded, and cross-laminated. It is 98 feet thick in Gebbie Creek, thins to 20 feet in the north, and is about 80 feet thick near the southern boundary of the Sheet area.

The Wall Sandstone Member contains rare marine fossils, and is Lower Permian in age. It was deposited in a shallow-water marine environment.

Collinsville Coal Measures

The Collinsville Coal Measures were named by Reid (1924) and described in great detail by Webb & Crapp (1960). No type section is defined for the unit but a number of fully cored holes have penetrated most of it. The Collinsville Coal Measures crop out to the west of the Collinsville Fault. They occupy a broad area around the nose of the Bowen Syncline and a narrower strip along the western limb of the syncline. They form soil-covered flats with low rises and a few rocky ridges near and west of Collinsville. To the south-west, along Parrot Creek, they form high hills with steeply incised drainage.

Lithology

The Collinsville Coal Measures consist predominantly of sandstone, coal, siltstone, shale, and conglomerate. A massive unit, the Glendoo Sandstone Member (Webb & Crapp, 1960), occurs near the middle of the formation. It consists of quartz sandstone and quartz greywacke, calcareous and fossiliferous in places, and siltstone. The lithology of the Bowen Coal Measures is illustrated by the log of the Bowen Consolidated Coal Mines diamond drill-hole NS371 and the measured section of the basal 75 feet of the unit as shown on Plate 6.

The Collinsville Coal Measures, between Collinsville and the junction of Parrot Creek and the Bowen River, have been described by Webb & Crapp (1960), but the lithology farther south is somewhat different.

At the base of the formation, near Collinsville, is a poorly sorted polymictic pebble-cobble conglomerate which has been derived from the underlying Lower Bowen Volcanics. The pebbles consist mainly of volcanics, quartzite, mudstone, and shale. In the Parrot Creek area, the thick basal conglomerate grades into breccia and contains pebbles and small boulders of volcanic rocks derived from the underlying Bulgonunna Volcanics. The conglomerate is commonly deeply weathered, and contains a few thin interbeds of siltstone. It is intruded by many small intermediate sills and dykes. Elsewhere, in this area, the basal conglomerate overlying the Bulgonunna Volcanics is a hard mature pebble conglomerate, up to 1 foot thick, containing well rounded pebbles of volcanics.

The Glendoo Sandstone Member, which is not shown on the map, forms a distinctive sandstone unit between Collinsville and the Bowen River. It is about 60 feet thick in the type area near Glendoo homestead (Webb & Crapp, 1960). South of the Bowen River, it is represented by a thicker sequence of fossiliferous calcareous quartz greywacke and siltstone.

Near Collinsville, the Collinsville Coal Measures have been subdivided into three sub-units* - upper coal measures, Glendoo Sandstone Member, and lower coal measures - but all three are not everywhere present.

South of the Bowen River (Fig. 5 section 2) the equivalent beds to the Glendoo Sandstone Member are separated from the Lower Bowen Volcanics by a narrow unexposed zone, and it appears that the lower coal measures are overlapped in this area. The upper coal measures have the same lithology as at Collinsville.

Farther south, along Parrot Creek (Fig. 5, section 1), the lower coal measures crop out, and have the same lithology, complete with coal seams, as near Collinsville; but the upper coal measures have not been recognized. They may have lensed out or there may have been a change in lithology to quartz greywacke and siltstone similar to the local equivalents of the Glendoo Sandstone Member below and the Blenheim Formation above. Comparison of sections 1 and 2 in Figure 5 suggests that the latter explanation is correct. The top of the Collinsville Coal Measures is located below the beds where Fauna IV of the Blenheim Formation first appears.

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* The three subdivisions of the Collinsville Coal Measures are referred to as sub-units B1, B2, and B3, B1 being the oldest, by Dickins, Malone, & Jensen (1964). Unit B2 is a dominantly sandstone unit with marine fossils, approximately equivalent to the Glendoo Sandstone Member. Three sub-units B1, B2, and B3, lateral equivalents of these in the Collinsville Coal Measures, are recognized in the Gebbie Formation in Gebbie Creek. Distinct faunas, referred to as faunas IIIa, IIIb, and IIIc, are associated with units B1, B2, and B3 respectively.

Structure and Relationships.

The Collinsville Coal Measures in the Bowen Syncline generally dip south at less than 5^{o} around the northern nose, and east at 10^{o} or less on the west flank. In the northern nose, the unit is folded into several minor anticlines and synclines, and many faults are present. Most of them are high-angle reverse faults, such as the Collinsville Fault, with the eastern block uplifted, but some are thrust faults dipping gently east. The faults trend north to north-west, and the Coal Measures commonly dip more steeply and are more tightly folded near the faults. Faulting is less common and less severe on the western flank of the Bowen Syncline.

The Collinsville Coal Measures are disconformable and regionally unconformable on the Lower Bowen Volcanics. The disconformity is indicated by the absence of the Tiverton Formation between the Lower Bowen Volcanics and the Coal Measures, and by the presence of a basal conglomerate derived from the volcanics. The regional unconformity is evident 10 miles south-west of Havilah homestead, where the Collinsville Coal Measures transgress the Lower Bowen Volcanics and rest directly on the Bulgonunna Volcanics.

The relationship of the Collinsville Coal Measures to the Gebbie Formation is illustrated in plate 6, where the log of the Bowen Consolidated Coal Mines' borehole NS371 and the type section of the Gebbie Formation are shown. The Big Strophalosia Zone, a marker horizon throughout this part of the Bowen Syncline, is present in both the borehole and the measured section. The base of the Blenheim Formation in the borehole is at the base of conglomerate overlying the topmost coal of the Collinsville Coal Measures, and in the Gebbie Creek section, it lies at the base of a pebble conglomerate band above a monotonous sequence of quartz greywacke and siltstone. Fossil collection B261e, a rich Fauna IV collection, has also been used to locate the base of the Blenheim Formation in Gebbie Creek.

The Gebbie Formation in Gebbie Creek can be subdivided into three units, similar to those in the Collinsville Coal Measures. In the borehole, the coal measures above and below the Glendoo Sandstone Member do not contain marine fossils, but in Gebbie Creek, the equivalent units consist of carbonaceous quartz greywacke and siltstone with a few marine fossils, and several thin coal seams in the lower unit. The middle unit in the Gebbie Formation consists of quartz greywacke, siltstone, quartz sandstone, and pebble conglomerate, with several fossiliferous calcareous horizons. Fossil collection B261d, from this sequence, is equivalent to the fauna from the Glendoo Sandstone Member. The Wall Sandstone Member near the base of the Gebbie Formation does not appear to be present in the Collinsville Coal Measures.

The Collinsville Coal Measures are conformably overlain by the Blenheim Formation.

Environment of Deposition

The Collinsville Coal Measures were deposited in a deltaic or paludal environment around the north-western margin of a marine basin of deposition. The Glendoo Sandstone Member was formed during a marine transgression, and the coal seams interfinger with sandstone and siltstone beds, and lenses of conglomerate. Most of the coal seams overlie thin beds of dark shale with plant remains, but one seam rests on medium to coarse-grained sandstone. The coal seams are possibly drift coals in part.

Thickness

The Collinsville Coal Measures are 750 feet thick in borehole NS371, but thicken to about 900 feet in section 2, Figure 5 and to about 1400 feet in section 1, Figure 5.

Age

The fossils contained in the Glendoo Sandstone Member belong to Fauna IIIb of Dickins (Appendix). They indicate a late Lower Permian age.

Blenheim Formation (new name)

Definition

Derivation: The name is derived from Blenheim Creek, a tributary of the Bowen River, on the Mount Coolon 1:250,000 Sheet area.

Type Section: The type section is in Blenheim Creek. The top of the section is near the Nebo-Collinsville road crossing of Blenheim Creek at latitude 21°04'S., longitude 148°13'E. The base of the section is about half a mile upstream from the road crossing.

Distribution: The Blenheim Formation crops out in a narrow to moderately broad strip extending from near Mount Landsborough on the Mackay 1:250,000 Sheet area, north and north-east to near Collinsville, and then south-west to south-east across the Bowen, Mount Coolon, Clermont, and St Lawrence 1:250,000 Sheet areas to the north-east corner of the Emerald 1:250,000 Sheet area and the western part of the Duaringa 1:250,000 Sheet area. It also crops out around the Bundarra Granodiorite, in the Rosella Creek Anticline, and in several anticlines in the folded zone, north of the Mackenzie River.

Lithology: The principal rock types are siltstone, pebbly sandstone, quartz greywacke, fossiliferous calcareous siltstone and sandstone, coquinite, and limestone.

Thickness: The thickness is 2310 feet in the type section and 5200 feet near Mount Landsborough.

Fossils: Fauna IV of J.M. Dickins (Appendix) includes the following species: *Ingelarella magna*, *I. isbelli*, *I. havilensis*, *Notospirifer minutus*, *Megadesmus grandis*, *Terrakea solida*, *Strophalosia* cf. *brittoni* var. *gattoni*, *S. ovalis*, *Schizodus* sp. nov. B, Astartila cf. *cytheria*.

Age: The age is mainly or wholly Upper Permian.

Relationships: The Blenheim Formation rests conformably on the Gebbie Formation and Collinsville Coal Measures. It overlaps these units in the Clermont and Emerald 1:250,000 Sheet areas, where it unconformably overlies Devonian to Carboniferous volcanics and older rocks. It is conformably overlain by the Upper Bowen Coal Measures. The Blenheim Formation consists mainly of siltstone and quartz greywacke, whereas the Gebbie Formation includes a significant amount of quartz sandstone. The base of the Blenheim Formation is defined by a conglomerate above the Collinsville Coal Measures and by conglomerate to pebbly sandstone above the Gebbie Formation. The boundary marks a major transgression of the Blenheim Formation beyond the limits of the Gebbie Formation and the Collinsville Coal Measures.

Description

Within Bowen South, the Blenheim Formation crops out in a narrow strip on the eastern border of the Bowen Syncline and in a broad area around its nose and western limb. It is also exposed in the core of the Rosella Creek Anticline, south-east of Havilah homestead. The formation is mainly covered by soil with a few low strike ridges. The topography is rugged near the intrusion south of Emu Plains. Near Parrot Creek, the unit forms prominent cuestas with a gentle eastern slope and a steep western scarp. The cuestas rise up to 300 feet above Parrot Creek. The Rosella Creek Anticline consists mainly of plains with scattered outcrops and rubble on low rises and in shallow gullies. The crest of the structure forms a low rounded hill.

Lithology

The lowermost 650 feet and 700 feet of the Blenheim Formation in the Gebbie Creek and Exmoor Sections, and the bottom 500 feet of the section in borehole NS371 are illustrated in Plate 6. The entire Blenheim Formation was measured in Blenheim Creek in the Mount Coolon Sheet area, and this section is included in Plate 6. In Gebbie Creek the unit commences with pebbly sandstone overlain by carbonaceous quartz greywacke grading to coarse siltstone, and in the borehole it commences with a pebbly conglomerate band with predominantly siltstone above. The basal section contains thin conglomerate bands and scattered pebbles and boulders. It also includes the Big *Strophalosia* Zone, which lies 350 feet above the base of the formation in Gebbie Creek, and 390 feet above the base in the borehole.

The remainder of the Blenheim Formation is poorly exposed. It consists mainly of siltstone with thin to thick beds of quartz greywacke, calcareous and fossiliferous in places. The quartz greywacke beds crop out in the Bowen River near Exmoor homestead.

The upper part of the Blenheim Formation is exposed in the Rosella Creek Anticline. The principal rock types include fossiliferous calcareous medium-grained quartz greywacke; thin beds of grey-blue poorly fossiliferous limestone; thinly to thickly interbedded blue-grey to grey gypsiferous or micaceous siltstone, and laminated and cross-laminated fine to medium-grained quartz greywacke with worm tubes and tracks; varicoloured siltstone; and cross-bedded quartz sandstone with rare pebble and fine conglomerate bands. The siltstone constitutes more than 60 percent of the section.

In the Parrot Creek area, the Blenheim Formation includes medium-grained fine to coarse-grained laminated micaceous quartz sandstone, and medium to coarse-grained quartz greywacke. In places, the quartz greywacke is calcareous and fossiliferous and grades into sandy coquinite. The sandstone and quartz greywacke form the cuestas in the Parrot Creek area, but the siltstone is poorly exposed. The formation is more arenaceous on the western limb of the Bowen Syncline than farther east.

Structure and Relationships

The Blenheim Formation has a gentle dip on the western limb and around the nose of the Bowen Syncline, but it dips more steeply on the eastern limb. The unit is less affected by minor structures around the nose of the syncline than the underlying Collinsville Coal Measures, and on the eastern limb, it dips less steeply than the underlying Gebbie Formation. Within the Bowen Syncline, the formation crops out in the Rosella Creek Anticline, a structure about 8 miles long, trending parallel to the axis of the Bowen Syncline; at the southern end it splits into several folds. The dip of the Blenheim Formation in the anticline ranges from 10^{o} to 45^{o}.

The Blenheim Formation rests conformably on the Gebbie Formation and Collinsville Coal Measures. In places, the pebble conglomerate at the base of the formation fills washouts in the uppermost coal seam of the coal measures. This indicates that there were small breaks in the sedimentation. The Upper Bowen Coal Measures rest conformably on the Blenheim Formation.

Environment of Deposition

The Blenheim Formation is entirely marine. It was deposited during a general subsidence of the area, as the sea deepened near the eastern limb of the Bowen Syncline and transgressed to the west and north over the Collinsville Coal Measures. The formation, unlike the Gebbie Formation, contains no shallow-water structures. The higher proportion of arenite in the Blenheim Formation near Parrot Creek suggests that this locality was near the western margin of the basin.

Thickness

The Blenheim Formation is approximately 2600 feet thick near Exmoor homestead (Fig. 5, section 5). On the western limb of the Bowen Syncline the thickness is about 1800 feet in section 2, Figure 5, and about 1400 feet in section 1, Figure 5.

Age

The Blenheim Formation contains a rich marine fauna, Fauna IV of Dickins (Appendix). The fossils indicate that the unit is Upper Permian.

Big *Strophalosia* Zone

The name 'Big *Strophalosia* Zone' was given by Reid (1924) to a continuous horizon near the base of the Blenheim Formation in the Bowen South area. The name is not formal but is well established in the literature. The zone crops out around the nose of the Bowen Syncline and in many places on the western limb. In the east, it is well exposed between the Collinsville Fault and the Bowen River, near Gebbie Creek, but farther south it crops out only in the bank of the Bowen River near Exmoor homestead. The zone is not shown on the map.

The Big *Strophalosia* Zone consists of fossiliferous calcareous medium to fine-grained quartz greywacke grading into coarse siltstone, containing scattered pebbles, cobbles, and angular boulders, and some thin beds of conglomerate. Near Collinsville, grey-blue coarse siltstone is predominant, and near Parrot Creek the zone includes fossiliferous sandy limestone and coquinite. The fossiliferous beds are generally ferruginized and the weathered outcrops are yellow or brownish red. The lithology of the zone is illustrated in the measured section at Gebbie Creek and in borehole NS371 (Pl. 2).

The thickness of the Big *Strophalosia* Zone is 75 feet in borehole NS371, 100 feet in Gebbie Creek, and 105 feet near Exmoor homestead. On the western limb of the Bowen Syncline, it is estimated to be 60 feet thick (Fig. 5, section 1).

The zone is mostly richly fossiliferous, with poorly fossiliferous intervals in places. The species include *Strophalosia ovalis*, *S. clarkei*, *S. brittoni* var. *gattoni*, and *Terrakea solida*. The fauna of the Big *Strophalosia* Zone is discussed by Dickins in the Appendix; it indicates an Upper Permian age.

The random orientation of the fossils and the absence of productid spines in many places suggest that the sediments were possibly deposited from turbidity currents. This may explain the great areal extent of the zone and the presence of angular boulders and cobbles. Graded bedding appears to be absent.

Upper Bowen Coal Measures

In Bowen South, the Upper Bowen Coal Measures include the sequence between the Middle Bowen Beds below and the Carborough Sandstone above. This stratigraphic interval probably includes equivalent beds to the Rewan Formation, though the characteristic rock types have not been recognized in Bowen South. Thus, the 'Upper Bowen Coal Measures' as used in this Report are not identical with the 'Upper Bowen Coal Measures' in the Duaringa 1:250,000 Sheet area (Malone et al., 1963), where the Rewan Formation is present. The usage in this Report is the same as in the report on the Mount Coolon 1:250,000 Sheet area (Malone et al., 1964).

Distribution and Topography

The Upper Bowen Coal Measures are poorly exposed in a triangular area in the Bowen River Valley and extend south into the Mount Coolon Sheet area. The formation crops out in plains covered with soil and alluvium, but the trend of the bedding is generally visible on the air-photographs. East of the Redcliffe Tableland on the southern edge of the Sheet area, the Upper Bowen Coal Measures form a line of rugged hills in the metamorphic aureole around an igneous intrusion.

Lithology

The description of the lithology of the Upper Bowen Coal Measures is based on the Mount Coolon Sheet area, where the formation is better exposed. The lithology in Bowen South is similar, except for the presence of rare quartz sandstone. 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 composed of well-sorted subangular grains of quartz, fragments of volcanic rock, feldspar, and mica, and very little matrix. It commonly contains wood and bark. The sandstone forms thick lenses showing cross-bedding and festoon-bedding. They are medium to coarse-grained and are pebbly in places. Fine lithic sandstone is commonly interbedded with siltstone.

The calcareous lithic sandstone is a hard, medium to thick-bedded rock composed of angular grains of quartz and volcanic fragments set in a fine-grained cryptocrystalline matrix of calcite which forms up to 40 percent of the rock. Calcareous lithic sandstone is abundant in the Bowen South area, and weathered rounded yellow boulders crop out in the soil over a large proportion of the Upper Bowen Coal Measures. In places, the proportion of calcite increases and the rock grades into sandy limestone.

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

In a few places, beds of fine to cobble conglomerate are an important constituent of the Upper Bowen Coal Measures. They consist mainly of rounded fragments of volcanic rocks set in a hard brown matrix of quartz, mica, and chlorite grains, with some calcite cement. Elsewhere, lenses of conglomerate and poorly sorted conglomeratic sandstone are present. They are torrentially cross-bedded in some places, and commonly contain abundant bark, fragments of wood, and even entire tree trunks. The lenses of conglomerate may be river-channel fillings. A typical example is exposed in the Bowen River crossing near the southern margin of Bowen South.

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

Carbonaceous shale and thin coal seams are widely distributed. The coal seams are thick in a few places, but in every outcrop are intruded by sills.

Structure

Dips in the Upper Bowen Coal Measures are generally inclined towards the centre of the basin at angles of 25^{o} or less. Dips up to 60^{o} were noted at the southern end of the Rosella Creek anticline, where the unit is folded in several south-plunging anticlines and synclines with steep limbs. These structures die out a short distance to the south.

The upper and lower boundaries of the Coal Measures are not exposed in the Bowen South area, but the unit appears to be conformable with the Middle Bowen Beds below and the Carborough Sandstone above.

Environment of Deposition

The Upper Bowen Coal Measures are the result of lacustrine, fluviatile, and paludal sedimentation, in contrast with the marine environment of the Blenheim Formation. The area of deposition is smaller than that of the Blenheim Formation, and these changes may be related to the uplift of the area around the Urannah Complex. The uplifted area reduced the size of the basin and exposed the Lower Bowen Volcanics which are the source of the Upper Bowen Coal Measures sediments.

The abundance of calcite in the matrix of the lithic sandstone may be related to occasional incursions of the sea, or possibly to arid climatic conditions.

Thickness

The thickness of the Upper Bowen Measures about 6 miles south of the Bowen South area is estimated at 10,500 feet.

Age

No marine fossils are known. The abundant flora includes Glossopteris indica Sch. G. angustifolia Brong., G. conspicua Fm., G. spathulato-cordata Fm., Phyllotheca australis Brong., Nummulospermum bowenense Walk. and species of Sphenopteris, Cladophlebis, Samaropsis, and Vertebraria. These plants are a Permian to Lower Triassic assemblage. The marine fossils in the underlying Blenheim Formation indicate that the Upper Bowen Coal Measures are no older than earliest Upper Permian. They are regarded as Upper Permian and probably range into the Lower Triassic.

Carborough Sandstone

Nomenclature

The name 'Carborough Sandstone' was first used by Reid (1928b) for the rocks of the Carborough Range in the Mount Coolon 1:250,000 Sheet area. Reid (1925) had previously applied the name 'Redcliffe Series' to the same unit cropping out in the Redcliffe Tableland, but in later publications he abandoned the name in favour of Carborough Sandstone.

Distribution and Topography

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

The formation forms tablelands which rise 400 to 500 feet above the plains underlain by the softer Upper Bowen Coal Measures. The scarps of the tablelands are steep and covered with scree, but in places, benches have been found on the top of the massive sandstone beds, and occasionally on top of sills.

Lithology

Quartz sandstone with little if any matrix predominates. In addition to quartz, it may contain up to 15 percent chert, quartzite, and other rock fragments, and minor feldspar and mica. The grains are subrounded, medium to coarse in size, and well sorted. Larger grains are scattered through the rock or occur in bands. Many of the quartz grains have been partly dissolved. The sandstone beds are commonly cross-bedded, and in places layers of coarse sand and small pebbles follow the cross-bedding.

Structure

Dips in the Carborough Sandstone are generally less than 5^{o}. 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 north.

The Carborough Sandstone appears to be conformable with the Upper Bowen Coal Measures, but the contact is not exposed. It 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 Carborough Sandstone was probably deposited in a fluviatile environment. This is suggested by the presence of thick sets of planar cross-bedding in the unit. The change in lithology from the Upper Bowen Coal Measures to the Carborough Sandstone may be related to much slower subsidence of the area, which would permit reworking of the sediments by the streams to produce the mature clean Carborough Sandstone.

Thickness

The Carborough Sandstone is approximately 1500 feet thick in the Carborough Range in the Mount Coolon Sheet area.

Age

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

Tertiary Basalt

Basalt (Tb) 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; basalt flows underlie the Tertiary volcanics (Tv) near Brawl Creek; and two basalt plugs were mapped in the south-west of the area.

Most of the basalts in the Bowen Basin are plugs intruding the Upper Bowen Coal Measures. They form steep rounded hills 100 to 150 feet high. Remnants of basalt flows are preserved as mesas around some of the plugs. Most of the plugs consist of very fine-grained basalt. The basalt flows are mainly olivine-bearing, and differ widely in texture. The most common is a holocrystalline equigranular rock. The basalt flows and plugs are related to the basalts in the Mount Coolon Sheet area, where larger areas are preserved.

The basalts cropping out on the western side of the Brawl Creek block are mainly flows, but one possible plug was noted. They rest unconformably on a large Carboniferous intrusion to the west, and dip east at 5° to 10° beneath Tertiary acid volcanics in the south. At the northern end of the block they are faulted against plant-bearing Lower Bowen Volcanics. The basalt is dark grey, fine-grained, and commonly porphyritic. It is composed of euhedral phenocrysts of augite and labradorite in a matrix of plagioclase laths, granular pyroxene, and iron oxide. The phenocrysts and the plagioclase laths are aligned parallel to the direction of flow. The basalt is little altered and is assumed to be Tertiary.

Two small plugs of basalt were mapped west of Pyramid homestead. These are regarded as Tertiary because they have a similar magnetic orientation to other Tertiary basalts (P.M. Stott, pers. comm.).

Suttor Formation

Remnants of lateritized sub-horizontal sediments crop out in the southern and western parts of the Bowen South area. They are correlated with the Tertiary Suttor Formation in the Mount Coolon Sheet area (Malone et al., 1964), where the type area is in the Leichhardt Range, east of the Suttor River.

The Suttor Formation forms mesas up to 200 feet high in the Bowen Basin. Farther west, it forms mesas or plateaux, the plateaux being lower than the highest peaks of the older rocks.

Lithology

In the Parrot Creek area the Suttor Formation consists of friable cross-bedded coarse-grained feldspathic quartz sandstone with lenses of pebble to cobble conglomerate. The sandstone is overlain by argillaceous siltstone containing angular clear quartz grains and argillaceous sandstone. The pallid or mottled zone of the laterite profile forms the upper part of most outcrops.

Farther west, the sequence of sandstone, conglomerate, and siltstone is much more argillaceous. A hard white quartz siltstone is prominent at Rutherfords Table. It has a siliceous clayey matrix containing angular grains of clear quartz. It usually crops out at the top of the formation or is overlain by the ferruginous zone of the lateritic profile. The rock has been formed by partial silicification of argillaceous quartz siltstone in the pallid zone of the laterite profile. The angular grains of clear quartz were possibly derived from the Bulgonunna Volcanics.

At Rutherfords Table, the formation is much thicker than usual. The base of the sequence consists of auriferous river channel deposits, varying from fine sandstone to polymictic cobble conglomerate, generally somewhat argillaceous. The sequence includes beds of heavy mineral sands and a bed of oil shale, about 19 feet thick, which is present above the auriferous wash (Levingston, 1956b); its grade (12 gals/ton) is too low to be economic.

Structure and Relationship

The Suttor Formation is flat-lying, and the low dips noted are most probably depositional. The laterite capping the mesas of Suttor Formation is generally horizontal, but to the north of Rutherfords Table the laterite dips at about 5° away from high areas of Ukalunda Beds. The slopes may represent the tilt on the original land surface at the time of lateritization. The formation rests unconformably on the Devonian to Triassic rocks of the Bowen South area.

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 associated pyritic sediments at Rutherfords Table suggest the existence of a reducing environment for at least part of the time. The abundance of clay in the siltstone and sandstone, west of the Bowen Basin, indicates little sorting of the sediments. On the other hand, the current-bedded quartz sandstone in the Parrot Creek area, which is reworked and contains conglomerate lenses, possibly represents fluviatile sedimentation.

Thickness

The thickness of the Suttor Formation varies widely from place to place, depending on the topography of the underlying basement. The average thickness is about 200 feet, but at Rutherfords Table the formation was laid down in an old river valley and is about 350 feet thick.

Age

The Tertiary age of the Suttor Formation is based on a single dicotyledonous leaf from the Mount Coolon Sheet area.

Tertiary Volcanics

Volcanics, presumed to be Tertiary, occur in several places. The largest block, in the Brawl Creek area, consists of acid to basic flows and agglomerates. Tertiary volcanics also crop out near Flagstone Creek, east of Mount Poole; at the northern edge of the Bowen South area, between the Bowen and Burdekin Rivers; at the Pyramid and to the south-west; 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 steep rectilinear scarps around the block probably represent faults, and the top of the block is a dissected plateau.

Lithology

The volcanics in the Brawl Creek block include trachyte, rhyolite, dacite, obsidian, basalt, dolerite, and rhyolitic and basaltic agglomerate. All the rocks are generally deeply weathered.

Acid flows, ranging from rhyolite to dacite, are predominant. They are generally light-coloured porphyritic rocks with contorted flow banding. In some places the flows are massive. The volcanics form a thick layer capping the Brawl Creek block, with sheer cliffs along the western margin of the block. The volcanics dip to the east at about 10°.

Acid agglomerate is abundant. It forms massive beds, up to 60 feet thick, with angular to rounded boulders up to 12 feet in diameter. The boulders consist mainly of rhyolite, with contorted flow banding, and dacite. The agglomerate also contains some angular fragments of acid volcanic breccia.

The Tertiary volcanics include some black obsidian, and red, blue, green, and brown volcanic glass. The glass is massive and ranges from vitreous to partially devitrified. The vitreous flows show turbulent flow texture and perlitic cracks, and some contain inclusions of basalt.

The volcanics include some deeply weathered pinkish white porphyritic rocks with pink feldspar phenocrysts, which are probably trachytic in composition. The basalt is generally a dark porphyritic rock, and the feldspar phenocrysts and laths are oriented parallel to the direction of flow. Some of them are deeply weathered. Dolerite occurs as vertical dykes, up to 10 feet wide, in the volcanics.

The basalt agglomerate forms beds from 15 to 20 feet thick. The agglomerate consists of angular to rounded fragments of basalt, ranging from pebbles to boulders 2 feet in diameter, set in a purplish brown weathered matrix.

Structure

In the west, the Tertiary volcanics of the Brawl Creek block overlie basalts of presumably Tertiary age, but in the south, the volcanics are faulted against, or rest unconformably on, the Bulgonunna Volcanics. The smooth curves along the eastern boundary of the block suggest that the block has been formed by faulting.

The easterly dip of the Lower Bowen Volcanics to the east of the Brawl Creek block suggests that they overlie the Tertiary volcanics and Tertiary basalt and for this reason the latter were at one time included in the Bulgonunna Volcanics; but the presence of undevitrified glass suggests that the volcanics in the Brawl Creek block are younger than Carboniferous. The Brawl Creek Volcanics are probably separated from the Lower Bowen Volcanics to the east by a fault, and they have now been assigned to the Tertiary because of their similarity to the Tertiary lavas and minor intrusives in adjacent areas.

It has been suggested that the volcanics at Brawl Creek were deposited in a river valley, but they extend below the present day base level of erosion and possibly below the Tertiary base level. The Tertiary volcanics are therefore considered to be down-faulted against the Lower Bowen Volcanics.

Thickness

The thickness of the Tertiary volcanics in Brawl Creek is over 600 feet.

Flagstone Creek Area

Tertiary volcanics crop out north and south of Flagstone Creek, about 1 mile east of its junction with the Bowen River. They are similar to the acid volcanics in the Brawl Creek area, and include flows of rhyolite, dacite, and trachyte with minor acid agglomerate, but no basic rocks were seen.

They rest unconformably on the Lower Bowen Volcanics to the south-west and the Urannah Complex to the north-east. The Urannah Complex is commonly faulted against the Lower Bowen Volcanics. Some of the faults were active in the Tertiary, and the Tertiary vulcanism may be related to them.

Northern Area

The small area of volcanics cropping out 12 miles west-north-west of the Bowen River Hotel, between the Bowen and Burdekin Rivers, has been mapped as Tertiary. They consist of pink flow-banded lavas with phenocrysts of feldspar and mica, associated with dykes of similar composition. The dykes cut the flows and also the Bulgonunna Volcanics. The Tertiary volcanics crop out in a long north-trending ridge, mainly to the north of the Bowen South area. They have been assigned to the Tertiary because they appear to be younger than the Bulgonunna Volcanics, and are similar to other acid volcanics mapped as Tertiary.

The Pyramid

Several small plugs and dykes with associated volcanics crop out at the Pyramid, and to the south-west.

The Pyramid consists of coarse acid agglomerate and acid flow rocks, with radiating dykes of quartz-feldspar porphyry. Its conical shape and the radial distribution of the dykes suggest that it may be a volcanic centre. Two elongated areas of coarsely porphyritic rhyolite porphyry near the Mount McConnell road, about 10 miles south-west of the Pyramid, are probably dykes which are intrusive into the Ukalunda Beds.

Greenish weathered tuff, agglomerate, and flows of trachyte crop out in the high round hill about 2 miles south-west of the Pyramid. The rocks probably overlie Ukalunda Beds unconformably. They differ from other Tertiary volcanics in the area, and the shape of the outcrop suggests that they are draped about a volcanic centre.

The volcanics at two other localities nearby are also referred to the Tertiary.

The age of the volcanics and intrusives has not been definitely established, and many of them are similar in lithology to the Bulgonunna Volcanics. The two basalt plugs (Tb), to the south and south-west of the Pyramid, are almost certainly Tertiary. The trachytic volcanics south-west of the Pyramid are unlike the Bulgonunna Volcanics, and are similar to other Tertiary volcanics in south-east Queensland. The rocks at the Pyramid are similar to the Bulgonunna Volcanics, but some of the associated extrusives extend below the base of the Bulgonunna Volcanics and it appears that they were deposited in a depression eroded in the Bulgonunna Volcanics.

Mount McConnell

Mount McConnell is a plug intruding the Drummond Group. The plug is a blue-white porphyritic rock composed of cryptocrystalline quartz and mica. The hill is round and steep-sided and is similar to the Tertiary plugs in other areas.

About 4 1/2 miles north-east of Mount McConnell is a small plug surrounded by an aureole of hard medium-grained intermediate volcanics; the low central zone is composed of volcanic breccia and some flow rocks. The volcanics are intrusive into the Drummond Group. The plug is considered to be Tertiary.

Cainozoic Sediments

Two small areas of Cainozoic sediments are shown on the map. In the larger, which crops out about the Sellheim River south of Rutherfords Table, the sediments are mainly fluvial deposits. The second area, near the Sellheim River east of Rutherfords Table, consists of a thin remnant of ferruginous poorly consolidated gravel, containing pebbles and cobbles up to about 2 inches across. The gravel has been worked for gold, and may be equivalent to the auriferous alluvial gravel at the base of the Suttor Formation at Rutherfords Table. In several other parts of the Bowen South area, particularly in the Bowen River Valley, there are extensive superficial deposits of soil and alluvium (see Fig. 1)

IGNEOUS INTRUSIVES

The intrusive rocks in the Bowen South area include the following groups: Devonian-Carboniferous intrusives, Carboniferous intrusives, the Urannah Complex, and Mesozoic intrusives. The first two groups crop out west of the Bowen Basin. The Devonian-Carboniferous intrusives are older than the Bulgonunna Volcanics, which are intruded by the Carboniferous group. The Urannah Complex forms the eastern margin of the Bowen Basin, and is partly older and partly younger than the Lower Bowen Volcanics. The Mesozoic intrusives crop out in the Bowen Basin, and were intruded during or after the main episode of folding, which probably took place during the Upper Triassic. Some of them intrude the presumably Triassic Carborough Sandstone.

Devonian-Carboniferous Intrusives

Distribution and Topography

The Devonian-Carboniferous intrusives include four intrusions which crop out in a line trending roughly north-east from the south-west corner of the Bowen South area. The two larger bodies, along Pyramid and Percy Douglas Creeks, occupy irregular areas and are probably connected at depth. The intrusion near Hidden Valley homestead has an irregular outcrop, due partly to the faulted boundaries and partly to the presence of large roof pendants and embayments. The fourth mass, on the Sellheim River, near Isabella Creek, is relatively small. The intrusions underlie plains with low rises covered by coarse sandy soil, and scattered tors. Outcrops are abundant around the margins of the intrusions.

Lithology

The south-western intrusions are mainly adamellite, with subordinate biotite-hornblende granodiorite, hornblende granodiorite, and hornblende tonalite. The adamellite consists of alkali feldspar, plagioclase, and quartz, in approximately equal proportions, with minor calcite, biotite, hornblende, iron oxide, chlorite, epidote, and opalite. The texture ranges from allotriomorphic to hypidiomorphic granular. The intrusions have not been studied in detail.

The two intrusions around Hidden Valley homestead and near the confluence of the Sellheim River and Isabella Creek are composed mainly of biotite-hornblende adamellite. They are allotriomorphic granular to granophyric in texture and contain patches of micropegmatite composed of quartz and alkali feldspar. They consist of quartz, alkali feldspar, plagioclase, uralite, chlorite, biotite, hornblende, iron oxide, and epidote. The plagioclase occurs as phenocrysts, up to 3 mm across, and is zoned from andesine to oligoclase. The feldspar in the micropegmatite includes both potash feldspar and albite. In some specimens, the granophyric groundmass is fine-grained and the mafic minerals consist of a little uralite and chlorite. The feldspars are turbid and flecked with sericite. Pyrite and prehnite are present in some specimens.

One specimen from the Hidden Valley intrusive is a quartz-feldspar porphyry. It contains corroded euhedral phenocrysts of quartz, up to 3 mm in diameter. The original mafic minerals are pseudomorphed by uralite, chlorite, iron oxide, and epidote. The groundmass contains numerous circular patches of quartz and alkali feldspar with a fine 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, iron ore, and minor epidote, and apatite.

Relationships

The two larger bodies are intrusive into the Ukalunda Beds of Middle Devonian age. Both are unconformably overlain by the Carboniferous Bulgonunna Volcanics, and the more westerly intrusion appears to be unconformably overlain by the Drummond Group. These two intrusions may be Devonian in age. The Hidden Valley body is intrusive into the Ukalunda Beds and is unconformably overlain by the Bulgonunna Volcanics. The relationships of the Sellheim River intrusion are uncertain. It is probably intrusive into the Mount Wyatt Beds and older than the Bulgonunna Volcanics. It is included with the Devonian-Carboniferous intrusives because of its textural and mineralogical similarity to the Hidden Valley mass.

Carboniferous Intrusives

Ten intrusives are included in this group; the two in the north-west of the area have been plotted from air-photographs. All are thought to intrude the Bulgonunna Volcanics.

Distribution and Topography

Five of the intrusions crop out along the western margin of the Bowen Basin, and two others, probably connected at depth, crop out near Glendon homestead. The two intrusions in the north-west belong to more extensive bodies cropping out to the north of the Bowen South area. The tenth is a small body cropping out near Bobby Dazzler Creek.

Most of the intrusions crop out in broad valleys surrounded by high hills of the Bulgonunna Volcanics. The valleys are mainly covered with soil with some low rises and tors, but in places, the intrusions form high rocky hills. To the north of the Bowen South area some of the intrusions form deeply dissected rugged country similar to the topography of the Urannah Complex.

Lithology

The small outcrop near Bobby Dazzler Creek is composed of granodiorite with a hypidiomorphic granular texture. It consists of plagioclase, quartz, alkali feldspar, biotite, hornblende, and iron oxide. The granodiorite is cut by granophyric veins containing micropegmatitic intergrowths of quartz and alkali feldspar. The granodiorite is similar to the Sellheim River and the Hidden Valley Devonian-Carboniferous intrusions to which it may be related. It was thought to be intrusive into the surrounding Bulgonunna Volcanics, but it may be older.

The largest of the Carboniferous intrusions occupies a roughly rectangular area, about 16 miles long by about 10 miles wide, drained by Brawl Creek and its tributaries. The intrusion ranges from adamellite to granodiorite and is allotriomorphic to hypidiomorphic granular in texture, and granophyric in some specimens. The adamellite consists of quartz, turbid sodic plagioclase, perthite, biotite, and some muscovite, sericite, and iron oxide. The rock contains brecciated patches composed of granulated quartz and large grains of perthite. The granodiorite contains basic xenoliths and leucocratic veins. The granodiorite near one basic xenolith consists of quartz, plagioclase, alkali feldspar, biotite, hornblende, ilmenite, and prehnite. Biotite (4 percent) and hornblende (6 percent) are more abundant than elsewhere. The plagioclase is in the andesine-oligoclase range, and is strongly zoned and partly turbid. The perthite contains inclusions of biotite and plagioclase.

The Bulgonunna Volcanics north of the Brawl Creek mass are cut by fine-grained veins composed of quartz, turbid albite-oligoclase, bright green chlorite, and some iron oxide and sphene. The plagioclase is mottled owing to partial replacement by albite.

Another Carboniferous intrusion crops out in Sandalwood Creek at the northern margin of Bowen South, north-west of the Brawl Creek adamellite. It is biotite adamellite grading into granodiorite with a relatively low proportion of mafic minerals. It has an allotriomorphic granular texture, and its main constituents are quartz, plagioclase, and alkali feldspar. The plagioclase is zoned, and some grains have sodic rims. It shows turbid alteration in part. The alkali feldspar is microcline perthite, and is less turbid than the plagioclase. Biotite is the main mafic constituent, with a few small grains of amphibole.

The other Carboniferous intrusions have not been examined in thin section; they are mainly acid rocks, showing a considerable range in texture and grainsize.

Relationships

The Carboniferous intrusives, with the possible exception of that on Bobby Dazzler Creek, intrude the Bulgonunna Volcanics. Two of the intrusions are unconformably overlain by the Lower Bowen Volcanics of Lower Permian age. Age determinations on samples from three of the adamellites gave results of 280 million to 285 million years (A.W. Webb, pers. comm.), which agrees well with their stratigraphic position. There is no direct evidence that all of these intrusions are of the same age, but they are similar in lithology, and probably belong to a single intrusive episode.

Urannah Complex

Nomenclature

The Urannah Complex was named by Malone et al. (1964). The name is derived from Urannah homestead, at latitude 20°57'S., longitude 148°21'E., near the junction of Urannah

Creek and the Broken River. The complex is well exposed in the Broken River and its tributaries near Urannah homestead.

Distribution and Topography

The Urannah Complex crops out in the east of the Bowen South area. The western boundary lies about 3 miles east of Collinsville and extends roughly south-east to the southern edge of the area. The eastern margin of the complex lies just within the north-east corner of Bowen South.

The topography is generally rugged and includes some dissected to mature plateaux. The streams are generally swiftly flowing, wide, and shallow, and occupy the full width of steep-sided valleys. Large flat waterworn outcrops are common in the Broken River and its larger tributaries. The basic members of the complex weather more rapidly, and occupy low-lying areas covered with soil. The river flat near the Dart Yard extends east along Dart Creek for half a mile, and other small river flats occur along the Broken River and Urannah Creek. The flats represent local base levels of erosion.

Access to the complex is poor. One track runs from Emu Plains homestead, along the Broken River to Urannah homestead, then south to Eungella homestead, and a side track follows Dark Creek to a stockyard about 3 miles south of Normanby. There are also two other usable tracks into the complex: one runs east from Collinsville along Coral Creek, and the second follows the north bank of the Don River (north of the area mapped) to Normanby. The tracks are suitable for four-wheel-drive vehicles only.

Outcrops are abundant, but the rocks are generally deeply weathered. The relationships between the various members of the complex are best displayed in the large fresh waterworn outcrops in the Broken River and its larger tributaries, particularly in Urannah Creek below its confluence with Ernest Creek. Several of these outcrops were mapped and sampled in detail.

Lithology

The Urannah Complex includes ultrabasic, basic, intermediate, and acid igneous rocks. They range from fine-grained to pegmatitic, and represent several episodes of intrusion. Some of the igneous rocks are foliated. Nine episodes of intrusion have been recognized, but the only rock types shown on the map are hornblende granodiorite and hornblende diorite, which have been distinguished by photo-geological interpretation.

Basalt and Dolerite: The basalt and dolerite dykes appear to be of at least two different ages. Secondary calcite, epidote, chlorite, and hydrated iron oxides are abundant. Slight metamorphism of the older dolerite dykes has dehydrated some of the secondary hydrated iron minerals. Many of the basalts and dolerites are porphyritic and their texture is intergranular. Some show flow structure. The dykes range in width from 1 inch to 20 feet.

Gabbro and Hornblendite: Gabbro and hornblendite crop out in sub-circular depressions up to 1 square mile in area. The gabbro is rich in hornblende and grades into hornblendite. The hornblendite contains large poikiloblasts of green-brown hornblende enclosing anhedral crystals of labradorite (An_{60}).

Diorite and Tonalite: Diorite is the most abundant rock type in the Urannah Complex. It may be massive or foliated and almost gneissic, and ranges from fine to very coarse. Some patches contain hornblende crystals up to 2 inches across. Xenoliths are abundant in places, but elsewhere they are apparently absent. The diorite is composed of plagioclase (An_{50-60}), hornblende, minor quartz, and accessory iron oxide. Epidotization is common in some areas, particularly along joints striking at 100°. The diorite grades into tonalite and one specimen of biotite-hornblende tonalite was found to contain nearly 20 percent quartz. In places, the tonalite is more gneissic than the diorite. The diorite ranges from leucocratic to melanocratic, and in places, the massive diorite contains xenoliths of melanocratic diorite. Dykes of porphyritic leucocratic diorite also intrude the massive diorite.

The most persistent joints in the diorite trend at 335°.

Andesite and Microdiorite: Microdiorite and andesite are the most abundant dyke rocks in the Urannah Complex and intrude all the main rock types. Similar dykes occur in the conglomerates of the Lower Bowen Volcanics in Coral Creek, to the west of the complex. The dykes range from dark to light green: the colour is due to the abundance of epidote and chlorite. The dykes range from 1 inch to 20 feet in width, and branching is common. They are commonly porphyritic with a fine to medium-grained texture, and they generally have chilled margins.

All the dykes are deeply weathered, and patchy epidotization, sericitization, and saussuritization are common features. The mafic minerals are generally chloritized, and pyrite is a common accessory.

The andesite and microdiorite dykes intrude one another, and probably represent several overlapping periods of intrusion. The most common and persistent direction of strike is 335°. These dykes form a conspicuous pattern on the air-photographs.

The microdiorite forms some sub-circular intrusions from 100 to 300 yards in diameter, but they are not as common as the gabbros. They differ in grainsize and texture from the diorite. The microdiorite is a dark hornblende-rich rock with an equigranular texture and some quartz. Some of the porphyritic microdiorites contain brown hornblende and iron ore; others contain green hornblende.

Granite, Pegmatite, and Aplite: The granites are not abundant, and include porphyritic, graphic, and leucocratic varieties, ranging from massive to foliated. A few small dykes of pegmatite and aplite are also present.

Adamellite and Granodiorite: The adamellite and granodiorite range from massive to foliated and grade into gneiss in places. They commonly contain biotite and hornblende. Granodiorite, adamellite, and diorite are the principal members of the Urannah Complex. The granodiorite contains numerous xenoliths of melanocratic hornblende granodiorite, diorite, and amphibolite. It is intruded by pegmatitic and granitic dykes.

The granodiorite and adamellite become progressively more foliated from the south-west and south towards the north-east, and finally become gneissic around Normanby. The change is accompanied by a progressive increase in the number of quartz veins, many of which have been worked on a small scale for gold. The trend of the foliation is generally about 240°, with local variations.

Amphibolite: The amphibolite generally occurs as xenoliths or roof pendants in the diorite and granodiorite. It consists of a medium-grained equigranular aggregate of green hornblende, plagioclase, and minor quartz, with accessory iron oxide. The xenoliths are generally elongate, and range from a few inches up to 20 yards in length. They are abundant in some areas and absent in others.

Porphyries: Acid porphyries occur as non-foliated dykes intersecting granite, diorite, and granodiorite. They are cut by the andesitic and basaltic dykes. Some of the porphyries contain feldspar phenocrysts in a dacitic groundmass, others contain quartz and feldspar phenocrysts in a microgranitic to dacitic groundmass. The phenocrysts range up to 1 cm in diameter. The dykes are deeply weathered and the feldspar phenocrysts are largely altered to saussurite or sericite. The dykes are well jointed, and patches of epidote up to 4 inches across have developed along the joints in places. The acid dykes range up to about 2 feet wide, and appear to be randomly oriented.

Dacite: A few deeply weathered dykes of dacite and dacite porphyry occur in the Urannah Complex, cutting the acid and intermediate plutonic rocks. Some of the dacites are similar to the tonalite of the diorite/tonalite group, and others are probably genetically related to the acid porphyries.

Field Relationships

The Urannah Complex is particularly well exposed in a small tributary of the Broken River, about 2 miles north-west of Urannah homestead (grid ref. 657393 Bowen, F55/3). The outcrop consists of a waterworn surface extending over an area of 60 yards by 30 yards, and seven of the nine groups described above are present.

The oldest rocks are the amphibolite xenoliths, which are abundant in the diorite and granodiorite. The xenoliths are also found in the dacite and porphyry dykes, but they are not present in the andesitic and basaltic dykes. Small xenoliths of amphibolite are also found in the next member of the sequence, a melanocratic diorite which occurs as large xenoliths in the diorite and granodiorite.

The oldest intrusions consist of diorite and tonalite, which may represent the parent magma of the complex. They were followed by intrusions of granodiorite and adamellite, which are possibly acid differentiates of the diorite magma. Granite is next in the sequence, and in this area it does not contain xenoliths. The granodiorite and older intrusions have been sheared and foliated. The aplite and pegmatite associated with the granite invaded all earlier phases of the complex. They were followed by the dacite dykes and then the acid porphyries. The final phase was the intrusion of the andesite and dolerite dykes, which cut all the other rocks.

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

Structure and Relationships

The Urannah Complex is intrusive into the Connors Volcanics, and the contact is exposed near the junction of Dart and East Creeks. The relationship with the Lower Bowen Volcanics is more complex. In places, the Lower Bowen Volcanics are faulted against the larger plutonic elements of the complex, but they are intruded by the dykes and some of the smaller hornblende granodiorite masses in the Coral Creek area. Elsewhere, the Lower Bowen Volcanics probably dip off the Urannah Complex unconformably.

The Connors Volcanics are probably older than the intrusive elements in the Urannah Complex, though the amphibolite xenoliths and roof pendants may be as old or older. The oldest major intrusion in the Urannah Complex cuts the Connors Volcanics, but is older than the Lower Bowen Volcanics. This relationship is supported by age determinations and by the presence of large boulders of acid intrusives, probably derived from the Urannah Complex, in the conglomerate at the base of the Lower Bowen Volcanics in Coral Creek.

The age determinations indicate an important intrusive event in the Lower Permian, about 270 million years ago. None of the intrusions which have given this age are in contact with the Lower Bowen Volcanics, but the event is possibly associated with the beginning or end of the vulcanism.

Age determinations on samples from the Proserpine Sheet area indicate an intrusive event in the Upper Permian, about 245 million years ago. This was possibly associated with the uplift of the Connors Arch, before the Upper Bowen Coal Measures were laid down.

A lower Cretaceous intrusive event, about 125 million years ago, is also indicated by age determinations on samples from the Proserpine, MacKay, and Mount Coolon Sheet areas. The relationship of this event to the tectonic history of the Bowen Basin is uncertain, but it may be the same age as the Mesozoic intrusives.

The faults which separate the Urannah Complex and Lower Bowen Volcanics in places are probably related to uplift of the complex during the main episode of folding in the Bowen Basin. The high topographic relief of the complex in the MacKay and Proserpine Sheet areas suggests that there was also possibly some later uplift.

Mesozoic Intrusives

The Mesozoic intrusives include two laccoliths and a number of sills in the Permian to Triassic succession of the Bowen Basin. The laccoliths occupy 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 gentle, they crop out over more extensive areas.

Lithology

The laccolith on the southern margin of the Bowen South area is a leucocratic anorthite gabbro composed of anorthite and augite with accessory biotite and hornblende. Associated with this gabbro are basalt dykes, some of which intrude the Carborough Sandstone.

The second laccolith intrudes the Middle Bowen Beds and the Lower Bowen Volcanics south of Emu Plains homestead, and is surrounded by a prominent metamorphic aureole. It is a grey, leucocratic, holocrystalline biotite granodiorite.

The sills include microdiorite, hornblende microdiorite, feldspar porphyry, trachyte, and rhyolite porphyry. Some of them contain numerous large crystals of hornblende in a fine-grained groundmass. Many sills intrude the Collinsville Coal Measures. According to Webb & Crapp (1960) the feeder dykes were intruded along fault planes, and the sills are commonly intrusive into the coal seams. The sills are irregular in size and extent, and in places are more than 100 feet thick.

Age Determinations

The results of the potassium argon age determinations are tabulated below:

Group of Intrusive Rocks	Sample No.	K/Ar Age in m. years Biotite	Hornblende	Reference
Devonian to Carboniferous Intrusives	F55/3-17	295		) A.W. Webb, pers.comm.
	F55/3-18	290		)
			330	)
Carboniferous Intrusives	F55/3-1	280		) A.W. Webb, pers.comm.
	F55/3-3	285		)
	F55/3-8	285		
Urannah Complex	F55/3-13	270		) Webb, Cooper, & Richards, 1963.
	F55/3-12	271	271	)
	F55/3-15	271,272	258	)
	F55/3-14	270		)
	F55/3-24	270	283	) A.W. Webb, pers.comm.

The results obtained on biotite concentrates for the Devonian-Carboniferous intrusives are not significantly different from those obtained on the Carboniferous intrusives, but this may be due to the effects of the Carboniferous episode. The 330 million years age for the one hornblende concentrate is significantly older.

The 280-285 million years age for the Carboniferous intrusives places them in the Upper Carboniferous.

The results on the samples from the Urannah Complex indicate at least two periods of intrusion, and samples from other areas indicate that there were at least two other intrusive episodes. The results indicate an intrusive event about 270 million years ago, early in the Lower Permian. This event is possibly contemporaneous with the Lower Bowen Volcanics. The age of 283 million years obtained for the hornblende on sample F55/3-24, associated with an age of 270 million years for the biotite, may indicate that an older intrusion has been partly recrystallized during the younger event.

Ages determined on Urannah Complex samples from the Proserpine and MacKay 1:250,000 Sheet area (A.W. Webb, pers.comm.) confirm the 270 million year age, and indicate intrusive events in the Upper Permian, about 245 million years age, and in the Lower Cretaceous about 125 million years age.

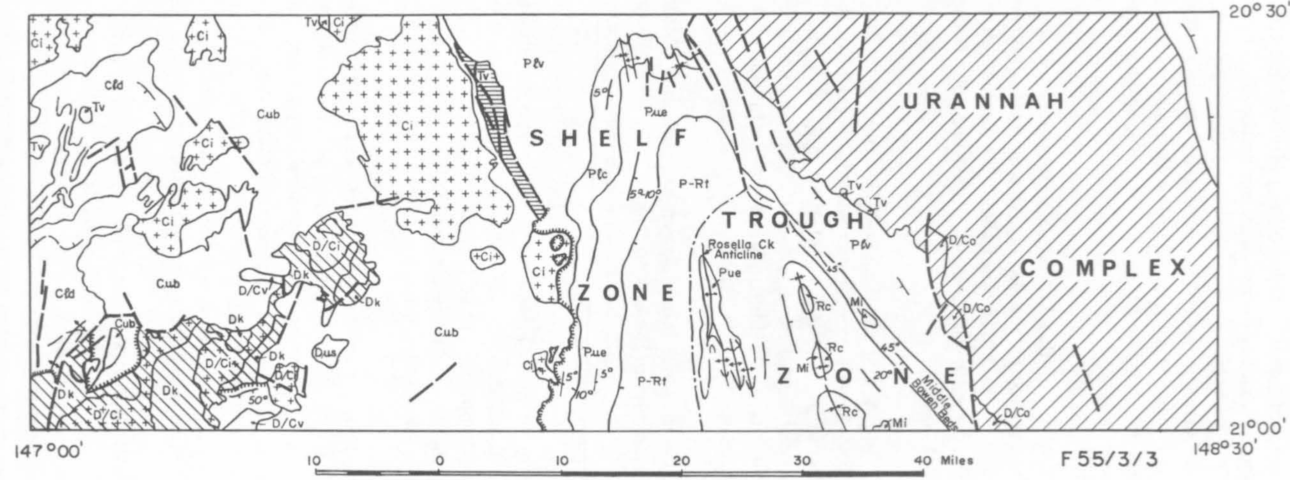
STRUCTURAL GEOLOGY

The major structural features in the Bowen South area are as shown in Figure 6.

The Ukalunda Beds and the Devonian-Carboniferous intrusives constitute the northern end of the Anakie High, which separates the Mount Wyatt Beds to the south-east from the Drummond Group to the north-west. The Anakie High trends north-east parallel to the folds in the Drummond Group and to the main structural trend of the Mount Wyatt Beds and

Fig. 6

STRUCTURAL SKETCH MAP BOWEN SOUTH



Reference

- Igneous intrusives.
- Connors Arch
- North-east trending Anakie High comprising Ukalunda Beds and Devonian-Carboniferous Intrusives
- Brawl Creek Fault Block
- Approximate boundary between postulated trough zone and shelf zone of Bowen Basin
- Unconformity

Note: Formation symbols as on Plate 5

overlying volcanics. The parallelism probably reflects the control which the High exercised over the depositional areas of the Mount Wyatt Beds and the Drummond Group. The Drummond Group and Mount Wyatt Beds were folded during a late Lower Carboniferous orogeny before the Bulgonunna Volcanics were laid down. This folding affected the High also, accentuating its structurally high position and producing some shearing of the Ukalunda Beds.

Several tongues of Bulgonunna Volcanics extend south-west on to the Drummond Group. Two of them are in the centre of synclines in the Drummond Group. The axial zones of the synclines probably formed depressions in which a greater thickness of volcanics accumulated.

The western boundary of the Lower Bowen Volcanics and of the Bowen Basin trends north-north-west. To the south, the Lower Bowen Volcanics are overlapped by the Collinsville Coal Measures, and in the north-west they abut against a fault block of Tertiary volcanics which is elongated in a north-north-west direction. The faults and the elongation probably reflect older structural trends.

The Connors Volcanics and the Urannah Complex constitute the Connors Arch. The axis of this major anticline trends north-north-west, parallel to the axis of the Bowen Syncline. It is flanked on the west by the south-west-dipping limb of the Bowen Syncline, and the steepness of this limb is possibly the result of uplift of the Connors Arch. In places, the Connors Arch is bounded on the west by high-angle reverse faults, with a downthrow to the west, which are also the result of uplift of the Arch.

The western limits of the Lower Bowen Volcanics and Middle Bowen Beds are probably close to the original boundary of the Bowen Basin. The western part of the basin was a shelf zone and contains a fairly thin sedimentary pile with some disconformities, but it was only slightly affected by subsequent folding.

In the east, 20,000 to 30,000 feet of volcanics and sediments were deposited in a trough zone extending east from the axis of the Bowen Syncline and overlapping the area now occupied by the Urannah Complex. This trough varied in size and environment during the Lower Permian. During the Upper Permian and Triassic it contracted westward to the area now mainly occupied by the Bowen Syncline.

The most conspicuous structure in Bowen South is the steeply dipping eastern flank of the Bowen Syncline. It is outlined by the Middle Bowen Beds, striking north-north-west and dipping south-west at angles of 40^{o} or more. The main axis of the syncline is occupied by discontinuous outcrops of the Carborough Sandstone. The axis trends north-north-west and is located east of the centre of the Bowen Basin. The asymmetrical relationship of the axis of the Bowen Syncline to the Bowen Basin as a whole is related to the greater thickness of sedimentation and stronger folding in the eastern trough of the Basin.

The Rosella Creek Anticline is one of the major structures to the west of the axis of the Bowen Syncline. It is an elongate dome, bifurcating at the southern end into a number of minor anticlines. The dip is steep in places, but the structure dies out rapidly to the north and south. The anticline probably does not persist to very great depth. It may have an intrusive core, but its elongate shape and the steep dips on the flanks suggest that this is not so. Possibly it may be associated with a shallow east-dipping thrust fault, separating this structure from the shallower dips to the west. Similar thrust faults are known farther south along the western limit of the trough zone.

TABLE 2 - SUMMARY OF GEOLOGICAL HISTORY

PERIOD	DEPOSITIONAL UNIT	INTRUSIVE UNIT	DESCRIPTION OF EVENTS
TERTIARY			Renewed uplift of Urannah Complex. Lateritisation during period of slow erosion followed by regional uplift producing dissection of Tertiary sediments
	Tertiary Volcanics	Tertiary Volcanics	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		Widespread thin veneer of lake sediments, encircling local basement highs
	Tertiary Basalt	Tertiary Basalt	Basalt flows and plugs
	U N C O N F O R M I T Y		
CRETACEOUS TO UPPER TRIASSIC		Mesozoic Intrusives Urannah Complex (in part)	Main period of uplift and erosion of Bowen Basin
			Main Bowen Basin folding and intrusion. Some intrusion in Urannah Complex
TRIASSIC TO UPPER PERMIAN	Carborough Sandstone		Deposition of mature well-sorted Carborough Sandstone, possibly fluviatile sedimentation in slowly subsiding Bowen Basin
	Upper Bowen Coal Measures		Reduction in size of Bowen Basin and change to restricted marine or brackish environment caused by uplift of Connors Arch. Latter is eroded and supplies sediments for Upper Bowen Coal Measures
	Blenheim Formation		Major extension of basin as shallow transgressive sea in which Blenheim Formation was deposited
LOWER PERMIAN	Collinsville Coal Measures; Gebbie Formation		Basin extends to east and north and becomes shallower. Deltaic conditions around margin in places e.g. where Collinsville Coal Measures deposited. Elsewhere, Gebbie Formation deposited in marine environment, at times shallow
	Tiverton Formation		Vulcanism ceases. Tiverton Formation deposited in moderately deep marine basin; apparently neither Lower Bowen Volcanics nor Connors Volcanics supplied sediments to the depositional area
	D I S C O N F O R M I T Y		
	Lower Bowen Volcanics	Urannah Complex (in part)	Development of Bowen Basin commences. Initially, contemporaneous vulcanism and intrusion in eastern trough; vulcanism continued with considerable deposition of volcanic derived sediments; marine environment towards end of Lower Bowen Volcanics. Basaltic vulcanism and freshwater sedimentation on western shelf.
	U N C O N F O R M I T Y		
CARBONIFEROUS	Bulgonunna Volcanics	Carboniferous Intrusives	Terrestrial vulcanism and sedimentation. Intrusion into Bulgonunna Volcanics and older rocks
			Main compressive folding of Drummond Group, Mount Wyatt Beds, and Devonian-Carboniferous Volcanics. Possibly some intrusive activity. Some regional metamorphism and folding of Ukalunda Beds
	Drummond Group; Devonian-Carboniferous Volcanics; Connors Volcanics	Urannah Complex (in part)	Intrusion and vulcanism near Ukalunda Beds high, producing the Devonian-Carboniferous Volcanics and supplying volcanics and sediments to sinking Drummond Basin west and north-west of Ukalunda Beds; Drummond Group deposited unconformably on Ukalunda Beds and some of the Devonian-Carboniferous intrusives
		Devonian/Carboniferous Intrusives	Connors Volcanics accumulated in east of Bowen South; subsequently intruded by earliest intrusives of Urannah Complex
UPPER DEVONIAN	Mount Wyatt Beds		Marine depostion of Mount Wyatt Beds, probably unconformable on Ukalunda Beds
	U N C O N F O R M I T Y		
MIDDLE DEVONIAN	Ukalunda Beds	Devonian/Carboniferous Intrusives	Folding, uplift, and intrusion of Ukalunda Beds with contact and low-grade regional metamorphism
			Deposition of Ukalunda Beds in marine environment. Possibly isolated basin or geosyncline of unknown extent

Faulting

Faulting is particularly prominent near the eastern limb of the Bowen Syncline. Near Collinsville, a series of parallel faults trends north-north-west, of which the most important is the Collinsville Fault (Webb & Crapp, 1960). The Collinsville Fault is a high-angle reverse fault, east block up, which forms the eastern margin of the Collinsville Coal Measures. The Lower Bowen Volcanics are faulted against the lowest beds of the Blenheim Formation, cutting out the 700 feet of the Collinsville Coal Measures. The throw is probably much greater than 700 feet. At the southern end, the throw of the fault is probably smaller, and it dies out in the steeply dipping sediments. The northern end of the fault apparently passes west of Mount Devlin and may abut against the north-east-trending fault which 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 about 200 feet. Other north-trending faults affect the Collinsville Coal Measures. These are important in mining but are not of regional significance. Most are high-angle reverse faults, downthrown to the west. To the east, there is a series of faults parallel to the Collinsville Fault. The first forms 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 Bowen South, north-trending faults separate the Urannah Complex and the Connors Volcanics from the overlying Lower Bowen Volcanics and Back Creek Group. These faults are similar to the Collinsville Fault and most of them are downthrown to the west. Possibly they are related to uplift of the Connors Arch during the Cretaceous or Tertiary, though the faults may have been active during Upper Permian uplift of the Arch.

GEOLOGICAL HISTORY

The geological history of the area is summarized in Table 2.

The oldest rocks in the area, the Middle Devonian Ukalunda Beds, are marine sediments of considerable thickness which were probably deposited in relatively deep water. They may have been deposited in an isolated basin or in a geosyncline co-extensive with the area of deposition of the Middle Devonian rocks cropping out near Charters Towers to the north. The fossils indicate a considerable time break between the deposition of the Ukalunda Beds and the Mount Wyatt Beds. In this period, the Ukalunda Beds were folded, intruded, and metamorphosed to some extent. Later, they were uplifted into their high position between the marine depositional area of the Mount Wyatt Beds and the possibly freshwater environment of the Drummond Basin.

In the Bowen South area, the only fossils found in the Drummond Group are plants which indicate a Lower Carboniferous age. Farther south, the sediments which apparently conformably underlie the Drummond Group contain Upper Devonian fossils. The basal sediments in the Drummond Basin were probably laid down during the Devonian. The Devonian to Carboniferous volcanics may be related to the volcanic activity which supplied detritus to the Drummond Basin. The Lower Carboniferous Drummond Group was folded before the Bulgonunna Volcanics were laid down; the folding took place probably during the late Lower Carboniferous but possibly in the Upper Carboniferous. None of the intrusions in the area can be related definitely to this folding.

The Bulgonunna Volcanics represent the last major volcanic activity to the west of the Bowen Basin. They consist of massive out-pourings of acid volcanics. Igneous intrusion on a large scale, perhaps partly contemporaneous with the vulcanism, completes the geological history of the western half of Bowen South as an active belt. Thereafter, it behaves as a relatively stable area, the only subsequent activity being epeirogenic uplift and subsidence, and minor Tertiary faulting, intrusion, and vulcanism.

The geological history of the Connors Volcanics is almost unknown. The volcanics accumulated and were intruded by the earliest plutonic elements of the Urannah Complex. Subsequently the volcanics and the complex subsided to permit accumulation of the Lower Bowen Volcanics, which were in part derived from them.

Sedimentation in the Bowen Basin began with vulcanism, probably with associated igneous intrusion, in the eastern trough zone of the basin. About the same time, relatively thin freshwater sediments and basaltic volcanics were deposited in the western shelf zone above the Bulgonunna Volcanics and Carboniferous intrusives.

The Middle Bowen Beds were deposited in the Bowen Basin after volcanic activity ceased. Initially, the Tiverton Formation was deposited in the trough zone of the basin. Then, the depositional area expanded to the north and west as a shallow sea, in which the Gebbie Formation was deposited. At this time, deltaic conditions developed in places around the margin, permitting the Collinsville Coal Measures to accumulate. Subsequently, marine seas trangressed farther to the west during regional subsidence and the Blenheim Formation was deposited.

The differences between the Middle Bowen Beds and the overlying Upper Bowen Coal Measures are the result of a considerable change in environment.

The Middle Bowen Beds comprise a sequence of quartz greywacke and siltstone with abundant marine fossils. The Upper Bowen Coal Measures are a lithic sandstone and siltstone sequence, derived from volcanics, and contain abundant plant material but no marine fossils. The change of environment is thought to be associated with uplift of the Connors Arch. Erosion of this arch provided the sediments which characterize the Upper Bowen Coal Measures.

The Carborough Sandstone overlies the Upper Bowen Coal Measures with no structural unconformity but with a marked lithological change. The coal measures consist of little reworked or sorted immature sediments with coarse and fine fractions deposited in the same area. The Carborough Sandstone is a mature, well sorted, coarse quartz sandstone. This change is possibly due to a slower rate of subsidence of the Bowen Basin, permitting greater reworking of the sediments. The Carborough Sandstone could be produced from much the same source areas as supplied the Upper Bowen Coal Measures if the sediments were reworked and the fine fractions removed.

Thin Tertiary sediments and basalt flows were deposited over much of the area and were subsequently lateritized. After regional uplift the sediments and basalt flows were dissected, and only remnants are preserved. The Tertiary intrusions and volcanic activity were probably controlled by pre-existing structural weaknesses. The Urannah Complex and the adjacent Connors Volcanics were uplifted probably in the late Tertiary.

ECONOMIC GEOLOGY

Gold

Most of the gold produced has come from Rutherfords Table, the Mount Wyatt goldfield, and Normanby.

The Mount Wyatt goldfield was one of the earliest known fields in Queensland (Reid, 1928). The presence of alluvial gold was known in 1868 and was reported on by Daintree (1870). The metalliferous deposits are found in granite or in the metamorphosed sediments around the margins of the intrusions. Small silver and copper lodes are also known in the goldfield but are uneconomic. Mines in the goldfield 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, but the reef pinched out, and within a few months the mine closed down. The other mines produced only negligible quantities of gold.

Rutherfords Table is a mesa of Tertiary Suttor Formation overlying granite. The auriferous river gravels occur at the base of the Suttor Formation, in a depression in the granite basement. The gold occurs as small rounded flakes and scales, and as wire gold. The grains range from microscopic size up to 2 mm in diameter; fragments up to half a pennyweight have been recorded. Rounding and pitting of the grains suggest they have travelled a considerable distance (Levingston, 1953b). Total production during the past 10 years is about 900 oz.

Gold was discovered at Normanby in 1872 (Jack, 1879b, 1893; Morton, 1920, 1921). The field reached its peak in 1891, when there were about 300 miners working there, but most of the operations had ceased by 1908. The field is in the Urannah Complex. The gold is associated with pyrite and chalcopyrite in siliceous reefs which intrude the andesite dykes, the youngest members of the complex. The reefs are generally 6 to 12 inches wide, with local bulges up to 3 feet.

In 1922, 34 oz of gold were produced from the Mount Poole goldfield 14 miles south-east of Collinsville (Morton, 1922). No subsequent production is recorded.

Several small mines in the Mount Hector district, in the north-east of Bowen South, have been worked for gold, silver-lead, zinc, and copper, but recorded production is small. The chief mines in the Cedar Range area were the Southern Cross, Cedar Ridge, Last Try, Enterprise, Hansa, and Tiger Rose.

The gold usually occurs in quartz reefs in fissures in medium-grained grey biotite granite, traversed by andesite dykes. Reports on the area suggest that the gold-bearing reefs are usually associated with intermediate or basic dykes. Ore minerals recorded include gold, pyrite, chalcopyrite, and bismuthite. Ridgway (1935b) reports lenses of galena, sphalerite, and pyrite in silicified volcanic rock in this area.

Reid (1935) reports small production of gold from leaders in granite and diorite at The Gap workings, near the headwaters of Mares Nest Creek.

Silver-Lead

The bulk of the silver produced in the area has come from the Sellheim silver mines, around Two-mile Creek, north of the Sellheim River (Jack, 1889). 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.

TABLE 3 - MINERAL PRODUCTION

(Based on records of the Queensland Mines Department)

COAL

Period	State Coal Mine (tons)	Bowen Consolidated Coal Mine (tons)	Total (tons)
1920 - 1931	965,572	379,169	1,344,741
1931 - 1941	1,617,589	557,254	2,174,843
1941 - 1951	1,933,113	778,026	2,711,139
1951 - 1961	1,352,150	2,184,804	3,536,954
Total	5,868,424	3,899,253	9,767,677
Value	£3,778,656	£6,779,250	£10,557,906

GOLD

Period	Production (oz)	Main Producers
1878 - 1900	7696	Normanby, Mount Wyatt
1901 - 1920	2648	Normanby, Mount Wyatt
1921 - 1940	391	Normanby, Mount Poole, Urannah
1941 - 1960	1176	Mount Wyatt, Rutherfords Table
Total	11,911	

SILVER

Period	Production (oz)	Value (£)	Ore (tons)
1883 - 1900	289,871	36,135	811
1901 - 1920	88,481	11,459	376
1921 - 1940	7207	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 (tons)	30	9	1

GRAPHITE

Period	Production (tons)	Value (£)	Main Producer
1935 - 1950	1587	15,765	Jacks Creek mine
1951 - 1961	243	3564	Jacks Creek mine

The Sunbeam mine yielded some extremely rich ore, assaying as high as 1200 oz of silver per 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 are fissure lodes in the Ukalunda Beds and in dolerites intrusive into them. Ore minerals include abundant galena, sphalerite, tetrahedrite, cerussite, and pyrite.

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

The Godkin mine, 9 miles south-east of Mount Hector, was worked for silver-lead around 1880, but no production records are available. It was opened up again in 1924, and 43 tons of ore were bagged, but returns from treatment are not recorded. The mine was reopened in 1952, and the production of 10 tons of copper-lead-zinc ore is recorded.

The Godkin deposit consists of irregularly distributed sulphides with siderite, barytes, rhodochrosite, quartz, and tourmaline in altered microgranites. The ore is complex and native copper, cuprite, covellite, chalcocite, chalcopyrite, cerussite, anglesite, galena, smithsonite, and sphalerite are reported by Cribb (1954).

The erratic distribution and complex composition of the ore has hindered development of the deposit. Cribb (1954) notes that 'development work is not sufficiently advanced to indicate the possible extent of the ore deposit and its potential value as a producer is still in question'.

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 are located on fissure lodes and all three were reported on by Morton (1945a, 1945b, 1946). The Daisy is 2 miles north-east of Ukalunda, and the other two are respectively half a mile south and half a mile east of the Daisy.

The almost vertical Daisy fissure was worked over a length of 620 feet and contained two ore-shoots, 250 feet apart. The mine produced ores of gold, copper, silver, and bismuth in 1889 and 1890. 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.

The Walhalla workings were opened in 1893, but no production was recorded. In 1936-1938 a shaft was sunk to 125 feet and some ore was sold for its gold content. The work indicated the existence of further 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.

Arsenic-gold ore was mined at the Salopia workings 1 1'2 miles south-east of Ukalunda. The auriferous arsenopyrite occurs sparingly in small quartz veins and as minor disseminations in highly altered Ukalunda Beds close to their contact with an intrusive granite.

Copper

During 1961 one copper prospect was being developed in the Bowen South area. It is situated north of the Sellheim River, about 3 miles south of Mount Wyatt. The ore occurs in Ukalunda Beds, close to their contact with granite. It consists of malachite, azurite, chrysocolla, chalcopyrite, and pyrite in an epidote-rich country rock. Some 250 tons of high-grade ore was stockpiled when the prospect was visited at the end of 1960 and further development work was done in 1961.

Iron

Connah (1935) and Brooks (1957) noted a deposit of magnetite about 1 1/2 miles east of Mount Wyatt. It is a small contact deposit of disseminated magnetite associated with garnet, epidote, and hornblende.

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 (1879a), and later by Reid (1929) and Powell Duffryn (1949). The most recent report on the Collinsville Coal Measures is by Webb & Crapp (1960), and the following summary is based on it.

The Collinsville Coal Measures include 11 named seams, of which the Bowen and the Blake Seams are being worked. Both seams are about 20 feet thick, and are of medium-volatile bituminous rank. The Blake Seam is a non-coking steaming coal, but coal from the Bowen Seam produces high-grade metallurgical coke. Bowen Consolidated Coal Mines Ltd works the Blake Seam by open cut and the Bowen Seam by underground methods at Scottville. The former State Mine at Collinsville worked the Bowen Seam underground until it closed in 1960, and was sold to Davis Contractors. In October 1963, this firm began to operate a fully mechanized underground mine to work the Bowen Seam.

Extensive feldspar porphyry intrusions have greatly reduced the reserves of workable coal. The intrusions follow fault planes and spread out as sills in the coal seams. One of the sills is 115 feet thick. Coal near the intrusions is low in volatile matter and loses its coking properties.

The eastern margin of the Collinsville Coal Measures is a high-angle easterly-dipping reverse fault, named the Collinsville Fault by Webb & Crapp (1960). It has a throw of more than 700 feet, and to the east of it the Collinsville Coal Measures have been removed by erosion.

McCarthy (1963) gives the measured reserves of the Bowen Consolidated and Collinsville coal mines as 112,500,000 tons of coking coal, 37,500,000 tons of non-coking coal, and 5,500,000 tons of unspecified grade.

Graphite

The Jacks Creek graphite mine was first reported on by Morton in 1934. It has produced 1830 tons of graphite since 1835, but recent production has been spasmodic. The mine lies about 11 miles south-east of Collinsville. The workings are in the Upper Bowen

TABLE 4 - WATER AND WELL DATA

Name of bore or well	Reference on geological map	Station	Depth (ft)	Water level (ft)	Depth water struck (ft)	Depth to which water rose (ft)	Supply (g.p.h.)	Quality
Twelve-Mile Mill	1	Birralie	200	80			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	Permanent	Good
Emu Plains No. 1	6	Emu Plains	72	52			400	Brackish
Emu Plains No. 2	7	"	64		56	27	2000	Slightly brackish
Stone Wall No. 1	8	"	52		48	23	8000	Good
Goanna Gully	9	Glendoo	80		40		1400	"
Goldbeetle No. 1 Mill	10	Heidelberg	50		37		Permanent	"
Desmond's Mill	11	"	50		20		"	"
Bell Creek Well	12	Mount 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	Good
Coral Creek Bore	*	"	71		65	57	2000	"
Coral Creek Well	19	"	40	14			Permanent, less than 2500	"
Charlie's Well	*	"	30	20			Semi-permanent	Good, but slightly limy.
Henry Run Well	*	"	40				Permanent	Slightly limy
Pelican Bore No. 1	22	Strathmore	80	45	50	45	2000	Hard
Lower Crush Bore No. 4	23	"	75	60	50	50	2000	"
Top Paddock Bore, No. 5	24	"	80	50	50	50	2000	"
Umina Bore No. 5	25	"	90	60	60	60	2000	Good
Bella Vista No. 10	26	"	90	40	40	40	2000	"

* Locality unknown.

Coal Measures close to the Collinsville Fault. Graphite, formed by metamorphism of coal, is distributed through two bands of sediment, 15 feet and 9 feet thick, 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 possibly not all of them are recoverable.

Clay

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

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 the bores are less than 100 feet deep, and most of them struck water at about 50 feet. The records are incomplete, but the information available is given in Table 4. Rainfall in the area is between 20 and 30 inches per year, and many landowners have constructed dams and earth tanks to water stock. Good drinking water can be obtained from tube wells in the sandy beds of the larger watercourses: the supply for Collinsville is obtained in this way.

Oil

Bowen Basin: The marine Middle Bowen Beds include some possible oil source beds. Potential reservoir beds are the thick quartz sandstone beds of the Collinsville Coal Measures and the Gebbie Formation and less commonly the Blenheim Formation, but the presence of igneous intrusions reduces the prospect of finding oil. The larger intrusions are confined to the eastern flank of the Bowen Syncline, and the intrusions are less common and smaller elsewhere. The carbon ratios* of the coals are very high. The coking and non-coking coals of the Collinsville Coal Measures have carbon ratios of about 75 percent. A coal seam in the Upper Bowen Coal Measures near Rosella Creek has a carbon ratio of 76 percent. These high carbon ratios suggest that there is little prospect that hydrocarbons are preserved in the section; but the relationships of carbon ratios to oil and gas accumulations is uncertain (Russell, 1951).

The Rosella Creek Anticline is a possible drilling site. It would be a relatively shallow hole, probably less than 4000 feet. The Middle Bowen Beds in the Rosella Creek structure almost certainly include some reservoir beds. Clean quartz sandstone crops out at several horizons in the Collinsville Coal Measures, about 12 miles to the west. Some sandstone was also noted in the Blenheim Formation, which becomes more sandy to the south on the western flank of the Bowen Basin.

Igneous intrusions occur in the vicinity of the Rosella Creek Anticline and some igneous rocks were noted in the rubble on the east flank of the anticline. They are probably thin sills with limited metamorphic effects.

The probable stratigraphic succession in the Rosella Creek Anticline is as tabulated below. The anticline possibly grew during deposition, with some thinning of the section over the crest, and the section may be much thinner than indicated.

* Ratio of fixed carbon to fixed carbon plus volatiles, expressed as a percentage.

Depth from Surface (Feet)	
0	Top of outcropping Blenheim Formation. Possibly 200 feet to 500 feet of Blenheim Formation eroded
1400-1500	Big Strophalosia Zone
1800	Top of Gebbie Formation or its equivalent, the Collinsville Coal Measures
2600	Calcareous, fossiliferous zone, equivalent to Glendoo Sandstone Member
3600	Top of Tiverton Formation
4000_	Lower Bowen Volcanics. The thickness of Tiverton Formation, 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 foetid limestone. 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. They are thought to be part of an extensive Lower and Middle Devonian sedimentary sequence which possibly extends to the west below the Drummond Basin and underlies the Mesozoic sequence in the Great Artesian Basin to the north-east. Below the Great Artesian Basin they are possibly less metamorphosed and may well be prospective for oil, since the Ukalunda Beds cropping out in the Bowen South area contain possible source and reservoir rocks.

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APPENDIX

PERMIAN MARINE MACROFOSSILS FROM THE BOWEN AND MACKAY 1:250,000 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 faunally and 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 respectively, are similar and are characterized by the pelecypods Deltopecten and Eurydesma. Fauna II has in addition the characteristic 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 measures 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 Bowen 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.

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* Glyptoleda has now been found in the Stanleigh Formation of the Springsure area, which contains a fauna referable to Fauna II. The above statement, however, still remains valid for the northern part of the Bowen Basin.

Table A

SPECIES DISTRIBUTION CHART

BOWEN MT COOLON AND MACKAY SHEET AREAS

SPECIES	Fauna IV. (Above Big Strophalosia Zone)	Fauna IV. (Big Strophalosia Zone)	Fauna IV. (Below Big Strophalosia Zone)	Fauna III C.	Fauna III B. (Glendoo equivalent, Gebbie Crk. and Exmoor	Fauna III B. (Glendoo Member)	Fauna III A.	Fauna II.	Fauna I.
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								●	
Taeniothaerus sp.								●	
Lissochonetes sp.								●	
Ingelarella ovata								●	
Notospirifer hillae								●	
Schizodus nov. sp. A.								●	
Pseudomyalina cf. mingenewensis								●	
Deltopecten sp.								●	
Streblopteria cf. englehardti								●	
Stutchburia cf. rundsi								●	
Cypricardinia? sp.cf. C.?gregaria								●	
Parallelodon sp. nov. A.								●	
Cancrinella farleyensis								●	
Trigonotreta sp.A.								●	
Gilledia cf. cymbaeformis								●	
Gilledia sp. nov.								●	
Deltopecten squamuliferus								●	
Aviculopecten tenuicollis								●	
Strophalosia brittoni								●	
Neospirifer (Grantonia) cf. hobartensis								●	
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.		●	●		●	●			
Phestia 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	●								

INTRODUCTION

The study of the Permian macrofossils from the Bowen Basin and their use for stratigraphy, initiated in 1960 (Dickins, 1964a; 1964b), is continued here. Fossils are now available from parts of the sequence from which none were previously collected, 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, the identifications 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, 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 also 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, previously Superintending Palaeontologist, but now Director of the Queensland Museum, 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 A. In constructing this table, information has been used from Dickins (1964a) 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, 1964a), to Kungurian (late Lower Permian) and probably early Upper Permian (Campbell, 1959; Dickins, 1961a).

FAUNAL SUBDIVISIONS AND CORRELATIONS

The divisions I, II, III, and IV, proposed in Dickins (1964a), are retained and further extended. Collections have now been made in the interval of 1500 feet which previously separated Fauna IV from Fauna III, and Fauna III has been subdivided into III a, b, c, which occur at three different stratigraphic 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 stratigraphic 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, & Jensen (1964, p.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 the fauna is represented by a single collection from the Lower Bowen Volcanics. As shown in Table A, it differs from Fauna II in having possibly three species which are not known from Fauna II and in lacking many species present in Fauna II.

* The formal names Tiverton Formation, Gebbie Formation, and Blenheim Formation have been proposed for units A, B, and C, respectively - see this Report.

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-eight species are 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 discussed the correlation of the Cattle Creek Formation in outcrop 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 Formation 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 Farley Beds of the Dalwood Group (Lower Marine Beds) and of the lower part of the Branxton Beds of the Maitland Group (Upper Marine Beds) between the Greta Coal Measures and the Fenestella Zone.

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

Fauna III

Fauna III lacks most of the species found in Fauna II. Altogether 42 species are identified; of these 8 occur in Fauna II and 16 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, 1963). 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. Ingelarella of the I. ingelarensis type first appears, 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 both. 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 caused by climate. The basin certainly became shallower.

Fauna IIIa contains 17 species, of which 4 are found in Fauna II and 8 in the overlying beds. Fauna IIIb also contains 17 species, of which 3 are found in IIIa and 8 in the overlying beds. Fauna IIIc has 18 species identified definitely, of which 5 are found in IIIb and 9 in Fauna IV.

* Unpublished work done since this Report was written, however, affords additional information on this problem.

In Table I, 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 these species are found in the Glendoo Member. Both lack species found in IIIa or IIIc, and 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 of either 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 Fauna 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, 16 of which carry over from the beds below. It is especially marked by the incoming of many new species of both 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 a 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 Strophalosia 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 connexion 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 that 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].

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 associations of fossils.

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1 Recently (Dickins, 1961b, p. 132) I suggested that P. coniforme (Etheridge Jnr) 1892 might be a synonym of P. costatum Campbell 1953, although it had a slightly lower spire. I have since examined specimens collected in the Department of Geology of the University of Queensland by R. F. 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 from that of P. costatum.

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

B686 - lat. 20°55'45"S., long. 148°08'30".

Pelecypods

Astartila cf. gryphoides (de Koninck, 1877)

Chaenomya sp. nov. A (same species as in MC479 - Dickins, 1964a)

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 the 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

M411 - lat. 21°29'15"S., long. 148°32'00"E.

Pelecypods

Merismopteria sp.

Brachiopods

Ingelarella profunda Campbell, 1961

Dielasmatid

M412a - 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 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.

M412b - Same position as M412a, but slightly higher stratigraphically.

Pelecypods

Astartila cf. gryphoides

Pachymyonia sp. ind. (one specimen similar to but may not be identical with P. cf. etheridgei Dun from MC479 of Dickins, 1964a)

Modiolus sp.

Deltopecten squamuliferus (Morris, 1845)*

Aviculopecten tenuicollis (Dana, 1847)

Streblopteria sp.

Cypricardinia? sp. ind.

Brachiopods

Cancrinella farleyensis (Etheridge & Dun, 1909)

Anidanthus springsurenis (Booker, 1932)

Strophalosia preovalis Maxwell, 1954

Strophalosia brittoni Maxwell, 1954

Taeniothaerus sp.

Neospirifer (Grantonia) cf. hobartensis (Brown, 1953)

Trigonotreta sp. A.

Ingelarella ovata Campbell, 1961

Ingelarella profunda Campbell, 1961

Notospirifer hillae Campbell, 1961

Cephalopods

Paragastrioceratidae gen. et sp.

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* In Dickins (1964a) the possible absence of some New South Wales species from the Queensland faunas was briefly discussed. Sampling from additional localities has, however, shown the presence of D. squamuliferus.

Fauna II (?)

M414 - 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 IIIa

B261 - lat. 20°44'30"S., long. 147°57'00"E.

Pelecypods

Glyptoleda cf. reidi Fletcher, 1945

Gastropods

Warthia sp.

Cephalopods

Ammonoids to be described by B.F. Glenister

Brachiopods

Cancrinella sp. (as at MC420, see Dickins, 1964a, but may be long ranging)

M413 - 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 MC420, Dickins 1964a)

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

M415 - lat. 21°28'00"S., long. 148°31'15"E.

Pelecypods

Glyptoleda sp.?

Megadesmus sp. nov.?

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* This sample is from the first or lower gastropod-pelecypod horizon of Campbell & Tweedale (1960, p.200). The second or upper gastropod-pelecypod horizon of Campbell & Tweedale is represented by M416.

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

M21 - 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

Brachiopds

Cancrinella sp.

Ingelarella cf. ingelarensis Campbell, 1960

Crinoids

Separate plates

Fauna IIIb

Glendoo Member

B634 - lat. 20°56'30"S., long. 147°41'15"E.

Pelecypods

Volsellina? sp.

Cypricardinia? sp. (as at B1633 - relationship to form in Fauna II not clear)

Brachiopods

Notospirifer cf. *extensus* Campbell, 1961

Large dielasmatid

Bryozoans

Branching stenoporids

B629 - lat. 20°55'30"S., long. 147°41'15"E.

Pelecypods

Gen. et sp. nov. (very plentiful)

Gastropods

Bembexia sp. nov. B

B1569 - lat. 20°48'15"S., long. 147°41'15"E.

Pelecypods

Gen. et sp. nov. (very plentiful)

Gastropods

Indet.

B1633 - lat. 20°49'00"S., long. 147°41'00"E.

Pelecypods

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

Astartila cf. *gryphoides* (de Koninck, 1877)

Merismopteria sp.

Notomya or *Pyramus* sp. (could be same species in Glendoo Member north of Bowen River and probably same species at B261d)

Gen. et sp. nov.

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

Stutchburia cf. *costata* (Morris, 1845)

Cypricardinia? sp. (seems similar to s ecies 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 have higher spires)

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 the dental plates are closer and more parallel: has some resemblance to N. darwini (Morris, 1845))

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

Bryozoans

Stenoporids or batostomellids

Fenestellids

Crinoids

Plates

Bones

Glendoo Member Equivalent (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 - see Dickins, 1964b)

Astartila cf. gryphoides (de Koninck, 1877)

Notomya or Pyramus sp. (apparently not the same species as at CL122, CL121, or Collinsville 5 - see Dickins, 1964b).

Merismopteria sp.

Volsellina? sp.

Gen. et sp. nov. (very plentiful)

Aviculopecten sp. ind.

Gastropods

Warthia sp.

Bembexia sp. nov. B

Worm Burrows

B711 lat. 20°56'30"S., long. 148°08'15"E.

Pelecypods

Merismopteria sp.

Gen. et sp. nov.

Fauna IIIc

M416* - Lat. 21°27'45"S., long. 148°30'00"E.

Pelecypods

Megadesmus? sp. (appears to be same at Collinsville 3 - Dickins, 1964b)

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

Notomya? sp. nov. (may be same as species of CL122 - Dickins, 1964b)

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 B270b and CL122 - Dickins, 1964b)

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)

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* Later work has shown the possibility that this locality could as readily be referred to Unit C as Unit B, and that the assemblage may be in Fauna IV rather than Fauna III.

M417 - 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 sp. 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

B261e - 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 CL225/1 - Dickins, 1964b)

Schizodus sp. nov. C

Gastropods

Mourlonia (Mourlonia) cf. strzeleckiana (Morris, 1845)

Brachiopods

Terrakea solida (Etheridge & Dun, 1909)

Strophalosia cf. typica (Booker, 1929) (same as in Collinsville 4 - Dickins, 1964b. Poorly developed ventral sulcus, which may distinguish it from S. typica)

Ingelarella cf. *magna* or *mantuanensis* Campbell, 1960

Bryozoans

Branching stenoporids

B683 - lat. 20°56'45"S., long. 148°08'00"E.

Pelecypods

Myonia cf. *carinata* (Morris, 1845)

Aviculo pecten 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

Ingelarella magna Campbell, 1960

Notospirifer cf. *minutus* Campbell, 1960

Pseudosyrinx sp.

Biplicate dielasmatids (same species as at B1570)

Blastoid or crinoid plates

(Since this collection was made *Ingelarella isbelli* has been identified from this locality. *Notospirifer* sp. B has also been found in immediately underlying beds).

B1634 - lat. 20°50'00"S., long. 147°42'00"E.

Brachiopods

Strophalosia sp.

Ingelarella cf. *ingelarensis* Campbell, 1960

Crinoid cup

M418 - lat. 21°27'00"S., Long. 148°30'30"E.

Pelecypods

Megadesmus grandis (Dana, 1847)

Megadesmus? sp. (similar to species in Collinsville 3 - Dickins, 1964b)

Stutchburia sp. ind.

Schizodus sp. nov. C

(Astartila cf. cytheria Dana, 1847, has now been identified from this locality and Notospirifer minutus, Ingelarella magna, and I. isbelli from beds immediately overlying).

Big Strophalosia Zone

B1570 (collected from zone as a whole) - lat. 20°50'00"S., long. 147°42'30"E.

Brachiopods

Terrakea solida (Etheridge & Dun, 1909)

Strophalosia brittoni var. gattoni Maxwell, 1954

Strophalosia clarkei (Etheridge Snr, 1872)

Strophalosia ovalis Maxwell, 1954

Neospirifer sp.

Ingelarella ingelarensis Campbell, 1960

Biplicate dielasmatid

Bryozoans

Branching and encrusting forms

Coral

B1570c - as for B1570, 0 to 16 feet above base of zone; 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.

Bryozoans

Encrusting forms including encrustations on pebbles up to 1 inch across

B1570b - as for B1570, 32 to 43 feet above base of zone; mainly fine to medium-grained calcareous sand

Brachiopods

Terrakea solida

Cancrinella sp. (simple type)

Strophalosia clarkei

Strophalosia ovalis

Neospirifer sp.

Ingelarella cf. ingelarensis

Bryozoans

Encrusting forms

Coral

B1570a - as for B1570, 101 to 117 feet above the base of zone; calcareous siltstone or limestone with some fine-grained sandstone

Pelecypods

Myonia cf. corrugata Fletcher, 1932

'Solemya' edelfeldti (Etheridge Jnr, 1892)

Brachiopods

Terrakea solida

Strophalosia cf. typica

S. cf. brittoni var. gattoni

S. clarkei

Neospirifer sp.

Trigonotreta sp. B.

Ingelarella cf. ingelarensis

Cancellospirifer sp.

(Two specimens almost certainly belonging to Notospirifer minutus have been found in this material)

Bryozoans

Encrusting Forms

Corals

B712 - 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

Bryozoans

Encrusting forms

Big *Strophalosia* Zone or slightly above or below

B594 - 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*

B628 - lat. 20°49'15"S., long. 147°43'00"E.

Pelecypods

Conocardium sp.

Brachiopods

Terrakea solida

Strophalosia ovalis

Bryozoans

Encrusting and fenestellid forms

Coral, single

B635 - lat. 20°56'30"S., long. 147°42'00"E.

Brachiopods

Terrakea solida

Strophalosia cf. *clarkei*

B667 - lat. 20°26'00"S., long. 147°45'15"E.

Brachiopods

Terrakea solida

Neospirifer sp.

M85 - 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)

Volsellina? 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*

Streptorhynchus cf. *pelicanensis* Fletcher, 1952

Bryozoans

Probably above Big *Strophalosia* Zone

M86 - lat. 21°34'45"., long. 148°33'15"E.

Pelecypods

Volsellina? cf. *mytiliformis* (Etheridge Jnr, 1892)

Astartidae gen., sp. ind.

Brachiopods

Cancrinella or *Terrakea* sp.

Strophalosia cf. *ovalis*

Neospirifer sp.

Bryozoans

Fenestellids

Corals

Cladochonus sp.

Solitary forms

Crinoids

Stem ossicles

Above Big Strophalosia Zone

B270a - lat. 20°57'00"S., long. 148°08'00"E., close to 'Streptorhynchus-bed'

Pelecypods

Phestia sp.

Astartila cf. cytheria Dana, 1847

Chaenomya sp.

Aviculopecten sp. ind.

Stutchburia cf. costata (Morris, 1845)

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

B270b - as for B270a, slightly higher stratigraphically

Pelecypods

Merismopteria sp. (very large specimens)

Aviculopecten sp.? (a large specimen with distinct concentric rugae)

Gastropods

Peruvispira sp. nov. (similar to species at CL122 and M416 and to P. trifilata (Dana))

B1572 - lat. 20°47'15"S., long. 147°44'45"E., '*Martiniopsis*-bed'

Brachiopods

Ingelarella havilensis Campbell, 1960

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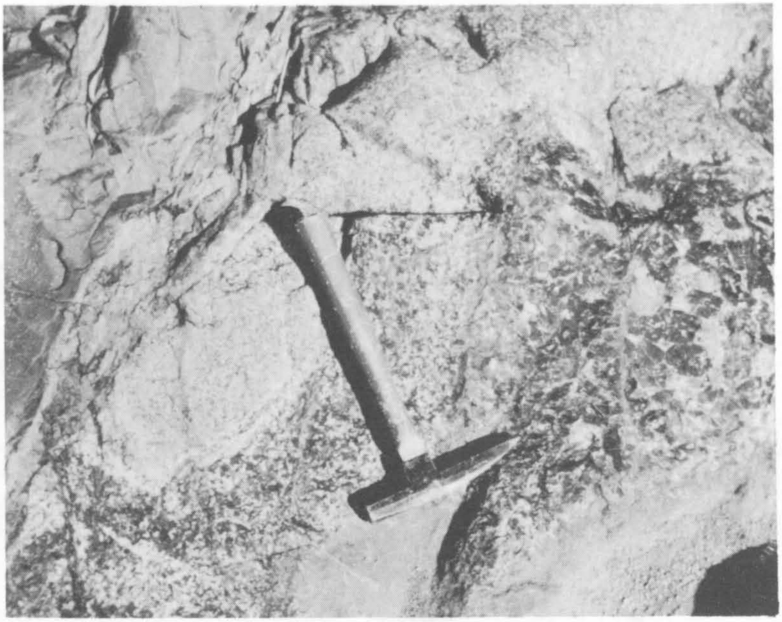


Fig. 1. Urannah Complex, three phases in diorite with acid porphyry dyke in top left hand corner.

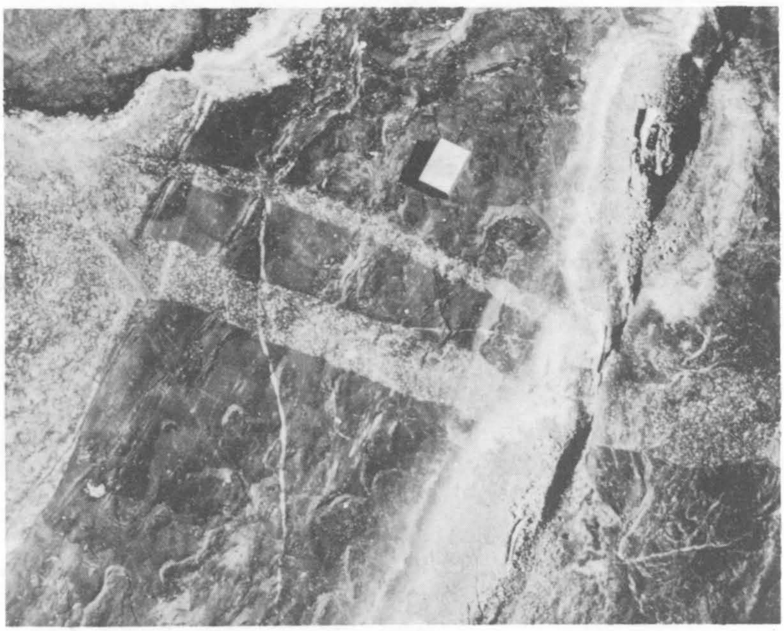


Fig. 2. Urannah Complex, amphibolite xenolith in foliated diorite cut by acid porphyry dykes.

Fig. 1. Urannah Complex, foliated diorite intruded by pegmatite dyke, and both cut by acid porphyry dyke.

Fig. 2. Urannah Complex, diorite cut by acid porphyry dyke (foreground), then by microdiorite (left hand side), then by dolerite (right hand side).

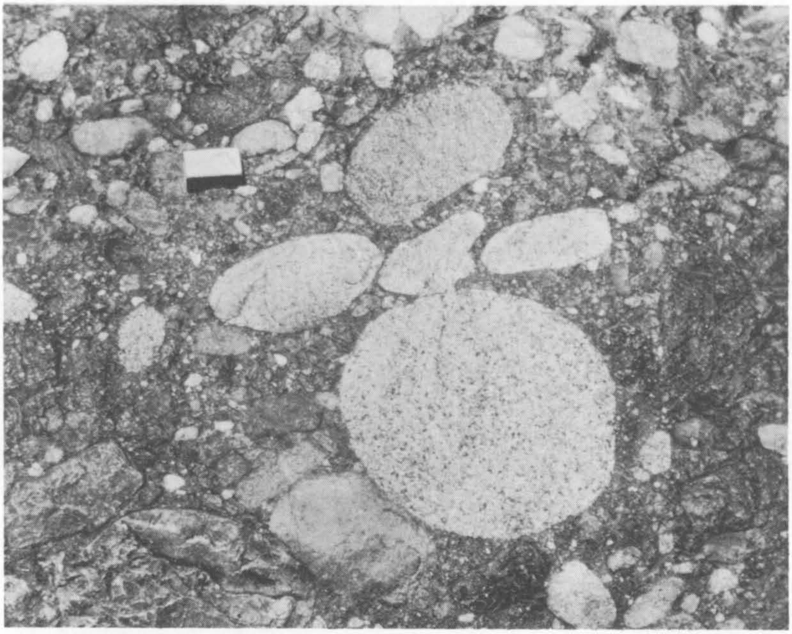


Fig. 1. Lower Bowen Volcanics, conglomerate in Coral Creek area.

Fig. 2. Lower Bowen Volcanics, conglomerate in Coral Creek area intruded by dyke of microdiorite similar to those in Urannah Complex.

PLATE 4.

Fig. 1. Tertiary volcanics, near Brawl Creek, showing contorted flow banding in dacite, part of thick layer shown in Fig. 2.

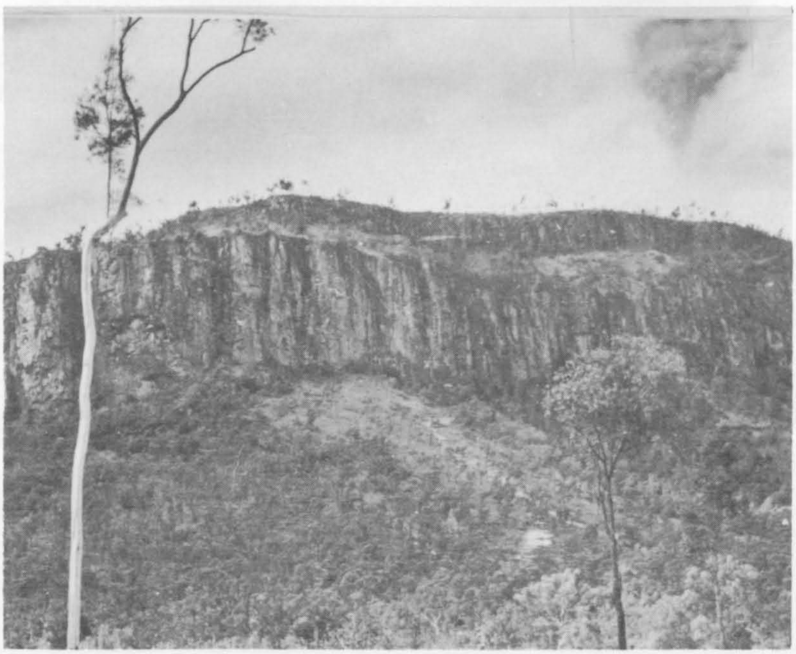


Fig. 2. Tertiary volcanics, near Brawl Creek. Western scarp of thick layer of flow-banded rhyolite and dacite. Layer dips east at shallow angles. Gentle slope below scarp is developed on agglomerate.

Plate 5

BOWEN SOUTH

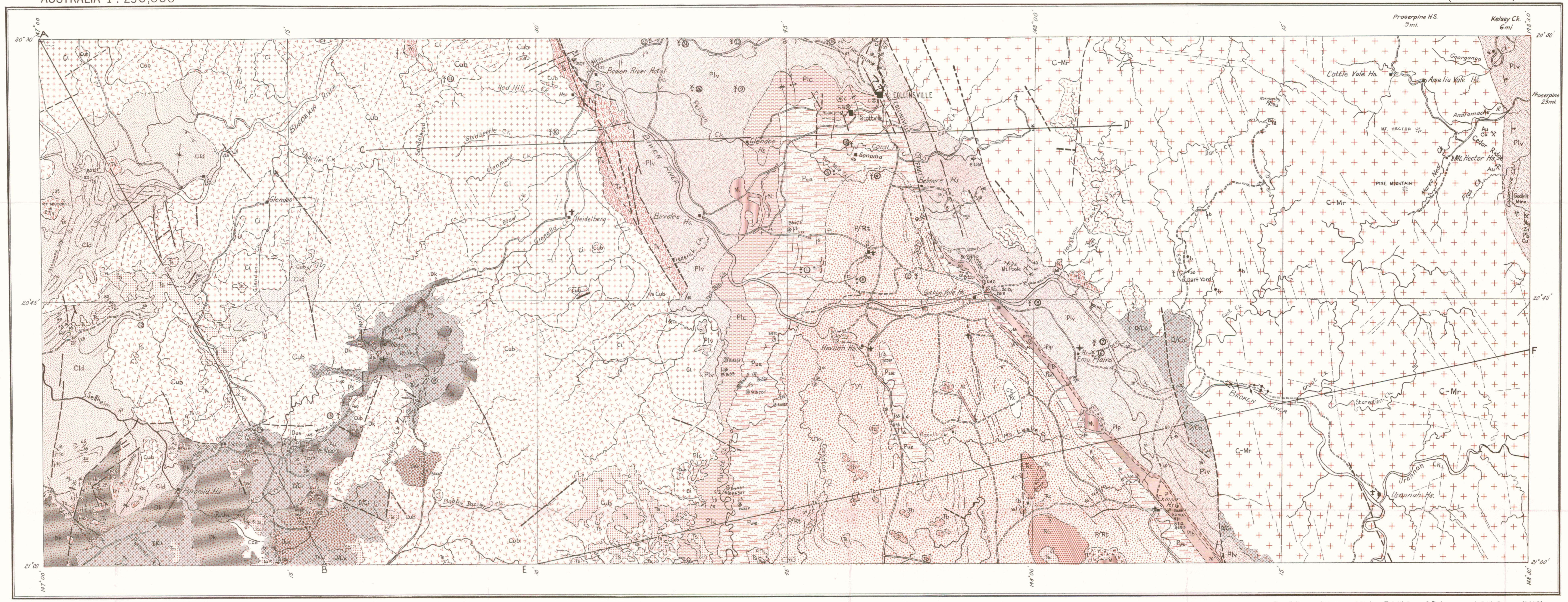
QUEENSLAND

AUSTRALIA 1 : 250,000

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

MAY 1965 EDITION

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
- B1633F Marine fossil locality
- B127F 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
- Pb Lead
- Ag Silver
- As Arsenic
- Bi Bismuth
- C Coal
- Cu Copper
- Cy Clay - use not specified
- Gt Graphite
- 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.

Reference

CAINOZOIC			Cz	Alluvial deposits, soil, ferruginous gravel.
CAINOZOIC	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 - MESOZOIC	CARBONIFEROUS - MESOZOIC	Urannah Complex	C-Mr	Diorite, granodiorite, adamellite, granite complex with some basic to ultrabasic components and intruded by several generations of acid to basic dykes
				Hornblende diorite, basic intrusives
	UPPER PERMIAN - TRIASSIC	Upper Bowen Coal Measures	P-Rt	Cross-bedded, well-sorted lithic sandstone, siltstone, quartz sandstone carbonaceous shale some coal seams, pebble and cobble conglomerate beds, dolomitic and calcareous sandstone
PALAEOZOIC	LOWER PERMIAN TO UPPER PERMIAN	Middle Bowen Beds Blenheim Formation	Pue	Siltstone, pebbly sandstone and quartz greywacke, fossiliferous calcareous siltstone and sandstone, coquinite, limestone.
		Collinsville Coal Measures	Plc	Quartz sandstone conglomerate, siltstone, fossiliferous, calcareous quartz greywacke, coal seams, carbonaceous shale
		Gebbie Formation	Plb	Quartz sandstone; quartz greywacke, carbonaceous in part; fossiliferous calcareous quartz greywacke and siltstone; siltstone; carbonaceous shale and minor coal
		Tiverton Formation	Plp	Quartz greywacke, siltstone; calcareous and fossiliferous in some beds, lenses and nodules; some limestone, coquinite, sandy limestone
	LOWER PERMIAN	Lower Bowen Volcanics	Plv	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	Cub	Dominantly rhyolitic volcanics, including porphyritic flows, crystal tuffs, agglomerates and auto-breccias; minor lithic sandstone and siltstone.
		Drummond Group	Cld	Sandstone, tuffaceous sandstone, siltstone, conglomerate, siliceous siltstone and impure chert, acid flows and tuffs, agglomerate, rare algal limestone lenses.
	DEVONIAN TO CARBONIFEROUS		D/Ci	Grey blue granodiorite, jointed in places with numerous roof pendants
		Undifferentiated Volcanics	D/Cv	Siliceous tuff, crystal tuff, porphyritic rhyolite, volcanic conglomerate
		Connors Volcanics	D/Co	Rhyolitic, dacitic and andesitic flows, agglomerate and breccia
	UPPER DEVONIAN	Mount Wyatt Beds	Dus	Lithic sandstone, siltstone, conglomerate.
	MIDDLE DEVONIAN	Ukalunda Beds	Dk	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.

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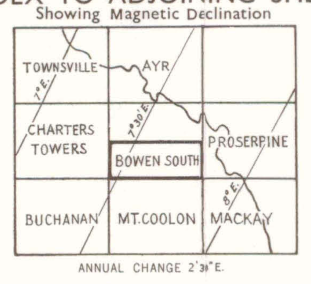
Aerial photography by Adastra Aerial Surveys; complete vertical coverage at 1:85000 scale.
Transverse Mercator Projection.

INDEX TO ADJOINING SHEETS
Showing Magnetic Declination

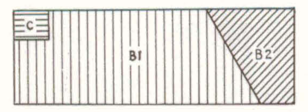


Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM



B 1 Detailed reconnaissance mapping. Very many traverses

B 2 Reconnaissance mapping. Numerous traverses

C Sketchy Some traverses and 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.) Some geological data from E.A.Webb, C.E.Crapp (Bowen Consolidated Coal Mines Pty. Ltd.)

Section A-B
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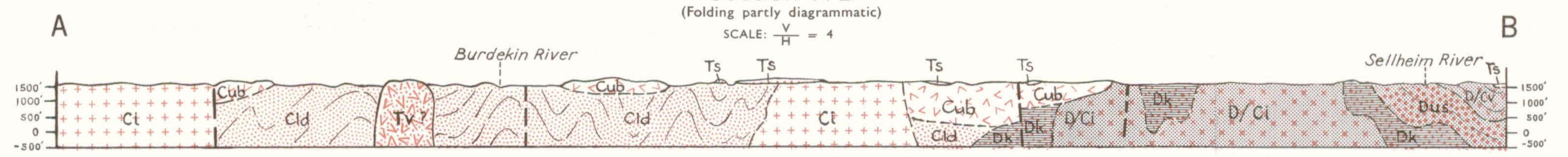

Section C-D
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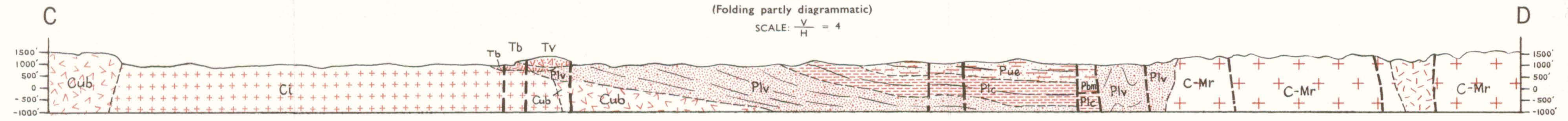

Section E-F
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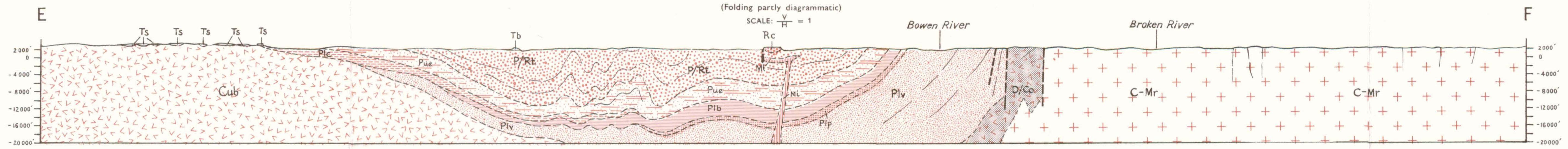

BOWEN SOUTH
SHEET SF 55-3
(SOUTH PART)

MEASURED STRATIGRAPHIC SECTIONS IN THE MIDDLE BOWEN BEDS