COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

Records 1964/108

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

by

E.J. Malone and L.V. Bastian

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SUMMARY

Ten sections were measured in the Duaringa and St. Lawrence 1:250,000 Sheet areas during 1963. Five of these were measured in the Back Creek Group (the former Middle Bowen Beds) near Leura Homestead in the north-east of the Duaringa Sheet area; of these one section, EM4, includes the basal 1800 feet of the Back Creek Group; the other four sections are not accurately located within the Back Creek Group. The other five sections were measured in the Folded Zone of the Bowen Basin, near Bundaleer Homestead in the Duaringa Sheet area; of these one section consists of almost 800 feet of Back Creek Group exposed in a series of anticlines and synclines; the other four sections are of the Upper Bowen Coal Measures. 56 specimens were collected from the measured sections and adjacent outcrops and brief descriptions of these specimens are included.

A number of bedding and cleavage attitudes and lineation directions were measured during the section measuring; these measurements are presented on fine stereographic projections. The styles of folding in the two areas are briefly discussed.

INTRODUCTION

The Duaringa and St. Lawrence 1:250,000 Sheet areas were mapped during 1962. Several areas of good outcrop, suitable for measuring section, were noted during 1962, and were measured during 1963 by E.J. Malone. He was assisted by J.A.J. Smit, of the Bureau of Mineral Resources, in measuring sections EM4, EM9, EM10, EM11, EM12 and EM13, and by B.A. Coxhead, of the Geological Survey of Queensland, in measuring section EM5, EM6, EM7, and EM8. Both Smit and Coxhead were members of the 1963 Baralaba Party.

During the section measuring, a number of bedding and cleavage attitudes and lineation directions were measured. These measurements are presented as stereographic projections, prepared by J.A.J. Smit. These give some indication of the style of folding in the various areas and are briefly discussed.

56 specimens were collected from the measured sections and adjacent rocks. These were examined in thin section by L.V. Bastian of the Bureau of Mineral Resources who wrote the chapter entitled Petrographic Notes.

LEURA HOMESTEAD AREA

Sections EM4, EM5, EM6, EM7 and EM8 were measured near Leura Homestead in the north-east of the Duaringa and the south-east of the St. Lawrence 1:250,000 Sheet areas. These sections were measured mainly in the Back Creek Group (the former Middle Bowen Beds) and are presented on Plate 1. There are no palaeontological data or lithological markers to indicate the inter-relations of these sections. They are tentatively correlated on their position relative to the base of the Back Creek Group. However, the base of the Back Creek is probably not everywhere at the same stratigraphic level even in this small area. Section EM4 commences at the base of the Back Creek Group. Sections EM5, EM6 and EM7, which are nearly continuous, commence about 1000 feet above the base of the Back Creek Group and are equated with the upper part of section EM4. Section EM8 is probably younger than sections EM4 to EM7.

Section EM4

The lower 650 feet of section EM4 consists of interbedded limestone and calcareous sediments, fossiliferous in part, flows, tuffs and tuffaceous sediments. It represents a conformable transition from the ~~Connors Volcanics (the former~~ Lower Bowen Volcanics) to the Back Creek Group. Only volcanics of the Devonian-Carboniferous Connors Volcanics crop out below the base of the section. Above 650 feet, section EM4 is lithologically very monotonous. Specimens EM4/4 and EM4/5 are typical of the lithic sandstone and siltstone which make up most of the upper 1300 feet of the section. The lithic grains of the quartz lithic sandstone are mainly of volcanic origin; this rock type could be described as tuffaceous sandstone.

A traverse was made to the east from the top of section EM4. The lithologies seen were mainly quartz lithic sandstone and siltstone, as in

section EM4. They included fawn to brown fine sandstone or siltstone containing dark claystone clasts and pellets, a lithology very similar to that at the base of section EM8. This rock type was associated with tuffaceous sandstone (specimen M10). The youngest rock type seen was a conglomerate (specimen M12). The significance of the conglomerate is discussed below.

No section could be measured east of the top of section EM4 because of increasing structural complexity. At first, the dips remain moderately low but vary in direction; further east, the section is moderately and then very tightly folded. The degree of structural complexity appears to be directly proportional to distance from the underlying Connors Volcanics.

Two stereographic projections, S.P.1 referring to section EM4 and SP2 referring to the traverse east of section EM4, are shown on Plate 3. Section EM4 was measured on one limb of a fold: the bedding and cleavage poles on S.P.1 are moderately well grouped and are obviously related to the same folding. The fairly close grouping of the lineation directions supports this and indicates the orientation of the axis of folding. S.P.2 is based on measurements made on both flanks of a number of folds. The relation and grouping of the bedding and cleavage poles suggest that the cleavage is axial plane cleavage developed during one period of folding. The lineation directions are reasonably well grouped, indicating the orientation of the axis of folding. S.P.1 and S.P.2 are in close agreement. The grouping of the cleavage poles indicate that the axial planes are slightly overturned, dipping steeply east.

Section EM5, EM6 and EM7

Sections EM5 and EM6 are separated by a gap of no outcrop but are effectively continuous. They cover that part of the Back Creek Group from approximately 1000 feet above the base to approximately 1825 feet above the base. Section EM7 is a short section measured near the top of section EM6. A gap of no outcrop between the sections and a swing in strike makes it difficult to correlate the two. Section EM7 is probably equivalent to the top part of section EM6 though it is possibly partly younger.

Section EM5 contains considerable primary volcanics as does the basal 1000 feet of the Back Creek Group, below the section. Coarse grained, calcareous volcanic sandstone (specimen M14) interbedded with possibly fine grained tuff is characteristic of the basal part of the Back Creek Group. No primary volcanics were recognized above section EM5. Siltstone and lithic sandstone make up all of sections EM6 and EM7 and are interbedded with the volcanics in section EM5. The lithic grains in the sandstone are mainly reworked volcanic material.

The sediments in these three sections were jointed and in places closely jointed. However, no recognizable cleavage was present. The lack of cleavage here is in sharp contrast to the well developed cleavage of the sediments in the vicinity of sections EM4 and EM8 and reflects the different structural regimes in these areas. As mentioned before, the competent

Connors Volcanics exercises considerable control of the degree of structural deformation of the adjacent Back Creek Group. The lack of cleavage in the sediments of sections EM5, EM6 and EM7 is probably because of their position on the shallow south-west dipping flank of the Connors Arch. The competent Connors Volcanics, occupying the core of the arch, protected the sediments on the west flank from the deformation which produced the cleavage in the sediments to the south and east. The inclination of the cleavage indicates that the folding stress came from the east.

Section EM8

This short section is difficult to locate accurately in the Back Creek Group. It is possible as much as 3000 feet above the base. The most distinctive lithology in this section is a fawn or grey coarse siltstone containing clasts, pellets and wisps of dark shale. A similar lithology was seen on the traverse east from the top of section EM4. Since no similar lithology is present in section EM4 or in sections EM5, EM6 or EM7, section EM8 is probably stratigraphically above these sections.

The sediments in the vicinity of section EM8 are very cleaved. The few cleavage and bedding attitudes and lineation directions measured are presented on S.P.3, Plate 3. The measurements were made on sediments folded into broad, gentle anticlines and synclines on the south plunge of the Connors Arch. The poles of the cleavage and the lineation directions are moderately closely grouped. There are not sufficient measurements to draw any definite conclusions. However, these few results suggest the cleavage is axial plane cleavage developed during the folding. The cleavage is steeply east dipping, as it is near section EM4. The axial planes of the folding are presumably steeply east dipping, also indicating application of the folding stress from the east,

The orientation of the axial plane of the folding, as indicated by S.P. 3, is at an angle to that indicated by S.P. 1 and S.P. 2. This difference is probably significant. It may be due to the effect on the pattern of folding of the Connors Volcanics folded with the Back Creek Group between section EM4 and section EM8. The distribution of the Connors Volcanics in the Leura Homestead area is shown on Plate 1.

In the vicinity of section EM8, the cleavage is developed in mudstone thinly to thickly interbedded with generally uncleaved lithic sandstone. The cleavage cuts some of the thinner sandstone beds. The photographs on Photo Plate 1 illustrate the appearance and distribution of the cleavage. Photo 3 is of the slightly eroded bedding surface of a mudstone interbed. It shows a conjugate set of steeply dipping joints cutting this nearly horizontal bed as well as the trace of the cleavage on the bedding, nearly parallel to the long axis of the joint set.

Conglomerate, Back Creek Group

Conglomerate crops out in the Back Creek Group in many places in the Leura area and throughout the Gogango Range to the south. Further

south, in the Monto and Mundubbera Sheet areas, the upper and lower parts of the Back Creek Group are separated by a disconformity (Dickins in Jensen, Gregory and Forbes, 1964). It is possible that the conglomerate is associated with the resumption of deposition after the disconformity. The abundance of volcanic pebbles and matrix in the conglomerate in places indicates contemporaneous volcanism. This volcanism may be associated with the tectonism which produced a resumption of deposition in this area.

The matrix and pebbles of the conglomerate east of Leura Homestead (M12) and of conglomerate from the Mackenzie River (M34) were examined in thin section and are more fully described later. The conglomerate from the Leura area has a volcanic sandstone matrix containing less than 10% quartz grains. Many of the pebbles are volcanic sediments or include possible volcanic detritus; the others are feldspathic quartzose sandstone. Conglomerate M34 shows no evidence of primary or derived volcanic detritus. It consists mainly of quartz sandstone to sub-greywacke and some siltstone pebbles in a clay matrix; the specimen includes one pebble of chert which is probably a devitrified volcanic glass. More mapping and sampling is required to indicate whether the different proportions of volcanic detritus in the two conglomerate samples is significant. The differences may represent only differences in provenance of these two widely separated samples. The importance of the conglomerate is that, if mapped, sampled and studied carefully, it may provide a means of subdividing the Back Creek Group in the structurally complex Gegango Range area.

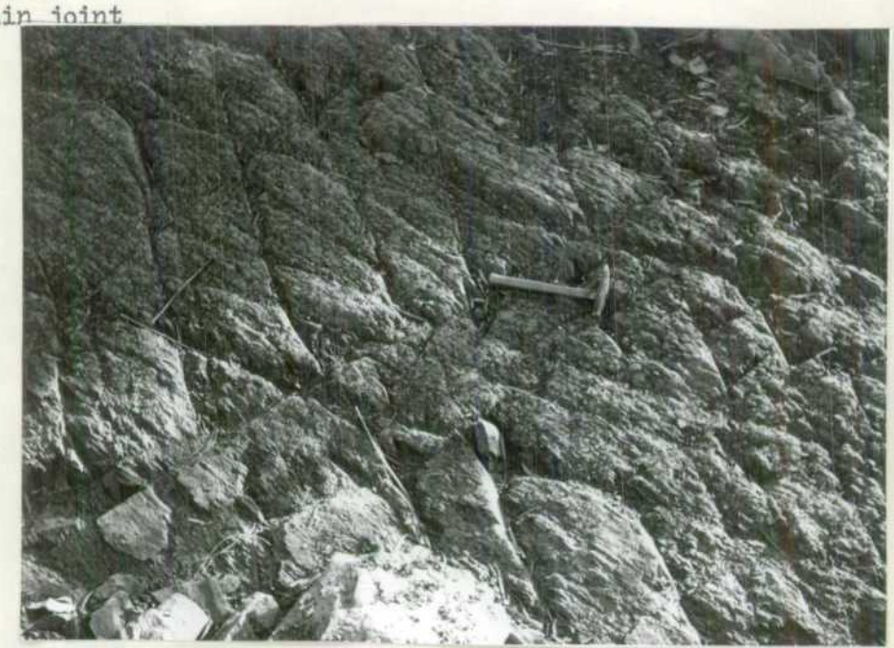
PHOTO PLATE I

Interbedded lithic sandstone and mudstone. Cleavage effects mudstone and thin sandstone beds only.

(Neg. No. M294)

Close up of mudstone and lithic sandstone beds, showing relation of cleavage to bedding.

(Neg. No. M294)



Slightly eroded mudstone bedding plane. Prominent conjugate joint set, at right angles to bedding. Trace of cleavage on bedding is parallel to long axis of joint set. Other joints are parallel to short diagonal of main joint set.

(Neg. No. M294.)

BUNDALEER HOMESTEAD AREA

Measured sections EM9, EM10, EM11, EM12 and EM13 were measured along the banks of the Mackenzie River between Wilpeena and Bundaleer Homesteads in the Duaringa 1:250,000 Sheet area. The measured sections are shown on Plate 2 together with partly schematic cross-sections showing the nature of the folding and the relation of the measured sections to each other and to the structures.

Section EM11

Section EM11 was measured in the Back Creek Group between a crest and the adjacent trough in a series of anticlines and synclines. Marine fossils were collected from two points in the section. These collections and other collections in equivalent stratigraphic positions in adjoining structures indicate that these rocks are Lower Permian and may be correlated with Unit B of the Middle Bowen Beds (Dickins, Malone and Jensen, 1964). The sediments in EM11 are unlike those in the Leura Homestead area, and possibly this part of the Back Creek Group is not represented in the Leura area.

One specimen of sandstone from about 100 feet above the base of section EM11 was collected during the 1962 field season and subsequently described. It is a feldspatho-lithic quartz sandstone, well sorted and fine grained, consisting of 60% quartz grains, 20% lithic fragments and plagioclase, 10% matrix and 10% aggregates of calcite and siderite. Section EM11 includes several lenses of hard, brown, calcareous lithic sandstone, similar to lenses found in the Upper Bowen Coal Measures in this area. One such lens (EM10/1) is described below.

Sections EM9 and EM10

Sections EM9 and EM10 were measured in the Upper Bowen Coal Measures. The base of section EM9 is near the base of the Coal Measures in this area. Section EM10 is stratigraphically above section EM9; the intervening section is not exposed but is probably less than 500 feet thick.

Most of the sediments in sections EM9 and EM10 contain predominantly detrital volcanic material. One specimen, EM9/3, differs from the others in containing abundant detrital chlorite, suggesting that it was derived from a nearby volcanic source. Primary volcanics are present in the Upper Bowen Coal Measures in this area, indicating contemporaneous volcanism. Possibly volcanics may have accumulated above the base level of erosion and supplied sediment to the surrounding area.

The quartz sandstone in section EM9 (specimens EM9/4 and EM9/5) differs markedly in composition from the sediments above and below. It is mainly quartzose but contains 10% to 15% of feldspar; detrital volcanic material is a minor constituent. Its composition suggests that it was derived from a granitic source. However, this lithology constitutes only a small part of the dominantly volcanic derived sediments. Possibly, it represents fluvial sedimentation derived from a relatively small part of the

provenance area of the Upper Bowen Coal Measures as a whole.

These sections include many nodules and lenses of calcareous lithic sandstone, and sandy limestone. The lenses range in size up to 20 feet in diameter and 4 feet thick; they are discoidal in shape and have rounded edges and generally rounded upper and lower surfaces. The larger dimensions of the lens are in the plane of the bedding. They are possibly concretionary in origin, involving migration of calcite through the sediments. A photograph of one such lens cropping out near section EM10 is shown on Photo Plate 2. Similar lenses are common throughout the Upper Bowen Coal Measures and the Back Creek Group in the Bundaleer Homestead area.

The Upper Bowen Coal Measures contain abundant fossil wood in several horizons in the Bundaleer Homestead area. Photo 2 on Photo Plate 2 shows a section of a large tree trunk in place within the sediments, which in this case are thinly bedded sandy siltstone. Most of the fossil wood , however, is associated with coarser sediments. The fossil wood in the photograph has a flat surface resting on the bedding; it has depressed the underlying sediments only very slightly.

Sections EM12 and EM13

Sections EM12 and EM13 were measured in the Upper Bowen Coal Measures on opposite flanks of a large asymmetric anticline. A cross section through the structure is shown on Plate 2 and this shows the relation between the two sections. Comparison of these two sections reveals the considerable lateral variation in lithology of the Upper Bowen Coal Measures in this area. Sections EM12 and EM13 are presented on Plate 2 with their lithological columns side by side to facilitate comparison.

The exact stratigraphic positions of sections EM12 and EM13 are not known. Probably, they are low in the Upper Bowen Coal Measures. The Back Creek Group is exposed in a number of anticlines in the area; it is probably at shallow depth in the core of the anticline on whose limbs sections EM12 and EM13 were measured.

The sediments in these sections are composed mainly of volcanic detritus and are generally similar to those in sections EM9 and EM10. Cone-in-cone limestone and dolomite rhombs are more common in EM12 and EM13 than in EM9 and EM10. Both these features are post-depositional and may reflect differences in the tectonic histories of the two areas.

Two collections of fossil plants, EM13/1 and EM13/2, were made in measured section EM13. The following identifications of these plants and comments were made by Mary E. White.

PHOTO PLATE 2

Photo 1

Discoidal lens of calcareous lithic sandstone in Upper Bowen Coal Measures, Bundaleer Homestead area.
Note rounded edge of lens and slight doming of bedding above lens.

(Neg. No. M/294)

Photo 2

Fossil wood, in Upper Bowen Coal Measures, Bundaleer Homestead area.
Note slight depression of bedding below wood.

(Neg. No.M/294)

Photo 3

Taeniopteris sp. associated with Glossopteris.
From section EM13, Upper Bowen Coal Measures, Bundaleer Homestead area.

(Neg. No. F/3810)

Collection EM13/1

Glossopteris conspicua Feist., G. ampla Dada, G. indica Sch., G. angustifolia Brong.
Glossopteris scale leaves of the large, thick variety with reticulated pattern on surface, believed to be of Glossopteris ampla
Vertebraria indica Royle, Cladophlebis roylei Arber, and equisetalean stems.

A typical Upper Bowen assemblage.

Collection EM13/2

Glossopteris conspicua Feist., G. ampla Dana, G. communis Feist., G. indica Sch., G. damudica Feist., G. tortuosa Zeiller, G. angustifolia Brong., and scales of Glossopteris ampla.
Dictyopteridium sporiferum, a male fructification such as occurs with Glossopteris communis in Upper Permian at Baralaba.
Cladophlebis roylei Arber, and equisetalean stems.

Portion of a leaf of Taeniopteris Sp. is present. This is interesting as there are only a few authenticated cases of Taeniopteris associated with Glossopteris and this is the first record of the association in the Upper Bowen.
Photo 3, Photo Plate 2, shows the specimen (magnified x 2). The parallel lateral veins and pronounced midrib are clearly seen.

FOLDING

The style of folding in the Bundaleer Homestead area is shown by the cross-section along the Mackenzie River and the larger scale cross-section through the EM12/EM13 anticline. Sterographic projection S.P. 4 (Plate 3) is based on measurements in the vicinity of sections EM9 and EM10, and projection S.P.5 (Plate 3) is based on measurements in the vicinity of section EM12 and EM13. Cleavage is extremly rare and poorly developed in the Bundaleer Homestead area, despite the tightness of the structures. This is in marked contrast to the Leura area and suggests a different mechanism of folding here or possibly folding under much less overburden. The direction of the fold axis in the vicinity of section EM4 is 030° (S.P.1 and S.P.2, Plate 3); in the vicinity of section EM8 it is 355° (S.P.3, Plate 3); and in the Bundaleer Homestead area, it is 330° (S.P. 4 and S.P.5, Plate 3). The change from 030° to 355° is thought to be due to the effects of blocks of volcanics folded with the sediments. The change to 330° in the Bundaleer area, together with the lack of cleavage in this area, is probably much more significant. The fold axis direction of 330° parallels the trend of the Folded Zone of the Bowen Basin (Malone et al 1963). The Bundaleer area is included in the Folded Zone. A discussion of the Folded Zone and its relation to other structural units in the Bowen Basin is not satisfactory without considering all of the Bowen Basin and its environs. This cannot be done in this record. The subject will be fully discussed in the final geological report on the Bowen Basin, to be produced after completion of the regional mapping in 1964. The following remarks on the Folded Zone take into account some information gained during the regional mapping of the Bowen Basin to date but not discussed in this paper.

The western boundary of the Folded Zone is marked by thrust faulting in places. A seismic survey across the Zone (Robertson, 1961) detected shallow dipping strata at a depth of about 16,000 feet, below the tight folds. The combination of a possible decollement below the Folded Zone, a thrust faulted western margin and the lack of cleavage in the zone suggest gravity tectonics as a possible mechanism of the folding. The very great uplift known to have taken place along the axis of the Connors Arch could have supplied the potential energy for the gravity tectonics. A cross-section through the Folded Zone, along a line about 25 miles north of Bundaleer Homestead, is shown on Plate 2. This cross-section suggests that the decollement surface is the top of the Lower Bowen ~~Connors~~ Volcanics.

PETROGRAPHIC NOTES

INTRODUCTION

Fifty six thin sections are described. Brief comments are made on the more obvious common features of specimens in a sequence, such as thos from measured sections, or pebbles from a conglomerate.

A few points are mentioned:

(1) Locality information is included in the main body of the report.

(2) The use of "volcanic" and "tuffaceous" for names follows that of Williams, Turner and Gilbert (1955), "tuffaceous" being used where there is some primary tuff material in a specimen, and "volcanic" being used where it contains only volcanic detritus, reworked from elsewhere.

(3) Cherty grains are usually found associated with detritus which is definitely volcanic, and in such cases are described as "devitrified glass", instead of the more general term "chert". In some specimens they contain traces of shards or corners of plagioclase laths, which show that they came from volcanic rocks.

(4) Plagioclase composition was determined wherever cleavages were distinct enough to give a reliable reading of the extinction angle.

SECTION EM4 - BACK CREEK GROUP

EM4/1 Medium-grained, pebbly, volcanic sandstone.

Texture Well sorted, average grain-size 0.3 mm., maximum 0.6 mm., some coarser grains up to 5 mm.

Clasts Plagioclase-rich flow rocks (composition of plagioclase not determined - 65%; devitrified glass lacking flow texture - 15%; individual grains of plagioclase, angular or, less commonly, lath-shaped - 10%.

Cement Chert - about 5%.

Alteration Irregular patches of Fontainebleu-textured calcite, replacing detritus - 5%; common authigenic sphene and a yellowish phyllosilicate.

EM4/2 Coarse-grained, pebbly, fossiliferous volcanic sandstone.

Texture Poorly sorted, grain-size, ranging from 0.12 mm., with one pebble > 5 mm.

Clasts Flow rocks, as in EM4/1 - about 70%; all grains whose plagioclase composition can be determined are spilites or soda-rhyolites, and possibly all of them may be sodic rocks. Many fragments are very irregular in shape, suggesting that this sediment was deposited very close to its source. Other clasts: fossil debris - 5%; yellowish phyllosilicate some of which appears to be altered volcanic glass - > 5%

minor devitrified glass lacking flow texture.

Matrix (15%) Low birefringent material, probably mainly glassy detritus, with subordinate opaque grains, illite, and minor calcite patches.

Alteration Authigenic sphene (1-2%) and apatite.

EM4/3 Very fine-grained, pebbly, volcanic sandstone.

Texture Well sorted, average grain-size 0.1 mm., maximum 0.15 mm., with a few granules up to 5 mm.; grains angular to subangular.

Clasts Quartz - 10%; plagioclase (those grains which can be determined are albite), slightly altered - 35%; devitrified glass, in parts turning to illite -> 40%; a few flow rocks.

Matrix (10%) Illitic films around grains, and flakes of authigenic phyllosilicate, with 2-3% carbonaceous clay in wavy shreds.

The granules of glass and flow rocks, up to 5 mm. across, show the same very irregular shapes as do those in EM4/2.

EM4/4 Siltstone and carbonaceous claystone.

(i) Siltstone portion:

Texture Fairly well sorted, average grain-size 0.05 mm., maximum 0.1 mm., angular grains.

Clasts Quartz - 30%; devitrified glass < 20%; plagioclase < 10%; minor biotite, muscovite, and chlorite.

Matrix Abundant, illitic.

Alteration Pale green authigenic phyllosilicate - 5%; calcite replacing detritus in isolated patches -< 5%.

(ii) Claystone portion:

This has an indented border with the siltstone. It is illitic and very carbonaceous, with much other unidentified detritus. The orientation of clay particles in the claystone is in a markedly direction to that of the clay particles in the siltstone; it appears that the claystone has retained its original orientation, as the particles are more or less parallel to the bedding surface, while those in the silt are steeply inclined to it.

EM4/5 Very fine-grained volcanic sandstone

Texture Fairly well sorted, average grain-size 0.1 mm., maximum 0.2 mm. grains mainly angular.

Clasts Quartz - 25%; plagioclase (albite wherever composition can be determined) -< 10%; untwinned feldspar - 10%; devitrified glass, many grains brownish, and on the whole better rounded than other material -> 30%; minor tourmaline and zircon.

Matrix (5 - 10%) Difficult to discern from the glassy grains; appears to be cherty, with illite.

Alteration Abundant; includes calcite, replacing detritus in irregular patches -< 10%; interstitial chlorite -> 5%; and plentiful sphene.

Due to the wide spacing of samples from Section EM4, only their obvious common features can be mentioned. They are composed essentially of volcanic detritus, and apparently contain no definitely contemporaneous pyroclastic material, such as shards. Fragments of flow rocks predominate in EM4/1 and EM4/2, but are very minor in the others, which may be largely derived from tuffs. Albite is the only plagioclase which has been determined, and the flow rocks are at least predominantly sodic. Houston (1963) described many spilitic rocks from the Rookwood Volcanics and Lower Bowen Volcanics, which are possible sources for much of the material in these sediments.

SECTION EM5 - BACK CREEK GROUP

EM5/1 Silty Shale

Texture Poorly sorted, mainly clay, with about 10% of angular to subangular silt; average grain-size of silt 0.05 mm.

Clasts Quartz, feldspars, micas, and devitrified glass.

The clay is mainly illite, well oriented. There are some silicified fragments, probably of fossils, and common fine carbonaceous debris.

EM5/2 Very fine-grained volcanic sandstone

Texture Very well sorted, average grain-size 0.1 mm., maximum $<$0.2 mm.; grains angular, except for grains of devitrified glass which show rounding.

Clasts Quartz - 15%; plagioclase (?albite) - 30%; devitrified glass, both transparent and brownish types - 40%; greenish brown phyllosilicate; minor chlorite, rare zircon, apatite and tourmaline.

Matrix A matrix cannot be distinguished from the glassy grains, owing to strong welding between grains.

EM5/3 Very fine-grained volcanic sandstone

Texture Well sorted, average grain-size 0.1 mm., maximum 0.2 mm.; grains angular to subangular.

Clasts Quartz - 5%; plagioclase and untwinned feldspars - 30%; devitrified glass, transparent or pale brown $>$50%; muscovite, biotite, chlorite and greenish-brown phyllosilicate; patches and shreds of coaly matter - $<$5%.

Matrix Quartz is strongly welded onto the glassy grains, and no definite matrix can be discerned.

Alteration Abundant small crystals of authigenic apatite and sphene.

EM5/4 Coarse-grained crystal-lithic-vitric tuff

General proportions, before calcite replacement: crystals - 45%, lithic fragments - 30%, recrystallized vitric matrix - 25%; with a very minor amount of possibly epiclastic material.

Texture Very poorly sorted, the most common grain-sizes ranging from 0.7 mm. - 1.6 mm., maximum 3 mm.; grains angular; some of the larger fragments have quite irregular shapes.

Clasts Crystals: euthedral albite and possible some K-feldspar.
Lithic fragments: vitric rhyolites, mostly devitrified, many VESICULAR GRAINS; AND ?SPILITES; ALL SHOW FLOW STRUCTURE AND CONTAIN VAR variable amounts of plagioclase phenocrysts. The thin section also has a fragment of fibrous calcite (? fossil) and some definite fossil fragments.

Alteration About 15% calcite, mostly replacing feldspars.

EM5/5 Fine-grained vitric-crystal tuff

There are about equal proportions of crystals and glass.

Texture Moderate sorting, average grain-size of crystals 0.12 mm., maximum 0.25 mm., grains angular.

Clasts Quartz - 10%; plagioclase (albite and oligoclase) -<20%; untwinned feldspar, including rare microcline - 10%; rare muscovite, zircon and tourmaline. Overgrowths on the quartz and feldspars are common.
Lithic fragments: minor (5%) fragments of flow rocks, mostly replaced by hydrated iron oxide.

Glass (45%) Only a few ill-defined shard forms can be recognised, due to strong recrystallization; it is strongly welded onto the crystals, and small stylolites, lined with hydrated iron oxides, are very common.

Alteration Abundant (5 - 10%) small crystals of authigenic apatite, and sub-ordinate sphene; hydrated iron oxides as noted above.

EM5/6 Very fine-grained vitric tuff

The ratio of glass to crystals is about 6:1.

Crystals Well sorted, with grain size 0.08 mm.; lath shapes suggest that most of them may be plagioclase.

Glass Strongly devitrified, but abundant ill-defined shard forms can be seen. Coaly fragments are common.

Alteration Many clumps of authigenic sphene.

These rocks are either tuffs or have been derived from tuffs, with relatively little reworking. Common features are the sodic plagioclase, and plentiful sphene and apatite which indicate that volatiles circulated in the material after deposition. The strong recrystallization, interlocking of grains and, in EM5/5, the numerous stylolites, all would support this. EM5/2 and EM5/3 are very similar to each other, and to the specimens EM4/4 and EM4/5. EM5/5 and EM5/6 strongly resemble lithologies in the Flattop Formation in the Mundubbera 1:250,000 Sheet area.

BACK CREEK GROUP, BASAL PART. (Below section EM5)

M14 Coarse-grained, calcareous, volcanic sandstone

Texture Fairly well sorted, average grain-size 0.8 mm., maximum 3 mm.; grains mainly subangular.

Clasts Volcanic rocks - 60%; most of these being plagioclase-rich flow rocks (probably all of which are soda-rich, as none of the plagioclase extinction angles exceed 20°); subordinate amount of devitrified, cherty, glasses, vesicular rhyolite with chalcedony or chlorite filling vesicles, and minor silicified rhyolite. There are a few individual grains of albite (<5%).

Alteration Calcite (30-40%) heavily replaces feldspars and the glassy lithic grains, and authigenic apatite occurs in accessory amounts.

SECTION EM6 - BACK CREEK GROUP

EM6/1 Fine-grained volcanic sandstone

Texture Moderate sorting, average grain-size 0.2 mm., maximum 0.55 mm.; grains angular to subangular.

Clasts Quartz - <15%; plagioclase (albite common) - <20%; K-feldspar 5%; devitrified glass, mostly a transparent cherty type - 35%; rock fragments, including ? andesite, claystones and sericitic grains, many of which are a pale greenish-brown colour - 15%; common accessories: tourmaline, apatite and zircon. There appears to be a cherty matrix (?10%), but this is difficult to discern from the devitrified glass.

Alteration Iron oxide (5%), replacing a carbonate mineral.

SECTION EM7 - BACK CREEK GROUP

EM7/1 Fine-grained volcanic sandstone

Texture Moderate soring, average grain-size 0.15 mm., maximum 0.4 mm.; grains subangular.

Clasts Quartz, many with volcanic embayments - 10%; plagioclase - 15%; K-feldspar - >5%; devitried glass - 30%, flow rocks (?andesite or spilite) - 5%; numerous brown claystones and sericitic grains, as in EM6/1; muscovite common, as large FLAKES. Possible matrix is difficult to discern.

Alteration 15% of a carbonate mineral (?dolomite), partly ferruginized.

EM6/1 and EM7/1 are very similar to each other, and closely resemble the volcanic sandstones of Section EM5.

SECTION EM 8 - BACK CREEK GROUP

EM8/1 Siltstone and carbonaceous claystone

There are several lithologies in this rock, interworked strongly, in the form of slumps and mud rolls. Two types of disruption are present:

(i) a portion with rolled textures, where a layer became partly injected into an overlying layer;

(ii) a portion with completely disrupted slivers and pockets of clay, indicating a more advanced stage of injection.

The main lithology is siltstone, well sorted, with an average grain-size of 0.05 mm., maximum 0.1 mm. Grains are angular, and include:

quartz - 30%; plagioclase and untwinned feldspar - 10%; devitrified glass - 15%; interstitial greenish grey phyllosilicate (? chlorite) - >5%. The abundant matrix is made up of chert and well oriented illite flakes, lying at a steep angle to the bedding plane, presumably due to tectonism. Accessory grains include muscovite, biotite, common apatite, subordinate tourmaline.

The other lithologies are :

(i) brown siltstone, containing abundant brownish phyllosilicates (? devitrified glassy matrix), patches rich in carbonaceous debris, and much hydrated iron oxide;

(ii) dark grey claystone, silty and very carbonaceous, the abundant coaly shreds being well oriented in the same direction as the illite in the siltstone.

BACK CREEK GROUP, (above Section EM4)

M10 Medium-grained volcanic sandstone

Texture Moderate sorting, average grain-size 0.3 mm., maximum 0.75 mm.; grains mostly angular to subangular, with glassy grains better rounded.

Clasts Quartz - 10%; plagioclase - 10%; transparent devitrified glass, occasionally chalcedonic - 20%; brownish lithic grains, roughly half of which appear to be volcanics such as flow rocks and tuffs, the remainder sediments such as coarse and fine siltstone, and carbonaceous claystone - 50%.

Matrix (10%): light to dark brown, very carbonaceous silty clay, resembling many of the lithic grains.

BACK CREEK GROUP (above Section EM8)

Specimens M26A, M26B and M26C are from cleaved sequence illustrated in Photo Plate 1.

M26A Argillaceous siltstone

Texture Well sorted, average grain-size).05 mm., maximum 0.12 mm.; grains mainly angular.

Clasts Quartz - 30%; plagioclase and untwinned feldspar ->10% micas; muscovite, biotite and greenish-brown phyllosilicate - 5%; devitrified glass, occasionally illitic - >20%.

Matrix (>30%): illite, material of low birefringence (? chert), and brown hydrated iron oxides, with a corrugated texture.

Two particle orientations are present:

(i) dimensional orientation of quartz, feldspar and glassy grains, parallel to the bedding;

(ii) cleavage orientation, marked by the illite and iron oxide corrugations, at a steep angle to the bedding.

M26B Fine-grained lithic-feldspathic greywacke

Texture Very poorly sorted, with modes in the sand and clay sizes, maximum grain-size 0.6 mm., average of sand mode <0.2 mm.; grains mainly angular.

Clasts (60%): Quartz <10%; feldspars, mostly fairly fresh albite, subordinate K-feldspar <25%; devitrified glass - 15%; flow rocks (?spilites) - 5%; minor micrographic rock, muscovite; silty clay grains, probably from shales - <10%.

Matrix (40%): a mixture of fine detrital silt, illite, yellowish green phyllosilicate and cherty material of low birefringence, with thin corrugated shreds of carbonaceous matter.

M26C Carbonaceous silty claystone

This is a homogeneous, silty clay rock. The silt (about 5%) ranges around 0.04 mm. in grain-size, and is made up mostly of grains of devitrified glass, with subordinate quartz, plagioclase, and greenish phyllosilicate. The clay is composed of well oriented illite and chert of low birefringence, with abundant thin corrugated shreds of carbonaceous matter.

M29 Fine-grained volcanic sandstone

Texture Moderate sorting, with a minor coarse mode; average grain-size 0.2 mm., maximum 0.8 mm.; grains mainly angular to subangular.

Clasts Quartz, some grains with metaquartzitic textures - 15%; feldspar, mostly plagioclase (?albite), most grains showing alteration, and some strongly altered - 20%; devitrified glass, some grains partly vitric, others containing laths of plagioclase - 20%; flow rocks, commonly altered, with rosettes of phyllosilicates - 10%; sandstones and siltstones - <5%; silty clay grains, probably from shales - 5%; green phyllosilicate (?chlorite), commonly with fibrous and rosette structures; minor muscovite.

Matrix (15%): silty, with illite, abundant coaly debris, fine greenish phyllosilicates and brown iron oxides.

Alteration Clumps of small sphene crystals are common.

As with other specimens from the Back Creek Group, the most obvious common feature of these rocks is the volcanic source of their detritus. Albite is again the only plagioclase which has been determined by means of grains with satisfactory cleavages. None of the numerous grains show extinction angles exceeding 20°, so it seems that this may be the only plagioclase present although oligoclase is possible. The lithologies appear closest to those of specimens EM6/1 and EM7/1; specimens from sections EM4 and EM5 have much brownish glass not noted in EM6/1, EM7/1, M26A, M26B, M26C or M29.

BACK CREEK GROUP

CONGLOMERATES

M12 Medium-grained, pebbly, volcanic sandstone

Texture Laminated - laminae range from unsorted to very poorly sorted; average grain-size 0.25 mm., some coarse grains ranging up to 3mm. There is also a layer of silty claystone. Grains are mainly subangular.

Clasts Quartz - <10%; feldspars, both plagioclase and K-feldspar - 25%; volcanic grains, mostly devitrified tuffs and similar glassey grains, with many flow rocks and rare granophyre - 20%.

Matrix Variable in layers, ranging from about 20% to over 90% in the silty clay layer, averaging about 40%; it consists mostly of a yellow-brown phyllosilicate and illite in mesh-like patches, with subordinate black or dark brown opaque matter in undulating stylolite-like layers. This feature suggests there may have been much compaction of the rock, and removal of matrix from between the clasts.

M12A - M12J (Pebbles)

M12A Fine-grained quartz sandstone

Texture Fair to poor sorting, average grain-size 0.15 mm.; grains subrounded.

Clasts Quartz, strongly welded by pressure solution - 75%; K-feldspar and plagioclase - 5%; chert - 5%; rock fragments, mainly of shale and siltstone - 5%.

Matrix (10%): illite.

M12B Very fine-grained tuffaceous sandstone

Texture Very silty and clayey; average grain-size 0.08 mm.; grains angular to subangular; well marked tectonic lineation at a steep angle to the bedding.

Clasts Plagioclase (mainly oligoclase) - 30%; devitrified glasses from tuffs, including glass shards (devitrified) - 10% to 20%.

Matrix (20% to 50%): a mixture of yellow-brown phyllosilicate, illite and devitrified glass.

M12C Vitric-crystal tuff and tuffaceous claystone

Texture Vitroclastic; laminated, with variable amount of pyroclastic material in the layers.

Clasts Glass shards exceed crystals; crystals include plagioclase, quartz, andesite, spherulitic rhyolite and phyllosilicates.

Matrix The clay is mainly devitrified glassy material, and there are irregular veinlets filled by albite crystals and a little interstitial quartz.

M12D Coarse siltstone

Texture Fairly well sorted, average grain-size 0.05 mm.; grains angular.

Clasts Quartz - <10%; plagioclase, many strongly sericitized - 30%; devitrified glass - 40%; common yellow-brown phyllosilicate; many accessory grains of apatite and zircon.

Matrix (10-20%): mainly devitrified glassy material.

M12E Fine grained volcanic sandstone

Texture Fairly well sorted, average grain-size 0.12 mm.; grains mainly subangular.

Clasts Quartz - <10%; feldspars, mainly plagioclase which is heavily sericitized - 40%; volcanic grains, mainly devitrified tuffs, with subordinate flow rock - 35%; yellow-brown phyllosilicate 5 to 10%.

Matrix Brownish or yellow-brown illitic detritus.

M12F Fine-grained subarkose

Texture Rather poorly sorted, average grain-size 0.12 mm.; grains subangular to subrounded.

Clasts Quartz - <70%; feldspars, mostly microcline and untwinned feldspars; few plagioclase - >15%; rock fragments, including shale, siltstone, rhyolite and andesite - 5%.

Matrix (10%): Chert and illite with fine silt.

M12G Very fine-grained volcanic sandstone, ? tuffaceous

Texture Fair sorting, with silty patches, average grain-size 0.1 mm.; grains mainly subangular.

Clasts Quartz - <10%; feldspars, mostly strongly sericitized plagioclase - 30%; volcanic grains, most of which are devitrified glasses from tuffs, sub-ordinate flow rocks - 40%.

Matrix Devitrified glass and illite.

M12H Very fine-grained, silty, quartz sandstone

Texture Very poorly sorted, average grain-size 0.1 mm., maximum 0.4 mm.; grains mainly subrounded.

Clasts Quartz- 65%; feldspars - <5%; cherk - 3%: rock fragments, mostly of shale and siltstone - <10%.

Matrix (20%): Illite and a brown phyllosilicate, with many cherty patches.

M121 Fine-grained quartz-lithic sandstone

Texture Poorly sorted, average grain-size 0.15 mm.; grains subrounded.

Clasts Quartz - >60%; feldspars, mostly microline - 10%; rock fragments, mostly of shale and siltstone, rare volcanics - 10%; minor chert, muscovite and biotite.

Matrix (15%): Illite, silt, and a greenish phyllosilicate.

M12J Calcareous siltstone

Texture Well sorted, average grain-size 0.05 mm.; grains angular.

Clasts Transparent minerals (roughly 10% is plagioclase, 15% is quartz, others not identified) - 40%; chert, probably devitrified glass - 20%; minor biotite and muscovite.

Matrix (20%): Illite and greenish phyllosilicate.

Alteration Calcite, replacing detrital grains and matrix - 15%.

These pebbles can be grouped according to lithology as follows:

M12A, F,H,I. These show the common features of poor sorting, subrounded grains, strong pressure solution; they are quartz-rich with some K-feldspar, approaching an arkose in composition, and have fragments of older sedimentary rocks - shale and siltstone.

M12B,C These show evidence of contemporaneous vulcanicity, in the form of shards mixed in with other detritus, but all their contents, including reworked material, may be of volcanic derivation.

M12D, E,G These show no positive evidence of contemporaneous vulcanicity, but their contents (abundant plagioclase, much devitrified glass, and subordinate flow rocks) suggest that they may be closely related to B and C - probably reworked tuffs. M12J may be put in this group, apart from its finer grain-size, as it appears to have much chert of volcanic origin.

M34 Polymict conglomerate

Texture Granules, up to 7 mm. in diameter in the thin section; moderately to well rounded.

Clasts Predominantly lithic, the most common rock type being a quartzose sandstone, its grains poorly sorted and showing good rounding; subordinate amounts of devitrified glasses, siltstones and ferruginous subgreywacke.

Matrix Illite.

M34A - M34I (pebbles)

M34A Fine-grained quartz-lithic sandstone

Texture Poorly sorted, average grain-size 0.1 - 0.15 mm.; grains mainly subrounded.

Clasts Quartz, strongly welded by pressure solution - 60%; plagioclase - $\leq$5%; chert and quartzite - 5%; shale - 10%; minor andesite, micas, chlorite, siltstone.

Matrix (10%): A mixture of illite, silt and greenish-brown phyllosilicate.

M34B Fine-grained quartz-lithic sandstone

Texture Poorly sorted, average grain-size 0.15 mm., grains subrounded to rounded.

Clasts Quartz, showing strong welding due to pressure solution - 70%; plagioclase, strongly altered - 5%; chert - 5%; sedimentary rocks, including shale, siltstone and very fine-grained sandstone - 10%.

Matrix/cement (10%: Illite, greenish yellow phyllosilicate, and cherty cement.

M34C Very fine-grained subgreywacke

Texture Poorly sorted, average grain-size 0.1 mm.; grains subangular to subrounded.

Clasts Quartz, minor quartzite and chert included - 60%; plagioclase and K-feldspar - $\geq$10%; sedimentary rocks; shale and siltstone - 15%.

Matrix ($\leq$15%): illite, with micas that are squeezed between quartz grains.

M34D Fine-grained, silty, quartz sandstone

Texture Poorly sorted, average grain-size 0.15 mm.; grains mainly subrounded; many quartz-filled veinlets, at an angle to the bedding, indicate shearing has occurred.

Clasts Quartz (including minor quartzite and chert), showing strong pressure solution - 75%; K-feldspar and plagioclase - 5%; sedimentary rocks - shale, siltstone and claystone - 5%; minor volcanic rocks.

Matrix/cement (10%): a mixture of silt, cherty cement, illite and brown opaque matter.

M34E Carbonaceous, sandy siltstone

Texture Poorly sorted, sandy siltstone; average grain-size 0.05 mm.; angular grains; traversed by burrow-like patches of clay.

Clasts Plagioclase, quartz and rock fragments; also an unidentified brownish material with a sheaf-like texture, which may be a devitrified basic glass; many black carbonaceous shreds. The clay ? burrows contain abundant disseminated carbonaceous matter.

Matrix Mixture of low birefringent clay, much carbonaceous matter, and chert.

M34F Chert

Texture Microcrystalline silica, which is structureless apart from some incipient development of chalcedony rosettes.

The rock has abundant criss-crossing veinlets of chalcedony. Some of these have sharp borders, while other have vague borders towards the chert groundmass material. This suggests that earlier veinlets formed when the material was still soft, or rich in fluids. The chert is thus most likely a devitrified volcanic glass.

M34G Fine-grained quartz sandstone

Texture Rather poorly sorted, average grain-size 0.12 mm.; grains mainly subrounded.

Clasts Quartz, strongly welded - 75%; plagioclase - 5%; minor chert; shale - 5%. There is abundant greenish-brown phyllosilicate, both as grains and in the matrix, the remainder of which is made up of illite and cherty cement. There are several narrow zones of sheared rock in the thin section.

M34H Quartz siltstone

Texture Fairly well sorted, average grain-size < 0.04 mm.; grains angular.

Clasts Quartz, common plagioclase; accessories abundant, including zircon, tourmaline and apatite.

M34I Fine-grained quartz sandstone

Texture Moderate sorting, average grain-size 0.12 mm.; grains subrounded to rounded.

Clasts Quartz (includes minor quartzite and chert), showing strong pressure solution - 75%; minor K-feldspar and plagioclase; shales - < 10%; some micas.

M34I (contd)

Matrix (5%): Illite, with minor cherty cement.

These pebbles can be grouped according to lithology as follows:

M34A,B,C,D,G,I These show the common features of poor sorting and subrounded grains that are strongly welded by pressure solution. They are quartz-rich, very similar to the sandstones of the conglomerate M12, but generally have more shale or siltstone fragments - up to 15% in M34C. A greater proportion of the pebbles have this lithology than is seen in M12.

Other pebbles (M34E,F,H) appear to be unrelated.

The volcanic and tuffaceous sandstones, which are common in M12, are (assuming that the suites of pebbles are representative) apparently not to be found in this conglomerate.

SECTION EM9 - UPPER BOWEN COAL MEASURES

EM9/1 VERY FINE GRAINED, QUARTZOSE, VOLCANIC SANDSTONE.

Texture Fairly well sorted, average grain-size 0.08 mm., maximum 0.2 mm.; grains angular to subangular and densely packed.

Clasts Quartz - 25%; plagioclase - 10%; K-feldspar - 5%; volcanic grains, of which 20% is devitrified transparent and brownish glasses, and 15% is flow rocks - 35%; phyllosilicate minerals - muscovite, biotite, rare chlorite, light brown clay or shale grains, and interstitial illite - 10%; coaly debris - 5%; common heavy minerals, including tourmaline, zircon and apatite.

Alteration Calcite (10%), replaces feldspars and illite in irregular patches.

EM9/2 Medium-grained volcanic sandstone

Texture Fairly well sorted, average grain-size 0.35 mm., maximum 0.8 mm.; grains angular to subangular, except for grains of devitrified glass, which are subrounded.

Clasts Quartz, many grains embayed - 10%; K-feldspar - 5%; plagioclase, many partly to considerably replaced by calcite - 10%; volcanic rocks of which about 20% is flow rocks, 40% is vitric and devitrified glasses, including transparent, brown and dark brown glass - 60%; one large grain of ? granodiorite.

Alteration (<10%): Calcite, replacing plagioclase and matrix, the remaining parts of which appear to be devitrified glassy material.

EM9/3 Fine-grained, calcareous, volcanic sandstone

Texture Well sorted, average grain-size 0.15 mm., maximum 0.3 mm.; grains mainly angular.

Clasts Quartz, some grains embayed - 5%; plagioclase, laths heavily replaced by calcite (original percentage was much higher) - 5% flow rocks, ? andesite, also heavily replaced - <10%; devitrified volcanic glass-5%; pale yellowish green chlorite, occurring

both as individual crystals or aggregates of small "books" - 25%; sedimentary rocks, siltstones and shales - 2%.

Alteration Strong replacement by calcite (50%), which completely pseudomorphs many grains.

EM9/4 Medium-grained, quartzitic, subarkose

Texture Well sorted, average grain-size ranging from 0.2 mm. to 0.35 mm. in different parts of the T.S., maximum 0.55 mm.; grains subangular to subrounded, but roundness is largely losy by welding.

Clasts Quartz (including some grains with metaqiartzitic textures), showing overgrowth and strong pressure solution 75%; K-feldspar, many grains kaolinised - <10%; plagioclase (albite; others may be also present), strongly sericitized ->5%; volcanic material, mostly devitrified glass with minor flow rock ->5%; fine micaceous grains (?shale) - 2%; minor muscovite.

Matrix Minor illite films around grains, most of the original pores lost by compaction of the sediment and grain welding.

EM9/5 Fine-grained, quartzitic, sandstone

Texture Very well sorted, average grain-size 0.12 mm., maximum 0.2 mm.; grains tightly welded, with numerous interlocking areas, but appear to have been originally subangular to subrounded.

Clasts Quartz - 65-70%; plagioclase, minor K-feldspar, rare myrmekite - <10%; chert - 10%; sericitic and clay grains, origin uncertain - 10%. (It is hard to say which of the sericitic grains of EM9/4 or EM9/5 may be altered plagioclase or shale).

Matrix Minor illite films, most of the pores removed by compaction of the sediment and grain welding.

EM9/6 Carbonaceous claystone (?tuffaceous)

This rock consists of abundant fine illite flakes and evenly disseminated carbonaceous debris, in a groundmass of fine chert (? devitrified volcanic "dust"). The illite is well oriented parallel to the bedding plane, which shows up as faint laminae due to variations in the amount of carbonaceous matter. There is also a streaky alignment of shreds of this matter roughly normal to the bedding, probably due to tectonic effects.

The bulk of the contents of EM9/1, EM9/2, EM9/3, and probably also of EM9/6, is from volcanic sources. The first two have a fairly wide variety of minerals, suggesting that a large source area is represented, but EM9/3, with its peculiar abundance of chlorite which appears to be detrital, seems to have come from a single parent rock, which may indicate it was laid down very close to the source. This hints that the pattern of source areas may have changed quickly during these times, a feature which would be consistent with contemporaneous vulcanicity. Although there is no direct evidence for this in the EM9 specimens, another

Upper Bowen section (EM12) contains a tuff. In general, volcanic grains showing flow textures are subordinate to the devitrified, more or less structureless, glasses; in the absence of definite vitroclastic structures, however, it cannot be shown that these glasses originated from tuffs - they may just as easily have come from vitric rhyolites.

EM9/4 and EM9/5 are quite different rock types, for which a granitic source seems to be indicated.

SECTION EM10 - UPPER BOWEN COAL MEASURES

EM10/1 Fine grained, calcareous, volcanic sandstone

Texture Well sorted, average grain-size 0.16 mm., maximum 0.3 mm.; most grains angular to subangular, but grains of devitrified glass better rounded.

Clasts Quartz, some with volcanic embayments - 5%; plagioclase, many grains heavily sericitized - 15%; colourless devitrified glass - >15%; brownish glass, some with chalcedony-filled vessicles, many grains vitric and opaque - 20%; other rock fragments, flow rocks and micaceous rocks - 5%; muscovite and greenish, yellow or brown phyllosilicates - <5%.

Cement (35%): Calcite, mainly as cement but also replacing grains; much of this is heavily ferruginized, as are some detrital grains.

This specimen, from a higher part of the Upper Bowen Coal Measures than the section EM9, shows the same general features as the volcanic sandstones of that section. The chalcedonic grains, however, are not seen in those sandstones. These fragments commonly have shard-like shapes, but this is thought to be due to breakdown under normal transport conditions rather than to pyroclastic effects, i.e. the rock is not considered to be tuffaceous.

SECTION EM12 - UPPER BOWEN COAL MEASURES

EM12/2 Vitric-crystal tuff

Texture Vitroclastic; composed of abundant devitrified glass shards in a devitrified glassy matrix, with subordinate crystals.

Crystals (<10%): plagioclase, some ? andesite fragments, and a few partly resobed quartz grains, with authigenic rims.

Alteration Numerous euhedral crystals of an authigenic carbonate mineral (? dolomite), strongly ferruginized - 10%; and calcite, replacing many of the glass shards, in general pseudomorphing them - about 10%.

EM12/3 Fine-grained volcanic sandstone

Texture Well sorted, average grain-size 0.15 mm., maximum 0.35 mm.; grains mainly subangular.

Clasts Volcanics - mostly devitrified glass, with subordinate flow rocks - 50%; albite, original percentage higher before replacement by calcite - <15%; minor quartz.

Matrix (5%): Minor illite and greenish-brown phyllosilicate.

EM12/3 (cont.)

Alteration As in EM12/2, rhombs of a ferruginized carbonate mineral - about 10%; and calcite, mostly replacing feldspars - 15%.

EM12/4 Calcareous, tuffaceous claystone

This rock consists of laminae of claystone and silty claystone, with abundant irregularly shaped patches of calcite replacement. The silt grains are mostly prismatic, and are probably mainly feldspars. The clay contains abundant illite, but the bulk of it is devitrified glassy material, with much dark brown opaque matter. The calcite shows incipient "come-in-cone" structure developed throughout the rock, which has been expanded by it; the most clearly defined seams are at the interfaces between silt and clay laminae. Many of the seams are asymmetrical, the calcite fibres being elongated at an angle to the bedding plane, while the shreds of clay caught between the fibres also are turned asymmetrically, commonly giving an inclined "V" form to the structures.

EM12/5 Ferruginous claystone which has been mostly altered to hydrated iron oxide. The iron oxide has a microgranular texture, its granules averaging around 5 in size, and the unaltered clay appears to be cherty - it is probably essentially devitrified volcanic "dust".

EM12/6 Carbonaceous siltstone

Texture Very clayey silt, with a minor (2%) sand admixture; average grain-size of the silt about 0.03 mm.

Clasts Sand: mostly angular quartz with overgrowths, some feldspars and flow rocks.

Silt: angular quartz, showing resorption features; plagioclase, some K-feldspar, muscovite, and abundant devitrified glass; the glass fragments are poorly distinguished from the matrix, which is very cherty, with some illite.

There are abundant black carbonaceous shreds.

Alteration Ferruginized ? dolomite rhombs, averaging about 0.05 mm. in size.

EM12/7 Calcareous siltstone

This rock consists of laminated siltstone and silty claystone. It has been expanded by abundant calcite, with incipient "one-in-one" structure developed in the more clayey parts, especially on the interfaces between silt and clay laminae. In these parts the clay is broken into shreds, commonly giving "V" shapes which would be the beginnings of cones. The silt has an average grain-size of 0.04 mm., and includes abundant plagioclase (max. extinction angle = - 17°), subordinate quartz, common carbonaceous shreds; grains are strongly replaced by the calcite, which is in turn replaced by 10-20% of dolomite rhombs.

EM12/8 Fine-grained volcanic sandstone

Texture Well sorted, average grain-size 0.15 mm., maximum 0.25 mm.; grains angular to subangular.

EM12/8 (Contd.)

Clasts Quartz - 5%; plagioclase (?all albite) - 25%; rare K-feldspar; transparent or brownish semiopaque devitrified glasses - 30%; flow rocks (?andesite or spilite) - 10%.

Matrix (20%): mostly a pale green phyllosilicate (? chlorite), and thin illite films around grains.

Alteration Calcite (5%) replaces some grains. Accessory apatite occurs as fairly large crystals.

These rocks are composed of essentially volcanic detritus, as are most of the specimens from section EM9, with the generally structureless devitrified glasses predominating over flow rocks. Contemporaneous vulcanicity is indicated by EM12/2. There are no significant differences in composition of the detritus in the volcanic sandstones of each of the measured sections, and it is noteworthy that all plagioclase for which the sign of the extinction angle could be determined, by use of cleavages, is albite. This suggests that the flow rock fragments could be spilites rather than andesites.

TWO sharp differences between the EM9 and EM12 specimens have been noted. Dolomite rhombs (assuming that ferruginized carbonate crystals are dolomite) occur in most of the EM12 specimens, but not in any of the EM9 specimens, and "cone-in-cone" structure is likewise common in the EM12 specimens, but not to be found in any of the others. Perhaps both of these features, which are post-depositional, are most likely to be related to differences in tectonic history between the localities.

SECTION EM13 - UPPER BOWEN COAL MEASURES

EM13/3 Claystone, with "cone-in-cone" structure

This rock consists of claystone, with many layers of "cone-in-cone" structure. The clay is brown, well oriented, and probably is mainly illite. It has been forced apart by the growth of the calcite fibres, and interlocking pieces of clay can be seen in some parts of the thin section. A slight coarsening in the size of calcite crystals in one direction suggests this may be the direction of growth. The clay laminae have a number of partly sheared planes oblique to the bedding; in these planes clay flakes have been turned by the shearing action, without actually parting completely. There are also some criss-crossing veinlets of calcite.

This specimen, which is from the same sequence as the EM12 specimens, shows similar features to them especially in the "cone-in-cone" structure.

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APPENDIX A

List of specimen field numbers, rock registration numbers and thin section numbers.

Field No.	Registration No.	Thin Section No.
EM 4/1	R16454	14093
EM 4/2	R16455	14094
EM 4/3	R16456	14095
EM 4/4	R16457	14096
EM 4/5	R16458	14097
EM 5/1	R16459	14098
EM 5/2	R16460	14099
EM 5/3	R16461	14100
EM 5/4	R16462	14101
EM 5/5	R16463	14102
EM 5/6	R16464	14103
M 14	R16439	14078
EM 6/1	R16465	14104
EM 7/1	R16466	14105
EM 8/1	R16467	14106
M 10	R16427	14066
M 26A	R16441	14080
M 26 B	R16442	14081
M 26C	R16443	14082
M 29	R16440	14079
M 12	R16428	14067
M 12A	R16429	14068
M 12B	R16430	14069
M 12C	R16431	14070
M 12D	R16432	14071
M 12E	R16433	14072
M 12F	R16434	14073
M 12G	R16435	14074
M 12H	R16436	14075
M 12I	R16437	14076
M 12J	R16438	14077
M 34	R16444	13802
M 34A	R16445	14084
M34B	R16446	14085

Field No.	Registration No.	Thin Section No.
M 34C	R16447	14086
M 34D	R16448	14087
M 34E	R16449	14088
M 34F	R16450	14089
M 34G	R16451	14090
M 34H	R16452	14091
M 34I	R16453	14092
EM 9/1	R16468	14107
EM 9/2	R16469	14108
EM 9/3	R16470	14109
EM 9/4	R16471	14110
EM 9/5	R16472	14111
EM 9/6	R16473	14112
EM 10/1	R16474	14113
EM 12/2	R16475	14114
Em 12/3	R16476	13801
EM 12/4	R16477	14116
EM 12/5	R16478	14117
EM 12/6	R16479	14118
EM 12/7	R16480	14119
EM 12/8	R16481	14120
EM 13/3	R16482	14121

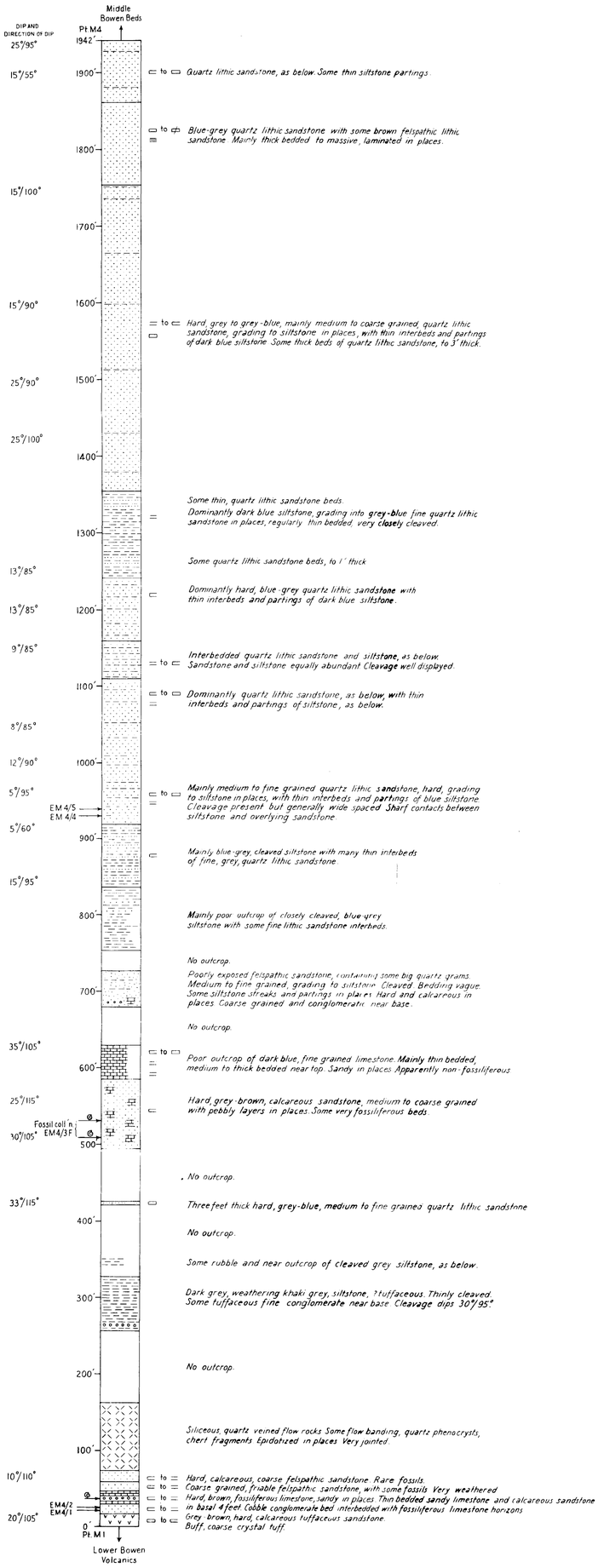
PLATE 1

MEASURED SECTIONS — LEURA HOMESTEAD AREA

SECTION EM4

MIDDLE BOWEN BEDS

In headwaters of Leura Creek.
Duaringa 1:85,000 photos, glossy, Run 2, Photo 5032.
Pts. M1 to M4.



⊂ to ▭ *Quartz lithic sandstone, as below. Some thin siltstone partings.*

▭ to ⊏ *Blue-grey quartz lithic sandstone with some brown felspathic lithic sandstone. Mainly thick bedded to massive, laminated in places.*

= to ⊂ ▭ *Hard, grey to grey-blue, mainly medium to coarse grained quartz lithic sandstone, grading to siltstone in places, with thin interbeds and partings of dark blue siltstone. Some thick beds of quartz lithic sandstone, to 3' thick.*

= *Some thin, quartz lithic sandstone beds.*
Dominantly dark blue siltstone, grading into ***grey-blue*** *fine quartz lithic sandstone in places, regularly thin bedded, very* ***closely*** *cleaved.*

Some quartz lithic sandstone beds, to 1' thick.

⊏ *Dominantly hard, blue-grey quartz lithic* ***sandstone*** *with thin interbeds and partings of dark blue* ***siltstone****.*

= to ⊏ *Interbedded quartz lithic sandstone and* ***siltstone****, as below. Sandstone and siltstone equally abundant. Cleavage well displayed.*

⊏ to ▭ = *Dominantly quartz lithic sandstone, as below, with thin interbeds and partings of siltstone, as below.*

⊏ to ▭ *Mainly medium to fine grained quartz lithic* ***sand****stone, hard, grading to siltstone in places, with thin interbeds and* ***part****ings of blue siltstone. Cleavage present but generally wide spaced. Sharp contacts between siltstone and overlying sandstone.*

⊏ *Mainly blue-grey, cleaved siltstone with many thin interbeds of fine, grey, quartz lithic sandstone.*

Mainly poor outcrop of closely cleaved, blue-grey siltstone with some fine lithic sandstone interbeds.

No outcrop.

Poorly exposed felspathic sandstone, containing some big quartz grains. Medium to fine grained, grading to siltstone. Cleaved. Bedding vague. Some siltstone streaks and partings in places. Hard and calcareous in places. Coarse grained and conglomeratic near base.

No outcrop.

⊏ to ▭ = *Poor outcrop of dark blue, fine grained limestone. Mainly thin bedded, medium to thick bedded near top. Sandy in places. Apparently non-fossiliferous.*

⊏ *Hard, grey-brown, calcareous sandstone, medium to coarse grained with pebbly layers in places. Some very fossiliferous beds.*

No outcrop.

▭ *Three feet thick hard, grey-blue, medium to fine grained quartz lithic sandstone.*

No outcrop.

Some rubble and near outcrop of cleaved grey siltstone, as below.

Dark grey, weathering khaki grey, siltstone, ?tuffaceous. Thinly cleaved. Some tuffaceous fine conglomerate near base. Cleavage dips 30°/95°.

No outcrop.

Siliceous, quartz veined flow rocks. Some flow banding, quartz phenocrysts, chert fragments. Epidotized in places. Very jointed.

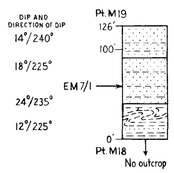
⊏ to = *Hard, calcareous, coarse felspathic sandstone. Rare fossils.*
⊏ to = *Coarse grained, friable felspathic sandstone, with some fossils. Very weathered.*
⊏ to = *Hard, brown, fossiliferous limestone, sandy in places. Thin bedded sandy limestone and calcareous sandstone in basal 4 feet. Cobble conglomerate bed interbedded with fossiliferous limestone horizons.*
⊏ to ⊂ *Grey-brown, hard, calcareous tuffaceous sandstone.*
Buff, coarse crystal tuff.

SECTION EM7

MIDDLE BOWEN BEDS

Along bank of Mackenzie River.
St Lawrence 1:85,000 photos. Run 8, Photo 5082
Bottom: Pt M18. Top: Pt M19.

Section EM7 overlaps or is equivalent to part of section EM6



= to ▭ *Interbedded medium to thick bedded hard sandstone, as below, and thin beds of friable fine sandstone and grey-blue siltstone.*

= to ⊏ *Medium - coarse grained, hard micaceous quartz lithic sandstone with thin interbeds of dark blue siltstone and sandy siltstone.*

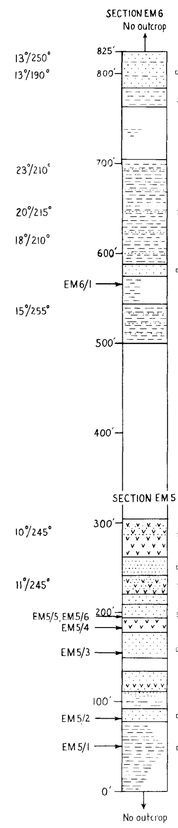
= *Dark blue siltstone and brown-grey sandy siltstone, showing contorted bedding.*
One 12" thick quartz lithic sandstone bed.

⊏ *Dark blue hard siltstone showing concentric weathering fractures.*

SECTIONS EM5, EM6

MIDDLE BOWEN BEDS

In small tributary of Mackenzie River, North of Tartarus Homestead.
St Lawrence 1:85,000 photos, Run 8, Photo 5082.
Section EM5. Bottom Pt 122. Top Pt M16. Base of section EM5 is approx. 1000' above Lower Bowen Volcanics. Section EM6 Bottom Pt 122-2. Top Pt M17.



⊂ to ▭ *Hard, micaceous, medium to coarse grained, lithic sandstone beds, lensing out along strike, interbedded with semi-friable fine sandstone and siltstone. Some thin lenses of hard, calcareous sandstone.*

Grey-blue and grey-brown siltstone and sandy siltstone.

No outcrop. Some rubble of siltstone.

= *Grey-blue and brown siltstone and sandy siltstone, laminated in places, mainly thinly interbedded. Some thin lenses of micaceous quartz lithic sandstone.*

⊂ to ▭ *Medium grained, grey-brown micaceous quartz lithic sandstone.*

Poor outcrop. Some rubble and near outcrop of siltstone.

Mainly siltstone and sandy siltstone with some micaceous quartz lithic sandstone lenses and beds, to 3' thick. Bedding poor, contorted in places.

No outcrop.

Tuff. Siliceous fine felspathic tuff at base, overlain by coarse, friable lithic tuff, containing numerous siltstone clasts and limestone nodules. Some tuffaceous sandstone near top.

⊏ to = *Hard grey quartz lithic sandstone, silicified in part.*

= *Fine grained grey-white tuff, and coarse crystal lithic tuff with some quartz lithic sandstone interbeds.*
Medium grained, grey quartz lithic sandstone.
= *Hard, siliceous grey felspathic quartz sandstone, mainly fine grained, some medium grained lenses. Laminated. Laminations contorted, ?slumped in places.*
Coarse crystal tuff, containing limestone nodules.

⊏ , = *Medium bedded, laminated in places, hard grey fine quartz lithic sandstone with silty laminations in places.*
No outcrop.

Mainly quartz lithic sandstone, fine to medium grained, poorly exposed. Contains interbed of dark crystal tuff.

Brown-grey siltstone containing dark siltstone clasts, and lenses of crystal tuff. Some interbedded quartz lithic sandstone.

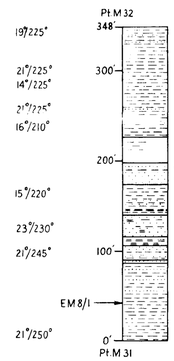
⊏ *Fine to medium grained, hard felspathic quartz lithic sandstone.*

⊏ to ▭ *Siltstone, hard, dark blue to grey, closely jointed, laminated in places. Contains discoidal mudstone pellets and ferruginous concretions.*

SECTION EM8

MIDDLE BOWEN BEDS

In Leura Creek, at Duaringa - Apis Creek Road crossing.
Base 250 yds. east of road. Pt M31, Duaringa 2/5030, Glossy.
Finish 200 yds. west of road. Pt M32, Duaringa 2/5030, Glossy.



= to ⊂ *"Shale-clast" siltstone, grey-buff, tough and resistant, with thin interbeds of softer siltstone and medium interbeds of hard, grey quartz lithic sandstone.*

No outcrop. Some siltstone rubble.

⊂ to = *Buff, cross bedded, fine to medium grained, medium hard quartz lithic*
⊂ to ▭ *sandstone, micaceous and silty and with siltstone interbeds near top.*

= to ⊂ *"Shale-clast" siltstone, as below with some interbeds of quartz lithic sandstone and of very cleaved siltstone and claystone.*

= *Hard, buff, fine-medium quartz lithic sandstone, quartz veined in places, with thin interbeds of buff siltstone and claystone.*

= *Light brown, closely cleaved claystone.*

= ▭ to ⊂ *Grey-brown sandy siltstone overlain by "shale clast" siltstone, as below, overlain by quartz lithic sandstone.*
Hard, medium grained, grey-buff quartz lithic sandstone.

= to ⊂ *Fawn-grey coarse siltstone with clasts, pellets and wisps of dark shale, micaceous in part and with some interlacing worm tracks on bedding surfaces. Thin to medium interbeds of dark grey, fine siltstone weathering more readily than the coarse siltstone. Some 6" to 9" thick grey lithic quartz sandstone interbeds near top.*

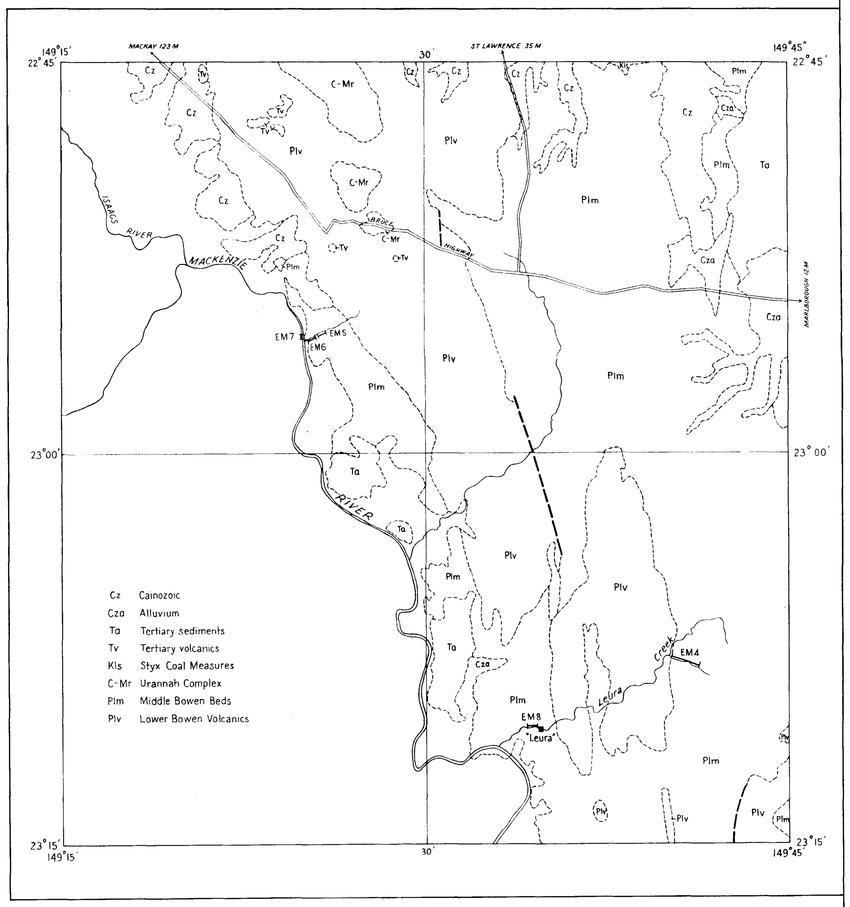
BEDDING

- ⊏▭ *Massive bedded*
- ▭ *Thick bedded - 12" to 40"*
- ⊂ *Medium bedded - 4" to 12"*
- ⊆ *Thin bedded - 0·4" to 4"*
- = *Laminated*

LOCALITY MAP

SCALE 1:250,000

5 0 5 10 MILES



INDEX TO 1:250,000 SHEETS

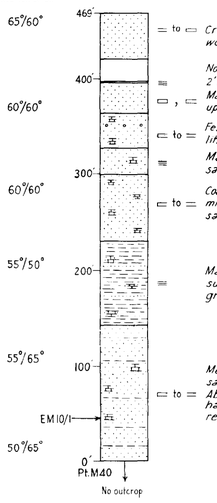
CHARTERS TOWERS	BOWEN	PROSERPINE	
BUCHANAN	MT COOLON	MACKAY	PERCY ISLES
GALILEE	CLERMONT	ST LAWRENCE	PORT CLINTON
JERICHO	EMERALD	DUARINGA	ROCKHAMPTON
TAMBO	SPRINGSURE	BARALABA	MONTO

MEASURED SECTIONS — BUNDALEER HOMESTEAD AREA

SECTION EM 10

UPPER BOWEN COAL MEASURES

Along south bank of Mackenzie River, about 1½ miles upstream from Dingo to Junee Homestead road bridge.
Base: Pt. M.40, Duaringa 2/5022, Glossy. Top: 220 yds. N.E. of Pt. M40.
Base is above gap in outcrop. Top is near trough of syncline.
Dip direction is reversed further to north east.



Cross-bedded, medium grained, medium hard lithic sandstone, with some fossil wood. Considerable quartz veining. Very jointed and some poorly developed cleavage.

No outcrop.

2' thick layer of interlaminated hard, dark siltstone and fine lithic sandstone.

Mainly thick lenses of coarse lithic sandstone with pebbles up to 1" across, passing into medium grained sandstone.

Festoon bedded, medium grained semi-friable blue-grey lithic sandstone with calcareous lithic sandstone lenses. Some very coarse to pebbly lithic sandstone lenses with abundant fossil wood in upper part.

Mainly interlaminated fine grey and dark blue lithic sandstone; some coarse sandstone near base.

Coarse grained to pebbly in places, grey-brown, cross and festoon bedded micaceous lithic sandstone with lenses of hard, fine to course calcareous lithic sandstone and some 2" to 4" thick beds of hard fine grey-blue lithic sandstone.

Mainly interlaminated grey-brown and dark, hard siltstone with sub-conchoidal fracture. Some interbeds of medium grained, semi-friable grey lithic sandstone and lenses of hard, fine calcareous lithic sandstone.

Medium grained, semi-friable, cross and festoon bedded, grey-brown micaceous lithic sandstone with hard calcareous lithic sandstone lenses, up to 20' long by 2' to 5' thick.

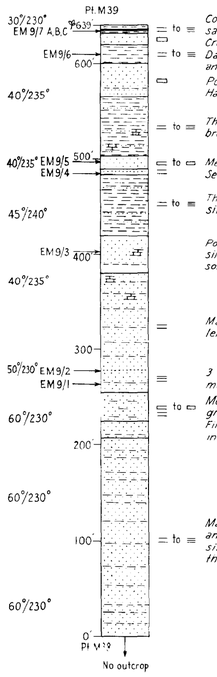
Abundant fossil wood in some horizons. Some thin to 6" thick beds and lenses of hard interlaminated brown and dark siltstone, ferruginous in part; and showing rectangular concentric layering in some lenses. Poor outcrop in part.

Section EM 10 is above Section EM 9. The gap between the two is unknown, but is probably less than 500'.

SECTION EM 9

UPPER BOWEN COAL MEASURES

Along south bank of Mackenzie River, about 1 mile upstream from Dingo to Junee Homestead Road Bridge.
Bottom: Pt. M.38, Duaringa 2/5022, Glossy. Top: Pt. M.39, Duaringa 2/5022, Glossy.



Coal and carbonaceous shale with thin interbeds of brown and grey fine lithic sandstone to siltstone and hard green-grey cherty siltstone with plant remains.

Cross-bedded lithic sandstone as at

Dark blue, tough siltstone, with sub-conchoidal fracture, laminated in part and interlaminated dark and grey-brown siltstone to fine lithic sandstone.

Poorly bedded, cross-bedded, fine, medium hard, grey-blue micaceous lithic sandstone with fossil wood. Hard, interlaminated dark and grey-brown siltstone to fine lithic sandstone near base.

Thin interbedded to interlaminated blue siltstone, dark carbonaceous siltstone and grey and brown fine to medium lithic sandstone. Some lenses of hard fine calcareous lithic sandstone.

Medium hard, somewhat case hardened, cross bedded quartz sandstone. Some lithic and felspar grains. Semi-friable, medium to coarse, micaceous quartz lithic sandstone.

Thinly interbedded to interlaminated blue siltstone, dark carbonaceous siltstone and grey and brown fine to medium lithic sandstone.

Poorly bedded, medium hard, blue-grey micaceous, fine to medium grained silty lithic sandstone with lenses of hard calcareous lithic sandstone and some interbeds of thinly interbedded fine sandstone and siltstone.

Mainly thin bedded sequence as at base. Some 1' to 2' thick lenses of hard, brown calcareous lithic sandstone.

3' thick bed of hard grey-blue lithic sandstone. Some beds and lenses of medium hard, blue-grey micaceous silty sandstone with worm tubes.

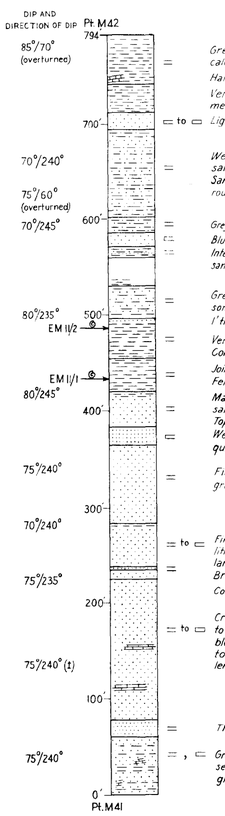
Medium hard, grey-blue micaceous silty sandstone with some lenses of grey-brown fine lithic sandstone. Some carbonised plant remains. Fine to medium grained, hard green-grey lithic sandstone with interbeds of thin bedded very fine sandstone and siltstone.

Mainly thin bedded, brown, silty micaceous lithic sandstone, fine grained with minor cross bedding and some dark carbonaceous laminae, interbedded with dark grey to black micaceous siltstone with brown ferruginous and black siltstone laminae and interlaminated to thinly interbedded, grey and dark, hard, very fine lithic sandstone to coarse siltstone.

SECTION EM 11

MIDDLE BOWEN BEDS

Along river-cut terrace, north bank of Mackenzie River, 1½ miles south-west of Bundaleer H.S.
Base: Pt. M.41 Duaringa 1/5112, Glossy. Top: Pt. M.42 Duaringa 1/5112, Glossy.



Grey blue siltstone, as below, but containing hard, round calcareous nodules, some of which contain fossils.

Hard calcareous lithic sandstone lens near base.

Very broken grey-blue siltstone with dark laminations and streaks. Mainly medium hard. Sandy and micaceous in part. Thin interbeds of hard sandy siltstone.

Light grey, medium to coarse grained, poorly sorted quartz felspathic-lithic sandstone

Well bedded siltstone and sandy siltstone with some thin beds of fine lithic sandstone. Mainly grey-brown with thin dark streaks and laminations. Micaceous. Sandier and less well bedded towards top. Thin layer containing medium-hard round nodules at top.

Grey-brown, very micaceous sandy siltstone with dark mudstone streaks, to ¼" long, along bedding.

Blue-grey, fine, hard felspathic quartz lithic sandstone.

Interbedded, brown and grey siltstone, sandy siltstone and beds and lenses of hard, fine lithic sandstone. Mainly no outcrop. Some tough yellow-grey siltstone with dark mudstone clasts near base.

Grey to grey-blue siltstone and sandy siltstone containing some thin hard beds of lithic sandstone.

1' thick bed, medium hard micaceous lithic sandstone with dark laminae.

Very closely jointed blue to grey-blue siltstone containing a few hard thin beds. Contains hard round nodules in upper 8'. Nodules are calcareous and may contain fossils.

Jointed and broken, light grey, brown and blue-grey, contain fossils. Felspathic micaceous siltstone. Fossiliferous.

Mainly medium hard to semi-friable, fine to coarse grained felspathic micaceous sandstone with abundant matrix and large mica flakes. Some quartz sandstone beds. Top part is poorly sorted, brown-grey silty sandstone with scattered coarse grains.

Well bedded, hard, medium to coarse grained, micaceous in part, quartz sandstone, grey-white, weathers brown. Some quartz veining.

Fine to medium grained, medium hard, cross bedded, grey micaceous quartz lithic sandstone.

Fine to medium grained, medium hard, cross bedded, grey to grey-brown micaceous quartz lithic sandstone. Grey, very micaceous sandy siltstone, with worm tracks and irregular laminations of dark mudstone in top 3'.

Brown micaceous fine sandstone, friable, weathers white.

Coarse grained, silty micaceous quartz lithic sandstone, medium hard to semi-friable. Bedding vague.

Cross and festoon bedded, grey, weathers grey-brown, medium hard to hard, medium to fine grained slightly micaceous quartz lithic sandstone. Exfoliates into rounded blocks on weathering in places. Mainly medium to thick beds but some interbeds, to 4' thick, of thin bedded sandstone. Thick hard brown calcareous lithic sandstone lenses. Sandstone is medium to coarse grained in upper 15 feet.

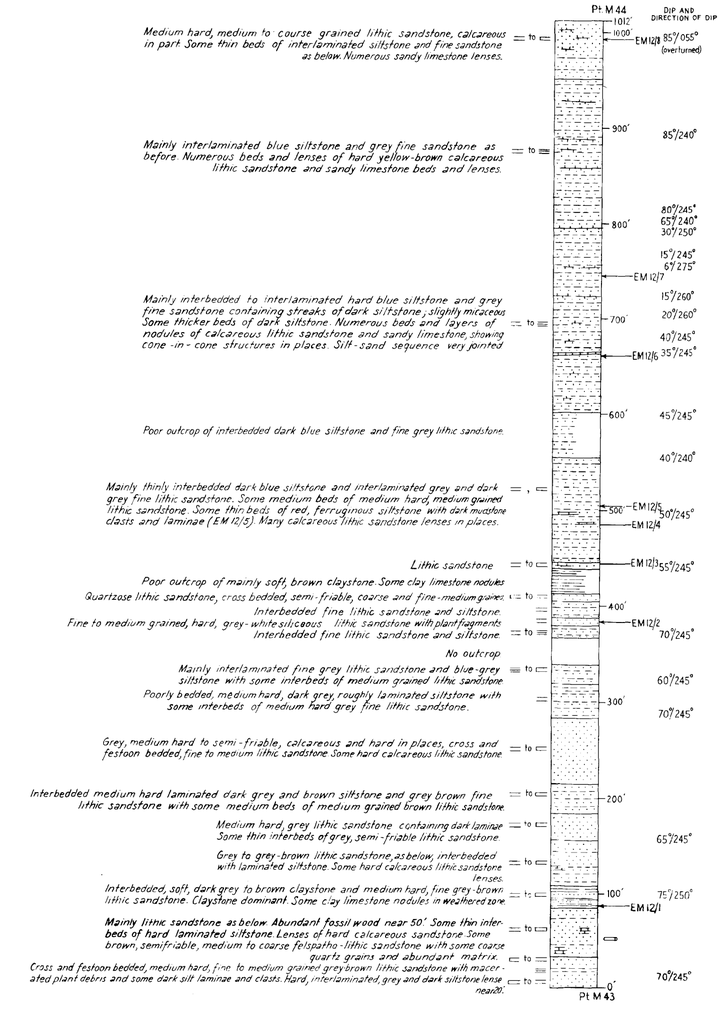
Thinly interbedded grey and brown fine lithic sandstone.

Grey micaceous coarse siltstone to silty fine lithic sandstone, medium hard to semi-friable, with worm tubes in places. Bedding vague. Some medium beds of medium hard, grey fine lithic sandstone and lenses of hard calcareous fine lithic sandstone. Sandy at top.

SECTION EM 12

UPPER BOWEN COAL MEASURES

North Bank of Mackenzie River, 1½ miles east of Oaky Creek
Base: Pt. M.43 Duaringa, Run 2, Photo 5022, Glossy



Medium hard, medium to course grained lithic sandstone, calcareous in part. Some thin beds of interlaminated siltstone and fine sandstone as below. Numerous sandy limestone lenses.

Mainly interlaminated blue siltstone and grey fine sandstone as before. Numerous beds and lenses of hard yellow-brown calcareous lithic sandstone and sandy limestone beds and lenses.

Mainly interbedded to interlaminated hard blue siltstone and grey fine sandstone containing streaks of dark siltstone, slightly micaceous. Some thicker beds of dark siltstone. Numerous beds and layers of nodules of calcareous lithic sandstone and sandy limestone, showing cone-in-cone structures in places. Silt-sand sequence very jointed

Poor outcrop of interbedded dark blue siltstone and fine grey lithic sandstone.

Mainly thinly interbedded dark blue siltstone and interlaminated grey and dark grey fine lithic sandstone. Some medium beds of medium hard, medium grained lithic sandstone. Some thin beds of red, ferruginous siltstone with dark mudstone clasts and laminae (EM 12/5). Many calcareous lithic sandstone lenses in places.

Lithic sandstone

Poor outcrop of mainly soft, brown claystone. Some clay limestone nodules

Quartzose lithic sandstone, cross bedded, semi-friable, coarse and fine-medium grained

Interbedded fine lithic sandstone and siltstone.

Fine to medium grained, hard, grey-white siliceous lithic sandstone with plant fragments

Interbedded fine lithic sandstone and siltstone.

No outcrop

Mainly interlaminated fine grey lithic sandstone and blue-grey siltstone with some interbeds of medium grained lithic sandstone

Poorly bedded, medium hard, dark grey, roughly laminated siltstone with some interbeds of medium hard grey fine lithic sandstone.

Grey, medium hard to semi-friable, calcareous and hard in places, cross and festoon bedded, fine to medium lithic sandstone. Some hard calcareous lithic sandstone

Interbedded medium hard laminated dark grey and brown siltstone and grey brown fine lithic sandstone with some medium beds of medium grained brown lithic sandstone.

Medium hard, grey lithic sandstone containing dark laminae. Some thin interbeds of grey, semi-friable lithic sandstone.

Grey to grey-brown lithic sandstone, as below, interbedded with laminated siltstone. Some hard calcareous lithic sandstone lenses.

Interbedded, soft, dark grey to brown claystone and medium hard, fine grey-brown lithic sandstone. Claystone dominant. Some clay limestone nodules in weathered zone

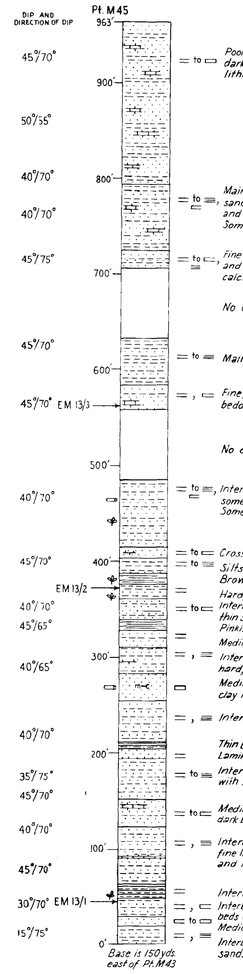
Mainly lithic sandstone as below. Abundant fossil wood near 50'. Some thin interbeds of hard laminated siltstone. Lenses of hard calcareous sandstone. Some brown, semi-friable, medium to coarse felspathic-lithic sandstone with some coarse quartz grains and abundant matrix.

Cross and festoon bedded, medium hard, fine to medium grained grey-brown lithic sandstone with macerated plant debris and some dark silt laminae and clasts. Hard, interlaminated, grey and dark siltstone lense nearby.

SECTION EM 13

UPPER BOWEN COAL MEASURES

North bank of Mackenzie River, about 1½ miles east of Oaky Creek
Base is 150 yds. east of Pt. M.43. Top is Pt. M.45.
Duaringa, Run 2, Photo 5022, Glossy.



Poorly bedded and poorly exposed in part, fine lithic sandstone, grey-brown with dark siltstone laminations. Some siltstone interbeds. Many cross-bedded calcareous lithic sandstone lenses. Plant fragments in fine sandstone in places.

Mainly interbedded to interlaminated, grey and dark grey siltstone to fine lithic sandstone. Some medium beds of medium grained lithic sandstone with silt laminae and with calcite veining and some dog-tooth quartz veining on joint surfaces. Some calcareous lithic sandstone lenses and bands of limestone nodules.

Fine to medium, hard, grey-brown lithic sandstone with some dark silt laminae and some thin beds of interbedded siltstone and fine sandstone. Some hard calcareous lithic sandstone lenses, to 3' thick by about 10' across.

No outcrop.

Mainly blue siltstone with many thin beds and laminae of fine lithic sandstone.

Fine, micaceous grey lithic sandstone, semi-friable and thin bedded or hard and medium bedded, containing dark siltstone laminae. Some discoidal to nodular sandy limestone layers.

No outcrop.

Interbedded to interlaminated, grey and dark grey siltstone to fine lithic sandstone with some medium beds of hard dark siliceous siltstone, commonly containing abundant plants. Some medium beds, calcareous in part, of fine to medium sandstone. Abundant fossil wood in places.

Cross-bedded, medium hard, medium to coarse grained feldspathic-lithic sandstone. Some calcareous lenses.

Siltstone with minor fine sandstone interbeds. Brown claystone with clay limestone nodules. Contains plants

Hard, blue siltstone with some interbeds of fine lithic sandstone. Some plant remains

Interbedded medium and fine lithic sandstone with some thin siltstone interbeds. Calcareous sandstone discoids common in some layers. Pinkish-brown claystone with clay limestone nodules.

Medium hard, medium lithic sandstone, with some dark silt laminae and thin interbeds of dark siltstone.

Interbedded siltstone and fine sandstone, as below. Some medium beds of hard, blue siltstone. Some layers of calcareous sandstone discoids.

Medium to coarse, cross-bedded sandstone with many thin pebble layers, pebbles to 1" across, and scattered clay nodules. Fossil wood common. Siltstone partings on cross beds in places.

Interbedded grey and dark grey fine lithic sandstone and siltstone.

Thin bed of brown claystone with clay limestone nodules. Laminated grey and dark grey medium to fine lithic sandstone.

Interbedded to interlaminated blue siltstone and grey fine sandstone, with some medium beds of fine to medium sandstone.

Medium grained, medium hard, cross-bedded grey lithic sandstone, feldspathic in part with some hard, dark blue siltstone interbeds and laminations. Some calcareous lithic sandstone to sandy limestone lenses.

Interbedded to interlaminated grey and dark grey siltstone and fine lithic sandstone. Some beds of medium to coarse sand, and rare beds and lenses of yellow-brown sandy limestone and calcareous sandstone.

Interbedded brown and grey claystone and siltstone. Some cellular clay limestone nodules along bedding, possibly a weathering effect.

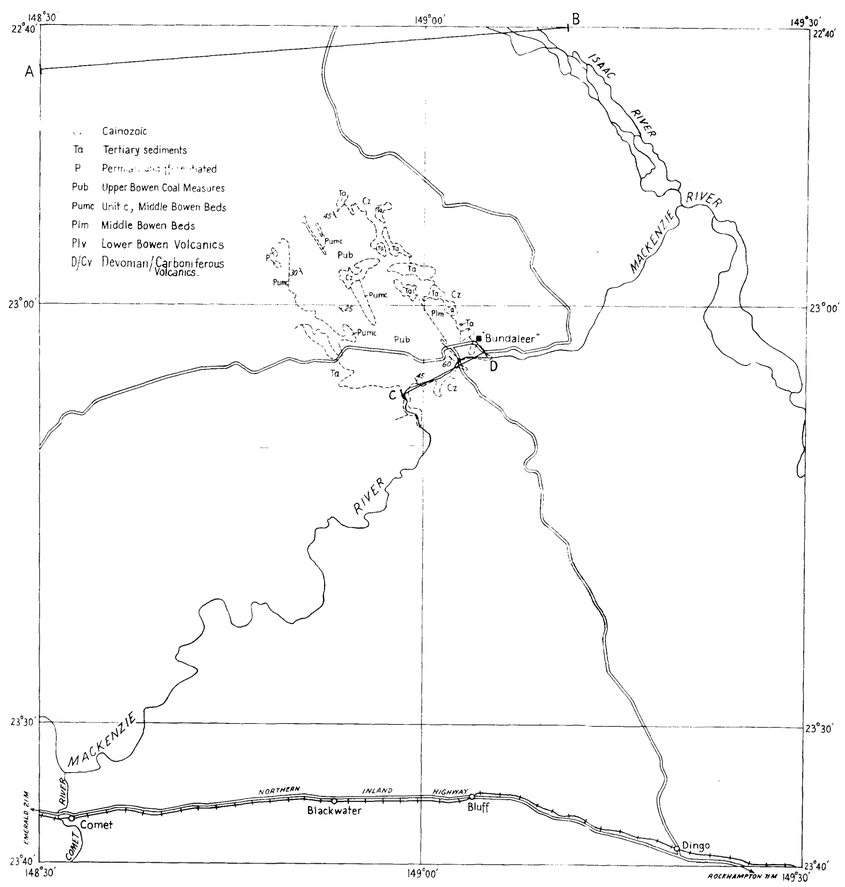
Interbedded hard dark blue siltstone and fine lithic sandstone. Some medium beds of med.-coarse sandstone. Some green siliceous siltstone beds with abundant plants. Medium to coarse, medium hard grey felspathic-lithic sandstone, cross-bedded and calcareous in places.

Interbedded to interlaminated grey and dark blue, medium hard, siltstone to fine lithic sandstone. Some calcareous lithic sandstone lenses.

LOCALITY MAP

SCALE 1:500,000

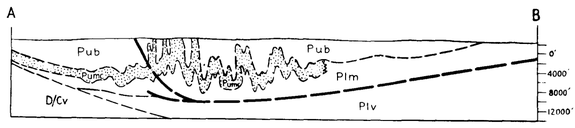
10 0 10 20 MILES



INDEX TO 1:250,000 SHEETS

CHARTERS TOWERS	BOWEN	PROSERPINE	
BUCHANAN	MT. COOLON	MACKAY	PERCY ISLES
GALILEE	CLERMONT	ST. LAWRENCE	PORT CLINTON
JERICHO	EMERALD	DUARINGA	ROCKHAMPTON
TAMBO	SPRINGSURE	BARALABA	MONTO

CROSS SECTION — FOLDED ZONE

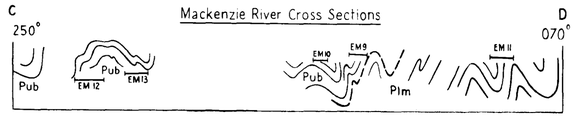


V/H = 2

Folding partly diagrammatic

SCALE 0 8 16 MILES

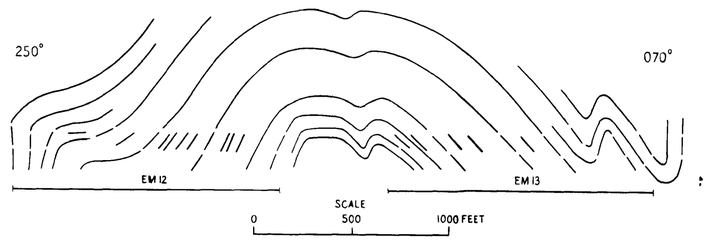
Mackenzie River Cross Sections



V/H = 1

Folding partly diagrammatic

SCALE 0 1 2 3 4 MILES



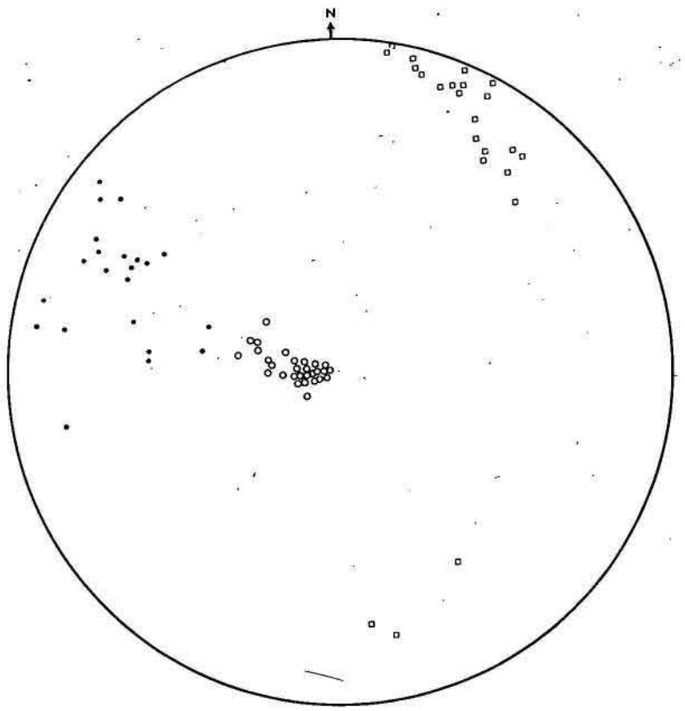
SCALE 0 500 1000 FEET

BEDDING

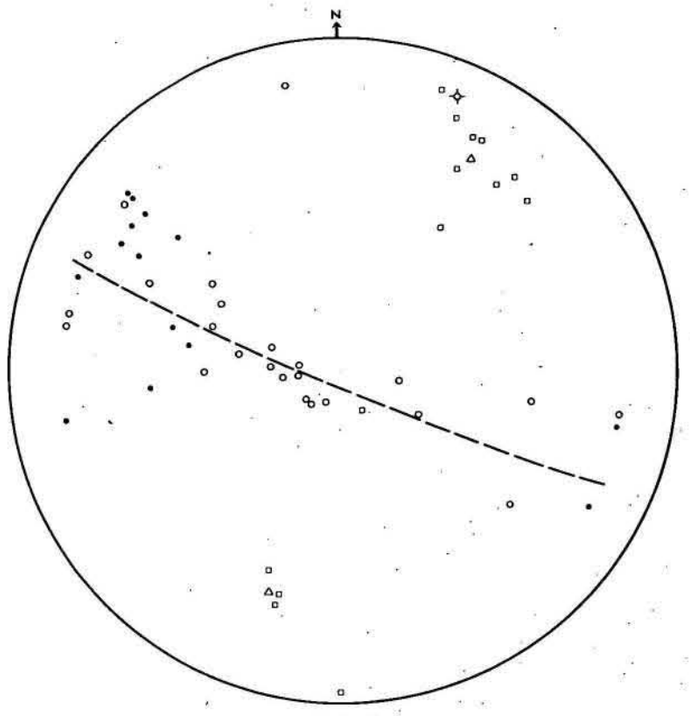
- Thick bedded - 12" to 40"
- Medium bedded - 4" to 12"
- Thin bedded - 0·4" to 4"
- Laminated

Bureau of Mineral Resources, Geology and Geophysics, Canberra, June 1964 To accompany Record No. 1964/108 F 55/17

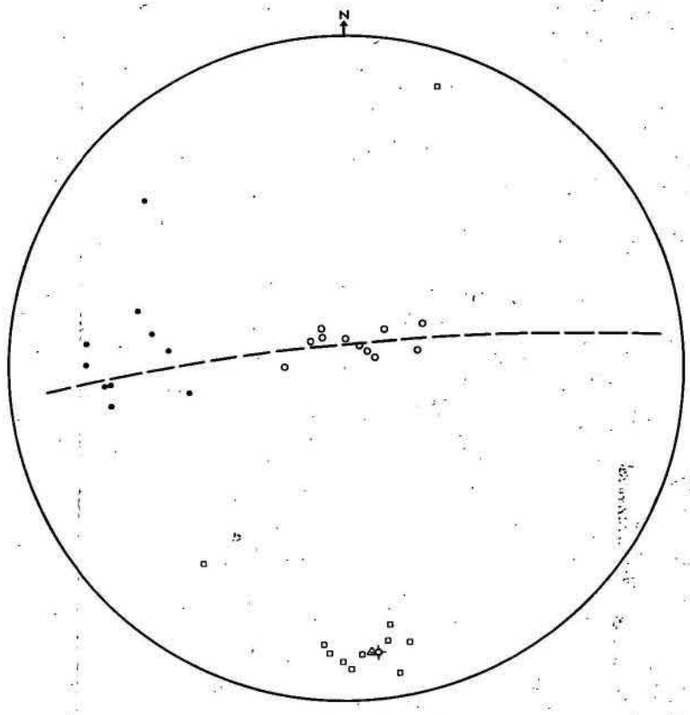
STEREOGRAPHIC PROJECTIONS OF BEDDING, CLEAVAGE AND LINEATION MEASUREMENTS



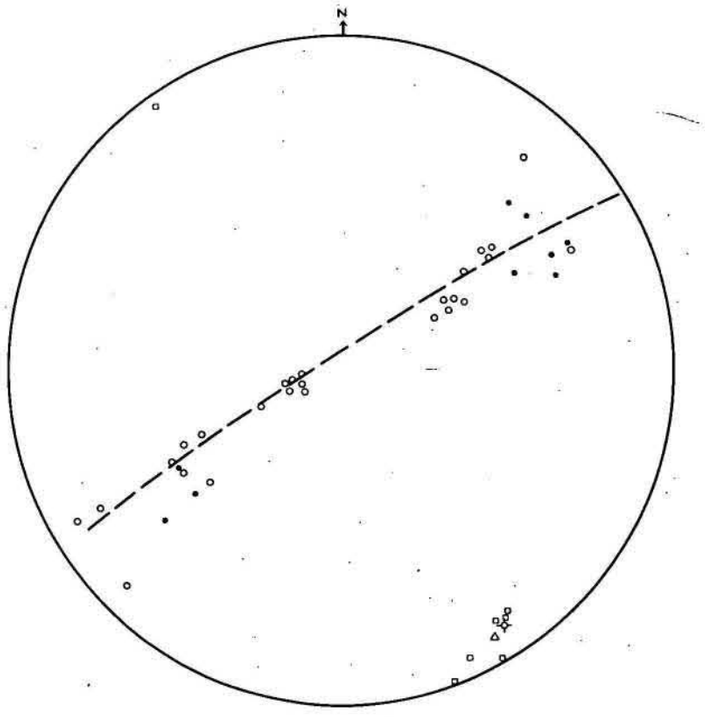
S.P. 1



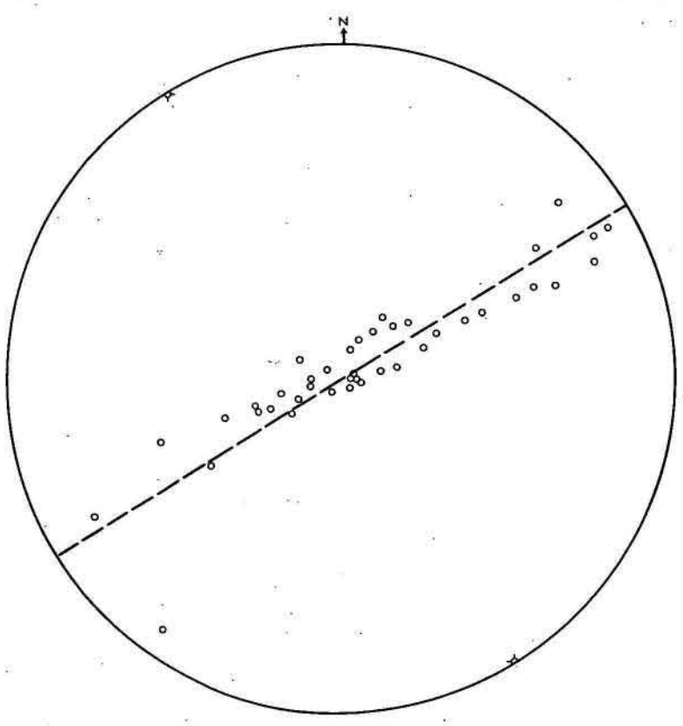
S.P. 2



S.P. 3



S.P. 4



S.P. 5

REFERENCE

- Bedding pole (Ss)
- Cleavage pole (S1)
- Lineation (S1/Ss)
- TT Circle
- TT pole = approximate fold axis direction
- Approximate fold axis direction as indicated by lineations

Projections based on 20cm. "Wulff" stereographic nets.

Bureau of Mineral Resources, Geology and Geophysics. June 1964

To accompany Record 1964/108

F55/27