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COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1963/60

THE GEOLOGY OF THE DUARINGA AND ST.LAWRENCE 1:250,000 SHEET AREAS, QUEENSLAND.

by

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CONTENTS

CONTENTS (CONTD.)

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THE GEOLOGY OF THE DUARINGA AND ST. LAWRENCE 1:250,000 SHEET AREAS, QUEENSLAND.

SUMMARY

Several major structural units contribute to the geological complexity and interest of the Duaringa and St. Lawrence 1:250,000 Sheet areas in East Central Queensland. These include the Marlborough block, parts of the Yarrol Basin, and structures within the Bowen Basin including the Gogango High, the Strathmuir Syncline, the Folded Zone, the Comet Platform, the western flank, and the Mimosa Syncline.

The oldest rocks are metamorphics in the Marlborough block; these were regionally metamorphosed, intruded by an ultrabasic complex, and then the metamorphics and ultrabasics were folded and intruded by a succession of younger acid to basic intrusions.

Two small inliers of fossiliferous Silurian to Lower Devonian sediments crop out in the east of the Duaringa Sheet area. These may be part of the basement to the Yarrol Basin; one inlier is on the trend of the Gogango High.

About 10,000 feet of Devonian to basal Lower Permian sediments and volcanics of the Yarrol Basin sequence crop out near the eastern margin of the Duaringa Sheet in the sinuous Craigilee Anticline, overturned on its west flank. In this area it is conformably overlapped by the Bowen Basin sequence. Equivalents of the Yarrol Basin sequence crop out on the off-shore islands and the mainland in the north-east of the St. Lawrence Sheet area.

The Gogango High, at one time considered to be a high of older rocks separating the Yarrol and Bowen Basins, consists dominantly of Permian rocks. A broad, south plunging anticline of Lower Bowen Volcanics occupies the core of the high in the northern part of the area. East of the high in the northern area, 5,000 to 10,000 feet of Lower Permian Carmila Beds and Middle Bowen Beds occupy the Strathmuir syncline. The east flank of this syncline consists of Lower Bowen Volcanics. The southern part of the Gogango High consists mainly of Middle Bowen Beds; but it also includes the Lower Bowen Volcanics and Rookwood Volcanics cropping out in complex anticlines and fault blocks and three areas of Undifferentiated Palaeozoic Beds. Sediments within this part of the high are tightly folded, overturned and faulted.

Middle Bowen Beds dip south-west off the northern part of the Gogango High, forming the eastern flank of the Bowen Syncline. A tightly folded but not overturned zone trends north-west across the centre of the area in which Middle Bowen Beds and Upper Bowen Coal Measures crop out. In the west of the area, gently folded Middle Bowen Beds and Upper Bowen Coal Measures crop out on the western flank of the Bowen Basin and on the Comet Platform.

The Triassic Rewan Formation crops out around the northern end of the Mimosa Syncline. Structures in the Rewan Formation conform to those in the underlying Upper Bowen Coal Measures, viz. gentle folding west of the Syncline and tight folding north-east of it. The competent, broadly folded Clematis Sandstone outlines the Mimosa Syncline. It overlies the Rewan Formation with apparent conformity but the broad folding of the Clematis Sandstone is in marked contrast to the tight folding of the Rewan Formation east of the Syncline.

The orogeny affecting the Bowen Basin sequence probably took place in the Triassic though some intrusions are possibly Lower Permian in age. The type of folding and the frequency of intrusion is fairly uniform within the Gogango High, the Folded Zone and the western part of the Bowen Basin. Folding becomes progressively gentler and intrusions less common westward, from one structural zone to the next. This may be due to the basement shallowing to the west, possibly in steps.

Post orogenic sedimentation includes Lower Cretaceous Styx Coal Measures which unconformably overlie Middle Bowen Beds. Many faults, mainly high angle reverse faults, were mapped in the east of the area; some of these are younger than Lower Cretaceous.

Tertiary sediments, mostly capped by a laterite profile, are widespread in the area; Tertiary basalt, volcanics and intrusives are less common. Superficial Cainozoic sediments cover much of the area.

Intrusions are fairly numerous but are generally small. Four groups are recognised. One is associated with the Marlborough block and consists of acid to ultrabasic intrusions, ranging in age from probably Middle Palaeozoic to post Permian. The second group are correlated with the Urannah Complex; they are Lower Permian or younger and most intrude the anticline of Lower Bowen Volcanics at the northern end of the Gogango High. The third group are small acid to basic intrusions cropping out in the east of the area. Those in the north-east of the St. Lawrence Sheet intrude Carboniferous sediments; the others are Permian or younger.

The Bundarra Granodiorite, in the north-west of the St. Lawrence Sheet area, is probably a Mesozoic body, intruded into the Middle Bowen Beds on the trend of the Folded Zone.

INTRODUCTION

The Bureau of Mineral Resources, in conjunction with the Geological Survey of Queensland, is undertaking a programme of regionsl mapping in the Bowen Basin, Queensland. Two field parties operated during 1962: the Duaringa Party, consisting of E.J. Malone, R.G. Mollan, and F. Olgers of the Bureau of Mineral Resources and A.G. Kirkegaard of the Geological Survey of Queensland, mapped the Duaringa and the southern half of the St. Lawrence 1:250,000 Sheet areas; the East Bowen Party, consisting of A.R. Jensen and C.M. Gregory of the Bureau of Mineral Resources and V.R. Forbes of the Geological Survey of Queensland, mapped the Mackay, the southern half of the Proserpine and the northern half of the St. Lawrence 1:250,000 Sheet areas.

This report deals with the geology of the Duaringa and St. Lawrence 1:250,000 Sheet areas. The area is bounded by latitudes 22°S and 24°S and by longitudes 148° 30' E and 150°E. It covers the central part of the Bowen Basin and extends beyond its eastern margin. In the east, the area includes a zone of complex geology involving both the Bowen Basin and Yarrol Basin sequences and a block of metamorphics and intrusives which are probably older than the Yarrol Basin sequence.

Access

The Central Railway and the Northern Inland Highway cross the Duaringa area from east to west. A number of small towns, including Duaringa, Dingo, Bluff, Blackwater and Comet are located along the Railway. These serve the pastoral and timber-cutting industries of the surrounding areas and are the focal points of networks of gravel roads and vehicle tracks giving access to areas north and south of the Railway.

The North Coast Railway and the Bruce Highway cross the St. Lawrence area. They run west from the south-east corner of the Sheet area and then north to the northern margin. The Railway lies close to the coast, north of St. Lawrence, and the Highway is 20 to 30 miles inland. Marlborough, Ogmore and St. Lawrence are small towns located beside the Railway. A number of vehicle tracks link the towns along the Railway and the various homesteads with the Bruce Highway, and some extend south into the Duaringa Sheet area.

Vehicular access throughout most of the area is good during the dry season. Exceptions are the Blackdown Tableland and the ranges to the south, and parts of the Boomer and Connors Ranges. Traversing these areas is possible only on horseback or on foot. In some parts of the Boomer Ranges, the scrub cover is impenetrable.

Most of the area has an annual rainfall of 20 inches to 30 inches; 30 to 40 inches of rain falls in the coastal part of St. Lawrence, east of the Connors Range. Vehicular travel away from main roads may be impossible for long periods during December to April when most of the rain falls. The winter months are mainly dry with fine, cool days and cold, often frosty, nights.

Cattle raising is the main industry in the area. At present, some of the larger holdings are being resumed and broken into smaller blocks to promote closer settlement and better land use. Scrub clearing operations are being encouraged by the State Government for the same reason. Wheat and other crops are grown in the south-east of the Duaringa Sheet area and some sugar cane is grown near the northern margin of the St. Lawrence Sheet area.

Timber cutting and coal mining are moderately important industries in the area. Saw mills are operating at Duaringa and Dingo. Coal is being mined at Ogmore in the St. Lawrence Sheet area and two small mines, the Excel and the Cambria, are operating at Bluff in the Duaringa Sheet area. Most of the population is engaged in maintenance and construction work on the railways and the roads.

The Duaringa and St. Lawrence Sheet areas were photographed in 1960 by Adastra Airways Ltd. The small scale of these photos (1:85,000) make it difficult in places to recognise tracks and other cultural features, to find locations accurately, and to plot sufficient detail in geologically complex areas. However, in general, they were very suitable for the purpose of the present survey: regional mapping to produce a final map at 1:250,000 scale.

Prior to the commencement of field work, W.J. Perry of the Bureau of Mineral Resources and B. de Lassus St. Genies of the Institut Francais du Petrole Mission in Australia produced photo-geological maps at 1:250,000 scale of the Duaringa and St. Lawrence Sheet areas. These maps were used as guides in planning and carrying out the field work. The planimetric bases of the photo-geological maps were enlarged to photo-scale, printed on a transparent medium and used as a base for compilation in the field. The maps accompanying this report were produced from photo reductions of the field compilations.

This report and maps are based largely on field work done between June 3rd and October 19th, 1962, by the Duaringa and East Bowen Parties. The western half of the Duaringa Sheet includes some of the mapping by Derrington and Morgan (1959, 1960) of Mines Administration Pty Ltd and some by King, Goscombe and Hansen of Utah Development Co. (1961). Utah is continuing a programme of detailed mapping and drilling in the Blackwater area to establish reserves of coking coal available for open-cast mining.

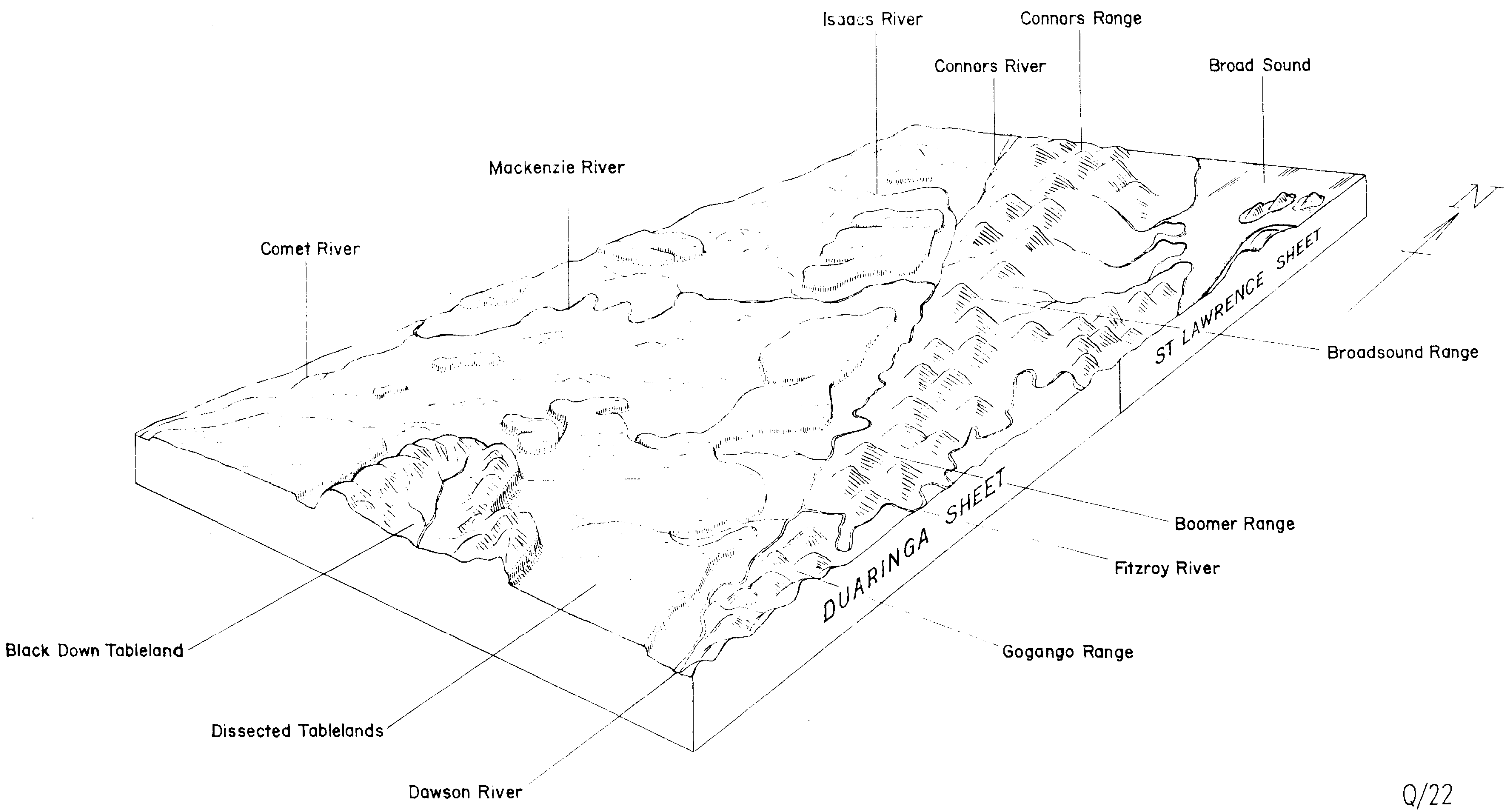
Visitors and Acknowledgements

During the season the parties were visited by Professor D. Hill of the Geology Department, University of Queensland, by Miss B. Houston, G. Tweedale and J. Dear of the Geological Survey of Queensland, and by J.E. Thompson, W.J. Perry and J.N. Casey of the Bureau of Mineral Resources.

J.M. Dickins, of the Bureau of Mineral Resources spent four weeks with each party. He assisted the survey by giving preliminary determination of fossil collections and by examining various critical sections with party members.

Fig. 1

PHYSIOGRAPHIC SKETCH MAP of the DUARINGA - ST LAWRENCE AREA



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Bureau of Mineral Resources, Geology and Geophysics, 1963. To accompany Record No 1963/60

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Professor Hill determined several fossil collections made in the area. Miss Houston examined 90 thin sections of rocks collected by the parties and her descriptions are incorporated in the text of this report. J. Dear determined several fossil collections from the Lower and Middle Carboniferous sediments and assisted the Duaringa Party by identifying the main units of the Yarrol Basin sequence in the eastern part of the Duaringa Sheet area.

D. King, P. Goscombe and L. Hansen, of Utah Development Co., were working in the Blackwater area at the time of this field work and assisted the Duaringa Party in a variety of ways. In particular, they made available some of the results of their detailed mapping.

PHYSIOGRAPHY

The Duaringa-St. Lawrence area can be subdivided into six topographic units (figure 1).

1) The dissected tableland occupies large areas in the Duaringa and the St. Lawrence Sheets. The main occurrences are in the south-west of the Duaringa Sheet and in a belt from the south-east of the Duaringa Sheet to the north-west of the St. Lawrence Sheet. The tableland, which is formed by a sheet of Tertiary sediments, is gently undulating and along the railway line, ranges in height from 500 feet above sea level at Walton in the west to 280 feet above sea level at Duaringa. Breakaways occur in many places along the edges of the tableland; mesas are a common feature of the region.

2) Rolling plains country occurs mainly in the north-west of the Duaringa area and in the south-west of the St. Lawrence Sheet. It occupies the areas between the tableland and the alluvial flats along the main rivers. The vegetation is medium to dense with dense brigalow patches in places.

3) Flood plains occur along the Mackenzie, Dawson, Isaacs, Connors and Comet Rivers and to a lesser extent along the Fitzroy River. The plains are most extensive in the southern part of the St. Lawrence Sheet where the Isaacs River joins the Mackenzie River.

4) The Blackdown Tableland in the south of the area rises steeply to 1500 feet above the surrounding country. The tableland has an extremely rugged surface which slopes gently to the south. The margins of the tableland consist of steep, scree-covered slopes, topped by almost vertical, broken cliffs (see photo, opp. page). The Shotover and Expedition Ranges lie along the western margin of the tableland, and the Dawson Range lies along the eastern margin. The area is densely timbered and cannot be traversed by vehicle.

5) The main ranges, comprising from north to south the Connors, Broad Sound, Boomer and Gogango Ranges, extend from the central northern

margin of the St. Lawrence Sheet area to the south-eastern corner of he Duaringa Sheet, a distance of 160 miles. In the north, the ranges reach a maximum width of 25 miles; they are only five miles wide where the Fitzroy River cuts them, north-east of Duaringa. The ranges are rugged, moderately to densely vegetated and can only be crossed in a few places. They become progressively lower and less extensive to the south, though local relief is considerable everywhere. The highest peak, 1400 feet above sea level, is in the Broadsound Range, seven miles north-west of Tooloombah Homestead. The ranges form a watershed which is breached only by the Fitzroy River, 12 miles north-east of Duaringa.

6) <u>The area east of the ranges</u> has a varied topographic expression. Gently undulating, moderately vegetated low country lies in a narrow belt directly to the east of the ranges. Coastal swamps occur near the mouths of Herbert Creek, the Styx River, Waverley Creek, and St. Lawrence Creek. Range country, up to 1200 feet above sea level, occurs in an area east of Ogmore in the St. Lawrence Sheet area, and a group of rugged, densely vegetated mountains occur around Marlborough.

<u>Drainage</u>

The Duaringa-St. Lawrence area, except a small area in the north-east, lies within the Fitzroy River drainage Basin. The main drainage channels of the area are the Mackenzie, Dawson, Isaacs, Connors, Comet and Fitzroy Rivers. The Mackenzie River meanders widely and has numerous oxbow lakes. In the western part of the Duaringa Sheet, the river flows in a north-easterly direction; its course may be structurally controlled. Near Manly Homestead in the south of the St. Lawrence Sheet, the Isaacs River, which has the Connors River as its main tributary, joins the Mackenzie River, which flows from here in a south-easterly direction along the western edge of the Boomer Range. The Dawson River flows in a north-westerly direction along the western edge of the Gogango Ranges and joins the Mackenzie River nine miles north-east of Duaringa to form the Fitzroy River. The Fitzroy River has a winding course, which is probably largely structurally controlled. The river flows easterly to the eastern boundary of the Duaringa Sheet and then northerly along the Sheet boundary. The Comet River flows northerly along the western boundary of the Duaringa Sheet to join the Mackenzie River at Comet. A small area north-east of the main ranges in the St. Lawrence Sheet area is drained by a series of creeks which flow directly to the sea.

PREVIOUS INVESTIGATIONS

The 1962 survey was the first to map the whole of the Duaringa and St. Lawrence Sheet areas. The little work done in these areas previously consisted of detailed mapping of small areas and some reconnaissance traverses through parts of the area.

The earliest work was undertaken to assist in coal prospecting. Rands (1892) described the geology in the vicinity of the Styx River. This area was mapped in detail by T.W.E. David about 1890. This work is unpublished but David's map is now held at the Geological Survey of Queensland. Dunstan (1898) described the geology around Collaroy and Carmila. Maitland (1895) made geological observations along the Central Railway. The most important early work was by Dunstan (1901a) who mapped a large area in the Duaringa Sheet. Cameron (1905) made a reconnaissance of a large area north of that mapped by Dunstan. Reid (1924) described sections in the eastern part of the St. Lawrence Sheet area; later Reid & Morton (1928) compiled a section across the Duaringa Sheet. Little improvement was made on Dunstan's work until after 1950 when companies engaged in oil search carried out further mapping. Derrington & Morgan (1959a, 1959b) mapped the western half of the Duaringa Sheet. Utah Development Company are engaged in a programme of detailed mapping and drilling in this area. Laing (1959) made a reconnaissance of the eastern half of the St. Lawrence Sheet area. Gough (1961a,b) mapped the area around Marlborough and St. Lawrence.

GENERAL GEOLOGY

Several major units contribute to the geological complexity and interest of the Duaringa-St. Lawrence area. Metamorphic and ultrabasic rocks of lower to middle Palaeozoic age crop out south of Broad Sound. South of these, the Middle Devonian to basal Lower Permian Yarrol Basin sequence crops out in an intruded sinuous anticline. Carboniferous sediments east of Broad Sound are probably part of the Yarrol Basin sequence. Two small areas of fossiliferous Silurian-Devonian sediments were mapped in the area; their relationship to the Yarrol Basin sequence is not known.

The Bowen Basin sequence occupies most of the Duaringa-St. Lawrence area. Units recognized in the area are the Lower Bowen Volcanics, the Rookwood Volcanics, the Carmila Beds, the Middle Bowen Beds and the Upper Bowen Coal Measures. The Rookwood Volcanics appear to be conformable on the Yarrol Basin sequence and to be conformably overlain by Middle Bowen Beds; they are considered to be equivalent in part to the Lower Bowen Volcanics.

Volcanics and sediments cropping out in the Gogango Range were mapped as Undifferentiated Palaeozoic rocks. Their relationship to the adjacent Middle Bowen Beds is not known.

Middle Bowen Beds and Upper Bowen Coal Measures crop out in an elongate, tightly folded zone trending north-north-west across the centre

ROCK UNITS OF THE DUARINGA - ST. LAWRENCE AREA

TABLE 1

Age		Rock Unit and letter symbol	Thickness	Lithology	Distribution	Topography	Palaeontology and age	Relationships	Depositional Environment
CAINOZOIC		Cz	Superficial, up to 300' reported in places.	Sand, soil, gravel, ferruginous gravel, and reworked laterite.	Widespread, particularly in west of St. Lawrence area.	Plains, generally little or no relief.			
		Cza	50' - 100' thick	Alluvial gravel, sand and silt.	Very extensive along major streams and near Broad Sound.	Flood plains, levees. Up to 50' relief from river level to levee banks.			
		Czp	50' - 100' thick	Sandstone, gravel and sand.	Around northern margin of Blackdown Tableland.	Steeply dissected fans sloping down from cliffs of Clematis Sandstone.		Piedmont deposit derived from Clematis Sandstone.	
	TERTIARY	Ta	>1000' in Duaringa area. Generally 200' to 400'.	Sandstone, siltstone, claystone, quartz pebble and fine conglomerate, diatomite, oil shale. Some interbedded basalt flows.	Main development in broad, shallow trough west of Isaacs, McKenzie, Dawson Rivers line. Scattered remnants further west.	Forms plateaus with steep scarp edges where capped by laterite. Elsewhere, forms dissected, hilly country of low relief, grading down into the Cz plains.		Unconformably overlies Triassic and older rocks.	Lacustrine, at times swampy, environment. Lakes may be very local, perhaps produced by basalt flows damming the drainage, or very extensive as in the main area of outcrop.
		Td	50' ±	Sandstone breccia; sandstone blocks in a sandy matrix, lateritised in places.	Northern end of Blackdown Tableland.	Rounded hills.		Produced by collapse of Clematis Sandstone through erosion of underlying, soft Rewan Formation.	
		Tb	100' to 200'	Basalt flows, rare plugs.	Small remnants in south-west and south-east of Duaringa; some plugs east of Balcomba Hs.	Mainly black soil plains; plugs form conical peaks.		Interbedded with Ta in places.	Terrestrial.
		Tv	Rhyolitic, trachytic, dacitic, and minor andesitic flows, pyroclastics, stocks and dykes.	Scattered outcrops in and west of Connors Range; large outcrop east of Craigilee Hs.	Forms groups of low, steep hills on Connors Range, and prominent isolated hills elsewhere.				

Age	Rock Unit and letter symbol	Thickness	Lithology	Distribution	Topography	Palaeontology and age	Relationships	Depositional Environment
MESOZOIC	Mv		Dacitic, andesitic, and basic crystal-lithic tuffs and agglomerate, tuffaceous conglomerate and sandstone.	South-east corner of Duaringa area.	Moderately high, steep hills grading down into low, rounded hills.		Appears to be unconformable on ?Middle Bowen Beds.	
LOWER CRETACEOUS	Styx Coal Measures. Kls	Probably about 3,000 feet. 1270' penetrated in drill hole near Tooloombah Creek.	Sandstone, conglomerate, siltstone, carbonaceous shale, coal.	Elongate basin south of Broad Sound.	Low, dissected hills grading down into soil covered plains.	Fossil flora including *Cladophlebis*, *Taeniopteris*, *Equisetites*, *Nathorstia*, *Phyllopteris*, also microplankton and spores, indicating Lower Cretaceous age.	Unconformable on Middle Bowen Beds.	Freshwater with some marine incursions. Probably deposited in near-coastal lake.
LOWER CRETACEOUS	Kl		Conglomerate, brown and friable with sheared and indurated siltstone pebbles.	Small outcrop 9 miles west of Coorumburra Homestead, Duaringa Sheet.	Low dissected hills.	Fossil flora including *Taeniopteris*, *Cladophlebis*.	Unconformable on Middle Bowen Beds. May be equivalent to Styx Coal Measures.	Freshwater. Pebbles in conglomerate are locally derived.
TRIASSIC	Clematis Sandstone Rc	Up to 500'	Cross-bedded, fine-coarse grained quartz sandstone, gritty in places, white, blue-white or red in colour; some buff to mauve siltstone interbeds with plant fragments; some thin bands of red ochre.	Blackdown Tableland, and Dawson, Shotover, and Expedition Ranges.	Dissected plateau bounded by high, steep cliffs.		Structurally conformable on Rewan side of Mimosa Syncline; contact faulted in places on east where structures of the units are at variance.	Cross bedding and maturity of sediments suggests deltaic environment.
TRIASSIC	Rewan Formation Rr	About 1500'	Red, buff and grey-green shale, mudstone, siltstone, inter-fingering in places with khaki to green lithic sandstone containing calcareous concretions and bands of clay pellets.	West, north and east of Blackdown Tableland.	Very readily eroded; forms soil covered subduid topography. Outcrop is confined to creeks and steep slopes below Clematis Sandstone cappings.	Plants : *Danaeopsis* sp.? *Linguifolium denmeadi*? *Dicroidium feistmanteli*? Equisetalean stems. Age. Triassic. Palynology also suggests Triassic age.	Conformable on Upper Bowen Coal Measures west of Blackdown Tableland. Involved in tight folding with that unit east of Tableland.	Red sediments are due to presence of ferric oxide. Cross bedding in sandstone suggests shallow water. Possibly two distinct provenances supplied sediment to this formation.

Age		Rock Unit and letter symbol	Thickness	Lithology	Distribution	Topography	Palaeontology and age	Relationships	Depositional Environment
PALAEOZOIC	PERMIAN	Undifferentiated Permian P.	Not known	Siltstone, quartz sandstone and quartz lithic sandstone of Upper Bowen Coal Measures or Middle Bowen Beds.	Western part of St. Lawrence Sheet area, south of Isaacs River.	Very subdued topography. Mainly soil covered. Vegetation trends reflect bedding.		Insufficient outcrop to distinguish between Upper Bowen Coal Measures and Middle Bowen Beds.	
	UPPER PERMIAN	Upper Bowen Coal Measures Pub	About 5000'	Siltstone, white, grey, green or dark, carbonaceous or calcareous in places, rarely hard, and splintery; green, siliceous siltstone, possibly volcanic ash, containing abundant plant remains; grey-blue, micaceous, worm tracked siltstone; grey-green, khaki or brown lithic sandstone, commonly festoon bedded and containing fossil wood, calcareous in places and containing calcareous concretions; quartz sandstone; thinly interbedded siltstone and calcareous lithic sandstone; carbonaceous shale; coal; limestone lenses.	In western part of Duaringa Sheet area and south-west part of St. Lawrence Sheet area.	Generally produces subdued topography and is usually soil covered. Outcrop is confined to creeks. Bedding trends are commonly reflected in vegetation patterns.	Upper Permian. Unit contains abundant plants including <u>Glossopteris</u> <u>jonesi</u> Walk. <u>G</u>. <u>conspicus</u>. <u>G</u>. <u>indica</u> <u>G</u>. <u>angustifolia</u> <u>Cladophlebis</u> <u>roylei</u> Arber. <u>Vertebraria</u> <u>indica</u> Royle Fossil Wood.	Conformably overlies Middle Bowen Beds with a transitional boundary in many places.	Restricted depositional environment permitting preservation of plants. Rapid deposition at times, with little reworking, wide festoon bedding, large fossil wood and immaturity of sediments; at other times very slow sedimentation in shallow water, wide animal tracks on some siltstone surfaces and formation of coal seams.
		Burngrove Member Pug	300'	Siltstone, grey, grey-green, or dark, carbonaceous in places, thinly laminated to massive; thinly interbedded with grey fine lithic sandstone, and showing small scale slump structures. Lithic sandstone, mainly fine, calcareous and felspathic in places. Green to grey siliceous siltstone with abundant plant remains. Limestone, yellow-brown, silty and sandy.	Thin belt extending north across Central Railway, west of Blackwater, to north-west of Duaringa Sheet area.	Subdued topography. Most outcrop in creek beds.	Fossil plants as in Upper Bowen Coal Measures.	Member within Upper Bowen Coal Measures. Distinguished by predominance of fine sediments, absence of festoon bedded coarse sandstone and fossil wood.	Shallow water, slow deposition, probably non-deposition at times, hence preservation of animal tracks on fossil mud flats.

Age	Rock Unit and letter symbol	Thickness	Lithology	Distribution	Topography	Palaeontology and age	Relationships	Depositional Environment
PALAEOZOIC — PERMIAN	Middle Bowen Beds Plm (Western Region)	Up to 1000' exposed in Duaringa and south-west St. Lawrence Sheet areas.	Blue-grey micaceous siltstone with worm tracks and shale clasts, calcareous and fossiliferous in places. Quartz sandstone, argillaceous or felspathic in places, semi-friable to medium hard, may be flaggy, cross-bedded or worm-tracked, pebbly in places. Some calcareous, fossiliferous quartz sandstone beds. Carbonaceous and micaceous laminae in places. Brown, micaceous quartz greywacke. Quartz pebble conglomerate. Thin coal seams.	South-west corner of St. Lawrence area; three irregularly shaped anticlinal crest areas in west of Duaringa Sheet area.	Mainly subdued topography. Most outcrop is in creek beds.	Marine fossils including <u>Terrakea solida</u> <u>Ingelarella mantuanensis</u> <u>Notospirifer minutis</u> <u>Streptorhyncus pelicanensis</u> belonging to Fauna IV. Age. Lower to Upper Permian.	Unit C, topmost unit of Middle Bowen Beds. Is conformably overlain by Upper Bowen Coal Measures with some signs of transitional contact. Base of unit not exposed.	Shallow water marine environment.
	Middle Bowen Beds Plm (Folded Zone)	Up to 3000'.	Grey, blue, or dark siltstone, micaceous and/or carbonaceous in places; nodular siltstone, nodules are hard, rounded, and contain "glendonites" and fossils in places. Thin to thick bedded, grey, hard quartz sandstone and quartz greywacke, cross-bedded, calcareous, micaceous and feldspathic in places, rarely fossiliferous. Siltstone and sandstone thinly interbedded in places. Buff to brown limestone. Some contact metamorphosed sediments in north-west of St. Lawrence Sheet area.	In several elongate anticlines in folded zone extending from Dingo north-north-west to Isaacs River and around Bundarra Granodiorite in north-west corner of St. Lawrence Sheet area.	Subdued topography, mainly soil covered. Vegetation trends follow the bedding and outline complex folds. Rugged hills around Bundarra Granodiorite.	Marine fossils include <u>Conocardium</u> sp. <u>Cancrinella magniplica</u> <u>Ingelarella ingelarensis</u> <u>I. angulata</u> <u>Chaenomya</u> sp.nov.B. <u>Astartila</u> cf. <u>gryphoides</u> of Fauna III; and <u>Notospirifer minutis</u> <u>Streptorhyncus pelicanensis</u> of Fauna IV. Age. Lower to Upper Permian.	Units B and C of the Middle Bowen Beds. Base of Middle Bowen Beds is not exposed. The sequence is conformably overlain by the Upper Bowen Coal Measures.	Moderately deep water, marine environment. Some of fossils suggest muddy environment.

Age	Rock Unit and letter symbol	Thickness	Lithology	Distribution	Topography	Palaeontology and age	Relationships	Depositional Environment
PALAEOZOIC PERMIAN	Middle Bowen Beds Plm (Connors River Area)	About 4000'.	Fossiliferous limestone and calcareous sandstone, brown tuffaceous sandstone, black shale, grey-dark blue micaceous siltstone with sporadic pebbles, nodular siltstone, calcareous siltstone.	North-north-west trending belt flanking west edge of Connors Range in St. Lawrence area.	Grades down from the high Connors Range to soil covered plains. Generally poor outcrop.	Marine fossils of Fauna II including Strophalosia preovalis Anidanthus springsurensis Cancrinella farleyensis Ingelarella ovata I. profunda Age. Lower Permian.	Fossils indicate presence of unit A. Units B and C may be present but poorly exposed. Unit overlies Lower Bowen Volcanics, apparently conformably.	Shallow water to moderately deep marine environment.
PALAEOZOIC PERMIAN	Middle Bowen Beds Plm (Eastern Region)	Possibly >10,000' in Boomer and Gogango Ranges; about 5000' in Apis Creek-Strathmuir area.	Siltstone, grey to dark blue, commonly containing dark shale clasts and pellets and some worm tracks, micaceous, carbonaceous or sheared. May be nodular, massive and jointed to thinly interbedded with lithic sandstone. Quartz sandstone, quartz lithic sandstone, lithic sandstone, tuffaceous sandstone; greywacke and sub-greywacke with some calcareous cement. Clastic rocks are sheared in places and may show low grade regional metamorphism. Pebble to cobble conglomerate containing clasts of sandstone, metamorphics and volcanics. Sheared siltstone and phyllite. Fossiliferous limestone, calcareous sandstone and siltstone.	Occupies much of Eastern Ranges from Tartarus Homestead to south-east corner of Duaringa. East of range, extends from Apis Creek north-east to Strathmuir and north to St. Lawrence. In south-east of Duaringa, unfossiliferous sediments are tentatively included in Middle Bowen Beds.	Topography is varied. Subdued topography in Apis Creek to Strathmuir area, with some hills. In ranges, unit generally forms dissected country, somewhat lower than volcanic units.	Marine fossils including Notospirifer hilli Anidanthus springsurensis Strophalosia preovalis Ingelarella profunda I. ovata Keeneia sp. Deltopecten limaeformis Ingelarella cf. plana Plagiostoma? sp.nov. Atomodesma (Aphania) sp. Cladochonus sp. Thamnopora sp. Age. Lower Permian.	Faunas 2 and 3 are present in the unit from Leura Creek north. Only Fauna 3 or high Fauna 2 found in south-east of Duaringa Sheet area. Unit appears conformable on Lower Bowen Volcanics and Rookwood Volcanics. Appears to be unconformably overlain by Mesozoic volcanics. Relationship to Undifferentiated Palaeozoic Beds not known.	Marine. Fossiliferous limestone near base overlying Lower Bowen Volcanics suggest shallow water initially. However, apparent thickness and nature of sediments, and abundance of fine sediments suggest deposition in rapidly sinking trough.
PALAEOZOIC LOWER PERMIAN	Carmila Beds Pla	About 2000'	Conglomerate, tuffaceous conglomerate, dark green siltstone, lithic sandstone, rhyolite, dacitic and intermediate flows and tuffs.	Coastal strip of St. Lawrence Sheet area, north of St. Lawrence.	Forms moderately high cuestas grading down into coastal plain.	Permian, possibly Lower Permian. Fossil plants including Samaropsis dawsoni (Shirley) Noeggerathiopsis hislopi (Bunb.) Gangamopteris cyclopteroides G. clarkeana Feist. Glossopteris indica Sch. G. ampla Dana. Phyllotheca australis Bgt. Nummulospermum bowenensis Walk.	Unconformable on Urannah Complex which intrudes Lower Bowen Volcanics. Possibly equivalent to upper part of Lower Bowen Volcanics. Is unconformably overlain by Tertiary volcanics and sediments.	Freshwater or restricted marine.

Age	Rock Unit and letter symbol	Thickness	Lithology	Distribution	Topography	Palaeontology and age	Relationships	Depositional Environment
PALAEOZOIC — LOWER PERMIAN	Lower Bowen Volcanics Plv	Thickness not known and hard to estimate. Probably 10,000' to 20,000'.	Andesitic, trachytic, dacitic, basaltic flows and pyroclastics. Abundant agglomerate. Black to dark blue siltstone, commonly interbedded with tuffaceous sandstone, tuff and crystal tuff. Limestone, richly fossiliferous biostromal limestone and calcareous tuffaceous sandstone. Tuffaceous greywacke.	Occupies most of Eastern Ranges in St. Lawrence. Crops out in several isolated complex anticlines on Duaringa, north of the Fitzroy River. Crops out in a south-west dipping block, south of Broad Sound.	Produces rugged topography and high ranges.	Fossils indicate Lower Permian age. Fossils include <u>Anidanthus springsurensis</u> <u>Strophalosia preovalis</u> <u>Notospirifer</u> sp.nov. <u>Ingelarella ovata</u> <u>I. profunda</u> <u>Eurydesma hobartense</u> <u>Deltopecten limaeformis</u> <u>Keenia</u> sp.	Lower Bowen Volcanics are overlain by Middle Bowen Beds; may be faulted against Pzl metamorphics. They are intruded by the Urannah Complex and related intrusives, by Tertiary plugs and by other intrusives.	May be partly terrestrial. Fossiliferous sediments near top indicate marine conditions. Lower Bowen Volcanics may be result of island arc volcanic activity.
PALAEOZOIC — LOWER PERMIAN	Rookwood Volcanics Plr	Not known.	Spilite pillow lavas, keratophyre, silicified trachyte, basalt, agglomerate, tuffaceous conglomerate, sandstone and siltstone, volcanic breccia, chert.	Several separate areas of north-east Duaringa: along Rookwood Creek; at eastern edge of Boomer Range; and further east along Fitzroy River.	Produces mainly high, moderately rugged topography.	No fossil evidence. Thought to be Lower Permian.	Overlies and may interfinger with Dinner Creek Beds. Appears to be conformably overlain by what are regarded as Middle Bowen Beds. Thought to be equivalent, in part at least, to Lower Bowen Volcanics.	Pillow lavas indicate submarine extrusion.
PALAEOZOIC — CARBONIFEROUS TO LOWER PERMIAN	Dinner Creek Beds Pld	About 4000'	Conglomerate; sandstone and siltstone, silicified in places; chert; mudstone; andesitic sills and flows.	10 miles north-east of Rookwood Homestead at eastern margin of Duaringa Sheet area.	Forms long, moderately high strike ridges.	Contains fossil plants including <u>Noeggerathiopsis</u>. The unit is Carboniferous to possibly Lower Permian.	Overlies fossiliferous Middle Carboniferous sediments of Yarrol Basin sequence.	
PALAEOZOIC — CARBONIFEROUS	Middle Carboniferous. Cm	About 2000'	Calcareous siltstone and quartz greywacke, olive green to buff bryozoan mudstone, conglomerate, richly fossiliferous calcareous quartz greywacke beds, dark siliceous siltstone.	Crops out on east and west flanks of anticline centred about Craigilee Homestead.	Forms low hills and strike ridges.	Contains Middle Carboniferous fauna, mainly brachiopods including <u>Levipustula</u> <u>Neospirifer</u> <u>Phricidothyris</u> <u>Liriplica</u> <u>Alispirifer</u>	Probably disconformable on fossiliferous Lower Carboniferous sediments. Overlain by Rookwood Volcanics and Dinner Creek Beds.	Marine.

Age	Rock Unit and letter symbol	Thickness	Lithology	Distribution	Topography	Palaeontology and age	Relationships	Depositional Environment
PALAEOZOIC – CARBONIFEROUS	Lower-Middle Carboniferous Cl-m	Not known.	Oolitic limestone, calcareous siltstone and quartz greywacke, bryozoan mudstone, chert, conglomerate.	Two areas of outcrop south-east of Rodbank Homestead; and on islands and mainland east of Broad Sound.	Forms moderately high, broken hills to mature topography.	Contains Lower and Middle Carboniferous fossils.	Insufficient mapping to separate into Middle and Lower Carboniferous units. Apparently is faulted against Rookwood Volcanics.	Marine
PALAEOZOIC – CARBONIFEROUS	Lower Carboniferous Cl	About 2000'	Oolitic limestone, chert, quartz greywacke, sandstone, siltstone.	On east and west flanks of anticline centred about Craigilee Homestead. Small outcrop of limestone south of Melrose Homestead.	Forms long, high strike ridges, where steeply dipping.	Contains Lower Carboniferous (Visean) fauna including <u>Lithostrotion columnare</u> <u>L. arundineum</u> <u>L.</u> ex.gr. <u>stanvellense</u> Etheridge <u>Syringopora</u> <u>Symplectophyllum</u>	Overlies Devonian-Carboniferous Volcanics.	Marine
PALAEOZOIC – DEVONIAN – CARBONIFEROUS	Devonian Carboniferous Volcanics D/Cv	Unknown	Spilite, keratophyre and altered trachyte extrusives; volcanic agglomerate and conglomerate, tuff, crystal tuff and lithic crystal tuff, of possibly spilitic composition. Some altered keratophyre intrusives. Rare recrystallised oolitic limestone. Chert.	Single area of outcrop, extending from Redbank Homestead to south of Armagh Homestead.	Forms mainly low rounded hills with some high, moderately rugged hills.	No fossils. May be any age from Lower Devonian to Lower Carboniferous.	Appears to be unconformable on fossiliferous Silurian - Lower Devonian limestone. Is overlain by fossiliferous Lower Carboniferous (Visean) with transitional contact.	Possibly marine.
PALAEOZOIC – SILURIAN – DEVONIAN	Silurian to Devonian S-D	Unknown	Fossiliferous limestone. Fossiliferous limestone, recrystallized to marble in part, interbedded with buff phyllite, lithic tuff and agglomerate.	Two areas of outcrop: near Armagh Homestead, east of the Fitzroy River, and near Thuriba Homestead in the south-east corner of the Duaringa Sheet area.	Armagh outcrop is on a flat beside a small creek; the Thuriba outcrop is exposed in a small creek.	Fossils at Armagh include <u>Heliolites daintreei</u> <u>Favosites</u> sp.cf. <u>goldfussi</u> <u>Tryplasma</u> sp. Fossils at Thuriba include <u>Alveolites</u>? <u>Tryplasma</u> ? <u>Favosites</u> sp. Age is Silurian to Lower Devonian.	Is unconformably overlain by Devonian Carboniferous Volcanics near Armagh and by ?Mesozoic Volcanics near Thuriba.	Marine

Age	Rock Unit and letter symbol	Thickness	Lithology	Distribution	Topography	Palaeontology and age	Relationships	Depositional Environment
PALAEOZOIC	Undifferentiated Palaeozoic Beds Pzr	Unknown. Appears to be very thick but may include overfolded repetitions.	Grey-blue to buff siltstone, micaceous, commonly sheared; buff to grey mudstone and fine to coarse greywacke; mica phyllite; very fine to coarse crystal tuff and crystal lithic tuff, and agglomerate; some thin trachyte flows. Low grade regional and dynamic metamorphism common.	Three areas of outcrop: one extending north and south of the Railway line in the Gogango Range; second, south-east of Edungalba; the third a semi-circular block west of Rookwood Homestead.	Forms high, deeply dissected ranges.	No fossils. Age unknown.	Relationship to Middle Bowen Beds and Rookwood Volcanics not known.	
	Metamorphics. Pzl	Unknown	Quartz mica schist, quartzite, talc schist, hornfelsed quartz mica schist, pyroxenite. Unit has undergone high grade regional metamorphism and subsequent contact and dynamic metamorphism.	In several areas south-west, east and north of Marlborough.	Generally forms moderately high to low rounded hills grading into alluvial flats.	No fossils found. Age unknown.	Intruded by serpentinite complex and younger intrusives.	

of the area and in a gently folded zone in the south-west of the area. The Triassic Rewan Formation and the Clematis Sandstone crop out in the northern end of the Mimosa Syncline, between the two areas of outcrop of the Permian sediments.

The Lower Cretaceous Styx Coal Measures unconformably overlie Middle Bowen Beds in a small basin south-west of Broad Sound.

Tertiary sediments, commonly lateritised, and volcanics crop out over much of the area. Cainozoic sediments are widespread in the western part of the area.

The rock units mapped in the Duaringa-St. Lawrence area are summarized in Table 1, and are described in detail below.

MARLBOROUGH BLOCK

The Marlborough block is an area of complex geology in the south-east of the St. Lawrence and the north-east of the Duaringa 1:250,000 Sheet areas. The area was not mapped in detail and is only briefly described below.

The Marlborough block consists of metamorphics, probably the oldest rocks in the area, intruded by an ultrabasic complex. Metamorphics and ultrabasics were folded and intruded by a succession of younger intrusives.

METAMORPHICS

This unit consists of interbedded sediments and volcanics or minor intrusives which have undergone regional metamorphism and subsequently contact and dynamic metamorphism. It crops out in the following areas: a triangular block west of Marlborough Homestead; east and south of Marlborough; and around and south of Glenprairie Homestead. The topography produced by the unit is fairly subdued, generally consisting of low rounded hills and rises. It forms high, sharp crested hills west of Glenprairie Homestead.

Lithology

The unit includes quartz mica schist, talc schist, quartzite, hornfelsed quartz mica schist, and pyroxenite. These are generally well bedded, thin to medium bedded rocks with bedding and schistosity parallel in some places. A number of specimens were examined in thin section. These include a garnetiferous quartz-feldspar-biotite-muscovite schist, in which muscovite flakes are bent around longer grains of feldspar. One specimen examined is possibly a meta-quartzite. It consists of quartz grains and some feldspar augen, oriented muscovite flakes, and rare biotite. The biotite is freshly crystalline and undistorted and the quartz is free of strain shadows, suggesting that the rock has been hornfelsed.

Included in the unit are altered volcanics and intrusives. One of these is a dark, tough, fine grained schistose rock thinly interbedded with garnetiferous quartz mica schist. It consists of green hornblende, plagioclase and minor quartz, and is possibly an altered andesite or basalt.

The schist also includes some lenses consisting of quartz, green hornblende, and minor feldspar. The lenses were originally diorite or granodiorite subsequently sheared and metamorphosed to produce the present mineral assemblage.

Hornfelsed, coarse quartz mica schist and knotted schist form thin long bands in the ultrabasic complex, about 6 miles south-east of Marlborough. The trends of these bands are visible on the air photos but the bands are too thin to be shown on the map. They include thin layers of metamorphosed basic rocks, one of which contained some veins of azurite. The basic rocks include uralitized mela-gabbro. It consists of phenocrysts of augite partly replaced by actinolite in a groundmass of actinolite or hornblende and basic plagioclase.

In the Glenprairie Homestead area, the unit consists mainly of talc and chlorite schists. It includes some sheared conglomerate containing pebbles and cobbles of granite and lithic sediments in a fine, green, chloritic schistose matrix. One specimen examined is a very fine grained, schistose dacite containing phenocrysts of plagioclase and quartz. Schistosity is well developed in the matrix but the phenocrysts are not affected.

Structure and Relationships

Little is known about the structure of the metamorphics. The outcrops examined are widely separated and bedding is not obvious. The few schistosity directions measured suggest an east to north-east trend.

The relationship of the rocks 6 miles south-east of Marlborough indicates that the ultrabasic complex intruded the metamorphics. In most places, however, the contacts between the two are faulted. Near Marlborough Homestead, a north trending fault separates the ultrabasic complex from metamorphics with a prominent schistosity, striking east-west and dipping steeply north. Another fault contact is exposed in a highway cutting two miles west of Marlborough Homestead. The metamorphics are apparently faulted against Lower Bowen Volcanics west of Glenprairie Homestead.

The age of the Metamorphics is unknown. They are correlated with Lower Palaeozoic Metamorphics cropping out to the east. Although their stratigraphical relationship was not established, the grade of metamorphism of the rocks, and their complex geological history, suggest that they are older than the Permian rocks to the west. In addition, the east to north-east trend of schistosity is at variance with the north-north-west trend of the Permian Bowen Basin; this schistosity was not produced in the orogeny which folded the Bowen Basin sequence.

ULTRABASIC COMPLEX

This unit forms groups of very high, steep sided, sharp crested hills and ridges south, west and north of Marlborough. In one area the unit forms low, hilly country with very close drainage. The hills are densely vegetated in places, generally where part of a laterite profile is retained; elsewhere they carry moderate timber cover.

Lithology

There is considerable variation in texture and lithology within the complex, reflecting variations in the composition of the original ultrabasic intrusives. Most of the rocks are wholly or partly serpentinized, and serpentinite is probably the most common rock type. One specimen consists almost entirely of antigorite with a little iron oxide. It possesses a strongly developed fibrolamellar texture; the original rock was probably peridotite which apparently was first sheared and then hydrothermally altered to serpentinite. Some specimens consist of an intergrown mass of fibrous serpentine minerals with magnetite dust outlining the original olivine grain boundaries. In some, the olivine is still mostly unaltered with slight serpentinization along cracks in the olivine.

Serpentine tremolite rock, probably an alteration product of peridotite, is common in the unit; one specimen was probably altered harzburgite. One specimen of serpentine tremolite rock, containing small relict crystals of augite, had a matted texture and was sheared or contorted. The serpentine showed some preferred orientation; the tremolite was randomly oriented and probably formed after the serpentine.

One specimen examined was a uralitized gabbro, composed of uralite, plagioclase, minor calcite and opaques. The rock is a deuterically altered gabbro, not metamorphosed, and still retains a gabbroic texture.

Amphibolite and altered basalt are included in the ultrabasic complex, near the contact with intrusive granite. These altered rocks occur as pods in the serpentinite.

Relationships

The ultrabasic complex is intrusive into the metamorphics though the contacts are commonly faulted. It is shown on the map in contact with Lower Bowen Volcanics and Middle Bowen Beds, west of Marlborough. The actual contacts were not seen in the field. Unmetamorphosed Middle Bowen Beds crop out within 20 yards of the nearest outcrop of serpentinite, near the North Coast Railway. The boundary between the two units was photo-interpreted; it is a fairly straight contact and is probably faulted. The boundary between the Lower Bowen Volcanics and the ultrabasic complex was also photo-interpreted. This contact appears to be intrusive rather than faulted. However, younger intrusives intrude both units farther north; the ultrabasics, as mapped, may include some post Permian igneous rocks intruded along a faulted contact between the ultrabasics and the Lower Bowen Volcanics. That the ultrabasic complex intrudes the Permian sequence seems very unlikely.

The air photos show an abrupt termination of trends in Carboniferous sediments against the ultrabasic complex east of the Duaringa Sheet area. The boundary is fairly straight and is possibly faulted.

The age of the ultrabasic complex is not known.

INTRUSIVES

A small mass of gabbro intrudes the ultrabasic complex near Marlborough Homestead. This is mainly a medium grained rock but is very coarse in a few places containing crystals up to 1½ inches long. It is an olivine gabbro consisting of plagioclase, augite, olivine, and brown hornblende replacing augite. This rock shows no signs of serpentinization.

A long ridge of gabbro crops out about four miles east of Marlborough Homestead. This gabbro intrudes the ultrabasic complex; associated with it are very many small to large dykes of gabbro intruding the complex. The dykes trend east to north-east, generally, and consist of fine grained, apparently unaltered gabbro.

The rocks of the long ridge are very much altered. They are dominantly quartz amphibole rocks, consisting of large plates of actinolite and a few small relict plagioclase crystals in a very fine grained groundmass of granular quartz and flakes of amphibole produced during metamorphism. Untwinned plagioclase, a product of the metamorphism, is present in one specimen. The larger primary crystals are bent as a result of shearing. The rocks were sheared and subsequently hornfelsed during contact metamorphism by the granite cropping out north of the ridge.

Granite occupies much of the low, soil covered area about Marlborough. Outcrops are very rare as the granite is usually deeply weathered. 30 feet of very weathered biotite granite are exposed in a creek bank, south of Marlborough. The only fresh outcrop was senn in Marlborough Creek, ½ mile south of the Bruce Highway. The rock is a hornblende biotite adamellite containing numerous rounded xenoliths of partly granitized basic material. The extent of the granite was partly photo interpreted and partly based on examination of weathered outcrop and soil types. This granite intrudes the gabbro masses described above, the ultrabasic complex and the Metamorphics.

Three small intrusions crop out along the road from Marlborough to Glenprairie Homestead. The first of these is a very coarsely crystalline uralitized gabbro which intrudes the ultrabasic complex, the Metamorphics, and the Lower Bowen Volcanics. North of the gabbro is a small granite mass intruding the Metamorphics. The third is a diorite mass which crops out in an arcuate line of high hills. The hills are mainly composed of contact metamorphosed Metamorphics and Lower Bowen Volcanics. Diorite is intimately associated with the hornfelsed rocks, thin veins of diorite alternating with bands of hornfels. The main part of the intrusion is concealed by Cainozoic cover to the north-east; it was more susceptible to erosion than the metamorphic aureole.

SILURIAN - DEVONIAN

Rocks of Silurian-Devonian age crop out near Armagh and Thuriba Homesteads in the Duaringa 1:250,000 Sheet Area. These rocks are mapped as one unit but are not necessarily equivalent. The two areas are discussed separately.

Armagh Locality

Limestone crops out in an area 200 yards long by about 50 yards wide, crossed by the Wycarbah to Craigilee Homestead road about ¼ mile north of Armagh Homestead. The outcrop consists of low, bare knobs and benches protruding from soil cover. The only lithology present is a grey to white, fine grained, partly coralline limestone showing no signs of recrystallization. The limestone is poorly bedded to massive.

It is overlain by Devonian-Carboniferous Volcanics containing fragments of limestone near the contact. The poor bedding in the limestone is nearly normal to the regional trend of the volcanics and the contact is probably unconformable.

The corals indicate that the limestone was deposited in a moderately shallow marine environment. Nothing is known about the thickness or extent of the unit.

The following fossils were identified in the unit by Professor D. Hill: Heliolites daintreei, first group; Favosites sp. cf. goldfussi; F. sp.; Tryplosma sp.; ?Fletcheria sp. or ?Fletcherina sp.; Stromatoporoid and Algae. These are long ranging types, probably Lower Devonian but possibly as old as Silurian. (Appendix 2.)

Thuriba Locality

Fossiliferous limestone, interbedded with volcanics and sediments, crop out about ¼ mile north of Thuriba Homestead. The unit is exposed for about 50 yards in a small creek cutting across strike. Isolated boulders of limestone can be traced along strike for about ¼ mile north-north-west from the creek.

The lithologies present include sheared siltstone and phyllite, weathering to a buff-yellow colour, sheared volcanics including purple amygdaloidal extrusives, interbedded fine and coarse green tuffs and lavas, purple-green agglomerate and tuff. The fossils are contained in a one foot thick bed of limestone, sheared and largely recrystallized to marble, red and grey-white in colour, and containing broken pebbles of volcanics. One specimen of green tuff was petrologically examined. Five percent of the rock consists of a very fine grained, recrystallized and epidotised tuffaceous matrix. The clasts are commonly embayed and distorted fragments of fine grained extrusives with some altered crystals of feldspar and a few strained quartz crystals. The Silurian-Devonian sediments in this locality have undergone dynamic and low grade regional metamorphism.

A sequence of possibly Mesozoic, intermediate to basic volcanics crops out around the Silurian-Devonian rocks. The two were not seen in contact. The extent and thickness of the Silurian-Devonian rocks in this area are not known. The presence of coralline limestone in the unit indicates a marine, shallow water environment of deposition.

The limestone bed was sheared and largely recrystallized, making identification of fossils difficult. Professor D. Hill determined the following: Alveolites? sp., Tryplasma?, and Favosites sp., indicating a Silurian to Devonian age. (Appendix 2.)

YARROL BASIN SEQUENCE, FITZROY RIVER AREA.

Four units, Devonian to Carboniferous volcanics, Lower and Middle Carboniferous sediments, and the Dinner Creek Beds were recognized in the Fitzroy River area, near the eastern boundary of the Duaringa 1:250,000 Sheet area. In one area, undifferentiated Lower and Middle Carboniferous sediments were mapped.

These units are part of the Yarrol Basin sequence, which has been mapped in some detail to the east in the Rockhampton 1:250,000 Sheet area (Maxwell, in Hill & Denmead, 1960, pp 160-162, 168-175, 217-221.)

The Yarrol Basin sequence in the Fitzroy River area is structurally conformable. It crops out in the Craigilee Anticline, a large anticline with a curving axis that passes near Craigilee Homestead. The sequence unconformably overlies fossiliferous limestone of Silurian to Devonian age, and is overlain, with apparent conformity, by the Rookwood Volcanics. Although the relationship of the Dinner Creek Beds and the Rookwood Volcanics is not clear in the western limb of the Craigilee Anticline, the Dinner Creek Beds appear to pass laterally into the Rookwood Volcanics which directly lie on Middle Carboniferous sediments.

The geology of the Fitzroy River area is extremely complex. During the 1962 survey, only a limited amount of time could be spent in the area. Consequently, some areas require further work; these include the contact between the Rookwood Volcanics and the Dinner Creek Beds; in the area of undifferentiated Lower and Middle Carboniferous sediments, west of Hillview Homestead and the area south-west and south of the adamellite intrusion.

Devonian-Carboniferous volcanics

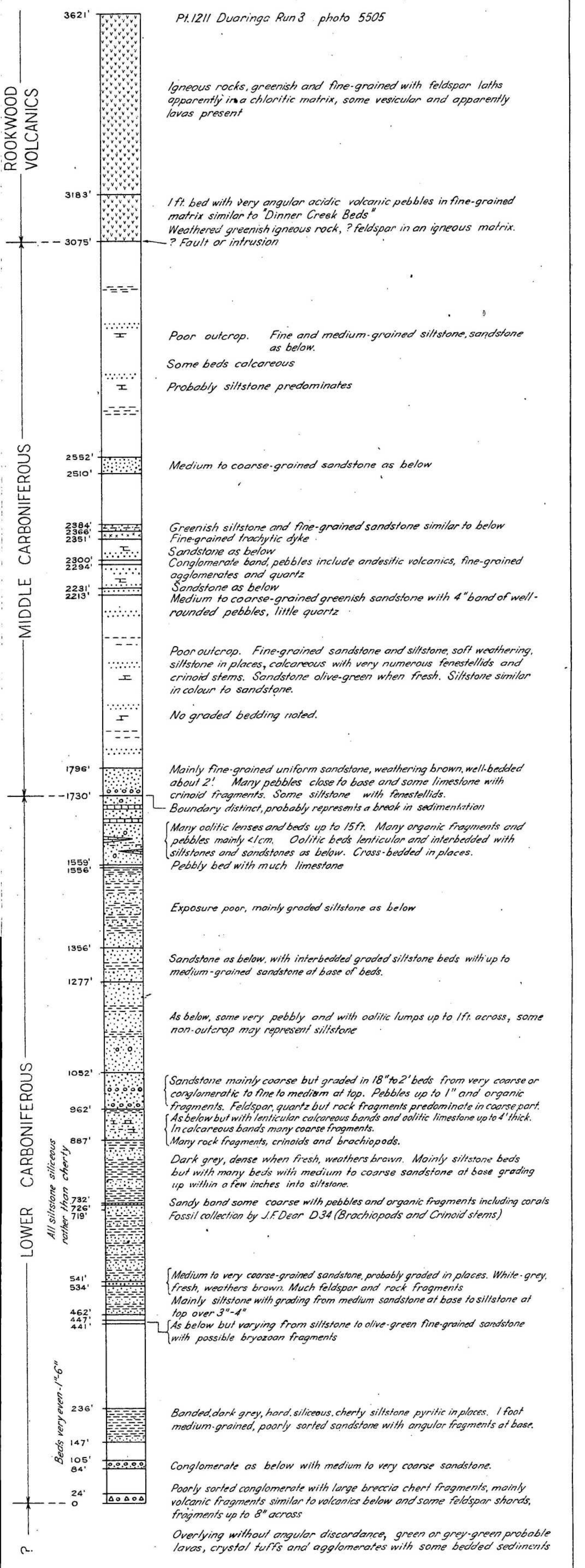
Volcanics crop out in a north-south trending belt from Melrose and Redbank Homesteads in the north to a few miles south of Armagh Homestead. They produce one group of high, moderately dissected hills east of Hillview Homestead, but generally form low hills and rolling plains.

The unit consists of a large number of lithological types. Volcanic conglomerate, tuff and chert occur north-east of Hillview Homestead. The conglomerate is massive; it consists of 85% fragments of tuff and

Fig.2

Measured Section of Lower & Middle Carboniferous Sequence, Yarrol Basin

West of Armagh Homestead, in Fitzroy River and in small tributary from west through Pt. 131·4



Measured by J.F. Dear (G.S.Q.) and J.M. Dickins using pace and compass. Scale 200 ft. to 1 inch

To accompany Record 1963/60

Bureau of Mineral Resources Geology and Geophysics May 1963 F55/16/2 PB sive volcanic rocks and 5% feldspar in a fine-grained tuffaceous ix. The tuffs are hard fine-grained greenish-grey rocks. Most are hic with 65% rock fragments and 15% feldspar in a very fine-grained tuffaceous matrix. Keratophyre is the dominant lithology in the hills $1\frac{1}{2}$ miles east of Hillview Homestead. The rocks are fine-grained, greenish grey, and porphyritic; albite phenocrysts, commonly partly replaced by calcite, make up about 5% of the rocks. Spilite, trachyte and oolitic limestone occur in the Fitzroy River bed one mile west of Craigilee Homestead. The spilite is massive, fine to medium grained dark greenish-grey and contains 70% of albite-oligoclase feldspar. The trachyte is a black, fine-grained rock containing about 15% phenocrysts of oligoclase and quartz in a very fine-grained matrix of feldspar, zeolite and chlorite. The limestone is black, fine-grained, and partly recrystallized; it consists of 55% oolites, 40% crystalline calcite, and 5% lithic fragments, quartz, and plagioclase. Near Armagh Homestead the unit contains andesitic tuffs with graded bedding and andesitic flows which are vesicular in places.

Immediately north-east of Armagh Homestead, the Devonian-Carboniferous volcanics overlie Silurian-Devonian limestone. Boulders of the limestone are contained in the volcanics, suggesting a disconformable or unconformable relationship between these units.

The thickness of the volcanics cannot be established accurately; at least 1200 feet occurs in the Armagh Homestead area; farther north as much as 5000 feet may be present.

No fossils were found in the volcanics. At the top they grade into the overlying Lower Carboniferous (~~Visean~~) sediments. They are partly of Lower Carboniferous age and may extend down into the Devonian.

South of Armagh Homestead the volcanics and overlying Carboniferous sediments are intruded by adamellite.

Lower Carboniferous sediments

The Lower Carboniferous sediments are well exposed in a series of low strike ridges which delineate the Craigilee Anticline. An isolated outcrop, one mile south-east of Melrose Homestead, is tentatively included in the unit.

The various rock types are shown in Figure 2, a measured section through the Lower and Middle Carboniferous sediments. Graded bedding is common throughout the Lower Carboniferous sequence. Oolitic limestone is the characteristic lithology of the upper part of the unit and several beds, up to 20 feet thick, crop out towards the top of the sequence. The limestone consists of 40% oolites in a matrix of finely granular calcite. The oolites average 0.5mm in diameter and in most cases have cores of crystal tuff or vitric tuff; a few have cores of either quartz or feldspar. Crinoidal stem segments are the most common organic remains found in the limestone. The section shows that siliceous siltstone is the dominant lithology in the basal part (0-887 feet) of the Lower Carboniferous unit;

these rocks can be compared with the Pond Argillites of the Stanwell area, 30 miles to the south-east (Maxwell, ibid, p.161) The upper part of the Lower Carboniferous unit can be compared with the Neils Creek Clastics (Maxwell, ibid, p.161.).

Sheared and recrystallized limestone, containing indeterminate fossils, crops out south-east of Melrose Homestead. The limestone is tentatively included in the Lower Carboniferous sediments. It crops out on a small hill surrounded by probable Devonian-Carboniferous volcanics. The relationship between it and the volcanics is not known. The limestone is on the axis of a broad syncline affecting Lower Carboniferous sediments which crop out two miles to the south-east, east of the Duaringa area. Possibly this limestone is an outlier of Lower Carboniferous. Alternatively, it may be equivalent to the Silurian-Devonian rocks at Armagh Homestead. Probable Devonian fossils have been reported from near Bannockburn Homestead, immediately east of the Duaringa Sheet area (Prof. D. Hill, pers. comm). The Bannockburn limestone and the limestone mapped as Lower Carboniferous are possibly the same.

The unit contains richly fossiliferous beds; brachiopods and corals are most abundant. The corals from oolitic limestones identified by Prof. D. Hill include several species of Lithostrotion, two species of Syringopora and a Symplectophyllum (Appendix 2). These indicate a Lower Carboniferous, probably Visean, age. The brachiopods were identified by Dear, (Appendix 3), and are Upper Tournaisian.

Middle Carboniferous sediments

The Middle Carboniferous rocks overlie the Lower Carboniferous sediments with probably a slight disconformity. The evidence for the disconformity is: the sharpness of the boundary between the two units, on both sides of the anticline; the persistent conglomerate at the base of the Middle Carboniferous unit; and the distinctiveness of the fauna in the Middle Carboniferous unit, compared with that in the Lower Carboniferous unit. The lithologies are illustrated in Figure 2. Fine to medium grained sandstone predominates in outcrop; siltstone and conglomerate are also present. The sediments are not graded. A thin bed of conglomerate occurs at the base, containing quartz pebbles and fragments of volcanic origin. Several thin beds of conglomerate occur higher in the sequence. The sandstone is commonly poorly sorted, and calcareous; some calcarenite is present. Some thin beds of calcareous sandstone contain abundant fossils, mainly brachiopods (Dear, Appendix 3).

The thickness of the Middle Carboniferous sequence varies considerably; west of Craigilee Homestead the thickness may be up to 5000 feet but this may be due to repetition of section.

In the western limb of the Craigilee Anticline, the Carboniferous rocks are overlain by the Rookwood Volcanics and the Dinner Creek Beds. The relationship between the Carboniferous sediments and these formations is structurally conformable; the contact between the Rookwood Volcanics and the Carboniferous sediments is probably partly faulted. The rocks overlying the Middle Carboniferous sediments in the east limb of the Craigilee Anticline are not exposed in the Duaringa Sheet area.

South and east of Armagh Homestead, the Carboniferous sediments are intruded by adamellite and Tertiary trachyte plugs and dykes.

Undifferentiated Lower and Middle Carboniferous sediments

Undifferentiated Carboniferous rocks crop out in a triangular area about 5 miles west of Hillview Homestead. They produce mainly low, soil covered hills and ridges with very little outcrop.

Rock types present include limestone, oolitic and crinoidal in part, siltstone containing bryozoa in places, quartz and lithic sandstone, pebbly in places, and tuffaceous rocks. Faulting and shearing are common throughout the sequence and no determinate fossils were found.

This unit includes rock types similar to those found in the Lower and Middle Carboniferous, but may include rocks of other ages.

Dinner Creek Beds

The Middle Carboniferous rocks south of Armagh Homestead are conformably overlain by a sequence of conglomerate, silicified sandstone and siltstone, plant bearing mudstone, and chert, intruded in places by andesitic sills. The plants were identified by Mary E. White (Appendix 5) as Noeggeratiopsis hislopi (Bunb.) of Carboniferous to Lower Permian age. These rocks are correlated with the Lower Permian Dinner Creek Beds (Dunstan, 1904.) The type area of the Dinner Creek Beds is in the Stanwell district of the Rockhampton 1:250,000 Sheet area, 30 miles south-east of Armagh Homestead.

In the Duaringa Sheet area, the unit was mapped only in a small area east of the Fitzroy River. Further mapping may reveal however that cherts which crop out in the Fitzroy River, south-west of Armagh Homestead and farther north, and which were mapped as part of the Rookwood Volcanics, possibly belong to the Dinner Creek Beds.

The Dinner Creek Beds form a series of rough, in places densely vegetated north-west trending strike ridges. The rocks are well bedded and generally thin bedded and dip steeply in a south-westerly direction. Chert is very common in the sequence and commonly laminated; the siltstone and sandstone are silicified. Andesitic sills, up to 20 feet thick, are fine-grained, greenish grey and consist of 65% plagioclase, 15% clinopyroxene, 15% epidote and chlorite, and 5%(?) siderite.

The thickness of the formation is probably in excess of 4000 feet, but cannot be estimated accurately because of strike faulting.

The Dinner Creek Beds are overlain in places by the Rookwood Volcanics and may be equivalent, in part, to this formation.

UPPER DEVONIAN TO MIDDLE CARBONIFEROUS ROCKS, NORTH EAST ST. LAWRENCE SHEET AREA

Upper Devonian to Middle Carboniferous rocks crop out on Long Island, Quail Island, and in small areas of the northern half of the peninsula forming the east shore of Broad Sound. The outcrops form hills and ridges between 300 feet and 700 feet high; timber cover is variable. Long Island and Quail Island were not visited and we are grateful to W.C. White, and G.A. Brown, Ampol Exploration, for providing field information on these; several outcrops were examined in the peninsula within the St. Lawrence Sheet, but most of the area is not readily accessible; several outcrops in the adjoining Port Clinton Sheet were examined.

The sequence consists of interbedded sandstone, siltstone and mudstone. The sandstone is grey and greenish, medium-grained, lithic, feldspathic, and some possibly tuffaceous. Some white silicified quartz sandstone and quartzite, commonly sheared and brecciated, are present. Dark grey micaceous tuffaceous siltstone with sandy clasts, indurated laminated cherty mudstone, phyllonites, and some volcanics (?keratophyric) are also present in the sequence. The rocks are commonly sheared, the degree of shearing varying markedly from area to area. Other rock-types were noted in the peninsula immediately east of the St. Lawrence Sheet area, where the rocks are more intensely sheared and indurated. The sequence consists of drab bluish-grey, coarse grained, calcareous quartz-lithic sandstone with thin beds of pebble conglomerate, interbedded with white, clayey quartz sandstone, grey and buff siltstone and shale, intensely cleaved and phyllitic in places, and black indurated mudstone with sandy laminae. Shear planes are parallel to bedding. Farther east, a sequence of regionally metamorphosed rocks is well exposed, especially along the north-east coast of the peninsula. The rocks include white, buff, and green, quartz schist and quartz mica schist, probably containing much chlorite, sheared volcanic rocks, some probably rhyolitic, and porphyries. The rocks are impregnated with quartz reefs and a few veins of copper and iron minerals; narrow basaltic dykes and faults are common.

The rocks on Long and Quail Islands are reported to be similar to those in the western half of the peninsula. They include sandstone, siltstone and mudstone containing bryozoa, crinoids and brachiopods, and fragmental crinoidal and oolitic limestone. Basic dykes intrude the sequence in places.

The relationships of the sequence to older and younger units are not known. The metamorphic rocks in the east of the peninsula probably belong to the same sequence as those in the west and on Quail and Long Islands; there appears to be a gradual increase in grade of metamorphism to the east. The regional north-north-east strike of the rocks is apparent on air-photos where they form strike ridges. On Long Island strike is sinuous, trending east in the northern part of the island, north-west in the central part, and north-north-east in the southern part;

local variations, apparently due to faulting, are visible on air-photos. On Quail Island there appears to be a persistent north-north-east strike with probably strike faults. The rocks are tightly folded with flank dips over 70°; shearing planes commonly parallel bedding, and cleavage at acute angles to bedding is present in the argillaceous rocks. The rocks are faulted, and intruded by small foliated granitic bodies.

The thickness of the sequence is unknown. Marine fossils were collected on Long Island and Barren Island by W.C. White and were determined by John Roberts (Appendix 4). Most of the collections are of Middle Carboniferous age. Species present include Levipustula levis Maxwell, Composita cf. magnacarinata Campbell, and Spinuliplica spinulosa Campbell.

The four collections from the southern end of Long Island contain only two species, Syringopora sp. and Cyrtospirifer? sp. The Cyrtospirifer? sp. suggests an Upper Devonian age.

The lithologies of these rocks and the faunas contained in them are similar to those of the Yarrol Basin. These rocks are tentatively correlated with the Yarrol Basin sequence.

LOWER BOWEN VOLCANICS

SUMMARY

The Lower Bowen Volcanics are the basal unit in the northern part of the Bowen Basin. They crop out in a structurally high position east of the Bowen Syncline and as a south-west dipping block, south of Broad Sound. The latter area may mark the eastern limit of deposition of the Lower Bowen Volcanics.

The unit is dominantly volcanic; in places, it includes thick sequences of mainly volcanic derived sediments. The volcanics are commonly andesite but may be dacitic, trachytic, rhyolitic or basaltic. Rock types include massive and porphyritic lavas, tuffs, crystal and lithic tuffs and abundant agglomerate. Sediments range from shale and very fine siltstone to coarse conglomerate.

The upper part of the Lower Bowen Volcanics contains marine fossils indicating a Lower Permian age. The unit may be entirely Permian or may have commenced in the Carboniferous. The relationship of the Lower Bowen Volcanics and the Carmila Beds suggests that these may be unconformities within the volcanic pile.

NOMENCLATURE

The name "Lower Bowen Volcanics" was first applied by Jack and Ethridge (1892) in the Collinsville area. The bulk of the unit in the St. Lawrence area is linked by continuous outcrop to the type area. Isolated outcrops in the St. Lawrence and Duaringa Sheet areas are included in the Lower Bowen Volcanics on generally good structural, lithological and stratigraphic evidence, particularly as the distances between outcrops are small.

DISTRIBUTION AND TOPOGRAPHY

The main area of outcrop of the Lower Bowen Volcanics are the high, rugged ranges trending south across the St. Lawrence Sheet area. Elsewhere they crop out in the block of hills west of Herbert Creek and as groups of high hills scattered through the ranges east of the Mackenzie River in the Duaringa Sheet area.

The unit produces a rugged topography of high hills, commonly rounded on top, and steep sided valleys. The most rugged topography is developed where the Volcanics are metamorphosed and silicified by intrusives of the Urannah Complex. Plateaus and upland valleys of mature topography are developed within the extensive Connors Range. These provide good grazing during and after the wet season but contain little permanent water. The sediments and bedded volcanics in the unit produce strike ridges and cuestas, grading down into plains. The best exposures of the unit are found in creek sections, though outcrop is generally good.

LITHOLOGY

The Lower Bowen Volcanics is a heterogeneous unit, dominantly volcanic but including locally thick sequences of sediments. Extrusives constitute about one third of the unit, and pyroclastics nearly half. The sediments, calcareous and fossiliferous in places, range from shale to conglomerate and are mainly derived from volcanics.

The extrusives are mainly andesite but dacite, rhyolite, trachyte and basalt are also present.

Andesite

Fine to coarse grained andesite is the most abundant flow rock. In places it is massive; in others either weakly flow banded or weakly to strongly porphyritic. Colour is commonly green and ranges from purplish-green to blue-green or grey. Phenocrysts comprise 1% to 30% porphyritic types and are mainly plagioclase; others include hornblende, potash feldspar, and rarely biotite and quartz. The phenocrysts are euhedral to anhedral crystals, laths and aggregates of small crystals. The largest phenocrysts are 0.5 inches in diameter; the average is about 0.2 inches. Some plagioclase phenocrysts show resorption; others show good zoning obvious even in hand specimen.

Plagioclase forms up to 70% of some flows but may be as low as 30% in the melanocratic varieties. Alteration products, mainly chlorite, epidote and calcite make up the remainder of the rock. Vesicles are rare, are usually less than ½ inch in diameter and are commonly filled with calcite. Quartz and epidote veins are common. They are usually small, up to a few feet long by less than one inch in width, but may be up to 6 inches wide in places.

Rhyolite, dacite and toscanite

Rhyolite and dacite are common in the Lower Bowen Volcanics. Toscanite is present though less common. The flows are fine to coarse-grained, weakly to strongly porphyritic or rarely massive, and grey to dark grey, brown, green or pink. Many show good flow banding. Phenocrysts include plagioclase, potash feldspar and quartz, in different proportions in different specimens. The phenocrysts are euhedral to anhedral, are commonly corroded and are less than 0.25 inches in diameter.

Trachyte and trachy-andesite

A few flows of trachyte and trachy-andesite are found throughout the Lower Bowen Volcanics. They are generally weakly porphyritic and contain small subhedral to anhedral crystals of plagioclase, potash feldspar, amphibole and minor quartz, and aggregations of small crystals of mafic minerals. Rounded xenocrysts of quartz were noted in one trachyte flow. Flow banding was observed in some; most specimens show pilotaxitic texture. One specimen examined is a silicified trachyte, traversed by a network of fine veins of chalcedony.

Basalt

Basalt is a minor rock type in the Lower Bowen Volcanics. It is abundant in a few areas, such as south-west of Tooloombah Homestead. The basalt is vesicular, amygdaloidal and porphyritic, rarely massive and dark to pinkish-grey or pinkish brown. The phenocrysts are generally embayed, anhedral prisms set in an intersertal to intergranular matrix, and consist of feldspar and augite and their replacements. One specimen contains numerous ellipsoidal amygdules filled with chlorite and chalcedony.

Most of the extrusives in the Lower Bowen Volcanics show some alteration with development of chlorite, epidote and calcite; others are partly recrystallized, possibly as a result of low grade regional metamorphism.

Pyroclastics

Agglomerate is possibly the most abundant rock type in the Lower Bowen Volcanics. It is generally massive though fine agglomerate crops out in places thinly interbedded with other volcanics. The fragments range from six feet to less than 1 inch in diameter. In places there is a rapid alternation of coarse and fine agglomerate. The agglomerate is commonly a mottled, pink and green rock; in places, it may be grey, dark grey, purple, brown and buff.

Photo Plate 1:

Agglomerate, Lower Bowen Volcanics. Boulders of porphyritic dacite and andesite set in an andesitic groundmass. Exposure occurs in small creek four miles N.E. of 'Markwell Homestead'.

(Neg.No. M/257).

Volcanic breccia is associated with the agglomerate in places. One outcrop, probably an auto-brecciated trachytic lava, consists of blocks of flow banded trachyte in a fine grained, probably trachytic, matrix. Another exposure of volcanic breccia contains rafted blocks, eight feet across.

The agglomerate is mainly of andesitic, dacitic and rhyolitic composition. Fragments are either of a single lava type or a mixture of extrusives and pyroclastics. The groundmass is either massive or porphyritic. It is recrystallized in some specimens, and sheared in others (see photo plate 1).

Tuff, lapilli tuff and crystal lithic tuff are very abundant throughout the unit. They are fine to coarse-grained, thick to thin bedded, pink, purple, brown, green, grey and white rocks. In places, it is a very fine-grained, dark grey to black rock, grading into ashstone. Graded bedding is common in the tuff.

Lapilli tuff is moderately abundant in the unit; lapilli are generally about ½ inch in diameter but individual bombs up to 1 foot in diameter were seen. A bed of calcareous lapilli tuff cropping out near Amet Dale Homestead contains marine fossils.

Lithic crystal tuff, ranging from lithic tuff to crystal tuff, constitutes a large proportion of the Lower Bowen Volcanics. The lithic fragments consist of fine-grained extrusives and pyroclastics, generally poorly rounded and showing some alteration and embayment. They range up to 6 inches in diameter, the larger ones showing better rounding. The crystal fragments are mainly subhedral to anhedral feldspar and quartz and are usually bent, broken, embayed, corroded and altered. The matrix is generally fine tuffaceous material. In one specimen, the matrix is fine-grained and spherulitic in part, probably the result of partial recrystallization of an originally glassy matrix.

Many tuffs have been sheared, partly recrystallized and altered to some extent. Epidotization has converted some to quartz-epidote rocks and small quartz epidote veins are common in some areas. Some specimens are extensively calcitized.

Sediments

Locally important developments of sediments crop out in places including west of Apis Creek, near Tooloombah, Tartarus and Collaroy Homesteads and near Herbert Creek. In these localities the sediments are found near the top of the Lower Bowen Volcanics. Very few sediments were noted in the Lower Bowen Volcanics in the Duaringa Sheet area.

The sediments include shale, siltstone, sandstone, tuffaceous greywacke, conglomerate and rare limestone. They are generally interbedded with volcanics.

The lutites are dark, hard and splintery; they are poorly bedded or interbedded with coarser sediments. Shearing and close jointing are common.

Sandstone contains mainly volcanic and feldspar grains and a relatively low proportion of quartz grains; no quartz sandstone was seen in the unit. The sandstone is well bedded, poorly sorted, fine to coarse-grained and pebbly in places. It is grey, green, brown and white and commonly develops a white weathered skin.

Some arenites contain a high proportion of matrix. One specimen of tuffaceous greywacke consists of clasts, to 1 cm in diameter, of basic volcanics set in a recrystallized matrix forming 25% of the rock. This rock was possibly formed by reworking of tuff.

Conglomerate ranges from pebble to boulder conglomerate. Sorting is good in some places, poor in others. Rapid alternation of coarse and fine conglomerate was noted at a few localities. The conglomerate is immature and contains mainly volcanic and plutonic fragments.

The composition of the clasts and matrix and the general immaturity of these sediments suggest that they were derived from a close, volcanic source. They are probably the result of local reworking of Lower Bowen Volcanics.

Calcareous siltstone and tuffaceous sandstone and rare beds of limestone crop out in places near the top of the Lower Bowen Volcanics; these calcareous sediments are rich in marine fossils.

STRUCTURE AND RELATIONSHIPS

The Lower Bowen Volcanics consist largely of agglomerate and other massive volcanics, yielding no structural information. In some places near the top of the unit, massive volcanics pass laterally into bedded volcanics and sediments. The bedded rocks exhibit structures which are generally concordant with structures in the overlying Middle Bowen Beds.

The main area of outcrop of the Lower Bowen Volcanics is essentially a broad, south plunging arch. Minor flexures affect both the bedded volcanics and the overlying Middle Bowen Beds at a few places on the flanks of the arch, for example in the Apis Creek to Tooloombah Homestead area.

A syncline was mapped in the Volcanics near Collaroy Homestead. It is a broad, gentle structure with flank dips of 15° to 30° and a shallow south plunge. The structure is compatible with the hypothesis that the Lower Bowen Volcanics in this arch are not tightly folded.

The Lower Bowen Volcanics near Herbert Creek form a south-west dipping block. At the southern end of this block, the volcanics dip east and are probably overturned. Some minor folding was noted in the north-west part of the block but the impression is of a large simple structure. Folding is tighter in the zone of probable overturning but the structures are much broader than the structures developed in less competent Middle Bowen Beds to the west.

In the Duaringa Sheet area, the Volcanics crop out in two large complex domes and several smaller, elongate anticlines overlain by Middle Bowen Beds. The contact between the two units was seen in a few places in both the Duaringa and St. Lawrence Sheet areas and appears to be conformable.

The Lower Bowen Volcanics are considerably more competent than the overlying Middle Bowen Beds; the difference in competence is made clear by the structures in the two units. Folds in the units above and below the contact die out down section in the Volcanics, and increase in complexity upwards in the Middle Bowen Beds.

Many igneous bodies intrude the Lower Bowen Volcanics, particularly in the St. Lawrence Sheet area. These are correlated with the Urannah Complex, the main mass of which crops out north of the area.

The relationship of the Lower Bowen Volcanics to the Carmila Beds is not clear. The Carmila Beds are unconformable on rocks of the Urannah Complex near the northern margin of the area, and, by inference, are unconformably younger than the Lower Bowen Volcanics intruded by the same Urannah Complex rocks. However, on moderately convincing palaeobotanical, structual and lithological evidence, the Carmila Beds are equivalent to bedded volcanics and sediments at the top of the Lower Bowen Volcanics and the base of the Middle Bowen Beds in the Tooloombah Homestead area. Possibly, the unconformity at the base of the Carmila Beds is a local unconformity within the intruded volcanic pile.

The Lower Bowen Volcanics are possibly faulted against Lower Palaeozoic metamorphics near Herbert Creek. A large diorite mass intrudes the Volcanics at the contact. Further south, the Volcanics are in contact with serpentinite but the relationship is not known.

Tertiary rocks were mapped in several places within the main area of outcrop of the Lower Bowen Volcanics. These are mainly flows and pyroclastics overlying the Volcanics but include some intrusive plugs.

ENVIRONMENT OF DEPOSITION

The Lower Bowen Volcanics are possibly the result of island arc volcanic activity on a relatively shallow shelf. Possibly much of the volcanic material accumulated above sea level, was eroded and redeposited as the volcanic derived sediments included in the unit. The presence of marine fossils at many places in the unit indicates that the environment was at least partly marine. The thick lenses of homogeneous volcanics, lensing out rapidly along strike probably indicate the existence of many volcanic vents.

The Lower Bowen Volcanics and the Rookwood Volcanics are of similar age. The Rookwood Volcanics are largely pillow lavas, indicating submarine extrusion. The Lower Bowen Volcanics contain some similar lithologies but no pillow structures or other evidence of submarine extrusion. This supports the thesis that the Lower Bowen Volcanics accumulated on a shallow shelf, with the volcanic piles growing above sea level and most of the volcanism being terrestrial.

The main development of sediments are in the Apis Creek to Tooloombah Homestead area and north of Strathmuir. This area may have been a marine basin of sedimentation with minor volcanism, within the island arc chain. The sediments were derived by erosion of exposed Lower Bowen Volcanics around the margin of the basin. The Carmila Beds were possibly deposited at the northern end of the basin, overlapping older Lower Bowen Volcanics and Urannah Complex.

THICKNESS

The thickness of part of the Lower Bowen Volcanics can be estimated at a few places where bedded volcanics predominate. A thickness of more than 10,000 feet is estimated north of Strathmuir where the sequence dips consistently south-west and is apparently little folded. Similar thicknesses have been measured in the unit at other places. It is not possible to measure the thickness of the massive volcanics which form the bulk of the unit. Locally, the unit may be up to 20,000 feet thick.

PALAEONTOLOGY AND AGE

Marine fossils were collected at seven localities in the Lower Bowen Volcanics. The collections, numbers SL22, SL199, SL397, SL683, Du179, Du192, and Du1000 are described in Appendix 1. The fossils present include Anidanthus springsurensis, Strophalosia preovalis, Notospirifer sp.nov., Ingelarella ovata, I. profunda, Eurydesma hobartense, and Deltopecten limaeformis, of Lower Permian age. They occur near the top of the Lower Bowen Volcanics and set an upper limit to the age of the unit. The Lower Bowen Volcanics may be entirely lower Permian, as the fossils do not indicate a basal Permian age, or, perhaps less likely, they may range down into the Carboniferous.

ROOKWOOD VOLCANICS

Summary

The Rookwood Volcanics, a new unit defined herein, consists of spilitic pillow lavas and minor agglomerate, volcanic breccia, trachyte and tuffaceous sediments and crops out in the east of the Duaringa Sheet area. In the Fitzroy River area, the unit overlies the Dinner Creek Beds and the Middle Carboniferous sediments. It is overlain, apparently conformably, by Middle Bowen Beds. The Rookwood Volcanics are thought to be Lower Permian in age, possibly equivalent in part to the Lower Bowen Volcanics. The abundance of pillow lavas indicates that the unit was mainly extruded under water. 3000 feet of volcanics are present east of the Fitzroy River; the total thickness may be greater elsewhere.

Name, type area

Rookwood Volcanics is the name proposed for the dominantly spilitic volcanics cropping out in the east of the Duaringa area. The name is derived from Rookwood Creek which flows through the type area of the formation, in the vicinity of Lat. 23°30'S., Long. 149°51' E.

Distribution and topography

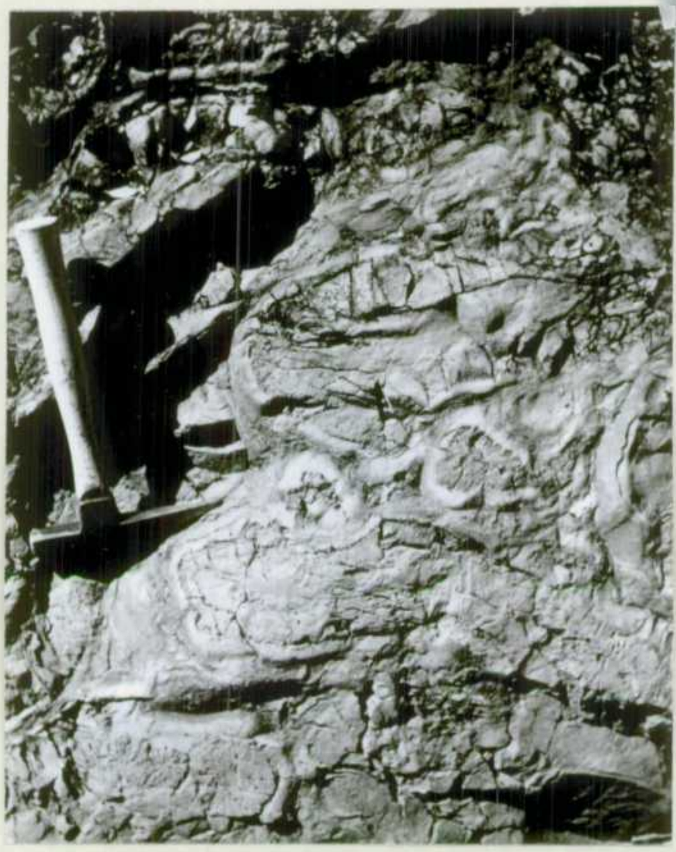
The unit crops out in three areas: a 20 mile long belt along Rookwood Creek; along the eastern edge of the Boomer Range from 2 miles north of Tynan Homestead to the north of the Duaringa Sheet area, and in a narrow strip in the Fitzroy River area, west of Hillview and Craigilee Homesteads and continuing south-east to the eastern boundary of the Duaringa Sheet area. The unit consists of resistant volcanic rocks which generally crop out well. They form low hills along Rookwood Creek and in the Fitzroy River area and prominent peaks along the eastern edge of the Boomer Range. The volcanics support open woodland vegetation producing a light photo pattern.

Lithology

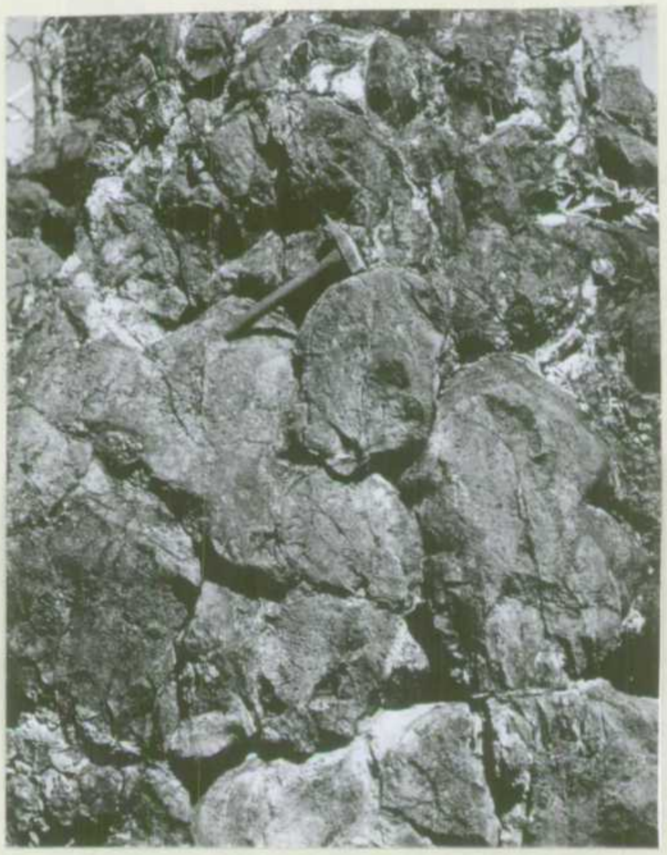
The Rookwood Volcanics consist mainly of spilitic pillow lavas, minor agglomerate, volcanic breccia, and silicified trachyte; tuffaceous sandstone and siltstone are also present. The spilitic rocks make up 95% of the unit. They are hard, fine-grained greenish-grey rocks; intersertal textures prevail with albite and oligoclase phenocrysts in a groundmass of chlorite, calcite, epidote and glass. Vesicles and amygdales of calcite and chlorite are abundant in some rocks. The pillow structure of the lavas is the characteristic feature of the unit. Very good examples of pillows can be seen in outcrops ¼ mile south and one mile south-west of Ohio Homestead, and in two localities in the Fitzroy River,

Photo Plate 2:

PILLOW LAVAS IN THE ROOKWOOD VOLCANICS.



Three miles
north-north-west
of Rookwood
Homestead.
(Neg.No.g/5348).



One mile north-west
of Ohio Homestead.
(Neg.No.g/5350).

four miles north-east of Tynan Homestead (one mile north of the road crossing), and south-west of Hillview Homestead. The pillows vary greatly in size and shape. They are from six inches to about three feet in diameter, the smaller ones being round, the larger ones ovoid (see photo plate. 2). The pillows have a thin outer skin and radial cracks; some have a thin vesicular layer beneath the skin. The little interpillow material present consists of green, dense fine-grained partly silicified limestone or marl. The agglomerates are extremely poorly sorted, and consist of large fragments of spilite and tuff in a tuffaceous matrix. The best exposures are in the Fitzroy River south-west of Hillview Homestead.

Structure and relationships

The Rookwood Volcanics is essentially a massive unit; bedding trends cannot be discerned on the air photos and dips could not be measured in the field. The relationships with the over- and underlying formations are not clear because exposed contacts are very rare. The base of the formation is only exposed in the Fitzroy River area where the volcanics crop out in the western limb of an anticline which exposes Silurian/Devonian, Carboniferous and Permian rocks. At the south-east end of the west limb, east of the Fitzroy River, the volcanics conformably overlie the Lower Permian Dinner Creek Beds. Along strike to the north, the Volcanics appear to overlap or to be lateral equivalents of the Dinner Creek Beds and directly overlie Carboniferous rocks. The contact is faulted in part. Overlying the Rookwood Volcanics are tightly folded thin sandstones and shales of the Middle Bowen Beds. The contact is well exposed in the Fitzroy River four miles north-east of Tynan Homestead; there, massive pillow lavas are conformably overlain by thin-bedded lithic sandstone, a bed of hematite, and tuffaceous and agglomeratic sediments. The contact is partly overturned. North of Rookwood Homestead and in the Boomer Range, north-north-west of Tynan Homestead, the contact is partly faulted.

At Rookwood Homestead, the volcanics are intruded by a granodiorite stock. The intrusive relationship is well exposed in the side of a hill, 1½ miles south-west of the homestead. Small gabbroic masses intrude the pillow lavas south-east of Old Craigilee Homestead, three miles north-north-west and eight miles south-south-east of Rookwood Homestead. Mineralogically they are very similar to the spilites, and could be late stage intrusions or perhaps represent the vents through which the spilites were extruded.

Thickness

The thickness of the formation can be determined only east of the Fitzroy River where 3000 feet of volcanics, mainly pillow lavas, are present. Greater thicknesses may be present in the Rookwood Creek area and north of Tynan Homestead.

Age

The stratigraphic position of the volcanics indicates a Lower Permian age. They can probably be correlated with part of the Lower Bowen Volcanics.

CARMILA BEDS

Summary

The Carmila Beds is a Permian freshwater sequence first recognised as a mappable unit on the Mackay 1:250,000 Sheet area, and traced onto the north-east of the St. Lawrence Sheet area. The unit consists of volcanics at the base, overlain by interbedded conglomerate, sandstone, and shale with some coaly seams. Plant fossils have been collected and determined as Lower Permian in age. It is thought to lie unconformably on the Lower Bowen Volcanics in places.

Nomenclature

The unit is named and described in more detail in the Geology of the Mackay Sheet area, (Jensen, Gregory and Forbes, 1963). Reid (1924) correlated rocks in Oakey Creek in the St. Lawrence Sheet area with Lower Bowen Volcanics, and Collinsville Coal Measures. These rocks are now included in the Carmila Beds.

Distribution and Topography

The unit crops out in a north-north-west trending coastal belt which has been traced as far south as St. Lawrence. To the west, it forms the inaccessible scrub and rain forest covered hills of the coast range. To the east, lower strike ridges and cuestas are developed, and the unit in places is covered by coastal alluvium.

Lithology

(a) Volcanics

Volcanics, in order of abundance, include lithic tuff, crystal tuff, flow rocks, volcanic breccia and agglomerate.

The lithic tuffs are generally bedded, coarse grained, tough, greenish brown, and acid or intermediate in composition. Some contain rounded pebbles, and were probably deposited under water.

Rhyolitic and dacitic crystall tuff are common, and trachytic crystal tuff has been noted. The acid crystal tuffs are frequently hard siliceous looking rocks with grains of felspar and clear quartz in a reddish-purple or light green fine-grained matrix.

Rhyolite and dacite are the most common flow rocks; trachyte is less common and andesite is rare. The flow rocks are commonly porphyritic, and flow banded in places. Acid volcanic breccia is not uncommon, but agglomerate is rare.

These volcanics, with occasional interbeds of sandstone and conglomerate, form the lower part of the Carmila Beds, and are overlain by a sedimentary sequence.

(b) Sediments

The upper part of the Carmila Beds is represented by a sedimentary sequence cropping out in creeks around Elalie, particularly Oakey Creek and Dry Creek.

Conglomerate is the most common rock type, and occurs near the base of the sedimentary sequence. It is generally light brown or greenish in colour, and not noticeably hardened - the pebbles tend to weather out. Matrix is commonly of poorly sorted, greenish, lithic sandstone, which varies in abundance from almost absent, to so dominant over the phenoclasts that the rock becomes a pebbly sandstone. The phenoclasts are preponderantly of acid volcanic rock, some showing perfect fluidal banding.

Sandstone occurs generally interbedded with, or overlying the conglomerate. Medium-coarse grained lithic sandstone predominates. It is generally brown or greenish in colour, poorly sorted, porous, and thickly bedded.

The best outcrop of the fine sediments and coal seams is in the southern bank of Oakey Creek, under the railway bridge. Here, approximately 300 feet of interbedded sandstone, siltstone, plant bearing shale, coaly seams, and conglomerate is exposed. The sandstone is light brown, poorly sorted, unaltered, porous, quartz-lithic sandstone. Light grey siltstone and clay shale, and dark carbonaceous shale are interbedded with coaly seams and some sandstone. The thickest of these coaly seams is about 15 feet thick, but it includes numerous shale bands, making up about 50% of the seam.

No definite intrusives into the Carmila Beds were seen, and the sediments are not noticeably hardened. Epidotisation is absent, and the only quartz veins seen cut acid tuffs at an outcrop four miles south of Clairview Bluff.

Age and Fossil Content

A collection of plant fossils, and a sample for palynological determination have been submitted from locality SL410, Oakey Creek. These fossils, together with others collected from the Carmila Beds on the Mackay Sheet, indicate a definite Permian, and probable Lower Permian age for the unit.

Structure and Relationship with other Units

The unit has a consistent regional dip of about 20° to the east and north-east; the rocks exposed on the St. Lawrence Sheet area represent the western limb of the gentle syncline mapped on the Mackay Sheet area. Structure in the vicinity of St. Lawrence is more complex, and will not be clear until more detailed mapping is carried out. At the mouth of St. Lawrence Creek acid tuff and crystal tuff of the Carmila Beds are exposed to the north, while immediately across the estuary, David's map records "glistening sandstone" and "fine conglomerate with Martinia subradiata", which are thought to be Middle Bowen Beds. Gough (1961b) was unable to correlate exposures to the south of latitude 22°20' with others he examined to the north of this latitude, and proposed a fault, which he called the St. Lawrence Fault, as a possible explanation. The present work has neither removed the problem, nor disclosed another simple explanation. The proposed fault trends W.S.W. from just south of South Red Bluff to Beaconsfield, and is upthrown on its north side. This line marks the northern limit of occurrence of known Middle Bowen Beds to the east of Connors Range, and also the northern limit of the Cretaceous sediments.

The Carmila Beds were thought to lie unconformably upon the Lower Bowen Volcanics on the Mackay Sheet; nothing seen in the St. Lawrence Sheet conflicts with this (Jensen et al 1963). However, while the Carmila Beds still forms a distinct regional unit with uniform trends and rare intrusives, the preponderance of volcanic rocks of all compositions to the north and west of St. Lawrence, makes it difficult to decide to which of the three units some outcrops belong (Lower Bowen Volcanics, Carmila Beds or Tertiary Volcanics).

Tertiary volcanics were separated chiefly on the basis of youthful topographic expression. Regular gentle north-east dips, scarcity of andesitic volcanics and of intrusives, and predominance of generally light coloured tuff and crystal tuff, distinguish the volcanics of the Carmila Beds from the Lower Bowen Volcanics. Three outcrops in the Clairview Creek Basin, four miles south-west of Kalarka, exposed what is thought to be the Lower Bowen Volcanics basement under the Carmila Beds. These outcrops expose disturbed purplish and greenish bedded andesitic tuff, agglomerate, and greenish siltstone, cut by quartz and epidote veins, and andesitic intrusives. Attitude is not clear, but one outcrop appears to dip north-west at 15°. (Regional dip of Carmila Beds is uniformly to the east or north-east).

It is thought that the Carmila Beds were deposited in a large fresh water basin formed to the east of the present position of the Connors Range, and separated from the Bowen Basin by a high formed of uplifted Lower Bowen Volcanics and Urannah Complex intrusives. The extrusion of the volcanics at the base of the Carmila Beds probably represents the later phases of igneous activity in the Urannah Complex.

The Carmila Beds are apparently overlain by the Middle Bowen Beds, but the relationship is not clear. The sediments at the top of the Carmila Beds, as exposed in Oakey Creek, do not appear to underlie the Middle Bowen Beds west of St. Lawrence. Possibly the Oakey Creek sediments are partly equivalent to the Middle Bowen Beds.

Thickness

No sections have been measured in the unit. Reid (1924) estimated that approximately 2,000 feet of sediments overlying at least 3,000 feet of volcanics are exposed in Oakey Creek. A thickness of 7,000 feet was estimated for the unit on the Mackay Sheet, in the Basin Creek area.

MIDDLE BOWEN BEDS

Summary

The Middle Bowen Beds are a fossiliferous, marine unit, of Lower Permian to basal Upper Permian age, recognised throughout the Bowen Basin. Four areas of outcrop of the Middle Bowen Beds, distinguished on structural or lithological characteristics, are recognised within the Duaringa-St. Lawrence area. These areas are the Western Region, the Folded Zone, the Connors River area, and the Eastern Region. They are described separately.

Units within the Middle Bowen Beds were introduced in the "Subdivision and Correlation of the Middle Bowen Beds", by Dickins, Malone and Jensen, 1962. These units and the faunas associated with them are referred to in this report.

Unit C, the uppermost unit of the Middle Bowen Beds, crops out in the Western Region, which is a zone of relatively shallow folding, of sinuous fold axes and of low dips. About 500 feet of section is exposed in this area, consisting mainly of quartz sandstone and blue-grey micaceous siltstone. Fossils are not numerous, are confined to a few stratigraphically close horizons, and belong to Fauna IV.

Units B and C crop out in the cores of anticlines in the Folded Zone, a 20-mile wide belt extending north-west across the area. Up to 4,000 feet of mainly lithic quartz sandstone, siltstone and nodular siltstone are exposed in the most deeply dissected structure. Fossils belonging to Faunas III and IV were collected at several localities. Only Unit C is exposed around the Bundarra Granodiorite at the northern end of the Folded Zone.

The base of the Middle Bowen Beds is not exposed and the top is conformably overlain by the Upper Bowen Coal Measures in the Western Region and the Folded Zone.

The Connors River Area contains Middle Bowen Beds cropping out adjacent to and west of the Connors Range in the northern part of the St. Lawrence Sheet area. These beds dip south-west into the Bowen Basin and form the eastern flank of the Bowen Syncline. They are poorly exposed siltstone, shale, fossiliferous limestone, and calcareous sandstone. The fossils belong to Fauna II indicating the presence of Unit A. The unit overlies the Lower Bowen Volcanics and is overlain to the west by Cainozoic sediments.

The Middle Bowen Beds of the Eastern Region differ markedly in lithology from the unit in other parts of the northern Bowen Basin. In this area, quartz sandstone is rare, lithic quartz sandstone is the dominant arenite; greywacke is present but minor; lutites, mainly siltstone, constitutes the bulk of the unit. A particularly distinctive rock type is blue-grey to buff siltstone containing clay pellets. The sediments are moderately to complexly folded, and in some places are overfolded. Most show some signs of low grade regional and dynamic metamorphism.

The Middle Bowen Beds overlie both the Lower Bowen Volcanics and the Rookwood Volcanics with apparent conformity. Their relationship to the Undifferentiated Palaeozoic Beds in the Gogango Range is not known. They appear to be unconformably overlain by possibly Mesozoic volcanics in the Thuriba Homestead area.

Fossils are rare in the Eastern Region. Most belong to Fauna II; some may be equivalent to Fauna III or high Fauna II. The unit is probably very thick though the structural complexity of the area makes it difficult to estimate thickness.

<u>Nomenclature</u>

The name Middle Bowen was first applied by Jack (~~1895~~ 1892) to the marine sediments of the Collinsville - Bowen River area. Subsequent workers, particularly Reid, have used and extended the application of this name. More recently, in "The Geology of Queensland", (Hill and Denmead, 1960, Fig. 27), the name was applied to the Lower Permian to basal Upper Permian marine sediments of the entire Bowen Basin.

The informal name, Middle Bowen Beds is used in this report. This name is well established in the literature and we will continue to use it pending reorganisation of the Bowen Basin nomenclature, at the conclusion of the present programme of systematic mapping in the basin.

Derrington and Morgan (1959a) named the Crocker and Maria Formations in the Middle Bowen Beds of the Duaringa Sheet area. We were not able to recognise these formations throughout the area. However, fossiliferous horizons in the Crocker Formation are time equivalents of fossiliferous horizons in the Folded Zone and in the Clermont and Bowen Sheet areas.

The Middle Bowen Beds will be described in four parts, each dealing with a broad area of outcrop of the unit distinguished from the other areas by lithological and structural characteristics.

The first area is the Western Region. This includes the areas of outcrop of the Middle Bowen Beds in the Duaringa Sheet area west of Blackwater and in the south-west corner of the St. Lawrence Sheet area.

The second area is the Folded Zone, a 20 mile wide belt trending north-north-west across the middle of the area.

The third area is the Connors River Area, a thin belt of Middle Bowen Beds cropping out adjacent to and west of the Connors Range in the St. Lawrence Sheet area.

The fourth area, the Eastern Region, is the largest. It includes the area of outcrop of the Middle Bowen Beds in the eastern half of the Duaringa-St. Lawrence area.

WESTERN REGION

Distribution and topography

Middle Bowen Beds crop out in a large, elongate, and oval area east of Comet and in two smaller areas to the north surrounded by Upper Bowen Coal Measures. It also crops out on the west flank of the Bowen Basin in the south-west of the St. Lawrence Sheet area.

Along and to the south of the Central Railway, the unit crops out on the flanks of mesas capped by Tertiary sediments and in low broken country below the level of the mesas. The country is rough and thickly timbered. North of the Central Railway, the unit forms gently undulating country; mesas are less common and relief is generally less. The unit is poorly exposed in the south-west of the St. Lawrence Sheet area. It crops out in creeks and as long low ridges and cuestas.

Lithology

The Middle Bowen Beds in the Western Region consist of a monotonous sequence of quartz sandstone and siltstone, and some calcareous sandstone, shale and rare coal. The sandstone is white to dark brown, semi-friable to medium hard, fine to medium-grained and well sorted. It is commonly thin to medium-bedded, and is cross-bedded and flaggy in places. In one outcrop, fine grained, micaceous, flaggy sandstone grades laterally into thick bedded, medium grained, pebbly sandstone. Worm tracks and tubes are common in the flaggy sandstone.

The sandstone is dominantly quartzose but some specimens include a proportion of lithic material, kaolin and mica. Pebbly beds are common near the base and scattered through the sandstone units. Fossiliferous, calcareous sandstone, commonly leached and ferruginized in outcrop, are widespread but represent only a small proportion of the unit.

Siltstone is poorly exposed in the unit in the Duaringa Sheet area. It is generally grey-blue to pinkish-grey and brown, jointed, micaceous coarse siltstone, sandy in places. It is commonly thinly interbedded with sandstone and grades into silty sandstone in places.

Siltstone is more important in the south-west of the St. Lawrence Sheet area. There, it includes micaceous grey-blue sandy siltstone and dark carbonaceous siltstone. The grey-blue siltstone contains numerous dark carbonaceous shale pellets, streaks and rocks. Some of these appear to be infillings of worm tubes. The siltstone is calcareous in places, and contains some crinoid stems and plates. It is interbedded with silty micaceous lithic quartz sandstone; both siltstone and sandstone are poorly sorted.

A 4 feet thick seam of coal, overlain by quartz sandstone crops out in Redrock Creek, 10 miles west of Cooroorah Homestead.

Structure and Relationships

The Middle Bowen Beds in the Western Region are gently folded into broad anticlines and synclines. Dips are generally about 5° but dips up to 35° were measured in places. The axes of the folds are sinuous, trending north-west to north-east. Gentle rolling of the beds was noted in several places. Amplitude of the folding is low. The Middle Bowen Beds crop out over an area of 170 square miles east of Comet, but only about 1500 feet of section is exposed.

The base of the Middle Bowen Beds is not exposed in this area. The unit is conformably overlain by the Upper Bowen Coal Measures with a transitional contact, and unconformably overlain by Tertiary sediments.

Palaeontology and age

Four fossil collections were made in the Western Region. Two of these Du 519 and Du 1214, belong to Fauna IV, the other two are indeterminate. The Fauna IV collections come from calcareous sandstone beds at approximately the same stratigraphic horizon, within a few hundred feet of the top of the Middle Bowen Beds. Fossils collected by Derrington and Morgan (1959a) in their Crocker Formation probably came from this horizon; collection Du 1214 was made at one of their localities. On palaeontological evidence, this horizon can be equated with fossiliferous horizons in the Folded Zone and with the Streptorhyncus pelicanensis bed of the Collinsville area, Bowen 1:250,000 Sheet. The thickness of Middle Bowen Beds above this fossiliferous horizon varies considerably from the Duaringa Sheet area to the Bowen Sheet area. The reason for this is not yet known.

The fossils indicate that the Middle Bowen Beds of the Western Region are Kungurian or Kazanian (uppermost Lower Permian or basal Upper Permian) (Dickins, App. 1).

One bore hole A.F.O. Cooroorah No. 1 drilled in 1960 is located in the Western Region. It spudded high in the Middle Bowen Beds and penetrated the unit to 3010 feet. The sequence in the bore is correlated with the subdivision of outcropping Middle Bowen Beds in Dickins, Malone and Jensen, (1962). The 1962 survey confirms this correlation, although the upper part of the sequence encountered in the bore may be part of the transition from Upper Bowen Coal Measures to Middle Bowen Beds and may include some freshwater beds.

FOLDED ZONE

Distribution and topography

The Folded Zone is a linear belt extending from the southern margin of the Duaringa Sheet area west of the Dawson Range to the north-west corner of the St. Lawrence Sheet area. The zone is about 20 miles wide and is partly concealed by lateritised Tertiary sediments and Cainozoic cover.

The Middle Bowen Beds are only exposed north of the Mackenzie River within the Folded Zone. They crop out in the cores of isolated anticlines surrounded by Upper Bowen Coal Measures and in the dome about the Bundarra Granodiorite.

The unit generally produces gently undulating country with light to dense tree cover, similar to the topography formed on the Upper Bowen Coal Measures. The Middle Bowen Beds in the metamorphic aureole about the margin of the Bundarra Granodiorite produce a line of high rugged hills.

Photo Plate 3:

Closely jointed siltstone containing hard, round nodules. Most of nodules are in place.

Middle Bowen Beds.

North bank of Mackenzie River, 1½ miles south-west of Bundaleer Homestead.

(Neg.No.G/5253).

The trends of the Middle Bowen Beds and the overlying Upper Bowen Coal Measures are clearly revealed on the air-photos in the areas where the Cainozoic cover has been removed. In these areas exposures of Middle Bowen Beds are usually found, only in water courses. The Middle Bowen Beds and the Upper Bowen Coal Measures are not readily distinguishable on the air-photos. However, once the boundary has been established on the ground, it can usually be traced for some distance using the bedding trends visible on the air-photo.

Lithology

The upper part of the Middle Bowen Beds consisting of an interbedded sequence of sandstone, siltstone and shale is exposed in the folded zone. The boundary with the Upper Bowen Coal Measures is transitional; similar lithologies occur above and below the contact. The most obvious lithological change is the increase in the quartz content of the arenites, passing down into the Middle Bowen Beds. The sandstone is a light to dark grey or greenish, medium hard, commonly very cross-bedded, thin to thick-bedded rock. The specimens examined were well sorted, fine grained lithic quartz sandstone containing more than 60% quartz, and unsorted lithic grains, mainly vitric tuff and a few feldspar grains. The micaceous-argillaceous matrix forms less than 10% and siderite or calcite aggregates constitute up to 10% of the rock. Grit size angular grains and small pebbles of quartz are common.

Carbonaceous pyritic balls occur in a few beds; some beds contain a high percentage of feldspar, mica and carbonaceous matter. Worm tubes, normal to bedding and filled with black carbonaceous mud are common in the sandstone. Poorly sorted, calcareous sandstone is common and is sparsely to richly fossiliferous. Sandy and silty limestone occur as thin beds and lenses in the formation. Soft, dark blue-grey shale and carbonaceous shale are interbedded with the sandstone in places; they commonly contain silty intercalations and much carbonised material, including poorly preserved plant fossil impressions.

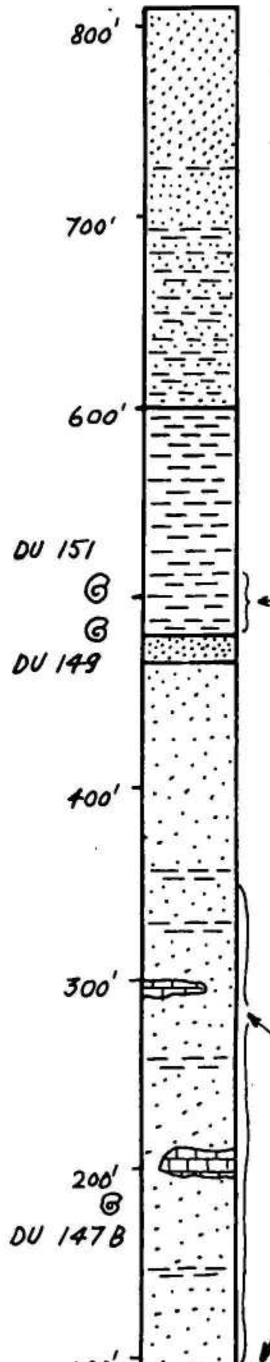
Siltstone is an important lithology in the Middle Bowen Beds in this area but is commonly poorly exposed. It is grey, grey blue or dark, commonly very jointed to splintery, micaceous in part and may be thinly to thickly interbedded with sandstone or occur as very thick poorly bedded units. In places, the siltstone contains hard, well rounded, dark blue mud balls, nodules or concretions, spherical or ovoid in shape, commonly formed about a fossil or fragment of calcareous material. (see photo plate 3).

TEXT FIGURE 3.

Composite, approximate lithological section.

Middle Bowen Beds.

North bank of Mackenzie River, 1½ miles south-west of Bundaleer Hs.



Thin to thick bedded, cross bedded medium hard grey to grey-brown fine to medium grained, rarely coarse grained and pebbly, quartz sandstone and lithic quartz sandstone. Near the base, mainly interbedded grey siltstone, sandy siltstone and fine sandstone.

Siltstone, grey, grey-blue and blue, poorly bedded, jointed, medium hard. Contains hard round nodules and concretions, some of which contain fossils. Contains 'glendonites' in places.

Approximate position of localities DU 269 and DU 764.

Medium to thick bedded, grey-white, medium grained quartz sandstone

Thin to thick bedded, fine to medium, rarely coarse grained quartz sandstone and lithic quartz sandstone, feldspathic in places. Grey to grey-green, semi-friable to medium hard. Much crossbedding. Fossiliferous in places. Worm tubes and tracks common.
Some thin interbeds of dark grey-blue and grey siltstone. Some lenses of unfossiliferous pink-brown limestone, possibly slump lenses.

Approximate position of localities DU 149A and DU 151A.

Petrological specimen DU 150B. Feldspatho-lithic quartz sandstone. Well sorted, fine-grained. Quartz grains >60%. Other grains are vitric tuff and plagioclase. Matrix 10% is micaceous argillaceous. Calcite and siderite aggregates 10% of rock.

White, fine-grained, semi-friable argillaceous quartz sandstone, mainly thin to medium bedded.
Thin to medium interbedded dark grey-blue siltstone, micaceous siltstone and fine-grained, grey lithic quartz sandstone with abundant worm tracks and tubes.

Bureau of Mineral Resources, Geology and Geophysics, May 1963. | To accompany Record 1963/60 | F55/16/1

Pinkish brown limestone, unfossiliferous and possibly inorganic in origin, crops out in the sequence in a few places as thick, blunt ended lenses, about 6 feet thick by 50 feet long. The bedding of the underlying and to a less extent the overlying sediments is deformed, but usually not disrupted to accommodate the limestone. These may be slump masses which have differentially compacted the underlying sediments.

The lithologies of the Middle Bowen Beds exposed in the centre of the anticline west of Bundaleer are illustrated in Text Figure 3. This is a composite and approximate section of the lowest beds exposed.

The Middle Bowen Beds about the Bundarra Granodiorite consist of quartz sandstone and lithic quartz sandstone, indurated and silicified in places, and siltstone, coarse, sandy and micaceous in places, and dark, purplish blue and white. Calcareous fossiliferous siltstone is present in places. Contact metamorphosed rocks near the intrusion include andalusite hornfels and graphitic schist.

Structure and Relationship

The Middle Bowen Beds are conformably overlain by the Upper Bowen Coal Measures; the base of the Middle Bowen Beds and the underlying rocks are not exposed in the Folded Zone.

The unit is exposed in the cores of domes and anticlines of large amplitude, north of the Mackenzie River. The largest of these is an anticline west of Bundaleer Homestead. Middle Bowen Beds are exposed in this structure for 8 miles north from the Mackenzie River. This structure has a deeply crenulate crest and numerous minor folds on the flanks. The structure plunges to the north-west and south-east but the noses are concealed. The amplitude is greater than 4,000 feet which is the thickness of Middle Bowen Beds exposed in the structure. Flank dips range from 45° to 80°.

Considerably less of the Middle Bowen Beds is exposed in the other structures in the Folded Zone. It crops out in two small elongate domes, about two miles long by one mile wide, connected by a gentle saddle near Barwon Park Homestead. Flank dips on these structures range from 2° to 12°. The gentleness of this structure reflects a progressive decrease in tightness of folding from east to west across the Folded Zone. Further north, the Middle Bowen Beds crops out mainly in elongate anticlines some of which are interconnected. The amplitude of these structures varies; the greatest thickness of Middle Bowen Beds is exposed in the structure east of Warwick Homestead. Flank dips on these range from 10° to 70°.

The Middle Bowen Beds around the Bundarra Granodiorite are steeply dipping and sheared and schistose close to the contact. The dips decrease rapidly away from the intrusion.

Environment of Deposition

The unit is marine. It was probably deposited in shallow to moderately deep water. Some of the fossils collected are common in muddy environments, below the depth of wave action, and probably part of the unit was deposited in this environment.

The abundance of cross-bedding in the sandstone indicates the presence of considerable current action, probably in relatively shallow water. The transition to the overlying Upper Bowen Coal Measures may be associated with a gradual restriction of access of the sea to the Basin.

Thickness

A maximum thickness of 4,000 feet of Middle Bowen Beds is exposed in the Bundaleer Homestead structure. This thickness was computed from air-photos using measured dip and strike information.

Palaeontology and Age

Eight fossil collections were made near the Mackenzie River south-west of Bundaleer Homestead. The relative positions of these collections are shown on the lithological column, Text Figure 3. Four collections were made from a dominantly siltstone unit and four collections from an underlying sandstone unit. The upper four collections appear to belong to Fauna IIIB and this suggests correlation of the siltstone unit with unit B2 in the Collinsville area. The siltstone unit may also be correlated with the Ingelara Shale of the Springsure area. Collection Du147b from the underlying sandstone unit contains one species known elsewhere from fauna IIIb; the sandstone is possibly equivalent to unit B2; it may be older in part. No fossils belonging to Fauna IV were found in the Bundaleer Homestead area. Unit C is apparently present but is not well exposed.

A further eight collections were made in other parts of the Folded Zone. All of these are probably Fauna IV associated with Unit C. Several collections came from a calcareous sandstone horizon which on fauna and lithology is probably equivalent to the Streptorhyncus pelicanensis bed of unit C of the Middle Bowen Beds in the Collinsville area. Most of the fossils found in the Western Region came from an equivalent horizon. Collections come from a horizon which may be equivalent to the Big Strophalosia Horizon. The fossil collections are determined and the palaeontology and correlations are discussed in Appendix I. The fossils collected indicate that the beds are Artinskian to Kazanian (Lower Permian to basal Upper Permian).

CONNORS RIVER AREA

The Connors River area includes a line of discontinuous outcrop of Middle Bowen Beds, west of the Connors Range, striking west of north and dipping gently to the west. The unit generally forms flat country; some rounded hills with long gentle slopes are present in places. In a few areas, such as near Yatton Creek, the unit forms small strike ridges. Outcrop is poor, and most of the area is covered by Brigalow scrub.

The unit overlies the Lower Bowen Volcanics; its upper boundary, presumably with the Upper Bowen Beds, is obscured by Cainozoic cover. Only the basal fifteen hundred feet of section are exposed and only siltstone and limestone are present.

Lithology

The base of the unit is well exposed seven miles north-north-east of Yatton Homestead, near the Bruce Highway, where a brown fossiliferous limestone, the Yatton Limestone (Laing In Hill and Denmead 1960, pp. 202-204, 208.) overlies massive andesitic tuff, of the Lower Bowen Volcanics. Further north, in Sheepskin Creek, at least 400 feet of blue micaceous siltstone, with abundant small rounded pebbles, crops out at the base of the Middle Bowen Beds. This sequence lies on black tuff interbedded with andesite. On Main Range Creek, further to the north again, the base of the unit is marked by fossiliferous blue calcarenite with well preserved marine fossils. Above the calcarenite is 1400 feet of dark blue, thin to medium bedded, micaceous siltstone, which is closely jointed in places. It contains 10% of rounded pebbles of quartz volcanic rocks and coarse siltstone; maximum diameter of the pebbles is 3" and the average ½". Calcareous concretions up to six inches in diameter were observed in some localities.

Bedding trends, well displayed on the aerial photos, and field measurements, indicate that the regional dip is about 15° to the west. Locally the dip increases and small folds and faults interrupt the regional pattern. A small anticline near Cardowan plunges to the north-east and the eastern limb has been faulted off. The Yatton limestone is folded into a south plunging syncline, and a fault displaces the eastern limb by half a mile.

Fossils and lithology indicate that the Middle Bowen Beds in the Connors River Area belong to unit A. Four fossil collections were made and all belong to Fauna II. The collections are determined and discussed in Appendix 1. They indicate a Lower Permian age for these sediments.

EASTERN REGION

Most of the Middle Bowen Beds in the Eastern Region are identified on lithology alone. Fossils are abundant in a few localities but are not widely distributed. However, they are associated with reasonably distinctive lithologies which are present throughout the beds included in the unit. South of the Fitzroy River, part of the unit is mapped as ? Middle Bowen Beds. These beds are somewhat unlike the fossiliferous Middle Bowen Beds cropping out near Thuriba Homestead. They are similar to the Middle Bowen Beds north of the Fitzroy River, however, and are tentatively included in the unit.

Distribution and Topography

The Middle Bowen Beds of the Eastern Region crop out in the belt of ranges extending north-north-west from the south-east corner of the

Duaringa Sheet area. The western boundary against Cainozoic sediments, is a relatively straight line marked by the Dawson and Mackenzie Rivers. This boundary probably reflects structural control.

The northern boundary is, in part, the contact with the underlying, anticlinally folded Lower Bowen Volcanics. This contact extends from Tartarus Homestead on the west flank of the structure to near St. Lawrence township on the east flank. Further east Middle Bowen Beds crop out in a generally synclinal area between blocks of Lower Bowen Volcanics. They are bounded to the north by overlying Styx Coal Measures. The eastern boundary of the Middle Bowen Beds of the Eastern Region is partly against Cainozoic sediments and partly against underlying Rookwood Volcanics.

Within the area, the Middle Bowen Beds crop out around complex anticlines and fault blocks of the Lower Bowen and Rookwood Volcanics, and blocks of Undifferentiated Palaeozoic Beds.

The Middle Bowen Beds of the Eastern Region produce a deeply dissected, rugged low topography with a dendritic drainage. They are highest adjacent to the blocks of volcanics within the ranges; from there they grade down to the level of the alluvial plains adjacent to the ranges. Many small intermontane valleys have developed on the Middle Bowen Beds within the ranges.

The unit forms mainly soil covered plains in the Apis Creek to Strathmuir area; it forms low to moderately high hills west of Stoodleigh Homestead.

The Middle Bowen Beds in the ranges produce a thin, rubbly soil cover, generally supporting a dense scrub growth. In the lower country, the unit has a deep, soil cover and is commonly cleared for cultivation or pasture improvement. The best, and in some places the only, exposures are found in creek sections.

Lithology

The Middle Bowen Beds of the Eastern Region are dominantly a lutite sequence, generally well-bedded, with many thin to very thick interbeds of arenites. Conglomerate is present but not abundant. Fossiliferous limestone and calcareous sediments crop out in several places, particularly near the base of the sequence. Bedded volcanics are present in the unit.

Lutites

The most distinctive rock type in the unit, and one of the most abundant, is a tough dark grey, grey green or buff siltstone containing very many patches of dark grey carbonaceous shale. These were seen to be interlacing, flattened tubes on some bedding surfaces, suggesting that they may be infillings of worm tubes. Elsewhere, they were discrete, tubular or flattened pellets some of which have a rounded shape, and others thin out to wisps of shale interfingering with the siltstone matrix. In thin section, most pellets are seen to contain thin carbonaceous laminae which are straight and parallel and stop at the edges of the pellets. These are probably clasts of carbonaceous shale incorporated in the siltstone. Some are somewhat rounded to produce the tubular shapes. They are $\frac{1}{8}$" to $\frac{1}{4}$" in diameter of cross-section and are about 1" long. Most are aligned parallel to the bedding. The host rock for these clay pellets is generally a siltstone but in some places it grades from coarse siltstone to fine sandstone.

This clay pellet siltstone generally produces a more prominent outcrop than the siltstone and fine sandstones with which it is thinly to thickly interbedded.

Medium to thick units of indurated, poorly bedded, dark-grey to blue siltstone are common in the Middle Bowen Beds. These are closely jointed to splintery, the jointing being at any angle to the bedding up to 90°. The jointing commonly stops at the contact with a bed of clay pellet siltstone.

Colour banding is common in the siltstone in some places, particularly where it is thinly interbedded with fine lithic quartz sandstone. The colours, buff, yellow and pinkish blue are usually produced by weathering from the original grey to grey-blue colour. This colour banding parallels bedding in most cases.

Pods and lenses of limestone, possibly organic in part, are contained in the siltstone in the Balcomba Homestead area **** A distinctive unit in the Thuriba Homestead area is an interbedded sequence of fine to very fine, grey sandstone and dark grey or greenish grey, splintery siltstone. Beds are usually about $\frac{1}{2}$ inch to 2 inches thick. Some graded bedding was seen in the grey sandstone. This sequence is very tightly and complexly folded, the structures being well shown by the regular bedding. Similar thin and regularly bedded sequences crop out in a few other localities in the Middle Bowen Beds.

The Middle Bowen Beds of much of the Eastern Region have undergone low grade regional dynamic metamorphism. The effects of this area are most clearly shown by the finer sediments. The siltstone may best be described as sheared siltstone though in some places they are metamorphosed to phyllite. Slaty cleavage is commonly developed in the shale, though no slate was observed. The argillaceous matrix of many specimens has been partly recrystallized with the development of parallel mica flakes and stringers. Quartz veinlets parallel the shearing in some specimens.

Several thin sections of lutites were examined. These revealed the composition of the silt and sand grains in these rocks and the extent of metamorphism. The clastics are similar to those found in the arenites; they consist of quartz, vitric tuff, glass shards, and feldspar, with

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**** Near Stoodleigh Homestead, hard, dense, dark blue calcareous siltstone nodules or concretions are contained in purplish blue coarse siltstone. Some of these nodules contain fossils.

quartz predominant. The lithic fragments and feldspar grains were calcitised in one specimen of calcareous foraminiferal siltstone.

Arenite

Sandstone and greywacke or sub-greywacke constitute less than half of the Middle Bowen Beds. They are generally thinly to thickly interbedded with the lutites but in a few places crop out as massive persistent units producing prominent bedding trends on the air-photos. They are blue, grey, white or brown, hard, tough rocks showing no shearing or close jointing.

Twenty-two thin sections of arenite specimens from various parts of the area were examined and all were extremely similar. Eighteen of them were lithic quartz sandstone; the others were similar in composition but contained too much matrix to be classified as sandstone.

The sandstones were mainly fine to medium-grained, well sorted rocks. Some medium to coarse specimens showed only moderate sorting. Quartz grains and lithic fragments were equally abundant in most cases; rock fragments were dominant in the coarser specimens, quartz in the fine.

The lithic grains were sub-rounded to rounded. They consisted of fine microgranular material, possibly vitric tuff, silicified tuff or chert, quartzite, mica phyllite and argillite, the last three being important in only a few specimens. The quartz grains were angular to subangular or tabular with ragged outlines and were generally strained. Some quartz grains contain apatite or rutile needles.

Feldspars constitute a few percent, always less than 10%, of every specimen. They consist of broken laths of plagioclase, usually andesine, some potash feldspar and some grains of graphic intergrowths of quartz and feldspar.

The matrix is argillaceous or finely micaceous, including green hydromica in some specimens. It generally constitutes 5% to 10% of the rock but in some specimens is little more than a thin film coating the grains. Opaque carbonaceous shreds are common in many specimens.

Secondary calcite occurs as a cement and as a replacement of feldspar in some specimens. In one specimen, the calcite forms almost 40% of the rocks.

Accessory minerals include grains of zircon, usually altered, tourmaline and apatite. Similar accessories were noted in one specimen from the Undifferentiated Palaeozoic Beds. Heavy mineral studies might indicate the source of these sediments and possibly indicate the relationship of the Middle Bowen Beds and the Undifferentiated Palaeozoic Beds.

The matrix of the sandstone specimens generally showed some effects of dynamic metamorphism, such as oriented mica stringers and flakes. In one specimen, the lithic grains had been elongated and micas had developed in the matrix parallel to the elongation.

The other arenites examined contained 20% to 25% of matrix. The clastic component consisted of roughly equal amounts of lithic fragments and quartz grains and less than 5% of feldspar grains. The lithic fragments were mainly fine grained volcanics, as in the sandstone specimens, but in one specimen quartzite was the dominant lithic material. Carbonaceous matter, mica flakes, tourmaline and zircon were the accessories. The matrix of some of these had been partly recrystallized to form sub-parallel mica stringers. In most specimens it was difficult to distinguish the lithic grains from the matrix.

Conglomerate crops out in only a few localities in the Middle Bowen Beds of the Eastern Region, though pebbly and conglomeratic sandstone are more common. The main exposures of conglomerate were mapped near the western boundary of the Region.

Conglomerate crops out in the Mackenzie River near the Balcomba Homestead crossing and in the Fitzroy River below the junction of the Mackenzie and Dawson Rivers. These rocks consist of close packed pebbles and cobbles of indurated, buff sandstone in a sandy, argillaceous matrix. They overlie thinly interbedded lithic quartz sandstone and clay-pellet siltstone.

Conglomerate of a different type crops out near Edungalba. It consists of well rounded, flattened hard lithic fragments, mainly of small to medium pebble size, scattered in a sheared silty matrix. The pebbles are aligned parallel to the shearing. Somewhat similar conglomerate crops out east of Rio Homestead.

The source of these conglomerates is not known. Neither do we know the significance of conglomerate occurring near the western margin of the Eastern Region, a straight boundary which may be an important, structurally controlled lineament.

Calcareous siltstone and sandstone are relatively rare in the Middle Bowen Beds in this area. These rock types are commonly fossiliferous and many of their outcrops are marked on the map as fossil collection localities. They crop out in the Thuriba area in Leura Creek and in the Strathmuir area. Unfossiliferous limestone lenses and pods are enclosed in sheared siltstone in Balcomba Creek, and calcareous pods or concretions are found in siltstone in many areas. Fossiliferous limestone, calcareous tuff and tuffaceous calcarenite are common at the base of the Middle Bowen Beds overlying Lower Bowen Volcanics. Richly fossiliferous limestone is well developed at this stratigraphic level near Yatton Homestead.

Bedded volcanics and tuffaceous sediments are included in the Middle Bowen Beds at a few places near the contact with the Lower Bowen Volcanics. These include lithic crystal tuff, vitric tuff and tuffaceous sandstone. They are similar to some of the arenites in the Middle Bowen Beds but generally contain no quartz grains and a greater proportion of matrix. These bedded volcanics are usually minor components in a dominantly sedimentary sequence. However, north of Tartarus Homestead, they constitute most of the basal few hundred feet of Middle Bowen Beds. On the St. Lawrence 1:250,000 Sheet the boundary between the Middle Bowen Beds and the Lower Bowen Volcanics should have been located higher to include these volcanics in the lower unit.

Structure and Relationship

The type of folding in the various areas in the Eastern Region are discussed in the section on Structural Geology. In brief, it consists of moderate folding with dips less than 30° in the Tartarus area and near the Lower Bowen Volcanics, east of Strathmuir. In the Leura area the folding is tighter with cross folding producing a dome and basin pattern; no overfolding is present. Elsewhere, the beds are tightly and complexly folded and overturned, and are sheared, jointed and faulted.

The Middle Bowen Beds conformably overlie the Lower Bowen Volcanics. In many places, this boundary is clearly marked by marine, commonly fossiliferous sediments overlying massive volcanics. In other places for example the Tartarus Homestead area, the top beds of the Lower Bowen Volcanics are bedded volcanics and tuffaceous sediments which are difficult to distinguish from the Middle Bowen Beds. In such cases, the boundary is placed between dominantly volcanics below and dominantly marine sediments above.

The contact between the Middle Bowen Beds and the Rookwood Volcanics was seen at only two localities: in the Fitzroy River, 10 miles north-east of Rookwood Homestead; and west of the Boomer Range, 8 miles north of Rookwood Homestead. At both these localities, the Middle Bowen Beds were conformable on the Rookwood Volcanics. The actual contact was similar to that between Middle Bowen Beds and massive Lower Bowen Volcanics. The relationship between the Middle Bowen Beds and the three areas of outcrop of Undifferentiated Palaeozoic Beds are not clear. They are discussed in the section dealing with the Undifferentiated Palaeozoic Beds. Siltstone and sandy siltstone of the Middle Bowen Beds crop out near the ultrabasic complex west of Marlborough. The actual contact is concealed. The lack of metamorphism suggests that the Middle Bowen Beds are unconformably younger. The contact may be faulted.

Volcanics, of possibly Mesozoic age, appear to be unconformable on the Middle Bowen Beds in the south-east corner of the Duaringa 1:250,000 Sheet Area. The little bedding seen in the volcanics was nearly flat-lying; the Middle Bowen Beds are tightly folded and steep dipping. The two crop out within 20 yards of one another but were not seen in contact. The volcanics appeared to be the younger of the two.

In the Strathmuir area, the Lower Cretaceous Styx Coal Measures are unconformable on the Middle Bowen Beds. Further south, west of Redbank Homestead, small areas of mainly conglomerate, containing Lower Cretaceous plants, unconformably overlies the Middle Bowen Beds. Elsewhere, unfolded

Tertiary sediments overlie the unit in a number of places.

Environment of deposition

Marine fossils are sufficiently widespread to indicate that the Middle Bowen Beds are in the main a marine unit. The fossiliferous limestone occurring near the base of the unit suggests initial shallow water conditions. However, the apparent thickness of the unit, the abundance of lutite, the regular bedding and the lack of shallow water structures suggest that most of the unit was deposited in moderately deep water in a rapidly sinking trough.

Neither the environmental significance of the conglomerate on the western margin of the Gogango-Strathmuir area nor the source of the conglomerate fragments are known. The conglomerate is generally immature, which argues against a distant source.

Palaeontology and Age

Nineteen fossil collections were made in the Middle Bowen Beds of the Eastern Region. These collections are described in Appendix 1. Most of those from the northern part of the Region belong to Fauna II, associated with Unit A in the northern part of the Bowen Basin. The fossils collected in the Thuriba area are younger; they belong to Fauna III or are high in Fauna II. The Middle Bowen Beds of the Eastern Region are time equivalents of Units A and possibly B, but differ in lithology.

Several collections, particularly Du1022 (Leura Creek) and SL346 (St. Lawrence Area) were made near the base of the Middle Bowen Beds and are difficult to distinguish from Fauna I, associated with the top part of the underlying Lower Bowen Volcanics. The differences between Faunas I and II are minor, indicating that there is no time break of any consequence between Lower Bowen Volcanics and Middle Bowen Beds. This is contrary to the opinion expressed in the "Geology of the Mt. Coolon Sheet area" (Malone et al, 1961). Possibly, there are local disconformities.

Collections Du 745, and Du 686 were made near the base of the Middle Bowen Beds. The two localities are 8 miles apart, on opposite flanks of an anticline of Lower Bowen Volcanics near the southern edge of the St. Lawrence Sheet area Du 745 is near Apis Creek and Du 686 is north of Tartarus Homestead. Collection Du 686 is either Fauna III or Fauna II; Du 745 is doubtfully located but may be high in Fauna II. It appears to be younger than collection Du1022A. Below the fossil localities are thick sequences of bedded volcanics, mapped as Lower Bowen Volcanics and overlying massive volcanics. The Bedded volcanics are possibly time equivalents of the lower part of the Middle Bowen Beds. The top of the massive volcanics within this structure may be equivalent in time to the top of the massive volcanics cropping out in Leura Creek, 20 miles to the south-east. The Leura Creek volcanics are overlain by fossiliferous Middle Bowen Beds from which collection Du 1022A (Low Fauna II) was made. The sequence above Du 1022A is entirely marine sediments. The relatively young faunas at the base of the Middle Bowen Beds in the Apis Creek and Tartarus Homestead areas indicate that vulcanism continued longer in this area than elsewhere.

Five collections were made in the Thuriba area; most of the fossils collected are distorted and are not easy to compare with fossils from other localities. The collections appear to be closely comparable and represent either Fauna III or are high in Fauna II. The fossiliferous sediments in the Thuriba area are underlain by unfossiliferous (?) Middle Bowen Beds which are similar in lithology to the beds in the Leura Creek area.

The fossils collected in the Eastern Region are mainly Artinskian (Lower Permian) in age. They may extend down into the Sakmarian.

UNDIFFERENTIATED PALAEOZOIC BEDS

Rocks cropping out in three separate areas in the eastern part of the Duaringa Sheet area are included in this unit. The rock types include greywacke, mudstone, siltstone, trachyte, andesitic agglomerate, lithic-crystal tuff and mica phyllite. Most have undergone low grade regional and dynamic metamorphism and some have been thermally metamorphosed. They are moderately to tightly folded and overfolded in places.

The stratigraphic position of these beds is not known. Their structural complexity and degree of metamorphism indicate that they were involved in the main orogenic phase and are almost certainly ~~younger than~~ Permian or older. Their relationship to the Middle Bowen Beds is unknown. They are separated from that unit mainly on lithologies.

Distribution and Topography

The unit crops out in three areas, near Rookwood Homestead, and near Grantleigh and Edungalba Sidings.

The Rookwood area is a north-north-west trending, crescent shaped area about 4 miles west of Rookwood Homestead. In this area the unit dips consistently east at 10° to 35°. The shallow dips and resistant lithologies produce a series of prominent, east sloping cuestas which decrease in height from west to east. The topography and the open woodland and dense grass cover developed on the unit produce a photo pattern very different from that of the Middle Bowen Beds to the west. The Rookwood area has a straight boundary on the east against Cainozoic sediments.

The Grantleigh area is the largest. It extends for about 4 miles south-west of Grantleigh along the highway and extends north-west to the Fitzroy River and south-east beyond the eastern boundary of the Duaringa Sheet. This area is the eastern part of the Gogango Range. It consists of rugged, moderately to deeply dissected hills thickly covered by scrub and timber.

The Edungalba area consists of about 10 square miles of high, moderately dissected hills covered with dense scrub and timber. It is located about three miles east of Edungalba, and extends south to the highway.

Lithology

The Undifferentiated Palaeozoic Beds consist of greywacke, mudstone, siltstone, tuffaceous sediments, tuff, agglomerate and rare flows. The sediments are mainly fine grained arenites, dominantly greywacke, and mudstone and siltstone. Greywacke and siltstone are commonly thinly interbedded and contain carbonaceous laminae.

The greywacke is a fine to medium grained, buff, thin-bedded to massive, cross-bedded, semi-friable rock grading into mudstone in places. It consists of up to 50% of fine grained, usually recrystallized micaceous matrix. The clasts are rounded to subangular. The most abundant is quartz, usually containing abundant minute inclusions and, in one specimen, small euhedra of apatite. Plagioclase and microperthite clasts and lithic fragments are about equal in abundance. The lithic fragments include fine-grained volcanics, chert and mica phyllite. One specimen examined contained rare, broken euhedra of zircon. All the specimens examined had undergone low grade regional metamorphism; in one specimen, porphyroblasts of muscovite and chlorite had grown.

The greywacke is similar to a few specimens in the Middle Bowen Beds. Generally, it differs from the Middle Bowen Beds arenites in containing a much greater proportion of matrix.

Other sediments in the unit include grey, green and buff siltstone, sheared, jointed and quartz veined, and probably tuffaceous in part. Two specimens of siltstone examined had been metamorphosed to mica phyllite. They consist of fine grained clasts or interlocking anhedra of quartz and feldspar in a fine recrystallized micaceous matrix displaying a preferred orientation. The mica is biotite in one specimen, and sericite, muscovite and chlorite in the other. One specimen had undergone two periods of dynamic metamorphism with the stresses acting normal to one another, producing two prominent schistosity directions marked by alignment of iron-stained mica flakes. In one direction, the mica flakes are aligned in straight lines; in the other, they form a chevron pattern.

In places the unit includes thinly interbedded grey-white, micaceous fine greywacke or tuffaceous sandstone, grey-green very fine greywacke and grey-green to buff silsttone and mudstone. These sediments cleave very readily parallel to the bedding; some have a well developed schistosity normal to the bedding. Thick units of buff-yellow siltstone crop out in places; these are very closely cleaved and split into sheets during weathering.

Sediments cropping out near the eastern margin of the Rockwood area have been affected by contact as well as regional metamorphism. One rock type is a sandy hornfels consisting of quartz, feldspar and lithic grains, some of which are recrystallized, set in a hornfelsed quartzo-feldspathic matrix. The contact metamorphism is thought to have been caused by the granodiorite intrusion cropping out two miles to the east. The intervening area is occupied by Cainozoic sediments.

The volcanics are mainly lithic crystal tuff, fine to very coarse-grained, massive to thin-bedded and, in places, interbedded with siltstone. Their clastic content ranges from 20% to 90%; it may be of dominantly lithic fragments or of dominantly feldspar fragments. The lithic grains include acid to intermediate flow banded extrusives and crystal tuff. The feldspars are commonly sericitized and recrystallized. Most of these rocks have been slightly metamorphosed producing recrystallization of the matrix. They are commonly sheared and many possess a distinct foliation at an angle to the bedding. Stringers of mica, epidote and calcite parallel the foliation in places.

Agglomerate crops out west of Grantleigh Sidings. It is a massive, poorly sorted, very coarse grained rock. One specimen consisted of red, partly recrystallized fragments of porphyritic andesite set in a hornfelsed, cryptocrystalline to fine grained matrix of possibly andesitic crystal tuff. Volcanic conglomerate crops out in the same area. It is a massive, very coarse-grained, greenish-grey rock with a distinct foliation. The long axes of the fragments are aligned parallel to the foliation. The fragments comprise about 80% of the rock and consist of acid volcanic extrusives and minor crystal tuff. The matrix consists of recrystallized quartzo-feldspathic material with a lineation parallel to the foliation.

Metamorphosed trachyte crops out in the Rookwood area. It is a dark greenish-grey, silicified, schistose rock consisting of about 25% of subhedral to anhedral oligoclase and minor potash feldspar phenocrysts set in a pilotaxitic groundmass. The groundmass contains mica flakes aligned parallel to the flow direction. The rock is cut by several fine siliceous veins, normal to the schistosity.

Structure and Relationships

In the Rookwood area, the unit dips east at 10° to 35°. It is separated by fairly straight, possibly faulted boundaries and two elongate intrusives from steeply dipping Middle Bowen Beds to the west. The difference in the structures of the Undifferentiated Palaeozoic Beds and of the Middle Bowen Beds and the possibly faulted boundaries suggested that the Rookwood area might be a thrust block. However, on the ground, similar rock types were found on both sides of one possible fault boundary.

The unit is separated from the Middle Bowen Beds because its lithologies and structure are different from those of the Middle Bowen Beds. In addition, they have undergone more dynamic, regional and thermal metamorphism than the Middle Bowen Beds to the west. This may be due to thermal and dynamic metamorphism associated with the intrusion of the granodiorite mass to the east and need not imply that they are older than the Middle Bowen Beds. The western boundary faults of the Rockwood area are arranged concentrically with respect to the intrusion and may be the result of the intrusion.

Photo Plate 4:

Folding in Undifferentiated Palaeozoic Beds.
Road Cuttings, Gogango Range, four miles
west of Grantleigh Siding.

Normal folds. (Neg.No.g/5352).

Recumbent folds.

The structures in the Grantleigh area are much more complex. The dominant dip is between 40° and 70° to the east but in places is overturned. The variation in type of folding is shown by the two photos opposite this page. The upper photo is of part of a series of normal folds with flank dips about 30° and vertical axial planes. These beds are offset by numerous normal faults; to the east, the sequence resumes the regional east dip. The lower photo is of tight, recumbent folds with all flanks dipping east and axial planes dipping at 15° to the north-north-east. Tight minor folds of this type are common in the area. They may be minor folds on the flank of a large, overturned fold or may have developed, associated with thrust faulting, during the overturning. Faulting, shear zones and quartz veining are common in this area.

In the Grantleigh area, greywacke, mudstone, sheared siltstone and phyllite constitute most of the unit; a thick, east dipping sequence of agglomerate and crystal tuff crops out near the eastern margin. Between the Grantleigh and Edungalba areas of Undifferentiated Palaeozoic Beds is a thick sequence of east dipping, thick bedded, lithic quartz sandstone. The trend of this sandstone can be traced on the airphotos to the north. It is on strike with similar sandstone mapped as Middle Bowen Beds north of the Fitzroy River. Accordingly, it is included in the Middle Bowen Beds in this area. Its relationship to the Undifferentiated Palaeozoic Beds is unknown. The sandstone sequence is dipping east at between 45° and 75°, but no evidence was found to indicate which way it was facing.

The Undifferentiated Palaeozoic Beds of the Grantleigh area are separated from the Middle Bowen Beds on lithology, particularly on the presence of greywacke as the main arenite. Quartz lithic sandstone is the main arenite of the Middle Bowen Beds.

The Undifferentiated Palaeozoic Beds of the Edungalba area are dominantly bedded lithic crystal tuff and sheared siltstone and phyllite. The predominance of primary volcanics distinguishes them from the Middle Bowen Beds. The unit crops out in a road cutting beside the highway, cut by a thirty-yard wide, east dipping, shear zone. Within the shear zone, brecciated tuffaceous siltstone is intruded by numerous quartz veins. Volcanics on either side dip shallowly towards the shear zone. Fine-grained tuffs and siltstone, between thick beds of coarse tuff, are cut by numerous small shears inclined at about 45° to the bedding; the shears are very small low angle thrusts, indicating compression from the east. About one hundred yards south, in a creek, probable Middle Bowen Beds are dipping vertically. The reason for this structural difference is not known; the Middle Bowen Beds are considerably less competent which may explain it.

The relationship of the Undifferentiated Palaeozoic Beds to the Middle Bowen Beds in the Gogango Range is not known. The area is structurally very complex and, despite the generally good outcrop, it was not possible to establish the relationship. Unfortunately no fossils were found in the area. The two units have some lithologies in common, have generally similar tectonic and metamorphic histories, and are closely associated. Probably both belong to the same, major depositional cycle.

A possible correlate of the Undifferentiated Palaeozoic Beds are the Owl Gully Volcanics of the Yarrol Basin.

The Undifferentiated Palaeozoic Beds are mainly water lain sediments, probably marine though there is no conclusive evidence for this. Some of the clasts in the arenites suggest that the unit was derived from a partly granitic and metamorphic provenance.

The age of the unit is not known. A Permian age for the unit in the Grantleigh and Edungalba areas seems likely; the unit in the Rookwood area may be older.

The thickness is not known but about 3,000 feet is possibly present in the Rookwood area.

UPPER BOWEN COAL MEASURES

Summary

The Upper Permian Upper Bowen Coal Measures crop out in large areas of the Duaringa - St.Lawrence area. The formation consists of interbedded argillaceous and arenaceous lithic sediments, calcareous and tuffaceous in places, impure limestone and coal.

The formation is about 3,500 feet thick. It overlies the Middle Bowen Beds with a transitional contact, and is overlain apparently conformably, by the Triassic Rewan Formation. The formation is tightly folded in a belt extending from the south-east to the north-west of the region, and gently folded in the western half of the region.

Nomenclature

During the regional survey of the Bowen Basin the Upper Bowen Coal Measures have been mapped in the Clermont, Mount Coolon, Emerald, Bowen, and Mackay 1:250,000 Sheet areas (Veevers, et al, 1961: Malone et al, 1961: Veevers et al, 1962; Malone et al, 1962; Jensen et al, 1962). In parts of these areas, equivalents of the Triassic Rewan Formation are included in the Upper Bowen Coal Measures. In the Duaringa - St.Lawrence area the name 'Upper Bowen Coal Measures' is restricted to the Upper Permian Coal Measures and the Triassic Rewan Formation is recognized as a separate unit.

The published informal name Upper Bowen Coal Measures is retained because the Upper Permian Coal Measures in the Duaringa - St.Lawrence area are: (1) in the same stratigraphic horizon as the Upper Bowen Coal Measures in the type area in the northern part of the Bowen Basin; (2) closely similar lithologically to the rocks in the type area; they are almost certainly continuous from the type area to the Duaringa - St.Lawrence area. (The Burngrove Member of the Upper Bowen Coal Measures is mapped only in the Duaringa Sheet area)

The Upper Permian - Triassic nomenclature of this report is compared in the following table with the nomenclature used in previous reports on the northern part of the Bowen Basin (Malone et al 1961 and 1962) and with the nomenclature used by other workers in the Duaringa - St.Lawrence area.

<table>
<tr><th></th><th colspan="2">This Report</th><th>The Geology of the Mount Coolon Sheet area. (Malone <u>et al</u> 1961) The Geology of the Bowen South Sheet area (Malone <u>et al</u> 1962).</th><th colspan="2">Derrington, S.S., 1961. Tectonic framework of the Bowen Basin, Queensland. A.P.E.A. Conference Papers March 1961.</th><th colspan="2">Detailed mapping in the Blackwater area. Utah Development Company (unpub.).</th></tr>
<tr><td rowspan="2">TRIASSIC</td><td colspan="2">Clematis Sandstone</td><td>Carborough Sandstone</td><td colspan="2">Clematis Sandstone</td><td colspan="2">Clematis Sandstone</td></tr>
<tr><td colspan="2">Rewan Formation</td><td rowspan="4">Upper Bowen Coal Measures</td><td rowspan="4">Taurus Formation</td><td rowspan="2">Woodlands Member</td><td rowspan="4">Taurus Group</td><td>Arduran Shale. Sagittarius Sandstone</td></tr>
<tr><td rowspan="3">UPPER PERMIAN</td><td rowspan="3">Upper Bowen Coal Measures.</td><td rowspan="3">Burngrove Member</td><td>Mammoth-Rangal Coal Measures</td></tr>
<tr><td>Carnangarra Member</td><td>Burngrove Member</td></tr>
<tr><td>Macmillan Member</td><td>Churchyard - Tolmies Coal Measures</td></tr>
</table>

DISTRIBUTION AND TOPOGRAPHY

The Upper Bowen Coal Measures crop out extensively in the western half of the area. Two distinct areas of outcrop, representing different tectonic environments, are discussed separately.

1. A slightly sinuous north-west trending belt, about five miles wide near Carfax Homestead, and fifteen miles wide near Dingo. This area will be referred to as the "Carfax-Dingo Belt".
2. Much of the area west of longitude 148°55' in the Duaringa Sheet and the extreme south-west corner of the St. Lawrence Sheet. This area will be referred to as the "South-west Area".

Carfax-Dingo Belt

The Upper Bowen Coal Measures form gently undulating country with broad shallow valleys; the best exposures occur along creek courses. Thick black clayey soil, supporting dense brigalow scrub, commonly occurs along interfluves. Where soil cover is thin, the lithologies control the vegetation; the beds are tightly folded and long, narrow rows of trees of different types but commonly brigalow, with narrow belts of low scrub and grass in between, delineate the trends of the steeply dipping beds. On air-photos the bedding trends are very marked; individual beds can be traced for several miles, and structures easily delineated.

Photo Plate 5:

Fossil wood. Upper Bowen Coal Measures seven miles east of Wilpeena Homestead. (Neg.No.g/5354).

Coal Seam in Upper Bowen Coal Measures, German Creek, St.Lawrence Sheet area. (Neg.No.g/5103)

South-west Area

The Upper Bowen Coal Measures in this area form gently undulating country with variable tree cover. The trends of beds, visible on air-photos where soil is thin can be traced for several miles. The beds are gently folded and have wide outcrops; hence the air-photo pattern is different from that of the Carfax-Dingo Belt.

Lithology:

The Upper Bowen Coal Measures consist of a rapidly alternating sequence of sandstone, siltstone, mudstone, impure limestone, tuff, chert and coal. Beds are commonly only a few feet thick, rarely exceeding fifteen feet.

Lithic sandstone is the dominant rock-type in outcrop. The sandstone is drab green, grey, and brown, fine to coarse-grained, and moderate to poorly sorted; grains are angular to sub-rounded. Lithic (dominantly volcanic) content is high, quartz low; some sandstone is feldspathic, and some tuffaceous. Much of the sandstone contains a high proportion of calcareous detrital grains and calcite in the matrix, commonly segregated into ovoid concretions and lenses with fontainebleau texture. Large logs of fossil wood are commonly associated with coarse, pebbly, festoon-bedded sandstone. (See photo plate 5). Thin layers of mud pellets and flakes are found in sandstone; also mascerated carbonised plant fragments are common.

Siltstone and mudstone are olive green and black rocks, hard and cherty in places; some beds consist of interlaminate green siltstone and black mudstone, the siltstone laminae being calcareous. The laminae are impersistent, either lensing out or being cut out by micro-faults and small-scale cross-bedding. Soft, black, grey, and greenish shale, commonly with carbonised plant remains is also present.

Dark blue limestone, weathering khaki, crops out as thin beds and lenses. It contains much silt and mud and, in places, bands of black pyrite crystals. A few beds of fine-grained white vitric tuff are present in the sequence; tuffaceous material is present in most of the clastic rocks. Thin green and grey cherty beds, containing layers of well-preserved fossil leaves and stems, are common throughout the sequence.

Coal crops out poorly but is known, from bores, to be present throughout the sequence; seams are up to thirty feet thick. The coal in the south-west area is commonly sub-bituminous with good coking qualities; in the Carfax-Dingo Belt, it is semi-anthracite. Coal seams crop out in German and Roper Creeks in the St.Lawrence Sheet area, and in the Mackenzie River at the junctions with Oaky and Blackwater Creeks and near Carnangarra Homestead. (See photo plate 5).

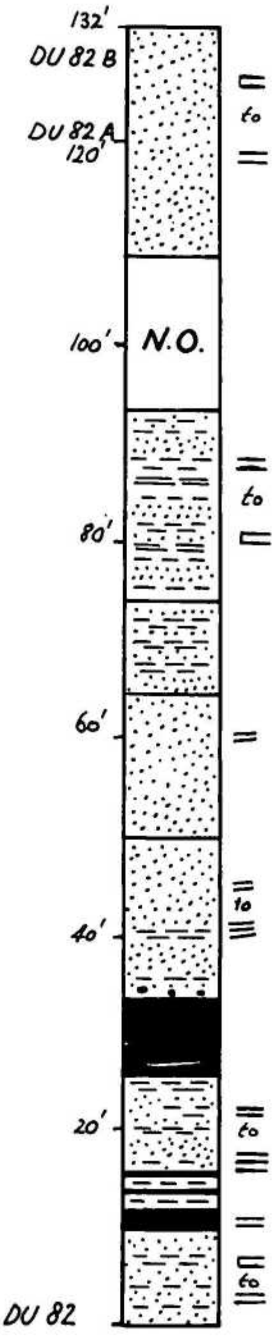
Sandstone is commonly cross-bedded and, in places, festoon-bedded. Ripple marks are absent. Small-scale cross-bedding and slump structures are common in the inter-laminate silt-shale beds. The slump structures consist of rolled-up, and contorted laminae, and small masses of intermingled mud-silt fractions; small-scale faults and small silt dykes are

TEXT FIGURE 4.

Measured Section. Upper Bowen Coal Measures.

German Creek and small tributary, 10 miles north-west of Mt. Stuart Homestead.

Measured by Abney Level.



Micaceous quartz sandstone. Cross-bedded. Some ripple marking and ? load casting. Well bedded to flaggy in places. Some pebbly bands up to 9" thick. Some silty layers.

Interbedded and laterally grading grey jointed splintery siltstone and grey, fine to medium grained lithic quartz sandstone. Some calcareous lithic sandstone lenses up to 3 feet thick.

Poor outcrop. Mainly grey to brown sandy siltstone. Abundant macerated plant debris. Thin band of calcareous lithic sandstone near base.

Thin bedded sandstone, flaggy in places. Micaceous. Some lithic grains. Semi friable to medium hard. Lithic matrix.

Cross bedded, fine to medium grained micaceous sandstone. Some silty interbeds. Some carbonaceous streaks and laminae. Lithic matrix.

Thin bedded coal. Some silty bands.

Grey-brown micaceous siltstone interbedded with dark carbonaceous shale and thin yellow stained bands of coal. Some grey-blue lithic sandstone.

Coal seam with micaceous siltstone interbeds.

Cross bedded grey-brown lithic sandstone. Semi friable. Hard and calcareous in places.

Thick bedded. 12"-40". Thin bedded. 0.4"-4".
Medium bedded 4"-12". Laminated.

associated with the slump structures. In the coarser sediments, lenses and concretions of impure limestone with irregular, contorted bedding are probably slump rolls. Graded bedding was noted in several sandstone, and siltstone beds.

Beds of medium to coarse-grained white quartz sandstones are mapped near the nase of the Upper Bowen Coal Measures in the South-west Area; they can be traced for several miles and are delineated on the map.

The lithologies and relationships of the Upper Bowen Coal Measures of the South-west Area are illustrated in a small section (Text figure 4), measured in Gorman Creek.

Structure and Relationship

The Upper Bowen Coal Measures conformably overlie the Middle Bowen Beds; the boundary is transitional and difficult to place accurately. The formation appears to be conformably overlain by the Rowan Formation with a possibly transitional boundary. The formation occurs in two different tectonic environments which coincide with the two areas of outcrop discussed above. The Carfax - Dingo Belt is a zone of steep dips, and close, tight folds whereas the South-west Area is a zone of shallow dips, and broad, gentle folds.

The strike in the folded belt is slightly sinuous, in the southern part it is 160°, in the central part 150°, and in the northern part 155°. The fold axes are straight. Flank dips are very variable; in the east and central parts of the zone dips are commonly between 45° and 75°, but slight over-turning and flank dips as low as 30° are also present. Along the western edge of the zone, notably between Barwon Park Homestead and Foxleigh Homestead, flank dips are much shallower commonly falling in the range 5° to 30°.

The structures in the tightly folded zone are commonly steeply plunging narrow domes and basins, several miles long and less than half a mile wide. The amplitude of the folds is variable; in some anticlines the base of the formation is exposed with outcrops of Middle Bowen Beds in the cores. Small en echelon folds with amplitudes of several hundred feet lie on the flanks of larger folds; the small folds are isoclinal, and several are within distance of a few hundred yards across strike, notably a few miles north of Melmoth Homestead. The best exposures of tightly folded Upper Bowen Coal Measures are found along the banks of the Mackenzie River, west and east of the Dingo-Barwon Park road crossing. The folds exposed west of the crossing have east-dipping axial planes; the west limbs of some anticlines are slightly overturned. The crests of the folds are sharp and the "knees" of monoclines are acute angles. Small, plunging folds are imposed on the flanks of large anticlines. The sediments within this zone of tight folding are mildly indurated and jointed in places but not sheared. They contain a few thin quartz veins along bedding planes. Few faults are mapped in the zone; apparently faulting was locally minor, but possibly important regionally.

Photo Plate 6:

Animal [redacted] tracks on siltstone surface.
Burngrove Member, Upper Bowen Coal Measures.
Six miles north of Cooroorah Homestead.

(Neg.No.g/5349)

(Neg.No.g/5347).

The structuresare generally broader between Barwon Park and Foxleigh Homesteads, and north-east of Warwick Homestead; some elongate domes, notably a few miles north of Barwon Park Homestead, probably have a few hundred feet of closure.

Upper Bowen Coal Measures are exposed in the cores of tight anticlines in the Bluff area, surrounded by Rewan Formation. Shallow east dipping thrust faults are exposed in the workings of the Excel Mine at Bluff, displacing Upper Bowen Coal Measures. The small throw of these faults indicates pressure from the east.

The Upper Bowen Coal Measures of the South-west Area are gently folded. A major undulating anticline trends sinuously north and north-east across the western part of the Duaringa Sheet area. Middle Bowen Beds crop out in three large culminations on the anticline which are from south to north, the Comet, Redrock, and Big-Churchyard Culminations (Derrington & Morgan, 1959a and b). The Upper Bowen Coal Measures overlie the Middle Bowen Beds, and dip off the structures at 5° to 10°. The Loleham and Four Mile Anticlines were mapped in the Upper Bowen Coal Measures by Derrington & Morgan (1959a) south of the Comet culmination. East of the anticline, a regionsl east dip in the Upper Bowen Coal Measures is interrupted by many small, low amplitude folds with axes parallel to the regional strike. The folds produce local west dips of 20° but their closure is small. The Upper Bowen Coal Measures are folded into a broad syncline north-west of the Big Churchyard Culmination. South of this syncline, notably around Talagai Homestead, the Upper Bowen Coal Measures are folded into gentle domes and basins with small closures. North-west of a line joining Girrah and Jellinbah Homesteads the folding is transitional between the gentle structures of the South-west Area and the tight folds of the Carfax-Dingo Belt.

Faulting appears to be minor in the South-west Area as in the Carfax-Dingo Belt; small faults can be discerned on air-photos where the faults offset strike trends. North-east trending alkaline trachyte dykes and probable sills intrude Upper Bowen Coal Measures north-east of Warwick Homestead and west of May Downs Homestead; they are probably Tertiary. Basic dykes and sills, probably Tertiary, intrude the Upper Bowen Coal Measures in the Cooroorah Homestead and Minnie Creek areas.

The structure relationship of the Upper Bowen Coal Measures to the Middle Bowen Coal Measures and the Rewan Formation are discussed in the sections describing these formations.

Environment of Deposition

The Upper Bowen Coal Measures were deposited in a spasmodically subsiding freshwater or brackish water basin, with possibly restricted access to the sea at times. The environment favoured the preservation of plant remains and apparently inhibited the presence of marine fossils. The rapid alternations of arenites and argillites suggest an active margin to the basin. The coal seams indicate periods of slow sedimentation and probably swamp conditions. Some of the coals are drift coals, formed in swamps to the west and swept into the basin; drift coals also require slow clastic sedimentation. Periods of slow sedimentation alternating with periods of coarse clastic sedimentation and slump structures indicate spasmodic, rather than gradual, subsidence. Similarly, graded beds and mud clasts in sandstone beds suggest turbidity current deposition. The cherty leaf beds are fine siliceous ashstone containing layer upon layer of very well preserved leaves. The rapid deposition of these beds, and their siliceous content are responsible for the good preservation of the leaves. The presence of tuffaceous sediments and vitric tuffs in the Upper Bowen Coal Measures indicates contemporaneous vulcanism.

Thickness

The thickness of the Upper Bowen Coal Measures is difficult to estimate. The formation is probably about 3,500 feet thick in the South-west Area. It is probably thicker in the Carfax-Dingo Belt although no estimate was made.

Age and Palaeontology

The formation contains abundant plants and numerous collections were made and are described in Appendix 5. The plants indicating a Permian to Triassic age, include; Glossopteris indica Sch., Glossopteris angustifolia Bgt., Glossopteris ampla Dana. The Upper Permian age of the Upper Bowen Coal Measures is based on palaeontological and palynological evidence from the underlying and overlying formations. The uppermost part of the Middle Bowen Beds contains marine fossils of late Lower to early Upper Permian age. Spores from the overlying Rewan Formation are Triassic. A few spores from the top of the Upper Bowen Coal Measures are not specifically diagnostic but indicate Permian, rather than Triassic age.

BURNGROVE MEMBER

Summary

The Burngrove Member consists of 300 feet of dominantly grey-green siltstone with interbedded sandstone. It is   in the western part of the Duaringa Sheet area, dipping east off the Comet Platform. The member is distinguished from the rest of the Upper Bowen Coal Measures by the absence of thick, festoon and cross-bedded sandstone units with fossil wood. It represents a period of slow, quiet sedimentation near the margin of the basin.

Nomenclature

The name is introduced in this report. It is derived from Burngrove Creek in the south-west of the Duaringa 1:250,000 Sheet area. The type area is along Burngrove Creek, south of the Central Railway, at Lat.23°35'45"S., Long.148°46'30"E. No sections were measured. The unit was first recognised as a mappable unit by geologists of the Utah Development Company in their detailed mapping and drilling of the Blackwater area.

Distribution and Topography

The member occupies a long, narrow strip extending for fourteen miles south and south-east from the Central Railway and for thirty-five miles north. To the south, the unit disappears under Cainozoic sediments. In the north-west of the Duaringa Sheet area, the unit ceases to be distinct. In general, the unit produces a very subdued topography. Most outcrops are found in creeks.

Lithology

Siltstone is the dominant lithology. It is green to grey-green, well-bedded to massive; in places it is thinly interbedded and interlaminated with dark carbonaceous siltstone, and fine grained, calcareous lithic sandstone. The siltstone contains abundant mascerated plant debris and in places, well preserved plants. In a few outcrops, the siltstone is hard and cherty, and grey-green to white. It commonly has a nodular weathering surface.

Calcareous lithic sandstone makes up almost half the unit. It is medium hard, fine to coarse grained, very well bedded and sorted, and contains abundant mascerated and carbonised plant material. Fine sandstone is commonly thinly interbedded with grey-green to dark siltstone, and carbonaceous siltstone; these sediments show very small scale interfingering and slumping.

The sandstone consists of sub-rounded to rounded lithic grains, mainly vitric tuff, slightly in excess of euhedral grains and broken laths of feldspar, mainly andesine. The feldspar is commonly partly replaced by calcite. Euhedral quartz grains comprise 5% to 10% of the rock. Optically continuous calcite cements the grains together and may comprise up to 25% of the rock. Many specimens show fontainebleau structure in the hand specimen. Irregular bands of argillaceous material are present in some specimens.

Yellow brown, sandy or silty limestone crops out as irregular lenses in the sequence.

Structure and Relationship

The unit is included within the Upper Bowen Coal Measures, approximately 1,000 feet above the base, between the two main coal bearing sequences. Mapping the Burngrove Member assists in prospecting for coal. In particular, the thick seam being prospected by Utah Development Company is present in a known stratigraphic position above the Burngrove Member. Regionally, it is part of a sequence dipping shallowly east and north-east off the Comet Platform. Locally, the unit is involved in minor folding and may dip at angles up to 25°.

Environment of Deposition

The Burngrove Member probably represents a period of slow, quiet sedimentation. It lacks the coarse clastics, the fossil tree trunks, and the intense cross-bedding and festoon bedding of the Upper Bowen Coal Measures, above and below. Animal tracks are preserved on an extensive surface in the unit, six miles north of Cooroorah Homestead (see photo plate 6). This surface was probably above water level at the time the tracks were made. The Burngrove Member was possibly deposited in shallow water near the margins of the fresh or brackish basin; the depositional area was possibly an interfluve between rivers supplying detritus to the basin. The coarse clastics above the unit indicate that the environment of the Burngrove Member was short lived.

Thickness

Detailed mapping and drilling by Utah Development Company indicates a thickness of three hundred feet for the unit. It may be thicker in the northwest of the Duaringa Sheet area where the unit contains a proportion of coarse clastics and where toward the north it loses its identity.

Palaeontology and age

The unit contains a fossil flora including Glossopteris conspicua, Feistmantel, G.browniana Brong., G.indica Sch., G.angustifolia Brong., Sphenopteris lobifolia Morris. These are of Permian to Lower Triassic age. The units stratigraphic position indicates that it is Upper Permian.

UNDIFFERENTIATED PERMIAN ROCKS

Scattered outcrops of Permian rocks occur in the area between Carfax, Warwick, and May Downs Homesteads, and north-west of Warwick Homestead. The outcrops form low undulating country, with thin clay soil cover supporting thick timber, mainly brigalow; exposures are poor and confined to creeks. The beds are tightly folded and bedding trends are visible on air-photos.

The beds consist of Middle Bowen Beds and Upper Bowen Coal Measures, but outcrop is too poor to map them separately. Most outcrops are of drab grey, and greenish sandstone, commonly lithic and calcareous; some sandstone is quartzose, containing worm tubes. Drab coloured siltstone and mudstone, commonly cherty and shaly, are also present.

The rocks are steeply folded being part of the folded zone of Middle Bowen Beds and Upper Bowen Coal Measures described above. Dips are generally steeper in the outcrops in the east. Thicknesses are not known.

REWAN FORMATION

Summary

The Lower Triassic Rewan Formation crops out in the southern half of the Duaringa Sheet area. It consists of about 1,500 feet of thick beds of chocolate-coloured mudstone interbedded with lithic sandstone. It is disconformably overlain by the Clematis Sandstone and conformably overlies the Upper Bowen Coal Measures. The formation is tightly and incompetently folded on the east limb of the Mimosa Syncline and gently folded on the west limb.

Nomenclature

The name Rewan Formation was first published by Hill (1957) who based her account on the work of Shell (Shell [Queensland] Development Pty.Limited, 1952) and named after Rewan Homestead in the south-east corner of the Springsure Sheet area. In this area, which is the type area, Shell were able to split the formation into upper and lower units. The lower unit, Shell's 'Lower Rewan Group' is absent in places, has an average thickness of 300 feet and a maximum of 900 feet. 'It is characterized by coarse , often false-bedded and sometimes calcareous polygenic sandstones and grits. Thin intercalations of argillaceous beds, chiefly of chocolate brown clays, also occur. The strong variations in thickness suggests that the Lower Group is a facies of the Upper Rewan' (S.Q.D., 1952, p.36). Shell's Upper Rewan Group is described in the same report as 'on an average about 1,700 feet thick and is chiefly a complex of unbedded chocolate coloured clay. It is locally indian-red, with occasional intercalations of grey, white or green silty bands. Non-persistent beds and lenses of sand-stone are frequently intercalated in the clays.'

Prior to the present survey the Rewan Formation was mapped in the type area only. The rocks in the Duaringa Sheet area now assigned to the Rewan Formation were formerly correlated with the formation and named the 'Arduran Formation' (Derrington & Morgan, 1959a). After later work, Derrington and Morgan (1959b) abandoned their Arduran Formation, placing the unit in the upper part of their Permian Taurus Formation because they argued, the distinctive chocolate-brown argillaceous sediments of their Arduran Formation occur 'indiscriminately with green and olive drab coloured sediments' characteristic of the 'Taurus Formation'. This is a correct observation but the incoming of chocolate shales is regarded by us as a significant change. We regard the rocks in the Duaringa Sheet area to be so similar lithologically and in stratigraphic position to the Rewan Formation of the type area as to justify direct correlation; they are almost certainly continuous below the surface. This correlation is supported also by paly-nological and palaeobotanical data.

Distribution and Topography

The Rewan Formation crops out in the southern half of the Duaringa Sheet area between Blackwater and Dingo. Outcrops are poor because of the dominance of soft argillaceous sediments in the formation. The unit is best exposed at the base of the Clematis Sandstone escarpment, notably at the heads of Springton, Stony, and Duckworth Creeks. Good outcrops are also present in the Bluff area, a few miles north-north-east of Bluff in Wild Horse Creek, and in a small tributary entering the upper reaches of Charlevue Creek from the south. The formation forms flat to undulating, mainly soil covered plains with a vegetation of sparse, low scrub and scattered, dense patches of brigalow. Drainage gullies deeply incise the soft rocks, revealing the best exposures. The formation does not form a distinctive air-photo pattern or tone, due mainly to superficial cover. Bedding trend lines are visible on airphotos north of Bluff where the rocks are near the surface.

Lithology

Outcrop is too poor to distinguish Shell's twofold lithological division of the formation, although lithic arenaceous sediments appear to be more common towards the base of the formation. Soft, unbedded chocolate coloured mudstone is the characteristic, and the most abundant, rock of the formation; it crops out in thick beds, in places over 100 feet thick, notably near the head of Stony Creek. The chocolate coloured mudstone contains thin beds and intercalations of green siltstone and green fine to medium-grained lithic, feldspathic sandstone, and irregular pockets and stringers of light green mudstone, apparently unrelated to bedding. Some distinct layers consist of nodular calcareous concretions with fontainebleau texture. The argillaceous chocolate coloured sediments are dominant towards the top of the formation. In the lower part of the formation they are interbedded, in beds ranging from a few feet to 20 feet thick, with variously coloured argillaceous and arenaceous sediments. In the Bluff area, Wild Horse Creek, and Tantallon and Yarrawonga Homesteads area, the formation consists of fine to medium-grained green lithic feldspathic sandstone, purple, red, and chocolate coloured medium-grained lithic feldspathic sandstone, commonly friable, and khaki, pink, olive-green and buff-brown siltstone and shale. Hard secondary calcareous ovoid nodular concretions, up to five feet in diameter are present in green lithic sandstone. The sediments alternate rapidly with chocolate-coloured mudstone, notably north-north-east of Bluff in Wild Horse Creek, around Bluff and at the head of Springton Creek. The sandstone is commonly cross-bedded in units one to two feet thick; festoon-bedding is present in places, notably in Blackwater Creek south of Yarrawonga Homestead. The sandstone contains a few thin beds of intraformational conglomerate consisting of mud and silt pellets, commonly flattened parallel to bedding, and pebbles of green lithic sandstone. The pebbles and pellets are unsorted and particles ranging from coarse grain size to pebbles and pellets two inches across are intermingled.

Structure and Relationships

According to Shell (S.Q.D. 1952) 'there is evidence of a gentle regional angular unconformity at the base' of the Rewon Formation in the type area. In the Duaringa Sheet outcrop is too poor to confirm or refute this relationship. The interbedding of greenish and drab coloured lithic sandstone, typical of the Upper Bowen Coal Measures with chocolate and purple sediments towards the base of the Rewan Formation suggests a transitional, conformable boundary. However the two may be disconformable. The base of the Rewan Formation is taken at the base of the lowest chocolate-coloured mudstone bed. This horizon is near the Permian-Triassic boundary as indicated by spores (determined by P.R. Evans from shot-hole samples about one mile east of Blackwater). The Rewan Formation is unconformably overlain by the Clematis Sandstone in the type area. At the head of Stony Creek on the west limb of the Mimosa Syncline clean white kaolinitic quartz sandstone of the Clematis Sandstone is apparently conformable on drab green lithic sandstone and siltstone which is regarded as the top of the Rewan Formation. The marked difference in lithologies indicate different provenances for the two formations, which suggests a depositional break.

The Rewan Formation crops out in the limbs of the broad Mimosa Syncline which strikes north-north-west and plunges south. In the west limb of the syncline the unit has a regional dip of 1° to 5°, which is interrupted by small, shallow folds producing west dips, generally less than 10°, the folds are well exposed south of Yarrawonga Homestead in Blackwater Creek, and north-east of Tantallon Homestead. The formation is tightly folded in the east limb of the syncline. Incompetent folds are well exposed at the head of Springton Creek and south-west of Charlevue Homestead. The folds, commonly asymmetrical and slightly overturned in places, are 20 feet or less across and impersistent along strike. Apparently they are developed in zones on the flanks of broad, gentle folds. Minor thrusting is common and the rocks are mildly indurated and shear jointed. Incompetent folds in the Rewan Formation contrast with broad, gentle folds in the Clematis Sandstone, notably the Springton Anticline and flanking synclines. The competent Clematis Sandstone has adjusted to this incompetent folding by normal faulting; it dips steeply adjacent to fault planes, which commonly strike north-west on the west flank of the Springton Anticline where the Clematis Sandstone is faulted against the Rewan Formation; dips up to 70° in both formations occur along this fault. Folded Rewan Formation is exposed immediately west of Bluff and a few miles to the north and north-east of the township. Outcrop is confined to a few creek sections but where trends of bedding are visible on air-photos, structures can be delineated. The folds, striking north-west, are commonly about half a mile broad and a mile to two miles long, and some are elongate domes and troughs. Flank dips between 20° and 30° are most common but range from 5° to 70°. The folding is best exposed in Wild Horse Creek, and immediately west of Bluff, in Duckworth and Bluff Creeks. The Rewan Formation north of Wild Horse Creek is probably preserved only in synclines. The eastern boundary with the Upper Bowen Coal Measures was arbitrarily located on the 1:250,000 scale map, owing to poor outcrop and the transitional character of the boundary. Faulting in the Rewan Formation appears to be minor, small thrust faults affect the tightly folded rocks. Zones of slickensided coarsely crystalline calcite in shallow dipping beds in Stony Creek probably represent fault planes.

Environment of Deposition

The Rewan Formation is dominantly a 'red bed' sequence; similar 'red beds' were deposited in other parts of Australia at the base of the Triassic, notably in the Narrabeen Group in the Sydney Basin. The Rewan Formation consists dominantly of red argillaceous sediments devoid of organic matter, with marly sediments and intraformational conglomerate; some of the sediments contain dessication cracks. Grey-green siltstone and festoon-bedded sandstone with plant remains are interbedded with the 'red-beds'. Prider (in S.Q.D. 1952) believes the chocolate clays to be 'deep marine deposits formed entirely from terrigenous material' but the Shell geologists 'are of the opinion that these chocolate clays are lake deposits'. Phillips in Hill & Denmead (1960, p.188), suggests that the chocolate mudstone was derived from an arid or lateritic land surface. Other authors have suggested 'red beds' are aeolian deposits. It is generally accepted that the 'red-bed facies' is non-marine and formed in strongly oxidizing conditions. The presence of dessication cracks and intraformational conglomerate suggest intermittent shallow water deposition . According to some authors 'red-beds' indicate a hot arid climate whereas others postulate hot humid conditions.

Thickness

According to Shell (S.Q.D. 1952) the Rewan Formation in the Springsure Sheet is very variable in thickness with a maximum of 2000 feet. In the Duaringa Sheet the formation also appears to vary in thickness: it is possibly 1500 feet thick on the western limb of the Mimosa Syncline; in the Springton Anticline the formation appears to be thinner.

Age and Palaeontology

Probable Triassic plants (collection DU291, Appendix 5) were collected in the formation near the head of Springton Creek. Spores contained in samples from seismic shot holes a few miles east of Blackwater indicate a Triassic age for the unit (P.R. Evans pers. comm.). Shell (S.Q.D. 1952) assigned the whole of the Rewan Formation to the Lower Triassic because it unconformably overlay the Permian Bandanna Formation. Phillips(in Hill & Denmead 1960, p.188) 'considers the Clematis sandstone to overlie the Rewan with much greater unconformity, perhaps more suitable for a Permian-Triassic boundary'.

CLEMATIS SANDSTONE

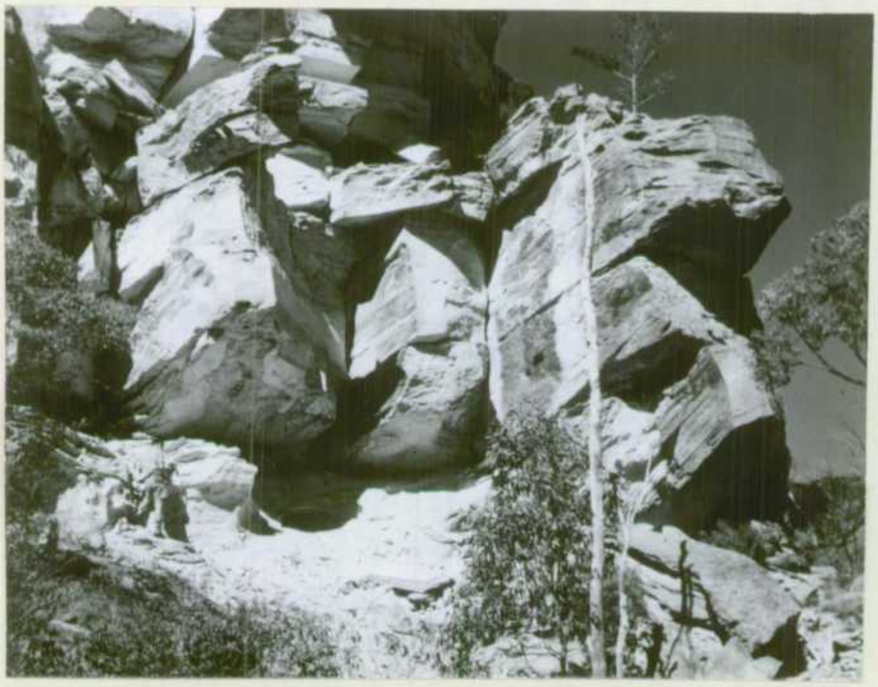
Summary

The cliff-forming Triassic Clematis Sandstone crops out in the southern half of the Duaringa Sheet area. It consists of 300 to 400 feet of clean quartz sandstone, disconformably overlying the Rewan Formation. It is the youngest formation exposed in the broad Mimosa Syncline and has been gently folded on the eastern limb of the Syncline.

Nomenclature

Jensen (1926) was the first to use the term 'Clematis series' for beds above the 'Upper Bowen' and below the 'Ipswich Beds'. Later authors used the name 'Carnarvon' for beds equivalent, at least in part, to beds named 'Clematis'. Whitehouse (1955) discussed the application of the various names (e.g. 'Carnarvon Red Member', 'Carnarvon Sandstone',

Photo Plate 7:



Cliff of Clematis Sandstone east of Yarrawonga Homestead.
(Neg.No.g/5351).

'Clematis sandstones') and preferred Clematis Sandstone on grounds of priority and convenience. He also designated the type area as the gorge of Clematis Creek in the Roma district, based on a verbal communication of Jensen.

Distribution and Topography

The Clematis Sandstone crops out in the Duaringa Sheet south of the Central Railway between meridians 149° and 149°30'. It is well exposed, forming precipitous white or pinkish-buff cliffs of the Expedition and Shotover Ranges in the west and cliffs and cuestas of the Dawson Range in the east (see photo plate 7). A densely timbered plateau about 2500 feet above sea level with deep gorges and waterfalls, lies between the ranges; this area, known as the Blackdown Tableland is accessible only on foot. An outlier of Clematis Sandstone south of   Bluff forms high cliffs, notably Arthur's Bluff. The outcrop of the Clematis Sandstone extends southwards into the Baralaba Sheet area, where it forms less prominent, though distinct, ranges.

Lithology

The Clematis Sandstone is essentially a white medium to coarse-grained quartz sandstone with thin beds and pockets of angular granules and pebbles of quartz. Purplish-red ferruginised layers, a few inches thick, are common giving the rock a banded appearance. The sandstone is micaceous, flaggy and kaolinitic in places. Interbeds of soft thin bedded light purplish-grey micaceous siltstone with plant fragments and soft white, kaolinitic, micaceous siltstone are found in a few places. The sandstone is commonly thick to medium bedded, and cross-bedded in units several feet thick. Sets of vertical joints are prominent in the sandstone; one set, striking north-west, is visible on the air photos in places.

Structure and Relationships

The Clematis Sandstone occupies the broad trough of the north-north-west striking Mimosa Syncline and the crests of two broad, parallel striking anticlines in the east limb of the Syncline. The west limb of the Syncline dips east at angles generally less than 5°. Flank dips in the folds on the east limb, range from 10° to 15°; they are readily discernible on the air photos because the sandstone beds form cuestas. Steep dips, locally nearly vertical, and pronounced slickensides occur in narrow fault zones along the axis of the Springton Anticline. These faults and a few transverse faults, formed as the resistant Clematis Sandstone adjusted to tight folding in the underlying incompetent Rewan Formation. The cliff of Clematis Sandstone south of Cooinda Homestead is probably a fault scarp, produced by a series of small north-west striking faults. Several probable faults in the Sandstone, with a common north-west strike, are mapped from distant lineaments on the air photos.

The Clematis Sandstone is disconformable on the Rewan Formation, as described above. In the Duaringa area it is overlain by Tertiary basalt and sediments. E. Vind of Marathon Exploration Pty Ltd (pers. comm.) noted dark shale and (probable) volcanic rocks lying on the Clematis Sandstone in an area about six miles east-north-east of Ardurad Homestead. The shale is possibly equivalent to the Moolayember Formation which lies conformably on the Clematis Sandstone in the Springsure and Baralaba Sheet areas; on the other hand the shale may be Tertiary. Tweedale (in Hill & Denmead, 1960, p.282) reported 'an isolated remnant of this group [i.e. Bundamba Group] also appears in the Black Down Tableland south of the Bluff, where it rests directly on the Clematis Sandstone'. Evidence to support the presence of younger Mesozoic sandstone unconformably overlying the Clematis Sandstone is lacking.

Environment of Deposition

The Clematis Sandstone represents a change to a quartz provenance from the underlying coal measure-red bed sequence. The Sandstone was probably deposited in a shallow water environment, possibly deltaic.

Thickness

The Clematis Sandstone is estimated at 300 to 400 feet thick along the western limb of the Mimosa Syncline but is probably slightly thicker along the eastern limb. In the Reid's Dome area of the Springsure Sheet the Clematis Sandstone is 250 to 400 feet thick. Tweedale (in Hill & Denmead, 1960 p.281) reports that 'between Shotover and Planet Downs [in the Baralaba Sheet area] this formation reaches its maximum thickness, in excess of 1000 feet, while along the eastern limb [of the Mimosa Syncline] the thickness is about 500 feet'.

Plant fossils from the Clematis Sandstone in the Springsure Sheet area indicate a Triassic age (Hill, 1957 p.12). Indeterminate plant remains only were found in the Duaringa Sheet area. Palynological data on surface and subsurface samples from the Clematis Sandstone indicate that the unit is Middle to Upper Triassic (Evans, 1963).

MESOZOIC VOLCANICS

Volcanics cropping out in the south-east corner of the Duaringa 1:250,000 Sheet area are considered to be Mesozoic in age. They are mainly shallow dipping pyroclastics of intermediate to basic composition, deposited on a very irregular surface. The volcanics appear to be unconformable on tightly folded sediments, tentatively included in the Lower Permian Middle Bowen Beds. The volcanics may be equivalent to the Triassic Cracow Formation of the Monto area.

Distribution and Topography

The unit crops out in the south-east corner of the Duaringa Sheet and extends south-easterly outside of the Sheet. It forms high hills, moderately rugged to sharp peaked in places, grading down into rolling foothills. The volcanics are usually less dissected than the surrounding sediments.

Lithology

The unit consists dominantly of pyroclastics. They include agglomerate, grey-green and pink, ranging from a fine grained well-bedded variety, interbedded with tuff, to massive boulder agglomerate. Volcanic conglomerate consisting of scattered bombs in a sheared brown tuffaceous matrix, crops out in places.

A prominent rock type in the unit is tough, massive, dark purplish-green crystal tuff, consisting of clasts of acid to basic plagioclase, augite, and devitrified glass in a tuffaceous matrix. Well-bedded lithic crystal tuff is also present in places, consisting of clasts of fine-grained volcanics and feldspar in abundant tuffaceous matrix. The rock is partly silicified and recrystallized.

Near the base, the unit includes brown tuffaceous greywacke, pebbly in places, and green, easily weathered, chloritic siltstone, containing scattered lithic pebbles. These basal sediments show intense shearing and jointing which die out rapidly up the section.

Structure and Relationships

Bedding is well developed in many places and is commonly flat lying or nearly so. No contact with the (?) Middle Bowen Beds was observed. However, nearly flat-lying volcanics were seen in several places within a few feet of tightly folded and steeply dipping (?) Middle Bowen Beds, suggesting that the volcanics are unconformably younger.

The unit is tentatively correlated with the Cracow Formation, a volcanic unit of Triassic age cropping out in the Monto area, about 20 miles south-south-east. The Cracow Formation is unconformable on equivalents of the Middle Bowen Beds (pers.comm. J.F. Dear).

THE STYX COAL MEASURES

The Lower Cretaceous Styx Coal Measures crop out in a north-trending basin, east of St. Lawrence. The unit consists of quartz sandstone, conglomerate, shale, and coal seams. It is dominantly freshwater but includes at least one marine incursion. The unit dips gently east but is tightly folded near the faulted eastern boundary; it is unconformable on Middle Bowen Beds.

The unit was named the Styx Series by Dunstan (in Walkom, 1915). Rands (1892) described the unit, following the discovery of coal in 1886, and subsequent prospecting in the area. The most detailed mapping of the unit, before 1900, was that of David; his work is unpublished but his maps and sections are held in the Geological Survey of Queensland.

TEXT FIG. 5.

BROADSOUND COAL COY.

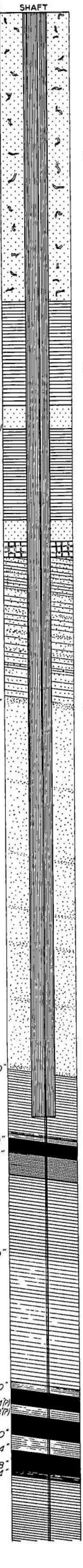
SECTION OF STRATA AND COAL SEAMS AT Nº1 SHAFT ¼ MILE FROM NEWPORT WHARF

Compiled by T.W.E. David from the reports and samples forwarded by the Company's Local Manager at St. Lawrence, Mr. R. Davidson. The sections of the coal seams are based on Mr. Davidson's report of them as recently proved in the Company's bore at the Nº1 Shaft.

Scale of Feet: 4 0 4 8 12 16

LEGEND

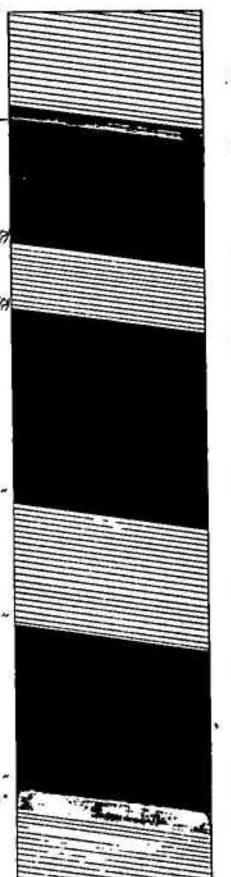
Mesozoic:
- Upper Cretaceous — Red Sandstone with worm burrows and hard white magnesitic Shales — Desert Sandstone Series.
- Triassic (?) — Ironstone. / Coal measures.



TOTAL	DETAILS	
25' 0"	25' 0"	Red sandstone with worm burrows.
34' 0"	9' 0"	Hard magnesitic shales, stained reddish grey by iron, sandy in places, probably altered tuffs.
36' 0"	2' 0"(?)	Red sandy felspathic rock.
44' 0"	8' 0"	Hard white sandy magnesite shales.
46' 0"	2' 0"	Rusty soft sandy felspathic rock with a little mica.
47' 3"	1' 3"	Ironstone, very impure, part limonite, part hæmatite.
64' 0"	16' 9"	Pale rusty grey sandy shale, slightly micaceous. (Perhaps this is the true commencement of the coal-measures.)
92' 0"	28' 0"	Pale reddish grey flaggy fine grained sandstone, passing downwards into a massive pale greenish and whitish grey sandstone with small cakes of coal.
96' 0"		Dark grey sandy clay shale with minute partings of bright bituminous coal. Shaft ends, bore begins.
98' 0"	6' 0"	
99' 3"	1' 3"	Coal: good. Analysis of coal from top seam by Dr. Helms, MA, FCS, Consulting and Analytical Chemist, Bridge St., Sydney. Moisture 2·57; Volatile Hydrocarbons 27·39; Fixed Carbon 63·15, Ash 6·09 (Coke 69·24); Sulphur ·086; 100·00. Specific Gravity 1·341
108' 0"	8' 9"	Carbonaceous clay shale with coal partings.
120' 0"	12' 0"	Clay shale, strong plastic with cakes of coal next seam.
121' 4"	1' 4"(?)	Coal, good.
122' 0"	0' 8"(?)	Band, soft clay shale.
124' 0"	2' 0"	Coal, good.
125' 4"	1' 4"	Band soft clay shale.
127' 0"	1' 8"	Coal with half inch band fair.
127' 4"	0' 4"	Coal and clay.
		Dark grey and black coaly shale.

DETAILED SECTION OF SEAM

Scale: One Inch = One Foot



TOTAL	DETAILS	
Depth from surface to roof of seam 120' 0"		Roof: clay shale, strong, plastic, with small coal partings.
1' 4"	1' 4"(?)	Coal: hard, dull black chiefly. Analysis: Moisture 2·58; Volatile Hydrocarbons 21·58; Fixed Carbon 63·82; Ash 11·51; Sulphur 0·51; 100·00. Specific Gravity 1·398. This coal does not Cake. The above is a copy of the Analysis by Dr. Helms, MA, F.C.S., consulting and Analytical Chemist, Bridge St., Sydney.
2' 0"	0' 8"(?)	Band: soft, grey, clay shale.
4' 0"	2' 0"	Coal: hard, dull black, mixed with softer bituminous coal cakes slightly. Analysis of mixed sample taken partly from this layer of coal and partly from the lower: Moisture 2·17; Volatile Hydrocarbons 24·78; Fixed Carbon 62·40, Ash 10·05 (Coke 72·45); Sulphur 0·60; 100·00. Specific Gravity 1·365. The above is a copy of the Analysis by Dr. Helms.
5' 4"	1' 4"	Band: soft, grey, clay shale
7' 0"	1' 8"	Coal: hard, dull black, mixed with softer bituminous coal. A ½ in band of dirty coal is present somewhere in this layer. Analysis is represented in preceding.
	0' 4"	Floor: coal and clay shale passing into dark grey coaly shale.

Note: the above analyses were made by Dr Helms from samples selected by me from the chips of coal obtained from the seams in the process of boring.

Distribution and topography

The Styx Coal Measures crop out in a north trending belt, 30 miles long by about 6 miles wide, extending south from St. Lawrence to near Tooloombah Creek. The unit produces a line of east sloping cuestas along the western margin; elsewhere it forms plains. Vegetation consists of light scrub and scattered patches of dense brigalow. Outcrops are rare except near the western margin.

Lithology

The unit is known from the Bowman and Ogmore shafts and from a diamond drilling programme carried out by the Queensland Mines Department between 1948 and 1951 in the Tooloombah Creek area (Morton, 1955). The following descriptions are based on Morton's work.

The Styx Coal Measures consist mainly of fine grained grey sandstone and shale, either interlaminated or in thick lenses. Some thin beds of calcareous sandstone are present. Distinctive green sandstone is common; it consists of grains of quartz, chert and shale, the green colour being due to a green hydromica filling interstices between the grains. Nine coal seams were noted in the sequence during the drilling.

Some of the drill holes penetrated underlying Permian sediments. These holes revealed a pebble conglomerate at the base of the Styx Coal Measures. The basal sandstone cropping out on the cuestas along the western margin is a light coloured, medium grained, cross-bedded pebbly quartz sandstone, tending to pebble conglomerate in places.

The lithology of part of lhe unit near the northern limit is illustrated in Figure 5, a vertical column drawn by David representing the sequence in the Broadsound No.1 Shaft and bore. The shaft is shown on the map by crossed hammers, about 3 miles east-south-east of St. Lawrence. It is now inaccessible. The vertical column shows an angular unconformity at 47', the upper part being referred to the "Desert Sandstone Series".

Material from the spoil heap at the top of the shaft was sampled during the 1962 season and was found to contain Permian spores. (P.R. Evans, pers.comm.). Another sample from the same locality, collected by K. Gough in 1961, was examined in the Geological Survey of Queensland and found to contain Cretaceous spores. Permian coal measures are known to the north, and possibly the spoil heap at this shaft is contaminated with material from further north.

Structure and Relationships

The unit is generally west dipping at about 5°. It is unconformable on the Middle Bowen Beds and is faulted against that unit along its eastern boundary. The Styx Coal Measures are crumpled and faulted for some distance west of the fault which is probably a high angle reverse fault, east block up. The bore holes which penetrate Permian sediments indicate that the Styx Coal Measures were deposited on an irregular surface, deepening progressively towards the faulted eastern boundary.

Environment of deposition

The Styx Coal Measures are dominantly freshwater. However, discovery of several species of microplankton at one horizon in the sequence indicates at least one marine transgression (Cookson and Eisenack, 1958). The unit was probably deposited in a near-coastal basin, to which the sea had occasional access. This basin lies on the axis of a major Permian syncline.

Thickness

The drilling in the Tooloombah Creek area revealed a maximum thickness of 1270' but the unit is probably much thicker to the east.

Walkom (1919) described a Lower Cretaceous flora from the unit. Spores present in the unit indicate a Lower Cretaceous, approximately Albian, age (Cookson and Dettman, 1958).

UNNAMED LOWER CRETACEOUS SEDIMENTS

A small area of Lower Cretaceous sediments were mapped in the Duaringa Sheet area, 9 miles north-west of Redbank Homestead. The main lithology is a brown, friable pebble conglomerate containing plants. The pebbles are mainly indurated siltstone similar to the dominant lithology of the surrounding Middle Bowen Beds. Some sandstone, siltstone and shale overlie the conglomerate. Outcrop is generally poor.

Plant specimens were identified by Mary E. White (Appendix 5). They include two species of Taeniopteris and one of Cladophlebis: all three species are found in the Styx Coal Measures, with which these rocks are correlated.

The pebble conglomerate at the base of this sequence is probably derived locally. The sequence was possibly deposited in a small, freshwater lake, about the same time as the Styx Coal Measures were deposited, 22 miles to the north. The two depositional areas may have been connected.

TERTIARY

Tertiary rocks are mapped as four units: sediments (Ta), sandstone breccia (Td), basalt (Tb), and undifferentiated volcanics (Tv).

Sediments

Nomenclature

Dunstan (1913) mapped Tertiary sediments in the Duaringa area as the 'Nerang-Duaringa Series'. Reid & Morton (1928) used the name 'Duaringa-Emerald Series' for Tertiary to post-Tertiary rocks in central Queensland. The name 'Duaringa Formation' was used on the Geological Map of Queensland (1953) for deposits of Tertiary age. Laing (1959) used the name 'Junee Formation' for sediments in the Junee Homestead area which he assigned to the Jurassic but are now regarded as Tertiary. A formal name was not used on the accompanying map for probable Tertiary sediments which are widespread in the Duaringa and St. Lawrence Sheet areas.

Distribution and topography

A thick sequence extends in a continuous belt, 20 to 30 miles wide from May Downs Homestead in the north to the southern boundary of the Duaringa Sheet, immediately west of the Isaacs, Mackenzie, and Dawson Rivers. A thinner sequence crops out in a belt, five to 15 miles wide, extending from Bluff in the south to Warwick Homestead. Tertiary sediments in the south-west of the area crop out in several mesas north of a line joining Ardurad and Galgathoa Homestead, and as a continuous sheet south of the line. The sediments form scattered outliers east of the Bruce Highway and the Mackenzie and Dawson Rivers. The sediments commonly form low tablelands, generally less than 200 feet high; the tablelands are widespread near May Downs and Junee Homesteads, between Alsace and Royles Homesteads, and near Laleham and Ardurad Homesteads. Locally, north-west of Duaringa, the tablelands have a relief of 400 feet. The tablelands are capped with a hard, lateritised zone which forms rocky cliffs; the lower slopes are scree covered and commonly thickly timbered. Sand and red lateritic soil on top of the tablelands support fairly dense timber, commonly rosewood.

Lithology

Unlateritised sediments are poorly exposed, in contrast to the upper, lateritised zone. The sediments consist mainly of unsorted gravelly and pebbly quartz sandstone, and silty clays; the coarser sediments are usually well lithified. Sandstone types include soft, off-white, medium-grained micaceous, clayey, quartz sandstone and buff, fine-grained, cross-bedded sandstone. In places, notably north of Junee Homestead, vertical tubes filled with dark silt, penetrate unsorted gravelly sandstone normal to bedding and probably represent worm burrows.

The sediments are known in bores. Dunstan (1901a) mentions 600 feet of clay and shale in the Duaringa Bore. Oil shale has been recorded in bores between Duaringa and Tryphinia while Ball (1928) describes outcrops of green and brown fissile oil shale in the Dawson River, about 14 miles south of Boolburra. Reid (1939a) records at least 30 feet of diatomaceous earth six miles north-west of Junee Homestead. Resin-bearing clay shales were also found by Dunstan (1916).

The lack of large exposures of the sequence and lateritisation of the upper part prevents accurate determination of bedding features. In a few places cross-bedding was observed, notably along the lower slopes of the tablelands north of Junee Homestead. The top 20 feet to 30 feet of the sediments (possibly more in places) are lateritised and, because of the relative hardness of the laterite, are well exposed.

Structure and relationships

Tertiary sediments are unconformable on Permian and Triassic rocks, and on older rocks in the eastern half of the area. The sediments are covered by superficial deposits, commonly reworked laterite and Tertiary sediments.

Dip slopes, generally dipping at less than 5°, are readily distinguished in the tablelands; regionally, when plotted from air-photoes, broad "structures" can be discerned, with slopes commonly striking parallel to present drainage. Several explanations of the "structures" are possible: they could be controlled by depositional dips in the Tertiary sediments; they could parallel a laterite profile developed on an undulating surface; they could be folds, which seems unlikely. Lack of bedding in outcrop prevents correlation of surface slopes and the internal structure of the beds.

Environment of deposition

The sediments are probably lacustrine and fluviatile deposits, laid down on an uneven land surface. The thickest belt of sediments in the area extends along the line of the Isaacs, Mackenzie, and Dawson Rivers. This line was possibly the site of a deeply incised Tertiary stream, subsequently filled with sediments. Basalt flows are interbedded with the sediments; sediments probably accumulated in lakes formed by basalt flows damming streams.

Thickness

The thickness of the sediments is probably very variable. Dunstan (1901) reports at least 600 feet in the Duaringa Bore. There are 200 to 300 feet in the tablelands immediately west of the Dawson, Mackenzie and Isaacs Rivers.

Age and Palaeontology

Fossil fish remains from the clays and shales in the Duaringa Bore (Dunstan, 1901a) were assigned to the oligocene by David (1932). Hills (1934) after examining other fossil fishes, reported that 'it is possible to state only that they are Tertiary'. Laing (1959) regards the sediments near Junee Homestead as Jurassic because 'Tertiary basalt appears in places to lap against scarps formed of Junee Formation and in other places to overlie it'. This relationship was not observed during the present survey.

Sandstone Breccia

Nomenclature

Derrington & Morgan (1959a) were the first to note the presence of the breccia. They called it the 'Duckworth Formation', correlating it with the Triassic Clematis Sandstone. Later work by Derrington & Morgan (1959b) proved the unit to be much younger in age, and assigned it to the Upper Tertiary. The name 'Duckworth Formation' is not used in this report; the sandstone breccia is essentially the same. The unit is of limited extent and we feel does not require a formal name.

Distribution and topography

The main area of outcrop is between Blackwater and Bluff extending for several miles north and south of the Central Railway. The unit is well exposed in low hills from a mile to a few miles west and north-west of Bluff. It crops out also in isolated foothills on the east side of Arthur's Bluff, and of the Dawson Range, near Charlevue and Cooinda Homesteads. It forms commonly low timbered hills and cuestas which can be identified on air-photos by their dark, stippled tone; the breccia is well exposed where it forms hills; where it forms gently undulating country north of the Central Railway, exposures are limited to shallow breakaways, and creek banks.

Lithology

The unit consists of large blocks and slabs 10 to 20 feet across of medium to coarse grained gritty cross-bedded quartz sandstone, set in an unsorted matrix of boulders, gravel and grit of the same sandstone. The sandstone blocks are irregularly tilted in places; in others they are so arranged that thick bedding is roughly continuous through adjacent blocks. The matrix is commonly lateritised, notably north of the Central Railway, a few miles east of Blackwater.

Structure and Relationships

The sandstone breccia unconformably overlies the Rewan Formation and appears to interfinger with other Tertiary sediments; this is very noticeable in the area between the Bluff-Jellinbah road and the Central Railway. In low hills immediately south of Bluff the breccia is overlain by lateritised Tertiary sediments. The air-photos reveal sloping surfaces, notably south of the Central Railway, which appear to be dip-slopes, dipping at 5° to 10° and striking north-west. On the ground the slopes are parallel to the bedding in the blocks of sandstone. The dips are probably depositional.

Environment of Deposition

The sandstone breccia is a subaerial deposit of restricted extent. It is derived almost totally from the Triassic Clematis Sandstone and is closely related to the present outcrop of this formation. It represents a remnant piedmont deposit. Lateral transportation of the large blocks of resistant sandstone was very small; the Clematis Sandstone was undercut by erosion of the underlying soft Rewan Formation, allowing sandstone blocks to collapse almost in place. The deposit was preserved by burial under younger Tertiary sediments; the breccia is now being reworked where this cover has gone.

Thickness

The unit varies in thickness; Derrington & Morgan (1959b) give an approximate thickness of 50 feet; in places it is probably about 100 feet thick.

Age and Palaeontology

It is probably Tertiary (pre-laterite). No fossils have been found in the unit.

Basalt

Basalt crops out in several, widely scattered areas. The largest outcrops are near Comet Downs Homestead, Raby Creek Homestead, a few miles south-west of Duaringa, and near May Downs Homestead. Small outcrops are scattered over the western half of the Duaringa Sheet. An outlier of basalt lies on the Blackdown Tableland at an elevation of about 1500 feet. Basalt produces black clayey soil and generally forms grassy downs.

The basalt is generally fine grained with clots of olivine phenocrysts. An andesitic basalt collected five miles south of Rangal consists of 40% andesine-labradorite, 40% pyroxene, 10% magnetite, about 5% rutile, and about 5% apatite. Vesicular and amygdaloidal basalt is also present. Derrington & Morgan (1959a) report the occurrence of medium grained basaltic tuffs.

Basalt flows, south-west of Duaringa, near the base of Mount Sirloin, and near May Downs Homestead, are interbedded with Tertiary sediments. Basalt is generally less than 20 feet thick; Derrington & Morgan (1959a) report 110 feet of flows at Kenmare Homestead.

Basic plugs, sills and dykes, mapped at a few places, were included in the unit. A small plug forms Mount Beardmore, about six miles north-east of Rookwood Homestead at the head of Balcomba Creek. Dunstan (1901a) describes the rock as nepheline basalt. Derrington & Morgan (1959b) report the occurrence of probable dykes and sills of medium to coarse grained basic rocks in the Minnie Creek-Cooroorah Homestead area and suggest that they are associated with the flow basalts.

Basalt is related to the widespread basalt sheet in the Emerald, Springsure and Clermont Sheet areas. It is regarded as Tertiary because it is interbedded with Tertiary sediments.

Undifferentiated Volcanics

Distribution and Topography

These rocks crop out mainly in the St. Lawrence Sheet area in the Connors and Broad Sound Ranges, and between the Ranges and the Isaacs River. Within the ranges, they form cappings on the tops of the hills, generally producing rough, boulder strewn surfaces, commonly bounded by cliffs, and steep hills. Patches of dense scrub grow on the volcanics. West of the ranges, the volcanics form rugged broken hills, commonly circular or elongate in plan.

Middlemount, a long, high ridge rising out of soil covered plains south of Warwick Homestead, in the south-west of the St. Lawrence Sheet area, is an isolated outcrop of the unit.

The only outcrop of the unit in the Duaringa Sheet area is east of Craigilee Homestead. It forms a steep sided, high area, moderately dissected with many peaks and rocky prominences.

Lithology

Rhyolite and rhyolitic agglomerate make up about 90% of the unit in the St. Lawrence Sheet area. The remainder includes dacite, toscanite, trachyte and tuff.

Rhyolite is commonly a pink, pale green or buff, very fine grained rock, Porphyritic varieties are rare; they usually contain small phenocrysts of quartz, potash feldspar, and biotite, commonly aligned parallel to flow banding. The rhyolite generally shows flow banding, either smooth or highly contorted, and is saccharoidal and vesicular in places. Contorted flow banded rhyolite is commonly associated with agglomerate containing boulders of similar material. The matrix of the agglomerate consists of a fine grained massive rhyolite. Fine grained light coloured tuff, containing bombs and fragments of rhyolitic lava in places, is associated with the agglomerate.

The unit includes flows and in some outcrops plugs of grey or cream dacite, generally porphyritic. Phenocrysts are mainly plagioclase, up to $\frac{1}{8}$" long, and less commonly quartz and biotite. Flow banding is less common than in the rhyolite but is well developed in places.

Trachyte is generally a pink to grey, porphyritic rock, containing phenocrysts of potash feldspar and commonly showing well developed flow banding. The toscanite occurs as very fine grained, dark grey, porphyritic rock containing phenocrysts of plagioclase, potash feldspar and quartz.

A light cream, medium grained trachy-syenite crops out at Middlemount. This is an elongate intrusion, about two miles long and crescentic in plan. Its northwest elongation parallels the strike of folded Permian sediments in this area. Possibly this body is a sill, intrusion of which was controlled by the sediments. Trachytic dykes and sills intrude Middle Bowen Beds and Upper Bowen Coal Measures north-east of Middlemount.

The outcrop east of Craigilee is a complex mass of acid volcanics, consisting of plugs, thick flows and radiating dykes.

The Tertiary volcanics, and associated intrusives, are unconformable on or intrusive into Carboniferous and Permian rocks in this area. The volcanics are apparently unfolded. They are deposited on an uneven land surface, and consequently vary greatly in thickness from place to place.

These rocks are regarded as being part of widespread Tertiary acid volcanic activity of this part of Queensland. This activity can be reliably dated as Tertiary in the Clermont 1:250,000 Sheet area. There is no indication of the age of these rocks in some outcrops in the Duaringa - St. Lawrence area; in others, they can be seen to be younger than Permian or Carboniferous.

CAINOZOIC

Piedmont deposits, (Czp) sandy gravels containing rounded and subangular boulders and blocks of Clematis Sandstone, form the footslopes of the Clematis Sandstone. The deposits are widespread south of Bluff and south-east of Blackwater where they also include reworked Tertiary sandstone breccia.

Undifferentiated Cainozoic (Cz) include soils, sand, alluvium, and reworked Tertiary sediments and laterite. These superficial deposits cover much of the western half of the area, and small areas in the eastern half. The deposits form featureless plains in interfluve areas with thick tree cover, including dense stands of brigalow. Black heavy-textured soil is developed in places; elsewhere they produce light sandy soils and sand cover.

Wide belts of alluvium are present along the sources of the Connors, Isaacs, Mackenzie, Dawson, and Fitzroy Rivers: mangrove swamps and alluvial flats are developed along the coast. The thickness of alluvium is variable; it is one hundred feet thick in parts of the Fitzroy River valley, east of the junction with the Mackenzie and Dawson Rivers. A water bore located four and a half miles east-north-east of Separation Homestead penetrated 275 feet of alluvium without reaching solid rock. The undifferentiated Cainozoic probably has an average thickness of less than fifty feet.

Laterite

Remnants of a laterite profile are widespread in the area. They constitute most of the top twenty to thirty feet of the dissected tablelands in the Duaringa - St.Lawrence area, west of the ranges, and crop out in smaller areas east of the ranges. The limits of the laterite are usually steep scarps in which the entire profile is exposed, as on Junee Holding and west of the Dawson and Mackenzie Rivers; in some places, the laterite has been progressively levelled off, zone by zone, until the underlying rocks are exposed.

The laterite developed mainly on Tertiary rocks, probably because these covered much of the area at the time. It also developed on igneous rocks, mainly ultrabasics, in the north-east and south-east corners of the Duaringa and St.Lawrence Sheet areas, respectively. Much of this laterite has been stripped off and reworked. The lower part of the profile was seen in a few places, grading down into deeply weathered serpentinite.

A complete laterite profile is present south of the Fitzroy River, north of Redbank Homestead. The laterite was developed on granodiorite; aplite and other veins can be traced from the granodiorite into the lateritic profile.

The laterite profile is about 300 feet above sea level near Duaringa; it is 725 feet above sea level twelve miles to the north-west. Since the laterite profile is apparently continuous, this difference in elevation suggests that either the laterite was developed on a sloping surface, or the area has suffered post-laterite epeirogenic warping.

IGNEOUS INTRUSIVES.

The largest group of igneous rocks in the area are the ultrabasic to acid intrusions of the Marlborough area. These were discussed previously in the section on the Marlborough Block. The second largest group belong to the Urannah Complex, discussed below. The other intrusions are mainly small to very small bodies of a wide variety of compositions cropping out in the eastern part of the area. The Bundarra Granodiorite is a solitary intrusive cropping out in the north-west of the St.Lawrence Sheet area.

The largest body is south-east of Armagh Homestead. It is an adamellite cropping out in the core of the Craigilee Anticline, intruding Carboniferous and possibly Permian rocks. It consists of: euhedral crystals of oligoclase, extensively altered to sericite and clay; slightly altered patch perthite, in part replacing plagioclase; quartz, partly interstitial and partly euhedral; chlorite and epidote, pseudomorphous after biotite; and small crystals of hornblende and accessory magnetite and sphene.

Adamellite crops out near Rookwood Homestead intruding the Rookwood Volcanics. This rock consists of: unaltered, euhedral laths of plagioclase, zoned from oligoclase to andesine; anhedral potach feldspar, possibly microcline, poikilitically enclosing other constituents; strained, interstitial quartz; large, ragged flakes of biotite; scattered crystals and clots of hornblende and accessory magnetite. This mass includes some dark coloured, less acid segregations. One such was a diorite consisting mainly of andesine and hornblende and accessory apatite, sphene and epidote.

Two small basic masses intrude the Rookwood Volcanics near Rookwood Creek. They are medium grained gabbros consisting of pyroxene and plagioclase (labradorite zoned to oligoclase) and interstitial chlorite and prehnite, the latter commonly spherulitic. Calcite, apatite, epidote and ilmenite are present as accessories. The composition and mineralogy of these rocks suggest they are genetically related to the magma which produced the pillow lavas of the Rookwood Volcanics. A larger body, of similar composition, crops out four miles north-west of Craigilee Homestead, intruding Middle Carboniferous sediments and Rookwood Volcanics.

A gabbro, very similar to the above, crops out on the south-west margin of the Rookwood area of Undifferentiated Palaeozoic Beds. This is an elongate body, intruded along the contact between Middle Bowen Beds and Undifferentiated Palaeozoic Beds. Another elongate intrusion was mapped about two miles further north. This rock has a very fine microgranular texture and contains large crystals possibly of pyroxene and possibly lithic fragments, including calcite. This rock may be a lithic tuff or a sheared and metamorphosed andesitic intrusive or extrusive.

Granodiorite crops out on the south bank of the Fitzroy River, east of Redbank Homestead. It consists of equal quantities of plagioclase and quartz, and less abundant potash feldspar and green hornblende. The plagioclase occurs as euhedral laths up to 3 mms. long of oligoclase - andesine, partly altered to sericite and andesine. The potash feldspar is perthitic and appears to be replacing plagioclase. It is absent in some specimens. The quartz shows well developed shadow extinction; it occurs as equant grains, about 0.8 mms. in diameter, groups of which are grown together. Hornblende is partly replaced by green chlorite. Accessory minerals include epidote and opaque iron oxide. A small intrusive was mapped ten miles west of Thuriba Homestead. This is a porphyritic rock with euhedral phenocrysts of pyroxene and plagioclase (? andesine) set in a devitrified glassy groundmass showing perlitic cracking. It is an andesitic or basaltic intrusive and may be Tertiary.

The elongate mass, mapped north of Leura Homestead, is a fine to medium grained, possibly dioritic intrusion, intruding Middle Bowen Beds and Lower Bowen Volcanics. A few, small, mainly granitic bodies were mapped near the eastern margin of the St.Lawrence Shoot area, intruding Carboniferous sediments.

The Bundarra Granodiorite crops out in the north-west of the St.Lawrence Sheet area. It occupies an area of negative relief and is surrounded by a metamorphic aureole producing a ring of high, rugged hills. The rock is very poorly exposed. It is mainly a leucocratic granodiorite but ranges to alkali granite. Biotite is the main ferromagnesian mineral ; hornblende is abundant in places and the rock approaches syenite.

The Bundarra Granodiorite intrudes and domes the Middle Bowen Beds. It was probably intruded during the folding of the Bowen Basin sequence and is considered to be Mesozoic.

URANNAH COMPLEX

Intrusives of the Urannah Complex crop out at the northern margin of the St.Lawrence Sheet area. These rocks are linked by continuous outcrop to the type area of the Complex in the Bowen 1:250,000 Sheet area. Fourteen isolated igneous masses cropping out in the central part of the St.Lawrence Sheet area are correlated with the Urannah Complex. These are similar in lithology to rock types in the Complex and were intruded on the same structural trend as the Complex.

The name Urannah Complex was introduced in "The Geology of the Bowen South area" (Malone et al.,1962). The type area is on Urannah Station in the south-east of the Bowen Sheet area. The Complex includes a wide variety of rock types and represents several phases of intrusion.

Distribution and Topography

These rocks crop out in isolated areas within the main ranges on the St.Lawrence Sheet area. They also occupy a few areas east of the ranges near the northern margin of the Sheet area. Within the ranges they tend to produce areas of negative relief relative to the adjacent Lower Bowen Volcanics. The large mass west of Tooloombah has produced a deeply incised and fairly mature valley. They are covered by deep soil and support a fairly heavy vegetation in the higher parts of the ranges, possibly due to their negative relief. Outcrops are confined to creeks and are not plentiful. Many of the areas within the ranges are almost inaccessible due to the roughness of the terrain and the thick vegetation.

Lithology

The unit includes a wide variety of rock types, any number of which may be present in individual areas of outcrop. The mass at the northern margin of the St.Lawrence Sheet includes granite, adamellite, tonalite, micro-granite, and microdiorite, and dykes of microdiorite , andesite and dacite. Granite is the main rock type in the area. It is generally pink, medium to coarse grained and, in places, is porphyritic in feldspar. Adamellite and tonalite are similar in texture to the granite;

the tonalite contains abundant hornblende with plagioclase and quartz. The micro-granite and micro-diorite are probably finer phases of the granite and tonalite. The micro-diorite and andesitic dykes, and the large, micro-diorite masses are all related but represent different phases of intrusion. Dykes are found throughout the mass. They range from a few inches to two feet wide, and commonly bifurcate; many are porphyritic. A few small xenoliths are found throughout the mass; they are dark and biotite-rich and may be dioritic to granodioritic in composition.

Similar rock types and relationships are noted in some of the masses to the south; others are different. Granodiorite is a common constituent of the mass east of Deaceys Homestead, together with monzonite, micro-granodiorite, micro-granite and granite. These rocks contain much more hornblende than do those to the north; dykes and xenoliths occur throughout the mass as before.

Only hornblende adamellite crops out in the small area at the head of K Creek. This is mainly a medium grained rock but contains crystals up to half an inch long of hornblende.

Gabbro crops out in three small areas, two south-west of Deaceys Homestead and the third south-east of there. The gabbro is massive and coarse-grained; it contains neither xenoliths nor dykes. It may be connected with the Complex at depth.

Granite and granodiorite containing a few small, biotite rich xenoliths crop out near Burwood Homestead. The masses west of Tooloombah Homestead and near the Bruce Highway are mainly acidic. They vary in composition from granodiorite through adamellite to alkali granite. Numerous north-east trending, trachyte dykes intrude the northern part of the largest mass.

Relationships

The Urannah Complex is intrusive into the Lower Bowen Volcanics. The main focus of intrusion is the core of a very broad south plunging anticline of Lower Bowen Volcanics. The Urannah Complex is of much less areal extent in the St.Lawrence Sheet area than in the Mackay Sheet area to the north. The Complex may be at a lower level in the St.Lawrence area, due to the regional south plunge. On the other hand, the Complex may be less well developed.

The Lower Permian Carmila Beds are unconformable on the Urannah Complex near the northern margin of the St.Lawrence Sheet area.

The age of the Urannah Complex is thought to be Carboniferous to Mesozoic. In this area, most of the rocks of the Complex may be basal Lower Permian.

STRUCTURAL GEOLOGY

The Duaringa - St.Lawrence area is mainly occupied by the Bowen Basin. Near the eastern margin are smaller structures, involving the Yarrol Basin sequence, and a block of presumably older metamorphics and intrusives. The Bowen Basin (or Bowen Synclinorium) consists of several structurally distinct elements. These include the 'Gogango High' which was originally considered (Hill, 1951) to be a high of the older rocks separating the Yarrol and Bowen Basins. However, in the Duaringa Sheet area the Bowen Basin sequence overlaps the Yarrol Basin sequence, and forms the bulk of the Gongango High.

The structural sketch map, Text Figure 6, outlines the main struxtural units in the Duaringa and St.Lawrence areas. These units are discussed below.

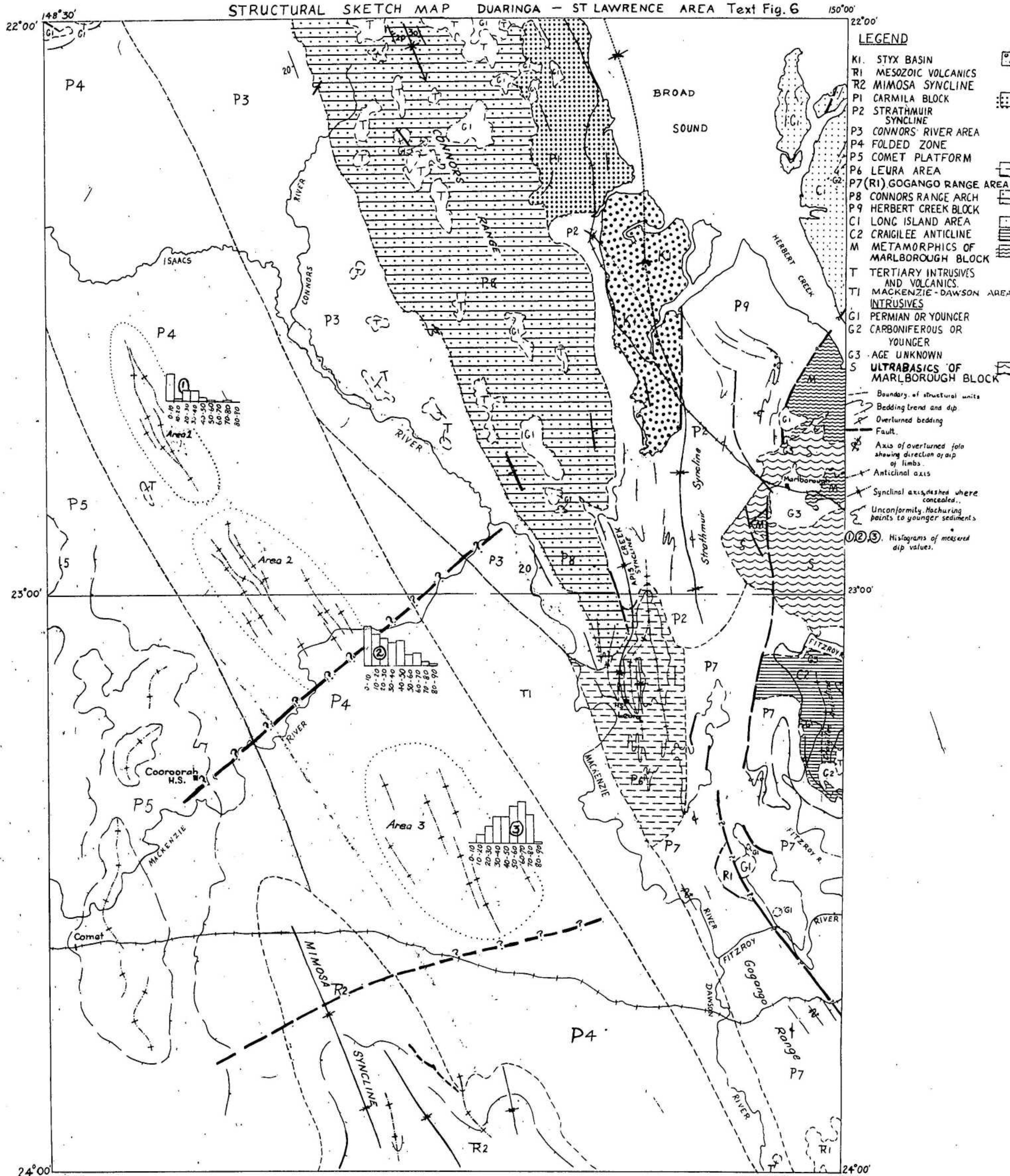
The Mackenzie Dawson Trough is a long, narrow strip between the Folded Zone and the Gogango and Leura areas. The trough is occupied by Tertiary sediments, possibly more than 1,000 feet thick. The thickness of sediments, much greater than is common for Tertiary sediments in this area, and the straightness of the trough suggest that it is fault controlled.

The Styx Basin (K1) is an elongate basin, plunging shallowly to the north. The basin is superimposed on an older syncline of similar trend. It is occupied by shallowly east dipping Lower Cretaceous sediments, unconformably overlying slightly steeper dipping Middle Bowen Beds. The basin is bounded on the east by a fault, probably a high angle reverse fault, east block up. The Cretaceous sediments are folded and faulted just west of the fault. They are absent east of the fault, where the Middle Bowen Beds are tightly folded and probably overfolded.

The Mesozoic Volcanics (R1), in the south-east of the Duaringa Sheet area, were deposited on an irregular basement and were apparently not folded.

A number of small structures are present in the northern end of the Mimosa Syncline (called the Leichhardt Syncline in some publications) (R2) within the Duaringa Sheet area. These consist of two prominent, sub-parallel synclines separated by two anticlines and a syncline. The eastern anticline is probably the result of faulting. The minor syncline and anticline to the west of the faulted anticline and the Mimosa Syncline as a whole, plunge south-south-east at a low angle. Further south, the Mimosa Syncline plunges south at a very low angle. The Mimosa Syncline is cut near its northern end by a north-north-east trending fault, south block down,

The Carmila Block (P1) is mainly a shallowly east dipping block of volcanics and sediments, the Carmila Beds. The block forms the western flank of an elongate, south plunging syncline. The nose of the syncline was mapped further north in the Mackay Sheet area. The eastern flank of the structure is missing, replaced by an upfaulted block of Upper Devonian to Lower Carboniferous volcanics and sediments.



To accompany Record 1963/60

The Strathmuir Syncline (P2) is a north to north-west trending structure occupied by Middle Bowen Beds. The syncline is outlined on the west and north-east by fossiliferous sediments and volcanics at the top of the Lower Bowen Volcanics. The structure loses its identity amid tightly folded and sheared sediments in the Duaringa area. On the western flank, the dips are generally less than 30° and the beds are folded into few minor structures. One fold, the Apis Creek syncline, is separated from the Strathmuir Syncline by anticlines with cores of Lower Bowen Volcanics. The eastern flank of the Strathmuir Syncline is quite complex; the Middle Bowen Beds are tightly folded in places, and faulting is common. The folding and faulting are possibly a result of thrusting from the east of the Marlborough Block.

The Strathmuir Syncline may be a southern extension of the syncline whose western flank is formerly the Carmila Block. The relationship between the two structures is obscured by the overlying Styx Basin sequence and the sea.

The Herbert Creek Block (P9) consists of Lower Bowen Volcanics. At the northern end of the block they dip southwest and form the north-east flank of the Strathmuir Syncline. Farther south, the Volcanics are tightly folded and generally dip east. These east dips may be overturned, due to thrusting of the Marlborough Block from the east. The trend of east dipping Lower Bowen Volcanics is almost parallel to the partly faulted boundary of the Marlborough Block.

The Connors River area (P3) consists of poorly exposed Middle Bowen Beds dipping to the west-south-west, away from the Lower Bowen Volcanics. The beds are involved in few minor folds and dip at angles generally less than 30°. They form the southerly extension of the eastern flank of the Bowen Syncline which extends from Collinsville to Leura Creek and disappears in the more complex folding of the Leura area.

The Folded Zone (P4) was previously referred to as the Dawson Tectonic Zone (Derrington, 1961). It is shown on the structural sketch map as an elongate, straight-sided zone, including three areas of outcrop and near outcrop of Middle Bowen Beds and Upper Bowen Coal Measures, areas 1, 2 and 3. Middle Bowen Beds domed by Bundarra Granodiorite (G1) are also included at the northern end of the zone. Within areas 1, 2 and 3, the attitudes of the beds were measured at many exposures, mainly in streams, and the strike of the beds is revealed by trends clearly visible on the aerial photographs. The measured dips and the bedding trends reveal tight to sub-isoclinal folding with generally parallel fold axes. Very tight minor folds occur on the flanks of major structures. The range of the measured dips is shown by the histograms on the strctural sketch map. Histograms 1, 2 and 3 refer to dips measured in areas of outcrop 1, 2 and 3 respectively. The histograms appear to indicate a progressive decline in the tightness of the folding from south to north. This decline may not be as rapid as the histogram 1 would indicate as it is based on relatively few measurements.

Up to 4,000 feet of Middle Bowen Beds are exposed in the Mackenzie River at the southern end of area 2. The same unit is found in the cores of other anticlines in areas 1 and 2 but the thickness exposed is less. The Folded Zone plunges regionally north from the Mackenzie River along the axial trend. A minor reversal of the direction of plunge is revealed by the greater thickness of Middle Bowen Beds exposed in area 1 anticlines than in area 2 anticlines. This plunge is reversed at the north-west corner of the St.Lawrence Sheet area where the sediments are domed by the Bundarra Granodiorite.

No Middle Bowen Beds were recognized in area 3 of the Folded Zone. The structures in this area are tighter than those to the north and are dissected to the same topographic level. The absence of Middle Bowen Beds suggests that the area is structurally lower. A north-east trending fault, along the line of the Mackenzie River is postulated between areas 2 and 3 to explain this difference in structural elevation. This faulting may explain a small but obvious difference in trend directions. The trend of areas 1 and 2 is 330° - 335°; the trend of area 3 is 340°.

A similar fault may cut the folded zone south of area 3. This is probably a continuation of the fault cutting the northern end of the Mimosa Syncline. The movements on both faults is probably similar (south block down) and both may be normal faults. Tertiary sediments overlap the Folded Zone south of area 3; this is compatible with a suggested lower structural position of the folded zone, south of the southernmost fault.

A reconnaissance seismic survey (Robertson, 1961) shows shallow dips below the Folded Zone at about 20,000 feet depth. This suggests that a decollement separates the tightly folded Permian sediments from the underlying rocks. The mechanism of the folding is not known. Slight overturning, producing steep east dips, and a few east dipping thrust faults indicate stress from the east, but there is no evidence of large scale thrusting. The sediments are only moderately indurated; cleavage, jointing and faulting are rare. The transition from the tight folds of the Folded Zone to the gentle folds of the Comet Platform to the west may be due to the presence of shallow basement in the Comet Platform area.

The <u>Comet Platform</u> (P5), (Derrington, 1961) occupies the south-west part of the Duaringa - St.Lawrence area, west of the Folded Zone and Mimosa Syncline. Structures within the Comet Platform area are low amplitude, short wave length folds with sinuous axial trends. Dips are generally less then 15° but are steeper north-east of Coorcorah Homestead, towards the Folded Zone.

Middle Bowen Beds are exposed over 150 square miles, surrounded by Upper Bowen Coal Measures in an anticlinorium east of Comet. Less than 1,000 feet of Middle Bowen Beds are exposed in this structure, indicating the low amplitude of the folding.

Bedding trends on air-photos in the Upper Bowen Coal Measures outline structures in many places. These trends show that structures affecting one horizon may not affect another horizon a few hundred feet up or down in the section.

East dipping Middle Bowen Beds crop out in the south-west of the St.Lawrence Sheet area and are included in the Comet Platform. These beds form part of the western flank of the Bowen Basin.

Three structural units, the Connors Range Arch, the Leura Area and the Gogango Range Area are recognized in the Gogango High.

The Connors Range Arch (P8) forms the southern end of the Eungella Strip (Hill, 1960). It is a south plunging anticline composed of Lower Bowen Volcanics, intruded by the Urannah Complex (G1) and Tertiary volcanic plugs (T) and capped by Tertiary flows(T). It may include some rocks older than Permian. The arch appears to be a broad, simple structure, not an anticlinorium. Some bedded volcanics in the unit are steeply dipping, suggesting some local tight folding. On the other hand, the steep dips may be due to contemporaneous slumping during deposition of the volcanic pile.

The Leura Area (P6) is located at the southern end of the Connors Range Arch. It consists of tightly folded Middle Bowen Beds with Lower Bowen Volcanics in the core of a complex dome bifurcating into two anticlines at its southern end. The southern extension of the Apis Creek Syncline is located between this dome and the Connors Range Arch. The structures in the northern part of the Leura area plunge to the south. Further south, the structures are mainly domes and basins, with north-south elongations. In this area, the regional plunge is effectively flat. Dips are generally less than 50°, and no evidence of overturning was seen,

The Gogengo Range Area (P7) is characterised by sheared sediments, steep and overturned dips, overfolding, faulting, and possibly thrust faulting. This area is occupied mainly by Middle Bowen Beds. Lower Bowen and Rookwood Volcanics occupy what appear to be the cores of complex, in places faulted anticlines. The southern blocks of Undifferentiated Palaeozoic Beds show the same type of structures as the Middle Bowen Beds and are included in this structural unit. The smaller block of Undifferentiated Palaeozoic Beds is delineated on the structural sketch-map as unit R1. The beds within unit R1 dip to the east at low angles; the shallow dips and lithological changes are reflected in a marked photo pattern change. The western boundary of the unit is arcuate and marked in places by lineaments; it is possibly a low angle thrust block. The arcuate western boundary is more or less concentric about a granodiorite intrusion (G1) a few miles to the east and may be related to the intrusion of that body.

The Long Island Area (C1) is a block of steeply dipping Carboniferous sediments, sheared and intruded in places. Insufficient work was done in this area to indicate the nature of the structures; on air photos the strike of the beds on Long Island appears to be sinuous.

The Craigilee Anticline (C2) is a sinuous, intruded anticline involving Devonian/Carboniferous Volcanics, Carboniferous sediments, Dinner Creek Beds and Rookwood Volcanics. Dips on the eastern flank are generally less than 45°. The beds on the western flank are generally steep with overturning in places. Some apparent thinning of units on the western flank may be due to faulting.

The Marlborough Block (M.S.) consists of metamorphics (M) and ultrabasics (S) which are probably the oldest rocks in the area. The boundaries of the block are concealed in many places. It appears to be faulted against the Lower Bowen Volcanics of the Herbert Creek Block (P9). A diorite mass intrudes both the metamorphics and the Lower Bowen Volcanics at this contact. The ultrabasics are shown in contact with Lower Bowen Volcanics and Middle Bowen Beds west of Marlborough. The contact was not seen on the ground and the actual relationship is not known.

The ultrabasics are either intrusive into or faulted against the Carboniferous and Permian rocks as the contacts cut across Carboniferous and Permian structures. If the serpentinite is Middle Devonian or older (as suggested by Hill, 1951) the contacts must be faulted. No direct evidence to support this was seen in the field.

A number of faults are shown on the structural sketch map in the eastern part of the area. The movement on most of these is east block up. They are possibly high angle reverse faults.

The probable fault east of sub-unit R1 is marked by a long thin trough of Cainozoic sediments north of the Fitzroy River and by the smoothly curved eastern margin of the Gogango Range. Movement on this fault may be east block up. It trends north-west and then north, parallel to the curving axis of the Craigilee Anticline. This fault forms part of a curving line of slightly offset faults, which extends from the Central Railway in the Duaringa area north-west, then north, then north-east to Herbert Creek in the St.Lawrence area. East of this fault area lie most of the Marlborough Block, the Craigilee Anticline and part of the Gogango Range Area. Immediately west of it is the zone of overturning and shearing of the Herbert Creek Block, of the eastern flank of the Strathmuir Syncline and of the Gogango Range Area. Further west, the overturning and shearing pass gradually into the simpler structures of the north-west Herbert Creek Block, of the western flank of the Strathmuir Syncline and of the Loura Area.

This fault line is not the boundary of any simple thrust block. However, it may mark the western limit of major faulting resulting from the thrusting.

Intrusives

Only two intrusives, the Bundarra Granodiorite (G1) and a Tertiary sill (T) are found in the Folded Zone. All other intrusive rocks are found east of the Folded Zone. Many are intruded into or near the Connors Range Arch and may have been intruded during the volcanic phase which produced the Lower Bowen Volcanics.

The Carboniferous or younger intrusives (G2) intrude Carboniferous rocks; however, they may be related to the orogeny which folded the Bowen Basin sequence.

General

The area of tightest folding in the Fold Zone, Area 3, is close to the Gongango Range area (P7), which is the most tightly folded part of the Gogango High. The reduction in intensity of folding northwards in the Folded Zone is similar to the reduction northwards in the Gongango High. However, dips in Area 1 of the Folded Zone are steeper than those found on the west flank of the Conners Range Arch. Intensity of folding in the sediments appears to be proportional to distance to basement or to underlying massive volcanics and intrusives.

The type of folding and the number of intrusions is reasonably uniform within each of the Gogango High, the Folded Zone and the Comet Platform. There is a much more marked change between these zones. Folding becomes progressively gentler and intrusions less common westwards, from the Gogango Range area to the Folded Zone and then to the Comet Platform. This may be due to each of the basement blocks below these areas being shallower than the preceding block to the east. (Basement here refers to the volcanics and sediments which underlie the Bowen Basin sequence). The Emerald-Duaringa Seismic survey (Robertson, 1961) indicated a depth of about 4,000 feet to basement in the Comet Platform area. Basement depth increased gradually eastwards to about 12,000 feet across the axis of the Mimosa Syncline. Further east still near Bluff a number of high angle reverse faults were recorded. In the Exel Mine, at Bluff, a low angle thrust fault is exposed. Both the subsurface reverse faults and the thrust fault dip east. A few horizontal dips are recorded below the Folded Zone from a depth of about 20,000 feet, which may be the depth to basement. This depth is not related to the thickness of section involved in the folding. The depth to basement in the Gogango Range area is not known.

GEOLOGICAL HISTORY

The oldest rocks in the area are the metamorphics in the Marlborough area. These were regionally metamorphosed and intruded by the ultrabasic complex, possibly as a large sill. Subsequently, the metamorphics and ultrabasics were folded and intruded by a succession of basic to acid intrusives, the youngest of which is probably post Permian.

The Silurian to Devonian sediments near Armagh and Thuriba Homesteads indicate that marine sedimentation took place in these areas at that time. Nothing is known of the extent of the sedimentation or of the subsequent geological history of the sediments.

Yarrol Basin sedimentation in the Craigilee area commenced with intermediate to basic volcanism in the Upper Devonian to Lower Carboniferous. This was succeeded transitionally by Lower Carboniferous (Visean) carbonate deposition. Thereafter sedimentation continued to the Lower Permian, interrupted by many hiatuses but no angular unconformities. In the Craigilee area, the Bowen Basin sequence overlaps the Yarrol Basin sequence.

The Bowen Basin was initiated at about the beginning of the Permian. Deposition commenced along the eastern margin, probably in a parallic, shallow water, partly marine environment with numerous volcanic islands. The Basin subsided to accommodate the Lower Bowen Volcanics and the Carmila Beds. About this time, the Rookwood Volcanics were extruded in a marine environment further east, conformably overlying the Yarrol Basin sequence.

Towards the end of the Lower Bowen Volcanics deposition, the Bowen Basin was established as a major marine sedimentary basin. The most rapid subsidence took place in the Eastern Region of the Duaringa-St.Lawrence area, where a considerable thickness of partly volcanic derived Middle Bowen Beds accumulated. Major downwarping of the Bowen Basin may have been accompanied by folding and uplift of the Yarrol Basin to the east. Erosion of the Yarrol Basin sequence and particularly of the volcanics at the top may have supplied much of the Middle Bowen Beds of the Eastern Region.

The sea transgressed westwards progressively; before the end of the Lower Permian it extended to the west of the Duaringa - St.Lawrence area. The Middle Bowen Beds are thinner in the western and central part of the area than in the Eastern Region; differences of lithology from west to east probably reflect different provenances.

The Undifferentiated Palaeozoic Beds are associated with the Middle Bowen Beds in the Eastern Region. The relationship is not clear. Possibly they represent a phase of volcanism and sedimentation after or late in the Middle Bowen Beds. Alternatively, they may be older rocks, placed in position by complex structural adjustments.

Early in the Upper Permian, the Bowen Basin changed gradually from a marine basin with a rich fauna to a restricted or freshwater basin apparently devoid of marine fauna and favouring preservation of plant material. The gradual change is shown by the transitional contact between the Middle Bowen Beds and the Upper Bowen Coal Measures in the west of the area. There were probably sporadic marine transgressions during the early part of deposition of the Upper Bowen Coal Measures, because lithologies typical of the Middle Bowen Beds are interbedded with basal Upper Bowen Coal Measures.

The Rewan Formation marks a further change of provenance and possibly basin environment. The chocolate to purplish red colour of much of this formation is due to the presence of ferric iron. The greenish sediments, interbedded with the chocolate sediments, contain ferrous iron and indicate that the depositional environment was not oxidizing. The ferric iron was derived from the provenance. Possibly the provenance area was subjected to a prolonged, weathering cycle, possibly under conditions of alternating humid and arid seasons such as are associated with present day lateritization processes. The high percentage of hematite and alumina in chocolate shale of the Rewan Formation suggests it could have been derived from a lateritic land surface (Phillips, in Hill and Denmead, 1960, pp.188). The presence of sediments typical of the Upper Bowen Coal Measures in the Rewan Formation indicates that the provenance is still partly the same. The reduced quantity of plant and wood remains in the Rewan Formation and the nature of the chocolate sediments suggest the change from the Upper Bowen Coal Measures to the Rewan Formation was possibly due to a change of climate. There is no evidence in the Duaringa - St.Lawrence area of unconformity or disconformity between the two units.

The Clematis Sandstone was deposited in Middle to Upper Triassic. The abrupt change from the chocolate shale and lithic sandstone of the Rewan Formation to the mature, quartz sandstone of the Clematis Sandstone indicates a considerable change of depositional environment and provenance. The contact between the two is structurally conformable in most places and faulted in some; it is probably disconformable.

The orogenic phase of the Bowen Basin may have commenced during or before the deposition of the Clematis Sandstone. It was most profound in the Eastern Region, where the Yarrol Basin and Bowen Basin sediments were folded, intruded and later partly overturned to the west.

The overturning is most common in the Middle Bowen Beds: a narrow, deep trough of dominantly lutites might be expected to yield more readily than the more competent and more extensive Yarrol Basin sequence to the east. The type of folding changes and the tightness of folding decreases to the west. The sub-isoclinal folding of the Folded Zone is separated by a decollement from the underlying basement. Apparently there were no intrusions into most of the Folded Zone; the Bundarra Granodiorite was intruded in a tectonic environment which was different from that of the Folded Zone to the south. The intrusive phase of the orogeny possibly continued for a long time. It may have commenced in early Permian while the youngest intrusives are possibly Triassic. The metamorphic and ultrabasic block of the Marlborough area was possibly faulted into its present position at a late stage in this orogeny. Some of the intrusives associated with the block are intruded along the fault contacts and intrude Permian rocks.

The subsequent history of the area is mainly epeirogenic rather than orogenic. The ?Mesozoic Volcanics of the south-east of the Duaringa Sheet area are probably Triassic-Jurassic; they are unfolded volcanics, unconformably overlying ?Middle Bowen Beds.

The Styx Coal Measures were deposited in a basin which downwarped in late Jurassic to early Cretaceous; this basin overlies the Strathmuir Syncline and was possibly controlled by this older structure. The present eastern margin of the Coal Measures is a high angle reverse fault, similar in kind to many of the faults in the Eastern Region. Possibly some of the faulting and overturning in this region took place during or after the Cretaceous.

Acid to intermediate volcanics and associated intrusion was a feature of the Tertiary. These were most common in the Connors Range Arch, near the main line of intrusion of the Urannah Complex. Tertiary basalt was extruded over part of the area as isolated sheets. There is no evidence that the isolated remnants once formed part of a continuous sheet. Tertiary sediments, commonly lateritized, cover much of the area. Their thickness and, particularly around Bluff, their lithology were controlled by the pre-existing topography.

There was possibly some epeirogenic warping of the area since the formation of the laterite profile on the Tertiary sediments. This initiated the present cycle of erosion which has removed much of the Tertiary cover. Widespread blankets of Cainozoic sand and gravel and deep alluvial deposits along the rivers cover much of the area.

ECONOMIC GEOLOGY

Coal is the only mineral product of any importance in the Duaringa and St.Lawrence Sheet areas. Production is confined to two areas; the central part of the Duaringa Sheet area, from the Permian Upper Bowen Coal Measures; and the eastern part of the St.Lawrence Sheet area, from the Lower Cretaceous Styx Coal Measures.

Duaringa Sheet area. Coal has been prospected for, and found, over a large area of the Duaringa Sheet, but to date has been mined in the Rangal and Bluff areas only. It was first recorded by Leichhardt in 1845, cropping out in the banks of the Mackenzie River. Several shafts were sunk, and tunnels driven, in the Tolmies area before 1895. For a few years after 1900, a seam up to twenty-four feet thick (the Mammoth seam) was prospected near Jellinbah Homestead. Later this seam was traced south towards the Central Railway. The Mount Morgan Gold Mining Company sank several shafts between Jellinbah and Blackwater. These shafts produced little coal because the quality of the coal and distance from transport made them uneconomic compared to other sources. The Mount Morgan Company eventually obtained coal from Baralaba.

There was some prospecting for coal west of Duaringa between 1900 and 1910. One seam was opened up but the coal was too soft and friable to transport. Several seams were located, up to ten feet thick, but were generally steeply dipping, anthracitic coal. During this time, several seams up to seven feet thick were found five miles north-east of Bluff.

Coal was discovered cropping out in Duckworth Creek, near Bluff in 1903. Four collieries have operated in the Bluff area; of the four the Excel and the Cambria are still operating. The various collieries, their period of operation and approximate production figures to 1960 are given in the following table:

Bluff Colliery	(1905-1925)	165,000 tons
Windsor Colliery	(1933-1957)	250,000 tons
Excel Colliery	(1939-1960)	345,000 tons
Cambria Colliery	(1926-1960)	550,000 tons

The total production for the field is about 1,310,000 tons.

At the present time, the Cambria mine works a twelve foot thick seam, and the Excel a six foot thick seam. The two seams are separated by about 140 feet of shale, siltstone and sandstone. The coal is low volatile bituminous to semi-anthracite.

A colliery operated at Rangal from 1923 to 1940; about 140,000 tons of coal was produced from a ten foot thick seam.

Utah Development Company is currently carrying out a programme of detailed mapping and drilling to evaluate reserves of coking coal suitable for open cut mining. They are working mainly in the area west of Blackwater, north and south of the Central Railway.

<u>St.Lawrence Sheet area:</u>

<u>Styx Coal Field:</u> Coal was first discovered in the Styx River area in 1887, and there was some prospecting for two or three years. It was not until 1918 that a shaft was sunk by the Queensland Government at Bowman to exploit a promising seam previously located by diamond drilling. Production commenced at this mine, known as Styx No.1 State Colliery, Bowman, in the following year. Owing to the unsuitability of the first site, a second shaft Styx No.2 State Colliery, Bowman, was sunk ten chains to the south. The mines at Bowman were abandoned in 1925 in favour of a third pit commenced in 1923 at Ogmore, two and a half miles to the north. This mine worked for two years as Hartley State Colliery, and then continued to the present, on the one seam, as Styx No.3 State Colliery, Ogmore. Private enterprise entered the field in 1930, when the Bowman Coal Mining Syndicate opened up a colliery adjacent to the old State Mine at Bowman.

<u>Production</u>

Colliery	Tons	Value (£)	Years of Production.
Styx No.1, Bowman	4,930	4,800	1919-21
Styx No.2, Bowman	103,344	106,261	1921-25
B.C.M.S., Bowman	62,193	61,032	1932-48
Styx No.3, Ogmore	1,556,251	2,831,318	1924-61
TOTAL	1,726,718	3,003,411	1919-61

In 1948 to 1951 the Queensland Mines Department tested an area near Tooloombah Creek, by diamond drilling. Three seams, each with a minimum thickness of three feet, were found. The drilling proved reserves of four million tons of coal, in seams more than three feet thick; approximately half was in seams over four feet thick. These reserves have not yet been exploited.

St.Lawrence Township Area: The occurrence of coal in the St.Lawrence area was known before 1889. The Broadsound Coal Company engaged in a vigorous prospecting campaign between 1889 and 1891. Seven bore holes and at least five shafts were put down in the vicinity of St.Lawrence. They were successful in locating coal in a shaft within one-quarter of a mile of the wharf at Newport, on Waverley Creek, about three and a half miles south-east from St.Lawrence. However, an influx of water in June 1891 forced closure of the mine and no production is recorded.

Coal from a dump near the old shaft has been analysed -

Fixed carbon	63.6%
Volatiles	24%
Ash	9%
Moisture	3.4%

GOLD

Gold was discovered at Yatton, seven miles east-south-east of Croydon Homestead, around 1880, and about 5,000 ounces of gold was estimated to have been won by gully raking before the field was proclaimed in 1886. Recorded production since then has been negligible, and the field was abandoned by 1891.

Jack (1888) described the field, and referred to "dioritic country rock intersected by dykes of silicated felsite". The gold occurs as flakes associated with quartz, calcite and siderite in brecciated zones within the diorite.

Gold also occurs in quartz veins cutting volcanics of the Carmila Beds in the Salt Hill area nine miles north-north-east of St.Lawrence. Only production recorded is 7 ounces of gold in 1950.

MOLYBDENITE

Ball (1918a) reports quartz-molybdenite veins with some chalcopyrite cutting granite in the Connors Range, near Cardowan. He gives the locality as twenty-eight miles north west of St.Lawrence, and forty miles by road. No production is recorded, and the highest of three assays done gave 0.6% MoS_2.

LIMESTONE

Connah (1958) reports a limestone belt up to at least 220 feet thick about Yatton. The distance from the railway is a serious disadvantage. An assay of Yatton limestone by AMDL gave 0.028%.P.

MAGNESITE

Magnesite was noted at several places in the ultrabasic complex south and south-east of Marlborough. The magnesite is generally high grade and occurs in veins of various sizes. The most important mine is Frasers Workings, six and a half miles south-south-east of Marlborough. Reserves are probably a few thousand tons; to date only small amounts have been mines.

It was noted in the field that the magnesite was often close to gabbro dykes; the magnesite may be due to alteration of the serpentinite by the gabbro.

CHROMITE

Small deposits of chromite have been mined at several places in the ultrabasic complex. All deposits are relatively small and the chrome/iron ratio is below that required for chrome ore. Some chromite has been mined for use as metallurgical ore. X-ray spectrochemical analysis of a chromite floater, collected during the 1962 season, gave a chromium/iron ratio of 1.9 : 1; the floater contained 27.7% chromium and 14.4% iron. Small deposits of alluvial chromite may be found in the ultrabasic complex.

COPPER

Copper has been recorded from Lower Bowen Volcanics north-east of Balcomba Homestead and in the Collaroy Homestead area. The copper occurs as native copper, sulphide, oxide and carbonate in veins which are generally irregular and discontinuous.

OIL SHALE

Tertiary oil shale has been recorded from bores in the Duaringa area and also cropping out in the Dawson River south-east of Duaringa. Distillation tests on samples from outcrop gave yields of 10 - 21 gallons per ton. A drilling programme carried out by the Queensland Mines Department west of Duaringa revealed only thin beds of oil shale within 200 feet of the surface.

Ball (1927) reports a shale from Styx Pit, which on destructive distillation yielded crude oil at one gallon per ton.

NICKEL

Two samples were collected during the 1962 survey from the base of the laterite profile developed on the ultrabasic complex, south-west of Marlborough. Analysis of the two samples gave nickel contents of 0.19% and 0.63%. An iron ore boulder from the ferruginous zone of the laterite profile contained 0.16% nickel and 0.88% chromium. The laterite profile has been eroded from most of the ultrabasic complex. Prospecting may locate deposits of nickel in the remaining laterite or in areas of reworked laterite.

IRON

Boulders of iron ore are contained in reworked laterite near the south-west of the ultrabasic complex. The quantity and quality of the iron ore are not known. A grab sample of laterite soil from three miles south-east of St.Lawrence was analysed and contained 17% iron and 9% aluminium.

WATER

There are no artesian water bores in the area. The rainfall of the area is reasonably high and the pasturalists rely on surface water and dams for most of their water. A large number of bores have been sunk into river alluvia to supplement surface water supplies during the dry winter months. A few bores have been sunk in the Upper Bowen Coal Measures and the Middle Bowen Beds of the Comet Platform area. Some of these have proved good producers but aquifers are difficult to predict. Very few records of these bores exist.

PETROLEUM

The Eastern Region of the Duaringa and St.Lawrence area consists mainly of volcanics and complexly folded, intruded, and metamorphosed sediments. There is virtually no possibility of petroleum production from these rocks.

Further west, in the Folded Zone, the sediments are not metamorphosed to any extent and intrusions are rare . The Upper Bowen Coal Measures include good cap rocks and the Middle Bowen Beds include source and possible reservoir rocks. However, the structures are very tight and steep flanked throughout most of the zone. The steep dips make seismic prospecting almost impossible, and it would be difficult to locate structural targets. In addition, the areal extent of closure would probably be fairly small because of the tight folding.

Nothing is known of the lithologies and structures of Permian sediments between the Folded Zone and the Eastern Region. This is probably, though not necessarily, a zone of tight folding.

Near the western margin of the Folded Zone structures are broader and flank dips are gentler. A complex anticline, closed in Upper Bowen Coal Measures, was mapped in the St.Lawrence Sheet area, nine miles south-east of Foxleigh Homestead. This structure has closure over an area possibly up to ten square miles and probably persists at depth. The western margin of the Folded Zone and further west, particularly in the St.Lawrence Sheet area, may be quite prospective. Here, the Middle Bowen Beds and the lower part of the Upper Bowen Coal Measures, contain considerable thicknesses of quartz sandstone which are potential oil reservoirs. The area is on the western flank of the Bowen Basin where up dip migration of oil from potential source rocks in the deeper part of the Basin is possible.

The attractiveness of this area is reduced by the results of the A.F.O. Cooroonah No.1 Bore. This penetrated about 3,000 feet of Middle Bowen Beds, including considerable quartz sandstone. However, the sandstone was hard and siliceous and had very little porosity. It is not known if silicification of the sandstone is a local phenomena or is widespread in the area. If widespread, then the oil potential of the area is very limited. The area warrants further investigation to determine its oil potential.

The Middle Bowen Beds in the Comet Platform area are gently folded and unaltered, and include considerable thicknesses of quartz sandstone. The sequence may contain accumulation of oil. However, the structures are shallow and sinuous and some apparent culminations may not be effectively closed. Closure in the Upper Bowen Coal Measures is probably necessary to ensure an effective cap over any structure.

SUMMARY OF GEOLOGICAL RESULTS AND PROBLEMS

The most important result of the 1962 season mapping is that the Bowen Basin overlaps the Yarrol Basin in the north-east of the Duaringa Sheet area. The relationship is displayed in a structurally conformable sequence on the west flank of the Craigilee Anticline. The lower part of this sequence is identified as Yarrol Basin Sequence on lithologies and fauna; the upper part is identified as Bowen Basin sequence on lithologies and distribution. The nature of the succession in this area, from Devonian/Carboniferous volcanics to Permian Middle Bowen Beds, requires further study. It probably includes major disconformities and possibly angular unconformities though the main folding is late- or post-Permian.

The Yarrol Basin sequence was mapped in general terms only. It is well developed in the complex Craigilee Anticline, a structure requiring, and worthy of, much more detailed mapping. The Silurian/Devonian rocks near Armagh Homestead require further study to establish their relationship to the Yarrol Basin sequence.

The Gogango High was originally thought to consist of older rocks separating the Bowen and Yarrol Basins. The 1962 mapping shows that it is a complex structural zone within the Bowen Basin and consists mainly of Permian sediments and volcanics. An inlier of Silurian/Devonian rocks was mapped in the south-east of the Duaringa Sheet area, on the trend of the Gogango High. The inlier is overlain by ?Middle Bowen Beds but apparently by none of the Yarrol Basin sequence. Thus the 'Gogango High', in this area, contains older rocks which were west of the Yarrol Basin but were overlapped by the Bowen Basin. The 'Gogango High', particularly south of Balcomba Homestead, requires much more work to establish:

(i) the relationship and extent of the Silurian/Devonian rocks;
(ii) the age of the ?Middle Bowen Beds;
(iii) the age and relationships of the Undifferentiated Palaeozoic Beds; and
(iv) the age of the ?Mesozoic volcanics.

Mapping in the Baralaba and Monto Sheet areas during 1963 may throw light on some of these problems.

The Carmila Beds of the St.Lawrence Sheet area require further work to clarify their stratigraphic position. They may be equivalent to the bedded volcanics and sediments at the top of the Lower Bowen Volcanics and the base of the Middle Bowen Beds in the Apis Creek to Tooloombah Homestead area. The Carmila Beds are unconformable on intrusions of the Urannah Complex. Three age determinations on rocks of the Complex give ages very low in the Permian but the Complex includes some younger intrusions. Further samples will be collected during 1963 to give more information on the age of the Complex and other intrusives in the area.

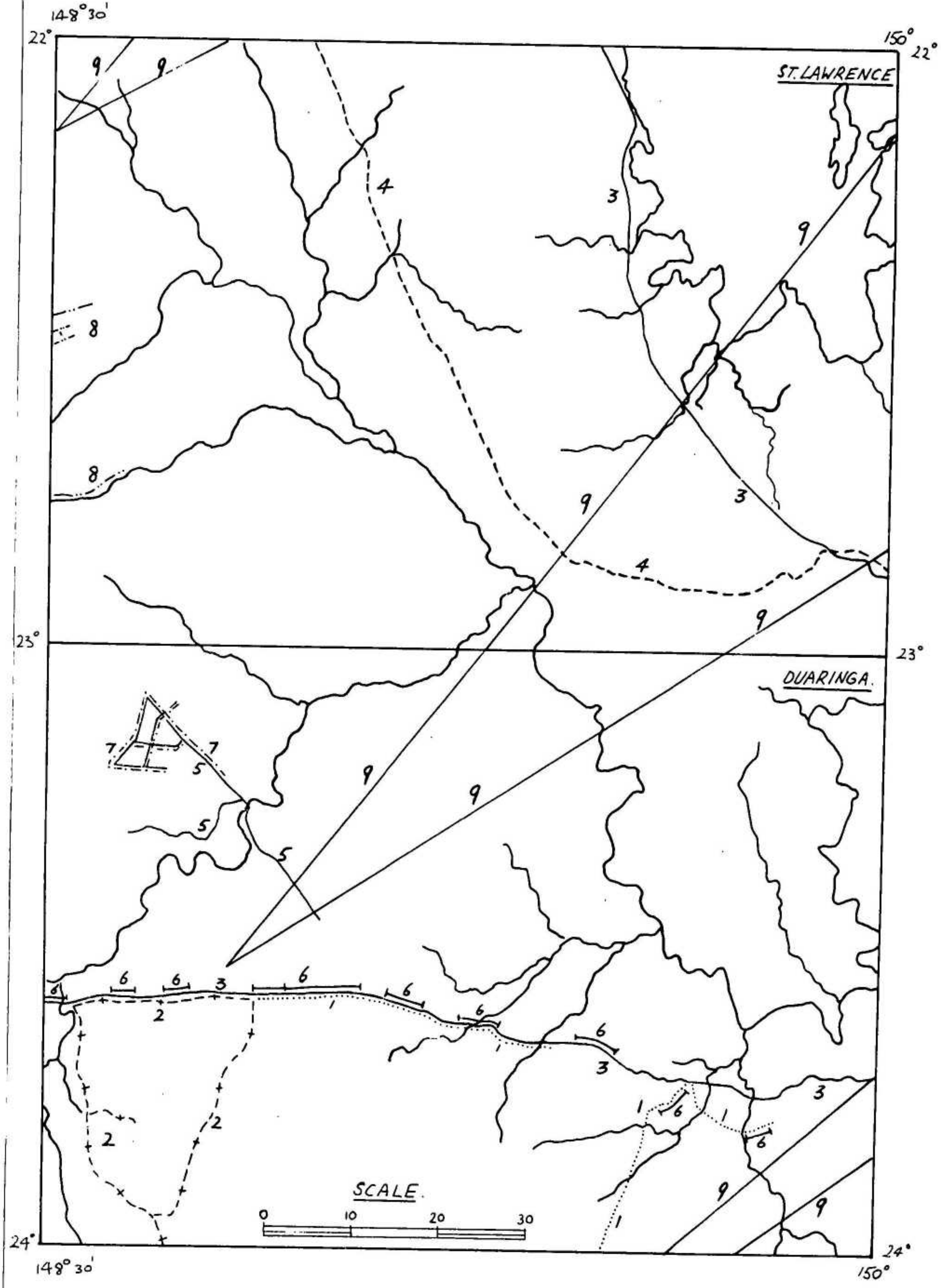
The 1962 mapping in the Folded Zone of the Bowen Basin assisted in correlating the Middle Bowen Beds of the northern part of the Bowen Basin with those of the Springsure area. A fossil fauna collected near the Mackenzie River can be correlated with the fauna of the Ingelara Shale, Springsure area, and the fauna of unit B2 of the Middle Beds of the northern Bowen Basin. (Dickins et al,1962). This reinforces our belief that the Middle Bowen Beds can be subdivided into broad units of basin wide extent.

The relationship of the Rowan Formation to the Upper Bowen Coal Measures is not definitely established yet. No evidence of an unconformity between the two units was seen in this area. Further north, in the Mount Coolon Sheet area, equivalents of the Rewan Formation were included in the Upper Bowen Coal Measures. Whether or not an unconformity exists at the base of the Rewan Formation in the type area will be examined during 1963.

The most important problem for future work is correlation of the Permian/Triassic succession of the northern Bowen Basin, including the Duaringa - St.Lawrence area, with the Permian/Triassic succession of the southern Bowen Basin and of the subsurface below the Surat Basin. Rationalising the nomenclature used in these areas will also present a considerable problem.

Figure 7.

LOCALITIES OF GEOPHYSICAL SURVEYS



Gravity Surveys

(1) Warren, 1959

(2) Oldham, 1958

(3) Marshall & Norain, 1954

(4) Eastern Australian Regional Net

(5) Burbury, 1959

Seismic Surveys

(6) Robertson, 1960

(7) Moss and Morton, 1961

(8) Mines Administration Pty Ltd. (In progress)

Aeromagnetic Survey

(9) Hartman, 1963

To accompany Record 1963/60

F 55/10

RÉSUMÉ OF GEOPHYSICAL INVESTIGATIONS

A considerable amount of geophysical work of various kinds has been carried out in the Duaringa and St. Lawrence Sheet areas. Some are regional projects which covered the entire area; others are more detailed investigations of small areas or reconnaissance work covering only part of the area.

Seismic

A seismic refraction traverse (Smith, 1951) near Comet in the west of the Duaringa Sheet area was the earliest seismic work in the area. A detailed seismic survey was made of the Cooroorah Anticline in 1959 (Moss and Morton). Subsequently, a discontinuous reconnaissance seismic reflection line was shot from Emerald to near the Dawson River, along the highway (Robertson, 1961). These surveys were carried out by the Geophysical Branch of the Bureau of Mineral Resources. In 1962, a seismic survey of the Clermont-Annandale area was commenced by United Geophysical Co. for Mines Administration Pty Ltd. This survey includes some lines shot in the western part of the St. Lawrence Sheet area.

Gravity

Some gravity measurements were made by Marshall and Narain (1954) as part of a regional gravity investigation of eastern and central Australia. Some measurements were also made along the Bruce Highway in the St. Lawrence Sheet area by the Bureau of Mineral Resources as part of the Eastern Australian Regional Net. The Bureau of Mineral Resources carried out a semi-detailed gravity survey in the Comet-Rolleston area (Oldham, 1958) which includes the south-west corner of the Duaringa Sheet area. A gravity survey of the Roma-Theodore area by Mines Administration Pty. Ltd. (Warren, 1959) includes the southern part of the Duaringa Sheet area. Mines Administration Pty Ltd also carried out a regional gravity survey (Starkey, 1959) covering all of the Duaringa and St. Lawrence Sheet areas and a detailed gravity survey of the Cooroorah Anticline (Burbury, 1959).

Aeromagnetic

A reconnaissance aeromagnetic survey of the Great Barrier Reef was flown for Australian Oil and Gas Corporation in 1962. Some of the flight lines overlap the St. Lawrence Sheet area. The Bureau of Mineral Resources commenced a regional aeromagnetic survey of the Bowen Basin in 1961 and this survey is nearing completion. The Duaringa and St. Lawrence Sheet areas were flown during 1962. East-west flight lines are two miles apart with north-south tie lines every 10 miles.

Text Figure 7 shows the location of seismic lines, and gravity measurements and aeromagnetic flight lines for these surveys covering parts of the area. The flight lines for the Bureau of Mineral Resources aeromagnetic survey are not shown.

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APPENDIX 1

PERMIAN MARINE MACROFOSSILS FROM THE ST. LAWRENCE AND DUARINGA SHEET AREAS

by

J. M. Dickins

SUMMARY

With the exception of possibly two localities, the fossils collected from the eastern parts of the Sheet areas, i.e. between the central eastern part of the Bowen Basin and the coast, are referred to Faunas I and II of Dickins (1961a). The two localities which form an exception, one in the south-eastern part of St. Lawrence and the other in the south-eastern part of Duaringa, may represent Fauna III. Fossils from the eastern parts of the two Sheet areas in the Geological Survey of Queensland suggest the same conclusion; a single locality, however, in the eastern part of the St. Lawrence Sheet area appears to represent Fauna III.

At Apis Creek a Fauna II assemblage is found in beds with primary volcanic sediments, whereas in the Bowen Basin to the north primary volcanics are not known at this level in the Middle Bowen Beds, but are confined to the underlying Lower Bowen Volcanics.

Only Faunas III and IV are found in the Folded Zone and Fauna IV in the Western Region. In the Folded Zone, brachiopods typical of the Ingelara Shale of the Springsure area (for sequence in Springsure see Phillips in Hill & Denmead 1960, p.185) are associated with molluscs of Fauna IIIB. This therefore, affords firm evidence for the correlation of the Ingelara Shale with Unit B2 and the Glendoo Member of the Collinsville Coal Measures (Webb & Crapp, 1960) of the northern part of the Bowen Basin and further indirect evidence for the correlation of the Mantuan *Productus* Bed with the Big *Strophalosia* Zone. Equivalents of the *Streptorhynchus* Bed and possibly the Mantuan *Productus* Bed (= Big *Strophalosia* Zone and *clarkei* bed) are also represented in the Folded Zone. The main fossiliferous horizon of the Western Region, contained in the Crocker Formation (Derrington and Morgan, 1959) seems equivalent to the *Streptorhynchus* Bed of the Collinsville area (Isbell, 1955). The possibility cannot be dismissed, however, that here this fauna ranges higher than previously known.

Only a relatively few species are added to those recorded in previous reports by the author and the value of the faunal subdivisions proposed is further examined. As already shown the fossils indicate a time interval extending from late Sakmarian or early Artinskian (Lower Permian) to possibly Kazanian (early Upper Permian).

INTRODUCTION

Fossils from the Emerald, Clermont, Mt. Coolon, Bowen and Mackay Sheet areas of the Bowen Basin have been considered in previous reports (Dickins, 1961a; 1961b; 1962a; and 1962b). This study is now continued. Pelecypods, gastropods and brachiopods are considered at the specific level and the faunal subdivisions of previous reports have been used and amplified. The latest publications available have been used and consistency has been maintained by direct comparison of specimens.

I am grateful to many colleagues within the Bureau for discussion on this work, and to K.S.W. Campbell of the Australian National University, J.F. Dear of the Geological Survey of Queensland, and Dorothy Hill of the University of Queensland.

The fossils are most conveniently treated according to the areas within which they occur and within these areas they are considered in stratigraphical order. These areas correspond to those used in the main report. The Connors River Area and the Eastern Region contain the oldest fossils and are considered first. Subdivisions of the Eastern Region are made. The other two main areas are the Folded Zone and the Western Region.

THE FAUNAS AND THEIR RELATIONSHIPS

Connors River Area

Fauna II

SL 603. In Main Range Creek, ½ mile west of Bruce Highway.

Pelecypods

Deltopecten limaeformis (Morris) 1845

Brachiopods

Cancrinella farleyensis (Etheridge & Dun) 1909

Anidanthus springsurensis (Booker) 1932

Strophalosia preovalis Maxwell 1954

Neospirifer (Grantonia) cf. hobartensis (Brown) 1953

Trigonotreta sp. A.

Ingelarella ovata Campbell 1961

Cancellospirifer ? sp.

Ostracods

SL 608. One mile west-north-west of Saltbush Park turn-off from the Bruce Highway.

Pelecypods

Aviculopecten sp.

Streblopteria sp.

Gastropods

Peruvispira sp. (not comparable with P. allandalensis (Fletcher) 1958, but may be comparable with P. elegans (Fletcher) 1958.)

Brachiopods

Cancrinella farleyensis

Anidanthus springsurensis

Strophalosia preovalis

Lissochonetes sp.

Neospirifer (Grantonia) cf. hobartensis

Ingelarella ovata

Ingelarella profunda Campbell 1961

Dielasmatids

Corals

Cladochonus sp.

Conulariids, fenestellid bryozoans, and a straight nautiloid

SL 610. One mile south of the Main Range Creek, on the Bruce Highway, east side of road.

Gastropods

Mourlonia (Mourlonia) sp. nov.

SL 643. One mile east of Bruce Highway, hill on south side of Yatton Creek, "Yatton Limestone".

Pelecypods

Steblopteria ? sp. ind.

Cypricardinia ? sp.

Brachiopods

Cancrinella farleyensis

Anidanthus springsurensis

Strophalosia preovalis

Neospirifer sp. A.*

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* It is now proposed to recognise two species within the grouping Neospirifer sp. previously used (see Dickins, 1962b). Neospirifer sp. A can be distinguished from Neospirifer (Grantonia) cf. hobartensis by having the sulcus and the main plicae (fasciculae) less well developed. Neospirifer sp. B, which has been found only in Fauna IV has an even less well developed sulcus and the flanks are relatively smoother. Neospirifer sp.A appears to range from Fauna II, and possibly Fauna I, into Fauna IV.

Ingelarella ovata

Pseudosyrinx sp.

Corals

Cladochonus sp.

Single Corals

Fenestellid Bryozoans

Relationships

None of the fossils collected from the Connors River area is younger than Fauna II. The samples from SL 603 and SL 608 are definite Fauna II. SL 610 was collected at a similar stratigraphical position to SL 603 and SL 608. Although, from field evidence, SL 643 appears to be slightly lower stratigraphically than the other three samples, on the basis of the fossils identified it also seems to represent a Fauna II.

Eastern Region

Leura Area

Fauna II

Du 7/2 Collection from float in Leura Creek, downstream from Leura Homestead. Duaringa Sheet.

Brachiopods

Cancrinella sp.

Anidanthus springsurensis

Strophalosia preovalis

Neospirifer sp. ind.

Ingelarella cf. ovata

Ingelarella cf. profunda

Du 7/5 Collection from float in Leura Creek, near Leura Homestead. Duaringa Sheet.

Brachiopods

Anidanthus springsurensis

Neospirifer (Grantonia) cf. hobartensis

Du 1022A. In Leura Creek, 7 miles north-east of Leura Homestead. Duaringa Sheet.

Pelecypods

Eurydesma hobartense (Johnston) 1887

Deltopecten limaeformis

Gastropods

Keeneia sp.

Brachiopods

Ingelarella ovata

Ingelarella profunda

<u>Notospirifer hillae</u> Campbell 1961
<u>Notospirifer</u> sp. A?

Du 1022B. In Leura Creek, 7 miles north-east of Leura Homestead. Duaringa Sheet.

Pelecypods

<u>Modiolus</u> sp.?
<u>Deltopecten limaeformis</u>

Brachiopods

<u>Strophalosia preovalis</u>
<u>Neospirifer</u> sp. ind.
<u>Ingelarella</u> sp. ind.

Du 1022C. In Leura Creek, 7 miles north-east of Leura Homestead. Duaringa Sheet.

Fenestellid bryozoans and brachiopod fragments.

Du 1022D. In Leura Creek, 7 miles north-east of Leura Homestead. Duaringa Sheet.

Pelecypods

<u>Conocardium</u> sp.

Brachiopods

<u>Anidanthus springsurensis</u>
<u>Strophalosia</u> sp. ind.
<u>Lissochonetes</u> sp.
<u>Ingelarella</u> cf. <u>ovata</u>

Du 1030B. In tributary of Leura Creek, 6½ miles north-east of Leura Homestead. 1 mile south of Locality Du 1022. Duaringa Sheet.

Pelecypods

<u>Deltopecten</u> cf. <u>limaeformis</u>

Brachiopods

<u>Neospirifer</u> sp. A?
<u>Ingelarella ovata</u>
<u>Ingelarella profunda</u>

<u>Fauna II?</u>

Du 686. 5 miles north-north-west of Tartarus Homestead. St. Lawrence Sheet.

Pelecypods

<u>Aviculopecten</u> sp.

Brachiopods

<u>Cancrinella</u> sp.

<u>Strophalosia</u> sp. nov.? (specimens are very wide, and similar to those from Du 764 and Ingelara Shale).

<u>Lissochonetes</u> sp.

<u>Ingelarella</u> sp. ind.

Crinoid Stems

<u>Relationships</u>

From faunal and stratigraphical data all the samples from the Leura Area with the possible exception of Du 1022A and Du 686 belong to Fauna II. Both Du 1022A and Du 686 are close to the base of the Middle Bowen Beds in their respective areas. Four of the species identified at Du 1022A are common to Faunas I and II. From information considered later <u>Keeneia</u> sp. suggests Fauna I or a low Fauna II. <u>Notospirifer hillae</u> so far is not known in Fauna I. The evidence available, therefore, falls in favour of Fauna II, but if <u>Notospirifer</u> sp. A is indeed present, it is possible that Du 1022A can be more correctly referred to Fauna I.

Except for <u>Strophalosia</u> sp. nov.?, the fauna at Du 686 is scant. The specimens of <u>Strophalosia</u> are close to those from the Ingelara Shale and from Unit B in the Folded Zone (Du 764). Du 686, therefore, possibly represents a Fauna III, but more information is required on other species before any satisfactory conclusion is possible. In the meantime this locality is doubtfully referred to Fauna II because of its apparent low position in the Middle Bowen Beds.

Balcomba Area

<u>Fauna I or II</u>

Du 188. 5 miles east-north-east of Balcomba Homestead. Duaringa Sheet.

Pelecypods

<u>Eurydesma</u> cf. <u>hobartense</u>

Thuriba Area

Fauna III or High Fauna II

Du 158. Beside Power Line, 2 miles south-west of Thuriba Homestead. Duaringa Sheet.

Pelecypods

Plagiostoma? sp. nov.

Brachiopods

Neospirifer sp. A

Ingelarella cf. ingelarensis Campbell 1960

Pseudosyrinx sp.

Bryozoans

Branching stenoporoids

Du 159. 1½ miles south-west of Thuriba Homestead, Duaringa Sheet.

Corals

Thamnopora sp.

Cladochonus sp.

Du 508. 3 miles north-west of Thuriba Homestead. Duaringa Sheet.

Pelecypods

Modiolus sp. ind.

Plagiostoma? sp. nov.

Brachiopods

Strophalosia cf. sp. nov.

Ingelarella cf. ingelarensis or mantuanensis

Pseudosyrinx sp.

Punctate or spinose spiriferoid

Dielasmatid

Stenoporoid bryozoans

Corals

Cladochonus sp.

Du 510. 4½ miles north-west of Thuriba Homestead. Duaringa Sheet.

Stenoporoid bryozoans

Corals

Thamnopora sp.

Cladochonus sp.

Du 511. 3 miles west-north-west of Thuriba Homestead. Duaringa Sheet.

Pelecypods

Atomodesma (Aphanaia) sp. ind.

Aviculopecten sp.

Streblopteria sp. ind.

Astartila or Astarellidae gen. nov.sp.?

Brachiopods

Terrakea sp. (similar to species at M414 of Mackay Sheet area)

Cancrinella cf. _magniplica_ or _farleyensis_

Neospirifer sp. A.

Ingelarella cf. _plana_ or _mantuanensis_

Cancellospirifer ? sp.

Fenestellid Bryozoans

Single Corals

Crinoid Stems

Relationships

The faunas from the five localities (Du 158, Du 159, Du 508, Du 510 and Du 511)are closely comparable and from field data occur at a similar stratigraphical horizon. Only a relatively small number of species is represented and because these are distorted by shearing a comparison with faunas from elsewhere is difficult. Most of the species present are long ranging or the material is inadequate for positige identification. No species restricted to Fauna II occur and the forms referred to _Ingellarella_ cf. _plana_ or _mantuanensis_ and _I._ cf. _ingelarensis_ or _mantuanensis_ suggest the fauna as a whole is not older than the Sirius Shale of the Springsure sequence, i.e. not older than a high Fauna II. If _Cancrinella magniplica_ Campbell 1953 is present this would suggest the fauna is referable to IIIB, the probable Ingelara Shale equivalent. It does not appear to be younger.

Strathmuir Area.

Fauna I

Du 179 7 miles north-east of Steadleigh Homestead, St. Lawrence Sheet.

Brachiopods

Cancrinella farleyensis

Anidanthus springsurensis

Strophalosia cf. _preovalis_ or _jukesi_

Ingelarella cf. _profunda_

Indet. spiriferoid

Fenestellid Bryozoans

Crinoid Stems

Du. 192. 6 miles north of Stoodleigh Homestead. St. Lawrence Sheet.

Pelecypods

Deltoprecten limaeformis

Brachiopods

Cancrinella sp.

Cancrinella cf. farleyensis

Anidanthus springsurensis

Strophalosia cf. preovalis

Ingelarella profunda

Ingelarella cf. ovata

Notospirifer sp. A.

Fenestellid Bryozoans

Crinoid Stems

Du 1000. ½ miles south of Tooloombah Homestead.
St. Lawrence Sheet.

Pelecypods

Eurydesma hobartense

Gastropods

Keeneia sp.

Walnichollsia? sp. nov. A. (Walnichollsia? sp. nov. in Dickins 1962b and Dickins, Malone and Jensen, 1962, is now referred to Walnichollsia? sp. nov. B.

Brachiopods

Strophalosia preovalis

Strophalosia cf. jukesi

Notospirifer sp. A.

Relationships

These three localities are all found in the top part of the Lower Bowen Volcanics. Du 192 is in addition stratigraphically considerably below the top. Du 192 and Du 1000 are linked by the occurrence of Notospirifer sp. A. to Fauna I found in the upper part of the Lower Bowen Volcanics in the Mt. Coolon Sheet area (Dickins, 1961a). The Fauna at Du 179 could be either a Fauna I or a Fauna II. It is in a similar position stratigraphically to Du 192. Keeneia sp. from Du 1000 seems indicative of Fauna I or low Fauna II.

Fauna I or Fauna II

SL 346. About one mile north of St. Lawrence to Croydon Road, on road to Ripplebrook.

Pelecypods

Astartila? sp.

Deltopecten limaeformis

Aviculopecten sp. (simple form as in Fauna I)

Stutchburia sp. ind.

Brachiopods

Cancrinella cf. farleyensis

Strophalosia preovalis (some approach S. jukesi of Maxwell, 1954)

Aulostegos randsi Hill 1950

Bryozoans

Fenestellids

SL 683. On Granite Creek five miles south of Amot Dale Homestead.

Pelecypods

Deltopecten limaeformis

Deltopecten cf. squamuliferus (Morris) 1845

Streblopteria? sp. ind.

Gastropods

Keeneia sp.

Brachiopods

Terrakea pollex Hill 1950

Anidanthus springsurensis

Strophalosia sp. ind.

Aulostegos? sp. ind.

Gastropods

Keeneia sp.

Brachiopods

Cancrinella sp.

Strophalosia preovalis

Aulostegos? sp. ind.

Neospirifer (Grantonia) cf. hobartensis

Trigontreta cf. sp. A.

Cancellospirifer sp.

SL 370. In railway cutting, one mile south of St. Lawrence; in nodular or concretionary siltstone.

Brachiopods

Cancrinella farleyensis

Conulariids

Sponges

Spicules

SL 397. In small creek, 200 yards west of Prospect Hills Homestead.

Pelecypods

Eurydesma hobartense

Deltopecten limaeformis

Brachiopods

Neospirifer (Grantonia) cf. hobartensis

Ingelarella ovata

Steptorhynchus? sp. ind.

Relationships

The species present at these localities do not allow a conclusion on whether Fauna I or II is present. Aulosteges randsi found at SL 397 may be confined to Fauna I but in the collections made so far there is no definite indication on this. Keeneia sp. suggests SL 683 belongs to Fauna I or low Fauna II.

Fauna II

Du 745. ¼ mile north of Bruce Highway, 2 miles west of Tooloombah turnoff. St. Lawrence Sheet.

Pelecypods

Atomodosma sp.

Modiolus sp.?

Aviculopecten sp.

Streblopteria sp. (appears to be same species as that found in Fauna II at Homevale).

Streblochondria ? sp. (has fine radiating ribs)

Plagiostoma ? sp. nov. (similar to species at Du 508, Thuriba area).

Gastropods

Peruvispira sp. (seems different to Peruvispira occurring in Fauna II at Homevale).

Brachiopods

Anidanthus springsurensis

Strophalosia preovalis

Neospirifer (Grantonia) cf. hobartensis

Ingelarella plana or I. ovata

Spiriferid indet.

Corals

Cladochonus sp.

Single corals

Bryozoans

Fenestellids

Crinoid

Stem ossicles

Du 1017/2. ½ mile south of Bruce Highway at Tooloombah turnoff. St. Lawrence Sheet.

Brachiopods

Cancrinella sp.

Du 1020. North of Bruce Highway, at Apis Creek turnoff.
St. Lawrence Sheet.

Pelecypods

Atomodesma (Aphanaia) sp.

Corals

Cladochonus sp.

Favosites like Coral

Relationships

No conclusion on the position of Du 1017/2 or Du 1020 within the Permian sequence are possible on the basis of the fossils identified. Field information, however, suggests that Du 1020 is a few hundred feet stratigraphically above Du 745, so that it is considered together with Du 745. The relative position of Du 1017/2 is not clear, but for convenience it is considered with Du 745 and Du 1020.

Typical brachiopods of Fauna II are found at Du 745. If Ingelarella plana is present this would suggest the fauna is a high Fauna II, equivalent to the Sirius Shale of the Springsure area. Primary volcanics are associated with the fossil beds at Du 745, and vulcanism apparently continued on somewhat longer in the Apis Creek area after it has ceased in the northern part of the Bowen Basin (Mackay, Mt. Coolon, and Bowen Sheet areas).

Collaroy Area

Fauna I

SL 199. Two and a half miles west of Collaroy Homestead, about ¼ mile west of the Connors River.

Pelecypods

Astartila cf. gryphoides

Myonia cf. davidis Dun 1932

Notomya cf. antiquata (Sowerby) 1838

Eurydesma cf. hobartense

Deltopecten limaeformis

Aviculopecten sp. ind.

Oriocrassetella sp.

Astartella? sp.

Brachiopods

Cancrinella cf. farleyensis

Strophalosia preovalis (possibly S. jukesi is also present)

Aulosteges? sp. ind.

Lissochonetes sp.
Neospirifer sp.? (seems to differ from other species in having poorly developed fasciculation).
Ingelarella ovata
Notospirifer cf. *hillae* (has six lateral plicae)

Straight Nautiloid
Single Corals

Fauna I or II

SL 22. Three miles south-west of Collaroy Homestead.

Pelecypods
Eurydesma hobartense
Deltopecten limaeformis
Deltopecten cf. *illawarensis* (Morris) 1845 (one fragmentary specimen with broad primary ribs)

Brachiopods
Cancrinella farleyensis
Strophalosia preovalis
Aulosteges? sp. ind.
Neospirifer (Grantonia) cf. *hobartensis*
Notospirifer sp.? (possibly *N*. sp. nov. from Fauna I).
Bryozoans
Fenestellids
Stenoporoids

SL 59. Small conical hill, one mile east of Marylands Homestead.

Pelecypods
Myonia cf. *davidis*
Deltopecten limaeformis
Stutchburia sp. ind.
Gastropods
Keeneia sp.
Peruvispira sp. (as at SL 608, may be comparable with *P. elegans* (Fletcher) 1958).

Brachiopods
Cancrinella sp.
Anidanthus springsurensis
Strophalosia preovalis
Strophalosia brittoni Maxwell 1954
Aulosteges cf. *randsi* Hill 1950

Taeniothaerus sp.

Neospirifer (Grantonia) cf. hobartensis

Neospirifer sp. A.

Notospirifer hillae

SL 60. Three miles north of Marylands Homestead, on western side of Collaroy Creek.

Brachiopods

Anidanthus springsurensis

Strophalosia preovalis

Neospirifer (Grantonia) cf. hobartensis

Notospirifer hillae

Relationships

Of the four localities from which fossils have been collected in this area SL 22 and especially SL 199 occupy a low stratigraphical position. SL 199 is assigned to Fauna I largely on the occurrence of Notomya cf. antiquata and because of its low position in the sequence. N. antiquata is a species known from the Allandale Formation of the Hunter Valley of New South Wales. Forms related to D. illawarensis and N. sp. nov. suggest that SL22 may represent a Fauna I rather than Fauna II. The evidence, however, is not clear cut. Keeneia sp. and Aulostoges cf. randsi together with Notospirifer hillae suggest SL 59 is a low Fauna II similar in position to Du 1022A of the Leura area and SL 346, SL 397 and SL 683 of the Strathmuir area. The fauna of SL 60 indicates only that it is a Fauna I or II.

Folded Zone

Fauna III

Du 147b. 1½ miles west of Bundaleer Homestead. Duaringa Sheet.

Pelecypods

Astartila cf. gryphoides

Notomya or Pyramus sp. (appears to be same species as in Fauna IIIb at B261d of Bowen Sheet area).

Du 149. North bank of Mackenzie River, 1½ miles south-west of Bundaleer Homestead. Duaringa Sheet.

Pelecypods

Chaenomya sp. nov. B?

Gastropods

Platyteichum costatum Campbell 1953?

This locality also contains glendonites.

Du 149a. Float collection from near outcrop, north bank of Mackenzie River, 1½ miles south-west of Bundaleer Homestead. Duaringa Sheet.

Pelecypods

Chaemonya sp. nov. B.

Single Coral

Du 150. 1 mile south-south-west of Bundaleer Homestead. Duaringa Sheet.

Atomodesma (Aphanaia) sp.

Du. 151. 1 mile south-west of Bundaleer Homestead. Duaringa Sheet.

Pelecypods

Glyptoleda or Nuculana sp.

Conocardium sp.

Brachiopods

Cancrinella magniplica Campbell 1953[1]

Attenuatella sp. nov.[2]

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1. The specimens from this sample and from Du 764 identified as Cancrinella magniplica vary considerably in their transverse ribbing. Some have less pronounced ribbing (or wrinkling) similar to that shown by Campbell (1953, pl 1, figs. 1-5) - others show more distinct wrinkling as in pl. 1, figs. 6-8.

2. Attenuatella is a genus recently described and named by Stehli (1954, p. 343) from the Lower Permian of North America. I am grateful to K.S.W. Campbell for pointing this out to me.

Plekonella acuta Campbell 1953

Du 151a. 1 mile south-west of Bundaleer Homestead. Duaringa Sheet.

Pelecypods

Nuculopsis (Nuculopsis) sp.

Glyptoleda? sp.

Brachiopods

Ingelarella angulata Campbell 1959

Du 286. 1¼ miles west of Bundaleer Homestead. Duaringa Sheet.

Pleurotomariid gastropod

Straight nautiloid?

Serpulids

Large single corals

Du 764. 2 miles west-north-west of Bundaleer Homestead. Duaringa Sheet.

Pelecypods

Parallelodon sp. (specimens not very satisfactory but radial ribs seem to be of one order and therefore differs from Parallelodon sp. nov. B. of Fauna IV in which the ribs behind the posterior carina are coarser than those on the body of the shell).

Atomodesma? sp.

Conocardium sp.

Gastropods

Bembexia sp.

Brachiopods

Cancrinella magniplica

Strophalosia sp. nov. (this probable new species is flatter than S. preovalis or S. brittoni and the valves are wider than in S. clarkei. It is most closely related to specimens from the Ingelara Shale).

Lissochonetes sp.

Ingelara ingelarensis Campbell 1960

Attenuatella sp. nov.

Plekonella cf. acuta

Large single coral

Relationships

All these samples are close together stratigraphically. Du 149, Du 151, Du 286 and Du 764 come from a predominantly siltstone and grey quartz greywacke unit with rounded concretions and glendonites, which immediately overlies a sandy unit, forming the oldest rocks exposed in the Folded Zone, with Du 147b, Du 149a, Du 150 and Du 151a. The siltstone/quartz greywacke unit is in turn overlain by another sandy unit in which no fossils were seen. From the position of these units relative to the overlying Upper Bowen Coal Measures and by analogy with the sequence in Gebbie Creek and Cooroorah No. 1 Well (see Dickins Malone and Jensen, 1962) it seems likely that the two fossiliferous units together represent the equivalent of Unit B2 found in Gebbie Creek or possibly part of Units B1 and B2 respectively.

The fossils independently suggest a similar conclusion and furthermore suggest a correlation with the Ingelara Shale of the Springsure area.

Cancrinella magniplica, Ingelarella ingelarensis, I. angulata and Plekonella acuta are known also from the Ingelara shale as are the specimens most closely related to Strophalosia sp. nov. Cancrinella magniplica, Ingelarella ingelarensis and I. angulata, which may be found in younger beds, are not known in beds older than Fauna III.

Aetartila cf. gryphoides and Bembexia sp. which are also found in Fauna II are not known in beds younger than Fauna III and Notomya or Pyramus sp. and Chaenomya sp.nov. B are known only in Fauna III.

So far brachiopods have been poorly represented in Fauna III whereas they have been plentiful in Faunas II and IV.

Fauna III or IV

Du 283. 3 miles north-east of Barwon Park Homestead. Duaringa Sheet.

Brachiopods

Cancrinella sp. ind.

Ingelarella cf. ingelarensis

Du 424. 7 miles north of Warwick Homestead. St. Lawrence Sheet.

Pelecypods

Megadesmus cf. grandis (Dana) 1847

Notomya sp. (similar to species at CL 122 of the Clermont Sheet area).

Stutchburia compressa (Morris) 1845

Astartidae gen. nov. sp.? (appears to be closer to species of Fauna IV than that of Fauna III).

Gastropods

Warthia sp.

Platyteichum cf. coniforme (Etheridge jnr.) 1892

Du 469. 4 miles east-south-east of Warwick Homestead. St. Lawrence Sheet.

Brachiopods

Strophalosis sp. ind.

Ingelarella angulata

Ingelarella cf. havilensis Campbell 1960

Trigonotreta? sp.

Crinoids

Stem ossicles

Du 472. 3 miles east of Warwick Homestead. St. Lawrence Sheet.

Pelecypods

Glyptoleda cf. glomerata Fletcher 1945

Gastropods

Warthia sp.

Mourlonia cf. strzeleckiana (Morris) 1845

Relationships

The field relationships of these four samples suggest they are from Unit C of the Middle Bowen Beds which contains Fauna IV. The fauna of Du 424 and Du 464 is also suggestive of Fauna IV rather than Fauna III. It is not, however, conclusive. Du 283 is apparently stratigraphically higher than Du 383, referred to in the next section of the report.

Fauna IV

Du 383C. 12 miles south-east of Foxleigh Homestead. St. Lawrence Sheet.

The matrix of the fossils is very sandy.

Brachiopods

Strophalosia cf. ovalis Maxwell 1954

Neospirifer sp. B

Ingelarella cf. mantuanensis Campbell 1960

Notospirifer minutus Campbell 1960

Cancellospirifer sp.

Plekonella sp.

Streptorhynchus pelicanensis Fletcher 1952 (a number of specimens)

Single Corals

Du 383d. 12 miles south-east of Foxleigh Homestead. St. Lawrence Sheet.

Brachiopods

Terrakea cf. solida (Etheridge & Dun) 1909

Du 385. 12 miles south-east of Foxleigh Homestead. St. Lawrence Sheet.

Brachiopods

Strophalosia cf. brittoni var. gattoni Maxwell 1954

Neospirifer sp. B

Notospirifer sp. ind.

Cancellospirifer sp.

Streptorhynchus pelicanensis

Du 387. 13 miles south-east of Foxleigh Homestead.
St. Lawrence Sheet.

Brachiopods

Strophalosia cf. clarkei

Strophalosia cf. ovalis

Streptorhynchus pelicanensis

Single Corals

Fenestellid Bryozoans.

Relationships

Streptorhynchus pelicanensis in Du 383C, Du 385 and Du 387 suggests these samples are taken from the equivalent of the Streptorhynchus Bed of the upper part (Unit C) of the Middle Bowen Beds of the Collinsville area. This is confirmed by the occurrence of Notospirifer minutus in Du 383C and suggested by specimens of other species which are, however, too fragmentary for positive identification. These beds are also probably equivalent to the Pelecypod Bed of the Clermont Sheet area (see Veevers, Randal, Mollan and Paton, 1961) which has a similar fauna and is found in a similar stratigraphical position to the Streptorhynchus Bed. S. pelicanensis, however, is poorly represented in the Clermont area.

Du 383c, Du 385 and Du 387, the Pelecypod Bed, and the Streptorhynchus Bed are all sandy and are similar lithologically and faunally to fossiliferous beds in the Western Region (Comet Area) considered in the next section, which are included in the Crocker Formation (Derrington & Morgan, 1959, and in Hill & Denmead, 1960, p.207).

Du 383d is a coquinite and possibly represents the clarkei bed of the Clermont area; its field relationships suggest it comes from a slightly lower stratigraphical position than Du 383c.

Western Region

Fauna IV

Du 519 2½ miles south-east of Myrtle Park Homestead.
Duaringa Sheet.

Gastropods

Peruvispira sp. ind.

Brachiopods

Terrakea solida

Neospirifer sp. B

Ingelarella cf. havilensis

Ingelarella pelicanensis Campbell 1960

Streptorhynchus pelicanensis (a few specimens)

Wood

Large Single Coral

Du 1214. 9 miles east of Rhudanna Homestead. Duaringa Sheet.

Sandstone with pebbles up to $\frac{1}{2}$".

Brachiopods

Terrakea solida

Neospirifer sp. B

Ingelarella mantuanensis

Notospirifer minutus

Streptorhynchus cf. pelicanensis (rare)

Flat dielasmatid.

Single Coral

Relationships

These two collections are from the Crocker Formation. The occurrence of Ingelarella pelicanensis, Notospirifer minutus and Streptorhynchus pelicanensis suggests an horizon equivalent or close to the Streptorhynchus Bed of the Collinsville area. Possibly, however, these species range higher here than is known elsewhere as the Crocker Formation is so close to the top of the Middle Bowen Beds. The equivalent of the Big Strophalosia Zone has not been found so far in this area.

Fauna IV?

Du 85. In German Creek, at western margin of St. Lawrence Sheet.

Brachiopods

Ingelarella cf. ingelarensis

Crinoids

Stem ossicles and cup.

Du 890. 5 miles north-west of Carnangarra Homestead, Duaringa Sheet.

Pelecypods

Atomodesma (Aphanaia) sp.

Relationships

A few fossils found at these two localities are not characteristic forms. Field data, however, suggests they are referable to Fauna IV.

CONCLUSIONS

Connors River Area and Eastern Region

In the fossil collections made from the Connors River Area and the Eastern Region of the St. Lawrence and Duaringa Sheet areas, no faunas younger than Fauna II are indicated with the possible exception of the localities in the Thuriba area (south-east part of the Duaringa Sheet) and a locality (Du 686) in the south-east part of St. Lawrence.

The age of these collections, with the exception of that from a single locality, is confirmed by examination of the collections in the Geological Survey of Queensland. A similar fauna from this area is also recorded by Laing & Hill in Hill & Denmead (1960, p.221) and by J.T. Woods in unpublished reports to Reef Oil Pty Ltd. The fauna in the Survey collections labelled "Mt. Brunswick" contains Atomodesma (Aphanaia) sp., Strophalosia preovalis and an indeterminate species of Anidanthus and is therefore not younger than Fauna II.

The exceptional locality is $\frac{3}{4}$ mile south-east of Kooltandra Railway Station, St. Lawrence Sheet area, where species of Astartila or Astartellidae, Chaenomya and Terrakea are contained in a quartzose sandstone. This fauna appears to be younger than Fauna II and may represent Fauna III.

In the Apis Creek area (Du 745) and in the Thuriba area, at least, primary volcanics are found at a stratigraphic position higher than they are found in the area from near Yatton to the northern part of the basin near Collinsville. The top part of the Lower Bowen Volcanics as mapped in the Apis Creek area is apparently the time equivalent of at least part of Unit A of the Middle Bowen Beds in other parts of the Bowen Basin.

Although many of the brachiopods of Fauna II are found also in the lower fauna, the new collections have confirmed the distinctiveness of Fauna I. Notospirifer sp.A appears to be characteristic of Fauna I whereas Notospirifer hillae has not so far been recorded. Keeneia sp, although it apparently is also found in low Fauna II, is common, as is Strophalosia of the S. jukesi type. Notomya cf. antiquata (SL 199) seems significant but the significance of Aulosteges randsi and Deltopecten cf. illawarensis is not clear.

Because most of the species of the large number found in Fauna I also occur in Fauna II it is unlikely that Fauna I is a great deal older. Indeed in all the Eastern Region no fossils have been collected which appear to be greatly older than Fauna II.

I hope to be able to discuss the relationships of these faunas with those in the Hunter Valley of New South Wales in more detail later. A feature of Faunas I and II, however, is that on information available they have very few species or closely related species in common with the fauna of the Allandale Formation but have a larger number in common with the Farley and Branxton Formations higher in the sequence in the Hunter Valley.

The relationships of the faunas with those further south in the Yarrol Basin (see Maxwell in Hill & Denmead, 1960, p.217) is not clear.

Folded Zone and Western Region

No faunas older than Fauna III have been recognized in these areas. Fauna III has been found only in the core of a large anticlinal structure of the Folded Zone on the Mackensie River. Here molluscs typical of Fauna III and more particularly of Fauna IIIB are associated with brachiopods characteristic of the Ingelara Shale which therefore affords evidence for correlation of the Engelara Shale with Unit B2 and the Glendoo Sandstone Member of the Collinsville Coal Measures of the northern part of the Bowen Basin. Fauna IV is well represented both in the Folded Zone and the Western Region. In the Western Region it is found only in the Crocker Formation which may represent the Streptorhynchus bed of the Collinsville area and the pelecypod bed of the Clermont area. In the Folded Zone, as well as this, another slightly lower horizon is apparently equivalent to Big Strophalosia Zone and the clarkei bed.

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APPENDIX 2.

REPORT ON FOSSIL CORALS COLLECTED BY THE DUARINGA PARTY, 1962.

by

Dorothy Hill
(University of Queensland)

Du 600F: Limestone near Armagh Homestead, Duaringa 1:250,000 Sheet.

Heliolites daintreei, first group.
Favosites sp. cf. goldfussi
F. sp.
Tryplasma sp.
?Fletcheria sp. or ?Fletcherina sp.
Stromatoporoid
Algae

Age: Silurian or Lower Devonian. The fauna is of long-ranging types. H.daintreei ranges from Middle Silurian to Lower Middle Devonian. The large-celled Favosites is perhaps closer to the Lower and Middle Devonian F.goldfussi than to the Silurian and Lower Devonian F.gotlandica. The solitary Tryplasma indicates Silurian or Lower Devonian. The cylindrical fragments called ?Fletcheria or ?Fletcherina are probably from a fasciculate corallum, but having very negative characters such as extremely short septa they are difficult to place generically. The type species of Fletcheria is Silurian and that of Fletcherina is Devonian. On the whole I incline to a Lower Devonian age, but the possibility of a Silurian age cannot be discarded.

Du 948: Grey Limestone. Two miles north-west of Craigilee Homestead, Duaringa 1:250,000 Sheet.

Lithostrotion ex.gr.stanvellense Etheridge

Age: Lower Carboniferous, probably Visean.

Du 513/5: Near Armagh Homestead, Duaringa 1:250,000 Sheet.

Lithostrotion arundineum Eth.
Syringopora, 2 species

Age: Lower Carboniferous, probably Visean.

Du 160: Grey limestone near west bank of Fitzroy River, near Craigilee weir-crossing. Duaringa 1:250,000 Sheet.

Lithostrotion columnare Etheridge
Symplectophyllum sp.

Du 146: Near Thuriba Homestead, Duaringa 1:250,000 Sheet area.

The limestone is very sheared and determination is hazardous

The following were identified:

Alveolites ? three fragments
Tryplasma? pieces of corallites from a cylindrical corallum
Cladochonus? pieces of corallites
Favosites sp. (very small fragment)

Coriod Rugose coral, indet.
Solitary zaphrentoid Rugosa, gen. et.sp. indet.
Small, sparse fragments of branching Polyzoa.

As the first two genera mentioned are not known younger than the Devonian, and as both are common to Silurian and Devonian, I regard the age of the limestone as probably Silurian or Devonian.

APPENDIX 3.

Palaeontological report on Carboniferous fossils from the Duaringa 4-mile Sheet

by

J.F. Dear

(Queensland Geological Survey)

Locality : Du 131.4, in gully on western bank of Fitzroy River, west of "Armagh", Duaringa 4-mile Sheet.

Collector : Combined B.M.R. - G.S.Q. party, 1962.

Determinations : *Schizophoria* cf. *resupinata* (Martin)
Rhipidomella sp. ind.
Productina sp.
Chonetipustula sp.
Plicochonetes sp.
Prospira sp. ind.
Cleiothyridina sp. ind.
Crurithyris sp.
Straparollus sp.
Indet. solitary coral

Age : Upper Tournaisian

Locality : Du 365, approximately 4 miles south-east of "Armagh", Duaringa 4-mile Sheet.

Collector : Combined B.M.R. - G.S.Q. party, 1962.

Determinations : *Levipustula levis* Maxwell
Neospirifer sp.
Composita sp.
Indet. orthotetid
Rhombopora sp.
Fenestella rectangularis (Crockford)
Polypora sp. ind.
Indet. dielasmatid

Age : Middle Carboniferous

Locality : Du 598, approximately 3 miles south-south-east of "Armagh", Duaringa 4-mile Sheet.

Collector : Combined B.M.R. - G.S.Q. party, 1962.

Determinations : *Spinuliplica* cf. *spinulosa* Campbell
Liriplica sp. ind.
Composita sp.
Lisella sp.
Indet. dielasmatid
cf. *Sanguinolites* sp.
Conocardium sp.
Polypora tenuirama Crockford
Fenestella sp. ind.

Age : Middle Carboniferous

Locality : Du 943, on road, 2 miles west of "Craigilee" Duaringa 4-mile Sheet.

Collector : Combined B.M.R. - G.S.Q. party, 1962.

Determinations : *Levipustula levis* Maxwell
Spinuliplica sp. ind.
Composita sp.
?*Conocardium* sp.
Fenestella cincta (Crockford)
Fenestella cf. *cerva* Campbell
Fenestella malchi (Crockford)
Fenestella micropora (Crockford)
Polypora sp. ind.

Age : Middle Carboniferous

Locality : Du 949, south-west of road, 2 miles west of "Craigilee", Duaringa 4-mile Sheet.

Collector : Combined B.M.R. - G.S.Q. party, 1962.

Determinations : *Spinuliplica* sp. ind.

Age : Middle Carboniferous

Locality : Du 1201, approximately 2 miles north-east of "Armagh", Duaringa 4-mile Sheet.

Collector : Combined B.M.R. - G.S.Q. party, 1962.

Determinations : *Streptorhynchus* sp.
Reticulatia sp.
Phricodothyris sp.
Punctospirifer sp.
Rhombopora sp.
cf. *Evactinopora* sp.

Age : Middle Carboniferous

Locality : Du 1202, approximately 2 miles north-east of "Armagh", Duaringa 4-mile Sheet.

Collector : Combined B.M.R. - G.S.Q. party, 1962.

Determinations : *Levipustula levis* Maxwell
Alispirifer cf. *laminosus* Campbell
Neospirifer pristinus Maxwell
Peruvispira sp.
Indet. pectenoid pelecypod
Rhombopora sp.

Age : Middle Carboniferous

Remarks : The assemblage from Du 131.4 is considered to be of probable Upper Tournaisian age. Productina sp. compares closely with that figured by Maxwell (1954, pl.3, figs.9a,b) as Productus cf. minutus Muir-Wood from the Upper Tournaisian Schizophoria Zone of the Mt. Morgan district. A similar species was described by McKellar (1961, Pl.1, figs.5-8) from the Upper Tournaisian of the Bancroft district, to the north-east of Monto. Productina is unknown in the Visean faunas of the Yarrol Basin. A species of Plicochonetes almost identical with Plicochonetes sp. occurs in Upper Tournaisian strata at Cania, to the north-west of Monto. Schizophoria cf. resupinata ranges through most of the Tournaisian and Visean of the Yarrol Basin, and none of the remaining species from collection Du 131.4 are of value in age determination.

The most abundant form in collection Du 1201 is Streptorhynchus sp. This genus has not been recorded previously from the Carboniferous of Queensland but occurs in the Middle Carboniferous of New South Wales (Campbell 1962). The presence of Reticulatia sp., Phricodothyris sp., and cf. Evactinopora sp. in this assemblage suggests correlation with the faunas of the Branch Creek Formation of the Yarrol district (Maxwell 1960). Fleming (1960) considered that the bryozoa from the Branch Creek Formation closely resembled those found in the basal portion of the Neerkol Beds in the Stanwell district.

Most of the bryozoa found in the assemblages Du 365, Du 598, and Du 943, are characteristic of the Neerkol Beds; the presence in these assemblages of Levipustula levis and Spinuliplica cf. spinulosus strengthens the correlation with the fauna of the Neerkol Beds. Neospirifer pristinus from collection Du 1202 compares closely with the type material figured by Maxwell (1951, pl.3, figs. 1-8) from the Neerkol Beds.

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APPENDIX 4.

FOSSILS FROM LONG, BARREN, AND HUNTER ISLANDS NORTH QUEENSLAND

by

John Roberts

(1) Long and Barren Islands

Identifications.

Long Island South. Approximately 2½ miles south-west of station homestead (Middle Passage) Lat. 22°11'S Long. 149°53½'E.

Locality 1	*Syringopora* sp.
Locality 2	*Cyrtospirifer*? sp.
Locality 3	*Cyrtospirifer*? sp.
Locality 4	*Cyrtospirifer*? sp.

Long Island North Point. Lat. 22°03'S Long. 149°54'E.

Locality 5	*Fenestella* sp. indet.
Locality 6	*Levipustula levi* Maxwell 1951 *Spinuliplica spinulosa* Campbell 1961 *Composita* cf. *magnicarina* Campbell 1961 *Schuchertella* sp. *Fenestella* cf. *micropora* Crockford 1948. *Fenestella* sp. indet. *Rhombopora*? *bifurcata* Campbell 1961. *Fistulamina dispersa* Crockford 1948
Locality 7	*Levipustula levis* Maxwell 1951

Barren Island. Southern coast; Lat. 22°02'S Long. 149°58½'E.

Locality 8	*Levipustula levis* Maxwell 1951.
Locality 9	*Levipustula levis* Maxwell 1951 *Composita* sp. *Fenestella* sp. indet.

Conclusions

Cyrtospirifer? sp. suggests an Upper Devonian age for beds in the southern portion of Long Island, but because positive identification cannot be made these could be younger. *Cyrtospirifer*? sp. possesses a radial ornament and long cardinal area typical of *Cyrtospirifer* sensu stricto. The dental lamellae in the pedicle valve are shorter than in most species of this genus, but forms with dental lamellae of comparable length have been described from the Upper Devonian of Belgium

(C.grabaui Paeckelman by Vandercammen, 1959) and U.S.A. (C.oleanensis Greiner, 1957). Large and presumably older examples of these overseas species have very reduced dental lamellae similar to those in the Queensland specimens. The relatively coarse nature of the denticle grooves on the cardinal area suggests that this form could be closer to the Lower Carboniferous genus Unispirifer. The latter form, however, is readily distinguished by its coarser external ornament, shorter cardinal area on the pedicle valve and much smaller size.

The presence of Levipustula levis Maxwell, Spinuliplica spinulosa Campbell, Composita cf. magnicarina Campbell, Fenestella cf. micropora Crockford and Fistulamina dispersa Crockford in the Long Island North Point fauna indicates that it is of Middle Carboniferous (Moscovian) age.

The sediments on Barren Island are similarly of Middle Carboniferous (Moscovian) age.

(2) Hunter Island is located in the Duke Group of islands, east of the Mackay, and north of the Port Clinton 4 mile Sheets. East coast approximately 1 mile from Southern Point. Lat.21°58'S Long.150°08½'E.

Identifications

Locality 10	Favosites sp. Solitary rugose coral
Locality 11	Heliolites cf. daintreei Nicholson & Etheridge 1879 ?Gephuropora duni Etheridge 1920 Solitary zaphrentoid rugose coral
Locality 12	Favosites sp.
Locality 13	Favosites sp.
Locality 14	Goniatite gen. and sp. indet.

Conclusions

The age of the Hunter Island faunas, with the possible exception of locality 14, is Middle Devonian or older. If the determination of Gephuropora duni Etheridge is correct, the faunas can be more precisely dated as Lower Middle Devonian. However, extensive recrystallisation of the limestones on Hunter Island has hampered identification of genera and species.

The external ornament on the specimen from locality 14 somewhat resembles that found on a number of clymenid goniatites, but because sutures have not been found it is problematical whether this form can be referred to a genus in the Suborder Clymeniina. If further material proves this specimen to be a clymenid form, the beds at locality 14 are younger than those at the other localities, i.e. Upper Devonian.

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APPENDIX 5.

REPORT ON PLANT FOSSILS FROM THE DUARINGA AND ST. LAWRENCE 1:250,000 SHEET AREAS, QUEENSLAND

by

Mary E. White

Locality Du 262: 8 m. N. of Melmoth Homestead, Duaringa Sheet area. Upper Bowen Coal Measures.

Specimens F 22172

Glossopteris angustifolia Bgt.
Cladophlebis roylei Arber
Glossopteris indica Sch.
Glossopteris conspicua Feist.

A typical Upper Bowen assemblage.

Locality Du 279: 1 m. E.N.E. of Melmoth Homestead, Duaringa Sheet area. Upper Bowen Coal Measures.

Specimens F 22173

Glossopteris angustifolia Bgt.
Glossopteris conspicua Feist.
Modified leaves and scale leaves of G. angustifolia.
Vertebraria indica Royle.
Equisetalean stems.

A typical Upper Bowen assemblage.

Locality Du 756: 4 m. S.S.E. of Melmoth Homestead, Duaringa Sheet area. Upper Bowen Coal Measures.

Specimens F 22174 and F 22174(a)

Glossopteris indica Sch.
Glossopteris angustifolia Bgt.
Glossopteris conspicua Feist.
Glossopteris jonesi Walk.
Cladophlebis roylei Arber.
Glossopteris damudica ?
"Dictyopteridium sporiferum" a male Glossopteris fructification.

F 22174(a)

Taeniopteris sp.?

Glossopteris jonesi Walk. is a species very close to Taeniopteris. The Taeniopteroid tendency occurs in Upper Permian Glossopteridae. The Taeniopteris sp.? identified in specimen F 22174(a) might possibly be only the mid section of a leaf of G. jonesi.

The presence of Taeniopteroid forms and G. conspicua indicates Upper Permian age.

The "Dictyopteridium sporiferum" is a long, narrow organ whose surface is covered with circular sporangia. It is the same as examples from the Baralaba Coal Field which occur with Cistella bowenensis sp. nov. (White, MS) and may also be regarded as indicating Upper Permian age.

Locality Du 758: 1 m. S.S.W. of Melmoth Homestead.
Upper Bowen Coal Measures.

Specimens F 22180, F 22282 and F 22283

Glossopteris indica Sch.
Glossopteris ampla Dana.
Glossopteris ampla scale leaves
Glossopteris angustifolia Bgt.
Glossopteris browniana Bgt.
Cladophlebis roylei Arber.
Equisetalean stems.
Samaropsis seeds ?

Vertebraria indica Royle
Equisetalean stems.

"Dictyopteridium sporiferum" Feist. of the same type as is associated with Cistella bowenensis sp.nov. (M.E.W. ms.) from Baralaba, Queensland.

Glossopteris damudica ?

Age: Upper Bowen Assemblage. Upper Permian age confirmed by presence of "Dictyopteridium sporiferum" of Baralaba type.

Locality Du 760 C: 3 m. N.N.W. of Melmoth Homestead, Duaringa Sheet area.
Upper Bowen Coal Measures.

Specimens F 22175

Equisetalean stems.

No age determination possible.

Locality Du 775: 5 m. W.S.W. of Melmoth Homestead, Duaringa Sheet area.
Upper Bowen Coal Measures.

Specimens F 22176

Cladophlebis roylei Arber.
Glossopteris angustifolia Bgt.
Glossopteris conspicua Feist.

Age: Upper Permian.

Locality Du 795: 6 m. N.W. of Melmoth Homestead, Duaringa Sheet area.
Upper Bowen Coal Measures.

Specimens F 22177

Glossopteris angustifolia Bgt.
Glossopteris indica Sch.
Cladophlebis roylei Arber.

Age: Permian (no forms diagnostic of Upper or Lower).

Locality Du 873: Duaringa 4-mile; Run 3/5071.
Upper Bowen Coal Measures.

Specimens F 22285, F 22286, and F 22287 -

F 22288 bulk of collection.

Glossopteris ampla Dana.
Cistella ampla sp. nov.
Glossopteris conspicua Fm.
Glossopteris indica Sch. ?

Age: Upper Permian.

The specimens from this locality are most beautifully preserved and of great interest. Very large leaves of Glossopteris ampla are present in large numbers. A few small leaves of G. conspicua and two medium size leaves which may be G. indica are also present. Cone-like fructifications, some complete, and many more or less fragmentary, occur on many of the specimens. These are referred to Cistella ampla sp. nov. They are believed to be the fructifications of Glossopteris ampla.

Locality Du 5F: Duaringa 4-mile; Run 1/5113
Upper Bowen Coal Measures (Upper Permian).

Specimens F 22292

Glossopteris angustifolia Bgt.
Glossopteris indica Sch.
Glossopteris conspicua Feist.
Glossopteris ampla Dana.
Cladophlebis roylei Arber.

Age: Permian. Upper Bowen.

Locality Du 265: Duaringa 4-mile; Run 5/5101.
Upper Bowen Coal Measures.

Specimens F 22179

Equisetalean stems.
? Glossopteris fragment.

Age: ? Permian.

Locality Du 1212: Duaringa 4-mile; Run 4/5046.
Lower Permian Dinner Creek Beds.

Specimen F 22290

Noeggerathiopsis hislopi (Bunb.)

Age: Lower Permian. The Noeggerathiopsis is of the type present in Lower Permian Beds.

Locality Du 1230: Duaringa 4-mile; Run 5/5107
?Permian Middle Bowen Beds.

Specimens F 22291

Indeterminate.

Locality Du 829: Duaringa 4-mile; Run 1/5103
?Permian, Middle Bowen Beds.

Specimens F 22284

Equisetalean stems.

Age: Indeterminate.

Locality Du 291 a and c: Head of Springton Creek, about 14 m. S.S.W. of Dingo.

Specimens F 22178

Fragmentary plant remains are present. The following are tentatively identified:

Equisetalean stems.
Danaeopsis sp. ?
Seed.
Cone Scale.
Linguifolium denmeadi ?
Conifer foliage.
Dicroidium Feistmanteli ?

Age: Although the specimens are poor, the weight of evidence suggests Triassic age.

Locality Du 163(E): Duaringa 4-mile: Run 8/5021
? Permian, Middle Bowen Beds.

Specimens F 22280

Noeggerathiopsis hislopi (Bunb.)?

The specimen is poor and the determination is tentative. However, the impression appears to be of the type of Noeggerathiopsis hislopi characteristic of Lower Bowen sediments. (See attached note on Noeggerathiopsis).

Age: ?Lower Permian, or Upper Carboniferous?

Locality Du 520: Duaringa 4-mile; Run 6/5063
Middle Bowen Beds

Specimens F 22281

These specimens are very poor. A narrow leaf with parallel margins and a well defined midrib and fine secondary venation of Glossopteris type is probably referable to Glossopteris angustifolia Bgt, a long-ranging Permian form.

Age: ?Permian.

Locality SL 241: St. Lawrence 4-mile sheet; photo run 5, photo 48.

Specimens F 22299

Noeggerathiopsis sp. ?

Age: Permian or Upper Carboniferous.

Locality Du 971: Duaringa 4-mile; Run 1/5101
Permian or younger.

Specimens F 22289

Taeniopteris cf. T. spatulata var. major Seward.
Taeniopteris spatulata McClell.
Cladophlebis australis Morr.

Age: Jurassic or Lower Cretaceous. (All occur in the Styx River Coal Measures in Queensland with which correlation is made).

Locality SL 410 F: St. Lawrence 4-mile; photo run 1, photo 49.
Carmila Beds.

Specimens F 22300

Very large numbers of leaves of "Noeggerathiopsis hislopi (Bunb)." are present, ranging in size from small, complete leaves approximately 4 cm long and 1 cm broad at the widest part, tapering to a narrow petiolar region; to complete leaves approx. 10 cm long and 4 cm wide at widest part; to incomplete leaves, some with very coarse venation, of unknown length with breadth at least 8 cm. Associated with these leaves are very large seeds of Samaropsis dawsoni (Shirley) type which measure about 2.5 cm long and 2 cm broad near the base. These pear-shaped seeds show a divided apex and appear to have had a narrow wing. There is a strong possibility that they are the seeds of Noeggerathiopsis hislopi in this case.

"Noeggerathiopsis hislopi" of this type is characteristic of the Lower Bowen series and does not occur with typical Upper Bowen species. Dr. Plumstead, in a recent "Review of the Permo-Carboniferous Coal Measures of the Transvaal, South Africa" states that Noeggerathiopsis hislopi is "a survival of a pre-Glossopteris flora, which may be regarded as indicative of the earliest period of Gondwana coal formation, and if the Argentine dating is acceptable, as of a late Carboniferous age."

In view of Dr. Plumstead's remarks quoted above, it is possible that a pure assemblage of Noeggerathiopsis with its (?) seeds might be of Upper Carboniferous age. If Loc. SL 410 is from the base of the Carmila beds it might indicate that deposition of the sediments took place from Upper Carboniferous and continued into Lower Permian. However, if the age of the beds is known to be younger than Lower Permian volcanics, a Lower Permian age is indicated.

Age: A Lower Permian, or Upper Carboniferous to Lower Permian, age is suggested by plant evidence.

Note On Noeggerathiopsis hislopi (Bunb.)

"Noeggerathiopsis hislopi (Bunb.)" is a form-species name given to leaves which exhibit strongly parallel venation. Many shapes and sizes of leaf are involved. Long, narrow leaves, similar to Monocotyledon leaves in modern floras, (in general appearance) are most strictly referable to the species. Many broader examples with nearly parallel margins which taper towards the leaf base are also included. However, there are some broad leaves found in Lower Permian and Upper Carboniferous horizons in Australia and South Africa, with strong parallel venation, which have been referred to the species in the past for want of any better name to use. One such leaf is known as Palaeovittaria kurzi which has been described bearing Glossopteris type fructifications in the Lower Permian of South Africa.

It is impossible to define exactly when a coarse-parallel-veined leaf shows sufficient divergence in the veins from strictly parallel formation to warrant inclusion in Palaeovittaria kurzi. Usually preservation of leaves is of impression type with only major features of secondary venation visible and no detail of cell or stomata structure to assist.

Characteristic of the Lower Bowen series in Australia are large numbers of coarsely, more or less parallel-veined leaves. They differ very markedly from the most typical long, narrow, parallel-veined leaves of "Noeggerathiopsis hislopi" such as occur in the Greta Coal Measures as well as in the Upper Coal Measures in N.S.W. Wherever there is a record of an Upper Permian or even a Triassic occurrence of the species it involves leaves of the latter type, not of the type characteristic of the Lower Permian.

It seems probable that the typically Lower Bowen "Noeggerathiopsis" is not justifiably referred to the genus and not in any way connected with Cordaitales. It is much more likely that it is related to the Glossopteridae and to the "Palaeovittaria kurzi" which bears Glossopterid fructifications in South Africa. It is doubtful, however, if there is a good case for using the name "Palaeovittaria" in this instance. Some advanced Glossopterids (cf. mitchelli etc.) in Upper Permian horizons have evolved towards Taeniopteris and are now referred to as Palaeovittaria.

In identification of leaves in recent B.M.R. collections I have referred to Noeggerathiopsis hislopi "of Lower Bowen type" and have determined Lower Permian or Upper Carboniferous age for the fossil horizons. I am not aware of any example of Noeggerathiopsis hislopi "of Lower Bowen type" which occurs in Upper Permian strata, and have hopes that the type is confined to the earliest Gangamopteris and Glossopteris floras. I believe that Dr. Evans has isolated spores from horizons which contain Lower Bowen type Noeggerathiopsis and it will be interesting to see whether the separation of Upper and Lower Permian on this basis is valid. If it is, I think the time has come to give a new name to the leaves involved - a new genus "of unknown affinities" would be far less confusing to deal with. Noeggerathiopsis hislopi could then be more closely defined and limited.

The range of the limited Noeggerathiopsis hislopi (with leaves narrow in proportion to their length, veins parallel, and tapering gradually to a relatively broad base (many examples are known where such leaves are found attached in radiate manner)) is Permian to Lower Triassic. But the range of the new genus would be Lower Permian and Upper Carboniferous.

APPENDIX 6.

PETROGRAPHY

by

Beverley R. Houston.

(Queensland Geological Survey)

SILURIAN - DEVONIAN

Microslide:- GSQ 3084 ex Specimen:- GSQ/R 2275 Field No.:- Du 146B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 9 No.: 5073
Point:- 146

Location:- Thuriba Homestead area.

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

Micro:-

Texture:- Clastic; the clasts (about 95% of rock) are commonly distorted and embayed, 0.5 to 4mm. The matrix is very fine-grained, recrystallised.

Clasts:- Lithic Material:- about 85% of rock; fine-grained porphyritic and non-porphyritic extrusives and minor pyroclastics.

Feldspar (including oligoclase): > 5% of rock; altered crystals.

Quartz:- minor, strained.

Matrix:- Tuffaceous: about 5% of rock; recrystallised, epidotised.

Origin:- Slight recrystallisation of a pyroclastic rock. The fragments are similar to many of the Devonian Volcanics. The rock may have been slightly sheared.

Name:- RECRYSTALLISED CRYSTAL-LITHIC TUFF

Remarks:- Since this rock is primary rather than redeposited it is probably related to the Devonian Volcanics.

DEVONIAN - CARBONIFEROUS VOLCANICS

Microslide:- GSQ 3035 ex Specimen:- GSQ/R 2227 Field No.:- Du 968/4b

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 968/4

Location:- East of Hillview Homestead.

Macro:- A massive, fine-grained, greenish-grey, clastic rock.

Micro:-

Texture:- Clastic; the clasts (about 40% of rock) are broken and/or embayed crystals (o.1 to 0.8 mm., dominantly about 0.4 mm.) and distorted and/or embayed lithic fragments of about the same size.

Clasts:- Plagioclase (essentially albite): about 30% of rock; commonly replaced in part by chlorite and epidote, calcite or zeolite.

Quartz: minor

Lithic Material: about 10% of rock; very fine-grained altered volcanics.

Matrix:- Tuffaceous: about 60% of rock; altered in part to epidote, chlorite etc.

Origin:- Alteration of a volcanic pyroclastic rock.

Name:- SPILITIC LITHIC-CRYSTAL TUFF

Microslide:- GSQ 3037 ex Specimen:- GSQ/R 2229 Field No.:- Du 968/1

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 968/1

Location:- East of Hillview Homestead.

Macro:- A massive, fine-grained, medium grey igneous rock with numerous feldspar phenocrysts.

Micro:- Essentially similar to GSQ 3042 except in the following details:-

(1) The rock is traversed by a number of fine siliceous veins.

(2) The grain size of the groundmass is 0.02 to 0.06 mm.

(3) The variolitic texture is not so well developed in GSQ 3037.

(4) Abundant acicular crystals of plagioclase are evident in the groundmass.

Name:- KERATOPHYRE

Microslide:- GSQ 3040 ex Specimen:- GSQ/R 2232 Field No.:- Du 968/2b

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 968/2

Location:- East of Hillview.

Macro:- A massive, fine-grained, light grey rock with abundant feldspar phenocrysts.

Micro:-

Texture:- Porphyritic; the phenocrysts (about 25% of rock) are subhedral, 1 to 3 mm. The groundmass is uneven-grained (microcrystalline to 0.2 mm.), consisting of anhedra; variolitic in part.

Phenocrysts:- Plagioclase: about 25% of rock; considerably altered; albite, oligoclase and andesine can be identified.

Groundmass:- The following secondary minerals, in estimated decreasing order of abundance, can be identified:-

Zeolite
Chlorite
Epidote
?Carbonate
?Hydrogrossularite

Origin:- Alteration of a ?intermediate volcanic extrusive rock.

Name:- KERATOPHYRE

Microslide:- GSQ 3041 ex Specimen:- GSQ/R 2233 Field No.:- Du 968/2a

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 968/2

Location:- East of Hillview Homestead.

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

Micro:- Essentially similar to GSQ 3040 except that GSQ 3041 is not porphyritic and the variolitic texture is less well-developed than in GSQ 3040.

Name:- KERATOPHYRE

Microslide:- GSQ 3042 ex Specimen:- GSQ/R 2234 Field No.:- Du 968/3a

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 968/3

Location:- East of Hillview Homestead.

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

Micro:-

Texture:- Porphyritic; the phenocrysts (about 5% of rock) are anhedral to euhedral, 0.5 to 1.5 mm. The groundmass is variolitic, grain size about 0.02 to 0.04 mm.

Phenocrysts:- Albite: about 5% of rock; somewhat altered, commonly replaced in part by calcite.

Groundmass:- The only minerals which can be definitely distinguished are:-

Zeolite (? chabazite)
Chlorite
?Albite

Origin:- Alteration of an ? intermediate igneous extrusive rock.

Name:- KERATOPHYRE

Microslide:- GSQ 3043 ex Specimen:- GSQ/R 2235 Field No.:- Du 968/3b

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 968/3

Location:- East of Hillview Homestead.

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

Micro:-

Texture:- The rock consists of subhedral and anhedral lath-shaped phenocrysts, 0.08 to 0.7 mm. in an essentially allotriomorphic-granular groundmass, microcrystalline to 0.06 mm.

Phenocrysts:- Plagioclase: about 30% of rock; somewhat altered, commonly calcitised; oligoclase and andesine can be identified.

Groundmass:- The following minerals can be identified:-

Zeolite
Plagioclase
Chlorite
Calcite - minor.
Apatite - accessory.

Origin:- Alteration of an igneous rock, intrusive or high-level intrusive.

Name:- KERATOPHYRE

Microslide:- GSQ 3044 ex Specimen:- GSQ/R 2236 Field No.:- Du 968/4A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 968/4

Location:- East of Hillview Homestead.

Macro:- A tough, massive very fine-grained, black rock with abundant coarse feldspar phenocrysts.

Micro:- Essentially similar to GSQ 3037 except that the phenocrysts, which are up to 3 mm., are slightly embayed.

Name:- KERATOPHYRE

Microslide:- GSQ 3053 ex Specimen:- GSQ/R 2245 Field No.:- Du 373

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 373

Location:- Melrose Homestead.

Macro:- A massive coarse-grained, greenish-grey, clastic rock with several elongate fragments up to 1.2x3+ cm. of fine, greenish, bedded material.

Micro:-

Texture:- Clastic; the clasts (about 90% of rock) are to 1.2 cm., dominantly about 2 to 4 mm., subrounded to rounded, of high to low sphericity. The matrix is very fine-grained.

Clasts:- Lithic material: about 85% of rock, the following types can be recognised:-

Spilitic tuff (very coarse fragments)
Spilitic crystal tuff
Fine-grained extrusives) ?spilitic
Porphyritic extrusives)
Epidote-chlorite rock

Feldspar (?albite): about 5% of rock; broken crystals.

Clinopyroxene: rare; broken crystals.

Matrix:- Tuffaceous: about 10% of rock; very fine-grained, translucent.

Origin:- Sedimentary; by reworking of volcanic rocks.

Name:- VOLCANIC CONGLOMERATE

Microslide:- GSQ 3054 ex Specimen:- GSQ/R 2246 Field No.:- Du 375B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 375

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

Micro:-

Texture:- Clastic; the clasts (about 80% of rock) are of two types: (a) broken crystals 0.08 to 0.25 mm. and (b) rock fragments, 0.08 to 2.0 mm., of moderate to low sphericity, embayed. The matrix is very fine-grained.

Clasts:- Feldspar: about 15% of rock; broken crystals, essentially albite and labradorite; somewhat altered.

Lithic Material: about 65% of rock; the following are evident:-

Very fine-grained chloritic ?tuff (dominant).
Fine-grained basic fluidal rock.
Micaceous phyllitic material (not abundant).
Indeterminate calcitised, epidotised and chloritised rocks.

Matrix:- Tuffaceous: about 20% of rock; very fine-grained.

Origin:- Alteration of a volcanic pyroclastic rock.

Name:- SPILITIC CRYSTAL-LITHIC TUFF

Microslide:- GSQ 3055 ex Specimen:- GSQ/R 2247 Field No.:- 131/1

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5055
Point:- 131/1

Location:- Fitzroy River near Craigilee Homestead.

Macro:- A massive, fairly fine-grained, greenish-grey clastic rock.

Micro:- Essentially similar to GSQ 3054 except in the following details:-

(1) Calcite is less abundant in GSQ 3055.

(2) No fragments of micaceous phyllitic material are evident.

(3) Several fragments of silicified indeterminate rock occur (microcrystalline ? feldspathic allotriomorphic-granular mosaic).

(4) Fragments of porphyritic extrusives occur.

Name:- SPILITIC CRYSTAL-LITHIC TUFF

Microslide:- GSQ 3056 ex Specimen:- GSQ/R 2248 Field No.:- Du 133A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 133

Location:- West of Melrose Homestead.

Macro:- A massive, fine- to medium-grained, greenish-grey clastic rock with about 5% very fine-grained, elongate, pale green fragments up to 5 mm. across.

Micro:- The rock is very cloudy and hence detailed description is impossible. It appears to be essentially similar to GSQ 3054 except in the following details:-

(1) The rock fragments are dominantly about 1 mm.

(2) The clouding is due to extreme fine granular ?epidote and ?hydrogrossularite.

(3) The green fragments consist essentially of epidote, penninite and ?hydrogrossularite.

(4) Epidote is more abundant throughout GSQ 3056 than in GSQ 3054.

Name:- SPILITIC CRYSTAL-LITHIC TUFF

Microslide:- GSQ 3057 ex Specimen:- GSQ/R 2249 Field No.:- Du 133B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035 Point:- 133

Location:- West of Melrose Homestead.

Macro:- A tough, massive, light to medium grey, thinly-bedded rock.

Micro:- Extremely cloudy due to alteration. Two distinct beds are evident, Bed I (finer-grained) and Bed II (coarser-grained).

Bed I

Texture:- Clastic; the clasts (about 10% of rock) are 0.01 (fine acicular crystals) to 0.04 (broken crystals and rock fragments); matrix is very fine-grained.

Clasts:- Feldspar: > 5% of rock; fine acicular crystals and coarser broken crystals; commonly replaced by zeolite and/or ?hydrogrossularite and/or calcite.

Lithic Material: minor, very fine-grained, indeterminate.

Matrix:- Tuffaceous: about 90% of rock; chlorite, epidote and calcite can be recognised.

Bed II

Essentially similar to Bed I except in the following:-

(1) Clasts make up about 30% of rock - crystals 20% and lithic material 10%.

(2) The clasts are 0.01 to 0.2 mm., dominantly about 0.08 mm.

Origin:- Alteration of thinly-bedded volcanic pyroclastic material.

Name:- SPILITIC LITHIC-CRYSTAL TUFF

Microslide:- GSQ 3058 ex Specimen:- GSQ/R 2250 Field No.:- Du 133C

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 133

Location:- West of Melrose Homestead.

Macro:- A tough, massive, thinly-bedded, light to dark grey rock.

Micro:- The beds are basically of two distinct types:-

Type I (Light grey beds)

Texture:- Extremely altered, clastic, the clasts (5% of rock) are essentially broken, corroded crystals, about 0.04 mm.; rare fragments of lithic material can also be recognised. The matrix is very fine-grained, cloudy.

Clasts:- Feldspar: $<$ 5% of rock; broken crystals, commonly zeolitised.

Lithic Material: minor, indeterminate.

Matrix:- Tuffaceous: $>$ 95% of rock; about 5% penninite, abundant zeolite and minor epidote can be identified.

Type II (Dark grey beds)

Essentially similar to Type I except in the following:-

(1) Fewer clasts are recognisable.

(2) ?Devitrified ?shards are evident.

(3) The material contains abundant translucent and opaque material which, also, may be devitrified glass (in part, at least).

Origin:- Alteration of thinly-bedded volcanic, pyroclastic rocks; there is no definite evidence that the rock is spilitic but the mineral association suggests that it is so.

Name:- ?SPILITIC TUFF

Microslide:- GSQ 3059 ex Specimen:- GSQ/R 2251 Field No.:- Du 133D

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5035
Point:- 133

Location:- West of Melrose Homestead.

Macro:- A massive, medium-grained, light grey, clastic rock.

Micro:-

Texture:- Clastic, the clasts are difficult to distinguish but appear to make up about 85% of rock; they are 0.08 to 2 mm., dominantly about 0.7 mm.; lithic fragments are, in general, of moderate to low sphericity, distorted and/or embayed; crystals are commonly broken and/or embayed. The matrix is very fine-grained.

Clasts:- Lithic Material: about 65% of rock; the rocks are very fine-grained and the following can be recognised:-

Basic and/or intermediate extrusives (commonly crudely pilotaxitic)

Porphyritic extrusives

Chloritic ?tuffaceous material

?Quartzite (one fragment)

Feldspar: about 20% of rock; crystals, commonly calcitised.

Quartz: rare; embayed crystals.

Matrix:- Tuffaceous: about 15% of rock; translucent; chlorite, epidote and calcite can be recognised together with minor ?devitrified ?glass.

Origin:- Alteration of a volcanic pyroclastic rock.

Name:- SPILITIC CRYSTAL-LITHIC TUFF

Microslide:- GSQ 3079 ex Specimen:- GSQ/R 2271 Field No.:- Du 607

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.: 5055
Point:- 607

Location:- Craigilee Crossing of Fitzroy River.

Macro:- A massive, fine-grained black limestone cut by fine veins of white calcite.

Micro:-

Texture:- Oolitic, 0.25 to 2 mm.; partly recrystallised, 0.1 to 0.5 mm. The rock contains < 5% clastic grains.

Constituents:- Grains: < 5% of rock; plagioclase, quartz and lithic (spilite) fragments.

Oolites: about 55% of rock; translucent carbonate.

Crystalline calcite: about 40% of rock.

Origin:- Sedimentary; minor diagenetic recrystallisation has occurred.

Name:- RECRYSTALLISED OOLITIC LIMESTONE

Microscope:- GSQ 3080 ex Specimen: GSQ/R 2272 Field No.:- Du 607

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5055
Point:- 607

Location:- Craigilee Crossing of Fitzroy River.

Macro:- A tough, massive, very fine-grained, black rock containing about 15% phenocrysts.

Micro:-

Texture:- Porphyritic to glomeroporphyritic; individual phenocrysts (about 15% of rock) are 0.1 to 3 mm. (with the clusters 2 to 3 mm.), euhedral to anhedral, deeply embayed. The groundmass is very cloudy, essentially allotrimorphic-granular, about 0.03 mm. In general, there is a zone of finer-grained material about the phenocrysts.

Phenocrysts:- Alkali feldspar - oligoclase: about 10% of rock; extremely altered to chlorite, epidote, ?zeolite etc.

Quartz: about 5% of rock; slightly strained; with numerous minute inclusions.

Groundmass:- Consists essentially of:-

Feldspar
Zeolite
Quartz (minor)
Chlorite

Origin:- Alteration of an extrusive rock.

Name:- ALTERED TRACHYTE

Remarks:- This rock is somewhat similar to Keratophyres described from the Devonian Volcanics in the Hillview area.

Microslide:- GSQ 3081 ex Specimen:- GSQ/R 2273 Field No.:- Du 607

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5055
Point:- 607

Location:- Craigilee Crossing of Fitzroy River.

Macro:- A massive, fine- to medium-grained, dark greenish-grey igneous rock.

Micro:- Extremely altered.

Texture:- Uneven-grained, consisted of anhedral lath-shaped crystals up to 2 mm. and fine prismatic anhedra, about 0.5 mm.

Constituents:- Albite-oligoclase: about 70% of rock; considerably replaced by chlorite, with minor calcite and epidote.

Augite: > 5% of rock; uralitised in part.

Chlorite: about 20% of rock; filling interstices, with minor associated calcite and epidcte.

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

Origin:- Alteration of a volcanic rock, probably extrusive.

Name:- SPILITE

Remarks:- This rock is probably related to the Rookwood Volcanics or their equivalents.

INTRUSIVE IN MIDDLE CARBONIFEROUS

Microslide:- GSQ 3051 ex Specimen:- GSQ/R 2243 Field No.:- Du 365

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5055 Point:- 365

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

Micro:- Essentially similar to GSQ 3043 except in the following details:-

(1) GSQ 3051 contains about 10% feldspar phenocrysts, euhedral and subhedral, 0.5 to 2 mm.

(2) The feldspar phenocrysts have been partially replaced by epidote, penninite, zeolite, clinozoisite and calcite.

(3) The rock contains < 10% phenocrysts of subhedral amphibole crystals, 0.5 to 3 mm., pseudomorphed by secondary minerals - calcite, penninite, chlorite, opaques and epidcte.

Name:- KERATOPHYRE

DINNER CREEK BEDS

Microslide:- GSQ 3052 ex Specimen:- GSQ/R 2244 Field No.:- Du 367

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5055
Point:- 367

Macro:- A massive, fairly coarse-grained, greenish-grey clastic rock.

Micro:- Essentially similar to GSQ 3053 except that the very coarse fragments of bedded tuff do not occur.

Name:- VOLCANIC CONGLOMERATE

Microslide:- GSQ 3050 ex Specimen:- GSQ/R 2242 Field No.:- Du 359

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 4 No.:- 5045
Point:- 359

Macro:- A massive, fairly fine-grained, greenish-grey rock.

Micro:-

Texture:- Hypidiomorphic-granular, grain size about 0.25 to 0.5 mm.

Constituents:- Plagioclase: about 65% of rock; lath-shaped crystals, somewhat altered. Labradorite, andesine, oligoclase and ?albite are present.

Clinopyroxene: about 15% of rock; colourless subhedra and anhedra, somewhat ragged.

Chlorite: about 10% of rock; pale green, finely crystalline, filling interstices, secondary.

Epidote: $>$ 5%; very pale brown; secondary.

Carbonate (?siderite): $<$ 5% of rock; subhedra and anhedra; cleavage traces commonly filled with opaques.

Origin: Alteration of basic igneous rock, probably intrusive.

Name:- SPILITE

LOWER BOWEN VOLCANICS

Microslide:- GSQ 3013 ex Specimen:- GSQ/R 2205 Field No.:- Du 119/5

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 4 No.: 5043
Point:- 119/5

Location:- Balcomba Creek.

Macro:- A massive, fine-grained, light greenish-grey rock with a crude foliation; several fine quartz veins cut across the foliation.

Micro:-

Texture:- Recrystallised volcanic; the original texture appears to have been pilotaxitic or intersertal, grain size about 0.02 mm. Recrystallisation has resulted in the growth of fine (up to 0.05 mm.) granular crystals and very fine flakes. The foliation is not obvious.

Constituents:- Plagioclase: about 70% of rock, very fine crystals.

Epidote: about 20% of rock; very fine, granular; two varieties, colourless and light brown.

Chlorite: about 10% of rock; very fine and coarser flakes; light brown; the coarser flakes possibly represent altered primary mafic crystals.

Zoisite: minor.

Carbonate (?calcite): minor, secondary.

Origin:- Very low grade regional metamorphism of an extrusive volcanic, possibly andesite.

Name:- ALTERED, METAMORPHOSED ?ANDESITE

Microslide:- GSQ 3014 ex Specimen:- GSQ/R 2206 Field No.:- Du 119/4

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 4 No.:- 5043
Point:- 119/4

Macro:- A massive, fine-grained, light greenish-grey foliated rock. Several small veins cut the foliation.

Micro:- The rock is extremely altered.

Texture:- Remnants of the original texture (pilotaxitic or intersertal, about 0.1 mm.) are evident but the major part of the rock is recrystallised. The overall texture is of a "felted" mass of acicular and fibrous crystals, with crude spherulitic intergrowths in part. Superimposed of this texture are very fine, roughly parallel "stringers" composed of microcrystalline to cryptocrystalline granular material.

Constituents:- The percentage composition cannot be determined; feldspar and its derivatives are much more abundant than mafic minerals.

Plagioclase: acicular crystals, altered; overgrown in part.

Zeolite: ?pseudomorphous after plagioclase; intergrown with chlorite in the spherulitic bodies.

Chlorite: light brown; fibrous, intergrown with the zeolite; a second variety, ?penninite, occurs in the interstices of the crystal mesh.

Epidote: very fine granular, in the fine stringers which evidence the foliation.

Origin:- Regional metamorphism of an ?intermediate volcanic.

Name:- GREENSTONE

Microslide:- GSQ 3061 ex Specimen:- GSQ/R 2253 Field No.:- Du 928/2

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5059
Point:- 928/2

Location:- Boomer Range.

Macro:- A massive, pinkish-brown, clastic rock containing abundant feldspar crystals and some rock fragments.

Micro:-

Texture:- Clastic, the clasts (about 45% of rock) are broken and/or embayed crystals, 0.08 to 1.5 mm. (about 35%) and embayed rock fragments, 0.6 to 8 mm. of moderate to high sphericity (about 10%). The matrix is very fine-grained, translucent, flow-banded.

Clasts:- Oligoclase-andesine: $<$ 35% of rock; crystals altered to clay minerals and/or zeolite.

Potash feldspar: rare, altered.

Quartz: rare

Lithic material: about 10% of rock; very fine-grained volcanics.

Matrix:- Tuffaceous: about 55% of rock; clouded by abundant hematite dust.

Origin:- Alteration of pyroclastic rock.

Name:- ALTERED LITHIC-CRYSTAL TUFF

Microslide:- GSQ 3062 ex Specimen:- GSQ/R 2254 Field No.:- Du 937/3

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5059
Point:- 937/3

Location:- Boomer Range.

Macro:- A massive, greenish- and pinkish-grey, clastic rock with fragments up to 1.3 cm.

Micro:-

Texture:- Clastic; the clasts (about 85% of rock) are 0.6 to 13 mm., of very low to high sphericity embayed. The matrix is very fine-grained, extremely altered.

Clasts:- Lithic Material: about 85% of rock, the following can be recognised:-

Spilite
Tuff
Crystal Tuff
?Trachyte
Porphyritic extrusives

Matrix:- Tuffaceous: about 15% of rock; extremely altered to chlorite, calcite, hematite, dendritic opaques and epidote.

Origin:- Alteration of a pyroclastic rock.

Name:- ALTERED LITHIC TUFF

Microslide:- GSQ 3063 ex Specimen:- GSQ/R 2255 Field No.:- Du 992A

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St. Lawrence 1:85,000 Run:- 7 No.:- 5048
Point:- 992

Location:- South-west of Tooloombah Homestead.

Macro: A massive, pinkish-grey, clastic rock, with abundant feldspar crystals.

Micro:-

Texture:- Clastic; the clasts (about 60% of rock) are deeply embayed and/or broken crystals, 0.1 to 1.5 mm. The matrix is very fine-grained, recrystallised, spherulitic in part.

Clasts:- Andesine: about 40% of rock; altered to clay minerals and/or zeolite.

Quartz: about 10% of rock; strained, very deeply embayed.

?Hornblende: minor; replaced by epidote, chlorite and opaque dust.

Matrix:- Tuffaceous: about 40% of rock; occurs as chlorite, commonly spherulitic.

Origin:- Partial diagenetic recrystallisation of a pyroclastic rock; it is probable that the matrix was originally glassy.

Name:- RECRYSTALLISED CRYSTAL TUFF

Microslide:- GSQ 3064 ex Specimen:- GSQ/R 2256 Field No.:- Du 1002/1B

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St. Lawrence 1:85,000 Run:- 6 No.:- 5012
Point:- 1002/1

Location:- Granite Creek

Macro:- A massive, fine-grained, light grey, clastic rock with abundant feldspar crystals.

Micro:-

Texture:- Clastic; the clasts (about 65% of rock) are subhedral and embayed anhedral crystals, o.15 to 2 mm. (about 55%) and embayed lithic fragments 0.6 to 2 mm., of moderate to high sphericity. The matrix is very fine-grained, translucent (about 10%).

Clasts:- Andesine: about 50% of rock; crystals commonly altered to clay minerals and/or zeolite.

Quartz: about 5% of rock; strained.

Lithic material: about 10% of rock; very fine-grained volcanics.

Matrix:- Tuffaceous: about 35% of rock; extremely cloudy, altered.

Origin:- Alteration of a pyroclastic rock.

Name:- ALTERED LITHIC-CRYSTAL TUFF

Microslide:- GSQ 3065 ex Specimen:- GSQ/R 2257 Field No.:- Du 997/3B

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St. Lawrence 1:85,000 Run:- 7 No.:- 5046

Location:- South of Tooloombah Homestead.

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

Micro:-

Texture:- Porphyritic; the phenocrysts (about 10% of rock) are in general, anhedral, prismatic, embayed, about 0.5 to 1 mm. The groundmass is intersertal to intergranular, about 0.04 to 0.13 mm.

Phenocrysts:- Augite: $<$10% of rock; crystals replaced wholly or in part by bastite.

Oligoclase: $<$ 5% of rock; zoned crystals, somewhat altered.

Groundmass:- Labradorite: about 55% of rock; acicular crystals.

Augite: <10% of rock; fine, granular.

Serpentine: about 25% of rock; filling interstices.

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

Origin:- Alteration of a volcanic extrusive rock.

Name:- ALTERED BASALT

Microslide:- GSQ 3066 ex Specimen:- GSQ/R 2258 Field No.:- Du 993/1

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St. Lawrence 1:85,000 Run:- 7 No.:- 5048 Point:- 993/1

Location:- South-west of Tooloombah Homestead.

Macro:- A massive, light grey, clastic rock.

Micro:-

Texture:- Clastic; the clasts (about 80% of rock) are corroded and/or broken crystals, 0.09 to 1 mm. (about 60% of rock) and distorted lithic fragments, of moderate to low sphericity, 0.6 to 5 mm. The matrix is very fine-grained.

Clasts:- Oligoclase: about 60% of rock; altered to clay minerals and/or prehnite.

Lithic material: about 20% of rock; very fine-grained volcanics.

Matrix:- Tuffaceous: about 20% of rock; chloritic with minor prehnite.

Origin:- Alteration of a pyroclastic rock.

Name:- ALTERED LITHIC-CRYSTAL TUFF.

Microslide:- GSQ 3067 ex Specimen:- GSQ/R 2259 Field No.:- Du 995B

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St. Lawrence 1:85,000 Run:- 7 No.:- 5046 Point:- 995

Location:- South-west of Tooloombah Homestead.

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

Micro:- Essentially similar to GSQ 3065 except that granular augite is more abundant in GSQ 3067.

Name:- ALTERED BASALT

Microslide:- GSQ 3068 ex Specimen:- GSQ/R 2260 Field No.:- Du 8/2A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5031
Point:- 8/2

Location:- Leura Creek

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

Micro:-

Texture:- Porphyritic; the phenocrysts (about 5% of rock) are subhedral to anhedral, 0.17 to 1.3 mm. The groundmass is extremely altered, pilotaxitic, microcrystalline to 0.08 mm. The rock is traversed by a network of fine veins.

Phenocrysts:- Albite-oligoclase: about 5% of rock; zeolitised in part.

Groundmass:- Albite-oligoclase: about 95% of rock; zeolitised.

Epidote: minor, secondary.

Veins:- Chalcedony: with minor opaques.

Origin:- Alteration of a volcanic extrusive.

Name:- SILICIFIED TRACHYTE

Microslide:- GSQ 3069 ex Specimen:- GSQ/R 2261 Field No.:- Du 8/2B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5031
Point:- 8/2

Location:- Leura Creek.

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

Micro:

Texture:- Clastic; the clasts (about 90% of rock) are commonly distorted and embayed, 4 to 6 mm. The matrix is very fine-grained, flow-banded.

Clasts:- Lithic Material: about 90% of rock; the following can be recognised:-
Crystal Tuff (intermediate)
Pilotaxitic extrusive (very fine-grained)
Porphyritic extrusive (very fine-grained)
Porphyritic amygdaloidal extrusive
Lithic-crystal Tuff
Tuff

Matrix:- Tuffaceous: about 90% of rock; with abundant opaque dust.

Origin:- Pyroclastic

Name:- LITHIC TUFF

Microslide:- GSQ 3070 ex Specimen:- GSQ/R 2262 Field No.:- Du 8/8A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5031
Point:- 8/8

Location:- Leura Creek

Macro:- A massive, fine-grained, brownish-purple, clastic rock with clasts up to 3 mm.

Micro:- Essentially similar to GSQ 3071 except that the maximum size of the lithic fragments is 3 mm.

Name:- RECRYSTALLISED CRYSTAL-LITHIC TUFF

Microslide:- GSQ 3071 ex Specimen:- GSQ/R 2263 Field No.:- Du 8/8B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.:- 5031
Point:- 8/8

Location:- Leura Creek

Macro:- A massive, light grey, clastic rock containing fragments up to 2.5 cm.

Micro:-

Texture:- Clastic; the clasts are commonly difficult to distinguish from the matrix but appear to make up about 40% of rock. They are of two types: (a) about 30% of rock, lithic fragments, commonly somewhat embayed, upwards of 0.35 mm. (b) about 10 % corroded crystals, 0.17 to 1 mm. The matrix is allotriomorphic-granular, 0.02 to 0.04 mm.

Clasts:- Lithic material: about 30% of rock; the following types are recognisable:-

Porphyritic extrusive } ?Spilitic
Fine-grained extrusive }
Crystal Tuff
Tuff

Plagioclase: about 5% of rock; zeolitised and/or calcitised crystals.

Mafic crystals: < 5% of rock; replaced by epidote, calcite, chlorite and/or serpentine.

?Biotite: minor; replaced by chlorite and sphene.

Quartz: minor.

Matrix:- Quartzo-feldspathic material: about 50% of rock.

Sericite: about 10% of rock; pale green.

Origin:- Partial diagenetic recrystallisation of a pyroclastic rock.

Name:- RECRYSTALLISED AGGLOMERATE

Microslide:- GSQ 3072 ex Specimen:- GSQ/R 2264 Field No.: Du 928/2

Four Mile Map:- Duaringa

Air Photo (B.M.R.);- Duaringa 1:85,000 Run:- 3 No. 5059
Point:- 928

Location:- Leura Homestead area.

Macro:- A massive, red-brown, clastic rock containing abundant feldspar crystals and minor rock fragments.

Micro:-

Texture:- Clastic; the clasts (about 45% of rock) are subhedral and embayed anhedral crystals, 0.1 to 2 mm. (about 35% and elongate embayed rock fragments 0.2 to 4 mm. (about 10%). The matrix is very fine-grained, flow banded.

Clasts:- Andesine: about 35% of rock; crystals commonly bent.

Lithic Material: about 10% of rock; very fine-grained altered basic extrusives and rarely, ?rhyolite.

Matrix:- Tuffaceous: about 55% of rock; clouded by abundant hematite dust.

Origin:- Alteration of a pyroclastic rock.

Name:- ALTERED LITHIC-CRYSTAL TUFF

Microslide:- GSQ 3073 ex Specimen:- GSQ/R 2265 Field No.:- Du 998

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St Lawrence 1:85,000 Run:- 7 No.:- 5046
Point:- 998

Location:- South of Tooloombah Homestead.

Macro:- A massive, light to medium grey, clastic rock with fragments up to 1.3 cm.

Micro:-

Texture:- Clastic; the clasts (about 75% of rock) are 0.25 to 12 mm., of moderate to high sphericity, embayed. The matrix is finely crystalline, fibrous.

Clasts:- Spilite: about 75% of rock.

Matrix:- Tuffaceous: about 25% of rock; secondary prehnite if the only recognisable mineral.

Origin:- Alteration of a ?redeposited volcanic material.

Name:- ALTERED VOLCANIC GREYWACKE

Microslide:- GSQ 3074 ex Specimen:- GSQ/R 2266 Field No.:- Du 997/3C

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St. Lawrence 1:85,000 Run:- 7 No.:- 5046
Point:- 997/3

Location:- South of Tooloombah Homestead.

Macro:- A massive, fine-grained, pinkish-brown, igneous rock containing abundant coarse, yellow-green phenocrysts and irregular patches of white calcite.

Micro:-

Texture:- Porphyritic; the phenocrysts (about 10% of rock) are anhedral, corroded, lath-shaped crystals up to 7 mm. in length. The groundmass is intersertal, about 0.03 mm. Abundant irregular veins traverse the rock.

Phenocrysts:- Oligoclase: about 10% of rock; replaced in part by calcite, epidote and clinozoisite.

Groundmass:- Extremely altered, so that percentage composition cannot be determined. The following minerals can be recognised:-

Plagioclase - acicular crystals
Chlorite
Calcite
Epidote
?Hydrogrossularite

Veins:- Chlorite, chalcedony and calcite.

Origin:- Alteration of a basic volcanic extrusive.

Name:- SPILITE

Microslide:- GSQ 3075 ex Specimen:- GSQ/R 2267 Field No.:- Du 997/3D

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St. Lawrence 1:85,000 Run:- 7 No.:- 5046
Point:- 997/3

Location:- South of Tooloombah Homestead.

Macro:- A massive, fine-grained, greenish-grey, igneous rock containing about 10% ellipsoidal amygdules.

Micro:-

Texture:- Intersertal, grain size about 0.04 mm. Abundant amygdules are present and numerous fine veins traverse the rock.

Constituents:- Andesine: about 45% of rock; acicular crystals replaced in part by calcite.

Chlorite: about 50% of rock; filling interstices.

Epidote: $<$ 5% of rock; microcrystalline.

Opaques: $<$ 5% of rock; fine, granular.

Amygdules:- Chlorite and chalcedony.

Veins:- Siliceous.

Origin:- Alteration of a volcanic extrusive rock.

Name:- ALTERED BASALT

Microslide:- GSQ 3076 ex Specimen:- GSQ/R 2268 Field No.:- Du 1002/2A

Four Mile Map:- St Lawrence

Air Photo (B.M.R.):- St Lawrence 1:85,000 Run:- 6 No.:- 5012
Point:- 1002/2

Location:- Granite Creek.

Macro:- A massive, fine-grained, light to medium grey, thinly - and irregularly-bedded clastic rock.

Micro:- The different coloured beds are of different grain size; the coarse and fine are described; all size gradations between the two occur.

Coarsest Bed

Texture:- Clastic; the clasts (about 30% of rock) are 0.02 to 0.05 mm., subrounded to angular crystals. the matrix is very fine-grained.

Clasts:- Quartz: 20-25% of rock; strained.
Feldspar: 5-10% of rock; altered.

Matrix:- Argillaceous (?tuffaceous): about 70% of rock.

Finest Bed

Essentially similar to the coarse bed except that the clasts, 0.002 to 0.006 mm., make up about 5% of rock.

Origin:- Pyroclastic or sedimentary.

Name:- CRYSTAL ?TUFF

Microslide:- GSQ 3077 ex Specimen:- GSQ/R 2269 Field No.:- Du 1002/2B

Four Mile Map:- St. Lawrence

Air Photo (B.M.R.):- St. Lawrence 1:85,000 Run:- 6 No.:- 5012
Point 1002/2

Location:- Granite Creek.

Macro:- A massive, uneven-grained, light grey, clastic rock.

Micro:-

Texture:- Clastic; the clasts (about 90% of rock) are embayed lithic fragments of moderate to low sphericity, 0.4 to 9 mm. (about 60% of rock) and embayed and/or broken crystals, 0.17 to 1 mm. (30%). The matrix is extremely fine-grained, translucent.

Clasts:- Lithic Material: about 60% of rock; including altered very fine-grained extrusives and tuffs.

Andesine: about 30% of rock; crystals, commonly bent, zeolitised in part.

Quartz: minor; crystals.

Matrix:- Tuffaceous: about 10% of rock; altered.

Origin:- Alteration of a pyroclastic rock.

Name:- ALTERED CRYSTAL-LITHIC TUFF

Microslide:- GSQ 3088 ex Specimen:- GSQ/R 2280 Field No.:- Du 119/7

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 4 No.:- 5043 Point:- 119/7

Location:- Balcomba Creek

Macro:- A tough, massive, very fine-grained, white, fractured rock.

Micro:-

Texture:- Allotriomorphic-granular, 0.005 to 0.02 mm. The rock is traversed by a number of very fine veins.

Constituents:- Chalcedony: > 95% of rock.
Plagioclase: < 1% of rock.
Epidote: < 5% of rock.

Veins:- Siliceous.

Origin:- Silicification and/or recrystallisation of a ?rhyolite.

Name:- SILICIFIED ?RHYOLITE

Remarks:- This rock cannot be compared with any rocks described from the Duaringa 4-mile area.

Microslide:- GSQ 3093 ex Specimen:- GSQ/R 2285 Field No.:- Du 933/3A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5057 Point:- 933/3

Location:- Boomer Range.

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

Micro:- The rock is so heavily calcitised that no minerals can be identified; the calcite appears to be replacing acicular feldspar crystals which are crudely parallel either due to flow structure or to shearing.

Origin:- Shearing and alteration of an extrusive rock.

Name:- SHEARED ?FLUIDAL VOLCANIC

Microslide:- GSQ 3094 ex Specimen:- GSQ/R 2286 Field No.:- Du 933/3B

Four Mile Map:- Duaringa

Air Photo (B.M.R.): Duaringa 1:85,000 Run:- 3 No.: 5057
Point:- 933/3

Location:- Boomer Range

Macro:- A massive, fine-grained, purplish-grey, sheared rock.

Micro:- The rock is sheared, originally clastic, with feldspar crystals still recognisable. The remainder of the rock is recrystallised, with fine crudely parallel micaceous stringers, developed, and replaced in part by fine silica.

Origin:- Shearing, silicification and recrystallisation of a pyroclastic rock.

Name:- SHEARED SILICIFIED CRYSTAL TUFF

Microslide:- GSQ 3095 ex Specimen:- GSQ/R 2287 Field No.:- Du 933/3C

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5057
Point:- 933/3

Location:- Boomer Range

Macro:- A tough massive, light grey, sheared rock.

Micro:-

Texture:- Sheared. Originally clastic with lithic fragments (up to 12 mm.) and crystals in a fine matrix.

Clasts:- Lithic Material: predominant; fine-grained volcanics, extrusive and pyroclastic.

Crystals: feldspar dominant, with minor quartz.

Matrix:- The matrix is partly recrystallised with the development of crudely parallel stringers of mica.

Origin:- Shearing and partial recrystallisation of a pyroclastic rock.

Name:- SHEARED AND RECRYSTALLISED CRYSTAL-LITHIC TUFF

Microslide:- GSQ 3096 ex Specimen:- GSQ/R 2288 Field No.:- Du 956

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5057
Point:- 956

Location:- Boomer Range.

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

Micro:- An extremely altered (chlorite and epidote) sheared extrusive rock in which remnant feldspar crystals can be recognised.

Origin:- The mineral assemblage and general appearance indicate that the original rock was possibly spilitic.

Name:- SHEARED ?SPILITE

Microslide:- GSQ 3097 ex Specimen:- GSQ/R 2289 Field No.:- Du 959

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 2 No.: 5033
Point:- 959

Location:- Boomer Range.

Macro:- A massive, coarse (up to 3+ cm.) light grey sheared rock.

Micro:-

Texture:- Sheared; a number (about 45%) of attenuated and altered crystal and rock fragments occur in a fine-grained matrix.

Fragments:- Lithic material: altered extrusive and pyroclastic rocks.

Feldspar crystals: chloritised and calcitised.

Quartz crystals: strained.

Matrix:- Argillaceous: cryptocrystalline (recrystallised).

Origin:- Shearing and partial recrystallisation of a pyroclastic rock.

Name:- SHEARED AGGLOMERATE

Remarks:- The original rock appears to have been comparable with some of the Devonian Volcanics.

ROOKWOOD VOLCANICS

Microslide:- GSQ 3029 ex Specimen:- GSQ/R 2221 Field No.:- Du 556

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 5 No.:- 5109
Point:- 556

Location:- South of Rookwood Homestead.

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

Micro:- Essentially similar to GSQ 3033 except that minor zeolite is associated with chlorite in some of the amygdules.

Name:- SPILITE

Microslide:- GSQ 3030 ex Specimen:- GSQ/R 2222 Field No.:- Du 559

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 5 No.:- 5109
Point 559

Location:- South of Rookwood Homestead.

Macro:- Essentially similar to GSQ/R 2225.

Micro:- Essentially similar to GSQ 3033 except that epidote is more abundant (about 5%).

Name:- SPILITE

Microslide:- GSQ 3031 ex Specimen:- GSQ/R 2223 Field No.:- Du 594B

Four Mile Map:- Duaringa

Air Photo (B.M.R.);- Duaringa 1:85,000 Run:- 4 No.:- 5045
Point:- 594

Location:- Fitzroy River East of Rookwood Homestead.

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

Micro:- Essentially similar to GSQ 3041 but with about 5% fine (about 0.25 mm.) phenocrysts of zeolitised plagioclase.

NAME:- KERATOPHYRE

GSQ/R
Microslide:- GSQ 3032 ex Specimen:- 2224 Field No.:- Du 977A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:-1 No.:- 5101
Point:- 977

Location:- West of Redbank Homestead.

Macro:- A massive, fairly fine-grained, greenish-grey igneous rock.

Micro:- Essentially similar to GSQ 3036 except in the following details:-

(1) The phenocrysts are up to 5 mm. in length in GSQ 3032.

(2) The grain size of the groundmass is somewhat coarser, about 0.3 to 0.5 mm.

(3) Recognisable feldspar is much more abundant while epidote and relic pyroxene are less abundant.

(4) Relic pyroxene is more abundant than secondary epidote.

(5) The feldspar can be determined as albite.

Name:- SPILITE

GSQ/R
Microslide:- GSQ 3033 ex Specimen:- 2225 Field No.:- Du 977D

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 1 No. 5101
Point:- 977

Location:- West of Redbank Homestead.

Macro:- A massive, fine-grained, medium grey rock with irregular pale greenish amygdules, up to 2 mm.

Micro:- Essentially similar to GSQ 3049 except in the following details:-

(1) About 5% ?hydrogrossularite occurs in GSQ 3033.

(2) About 10% relic titaniferous clinopyroxene occurs in GSQ 3033.

Name:- SPILITE

Microslide:- GSQ 3034 ex Specimen:- GSQ/R 2226 Field No.:- Du 979A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 1 No.:- 5101
Point:- 979

Location:- West of Redbank Homestead.

Macro:- A massive rock comprising about 95% "boulders" about 7+ cm) of fine-grained dark grey material in a matrix of medium-grained greenish grey clastic material.

Micro:-

Texture:- Clastic; the clasts (about 98% of rock) are of two dominant sizes- (a) see macro (b) 0.3 to 1 mm., dominantly broken and/or corroded crystals with some rounded lithic fragments. The matrix is very fine-grained.

Clasts:- Lithic Material: about 95% of rock; essentially amygdaloidal spilite (coarse) with rare finer grains of fine-grained tuff.

Feldspar: about 2% of rock; commonly saussuritised.

Clinopyroxene: $>$ 1% of rock.

Quartz: $<$ 1% of rock.

Matrix:- Tuffaceous: about 2% of rock.

Origin:- Sedimentary or by faulting.

Name:- VOLCANIC BRECCIA

Microslide:- GSQ 3036 ex Specimen:- GSQ/R 2228 Field No.:- Du 957

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5057
Point:- 957

Location:- West of Craigilee Homestead.

Macro:- A massive, fine-grained, greenish-grey, igneous rock.

Micro:- Extremely altered.

Texture:- Originally porphyritic with about 5% subhedral lath-shaped phenocrysts, about 1 mm. The original groundmass texture is indeterminate, possibly intersected or inter-granular; the grain size was about 0.2 mm. In the groundmass relic subhedra and secondary anhedra (0.02 to 0.2 mm.) are intimately associated.

Phenocrysts:- Plagioclase (indeterminate): about 5% of rock; replaced, to varying degrees, by unidentified secondary minerals.

Groundmass:- The minerals which can be recognised, in estimated decreasing order of abundance, are as follows:-

Epidote) secondary
Clinozoisite)
Clinopyroxene: relic.
Chlorite: secondary
?Hydrogrossularite: secondary.
Plagioclase: relic, altered.
Calcite: secondary, minor.
Zeolite: secondary, minor.
?Silica: secondary, minor.

Origin:- Alteration of an igneous, ?extrusive rock, probably basaltic.

Name:- SPILITE

Microslide:- GSQ 3038 ex Specimen:- GSQ/R 2230 Field No.:- Du 974

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 1 No.:- 5101
Point:- 974

Location:- West of Redbank Homestead.

Macro:- Essentially similar to GSQ/R 2231

Micro:- Essentially similar to GSQ 3049 except in the following details:-

(1) About 5% fine euhedral to anhedral opaque crystals occur in GSQ 3038.

(2) About 30% relic titaniferous clinopyroxene is associated with the secondary minerals in GSQ 3038.

(3) At least 2 different varieties of chlorite occur in the amygdules in GSQ 3038 and each is different from that in GSQ 3049.

Name:- SPILITE.

Microslide:- GSQ 3039 ex Specimen:- GSQ/R 2231 Field No.:- 978

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 1 No.:- 5101
Point:- 978

Location:- West of Rookwood Homestead.

Macro: A massive, very fine-grained medium grey rock with a number of fine, dark lustrous amygdules.

Micro:- Essentially similar to GSQ 3049 except in the following details:-

(1) The amygdules in GSQ 3039 are all of chlorite.

(2) Minor patches of ?hydrogrossularite occur in GSQ 3039.

(3) About 30% pseudofibrous relic titaniferous clinopyroxene occurs admixed with the secondary minerals in GSQ 3039.

Name:- SPILITE

Microslide:- GSQ 3045 ex Specimen:- GSQ/R 2237 Field No.:- Du 513/3

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 4 No.:- 5045
Point:- 513/3

Location:- 4 miles North-north-west Tynan Homestead.

Macro:- A massive, very fine-grained, light grey rock with abundant phenocrysts. A band of coarser, green material traverses the rock.

Micro:-

Texture:- Porphyritic; phenocrysts (about 10% of rock) subhedral and euhedral, 1 to 4 mm. In general, the groundmass is extremely fine-grained, cloudy, but about some of the phenocrysts is a zone of coarser material similar to GSQ 3049 in texture and composition. Scattered at random are microlites which make up about 5% of rock. The rock is traversed by numerous very fine veins and one coarser one (see macro). Some amygdules occur at random.

Phenocrysts:- Oligoclase: about 5% of rock, extremely altered

Microlites:- Feldspar:) Epidote:) about 5% of rock

Groundmass:- Devitrified Glass: about 85% of rock; rich in chlorite.

Amygdules:- Chlorite

Veins:-Chlorite, Epidote, Calcite, Quartz and/or Zeolite.

Origin:- Alteration of a volcanic, extrusive.

Name:- SPILITE

Microslide:- GSQ 3046 ex Specimen:- GSQ/R 2238 Field No.:- Du 513/4

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 4 No.:- 5045
Point:- 513/4

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

Micro:- Essentially similar to GSQ 3039 except that epidote is slightly more abundant in GSQ 3046.

Name:- SPILITE

Microslide:- GSQ 3047 ex Specimen:- GSQ/R 2239 Field No.: Du 530

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 5 No.:- 5107 Point:- 530

Location:- North of Rookwood Homestead Area.

Macro:- Essentially similar to GSQ 3049 except in the following details:-

(1) The acicular feldspar crystals in GSQ 3047 are about 0.02 mm. in length.

(2) Fine euhedral apatite is abundant.

(3) About 5% ?hydrogrossularite occurs.

(4) Nearly 5% fine euhedral and subhedral opaque crystals occur.

(5) About 5% relic clinopyroxene occurs.

(6) About 5% of rock is made up of "patches" of a secondary epidote mosaic, possibly replacing phenocrysts.

(7) The rock is traversed by veins of quartz, epidote and apatite.

Name:- SPILITE

Microslide: GSQ 3048 ex Specimen:- GSQ/R 2240 Field No.:- 531

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:-5No.: 5107 Point:- 531

Location:- Rookwood Homestead Area

Macro:- A massive, fine-grained, grey-green rock traversed by irregular fine veins.

Micro:- Essentially similar to GSQ 3049 except that pale yellow epidote makes up about 40% of the rock. Pseudomorphs of pyroxene by epidote are obvious.

Name:-

Microslide:- GSQ 3049 ex Specimen:- GSQ/R 2241 Field No.:- 537

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 5 No.:- 5109 Point:- 537

Location:- Rookwood Homestead

Macro:- A massive, fine-grained, medium grey specimen of pillow lava; layers of vesicles and white amygdules are abundant.

Micro:-

Texture:- Intersertal, amygdaloidal. About 30% acicular feldspar crystals (about 0.085 to 0.255 mm. in length) occur at random in a very fine-grained groundmass of secondary minerals. The amygdules are irregular, up to 2 mm., and tend to be concentrated in bands.

Constituents:- Albite: about 30% of rock; acicular crystals, extremely altered.

Secondary Minerals: about 70% of rock; filling interstices between albite crystals. The following can be recognised:-

Chlorite - predominant.
Calcite - minor.
Epidote - minor.

Amygdules:- Chlorite, Calcite or Chlorite and Calcite.

Origin:- Extreme alteration of a volcanic extrusive.

Name:- SPILITE

Microslide:- GSQ 3060 ex Specimen:- GSQ/R 2252 Field No.:- Du 616

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.: 5055
Point:- 616

Location:- In Boomer Range, 4 miles north-north-west of Tynan Homestead.

Macro:- A massive, fine-grained, dark grey rock containing about 40% rounded, elongate (1x3+ cm.) fragments of very fine-grained light grey material.

Micro:-

Texture:- Clastic, the clasts (about 65% of rock) are of 2 dominant sizes - (a) see macro (b) 0.04 to 0.22 mm., dominantly about 0.13 mm. subrounded to subangular, of moderate to low sphericity. The matrix is very fine-grained.

Clasts:- Coarse Lithic Material: about 40% of rock (see macro); the following are represented:-

(a) Pyritised chloritic tuff with fragments of ? crinoidal limestone.

(b) Spilite, consisting essentially of calcitised feldspar (about 0.17 mm. in length) in a chlorite matrix.

(c) Very fine spilite (cf.(b) above) with xenoliths of fine tuff.

Fine Lithic Material: about 5% of rock; very fine-grained ?volcanics.

Quartz: about 10% of rock; strained.

Feldspar: < 5% of rock; commonly altered.

Calcite (?limestone): about 5% of rock.

?Carbonaceous matter: minor.

Iron oxides: minor.

Mica: minor.

Matrix:- Tuffaceous: about 35% of rock.

Origin:- Sedimentary.

Name:- VOLCANIC CONGLOMERATE

Microslide:- GSQ 3078 ex Specimen:- GSQ/R 2270 Field No.:- Du 621

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 4 No.:- 5045
Point:- 621

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

Micro:-

Texture:- Allotriomorphic-granular to intersertal, grain size cryptocrystalline to 0.17 mm. About 40% of the rock is crystalline secondary minerals.

Constituents:- Oligoclase: > 55% of rock; extremely altered to clay minerals and/or zeolite.

Chlorite: < 5%.

Secondary Minerals:- Quartz and chalcedony with minor associated chlorite and zeolite.

Origin:- Alteration of a volcanic extrusive rock.

Name:- SILICIFIED TRACHYTE

Remarks:- This rock bears a marked similarity to many of the unidentified lithic fragments in the Lower Bowen Volcanics.

MIDDLE BOWEN BEDS

Microslide:- GSQ 3085 ex Specimen:- GSQ/R 2277 Field No.:- Du 117A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:-4 No.:- 5043
Point:- 117

Location:- Balcomba Creek.

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

Micro:-

Texture:- Clastic, partly recrystallised; the clasts (about 75% of rock) are 0.15 to 1 mm., dominantly about 0.35 mm., subrounded to subangular, of moderate to low sphericity. The matrix has partly recrystallised as crudely parallel micaceous stringers.

Clasts:- Lithic material: about 40% of rock; including quartzite and very fine-grained volcanics.

Quartz: about 30% of rock; strained.

Feldspar: $<$ 5% of rock.

Mica: $<$5% of rock.

Matrix:- Argillaceous (micaceous): about 25% of rock; partly recrystallised.

Origin:- Low-grade regional metamorphism of a sediment. The rock is derived principally from pre Upper Devonian rocks (cf. Anakie Metamorphics and pre Devonian granites) but valcanic fragments possibly derived from the Devonian spilites are present.

Name:- METAMORPHOSED GREYWACKE

Microslide:- GSQ 3086 ex Specimen:- GSQ/R 2278 Field No.:- Du 117B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:-4 No.: 5043
Point:- 117

Location:- Balcomba Creek.

Macro:- A massive, fairly fine-grained, light grey, clastic rock, crudely foliated.

Micro:- Essentially similar to GSQ 3085 except in the following details:-

(1) The grain size is 0.04 to 0.3 mm., dominantly about 0.2mm.

(2) The recrystallised matrix is heavily stained with limonite and hematite.

(3) Rare flakes of muscovite are present.

Name:- METAMORPHOSED GREYWACKE

Microslide:- GSQ 3087 ex Specimen:- GSQ/R 2279 Field No.:- Du 625

Four Mile Map:-Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:-5 No.:- 5109
Point:- 625

Macro:- A massive, fairly fine-grained, grey, ironstained, clastic rock; bedding is not clearly marked.

Micro:-

Texture:- Clastic, the clasts (about 85% of rock) are 0.12 to 1 mm., dominantly about 0.35 mm., subrounded to subangular, of moderate to low sphericity. The matrix is very fine-grained.

Clasts:- Lithic Material: about 65% of rock; including very fine-grained volcanics and quartzite.

Quartz: $\nless$ 10% of rock; strained.

Feldspar: minor.

Matrix:- Argillaceous (?tuffaceous): $\ngtr$ 10% of rock; very fine-grained, slightly recrystallised in part.

Cement:- Ironstained carbonate: $\nless$ 5% of rock.

Origin:- Induration of a sediment.

Name:- INDURATED SUBGREYWACKE

Remarks:- See GSQ 3092.

Microslide:- GSQ 3089 ex Specimen:- GSQ/R 2281 Field No.:- Du 617A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5057
Point:- 617

Location:- South of Boomer Range.

Macro:- A massive, fine- to medium-grained, light brown clastic rock.

Micro:- Essentially similar to GSQ 3090 except in the following details:-

(1) Rare fragments of micaceous sandstone are present.

(2) Rare flakes of chloritised biotite are present.

(3) The carbonate is limonite- (not hematite-) stained.

(4) The grains are 0.1 to 0.5 mm., dominantly about 0.3 mm.

Name:- INDURATED SUBGREYWACKE

Microslide:- GSQ 3090 ex Specimen:- GSQ/R 2282 Field No.:- Du 617B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5057
Point:- 617

Location:- South of Boomer Range.

Macro:- A massive, fine- to medium-grained, red-brown clastic rock.

Micro:- Essentially similar to GSQ 3087 except in the following details:-

(1) GSQ 3090 contains a grain of microperthite.

(2) Detrital matrix makes up only about 5% of the rock.

(3) Secondary hematite-stained carbonate makes upt about 10% of the rock.

(4) Rare fragments of mica phyllite occur.

Name:- INDURATED SUBGREYWACKE

Microslide:- GSQ 3091 ex Specimen:- GSQ/R 2283 Field No.:- Du 618A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.: 5057
Point:- 618

Location:- South of Boomer Range.

Macro:- A massive, fine-grained, dark grey clastic rock with a distinct bedding.

Micro:- Essentially similar to GSQ 3092 except in that the grain size is 0.06 to 0.17 mm., dominantly about 0.12 mm.

The bedding cannot be distinguished microscopically.

Name:- INDURATED SUBGREYWACKE

Microslide:- GSQ 3092 ex Specimen:- GSQ/R 2284 Field No.:- Du 618B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 3 No.:- 5057
Point:- 618

Location:- South of Boomer Range.

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

Micro:-

Texture:- Clastic; the clasts (about 90% of rock) are subrounded to subangular, of high to low sphericity, 0.04 to 0.3 mm., dominantly about 0.2 mm. The matrix is very fine-grained.

Clasts:- Lithic material: about 60% of rock; including very fine-grained volcanics, chlorite "pellets", and mica phyllite.

Quartz: about 20% of rock; slightly strained.

Feldspar (including oligoclase): $\leqslant$ 10% of rock; calcitised in part.

Mica: minor.

Matrix:- Argillaceous (micaceous): $>$ 5% of rock; slightly recrystallised.

Cement:- Calcite: $<$ 5% of rock; secondary.

Origin:- Minor diagenetic recrystallisation of a sedimentary rock.

Name:- INDURATED SUBGREYWACKE

Remarks:- Although the lithic fragments in this rock are unidentifiable, their general appearance is similar to that of the Devonian Volcanics; hence it is improbable that this rock is older than those formations.

UNDIFFERENTIATED PALAEOZOIC BEDS

Microslide:- GSQ 3010 ex Specimen:- GSQ/R 2202 Field No.:- Du 6.8B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.: 5097
Point:- 6.8

Location:- Highway Cuttings, Gogango Range.

Macro:- A tough, massive, fine- to medium-grained, green, foliated rock.

Micro:- Essentially similar to GSQ 3018 except in that epidote is much more abundant (about 35%). Recrystallisation has proceeded to a greater degree and no lithic fragments can be definitely determined.

Name:- SHEARED AND METAMORPHOSED CRYSTAL TUFF

Microslide:- GSQ 3011 ex Specimen:- GSQ/R 2203 Field No.:- Du 6.8C

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.:- 5097
Point:- 6.8

Location:- Highway Cuttings, Gogango Range.

Macro:- A massive, fine- to medium-grained, greenish-mauve rock with a distinct foliation.

Micro:-

Texture:- A partly recrystallised and sheared rock containing some 20% clasts, about 1.0 mm. Abundant very fine granular epidote is distributed at random. Very fine stringers of micaceous material parallel the foliation. A few fine veins traverse the rock.

Clasts:- Feldspar: > 10% of rock; altered, recrystallised in part.

Lithic material: < 10% of rock recrystallised in part.

Matrix:- ?Feldspar: about 55% of rock; cryptocrystalline; some chlorite is believed to be associated.

Epidote: about 20% of rock; very fine granular.

Mica: about 5% of rock; fine "stringers".

Veins:- Quartz.

Origin:- Shearing and regional metamorphism of a pyroclastic rock.

Name:- SHEARED METAMORPHOSED LITHIC-CRYSTAL TUFF

Microslide:- GSQ 3012 ex Specimen:- GSQ/R 2204 Field No.:- Du 6.8A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.:- 5097
Point:- 6.8

Location:- Highway Cuttings, Gogango Range.

Macro:- A massive, uneven-, coarse-grained (up to >6 cm.) rock comprising dark red fragments in a very fine-grained red and white mottled matrix.

Micro:-

Fragments:-

Partly recrystallised, porphyritic andesite.

Matrix:-

Texture:- The original rock is not definitely determinable but appears to have been an andesitic crystal tuff. About 5% corroded ?relic crystals (about 0.5 mm.) are disposed at random in crudely hornfelsic material (grain size cryptocrystalline to 0.08 mm.).

Constituents:- Andesine: about 5% of rock; lath-shaped, twinned, corroded ?relic crystals.

Feldspar: about 50% of rock.

Epidote: about 40% of rock; granular, colourless to brown.

Chlorite: about 5% of rock.

Origin:- Low grade metamorphism of pyroclastic volcanic, probably andesitic.

Name:- METAMORPHOSED ?ANDESITIC AGGLOMERATE

Microslide:- GSQ 3015 ex Specimen:- GSQ/R 2207 Field No.:- Du 107

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 5 No.:- 5107
Point:- 107

Location:- South-west of Rookwood Homestead.

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

Micro:- Essentially similar to GSQ 3017 except that irregular, broken strings of carbonate (?calcite), with associated microcrystalline epidote, parallel the foliation (about 5% of rock).

Origin:- As for GSQ 3017. The rock GSQ/R 2207 may have undergone minor shearing, also.

Name:- ? SHEARED METAMORPHOSED CRYSTAL TUFF

Microslide:- GSQ 3016 ex Specimen:- GSQ/R 2208 Field No.:- Du 104

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 5 No.:- 5107
Point:- 104

Location:- South-west of Rookwood Homestead.

Macro:- A tough, massive, banded, light greenish-grey, fine-grained rock with a crude foliation almost parallel to the banding. The rock is traversed by several very fine veins.

Micro:- Essentially similar to GSQ 3017 except in the following details:-

(1) In GSQ 3016 the clasts are up to 0.16 mm.

(2) The parallel "stringers" of mica are less well-developed in GSQ 3016.

(3) Several fine (about 0.2mm.) veins consisting of a micro-crystalline quartz mosaic cut the rock.

Name:- METAMORPHOSED AND SILICIFIED CRYSTAL TUFF

Microslide:- GSQ 3017 ex Specimen:- GSQ/R 2209 Field No.: Du 6A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.:- 5097
Point:- 6

Location:- Highway Cuttings, Gogango Range.

Macro:- A massive, fine-grained, banded, light greenish-brown rock with a crude foliation inclined at about 30% to the bedding.

Micro:- The banding is not evident in the microslide.

Texture:- Originally clastic, containing about 25% clasts, 0.025 to 0.1 mm. Recrystallisation of the matrix has occurred resulting in the development of crypto-crystalline to microcrystalline material. Fine, crudely aligned, micaceous "stringers" parallel the foliation.

Clasts:- Feldspar (?plagioclase): about 25% of rock; strongly sericitised, possibly due to recrystallisation.

Matrix:- ?Feldspar:

Epidote:

Mica:- (possibly including stilpnomelane).

Origin:- Low grade regional metamorphism of an intermediate pyroclastic rock.

Name:- METAMORPHOSED CRYSTAL TUFF

Microslide:- GSQ 3018 ex Specimen:- GSQ/R 2210 Field No.:- Du 6C

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.:- 5097
Point:- 6

Location:- Highway Cuttings, Gogango Range.

Macro:- A massive, fine- to very fine-grained, light greenish-brown, thinly- and irregularly-bedded rock with a distinct foliation inclined at about 30° to the bedding.

Micro:- The different beds are of two distinct types, one apparently coarser than the other.

(a) Coarser Bed

Texture:- Essentially clastic, consisting of about 20% clasts, 0.03 to 0.14 mm. (dominantly about 0.04 mm.), subrounded to subangular, of moderate to low sphericity (commonly embayed), in a very fine-grained matrix.

Clasts:- Feldspar: crystalline, somewhat altered.

Matrix:- Tuffaceous: chloritic.

(b) Finer Bed

Essentially similar to the above but with about 5% clasts, 0.01 to 0.04 mm., dominantly about 0.02 mm.

Superimposed on this texture is a network of very fine roughly parallel "stringers" (about 5-10% of rock) consisting of fine flakes of unidentifiable yellow-brown mica. This direction parallels the macroscopic foliation. The mineral is the product of partial recrystallisation.

Origin:- Low grade regional metamorphism of a bedded pyroclastic rock.

Name:- METAMORPHOSED CRYSTAL TUFF

Microslide:- GSQ 3019 ex Specimen:- GSQ/R 2211 Field No.:- Du 6B

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.:- 5097
Point:- 6

Location:- Highway Cuttings, Gogango Range.

Macro:- A massive, coarse-grained, buff-coloured clastic rock with a vague foliation.

Micro:-

Texture:- Extremely altered, essentially clastic but with minor apparent recrystallisation of the matrix. The clasts (about 90% of rock) are 1 to 8 mm. (dominantly 2 to 3 mm.), rounded, of moderate to high sphericity.

Clasts:- Lithic Material: about 90% of rock; fragments of intermediate to acid extrusives (commonly fluidal) and of crystal tuff.

Matrix:- Feldspar: fine crystals)
Chlorite: flakes, pale yellow) about 10% of rock
Limonite-staining: abundant)

Origin:- Slight regional metamorphism of a pyroclastic rock. The chlorite flakes in the matrix appear to represent partial recrystallisation; the original material was probably crystal tuff.

Name:- ALTERED METAMORPHOSED CRYSTAL-LITHIC TUFF

Microslide:- GSQ 3020 ex Specimen:- GSQ/R 2212 Field No.:- Du 6/9

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.:- 5079
Point:- 6/9

Location:- Highway Cuttings, Gogango Range.

Macro:- A massive, very coarse-grained (up to 15 mm.), greenish-grey, foliated clastic rock.

Micro:-

Texture:- Foliated clastic; the clasts (about 80% of rock) are, in general, rounded and of low sphericity 0.1 to >5 mm.: the long axes are aligned parallel to the foliation. The matrix, which is very difficult to distinguish from some of the fragments, is recrystallised with a grain size of about 0.02 mm. and has a lineation parallel to the elongation of the clasts.

Clasts:- Lithic Material: about 80% of rock; essentially acid volcanic extrusives with minor ?crystal tuff; some grains have undergone partial recrystallisation.

Matrix:- Quartzo-feldspathic material: about 15% of rock; recrystallised argillaceous material.

Epidote, Mica: about 5% of rock; distributed at random.

Origin:- Low grade regional metamorphism of a pyroclastic rock.

Name:- METAMORPHOSED AGGLOMERATE

Microslide:- GSQ 3021 ex Specimen:- GSQ/R 2213 Field No.: Du 109

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 5 No.:- 5107
Point:- 109

Location:- South-west of Rookwood Homestead.

Macro:- A massive, dark greenish-grey, silicified, schistose rock.

Micro:-

Texture:- Essentially a porphyritic, pilotaxitic rock consisting of about 25% subhedral to anhedral phenogrysts (0.6 to 1 mm.) in a pilotaxitic (about 0.04 mm.) groundmass. About 5% ?amygdules occur at random. The groundmass is clouded with finely divided opaques (about 5% of rock) and about 20% parallel mica flakes (0.2 to 1.2 mm.) are distributed in bands and as random flakes. These flakes approximately parallel the flow direction. Minor recrystallisation of some of the phenocrysts has taken place. Several fine siliceous veins cut the rock normal to the schistosity.

Phenocrysts:- Feldspar: about 25% of rock; slightly altered oligoclase and ?potash feldspar (minor); rare crystals have undergone slight recrystallisation; there is no apparent preferred orientation.

?Amygdules:- Epidote, Clinozoisite, Chlorite and minor Quartz: about 5% of rock in general, radiating.

Groundmass:- Acid feldspar (dominantly oligoclase) and Quartz: about 45% of rock; respective minerals difficult to distinguish.

Opaques: about 5% of rock; very finely divided.

Mica: about 20% of rock; essentially blue-green chlorite with anomalous purple interference colours.

Origin:- Regional metamorphism of an extrusive volcanic rock.

Name:- METAMORPHOSED TRACHYTE

Microslide:- GSQ 3022 ex Specimen:- GSQ/R 2214 Field No.:- Du 6/5A

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.:- 5079
Point:- 6/5

Location:- Highway Cuttings, Gogango Range.

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

Micro:-

Texture:- A partly recrystallised clastic rock consisting of about 60% clasts (about 0.07 mm., subrounded to subangular, of moderate to low sphericity) in a recrystallised (micaceous) matrix. "Stringers" of parallel mica flakes envelop the grains and indicate an apparent parallelism of bedding and schistosity.

Clasts:- Quartz: about 20% of rock; with abundant minute inclusions.

Feldspar: $\geqslant$ 10% of rock; sericitised.

Lithic Material: $\leqslant$ 10% of rock; very fine-grained, unidentifiable.

Matrix:- Micaceous: about 40% of rock; dominantly sericite with some muscovite flakes. Limonite- and hematite-staining abundant.

Origin:- Low grade regional metamorphism of a very fine-grained greywacke.

Name:- RECRYSTALLISED GREYWACKE

Microslide:- GSQ 3023 ex Specimen:- GSQ/R 2215 Field No.:- Du 106

Four Mile Map:- Duaringa

Air Photo (B.M.R.);- Duaringa 1:85,000 Run:- 5 No.:- 5107 Point:- 106

Location:- South-west of Rookwood Homestead.

Macro:- A massive, fine-grained, dark grey, rock with two

Texture:- The two schistosity directions are prominently marked by two sets of parallel bands of ironstained mica flakes. In one direction these are fairly straight; in the second a chevron pattern is obvious. This pattern is superimposed on a hornfelsic texture, grain size about 0.0025 to 0.01 mm.

Constituents:- Quartzo-feldspathic material: about 45% of rock; fine interlocking anhedra.

Mica: about 50% of rock; very fine granular and coarser aligned flakes; dominantly biotite, straw yellow to pinkish-brown.

Opaques: about 5% of rock; ?iron minerals, with associated hematite and limonite.

Origin:- Two periods of low grade dynamic metamorphism (with the forces acting normal to one another) of an argillaceous rock.

Name:- MICA PHYLLITE

Microslide:- GSQ 3024 ex Specimen:- GSQ/R 2216 Field No.:- Du 6/7

Four Mile Map:- Duaringa

Air Photo (B.M.R.): Duaringa 1:85,000 Run:- 7 No.:- 5097
Point:- 6/7

Location:- Highway Cuttings, Gogango Range.

Macro:- A massive, fine-grained, medium-grey, thinly-bedded rock with a marked schistosity developed normal to the bedding. The bedding is accentuated by variations in the percentage of opaques.

Micro:- Thin section cut normal to bedding and schistosity.

Texture:- The bedding is not obvious in section but the schistosity is marked by parallel fine "stringers" of opaque material.

Originally clastic, consisting of about 40% clasts, 0.02 to 0.06 mm. (dominantly about 0.04 mm.), subrounded to rounded, of low to high sphericity in a fine-grained matrix. The matrix has been partially recrystallised with the development of mica which displays a preferred orientation.

Clasts:- Quartz and Feldspar: about 30% of rock.

Lithic Material: about 5% of rock; altered and ironstained.

Zircon: rare, rounded.

Matrix:- Micaceous: about 55% of rock; sericite, muscovite and chlorite (pale yellow-brown).

Opaques (manganese oxides); about 5% of rock; associated with the mica flakes.

Origin:- Low grade regional metamorphism of a silty mudstone.

Name:- MICA PHYLLITE

Microslide:- GSQ 3025 ex Specimen:- GSQ/R 2217 Field No.:- Du 108

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 5 No.:- 5107
Point:- 108

Location:- South-west of Rookwood Homestead.

Macro:- A massive, medium-grained, buff-coloured clastic rock. There is an apparent, crude schistosity roughly paralleled by quartz veins (up to 2 mm.).

Micro:-

Texture:- Originally clastic, consisting of about 45% clasts, 0.17 to 1.9 mm. (dominantly about 0.6 mm.), subrounded to rounded, of low to moderate sphericity, in a fine-grained matrix. The matrix has subsequently been hornfelsed (grain size about 0.01 to 0.06 mm.) while many of the siliceous clasts have undergone partial recrystallisation, the amount being inversely proportional to grain size.

"Clasts":- Quartz:- >15% of rock; grains strained, with abundant inclusions; many of the grains, especially the finer ones, have been partially recrystallised with the development of a very fine mosaic.

Oligoclase: about 15% of rock; slightly altered; degree of recrystallisation slight.

Microperthite: about 10% of rock; slightly altered; degree of recrystallisation slight.

Lithic Material: ≤ 5% of rock; recrystallised, Pilotaxitic ?trachyte.

"Matrix":- Quartzo-feldspathic material: about 35% of rock

Mica: about 20% of rock; two generations occur:-

(a) Muscovite: coarse flakes, aligned roughly parallel to the apparent schistosity (hand specimen).

(b) Biotite: very fine, flakes, aligned parallel to the muscovite; pleochroic from colourless to deep yellow-green.

Veins:- Quartz: strained, partially recrystallised.

Origin:- Thermal metamorphism of a sediment which had previously undergone silicification and low grade regional metamorphism.

Name:- SANDY HORNFELS

Microslide:- GSQ 3027 ex Specimen:- GSQ/R 2219 Field No.:- Du 6.3

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 7 No.:- 5097
Point:- 6.3

Location:- Highway Cuttings, Gogango Range.

Macro:- A massive, fine-grained, buff-coloured, thinly-bedded, ?graded, micaceous clastic rock.

Micro:-

Texture:- Essentially clastic though partially recrystallised; the bedding is not obvious in thin section and there is no evidence of grading. The clasts, which are commonly difficult to distinguish from the matrix, appear to make up about 65% of the rock; in general, they are subrounded, 0.02 to 0.17 mm. (dominantly 0.09 mm.) and of moderate sphericity; some corrosion of the grain boundaries by the recrystallised matrix (micaceous) has taken place. these mica crystals (including about 5% porphyroblasts about 0.12 to 0.25mm.), display a crude preferred orientation, dipping at approximately 40° to the macroscopic bedding.

Clasts:- Quartz: about 30% of rock; strained, with abundant minute inclusions and some coarser euhedra of apatite.

Plagioclase (?andesine); about 10% of rock; fresh, twinned.

Lithic material: about 20% of rock; including mica phyllite, chert, and very fine-grained ?volcanics.

Mica: minor; altered.

Zircon: rare; broken euhedra.

Limonite: fairly abundant.

Matrix:- Micaceous (originally argillaceous):abpit 30% of rock; sericite, muscovite, yellow-green chlorite and ?biotite (colourless to bright yellow) can be recognised.

Porphyroblasts:- Muscovite, Chlorite, ?Biotite: about 5% of rock.

Origin:- Partial recrystallisation, due to low grade regional metamorphism, of a sediment, derived from a terrain which appears to have been dominantly granitic and metamorphic.

Name:- PORPHYROBLASTIC GREYWACKE

(?) MESOZOIC VOLCANICS

Microslide:- GSQ 3082 ex Specimen:- GSQ/R 2274 Field No.:- Du 145

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- 9 No.:- 5073 Point:- 145

Location:- Thuriba Homestead area.

Macro:- A tough massive, fine-grained, greenish-grey igneous rock.

Micro:- Essentially altered.

Texture:- Clastic; the clasts (about 85% of rock) are 0.17 to 2 mm., essentially subhedral and anhedral crystals.

Clasts:- Acid to basic plagioclase: dominant; extremely altered.

Augite: commonly extremely altered.

Devitrified (chloritic glass: minor.

Matrix:- Tuffaceous: recrystallised.

Origin:- Alteration of a basic pyroclastic rock. Minor shearing may have occurred.

Name:- ?SPILITIC CRYSTAL TUFF

Microslide:- GSQ 3084 ex Specimen:- GSQ/R 2276 Field No.:- Du 146C

Four Mile Map:- Duaringa

Air Photo (B.M.R.):- Duaringa 1:85,000 Run:- No.:- 5073
Point:- 146

Location:- Thuriba Homestead area.

Macro:- A pinkish-grey, bedded clastic rock.

Micro:- Three essentailly different beds are evident. The rock is traversed by fine quartz veins.

Bed I

Texture:- Clastic; the clasts (about 30% of rock) are 0.06 to 1.5 mm., subrounded to subangular, embayed, of moderate sphericity. The matrix is very fine-grained, translucent.

Clasts:- Lithic Material: about 20% of rock; very fine-grained volcanics.

Feldspar (including oligoclase): about 10% of rock; commonly epidotised and/or chloritised.

Matrix:- Tuffaceous: about 70% of rock; slightly recrystallised.

Bed II

Essentially similar to Bed I except in the following:-

(1) Clasts make up about 70% of rock

(2) Clasts are 0.08 to 0.5 mm.

Bed III

Essentially similar to Bed I except that the clasts are 0.02 to 0.08 mm.

Origin:- Silicification and partial recrystallisation of a pyroclastic rock.

Name:- SILICIFIED AND RECRYSTALLISED CRYSTAL-LITHIC TUFF

PRELIMINARY EDITION, 1963

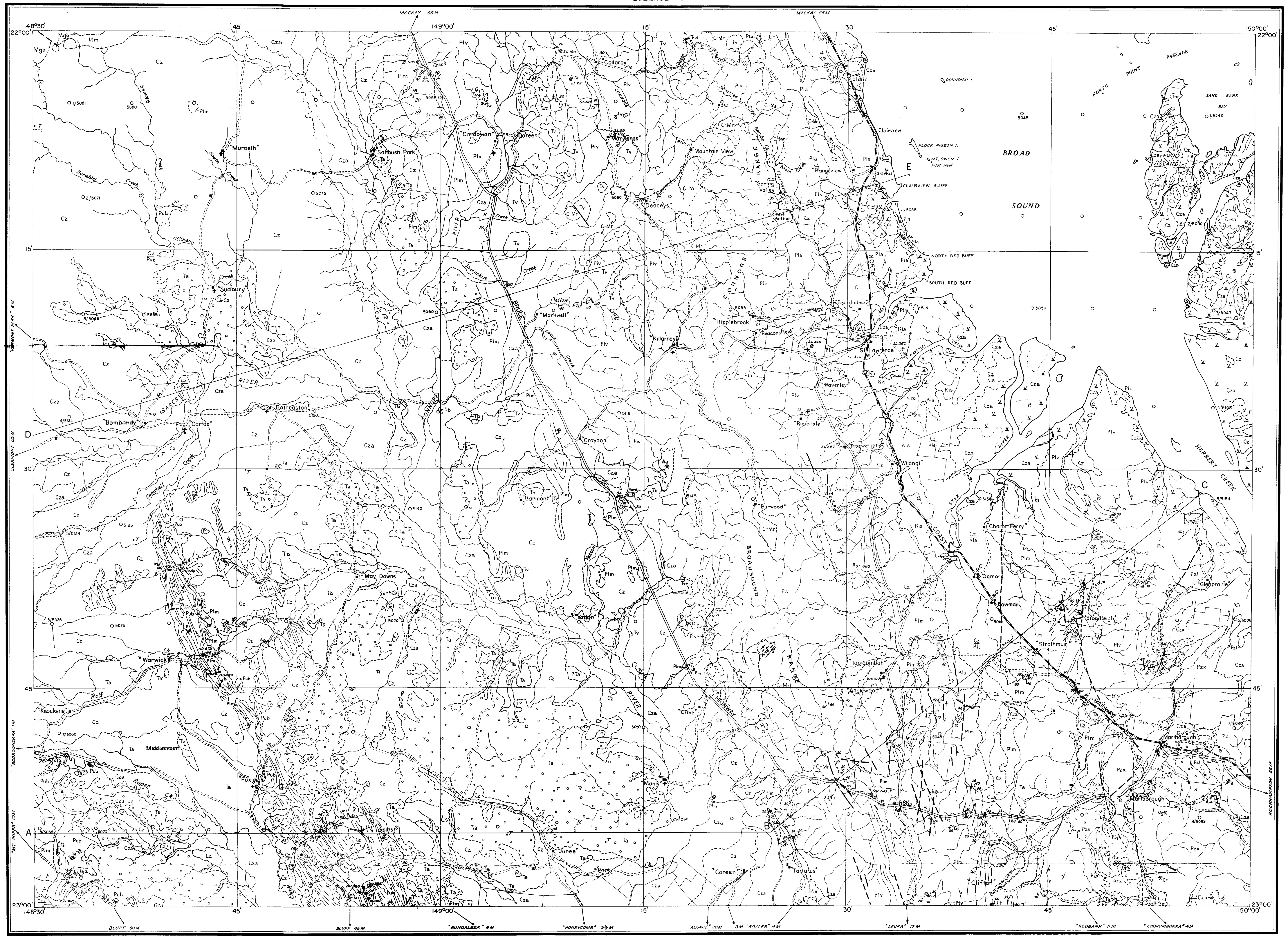
SUBJECT TO AMENDMENT

AUSTRALIA 1:250,000

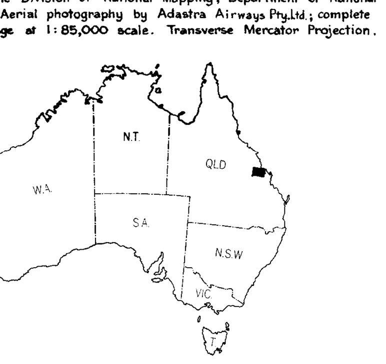
ST LAWRENCE

QUEENSLAND

1:250,000 GEOLOGICAL SERIES SHEET SF 55-12

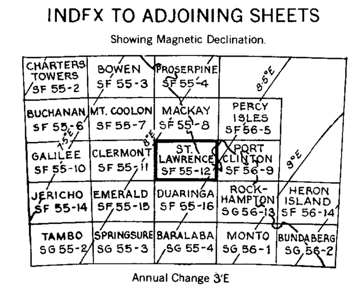


Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Slotted template control supplied by the Division of National Mapping, Department of National Development. Aerial photography by Adastra Airways Pty.Ltd.; complete vertical coverage at 1:85,000 scale. Transverse Mercator Projection.



INDFX TO ADJOINING SHEETS

Showing Magnetic Declination.



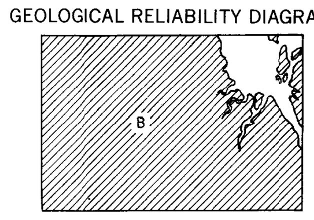
Annual Change 3'E

Scale 1 : 250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM



B Detailed reconnaissance - numerous traverses with air-photo interpretation

Geology and compilation, 1962, by: E.J. Malone, A.R. Jensen, R.G. Mollan, F. Olgers, and C.M. Gregory, (B.M.R.); A.G. Kirkegaard and V.R. Forbes, (Q.G.S.)

Drawn by: F.J. Roberts.

Reference

CAINOZOIC	UNDIFFERENTIATED		Cz	Soil, sand, gravel, alluvium, reworked laterite
			Cza	Alluvium
			(open circles)	Laterite, and reworked laterite
	TERTIARY		Ta	Sandstone, siltstone, claystone, diatomite, conglomerate, some volcanics
			Tb	Basalt
			Tv	Rhyolitic, dacitic, and andesitic lavas and pyroclastics
MESOZOIC	LOWER CRETACEOUS	Bundarra Granodiorite	Mgb	Leuco-granodiorite
		Styx Coal Measures	Kls	Sandstone, conglomerate, siltstone, carbonaceous shale, coal
	CARBONIFEROUS TO MESOZOIC	Urannah Complex	C-Mr	Granite, adamellite, diorite and gabbro, with andesite dykes
			(crosses)	Granite
PALAEOZOIC	PERMIAN	Upper Bowen Coal Measures	Pub	Lithic and calc-lithic sandstone, quartz sandstone, siltstone, carbonaceous shale, coal, siliceous siltstone with plant remains, limestone
		Undifferentiated Upper Bowen Coal Measures and Middle Bowen Beds	P	
		Middle Bowen Beds	Plm	Quartz and quartz-lithic sandstone, micaceous siltstone, limestone, sheared siltstone, dark-grey to buff phyllite
		Carmila Beds	Pla	Acid crystal tuff, some acid lava, conglomerate, lithic sandstone, siltstone, carbonaceous shale, coal
		Lower Bowen Beds	Plv	Andesitic to dacitic pyroclastics and lavas; some rhyolitic and basaltic volcanics. Some fossiliferous limestone, tuffaceous sandstone, siltstone, conglomerate
		Rookwood Volcanics	Plr	Basalt, mainly pillow lavas; some agglomerate, tuffaceous sandstone, siltstone
	LOWER-MIDDLE CARBONIFEROUS		Cl-m	Oolitic limestone, calcareous siltstone, sandstone, siltstone, conglomerate
	UNDIFFERENTIATED		(x pattern)	Granite, granodiorite
			(dash pattern)	Diorite
			(pattern)	Gabbro
			Pzx	Ultrabasic complex, mainly serpentinite
			Pzl	Quartz mica schist, phyllite

- Geological boundary
- Fault

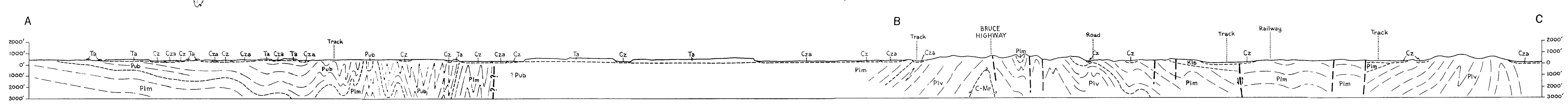
Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

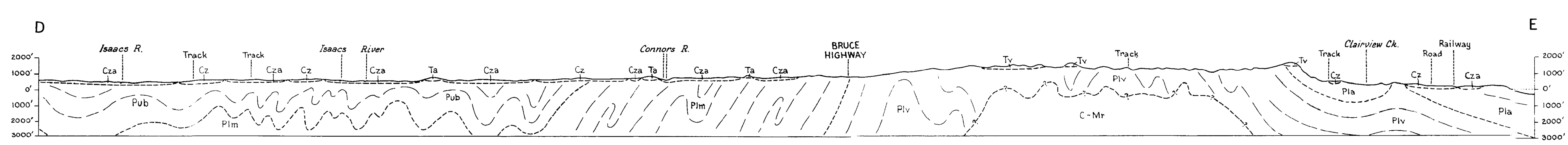
- 75 Strike and dip of strata
- Vertical strata
- Horizontal strata
- Dip < 15° } air-photo interpretation
- Trend lines } air-photo interpretation
- Joint pattern } air-photo interpretation
- 70 Strike and dip of foliation
- Vertical foliation
- Macrofossil locality
- Plant fossil locality
- Fossil wood locality
- SL 199 Text reference to fossil locality
- Dyke or vein: g - gabbro, tr - trachyte
- C Mine
- Au Gold
- C Coal
- Cr Chromium
- Mg Magnesite
- Dam
- T Earth tank
- Mangrove
- Road
- Vehicle track
- Railway with siding
- Fence
- "Yatton" Homestead
- Landing ground
- 8/5089 Air-photo centre point

Sections

Folding diagrammatic

SCALE: $\frac{V}{H} = 4$





ST LAWRENCE

SHEET SF 56-12

DUARINGA

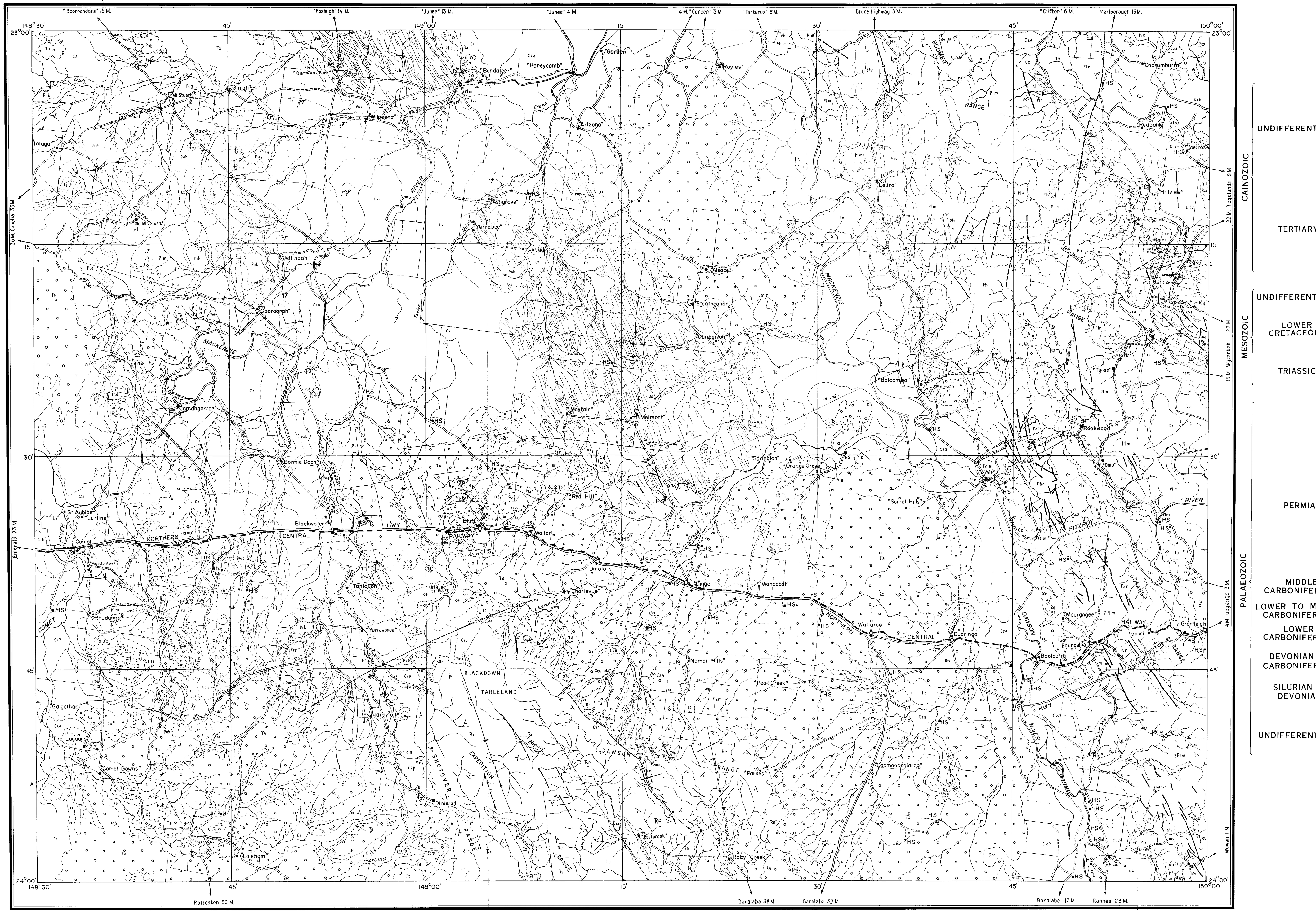
QUEENSLAND

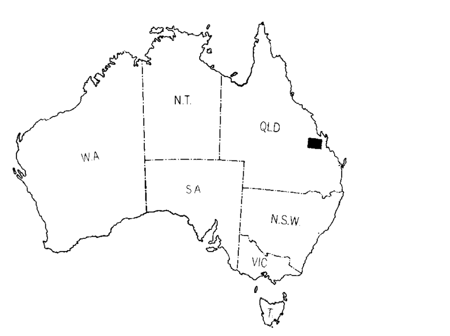
AUSTRALIA 1:250,000

1:250,000 GEOLOGICAL SERIES SHEET SF 55-16

PRELIMINARY EDITION, 1963

SUBJECT TO AMENDMENT





Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Slotted templates supplied by Division of National Mapping, Department of National Development. Aerial photography by Adastra Airways Pty Ltd; complete vertical coverage at 1:85,000 scale. Transverse Mercator Projection.

INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

BUCHANAN SF 55-6	MT COOLON SF 55-7	MACKAY SF 55-8	PERCY ISLES SF 56-5	
GALILEE SF 55-10	CLERMONT SF 55-11	ST LAWRENCE SF 55-12	PORT CLINTON SF 56-9	
JERICHO SF 55-14	EMERALD SF 55-15	DUARINGA SF 55-16	ROCKHAMPTON SF 56-13	HERON ISLAND SF 56-14
TAMBO SG 55-2	SPRINGSURE SG 55-3	BARALABA SG 55-4	MONTO SG 56-1	BUNDABERG SG 56-2
AUGATHELLA SG 55-6	EDDYSTONE SG 55-7	TAROOM SG 55-8	MUNDUBBERA SG 56-5	MARYBOROUGH SG 56-6

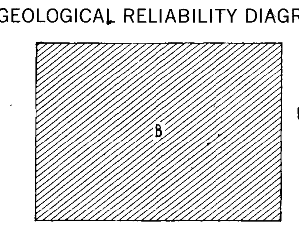
Annual change 3'E

Scale 1 : 250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

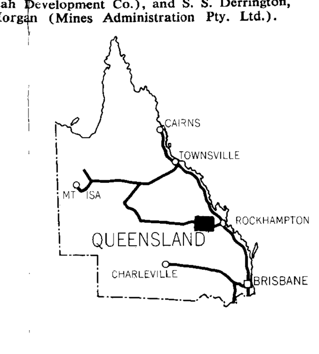
GEOLOGICAL RELIABILITY DIAGRAM



B. *Detailed reconnaissance–numerous traverses, air-photo interpretation*

Geology and compilation, 1962, by E.J. Malone, R.G. Mollan, F. Olgers, (B.M.R.); A.G. Kirkegaard, (Q.G.S.)
Drawn by; G. Matveev, (B.M.R.).

Some data supplied by D. King, P. Goscombe, L. Hansen (Utah Development Co.), and S. S. Derrington, K. H. Morgan (Mines Administration Pty. Ltd.).



Reference

CAINOZOIC

UNDIFFERENTIATED
- Cz — *Soil, sand, gravel, alluvium, reworked laterite*
- Cza — *Alluvium*
- (circles) — *Laterite and reworked laterite*
- Czp — *Piedmont deposits*

TERTIARY
- Ta — *Sandstone, siltstone, claystone, diatomite, conglomerate; some volcanics*
- Td — *Sandstone breccia*
- Tb — *Basalt*
- Tv — *Rhyolitic and trachytic flows and intrusions*

MESOZOIC

UNDIFFERENTIATED
- Mv — *Andesitic to dacitic agglomerate, tuff and flows; some tuffaceous conglomerate and sandstone*

LOWER CRETACEOUS
- Kl — *Sandstone, conglomerate, siltstone, shale*

TRIASSIC
- Clematis Sandstone — Re — *Quartz sandstone; siltstone interbeds*
- Rewan Formation — Rr — *Red and buff mudstone, siltstone and sandstone; grey-green lithic sandstone*

PALAEOZOIC

- (+ +) — *Granite, granodiorite*
- (dashes) — *Diorite, intermediate intrusives*

PERMIAN
- Upper Bowen Coal Measures — Pub — *Lithic sandstone, calcareous in places, quartz sandstone, limestone, siltstone carbonaceous shale, coal; siliceous siltstone with abundand plant fossils*
- *Quartz sandstone lenses*
- Burngrove Member — Pug — *Calcareous lithic sandstone, carbonaceous siltstone, grey-green siltstone*
- Middle Bowen Beds — Plm — *Quartz sandstone, quartz lithic sandstone, siltstone, limestone, conglomerate, sheared siltstone, phyllite, greywacke, tuffaceous sandstone*
- Lower Bowen Volcanics — Plv — *Andesitic flows and pyroclastics; some rhyolitic and basaltic volcanics*
- Rookwood Volcanics — Plr — *Spilitic, pillow lavas, and agglomerate; some tuffaceous sandstone and siltstone*
- Dinner Creek Beds — Pld — *Conglomerate, sandstone, siltstone, tuffaceous sandstone; some basic to intermediate volcanics*

MIDDLE CARBONIFEROUS
- Cm — *Calcareous siltstone and sandstone with some richly fossiliferous horizons, conglomerate, mudstone*

LOWER TO MIDDLE CARBONIFEROUS
- Cl-m — *Limestone, mudstone, siltstone, sandstone, conglomerate*

LOWER CARBONIFEROUS
- Cl — *Oolitic limestone, siltstone, mudstone, sandstone, chert*

DEVONIAN TO CARBONIFEROUS
- D-Cv — *Intermediate to basic flows and pyroclastics; chert*

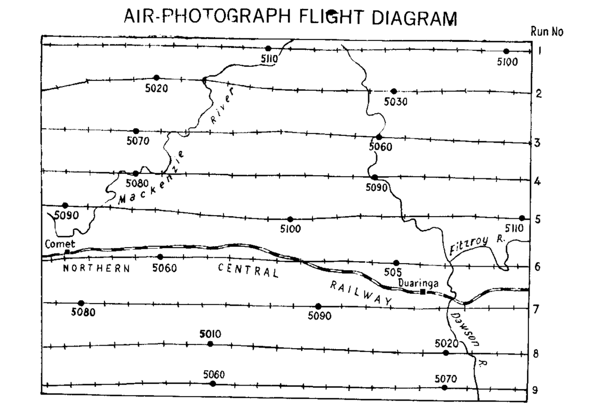
SILURIAN TO DEVONIAN
- S-D — *Fossiliferous limestone and marble, phyllite, tuffaceous sandstone, agglomerate*

UNDIFFERENTIATED
- Pzr — *Quartz sandstone, quartz lithic sandstone, siltstone, micaceous siltstone, mudstone, sheared siltstone, phyllite, greywacke, tuff, agglomerate*
- Pzx — *Ultrabasic igneous complex, mainly serpentinite*

Geological boundary
Anticlinal axis, showing plunge
Synclinal axis, showing plunge
Monoclinal axis
Axis of overfolded beds
Plunge of minor fold (10°)
Fault
Where location of boudaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed boundaries and folds are dotted, faults are shown by short dashes
20 *Strike and dip of strata*
Vertical strata
Horizontal strata
78 *Strike and dip of overturned strata*
Dip < 15° — *Air-photo interpretation*
Dip > 45° — *Air-photo interpretation*
Bedding trend line — *Air-photo interpretation*
Joints — *Air-photo interpretation*
84 *Strike and dip of foliation*

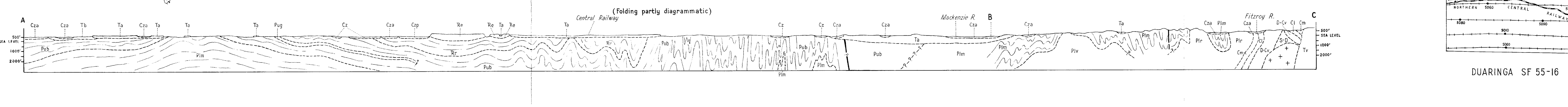
Macrofossil locality
Plant fossil locality
163 *Fossil wood*
t *Dyke, t-trachyte*
Mine C-coal
A.F.O. Cooroorah No 1 *Dry hole*
T *Tank*
Dam
Road
Vehicle track
Railway with siding
"Balcomba", HS — *Homestead*
Airstrip

AIR-PHOTOGRAPH FLIGHT DIAGRAM



Section A-B-C

(folding partly diagrammatic)



DUARINGA SF 55-16