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PRECAMBRIAN GEOLOGY OF THE MOUNT ANGELAY 1:100 000 SHEET AREA (7055), NORTHWESTERN QUEENSLAND - PRELIMINARY DATA

by

P.J.T. Donchak, D.H. Blake and A.L. Jaques

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## ABSTRACT

The Precambrian rocks of the Mount Angelay Sheet area belong to the Cloncurry Complex of the Mount Isa Inlier. They have been multiply deformed, and steep dips and northerly trends predominate.

The oldest unit is probably the Soldiers Cap Group, consisting of schist, meta-arenite, gneiss, pegmatitic segregations, and amphibolite. The three subdivisions of this group - the Llewellyn Creek Formation, Mount Norna Quartzite, and Toole Creek Volcanics - have been separately mapped out only in the far north. The group has been regionally metamorphosed to amphibolite grade, and deformed by at least three generations of folding. It appears to be partly faulted against and partly conformable with the Corella Formation, which consists of bedded and brecciated calc-silicate rocks, calcarenite (in the northwest), and minor black shale and pelitic schist. Most Corella Formation rocks have been regionally metamorphosed to amphibolite grade, and deformed by at least two generations of folding. However, in the northwest, Corella Formation calcarenites and breccias are of lower grade, probably greenschist facies; these rocks are conformably overlain by feldspathic arenite and quartz arenite of the Roxmere Quartzite, and also probably by black slates of the Marimo Slate.

In the southwest, amphibolite-grade pelitic schist, metagreywacke, and black slate of the Kuridala Formation occur partly faulted against and partly conformably overlain? by the Corella Formation. These rocks have been deformed by two, possibly three, generations of folding. A major structural feature is an elongate basin, formed by refolding of the first generation schistosity, along the western margin of the Sheet area.

Coarse to medium-grained, porphyritic to even-grained plutons of Williams Granite intrude all Precambrian formations except the Roxmere Quartzite and Marimo Slate. Metadolerite and dolerite bodies intrude all Precambrian units except the Roxmere Quartzite.

Flat-lying Mesozoic conglomerate and sandstone of the Gilbert River Formation form mesa cappings overlying Precambrian rocks.

Copper has been produced from a few small disused mines and from the major abandoned workings at Kuridala (the Hampden group of mines). The ore bodies appear to be localised along shears in black shale within the

Kuridala and Corella Formations. Low-grade lead, copper, and zinc mineralisation is associated with banded ironstone in the Soldiers Cap Group.

INTRODUCTION

## Location

The Mount Angelay 1:100 000 Sheet area covers about 3 000 $km^2$ in northwest Queensland. It occupies the northeast corner of the Duchess 1:250 000 Sheet area (SF54-6) and is bounded by latitudes $21^\circ$ and $21^\circ30'$S and longitudes $140^\circ30'$ and $141^\circ$E.

## Access

Access to the western side of the Sheet area is through the abandoned township of Kuridala (just west of GR 482455), which is linked by an unsealed road to the township of Malbon in the Malbon Sheet area. This road continues north to the Barkly Highway and south, through the abandoned townsite of Selwyn, to the Hamilton River and the Boulia-Winton roads. From Kuridala, four-wheel-drive tracks lead north towards Cloncurry, or east towards Doherty Waterhole (GR 603531) and then north to Cloncurry via Snake Creek (GR 643780) or Soldiers Cap (at about GR 726780).

In the northeast a vehicle track leaves the Landsborough Highway near Maronon homestead (GR 920708) and continues south to Glen Idol outstation (GR 800475) and then southeast to Percol Plains homestead, 9 km east of the Sheet area boundary. This track and its associated offshoots, which service bores and fences, allows access to the eastern part of the Sheet area.

East-west access across the Sheet area is either via a little-used track linking the Doherty Waterhole-Snake Creek track with the Maronan-Glen Idol track, or via a track in the south linking Mount Tracey homestead (GR 558332) in the west with Boorama Waterhole (GR 817316) in the east. This track is maintained in a reasonable condition except for a few kilometres west from near Boorama Waterhole, where four-wheel-drive access is difficult in places.

All roads and tracks in the Sheet area may become impassable after heavy rain.

## Population and industry

In 1978 and 1979 a few people were involved in a small-scale copper leaching operation at the Hampden group of mines on the western boundary of the Sheet area. The only permanent habitations are the homesteads at Maronon in the east and Mount Tracey in the southwest. Cattle raising is the main industry. Some sheep are raised in the southeast.

## Climate

The area has a semi-arid tropical climate (Slatyer, 1964), characterised by a long, dry 'winter' season, and a short wet 'summer' season. The annual average rainfall is about 375 mm, most of which falls between November and March. During 'winter', days are warm and sunny and nights are cold to cool; 'summer' days and nights are hot. At Cloncurry, 32 kilometres north of the Sheet area boundary, average daily minimum and maximum temperatures range from 10 and 24°C respectively during the coolest month, July, to 24 and 38°C respectively during November, December, and January. Relative humidity is generally low, mainly between 15 and 50 percent. The climate is discussed in greater detail by Carter, Brooks, & Walker (1961) and Slatyer (1964).

## Topography and Drainage

Flat rolling plains occupy the eastern part of the Sheet area. Rugged terrain to the west forms part of the Isa Highlands of Twidale (1964, 1966). The central and northern parts of the Sheet area are the most rugged, and consist of ridges and hills, generally less than 100 m high, and some small plateau areas and mesas. Gently undulating country in the southwest, drained by the Cloncurry River, passes south and east into deeply dissected mesa country occupying the southern-central part of the Sheet area.

The central part of the Sheet area forms part of the Selwyn Range, which separates the Fullarton River drainage system in the east from the Cloncurry River drainage system in the west; both systems drain into the Gulf of Carpentaria. There is a general absence of permanent

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surface water, except for a few small waterholes. Water-bores are scattered throughout the more accessible parts of the Sheet area.

## Vegetation

The rocky highlands in the west support a vegetation of spinifex and scattered low trees, mainly eucalypts and shrubs. Dense 'turpentine' bush (Acacia lysiphloia) covers a strip of hilly country from Glen Eva (GR 488563) north to the Sheet area boundary. The flood plain of the Cloncurry River and to a lesser extent the undulating country south of Kuridala support a cover of Mitchell and Flinders grasses, and spinifex. The eastern plains are dominated by low spinifex in the west, giving way eastwards to Mitchell grass and Flinders grass. Medium to large gum trees are abundant along watercourses. For further details on the vegetation see Carter & others (1961) and Perry & Lazarides (1964).

## Previous geological literature

The geology of this area was included in the account of the Precambrian Mount Isa Inlier by Carter & others (1961), which resulted from broad reconnaissance mapping during the 1950s. Carter & Öpik (1963) compiled the explanatory notes for the Duchess 1:250 000 Sheet area, which includes the Mount Angelay 1:100 000 Sheet area. White (1957) mapped and described rocks of the Kuridala and Staveley (= Corella in this report) Formations in the southwest. Noon (1976) has described mineral exploration in the Sheet area up to February 1976. Many of the units on the Mount Angelay Sheet continue north into the Cloncurry 1:100 000 Sheet area (Glikson & Derrick, 1970), west into the Malbon 1:100 000 Sheet area (Noon, 1978, 1979), and south into the Selwyn region (Blake, Jaques, & Donchak, 1979).

## Present investigations

During the 1978 field season and a short period in 1979, the Precambrian rocks of the Sheet area were mapped by P.J.T. Donchak (GSQ), D.H. Blake (BMR), and A.L. Jaques (BMR), using 1:25 000-scale colour aerial photographs taken in 1972. The adjoining 1:100 000 Sheet areas to the south and southwest (Selwyn and Mount Merlin respectively) were mapped mainly by Blake and Jaques during the same period (Blake & others, 1979). Field data were recorded on transparent photo-overlays by the geologists and were transferred onto photo-scale compilation sheets by G.A. Young (BMR draftswoman) in the field. These sheets were subsequently checked, corrected, reduced to 1:100 000 scale, and redrawn as the Preliminary Edition 1:100 000 map sheet. This Record was prepared from field data and some follow-up petrological studies.

## Terminology

In this work, sandstones are classified according to Pettijohn, Potter, & Siever (1972); grainsizes used are as follows: fine, 0.125 to 0.25 mm; medium, 0.25 to 0.5 mm; coarse 0.5 to 1 mm. Bedding thickness terms follow the usage of McKee & Weir (1953) as follows: thinly laminated, $<$ 2 mm; laminated, 2 mm to 1 cm; very thin-bedded, 1 to 5 cm; thin-bedded 5-60 cm; thick-bedded, 60-120 cm; very thick-bedded, $>$ 120 cm.

Metamorphic facies terminology follows the usage of Winkler (1974). The term 'granofels', as suggested by Goldsmith (1959), is used for medium to coarse-grained, non-foliated metamorphic rocks. The term 'quartzite' refers to a metamorphic rock containing at least 90 percent quartz, generally formed by recrystallisation of quartz arenite.

The term 'concordant' refers to parallelism of lithological contacts where a hiatus cannot be recognised but may exist (Gary & others, 1972). 'Transposed' bedding refers to a bed or sequence of beds which has been tectonically deformed and reorientated such that present banding no longer reflects the original sedimentary sequence (Hobbs, Means & Williams, 1976).

The term 'massive' applies to a rock with no visible internal features, including bedding.

## OUTLINE OF GEOLOGY

The oldest unit of the Precambrian sequence exposed in the area is assumed to be the Soldiers Cap Group. This unit consists of mica schist, gneiss, meta-arenite, quartzite, banded ironstone, metabasalt, ortho-amphibolite, and calc-silicate rocks. Garnet porphyroblasts are common, and porphyroblasts of sillimanite, andalusite, and staurolite are abundant locally. To the west of the Soldiers Cap Group are amphibolite-grade bedded and brecciated calc-silicate rocks of the Corella Formation, mainly units symbolised as Bkc and $Bkc_{br}$. The Corella Formation immediately adjacent to Soldiers Cap rocks invariably consists of calc-silicate breccia. Complex faulting along the line of the Cloncurry Fault obscures the relation between the two units. In the contact area, however, interlayered calc-silicate rocks and Soldiers Cap-type schists occur at a few localities where no faulting is apparent, indicating a possible conformable to inter-fingering relation. Both the Soldiers Cap Group and adjacent rocks of the Corella Formation have been regionally metamorphosed to amphibolite grade; up to three generations of folding are evident; and steep dips and northerly trends predominate.

In the northwest, fine-grained calcareous granofels, calcareous and feldspathic arenites, and variably calcareous breccias, provisionally mapped as part of the Corella Formation, are symbolised as $Bkc_x$ and $Bkc_{xbr}$. These rocks are in part faulted against and in part conformable with slate and minor arenite and limestone of the Marimo Slate to the west and north. Facing in cross-bedded sandstone forming the Mick Creek Sandstone Member of the Marimo Slate, on the northern boundary of the Sheet area, indicates that this Member overlies the $Bkc_x$ rocks to the south. The $Bkc_x$ rocks are separated from other Corella rocks to the east by the northeast-trending Big Mick and Martin Creek Faults. In the far northwest $Bkc_x$ rocks appear to be conformably overlain by cross-bedded and ripple-marked feldspathic meta-arenite mapped as Roxmere Quartzite.

To the south, the northwest-trending Straight Eight Fault separates mica schist, meta-arkose, metagreywacke, and slate of the Kuridala Formation from the Corella Formation to the east. The Kuridala Formation is commonly garnetiferous, and staurolite and andalusite porphyroblasts are locally abundant. It forms a narrow structural basin, outlined by metadolerite sills, centred on the township of Kuridala. Five kilometres north of Kuridala, just within the Sheet area, the Kuridala Formation appears to be conformable with the Corella Formation. In the Selwyn area to the south, possible equivalents of unit $Bkc_x$ of the Corella Formation, mapped as a unit of the Staveley Formation by Blake & others (1979), appear to overlie the Kuridala Formation.

Various bodies of Williams Granite intrude the Corella and Kuridala Formations and the Soldiers Cap Group. A large (30-km wide) pluton of this granite occupies the southern part of the Sheet area, and smaller bodies occur to the north. Fine-grained and mainly leucocratic unnamed granite forms smaller bodies, localised along the Cloncurry Fault, intruding Corella and Soldiers Cap rocks. The Kuridala and Corella Formations, the Soldiers Cap Group, and the Marimo Slate are intruded by basic dykes and sills of several ages, the youngest intrusions being post-tectonic east-trending dolerite dykes which also cut the Williams Granite.

The Precambrian rocks are unconformably overlain by flat-lying conglomerate, sandstone, and grit of the Mesozoic Gilbert River Formation.

## DESCRIPTIVE NOTES ON PRECAMBRIAN STRATIGRAPHIC UNITS

### SOLDIERS CAP GROUP

Map symbols. Bo, $Bo_d$, $Bo_c$, $Bo_{ch}$ (undivided Soldiers Cap Group); Bol, $Bol_d$ (Llewellyn Creek Formation ); Bon, $Bon_d$, $Bon_q$ (Mount Norna Quartzite); Bot, $Bot_d$ (Toole Creek Volcanics).

Nomenclature. Named Soldiers Cap Formation by Carter & others (1961); upgraded to Soldiers Cap Group by Derrick, Wilson, & Hill (1976), who distinguished three formations - Llewellyn Creek Formation (Bol), Mount Norna Quartzite (Bon) and Toole Creek Volcanics (Bot).

Distribution. Crops out as north-northwest-trending belt up to 32 km wide.

Thickness. Uncertain owing to tight folding, but probably in excess of 7500 m. Llewellyn Creek Formation is about 3000 m thick; Mount Norna Quartzite is about 2000 m thick, and Toole Creek Volcanics is about 2500 m thick.

Airphoto characteristics. Forms low, brown to buff strike ridges; more subdued than adjacent Corella Formation.

## Undivided Soldiers Cap Group

Lithology. Petrographic data are summarised in Table 2.

Unit Bo: interlayered schist and gneiss, meta-arenite, pegmatite segregations, banded iron formation; minor metarhyolite.

Schist: brown to grey, medium to coarse-grained; consists of feldspar (sodic plagioclase ± microcline) + quartz + muscovite ± biotite; ranges from almost pure muscovite schist to almost pure biotite schist; retrogressive chlorite-muscovite schist interfingers with Corella Formation calc-silicate rocks in southeast; graphitic cordierite-quartz-feldspar-muscovite-apatite schist occurs at GR 849418, 4 km northwest of Gidya Tank; cordierite is also recorded at several other localities. Porphyroblasts of muscovite (pseudomorphs?) and garnet, and fibrolitic sillimanite occur locally and antedate the second-generation crenulation foliation. First-generation foliation is defined by a strong alignment of micas parallel to primary banding (= bedding) except in rarely observed first-generation fold hinges.

Gneiss: light, even to uneven-grained, medium to fine grained, banded; generally consists of feldspar + quartz + muscovite ± biotite; porphyroblasts rare; gneissic banding ranges from well-defined laminations to vaguely defined mica-poor bands up to 30 cm thick interfingering with mica-rich layers up to 3 cm thick; banding generally parallels first-generation foliation. Some gneiss may represent metamorphosed greywacke. In many places, especially in south, some gneiss is migmatitic, and contains segregations, veins, and boudins of pegmatitic to aplitic leucogranite typically consisting of alkali feldspar, quartz, muscovite, and/or tourmaline. Subconcordant pegmatite dykes up to 2 m thick commonly crop out as resistant ridges or 'walls' up to 2 m high (e.g., at GR 695665). Migmatitic bands commonly exhibit irregular first-generation minor folds. A pegmatite dyke 30 cm wide at GR 659712 is isoclinally folded about a ?second-generation axial plane.

Meta-arenite: buff to grey; medium and even-grained; thick-bedded to massive; occurs in sequences tens of metres thick; foliated and generally highly micaceous, with muscovite and/or biotite oriented parallel to the first generation foliation. Elongate feldspar-sillimanite aggregates about 2 cm long are common in a few places, aligned parallel to the

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dominant foliation, and may represent either porphyroblasts or small pebbles. Some feldspathic meta-arenite and quartzite beds up to 2 m thick can be traced for several hundred metres. Meta-arenites commonly consist of plagioclase + quartz ± microcline ± porphyroblastic garnet ± biotite ± muscovite ± minor chlorite; small amounts of calcite and clinopyroxene occur in subordinate calcareous meta-arenite (e.g., at GR 833465); quartz content of meta-arenites is generally less than 20%, but some true quartzites do occur. Traces of remnant sedimentary structures are locally visible in exposures in far north.

Banded iron formation: tight to isoclinally folded beds averaging about 1 m thick and continuous for distances of up to 1 km; black to dark brown; thin-banded to laminated; fine to medium-grained; consists of feldspar + quartz + hematite + magnetite ± gahnite ± apatite; host to low-grade lead, zinc, and copper mineralisation; may define a marker unit extending from Fairmile Prospect (GR 840518), near Glen Idol, southwards to Dingo Prospect (GR 907240) and into Selwyn Sheet area.

Metarhyolite: crops out in small area between Foxes Creek and the Williams River, near GR 720633; associated with amphibolite, feldspathic quartzite, and meta-arenite; intruded by medium to fine, locally porphyritic, granitic rocks mapped as Williams Granite (pink biotite granite, grey granodiorite and diorite, minor hornblende granite), and also by pegmatite and aplite veins and by a non-metamorphosed easterly trending dolerite dyke. Metarhyolite is pale grey to buff or pinkish, fine to very fine-grained (cherty), streakily banded, gneissic or massive and quartzitic, and in places contains sparse small feldspar phenocrysts; it consists of albite + microcline + quartz ± minor biotite, pale green amphibole, garnet, and opaque minerals.

Unit $Bo_d$: amphibolite, metadolerite, and metabasalt; commonly forms concordant bodies ranging from a few metres to several tens of metres thick.

Metadolerite: medium to coarse-grained; commonly has schistose margins and massive centres in which subophitic textures may be preserved; metamorphic green hornblende and albite are main components, but some relict pyroxene may also be present.

Metabasalt: similar mineralogy to metadolerite; oval to lenticular feldspar aggregates define original amygdales, indicating probable extrusive origin.

Amphibolite of undertain origin: schistose to gneissic and commonly has a streaky or mottled appearance; some contains abundant garnet porphyroblasts and may represent metamorphosed scoriaceous basalt, as in the Selwyn region to the south (Blake & others, 1979).

Unit $Bo_c$: laminated, massive and brecciated calc-silicate rocks; occur sporadically as lenses and interbeds throughout Soldiers Cap Group, but most commonly near outcrops of Corella Formation; includes well-exposed sequences of interbedded schist, quartzite, and brecciated to laminated calc-silicate lenses (too small to be shown on map) along the Fullarton River at GR 760530, and marble and minor calcareous granofels interbedded with metasiltstone and amphibolite (?metabasalt) at northern end of Fairmile Prospect (at GR 843518).

Unit $Bo_{ch}$: pale grey to dark bluish grey fine-grained (recrystallised) chert; forms small pods and lenses generally less than 10 m thick; ranges from massive to vaguely banded.

## Llewellyn Creek Formation

### Lithology

Unit Bol: muscovite schist (commonly containing garnet and/or andalusite), phyllite, and metasiltstone; main schistosity strongly crenulated by later deformation between the east and west branches of Snake Creek, at GR 660780.

Unit $Bol_d$: concordant amphibolite bodies (?sills) up to 200 m thick near headwaters of Sandy Creek (e.g., at GR 700775).

## Mount Norma Quartzite

### Lithology

Unit Bon: interbedded quartzite (about 5% of outcrop), andalusite and garnet-bearing schist, fine-grained micaceous meta-arenite, and minor metagreywacke and conglomerate. Meta-arenite and quartzite form beds 1 to 2 m thick, and generally exhibits poorly preserved cross-bedding and ripple marks.

Unit $Bon_d$: concordant amphibolite body (?sill) up to 300 m thick.

Unit $Bon_q$: quartzite unit about 6 m thick, separating Mount Norma Quartzite from Llewellyn Creek Formation.

## Toole Creek Volcanics

### Lithology

Unit Bot: fine-grained muscovite-garnet schist with staurolite porphyroblasts in places, carbonaceous metasiltstone, and quartzite.

Unit $Bot_d$: concordant amphibolite bands up to 200 m thick; makes up about 40 percent of formation in Sheet area; bands range from massive featureless bodies to vesicular lavas with recognisable flow-margin breccias. Unit includes dark grey medium-grained laminated to thin-banded granofels forming part of large pendant within Williams Granite at GR 707722; granofels consists of alternating bands of feldspar/fibrolitic sillimanite and feldspar/biotite.

## Soldiers Cap Group: general

Structure and metamorphism. The Soldiers Cap Group has been subjected to at least three generations of folding. A pervasive first-generation foliation is associated with first-generation isoclinal folds which generally trend north-northeast. Tight to isoclinal, north-northeast-trending second-generation folds are common east of the Fullarton River (e.g., at GR 845550). They have wavelengths up to 1 km and a well-developed axial-plane crenulation cleavage. A third-generation fold of about 2 km amplitude occurs east of Snake Creek in the far north, at GR 670780. Here, basic dykes, which postdate second-generation folding in the Cloncurry Sheet area, are refolded about a southeasterly plunging third-generation axis.

Presence of sillimanite and cordierite and abundance of gneissic and migmatitic rocks and granitic dykes and veins (probably derived by incipient anatexis) south of the Williams River indicates metamorphism to upper amphibolite grade. Rocks to the north appear to be of lower grade, as they show better preserved sedimentary features; however, the presence of staurolite and sillimanite indicates that they too have been metamorphosed to amphibolite grade. Intrusion of Williams Granite postdates the amphibolite-grade regional metamorphism.

Relations. The Soldiers Cap Group is reportedly overlain unconformably by breccias of the Corella Formation in Cloncurry 1:100 000 Sheet area to the north (Glikson & Derrick, 1970), but recent work (Blake & Derrick, 1979; Wilson, 1979) has not confirmed this relation. No evidence for such an unconformity was found in the Mount Angelay Sheet area, and interbedded calc-silicate lenses occurring in the Soldiers Cap Group along the Fullarton River near the Corella Formation boundary suggest a conformable relation. The Group is intruded by Williams Granite, unnamed granite, and pegmatite, metadolerite, and dolerite dykes and sills. The sequence Llewellyn Creek Formation (at the base), Mount Norna Quartzite, and Toole Creek Volcanics (at the top) is conformable.

Age. Proterozoic.

Correlations. The three formations of the Soldiers Cap Group mapped in Cloncurry Sheet area to the north have been traced southwards into Mount Angelay Sheet area only as far as the Williams River area. Banded iron formation and amphibolite near Fairmile Prospect may be equivalent to the most distinctive formation, Toole Creek Volcanics. Undivided Soldiers Cap Group extends south into Selwyn Sheet area, where it appears to grade westwards into Kuridala Formation.

Mineralisation. Banded iron formation is associated with low-grade lead, zinc, and copper mineralisation at Fairmile (GR 840518) and Dingo (GR 907240) prospects.

MARY KATHLEEN GROUP

## Kuridala Formation

Map symbols. Bkr, $\text{Bkr}_g$, $\text{Bkr}_s$.

Nomenclature. Defined by Carter (1959).

Distribution. Covers about 80 $km^2$ in southwest part of Sheet area.

Thickness. Uncertain owing to structural complexity; probably over 3000 m.

Type section. From a point 1.6 km north of Kuridala, west for 3.2 km (almost entirely in Malbon Sheet area).

Airphoto characteristics. Occurs as brown to buff, knife-edged strike ridges and rounded hills with a relatively high reflectivity.

Lithology. Petrographic data given in Table 3.

Unit Bkr: fine-grained muscovite ± biotite ± chlorite schist, commonly containing porphyroblasts of garnet, less commonly of andalusite and staurolite; some interbedded pink medium-grained meta-arkose containing subrounded feldspar and quartz grains and forming beds up to 3 m thick; minor very thin-bedded dark graphitic metasiltstone and phyllite, fine to medium-grained muscovite and biotite-bearing, locally cross-bedded (at GR 495480), pale grey to brown meta-arenite, fine to medium-grained cream quartzite as beds 2 to 3 m thick, and, south from GR 498450 for 1.5 km, hematitic ironstone forming bands about 1 m thick.

Unit $Bkr_g$: grey to buff, medium-grained, very thick-bedded metagreywacke consisting of feldspar + quartz + biotite (some alteration to chlorite) ± muscovite. Also includes minor grit, around GR 497411, consisting of quartz-feldspar grains, siltstone fragments, and medium-grained, subangular detrital quartz and feldspar in a fine-grained recrystallised sericitic matrix; thick-bedded medium-grained, micaceous, feldspathic quartzite; and minor thick-bedded, banded ironstone (e.g., at GR 565412). Poorly sorted breccia consisting of rounded to angular, bedded to massive meta-arenite fragments up to 30 cm across set in an arenaceous matrix, occurs at a few localities along the Straight Eight Fault Zone and at GR 526445, 4 km southeast of Kuridala.

Hampden Slate Member - unit $Bkr_s$: occupies core of structural basin centred on Kuridala; consists of grey to black carbonaceous metasiltstone and slate, calcareous in part, locally with small clots of feldspar possibly replacing andalusite porphyroblasts; also includes some laminated calc-silicate rocks, possibly formed by thermal metamorphism during intrusion of dolerite sills.

(7-

Structure and metamorphism. In the Kuridala Formation the dominant schistosity, $S_1$, generally parallels bedding. $S_1$ is refolded by a later deformation to produce the structural basin centred on Kuridala. The eastern half of the basin is cut by the north-trending Hampden Fault, and is bounded to the east by the Straight Eight Fault. The formation has been subjected to amphibolite-grade regional metamorphism, probably associated with the first-generation deformation event. Later chlorite-producing, retrogressive greenschist facies metamorphism may be associated with a northerly-trending crenulation, apparently axial-planar to the basin structure.

Relations. The Kuridala Formation is flanked to the west, apparently conformably, by the Corella Formation. Its eastern boundary with the Corella Formation is complexly faulted along the Straight Eight Fault. No unequivocal facing evidence was found to indicate the relative age of the two units, and the nature of the first-generation structures near Kuridala have been obscured by second-generation and later deformation events. If simple 'layer-cake' stratigraphy younging east is assumed to the west, as in the Malbon Sheet area (Noon, 1978, found some supporting facing evidence for this), the Kuridala Formation overlies the Corella Formation. However, widespread evidence of tight folding was found immediately to the west of the Kuridala Formation during the 1979 field season, and facing evidence here is therefore potentially misleading. The apparent stratigraphic equivalence of the Kuridala Formation and the Soldiers Cap Group in the Selwyn region (Blake & others, 1979), and the higher metamorphic grade of the Kuridala Formation, compared with the Corella Formation to the west, indicate that the Kuridala Formation may be older, rather than younger, than the Corella Formation, and this is the interpretation tentatively adopted by the authors of this report. The Kuridala Formation is intruded by Williams Granite and many basic sills and dykes.

Correlations. Recent mapping in the Selwyn region to the south indicates that the Kuridala Formation there is probably a correlative of the Soldiers Cap Group (Blake & others, 1979).

Mineralisation. Copper mineralisation occurs in black slate and schist along the Hampden Fault at the Hampden group of mines. Low-grade sub-economic uranium mineralisation has been reported in ironstones south of Farley Creek, at GR 565412.

## Corella Formation

Map symbols. Bkc, $Bkc_{br}$, $Bkc_p$, $Bkc_q$, $Bkc_s$, $Bkc_x$, $Bkc_{xbr}$.

Nomenclature. Defined by Carter & others (1961); definition revised by Derrick & others (1977a); type section in Marraba Sheet area. Previously mapped by Carter & others (1961) and White (1957) in Mount Angelay Sheet area as Corella Formation, Marimo Slate, Staveley Formation, and Soldiers Cap Formation.

Distribution. Forms 20-km-wide north-northwest-trending belt occupying much of western half of Sheet area.

Thickness. Uncertain owing to faulting and folding, but probably over 5000 m.

Airphoto characteristics. Dark brown to dark grey rolling hills, parallel ridges, and rocky hillocks.

Lithology. Petrographic data given in Table 4.

Unit Bkc: massive and laminated to thin-bedded calc-silicate granofels; subordinate brecciated calc-silicate rocks.

Massive calc-silicate granofels: consists of feldspar + calcite $\pm$ hornblende $\pm$ actinolite $\pm$ quartz; locally grades imperceptibly into hornblende granite of similar appearance and general mineralogy - calc-silicate rock is granitised, presumably by metasomatic processes in which Na and K replaced Ca and Mg; in some places, basic intrusions appear to have melted and mixed with adjacent calc-silicate rocks to form massive hybrid calc-silicate rocks (e.g., at GR 770321).

Laminated to thin-bedded calc-silicate granofels: forms steeply-dipping 'tombstone'-like exposures; defines large-scale open to tight fold structures. Vertical cross-fractures at 90° to the bedding are common, probably resulting from stress during folding. Rare convolute (?slump) structures occur within some beds. In a few highly deformed areas original bedding has been obliterated by a tectonic transposition lamination, but commonly no penetrative deformation fabric is developed. Sedimentary and tectonic laminations are formed by alternating mafic and felsic bands;

thicker layering is defined by variations in carbonate content. Thick marble beds are present in a few places. The granofels commonly consists of calcite + albite ± microcline ± salitic clinopyroxene ± hornblende ± actinolite ± scapolite ± epidote ± quartz ± garnet ± muscovite ± biotite ± chlorite + apatite + sphene + opaques; scapolite occurs as poikiloblasts intergrown with feldspar, quartz, sericite, or calcite, and may be rimmed by clinopyroxene or iron oxides; garnet also occurs as poikiloblasts; hornblende commonly forms equidimensional to lenticular poikiloblasts which may define a lineation in fold hinges parallel to first-generation fold axes.

Unit $Bkc_{br}$: brecciated calc-silicate rocks, subordinate non-brecciated, massive to banded calc-silicate rocks, and minor amphibolite; forms more than 50 percent of Corella Formation in Sheet area. Most breccias are massive, but some, notably those west of Boorama Waterhole (GR 817315), have a well-developed foliation; enclosed fragments are rounded to angular, and range from less than 1 cm to several tens of metres across; massive, fine to medium-grained calc-silicate rock commonly occurs as relatively small rounded clasts, whereas banded medium-grained calc-silicate rock commonly forms the larger angular blocks. Matrix of breccia is commonly coarser-grained than enclosed clasts, but similar in mineralogy. Calc-silicate breccia consists of feldspar ± quartz + calcite + actinolite ± hornblende ± epidote + sphene ± garnet. Amphibolite probably representing metabasalt is present locally; at GR 824343 it is interlayered with very fine-grained, streakily laminated rock consisting of quartz, tourmaline, and minor feldspar and green hornblende.

Some breccia appears to be stratabound and associated with slump folding, whereas some appears to have been either intruded or faulted into place.

Calcareous and non-calcareous breccias along the Straight Eight Fault, adjacent to Kuridala Formation, are tentatively included in the Corella Formation; some of the breccias contain rare fragments of staurolite-cordierite-garnet schist in a recrystallised feldspathic matrix, and may have been formed by cataclasis during movement along the Straight Eight Fault.

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Unit $Bkc_p$: forms northerly-striking lens, 1 km long and 80 m wide, at GR 530680, about 2 km northeast of Buddenberri Rockhole; consists of strongly foliated, fine-grained, biotite-muscovite schist showing well-developed second-generation crenulation; contacts with surrounding calc-silicate rocks not exposed.

Unit $Bkc_q$: forms 200-m-wide belt, associated with black slates, along the Straight Eight Fault; consists of buff calcareous to non-calcareous, feldspathic quartzite; massive pink, arkosic calc-silicate rocks; and minor calcareous grit.

Unit $Bkc_s$: black slate forming north-northwest trending lenses up to 100 m wide in 10-km-long belt extending from GR 628480 to GR 586565, and several small lenses along the Straight Eight Fault (e.g., at GR 520493); rock types in lenses range from fissile black slate, locally with small feldspar clots (?after andalusite), to non-fissile laminated carbonaceous metasiltstone; lenses appear to be conformable with adjacent calc-silicate rocks.

Unit $Bkc_x$: crops out mainly in northwest, but also in west as small ?inliers in Kuridala Formation (e.g., at GR 482525), and west of Mount Tracey homestead, near GR 500330; together with unit $Bkc_{xbr}$ it is less metamorphosed than other Bkc units, lacks amphibole and pyroxene (except in area west of Mount Tracey homestead), and has higher proportion of non-calcareous lithologies; consists of brown to black, laminated to thick-bedded, fine to medium-grained, calcareous granofels; red-brown to buff, fine to medium-grained, thin to thick-bedded feldspathic arenite with some sedimentary breccia; minor ripple-marked quartzite and cross-bedded, partly calcareous, micaceous siltstone; and, west of Mount Tracey homestead, pink cross-bedded to massive meta-arkose and interbedded laminated to thin-bedded, pyroxene-bearing calc-silicate granofels.

Arenites and bedded breccia: commonly exhibit ripple marks, fine-scale cross-bedding, and convolute bedding outlined by hematite granules concentrated along bedding laminae; generally red-brown due to iron-staining; some detrital quartz and feldspar grains commonly visible. A cross-bedded bed of breccia about 2 m thick is exposed at GR 490716, 4 km west of Vulcan mine, in a sequence of fine-grained

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calcarenite and medium-grained calcareous granofels; it contains elongate to equidimensional fragments of arenite, calcarenite, and quartzite averaging 5 cm in diameter in a medium to coarse-grained arenaceous matrix; some dark grey calcareous laminae with gradational bases and sharp upper contacts occur within the breccia. Calcarenite beds nearby contain abundant halite casts up to 1 cm across.

Calcareous granofels and calcarenite commonly contain scapolite as spheroidal and/or matchstick-shaped porphyroblasts.

Unit $Bkc_{xbr}$: red-brown to grey, massive breccia with minor fractured, thin-bedded calcareous granofels and arenite.

Massive breccia: forms massive bodies, up to several hundred metres in thickness, which in places are strongly discordant to the surrounding bedding trends (e.g., at GR 490713); generally ironstained; contains fragments averaging 5 cm across of $Bkc_x$ rocks, including arenite, calcarenite, grey siltstone, and, near contacts with Marimo Slate, rare fragments of slate; some detrital grains are preserved in arenite fragments; matrix consists of partly recrystallised feldspar, calcite, minor quartz, and coarse euhedral hematite.

Structure and metamorphism. At least two generations of large-scale folding are evident in the Corella Formation. First-generation isoclinal folds are refolded about northerly trending second-generation axes. Fold patterns are obscured or destroyed in many places by the development of breccia zones.

Bkc/$Bkc_{br}$ rocks have been regionally metamorphosed to amphibolite grade, and diopside/salite-amphibole-scapolite assemblages are common. Later greenschist facies metamorphism probably caused the development of chlorite assemblages in the southeast.

The metamorphic grade of $Bkc_x$ and $Bkc_{xbr}$ rocks appears to be greenschist facies, as indicated by the general absence of amphibole and lower degree of recrystallisation in these rocks compared with those of units Bkc and $Bkc_{br}$. The grade difference between the $Bkd_x$ rocks and the rest of the Corella Formation is marked across the Big Mick and

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Martin Creek Faults, but is more subtle in the area east of the Last Call mine (around GR 540710). The apparent difference in metamorphic grade may be associated with lower calcite and higher sand and silt contents of $Bkc_x$ rocks compared with Bkc rocks. Alternatively, the $Bkc_x$/$Bkc_{xbr}$ rocks may be downfaulted against more metamorphosed (and ?older) Bkc/$Bkc_{br}$ rocks.

Relations. The Corella Formation is faulted against and also appears conformable with Roxmere Quartzite, Marimo Slate, Kuridala Formation, and the Soldiers Cap Group. Facings derived from cross-beds 1 km west of Buddenberri Rockhole (at GR 496669) indicate that unit $Bkc_x$ underlies Roxmere Quartzite conformably. No unequivocal facing evidence was found elsewhere in the Sheet area to determine the age of the Corella Formation relative to other units. The Corella Formation was reported to unconformably overlie the Soldiers Cap Group in the Cloncurry 1:100 000 Sheet area (Glikson & Derrick, 1970), because of cross-cutting contacts between Soldiers Cap rocks and calc-silicate breccia. However those contacts are now thought to be tectonic (Blake & Derrick, 1979; Wilson, 1979).

Correlations. Outcrops in the Sheet area are continuous with calc-silicate rocks mapped as Corella Formation in the Cloncurry and Marraba 1:100 000 Sheet areas to the north and the Selwyn 1:100 000 Sheet area to the south. The formation may be stratigraphically equivalent to parts of the Soldiers Cap Group. Rocks of units $Bkc_x$ and $Bkc_{xbr}$ are correlated with unit $Bkm_{1a}$ of the Marimo Slate and most of unit $Bkc_3$ of the Corella Formation in the Malbon 1:100 000 Sheet area, parts of unit Bkc of the Corella Formation in the Cloncurry 1:100 000 Sheet area, unit $Bks_x$ of the Staveley Formation in the Selwyn region 1:100 000 Sheet area, and possibly unit $Bkm_2$ in the Marraba 1:100 000 Sheet area.

Mineralisation. A few kilograms of gold were won late last century from the Last Call mine, situated in unit $Bkc_{xbr}$ at GR 526701. Since 1950 some copper has been produced from the Straight Eight mine (GR 528484) and the Lotta Coppa mine (GR 517496), both in black slate ($Bkc_s$) along the Straight Eight Fault, and also from the Mount Kalkadoon mine (GR 699542), where a mineralised fault zone cuts calc-silicate rocks of unit $Bkc_{br}$. Copper and low-grade molybdenum mineralisation occurs throughout the Mount Arthur black slate belt, and a small amount of copper ore has been produced from the Lanham shaft at Mount Arthur (GR 600534).

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## Marimo Slate

Map symbols. Bkm, $Bkm_c$, Bkk.

Nomenclature. Defined by Carter & others (1961); revised by Derrick & others (1977a) to include the Mick Creek Sandstone Member (Bkk). Marimo Slate cropping out in the Cloncurry and Marraba 1:100 000 Sheet areas to the north and northeast has been described by Glikson & Derrick (1970) and by Derrick & others (1971). The Mick Creek Sandstone in the Mount Angelay Sheet area was mapped by Carter & others (1961) as part of the Corella Formation.

Distribution. Occupies the northwest corner of the Sheet area. The Mick Creek Sandstone Member crops out as a small tongue just inside the northern boundary of the Sheet area, and extends about 15 km north into the Cloncurry 1:100 000 Sheet area.

Thickness. Uncertain owing to structural complexity, but probably greater than 2000 m.

Airphoto characteristics. Rounded light grey to tan, low hills (Bkm) and tan low rocky parallel ridges (Bkk).

Lithology.

Unit Bkm: mainly grey to black massive to less commonly laminated slate; also subordinate cross-bedded arenite, siliceous siltstone, chert, phyllite, and siliceous to calcareous breccia.

Slate: commonly contains numerous small holes (average diameter about 1 mm) resulting from weathering out of either pyrite, small concretions, evaporitic salts, or carbonaceous nodules; northerly-trending ferruginous zones of silicification and fracturing commonly define faults near boundary with Corella Formation.

Arenite: occurs as a few very thin bedded bands up to 1.5 m thick interbedded with slate near the westernmost contact with the Corella Formation (e.g., at GR 493751); hematite granules along bedding planes highlight fine-scale ripple cross-bedding which in some places appears to have been disrupted by slump-type movements before the completion of lithification.

Unit $Bkm_c$: 5-m-thick, shallowly dipping limestone bed at GR 545724, about 1 km east-northeast of the Vulcan mine; bounded on both sides by slate.

Unit Bkk - Mick Creek Sandstone Member: fine to medium-grained, well-bedded feldspathic arenite and quartzite; beds average 50 cm in thickness and commonly exhibit ripple marks and cross-bedding.

Structure and metamorphism. A steeply dipping, northerly trending, first-generation cleavage ($S_1$) is the dominant S-surface in the slates. Tight to isoclinal first-generation folds are evident in a few areas where bedding can be traced. A steeply plunging second-generation fold with an amplitude of about 1 km occurs in the northwest; its western limb is in the Malbon Sheet area and its eastern limb is in the Mount Angelay Sheet area. The V-shaped outcrop pattern of Corella Formation and (?overlying) Marimo Slate west of the Vulcan mine may define a north-plunging second-generation fold having an amplitude of about 4 km.

The Mick Creek Sandstone Member crops out in the keel of an overturned syncline (an antiform) plunging southeast.

The regional metamorphic grade of the Marimo Slate is uncertain owing to the lack of diagnostic minerals, but is probably about middle greenschist.

Relations. The Marimo Slate is conformable with unit $Bkc_x$ of the Corella Formation. The relative ages of the two units are uncertain because of the lack of unequivocal facing evidence and the possibility of overturned beds and complex folding near their contact. Most facing directions suggest that the Marimo Slate overlies unit $Bkc_x$.

Contrary to the conclusions of Glikson & Derrick (1970), facing evidence from overturned beds in the Mick Creek Sandstone Member indicates that this unit overlies unit $Bkc_x$ of the Corella Formation. No discordant relations between the two units were detected.

Age. Proterozoic.

Correlations. The Marimo Slate is continuous with similar rocks mapped as Marimo Slate in the Cloncurry, Marraba, and Malbon 1:100 000 Sheet areas to the north, northwest, and west. Noon (1978) considers the Marimo Slate to be equivalent to the Answer Slate in the Malbon 1:100 000 Sheet area. The Mick Creek Sandstone Member may be equivalent to the Roxmere Quartzite.

Mineralisation. Subeconomic copper deposits occur in the Marimo Slate at the Vulcan mine (GR 529719), the Greenmount leases (around GR 514743), and at an unnamed mine at GR 543722. Malachite staining is common along small shear zones throughout the formation (e.g., at GR 494755).

MOUNT ALBERT GROUP

## Roxmere Quartzite

Map symbol. Bpr.

Nomenclature. Defined by Carter & others (1961); included in the Mount Albert Group by Derrick & others (1977b).

Distribution. Forms a partly fault-bounded block in the northwest.

Thickness. Assuming no internal folding, the total thickness of the unit in the Malbon and Mount Angelay Sheet areas is about 3000 m, of which 1800 m occurs in the Mount Angelay Sheet area.

Airphoto characteristics. Forms buff, longitudinally aligned ridges and hills.

Lithology. Fine-grained brown to buff feldspathic arenite and quartzite with well-developed cross-beds, ranging from a few centimetres to nearly a meter in amplitude, and ripple marks; hematite concentrations locally highlight cross-beds; beds average about 1.5 m in thickness; minor grey to brown siltstone interbeds become more common towards west; bedded sedimentary breccias identical to those in unit $Bkc_x$ in the Mount Angelay Sheet area occur within the Roxmere Quartzite in the Malbon Sheet area (at GR 475700).

Structure and metamorphism. Appears to lack internal folding, and is regionally metamorphosed only to low greenschist grade.

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Relations. Conformably overlies unit $Bkc_x$ in the east; faulted against units $Bkc_x$ and $Bkc_{xbr}$ in the north and south.

Age. Proterozoic.

Correlations. Correlated with Roxmere Quartzite in the Cloncurry and Marraba 1:100 000 Sheet areas, and with Knapdale and Deighton Quartzites in the Mary Kathleen, Prospector, and Quamby 1:100 000 Sheet areas. May be contemporaneous with the Mick Creek Sandstone Member of the Marimo Slate. Presence of similar sedimentary rock types (including breccia) and structures in the Roxmere Quartzite and unit $Bkc_x$ indicate that these two units may have had a close spatial and temporal relation during their deposition.

Mineralisation. None known in the Sheet area.

## DESCRIPTIVE NOTES ON PRECAMBRIAN INTRUSIVE ROCK UNITS

### Williams Granite

Map symbols. Bgi, $Bgi_a$, $Bgi_d$.

Nomenclature. Defined by Carter & others (1961); named after Williams River, in the north of the Mount Angelay Sheet area; described by Joplin & Walker (1961) and Carter & Öpik (1963).

Distribution. Pgi forms the main part of a 28-km-wide batholith occupying the southwest corner of the Sheet area and extending south into the Selwyn 1:100 000 Sheet area; $Pgi_a$ forms a number of irregular, roughly elongate intrusions occupying the central and central northern parts of the Sheet area; $Pgi_d$ forms a small complex intrusive body about 3 km in diameter near the headwaters of the Williams River, around GR 720660.

Reference areas. At GR 688302, east of Policeman Soak, for Pgi; around Saxby Waterholes on Williams River (GR 790690) for $Pgi_a$; at GR 720660 on Williams River for $Pgi_d$.

Airphoto characteristics. Forms mainly pale tors and hilly terrain in north, locally with well-developed conjugate joints, whereas, in the south, flat-topped cappings formed of Mesozoic sediments or weathered granite, with dendritic drainage patterns, cover most of granite terrain; there are also some plains with sparse low rubbly exposures of granite.

Lithology. Petrographic data shown in Table 5.

Unit Pgi: mainly medium to coarse-grained, pink to rarely grey, non-foliated porphyritic biotite and/or green hornblende granite; minor non-porphyritic phases; granite is characteristically homogeneous and not sheared, has sharp and generally cross-cutting contacts with country rocks, and is rarely xenolithic. Porphyritic granite: phenocrysts mainly of subhedral, 2-3 cm long, pink microcline, characteristically with transverse fractures, also some perthitic intergrowths; cream sodic plagioclase also forms phenocrysts in places, but is most common as anhedral, partly sericitised crystals in groundmass; microcline generally appears to be more abundant than plagioclase; quartz crystals are typically strained; biotite commonly shows some alteration to chlorite; accessory minerals include sphene, zircon, apatite, and opaque iron oxides.

Unit $Pgi_a$: medium to coarse-grained, even-grained, biotite and/or hornblende granite; minor porphyritic to non-porphyritic granodiorite; contacts with country rocks are locally complex, and some areas mapped as granite containing up to 40 percent country rock; lit-par-lit type interfingering contacts common where plutons cut country rock at high angles to bedding trends; locally foliated/sheared, as at GR 705667.

Nonporphyritic granite: potash feldspar (microcline) generally predominates over plagioclase; plagioclase commonly shows alteration to sericite/muscovite; biotite commonly shows some alteration to chlorite; accessories include sphene, zircon, apatite, and opaque iron oxides; muscovite and tourmaline are common adjacent to Soldiers Cap Group metapelites, and calcite, clinopyroxene, hornblende, and sphene occur in contaminated phases near contacts with calc-silicate rocks of the Corella Formation.

Unit $Pgi_d$: even-grained and medium-grained, generally non-foliated diorite and granodiorite containing plagioclase, microcline, orthoclase, quartz, hornblende and minor sphene, epidote, and chlorite; minor granitic and doleritic phases also occur; locally recrystallised and foliated due to shearing; contains large xenoliths and pendants of Soldiers Cap Group rocks such as metarhyolite, gneiss, and amphibolite.

Structure and metamorphism. Williams Granite postdates major folding events in Soldiers Cap Group and Corella and Kuridala Formations. It is sheared by northeast and northwest-trending faults, and shows evidence of some greenschist facies metamorphism.

Relations. Bgi and $Bgi_a$ intrude Corella and Kuridala Formations; $Bgi_a$ also intrudes Soldiers Cap Group; $Bgi_d$ intrudes only Soldiers Cap Group. Williams Granite postdates all basic intrusives except for young, east-trending dolerite dykes, which intrude it; it is also intruded by swarm of northeast-trending aplitic dykes south of Farley Creek. The time relations between Bgi, $Bgi_a$, and $Bgi_d$ are not known.

Age. Proterozoic; younger than Corella Formation.

Mineralisation. None recorded.

## Unnamed granite

Map symbol. Bg.

Distribution. Forms small, irregularly shaped plutons near the Cloncurry Fault south of the Fullarton River.

Airphoto characteristics. Forms cream low hills which locally show prominent jointing; also forms knife-edged ridges along faults.

Lithology. Mainly fine to medium-grained, white to buff leucogranite; rarely foliated; locally includes some hornblende granite; xenoliths common near margins of granite bodies.

Relations. Intrudes Corella Formation and Soldiers Cap Group; some bodies probably antedate Williams Granite, but some may be younger; is strongly foliated in some areas adjacent to the Cloncurry Fault, probably because of some fault movement during emplacement.

Age. Proterozoic.

Mineralisation. None recorded.

## Acid dykes

Map symbols. Dyke symbol labelled peg (= pegmatite), gr (= granite), or q (= quartz).

Distribution. Pegmatite is abundant throughout the Soldiers Cap Group; aplite and granite dykes occur in Corella and Kuridala Formations within a few kilometres of granite batholiths; quartz veins form prominent features at GR 830276 in the southeast.

Thickness. Average about 2 m.

Airphoto characteristics. Many granitic and pegmatitic dykes form pale-toned upstanding 'walls'.

Lithology. Beg: quartz-feldspar pegmatite dykes and veins; those cutting Soldiers Cap Group contain coarse flakes of muscovite, and euhedral tourmaline crystals, some more than five centimetres in length.

gr: dykes and veins of pink non-foliated medium-grained, locally muscovite-bearing hornblende-biotite granite; dyke swarm south of Farley Creek consists of grey and pink, fine to medium-grained leucocratic granite or aplite; granite dykes south of Mount Tracey homestead are coarse-grained and porphyritic.

Structure and metamorphism. Some pegmatite dykes and segregations in the Soldiers Cap Group may be synchronous with the first-generation folding event, and all probably antedate the second-generation folding event. Most pegmatite and granite dykes have been metamorphosed to at least the greenschist facies.

Relations. Pegmatite dykes intrude Soldiers Cap Group. Aplite and granite dykes cut the Williams Granite and Corella Formation, and may be comagmatic with the Williams Granite.

Age. Proterozoic.

Mineralisation. None recorded.

## Basic intrusives

Map symbols. dl and unlabelled dyke symbol.

Distribution. Dykes, sills, and irregular pod-like bodies occur throughout the Sheet area; the youngest are two sets of en-echelon easterly trending dykes crossing central part of area.

Thickness. Less than 10 m to over 1000 m.

Airphoto characteristics. Outcrops are dark and range from low rounded hills to rubbly plains; thin dykes are usually eroded more readily than surrounding rocks, and form linear depressions.

Lithology. Metadolerite, massive and schistose amphibolite, and dolerite. Metadolerite and amphibolite: original igneous textures commonly partly preserved; feldspar generally sericitised and recrystallised; actinolite and hornblende replace pyroxene; biotite commonly partly altered to chlorite; petrographic data shown in Table 6.

Dolerite: forms easterly trending en-echelon dykes; ophitic; consists mainly of clinopyroxene partly altered to green hornblende, partly sericitised plagioclase, and opaque minerals.

Structure and metamorphism. Metadolerite and amphibolite bodies are steeply dipping, and were intruded before the second main folding event; most have been subjected to both regional amphibolite-grade metamorphism and to later retrograde greenschist-grade metamorphism. The easterly trending dolerite dykes are the youngest intrusions in the area, and do not appear to have been metamorphosed.

Relations. Metadolerite and amphibolite bodies intrude the Corella and Kuridala Formations, Marimo Slate, Soldiers Cap Group, and unnamed granite, and are intruded by Williams Granite. Easterly trending dolerite dykes intrude the Kuridala and Corella Formations, the Soldiers Cap Group, and the Williams Granite. At Boorama Waterhole (GR 817315) a small body of metadolerite (not shown on map) has intruded, melted, and been back-veined by unnamed granite to form a 'net-veined complex' in which blocks of metadolerite are enclosed in and veined by the granite; many of the metadolerite blocks are rounded and pillow-like, and have highly irregular, crenulose contacts (cf. Blake, 1966).

Age. Proterozoic.

Mineralisation. None recorded.

## DESCRIPTIVE NOTES ON MESOZOIC ROCK UNIT

### Gilbert River Formation

Map symbol. Jkg.

Nomenclature. Defined by Laing & Power (1959).

Distribution. Crops out in far north, centre and south, mainly overlying granite; most extensive in south.

Thickness. Ranges from about 3 m in north to about 40 m in south.

Airphoto characteristics. Forms flat-lying cappings on mesas; usually darker than laterite cappings.

Lithology. Coarse conglomerate, cross-bedded quartzose sandstone and grit, minor siltstone.

Structure and metamorphism. Formation consists of non-metamorphosed, flat-lying sedimentary rocks which postdate movement along the Cloncurry Fault.

Relations. Unconformable on Precambrian rocks.

Age. Late Jurassic to Early Cretaceous.

# STRUCTURE AND METAMORPHISM

## FOLDING

All Precambrian formations in the Sheet area have steep dips and mainly northerly trends. The first-generation, $F_1$, folds in all formations are isoclinal, have generally subvertical axial planes, and represent the most intense folding event affecting the rocks. The second-generation, $F_2$, folds in all formations are generally open to tight north to north-northeasterly plunging structures. Open, southeasterly plunging $F_3$ folds are only evident in the far north of the Soldiers Cap Group outcrop. In view of the similar nature of $F_1$ and $F_2$ folds in each formation, it is suggested that all formations have undergone the same two deformations, $D_1$ and $D_2$.

### Soldiers Cap Group

$F_1$ structural fabrics. First-generation axial-plane structures ($S_1$) form the dominant S-surfaces in these rocks, and define a regional meridional trend. $S_1$ ranges from a penetrative slaty cleavage defined by alignment of mica to an irregular discontinuous compositional banding (2 cm average width) within which mica is not strongly aligned. The compositional banding probably results from transposition of original bedding, locally enhanced by metamorphic differentiation. Boudinaged pegmatite and quartz veins are commonly parallel to $S_1$, and in places are isoclinally folded about it. Bedding is also generally parallel to $S_1$. Quartzite beds, ranging from a few centimetres to a few metres in width, form good structural as well as sedimentary markers, although they invariably pinch out along strike, as a result of either sedimentary lensing or transposition effects during $D_1$.

$F_1$ fold styles. Few $F_1$ folds have been recognised. Minor isoclinal $F_1$ folds with amplitudes up to about 1 m and minor small-scale rootless intrafolial folds of a few centimetres aplitude occur locally, and generally have shallow plunges. The mineralised horizon at the Fairmile prospect (GR 840516) defines a large north-plunging, almost isoclinal $F_1$ fold which has an amplitude of at least 3 km.

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$\underline{F_2}$ structural fabrics. The dominant second-generation features at outcrop scale are small crenulations varying from less than 1 mm to about 6 cm in amplitude. These are especially well developed in mica schist near the hinges of large-scale $F_2$ folds, where they locally have an associated subvertical $S_2$ crenulation cleavage. In a few areas an $S_2$ cleavage is defined by mica-rich bands which may obliterate $S_1$. However, second-generation foliations are absent or poorly developed in coarse gneissic rocks.

$\underline{F_2}$ fold styles. Large-scale $F_2$ folds occur sporadically in a northerly trending belt east of Glen Idol (GR 800475), but have not been recognised to the west, perhaps because of the disruption of outcrop continuity by granite intrusions. They are tight, and have amplitudes of from 1 to 5 km. They commonly plunge steeply to the north, although there are also some southerly plunges and basin-and-dome-type folds. Axial planes are mainly vertical and strike between north-northeast and north-northwest.

$\underline{F_3}$ structural fabrics. Third-generation axial-plane features are restricted to a regular series of small-scale crenulations in the north associated locally with a crenulation cleavage ($S_3$). These features, morphologically similar to those described for $F_2$, are common in mica schist on the limbs and hinges of large-scale $F_3$ folds (see below).

$\underline{F_3}$ fold styles. Third-generation folds occur in the northwest part of the Soldiers Cap Group belt, where basic dykes which postdate first and second-generation folds in the Cloncurry 1:100 000 Sheet area to the north are folded about the east-southeast trending axis of an $F_3$ antiform of 3 km amplitude (near GR 671777). Another possible $F_3$ fold is defined by $Pot_d$ roof pendants in a granite pluton near GR 722720, 7 km west-northwest of Saxby Waterholes.

## Corella Formation

$\underline{F_1}$ structural fabrics. Massive granofels and breccia of the Corella Formation show few small-scale structural features. However, a bedding-cleavage intersection lineation occurs in places around the hinges of tight $F_1$ folds. In these areas, $S_1$ is characterised by a preferred alignment of amphibole, and thin beds show a 'sawtooth' effect caused by migration of material during metamorphism along discrete $S_1$ planes about 5 cm apart.

$F_1$ fold styles. The geometry of folds in the Corella Formation can only be observed in areas where well-bedded calc-silicate rocks are well-exposed. $F_1$ folds are tight to isoclinal, have subvertical axial planes, and may be up to several kilometres in amplitude; for example, a tight, refolded $F_1$ fold 1 km south of Buddenberri Rockhole, plunging shallowly to the southwest, has an amplitude of at least 5 km. Doubly-plunging parasitic folds up to 50 m in amplitude occur on the limbs. Isoclinal refolded $F_1$ folds occur at GR 615697. The $F_1$ folds in the Corella Formation are similar to $F_1$ folds in the Soldiers Cap Group and were probably formed during the same $D_1$ deformation event.

$F_2$ structural fabrics. Second-generation features are generally poorly developed on mesoscopic and microscopic scales. Lineations and foliations similar to first-generation features are developed locally, and may be associated with a fracture cleavage.

$F_2$ fold styles. Second-generation folds are commonly open, with amplitudes of up to 5 km. Axial planes are subvertical and trend north-south. Fold axes plunge at moderate to steep angles either to the north or the south. Complex basic and dome-type interference folds are common in a belt north from Florence Creek to within 8 km of Big Mick Creek. Simple refolding of $F_1$ folds by $F_2$ folds occurs 3 km southwest of Buddenberri Rockhole, at GR 615643, and at GR 615697. The Corella Formation-Marimo Slate contact in the area northwest of Vulcan mine may have been folded by the $F_2$ event to produce the present v-shaped outcrop pattern. The $F_2$ folds in the Corella Formation are probably equivalent to similarly oriented $F_2$ folds in the Soldiers Cap Group.

## Kuridala Formation

To describe the complexity of this formation, its outcrop area is divided into three subareas, A, B, and C, as shown in Figure 1. Each subarea has a distinct fold style. The age relations between folding events in each of the subareas is uncertain, and more detailed work will be necessary to clarify them.

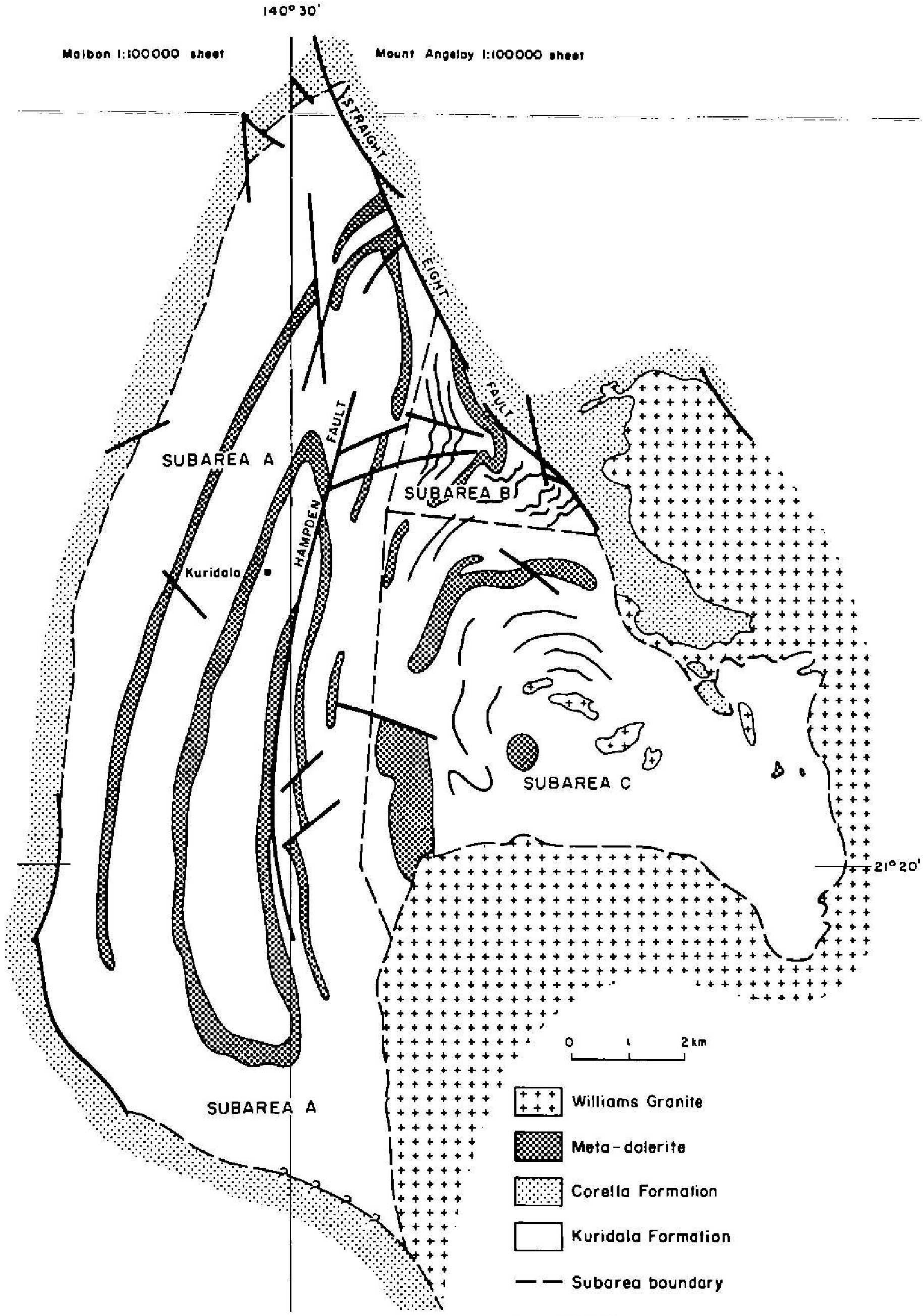


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Figure 1. Structural subareas in the Kuridala Formation

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Subarea A. In this subarea, the first-generation schistosity in the schists and meta-arenites is the major S-surface, and is commonly parallel to bedding. This schistosity and metadolerite sills in the sequence are folded to produce a narrow 16-km long north-northeast-trending second-generation structural basin. The schists in the hinge zones commonly show a fine crenulation cleavage which appears to be axial-planar to the basin structure. The basin-forming event is tentatively correlated with the $F_2$ events in the Corella Formation and Soldiers Cap Group.

Subarea B. In this subarea, the first-generation schistosity is subparallel to bedding, and forms open folds up to 200 m in amplitude. Around GR 510484, the folds have mainly steep easterly plunges. One kilometre to the east this folding episode is expressed as a box fold in a metadolerite sill. Contortions around GR 528473, adjacent to the Straight Eight Fault, may be related to the box-folding event, or may be drag folds associated with the fault. Folds around GR 510484 are cut by crenulations with subvertical northerly trending axial planes. These crenulations are similar in style and orientation to those developed in subarea A. The folds in subarea B appear geometrically unrelated to the basin structure of subarea A, and almost certainly postdate it. The crenulation event in subarea B, therefore, either postdates the crenulation event in subarea A, if the latter formed at the same time as the structural basin, or is synchronous with it, if the crenulation event in subarea A postdates the formation of the structural basin. A more detailed study is neoessary to decide between these alternatives.

Subarea C. The dominant structural feature of this subarea is an open fold, about 4 km in amplitude, plunging at about 20° to the southeast. This structure folds the first-generation schistosity, which is subparallel to bedding and metadolerite sills. Because of its different style, open folding of subarea C may be unrelated to, and later than, the basin structure of subarea A.

## Marimo Slate

$F_1$ structural fabrics. A penetrative $S_1$ fracture cleavage is dominant throughout the slates.

<u>$F_1$ fold styles</u>. First-generation folding is difficult to detect because bedding can rarely be observed within the slates of this unit. Where bedding can be identified, the beds are invariably folded about an $S_1$ cleavage. Tight to isoclinal northwest-trending $F_1$ folds with wavelengths of about 80 m occur 1 km north of Vulcan mine, and isoclinal $F_1$ folds with subhorizontal northeast-trending axes and wavelengths of about 800 m occur 6 km northwest of Vulcan mine.

<u>$F_2$ structural fabrics</u>. No second-generation cleavage is evident in the slates.

<u>$F_2$ fold styles</u>. Second-generation folds are mainly represented by open to tight flexures of $S_1$ plunging steeply north. A major $F_2$ fold with a wavelength of about 2 km straddles the northwest boundary of the Sheet area, its westerm limb being in the adjacent Malbon 1:100 000 Sheet area. The v-shaped outcrop pattern of the Marimo Slate may indicate a major north-plunging $F_2$ antiform. The $F_2$ folding event in the Marimo Slate is probably equivalent to that in the Corella Formation.

### <u>Mick Creek Sandstone Member</u>

This unit crops out in the hinge of a southeasterly plunging $F_1$ antiform (= overturned syncline) which protrudes south across the northern boundary of the Sheet area for a few hundred metres. An axial-plane fracture cleavage is developed locally.

### <u>Roxmere Quartzite</u>

No folding was observed within this unit in the Sheet area.

## FAULTING

The largest fault in the Sheet area is probably the Cloncurry Fault, which can be traced for almost 50 km north-northwest from Mount Boorama in the south. In places the fault forms the boundary between the Corella Formation and the Soldiers Cap Group, but elsewhere it lies wholly within one or other of the two units. Various types of Corella breccia and highly micaceous sheared Soldiers Cap rocks occur adjacent to the fault.

Bedding, where observed, is generally parallel to the fault. South of Mallee Gap Creek, silicified zones along the fault form knife-edged ridges. The fault zone here contains bodies of locally sheared unnamed leucocratic granite. Plutons of Williams Granite are sheared along the Cloncurry Fault, and thus probably antedate the latest fault movement. The easterly-trending dolerite dykes may postdate the Cloncurry Fault.

The outcrop pattern 2 km south of the Fullarton River (around GR 750512) suggests that the Cloncurry Fault may have originated as a low-angle thrust: at this locality an 'inlier' of Soldiers Cap Group is surrounded by hills of Corella Formation calc-silicate breccia; this breccia may represent a thrust slice overlying the exposed Soldiers Cap Group. The present line of essentially vertical faults shown on the map as the Cloncurry Fault may have resulted from subsequent readjustments along a pre-existing thrust zone. Alternatively, of course, there may have been no thrust movement at any time along the Cloncurry Fault, and the apparent low-angle contact between the two units at GR 750512 may be an original sedimentary/depositional feature.

The Straight Eight Fault (GR 500522), between the Corella and Kuridala Formations in the west, is another major northwest-trending feature. There is some evidence of shearing in schists along the fault, and some, if not all, of the breccias which occur in places along the fault are tectonic. Splay faults of the Straight Eight Fault to the east of the Lotta Coppa and Straight Eight mines are marked by quartz veins dipping about 60$^{\circ}$ to the northeast.

Northeast-trending dextral strike-slip faults are common in the eastern half of the Kuridala synformal structure. These may be splay faults of the north-northeast-trending Hampden Fault, a steeply dipping mineralised dextral strike-slip fault running the length of the synform.

The northeast-trending Big Mick (GR 532670) and Martin Creek (GR 500668) Faults in the northwest displace rocks mapped as Corella Formation. The inferred fault movement is west block down, juxtaposing less metamorphosed and possibly younger Corella rocks against more highly metamorphosed Corella rocks to the east. Displacement of beds by fault-drag indicates at least some dextral strike-slip motion along the Big Mick Fault.

Other faults in the northwest include east-trending faults along the northern and southern sides of the Roxmere Quartzite outcrop. As displacements appear to be greater in the west than in the east, these faults may have resulted from hinge movements about a northerly trending axis along the eastern margin of the Roxmere Quartzite.

Northerly-trending strike-slip faulting along lithological boundaries is evident in a few places within the Corella Formation and Soldiers Cap Group.

A few easterly trending faults occur in the centre of the Sheet area. These, the youngest faults in the area, are intruded in places by the non-metamorphosed dolerite dykes.

## METAMORPHISM

All Precambrian stratigraphic units in the Mount Angelay Sheet area, except units $Bkc_x$ and $Bkc_{xbr}$ of the Corella Formation and the Marimo Slate and Roxmere Quartzite, have been metamorphosed to amphibolite grade, and all Precambrian rocks, except the easterly trending dolerite dykes, have been affected by a regional greenschist facies metamorphism.

### Soldiers Cap Group

Regional metamorphism of the Soldiers Cap Group has produced the following assemblages: in basic rocks - green hornblende + epidote + quartz + alkali feldspar + plagioclase (oligoclase to andesine) $\pm$ garnet + opaques; in meta-arenites, quartzites, and meta-greywackes - alkali feldspar + plagioclase + quartz $\pm$ muscovite $\pm$ biotite $\pm$ garnet ($\pm$ clinopyroxene $\pm$ calcite in calcareous meta-arenites); in pelitic rocks - plagioclase + quartz + muscovite $\pm$ biotite $\pm$ garnet $\pm$ sillimanite $\pm$ cordierite $\pm$ andalusite $\pm$ staurolite.

The occurrence of clinopyroxene (diopside-salite) in some calcareous meta-arenite is typical of amphibolite-grade regional metamorphism. The occurrence of tschermakitic and pargasitic hornblende (rather than only actinolite) and relatively calcic plagioclase (at least

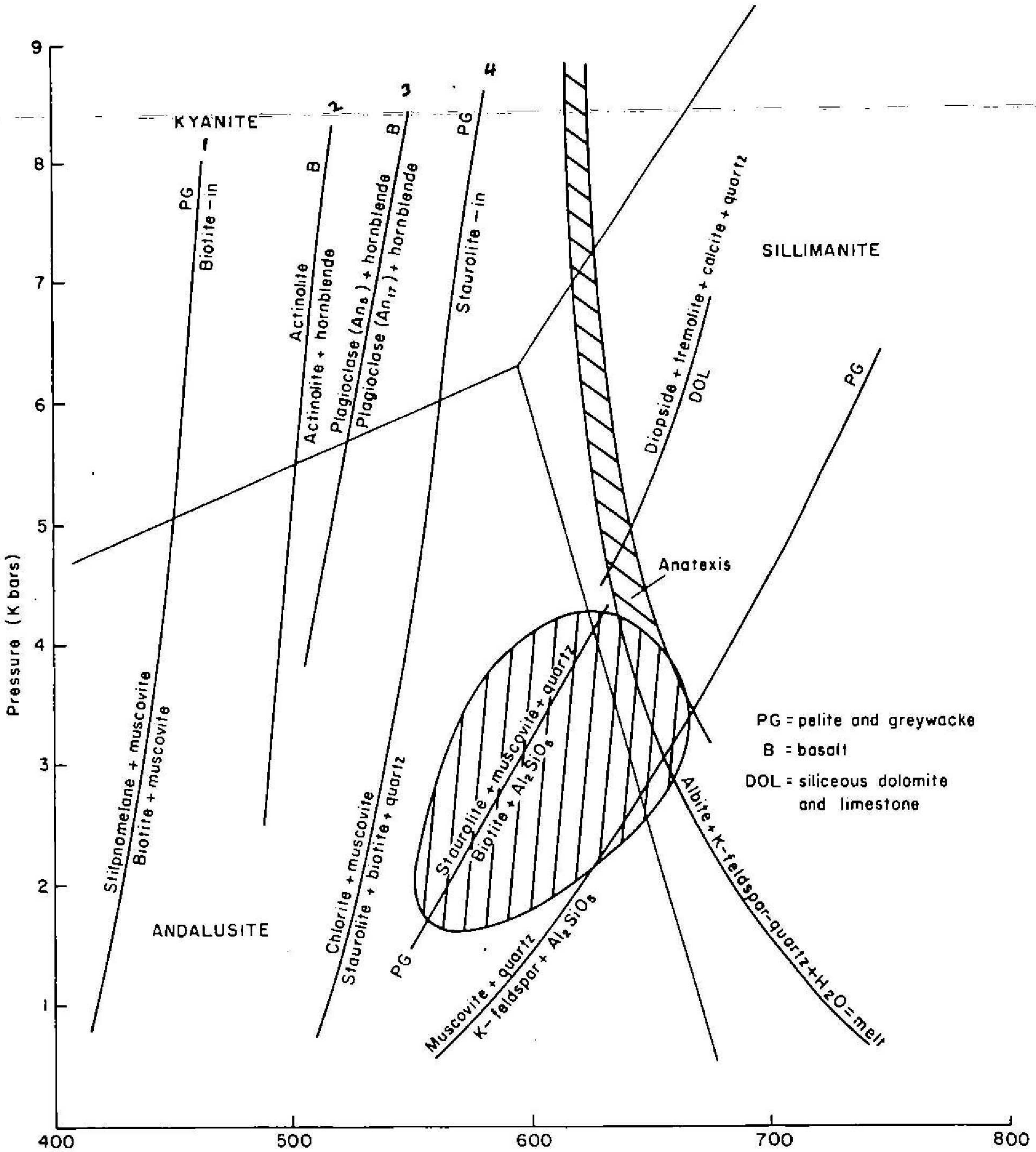


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Fig. 2 Phase Boundaries for $Al_2SiO_5$ polymorphs from Althans (1967, 1969), and Reaction Curves for common rock types from Winkler (1974) Curves 2 and 3 give approximate range of pressure - temperature conditions for formation of hornblende and sodic plagioclase in metabasites. Hatched region indicates inferred pressure-temperature conditions for amphibolite facies metamorphism over most of Mount Angelay Sheet area.

$An_{17}$ rather than $An_5$) in the basic rocks is also indicative of amphibolite grade with temperatures of at least 480°C (approximate intercept of curves 2 and 3 with X-axis of Figure 2).

Assemblages in the far north include andalusite and garnet in the Mount Norna Quartzite, and staurolite and sillimanite in pelitic metasediments interbedded with metabasalts and amphibolites of the Toole Creek Volcanics. Such assemblages are indicative of amphibolite-grade metamorphism with temperatures exceeding 500°C (the minimum temperature for the formation of staurolite from curve 4, Figure 2). The absence of sillimanite in favour of andalusite in the Mount Norna Quartzite limits the maximum temperature in this formation to about 660°C (see Figure 2). Despite the amphibolite-grade metamorphism, the metabasalts and metasediments here still retain some relict volcanic and sedimentary textures.

To the south, gneisses, meta-arenites, and quartzites with few recognisable sedimentary features become the dominant lithologies. Possible anatectic melts in the form of pegmatitic veins and segregations are abundant in these rocks and suggest a higher degree of metamorphism (probably 'upper' amphibolite grade) than that to the north. Andalusite is rare, and occurs mainly as sericitised pseudomorphs, and staurolite is absent. Sillimanite occurs in muscovite-biotite schist in several places, and cordierite has also been identified; the presence of these minerals suggests high-temperature amphibolite-grade metamorphism.

The alignment of fibrolitic sillimanite parallel to the first-generation foliation in regionally metamorphosed Soldiers Cap rocks implies that the amphibolite-grade metamorphism was contemporaneous with or later than the first-generation folding event. The second-generation folding event crenulated the sillimanite needles and therefore postdates the amphibolite-grade metamorphism. Chlorite present in some schistose and massive meta-arenites is probably related to a retrogressive greenschist facies metamorphism associated with the second-generation folding event.

## Kuridala Formation

Pelitic Kuridala Formation rocks on the western side of the Sheet area contain feldspar + quartz + muscovite + biotite + garnet ± andalusite ± staurolite ± chlorite. Staurolite and andalusite (rather than sillimanite) porphyroblasts associated with the first-generation foliation indicate lower amphibolite grade.

A schist fragment, presumably derived from the Kuridala Formation, found in a postmetamorphic fault breccia along the Straight Eight Fault near the Lotta Coppa mine contains staurolite, cordierite, and garnet, indicating very high-temperature amphibolite facies metamorphism.

Post-$F_1$ deformation producing northerly trending crenulations may be associated with a greenschist facies metamorphism which produced minor chlorite in some of the meta-arkoses, meta-greywackes, and schists. This greenschist metamorphism may be the same as that affecting the Soldiers Cap Group.

## Corella Formation

Calc-silicate rocks of units Bkc and $Bkc_{br}$ of the Corella Formation commonly contain calcite + sodic plagioclase (mostly albite) + microcline + quartz + scapolite $\pm$ actinolite $\pm$ hornblende + clinopyroxene $\pm$ epidote + sphene. The presence of clinopyroxene and hornblende is indicative of amphibolite-grade metamorphism. $Bkc_x$ rocks in the northwest lack amphibole and pyroxene, and appear to be of lower grade (?greenschist facies) than the Bkc and $Bkc_{br}$ rocks to the east. This may reflect lithological differences, a westward decrease in metamorphic intensity, juxtaposition of rocks of different metamorphic grades or different ages by faulting, or combinations of these.

Contact metamorphism of calc-silicate rocks at GR 501585, 3 km north-northeast of Glen Eva, has produced a skarn consisting almost entirely of garnet.

## Marimo Slate and Roxmere Quartzite

The Marimo Slate mineral assemblage of quartz + feldspar + graphite + sericite $\pm$ calcite is typical of greenschist facies metamorphism. This formation, and the Roxmere Quartzite, appear to have undergone regional metamorphism only up to greenschist facies.

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# ECONOMIC GEOLOGY

Copper is the only base metal that has been produced in economic quantities from the Mount Angelay 1:100 000 Sheet area. Minor subeconomic deposits of molybdenum occur at Mount Arthur in association with copper. Lead minerals are associated with copper minerals at the Fairmile prospect.

Gem-quality garnet is obtained from weathered garnetiferous schist at GR 835604, 14 km north of Glen Idol. High-quality amethyst occurs as veins in Kuridala Formation schists at GR 517426, 5 km southeast of Kuridala.

## Ore controls and associations

Base-metal deposits in the Sheet area are mainly along faults cutting favourable lithologies, such as slate and black shale in the Corella Formation, Kuridala Formation, and Marimo Slate, and some breccia beds in the Corella Formation and Marimo Slate. The reducing conditions indicated by the presence of carbon in slate and shale were probably favourable for the precipitation of syngenetic sulphides. Shear zones and associated breccias formed favourable structural sites for later epigenetic sulphide concentration. In the Mount Arthur mine area, changes in Eh-pH conditions across the interface between slate and calc-silicate rocks may have induced precipitation of secondary sulphides, although faulting may again have been the main factor in concentrating the ore minerals.

Stratiform lead, copper, and zinc deposits occur in ironstone bands associated with garnet quartzite and calc-silicate rocks of the Soldiers Cap Group. These ironstones may be at about the same stratigraphic level as the Pegmont lead-zinc deposit in the Selwyn region to the south (Blake & others, 1979). This type of mineralisation is probably syngenetic, the host rock lithology being the major control, although there may have been some epigenetic concentration during metamorphism.

## Subeconomic prospects

### Louise

At GR 879348, 7 km northeast of Boorama Waterhole, thin veins of secondary copper minerals occur in a silicified fault zone within the Soldiers Cap Group.

Landsborough

At this prospect, at GR 812428, 1 km east of Erics Tank, malachite is associated with a gossanous quartz lode in Soldiers Cap Group amphibolites.

Fairmile

This prospect is located at GR 840516, 4 km northeast of Glen Idol. Mineralised banded hematite-magnetite quartzite beds change along strike into banded garnet-magnetite-pyroxene-amphibole calc-silicate rocks. The banded rocks are interlayered with garnetiferous mica schist, marble, amphibolite, and minor carbonaceous metasediments of the Soldiers Cap Group. Lead in the banded ironstones occurs as complex sulphates and phosphates and rare unoxidised galena in manganiferous gossans which also contain some zinc and copper minerals.

Dingo

This prospect, situated at GR 907240, is similar to the Fairmile Prospect, 28 km to the north. Banded garnetiferous quartzites in a sequence of biotite quartzite, amphibolite, metagreywacke, and micaceous chlorite-sillimanite schist contain chalcopyrite, pyrrhotite, magnetite, and minor lead and zinc minerals.

Elizabeth Anne

This prospect is located at GR 565410, about 10 km northeast of Farley homestead. Banded ironstone containing small amounts of uranium north and south of Farley Creek is interbedded with quartzite, metagreywacke, and schist of the Kuridala Formation.

Greenmount leases

These leases are situated around GR 515742, about 1 km southwest of the Martin Creek-Little Mick Creek confluence. A shaft 9 m deep and many prospecting trenches are located in black slate and siliceous breccia of the Marimo Slate. Some secondary copper minerals are visible on the surface, commonly associated with granitic veins. Numerous gold diggings occur in the valley of a creek to the southeast, but have no recorded production.

## Mines with recorded production

### Last Call (Au)

This mine is located at GR 526702, 36 km north-northeast of Kuridala. The country rock consists of small lenses of black shale and impure limestone in calcareous breccia of unit $Bkc_{xbr}$ of the Corella Formation. The workings consist of more than a dozen pits and shafts of various depths and one large open cut. Pyrite is the only ore mineral evident. The mine was worked for gold in 1890, when good yields implied excellent future prospects. Despite increased activity in the period 1891-4, very little more gold was produced, and the mine was subsequently abandoned. Total recorded production is 130 tonnes of ore yielding 4.45 kg of gold between 1890 and 1894.

### Vulcan (Cu, Au)

This mine is situated at GR 529719, 3 km north of Last Call mine. The workings consist of two shafts and several small open cuts and pits within the Marimo Slate near the contact with the Corella Formation. Ore bodies consisting of malachite and some cuprite and tenorite occur in two fault zones which trend roughly east-west, at right-angles to the regional strike; these minerals are also present in a poorly defined stockwork of quartz-pyrite veins. An aplite dyke antedating the stockwork and containing pyrite and arsenopyrite occurs to the east of the workings. Copper ore was produced in 1905-6, 1913, and 1955. An attempt at commercial production of copper precipitate using local lime (the 'Murdoch process') was made in 1930-31. The project ended in financial disaster owing to technical problems with the plant and a shortage of funds. Total recorded production of the mine is 284.5 tonnes of ore averaging 4.2 percent copper, and 18.7 g of gold.

Mount Kalkadoon (Cu)

The mine is located 10 km west of Mount Angelay, at GR 699541. Syvret (1966) described the workings as consisting of two shafts, two open cuts, and three pits in calc-silicate rocks of the Corella Formation. He described the ore body as consisting of malachite, chrysocolla, and subordinate chalcocite in a quartz gangue in two lodes associated with a subvertical fault striking at about 295°. The larger of the two lodes is traceable for 51 m and has an average width of 1.2 m. The mine was worked in 1941, between 1951 and 1956, and between 1961 and 1969. Total recorded production is 167.73 tonnes of copper ore yielding 32.74 tonnes of copper. The average copper content was 22.4 percent up to 1964 and 9 percent from 1965 to 1969.

Lotta Coppa (Cu)

The mine is situated in one of several black slate lenses within the Corella Formation adjacent to a northwest-trending faulted contact with the Kuridala Formation at GR 517496, 8 km northeast of Kuridala. Malachite and azurite stain fracture surfaces and shears in black slate. The workings consist of an open cut, a short adit driven into the base of the hill below the open cut and linked to it by a vertical shaft, another vertical shaft sunk below the entrance to the adit, and a number of exploratory costeans. The mine was worked in 1967, when 192 tonnes of handpicked ore were produced, average grade 6 percent copper.

Straight Eight (Cu)

This mine is one of several small mines about 1 km south of the Lotta Coppa mine. It is situated near GR 528485, but its exact position is uncertain. It has the same lithological and structural associations as the Lotta Coppa mine. A total of 440 tonnes of copper ore averaging 5.1 percent copper were produced during the period 1967-69.

Mount Arthur (Cu, Mo)

This mine is located 14 km east-northeast of Kuridala. The workings are in lenses of carbonaceous slate and shale within calc-silicate rocks of the Corella Formation, and consist of two shallow shafts (the

Lanham shaft at GR 600534 and the Barnes shaft at GR 602520) and one small open cut. Some copper and molybdenum minerals are exposed in the Lanham shaft. Molybdenum contents are reported to range up to 13.8 percent across ore widths of 30 cm, but no molybdenum production is recorded. The mine was worked in 1964, when 11.67 tonnes of ore averaging 9.56 percent copper were produced.

Extensive exploratory mapping and drilling has taken place on the north-northwest trending Mount Arthur mineralised belt, which extends from 3 km north to 6 km south of Doherty Waterhole. The belt contains several small mineralised black shale lenses surrounded by brecciated and bedded calc-silicate rocks. North-northwest trending faults are well developed, as also are strike faults between slate and calc-silicate rocks. Copper, cobalt, gold, and molybdenum minerals occur at the contact between the two rock types. Copper minerals present include primary chalcopyrite and secondary chrysocolla, malachite, chalcocite, bornite and covellite. Erythrite and asbolite are the cobalt minerals reported. The copper-cobalt mineralisation may have been syngenetic, but the molybdenum mineralisation appears to be related to granite dykes. The ore reserves of the Mount Arthur belt are considered to be subeconomic at the present time.

<u>Hampden</u> (Cu, Au)

The Hampden mines are situated at Kuridala (GR 487465), where a major mining and smelting operation was conducted from 1911 to 1921 (Sullivan, 1953). The mines were closed in 1920 following fires in 1918 and 1919, caused by spontaneous combustion of the ore. Open-cut mining began in 1973 near the old Hampden No. 4 shaft, but this open cut has since been backfilled. Another open cut between the old Hampden No. 3 and No. 6 shafts was subsequently worked until the end of 1976. Total recorded production up to the end of 1976 is 5429 tonnes of ore, which yielded 273.5 tonnes of copper (5% Cu) and 376.112 kg of gold, together with 8.4 tonnes of copper precipitate yielding 5.1 tonnes of copper.

The ore-bodies occur along a north-trending shear zone, the Hampden Fault, which is up to 60 m wide and extends along the whole length of the elongate structural basin centred on Kuridala. The host rock is slate of the Kuridala Formation. The oxidised ore - consisting of chalcopyrite, marcasite, and pyrite - extends to a maximum recorded depth of 183 m. The most recently worked open cut, described by Brooks (1977), has exposed veins of chalcocite, malachite, cuprite, and hematite in kaolinised slate. The main lode is described as dipping 75° to the east, and the secondary ore shoot exposed in the open cut as dipping about 25° to the east.

## SUMMARY OF GEOLOGICAL HISTORY

The first period of sedimentation recorded in the Sheet area probably involved the deposition of shales and interbedded arenites and greywackes of the Soldiers Cap Group. These sediments appear to have been deposited offshore, possibly in deep water, where sedimentation of argillaceous material was intermittently interrupted by influxes of immature feldspathic sands derived from a nearby landmass. The Mount Norna Quartzite was possibly deposited closer to this landmass than the more argillaceous (at least in the Mount Angelay Sheet area) Llewellyn Creek Formation. Contemporaneous volcanic activity resulted in subaqueous basalt flows being interlayered with the sediments. The mineralised banded iron formation in the Soldiers Cap Group may have formed by exhalative-type chemical sedimentation during a volcanic phase.

In the Cloncurry area to the north it has been postulated (Glikson & Derrick, 1970; Glikson, 1972) that deformation, uplift, and erosion took place after the deposition of the Soldiers Cap Group and before the deposition of the Corella Formation. However, recent observations in the Cloncurry area (Blake & Derrick, 1979; Wilson, 1979) indicate that no such period of deformation and uplift took place before Corella Formation deposition, and evidence in the Mount Angelay area supports these conclusions. If an unconformity does nevertheless exist between the two units, it does not represent as major a time break as previously thought. In the Mount Angelay Sheet area, the boundary between the two units appears conformable, and both units appear to have been affected by the same first and second-generation folding events. From the available evidence we suggest that the Corella Formation was deposited more or less contemporaneously with Soldiers Cap sediments to the east, in a quiet shallow-marine shelf environment. Small restricted basins on this shelf were the sites for the local accumulation of carbonaceous shale.

At about the same time, the Kuridala Formation argillites and arenites were probably being deposited in a tectonically active basin to the southwest. However, the Corella Formation may have continued to accumulate after the cessation of sedimentation of the Soldiers Cap Group and the Kuridala Formation. The less calcareous $Bkc_x$ unit in the northwest may have been deposited during the waning stages of Corella Formation sedimentation. It was succeeded by black shales of the Marimo Slate, deposited in a low-energy environment, and the sands, possibly deltaic, of the Roxmere Quartzite.

Some time later, the region was subjected to a tectonic event ($D_1$) which resulted in tight to isoclinal folding ($F_1$) and, except perhaps in the northwest, amphibolite-grade regional metamorphism. Stresses induced by this first tectonism led to brecciation of calc-silicate rocks, and may have resulted in thrusting of the Corella Formation over the Soldiers Cap Group along the line of the Cloncurry Fault. Dolerite sills and plugs were intruded into the Kuridala and Corella Formations and the Soldiers Cap Group before and/or during the tectonism.

Regional second-generation folding, $F_2$, occurred later about northwesterly to northeasterly trending axes, producing tight, steeply plunging folds, domes, and basins (possibly including the basin at Kuridala). The Straight Eight Fault was probably initiated after this event. A third-generation folding event subsequently produced a large southeasterly plunging antiform in the Llewellyn Creek Formation in the far north. The various phases of Williams Granite and unnamed granite were intruded during and after the $D_2$ deformation event. Greenschist facies regional metamorphism probably accompanied the major post-$F_1$ folding and intrusive events.

Some time after the $F_2$ folding event the northeast-trending Big Mick and Martin Creek Faults in the northwest became active. Large, west-block-down, vertical displacements juxtaposed rocks of units $Bkc_x$ and $Bkc_{xbr}$ against more highly metamorphosed Corella Formation rocks to the east. Also, at about this time, movement took place along the Cloncurry Fault.

The east-west-trending dolerite dykes were intruded relatively late in the Precambrian, after tectonism and associated metamorphism had ceased. Following subsequent subaerial erosion, the Precambrian rocks were probably overlain by Cambrian sediments similar to those preserved in other parts of the Duchess 1:250 000 Sheet area and also in the Cloncurry 1:250 000 Sheet area. No trace of this Cambrian cover remains in the Sheet area, however, and presumably it was completely eroded before the deposition of the probably fluvial conglomerates and sandstones of the Gilbert River Formation which took place during Late Jurassic and possibly Early Cretaceous times.

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Table 1. Summary of Precambrian stratigraphy, Mount Angelay 1:100 000 Sheet area.

| Rock unit (and maximum thickness in metres) | Main rock types (and map symbols) | Relations |
|---|---|---|
| Dolerite | Fine to medium-grained ophitic dolerite (east-trending dyke symbol) | Intrudes Kuridala Formation, Corella Formation, Soldiers Cap Group, and Williams Granite. |
| Williams Granite | Medium to coarse-grained porphyritic hornblende and/or biotite granite (Bgi); medium-grained hornblende and/or biotite granite ($Bgi_a$); hornblende diorite, granodiorite ($Bgi_d$) | Intrudes Corella Formation, Soldiers Cap Group, and Kuridala Formation; intruded by dolerite dykes |
| Unnamed granite | Fine to medium-grained leucogranite and hornblende granite (Bg) | Intrudes Corella Formation and Soldiers Cap Group; uncertain contact relations with Williams Granite |
| Metadolerite | Fine to medium-grained metadolerite (primary texture partly preserved), amphibolite, hornblende schist (dyke symbol and dl) | Forms dykes, sills, and irregular bodies intruding Corella and Kuridala Formations, Soldiers Cap Group, Marimo Slate, and unnamed granite |
| **Mount Albert Group** | | |
| Roxmere Quartzite (1800; 3000 in Malbon Sheet area) | Feldspathic arenite and quartzite, minor micaceous siltstone (Bpr) | Faulted against and conformable on Corella Formation |
| **Mary Kathleen Group** | | |
| Marimo Slate (2000) | Black slate, arenite, siltstone, and minor phyllite, chert and siliceous to calcareous breccia (Bkm); minor bedded limestone ($Bkm_c$) | Conformable with unit $Bkc_x$ of Corella Formation |
| Mick Creek Sandstone Member (500) | Feldspathic arenite and quartzite (Bkk) | Conformably overlies unit $Bkc_{xbr}$ of Corella Formation |
| Corella Formation (5000) | Banded and massive calc-silicate granofels, minor calc-silicate breccia (Bkc); calc-silicate breccia, minor banded to massive calc-silicate granofels ($Bkc_{br}$); calcareous granofels, calcareous to non-calcareous feldspathic arenite, quartzite, and siltstone, minor bedded breccia ($Bkc_x$); brecciated calcarenite and quartzite, minor bedded calcareous granofels and arenite ($Bkc_{xbr}$); minor schist ($Bkc_p$); calcareous to non-calcareous laminated feldspathic quartzite, minor calc-silicate granofels ($Bkc_q$); black slate ($Bkc_s$) | Units $Bkc_x$ and $Bkc_{xbr}$ conformably underlie Roxmere Quartzite and may conformably underlie Marimo Slate. Units Bkc and $Bkc_{br}$ have equivocal and at least partly tectonic boundary with Soldiers Cap Group; intruded by Williams Granite, unnamed granite, metadolerite and dolerite |
| Kuridala Formation (3000) | Mica schist (commonly garnetiferous), meta-arkose, minor micaceous quartzite, banded ironstone, and phyllite (Bkr); metagreywacke, feldspathic quartzite, mica schist, minor breccia and banded ironstone ($Bkr_g$) | Faulted against and ?overlain conformably by Corella Formation; intruded by Williams Granite, metadolerite, and dolerite |
| Hampden Slate Member (400) | Black slate and minor calc-silicate granofels ($Bkr_s$) | Conformable on Bkr |
| **Soldiers Cap Group** | | |
| Undivided | Mica schist (locally with sillimanite), feldspathic gneiss, meta-arenite, pegmatite, banded iron formation, minor metarhyolite (Bo); calc-silicate rocks ($Bo_c$); metabasalt and metadolerite ($Bo_d$); minor chert ($Bo_{ch}$) | Faulted against and ?overlain conformably or unconformably by Corella Formation; intruded by Williams Granite, unnamed granite, and metadolerite |
| Toole Creek Volcanics (2500) | Mica schist (locally with staurolite or sillimanite), metasiltstone, quartzite (Bot); metabasalt, metadolerite ($Bot_d$) | Conformably overlies Mount Norna Quartzite; intruded by Williams Granite |
| Mount Norna Quartzite (2000) | Mica schist (commonly with garnet and andalusite and sometimes with sillimanite), quartzite, micaceous meta-arenite, minor conglomerate and metagreywacke (Bon); metabasalt, metadolerite ($Bon_d$); quartzite ($Bon_q$) | Conformably overlies Llewellyn Creek Formation intruded by Williams Granite |
| Llewellyn Creek Formation (3000) | Mica schist (sometimes with andalusite), phyllite, metasiltstone (Bol); metadolerite, metabasalt ($Bol_d$) | Equivocal contacts with breccias of the Corella Formation; intruded by Williams Granite |

Table 2: Soldiers Cap Group: petrographic data

| Sample No. (prefix 7853 | Location (GR) | Quartz | K-feldspar | Plagioclase | Muscovite | Biotite | Amphibole | Clinopyroxene | Garnet | Andalusite | Sillimanite | Cordierite | Staurolite | Scapolite | Sphene | Apatite | Zircon | Tourmaline | Opaques | Epidote | Calcite | Chlorite | Sericite | Other minerals; remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Gneiss** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0015 | 843398 | X | x | X | | X | | | | | | | | | | | | | | | | | | |
| 0024 | 825375 | X | X | X | x | X | | | | | | | | | | | | | | | | | | Allanite(?), t |
| 0038 | 927323 | X | X | X | | X | x | | | | | | | | | t | t | | t | t | | | | |
| 0038A | 927323 | X | x | X | t | X | X | | | | | | | | x | t | t | | x | t | t | | | Migmatitic |
| 0049 | 880337 | X | t | X | | x | | | t | | | | | | | | t | | t | t | | t | | Migmatitic |
| 0050 | 871341 | X | X | X | | x | X | | | | | | | | x | t | t | | x | t | | | | |
| 1104 | 972228 | X | X | x | | X | x | | X | | | | | | t | t | | | | | | | | Metavolcanic? |
| 1105 | 972231 | X | X | x | | | X | x | x | | | | | | x | t | | | t | | | | | Metavolcanic? |
| 4067 | 713549 | X | X | X | | | | | | | | | | | | t | | | x | t | | t | | Leucogneiss |
| 4071 | 7145[illegible] | X | X | X | x | x | | | t | | | | | | t | | t | t | t | | | | | |
| **Schist** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0012A | 851398 | X | x | | X | | | | | | | | | | | | | x | X | | | | | |
| 0030 | 869386 | X | | X | X | X | | | | (?) | | | | | | t | | | | | | | | Spotted |
| 0039A | 932325 | X | | X | t | X | | | x | | x | | | | | | t | | t | | | | | |
| 0093A | 854306 | X | | x | X | X | | | | | | | | | | | | | | | t | t | | |
| 0147 | 934398 | X | | X | X | X | | | | | x | | | | | | | | | | | | t | |
| 0149 | 929402 | X | | X | x | X | | | | | | | | | | t | t | | x | | | | | |
| 3330 | 849417 | X | X | | X | | | | | | | X | | | | x | | | | | | | | Graphite, x |
| 3346 | 840470 | x | X | | X | X | | | x | X | | | | | | | | t | | | | | | |
| 4201 | 830621 | X | | t | x | X | t | | | X | | | | | | | t | | t | | | | | |
| 4201A | 830621 | X | | | X | X | | | | | | | | | | | | | | | | | | |
| 4207 | 787627 | X | | X | X | X | | | | | | | | | | x | t | | | | | | | |
| 4225 | 878724 | X | | | x | | | | | | | | | | | t | | X | | | | | t | |
| 4225A | 878724 | X | | | X | X | | | | x | x | | | | | | | t | | | | | t | |
| 4233 | 802767 | X | | | X | X | | | X | | | | t | | | | | | t | | | | | ) |
| 4235 | 820768 | X | | | X | X | | | x | | | | | | | | | | t | | | | | ) |
| 4237 | 775773 | X | | | X | X | | | X | x | | | X | | | t | | | t | | | | | ) Mount Norna Quartzite |
| 4238 | 796759 | X | X | | X | X | | | | | | | | | | | | | | | | | | ) |
| 4240 | 803758 | X | | | X | X | | | | X | (?) | | | | | | | t | | | | | | |
| 4252 | 893637 | X | | | | | | | X | | | | | | | | | | X | | | | | |
| 4260 | 842603 | X | | x | x | X | | | | | X | | | | | | t | t | t | | | | | |
| 4274 | 823593 | X | | | X | X | | | | (?) | | | | | | t | t | | t | | | | | |
| **Meta-arenite** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0039 | 932326 | X | | X | | x | | | x | | | | | | | | t | | x | | | | | Rutile, t |
| 0049A | 876338 | X | X | X | | | | | x | | | | | | | | | x | | | | | | |
| 0093B | 854306 | X | t | X | t | X | | | | | | | | | | t | | | t | | | | | |
| 0116 | 850279 | X | x | X | | (x) | | | | | | | | | | t | | | t | | | t | t | |
| 0120 | 841278 | X | X | X | x | x | | | | | | | | | | t | | | x | | | t | t | |
| 0571A | 900240 | X | | ? | | | X | | X | | ? | | | | x | t | | | x | t | | t | t | ) Garnet quartzite, |
| 0571B | 900240 | X | | | t | x | | | X | | | | | | | t | | | x | | | t | | ) Dingo prospect |

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Table 2 (cont)

| Sample No. (prefix 7853) | Location | Quartz | K-feldspar | Plagioclase | Muscovite | Biotite | Amphibole | Clinopyroxene | Garnet | Andalusite | Sillimanite | Cordierite | Staurolite | Scapolite | Sphene | Apatite | Zircon | Tourmaline | Opaques | Epidote | Calcite | Chlorite | Sericite | Other minerals; remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Meta-arenite** (cont) | | | | | | | | | | | | | | | | | | | | | | | | |
| 1478 | 745635 | X | X | X | | X | | | | | ? | | | | | | | | t | | | | | |
| 3012 | 695662 | X | X | x | x | | | | | | | | | | | | | | | | | | | |
| 3039 | 743663 | X | X | x | X | X | | | | | | | | | t | | | | t | | | | | |
| 3136 | 771504 | X | X | x | | X | | | | | x | | | | | | | | | | | | | |
| 3334 | 900420 | x | X | x | | X | | | X | | | | | | | | | | | | | | | |
| 3337 | 871427 | X | X | | | | | | x | | | | | | | | | | | x | x | t | t | |
| 3351 | 903474 | X | X | | X | | | | | | X | | | | | | | | X | | | | | |
| 3521 | 813233 | x | X | | X | | | | | | | | | | | | | | x | | X | | | |
| 4200 | 853622 | X | t | X | X | X | | | | | | | | | | | t | | t | | | | | |
| 4218 | 824678 | X | | X | x | x | | | t | | | | | | | t | | | t | | | t | | |
| 4220 | 823685 | X | t | X | t | X | | | | | | | | | | | | | t | | | | | |
| 4241 | 873679 | X | | | | x | | | X | | | X | | | | t | | | t | | | | | |
| 4241A | 873679 | X | | | | | x | | X | | | X | | | | t | t | | x | | | | | |
| 4265 | 847597 | X | | X | x | x | | | | (?) | | | | | | | | | t | | | t | | |
| **Calc-silicate rocks** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0037B | 922326 | X | | X | | | x | X | X | | | | | | x | t | | | | X | | | | |
| 0048 | 867336 | X | | X | | | x | X | | | | | | | x | t | | | | X | | | t | Banded |
| 0052 | 862350 | X | x | X | | | X | X | | | | | | | x | t | | | t | t | t | | | Banded |
| 0086 | 859328 | X | x | X | | | X | | | | | | | | x | x | | | x | t | | | | Banded |
| 0574 | 879238 | | X | | | | X | | | | | | | | x | | | | | x | | | | Laminated |
| 1460 | 698629 | | | x | | | x | X | | | | | | | x | x | | | t | x | | | | Prehnite, x |
| 1460A | 698629 | | | X | | | x | X | | | | | | x | x | t | | | | t | | | | Prehnite, x |
| 1462 | 703628 | X | | X | | x | t | X | | | | | | | t | | | | X | | | | | |
| 3344 | 834471 | | X | | | | | X | | | | | | | | | x | | | | X | | | |
| **Metabasic rocks** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0012 | 851398 | | | X | | | X | x | | | | | | | t | t | | | t | t | | | | Schistose |
| 0039B | 932325 | | | X | | | X | | X | | | | | | | t | | | x | | | | | Schistose |
| 0099 | 867295 | | | X | | | X | | | | | | | | x | t | | | t | t | t | t | t | Gneissic |
| 0166A | 874255 | x | | (X) | | | X | | X | | | | | | | t | | | x | t | | | t | Gneissic metabasalt |
| 0167 | 875255 | | | X | | | X | | | | | | | | x | | | | | t | | | | Gneissic ?metabasalt |
| 1459 | 695630 | | | X | | | X | X | | | | | | | | | | | x | | | | | Hornfels |
| 1460 | 698629 | | | X | | | X | x | | | | | | | x | | | | | | | | | Foliated |
| 1671A | 842516 | X | | | | | X | X | x | | | | | X | x | t | | | x | | t | | | ?Metabasalt; Fairmile Prospect |
| 3017 | 695670 | | X | x | | | X | | | | | | | | | | | | x | | | | | ?Metabasalt |
| 3080 | 639727 | x | X | t | | | X | | | | | | | | | | | | x | t | | | t | Metabasalt |
| 3091 | 732752 | | X | | | x | X | | | | | | | | | | | | x | | X | | | Metabasalt |
| 3092 | 727748 | | X | | | | X | | | | | | | | | | | | x | | | | | ?Metadolerite |
| 3329 | 845412 | | x | X | | | X | | | | | | | | | | | | | | | | | ?Metadolerite |
| 3345 | 836468 | | X | x | | | X | | | | | | | | | | t | | x | | | | | ?Metadolerite |
| 3369 | 852552 | | X | x | | | X | x | | | | | | | | | | | x | | | | | ?Metadolerite |

Table 2 (cont)

| Sample No. (prefix 7853) | Location (GR) | Quartz | K-feldspar | Plagioclase | Muscovite | Biotite | Amphibole | Clinopyroxene | Garnet | Andalusite | Sillimanite | Cordierite | Staurolite | Scapolite | Sphene | Apatite | Zircon | Tourmaline | Opaques | Epidote | Calcite | Chlorite | Sericite | Other minerals; remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metarhyolite | | | | | | | | | | | | | | | | | | | | | | | | |
| 1466 | 720630 | X | ? | $\underline{X}$ | | | x | | | | | | | | | t | | | t | | t | | | Sparsely porphyritic |
| 1470 | 728632 | X | X | X | x | | | | $\underset{=}{X}$ | | | | | | | | | | t | | | | | Poikiloblastic |

X, major constituent (> 10% of rock)

x, minor constituent (1-10% of rock)

t, trace constituent (< 1% of rock) or alteration product

(), pseudomorphed

=, as porphyroblasts/phenocrysts

_, some as porphyroblasts/phenocrysts

## Table 3. Kuridala Formation: petrographic data

| Sample No. | Location (GR) | Quartz | K-Feldspar | Plagioclase | Muscovite | Biotite | Amphibole | Garnet | Andalusite | Cordierite | Staurolite | Zircon | Tourmaline | Opaques | Calcite | Chlorite | Sericite |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Schist** | | | | | | | | | | | | | | | | | |
| 79536064 | 511490 | X | X | | X | | | | X= | | | | | x | | x= | |
| 78536099 | 497430 | X | X | | X | X | | x= | | | x= | | | | | | |
| 78536101 | 518428 | X | X | | | | | | | | | | | | | | |
| 78536168 | 482417 | X | X | | X | X | | x= | | | | | | | | | |
| 78536203 | 540446 | X | X | | X | X | | | | | | | | | | | |
| 78536239 | 509487 | X | X | | X | X | | | | | | | | x | | | |
| 78536241 | 495493 | x | X | | | | | | | | | | | x | | | X |
| 78536391 | 485391 | X | X | | X | | | | | x= | | | | | | | |
| 78536392 | 489386 | X | X | | X | X | | | x= | | | | | | | | |
| 78536394 | 484374 | X | X | | X | x | | x= | | | | | | | | | |
| **Meta-arenites** | | | | | | | | | | | | | | | | | |
| 79536059 | 498488 | X | X | | x | t | | | | | | t | | | | | |
| 79536065 | 513486 | X | X | | x | | | | | | | | | t | | x | |
| 79536068 | 497482 | X | X | | X | X | | | | | | | X | | | | |
| 78536097 | 517429 | X | X | t | x | x | | | | | | | | | | | |
| 78536103 | 512436 | X | X | t | X | X | | | | | | | | | | | |
| 78536170 | 496411 | X | X | | X | X | t | | | | | | | | | | |
| 78536176 | 512415 | X | X | | X | X | | | | | | | | | | | |
| 78536187 | 530400 | X | X | x | x | X | | | | | | | | t | | | |
| 78536196 | 571431 | X | X | x | X | | | | | | | | | x | | | |
| 78536217 | 537450 | X | X | | x | X | | | | | | | | | | | |
| 78536247 | 497520 | X | X | | x | x | | | | | | | | | | x | |
| 78536412 | 572394 | X | X | x | X | X | | | | | | | | x | | x | |
| **Calc-silicate granofels** | | | | | | | | | | | | | | | | | |
| 78536245 | 485485 | | | | | | X | | | | | | | | X | | |

X, major constituent (>10% of rock)

x, minor constituent (1-10% of rock)

t, trace constituent (<1% of rock) or alteration product

=, as porphyroblasts

## Table 4. Corella Formation: petrographic data

| Sample No. (prefix 7853) | Location (GR) | Quartz | K-feldspar | Plagioclase | Muscovite | Biotite | Amphibole | Clinopyroxene | Garnet | Cordierite | Scapolite | Sphene | Apatite | Tourmaline | Opaques | Epidote | Calcite | Chlorite | Sericite | Other minerals; remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Banded calc-silicate rocks (units BKc and $BKc_{br}$)** | | | | | | | | | | | | | | | | | | | | |
| 0065A | 824343 | X | | | | | x | | | | | | t | X | | | | t | | Laminated |
| 0065B | 824343 | X | X | | | | X | | | | | | | X | | | | | | |
| 0065E | 824343 | X | | X | | | | | | | | | | | | | | | | |
| 0070 | 819316 | x | X | X | | | X | | | | | x | t | | x | | | | | |
| 0134 | 807371 | x | t | X | | | X | | | | | | t | | t | | | | | Laminated |
| 1451 | 815266 | x | X | X | | | X | | | | | t | t | | x | x | t | t | | Laminated |
| 1486 | 725425 | X | X | X | x | (?) | | | | | | | | | t | | | t | | |
| 1486A | 725425 | X | | <u>X</u> | | | X | X | | | | t | x | | x | | t | | | <u>Phlogopite</u>, t |
| 1494 | 706421 | X | x | X | | x | | | | (x?) | | | | | | | | t | t | |
| 1519 | 670415 | X | X | ? | | | | | | | | | | | X | | | | | |
| 3114 | 516595 | x | X | x | | | X | x | | | | t | x | | | X | X | | | |
| 3118 | 510655 | | X | | | | x | X | <u>X</u> | | X | | x | | | | | | | |
| 3388 | 492558 | x | X | | | | X | | | | x | | | | t | | X | | | |
| 3598 | 497657 | x | X | | | | <u>X</u> | x | | | <u>X</u> | x | | | | | X | | | |
| 4051 | 657508 | | x | X | | | t | X | | | | x | x | | x | x | t | | | |
| 4059A | 698526 | X | X | | | x | x | X | | | | | | | x | | X | | | |
| 4065A | 707545 | | | X | | | X | | | | | x | | | t | t | t | t | | |
| 4070 | 714528 | x | x | X | | | X | x | | | | x | x | | x | | t | | t | |
| 4074D | 724535 | | | X | | | X | X | | | | x | t | | x | x | x | t | | |
| 4540 | 625698 | X | | X | | | | X | | | | x | | | | | X | | | |
| **Brecciated calc-silicate rocks (units BKc and $BKc_{br}$)** | | | | | | | | | | | | | | | | | | | | |
| 0071 | 818316 | x | x | X | | | X | X | | | | x | x | | x | | | | | |
| 0072B | 816315 | | | X | | | X | X | | | | x | x | | x | | | | | |
| 0128 | 822371 | | | X | | | X | | | | | x | t | | t | | | | | <u>Rutile?</u>, t; <u>phlogopite</u>, t |
| 3108 | 489595 | x | X | X | | | X | | | | | x | | | t | | | | | |
| 3115 | 500585 | X | X | | | | | | X | | | x | | | | x | X | | | |
| 3119 | 667510 | | X | x | | | X | | | | | | | | x | | X | | | |
| 4064 | 693540 | | ? | X | | | X | X | | | | x | t | | x | x | t | | | |
| 4084 | 623484 | | | X | | | X | | | | | t | t | | x | | | | | |
| 4087 | 629477 | | | X | | | x | X | | | | x | t | | | t | X | | | |
| 4105 | 557507 | X | | X | | | X | | | | | x | | | | | | | | |
| **Metabasic rocks (unit $BKc_{br}$)** | | | | | | | | | | | | | | | | | | | | |
| 0065C | 824343 | | | X | | | X | x | | | | <u>x</u> | | x | | | | | | ?Metabasalt |
| 0065D | 824343 | | | X | | | X | | | | | x | t | | t | | | | | ?Metabasalt |
| 0065F | 824343 | | x | X | | x | X | X | | | | x | t | | x | x | | | | Metadolerite |
| 0072C | 816315 | | x | X | | | X | | | | | x | | | x | | | t | | ?Metabasalt |
| 4049 | 664504 | | | x | | | X | | | | | t | | | x | X | t | X | | ?Metadolerite |

Table 4. (cont)

| Sample No. (prefix 7853) | Location (GR) | Quartz | K-feldspar | Plagioclase | Muscovite | Biotite | Amphibole | Clinopyroxene | Garnet | Cordierite | Scapolite | Sphene | Apatite | Tourmaline | Opaques | Epidote | Calcite | Chlorite | Sericite | Other minerals; remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units $BKc_x$ and $BKc_{xbr}$ | | | | | | | | | | | | | | | | | | | | |
| 1520 | 490720 | X | ? | X | | t? | | | | | | | t | t | X | | $\underline{x}$ | t | t | Siltstone |
| 3105 | 490572 | | X | | | | X | | | | X | t | | | | | X | | | Granofels |
| 3126 | 556730 | t | X | | x | x | | | | | | | | | x | | | | X | Siltstone |
| 3301 | 519723 | X | X | | x | | | | | | $\underline{\underline{X}}$ | | | | | | X | | | Granofels |
| 3305 | 495717 | | X | | x | X | | | | | | | | | x | | X | | | Calcarenite |
| 3306 | 490717 | X | X | t | x | | | | | | | | | | x | | | | | Arenite |
| 3380 | 492714 | X | X | X | x | | | | | | | | | | X | | X | | | Breccia |
| 3384 | 493670 | X | X | | | | | | | | | | | | x | | | | t | Arenite |
| 3387 | 486660 | X | X | | | | | | | | | | | | | | | | | Breccia |
| 3403 | 503325 | x | X | X | | | | X | | | | X | | | | | | | | Granofels |
| 3408 | 495342 | X | X | | | | | | | | | | | | | | | | | Arkose |
| 3599 | 512682 | X | X | | | | | | | | | | | | x | | X | | x | Breccia |
| 0256* | 498750 | x | X | X | X | t | | | | | | | | | x | | X | t | | Calcarenite |

*prefix 7953

X, major constituent (>10% of rock)

x, minor constituent (1-10% of rock)

t, trace constituent (<1% of rock) or alteration product

( ), pseudomorphed

=, as porphyroblasts

_, some as porphyroblasts

## Table 5. Williams Granite: petrographic data

| Sample No. (prefix 7853 | Location (GR) | Quartz | K-feldspar | Plagioclase | Muscovite | Biotite | Amphibole | Clinopyroxene | Sphene | Apatite | Zircon | Tourmaline | Opaques | Epidote | Calcite | Chlorite | Sericite | Other minerals; remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Williams Granite** | | | | | | | | | | | | | | | | | | |
| 1458 | 693629 | X | X | X | | | x | x | t | x | | | t | t | | | | |
| 1467 | 721628 | X | X | X | | x | X | x | x | t | t | | x | | | | | Scapolite, x |
| 1497 | 704411 | X | X | X | | X | t | X | t | t | | | x | | | | | Melanocratic (CI ∿ 40) |
| 3015 | 707669 | X | X | x | | x | | | x | | | | t | | | | | |
| 3053 | 722660 | | X | | | | x | | x | | | | x | t | | t | t | Syenitic |
| 3059 | 656763 | X | X | X | | | x | | x | | | | x | t | | | | |
| 3076 | 627728 | X | X | X | | | x | X | x | | t | | | | t | | | |
| 3078 | 634727 | X | | X | | | X | X | x | | | | x | t | | | | Tonalitic |
| 3096 | 702742 | X | X | X | | | t | | x | | | | | | t | t | | |
| 3112 | 532608 | X | X | | | x | | | x | | t | | | | | t | | |
| 3161 | 760417 | X | X | X | | X | | | x | | | | | t | t | t | | |
| 3172 | 501392 | x | X | X | | X | | | x | | t | | x | | | t | t | Monzonitic, porphyritic |
| 3173 | 508396 | x | X | X | | t | X | | x | | t | | x | | | t | | Monzonitic, porphyritic |
| 3206 | 553445 | X | | X | | | X | | x | | | | x | | | | | Tonalitic |
| 3315 | 795426 | X | X | | | x | | | x | | t | | t | | | | | |
| 3415 | 546372 | X | X | X | | x | X | | x | | | | t | | | t | | |
| 3429 | 561306 | X | X | X | | x | x | | x | | t | | | | | | | Porphyritic |
| 3432 | 583334 | X | X | | | | | | | | | | t | | | t | | |
| 3444 | 642296 | X | X | X | | | | | t | | t | t | | t | t | t | t | Porphyritic |
| 3447 | 688301 | X | X | X | | | x | | x | | | | t | | | t | | Porphyritic |
| 3511 | 788572 | x | X | X | | X | x | | x | | | | | | | | | Monzonitic |
| 3524 | 622761 | X | X | | | X | X | | x | | | | x | | | | | |
| 3544 | 678458 | x | X | X | | | X | | t | | | | x | t | t | | t | Monzonitic |
| 4049B | 664504 | X | X | (X̲) | | (x) | | | t | t | | | t | t | | t | | Porphyritic |
| 4057 | 698498 | X | X | X | | x | X | | t | t | t | | x | | | t | t | |
| 4061 | 701535 | X | X | X̲ | | t | X | | x | t | | | x | t | | t | t | Porphyritic |
| 4205 | 821616 | X | X | X | x | x | | | | t | | | | | t | t | t | Fluorite, t |

X, major constituent (>10% of rock)

x, minor constituent (1–10% of rock)

t, trace constituent (<1% of rock) or alteration product

( ), pseudomorphed

_, some as phenocrysts

Table 6. Unnamed granite and metadolerite: petrographic data

| Sample No. (prefix 7853) | Location (GR) | Quartz | K-feldspar | Plagioclase | Muscovite | Biotite | Amphibole | Clinopyroxene | Sphene | Apatite | Zircon | Opaques | Epidote | Calcite | Chlorite | Sericite | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Unnamed granite** | | | | | | | | | | | | | | | | | |
| 0020 | 828388 | X | X | X | | X | | | | t | t | x | | | | t | Fine-grained, foliated |
| 0045 | 860342 | X | X | X | t | x | | | | | t | t | | | t | | Medium grained |
| 0054 | 843342 | X | X | X | t | x | | | | t | t | | | | t | | Medium grained |
| 0072D | 816315 | X | X | X | | x | | | | | | t | | | | | Fine-grained |
| 0137 | 824370 | X | X | X | t | X | | | | t | t | t | | | | | Fine-grained |
| 1104A | 973228 | X | X | | | | x | | x | t | | t | | t | | | Aplite vein |
| **Metadolerite** | | | | | | | | | | | | | | | | | |
| 0072D | 816315 | | | $\underline{X}$ | | X | X | | | | | x | | | | | Intrudes Єg |
| 0103 | 871279 | X | | ($\underline{X}$) | | (t) | X | (?) | | t | | x | t | | t | | Intrudes Єo |
| 1498 | 705395 | | | $\underline{X}$ | | | $\underline{X}$ | | x | t | | x | | | | | Intrudes $Єgi_a$ |

X, major constituent (> 10% of rock)

x, minor constituent (1-10% of rock)

t, trace constituent (< 1% of rock)

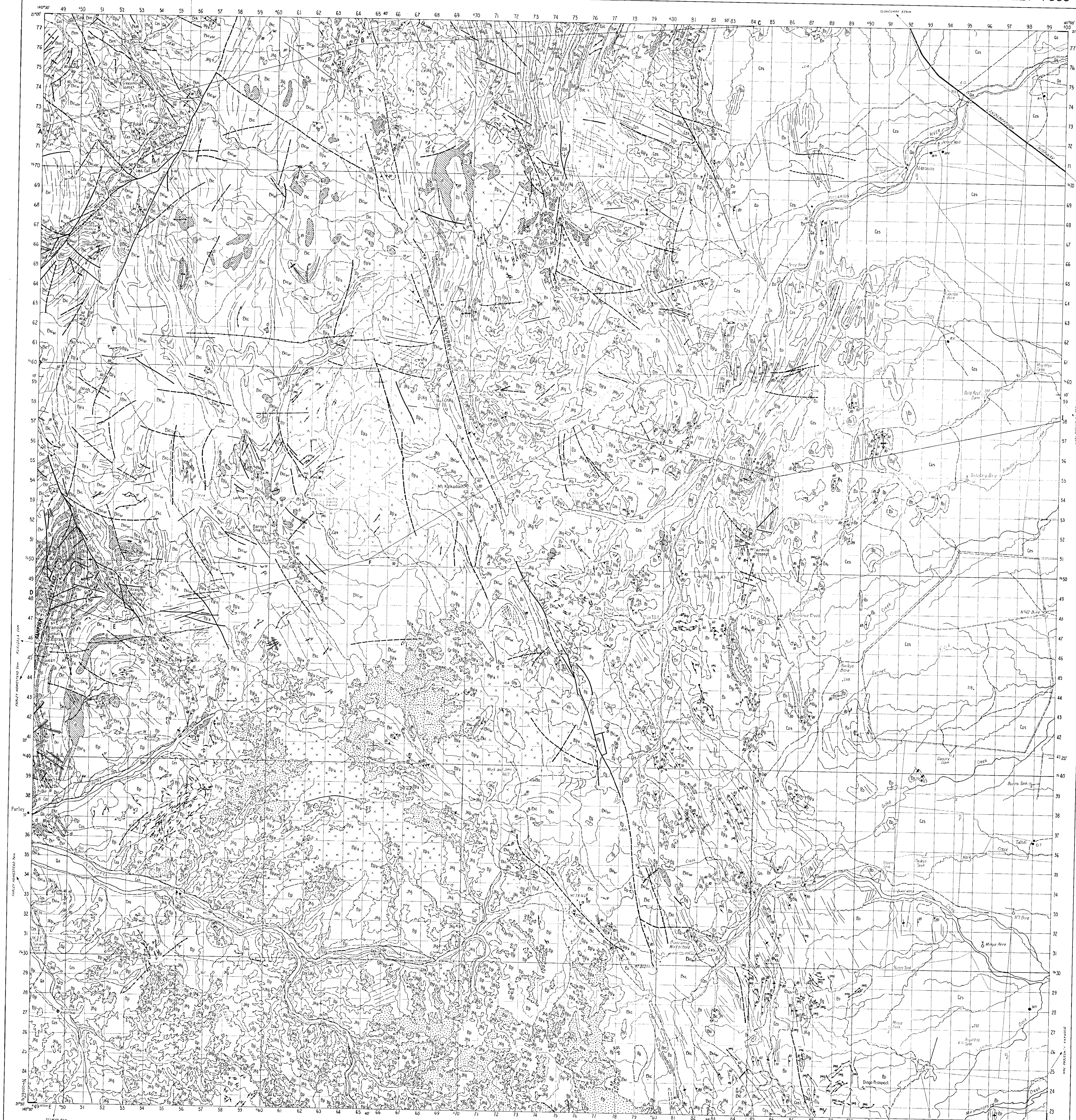
( ), pseudomorphed

_, some as phenocrysts

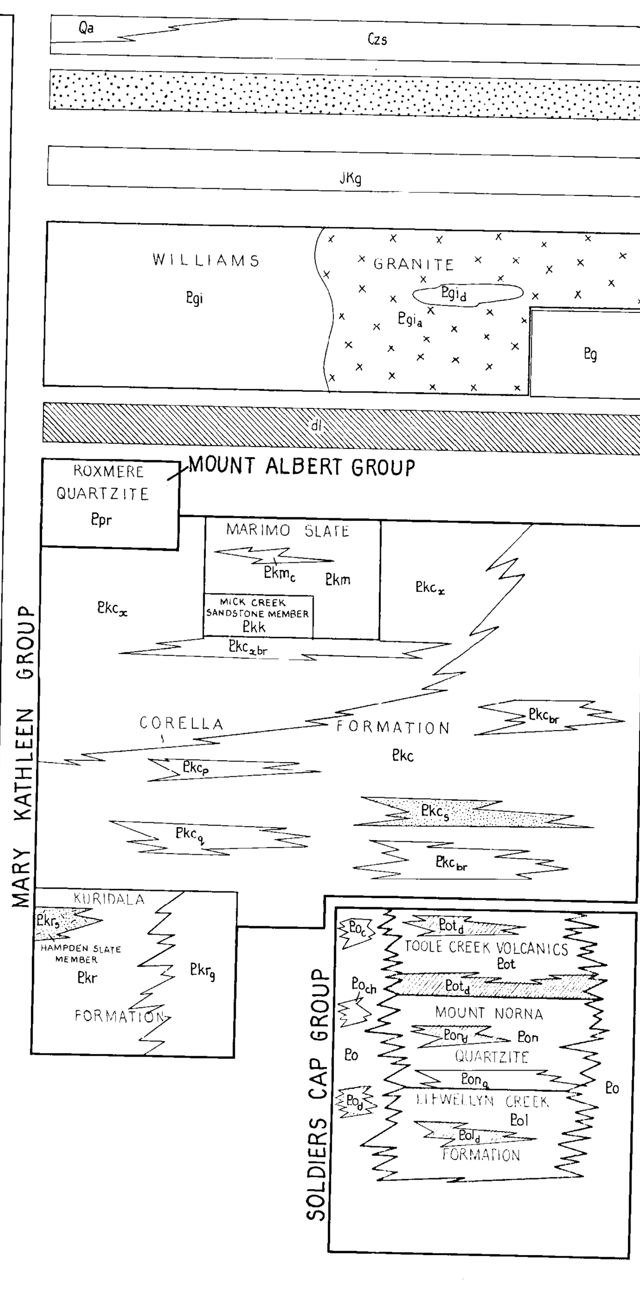
AUSTRALIA 1:100 000 GEOLOGICAL SERIES

# MOUNT ANGELAY
## QUEENSLAND

SHEET 7055



Qa Alluvial sand, gravel, silt, clay — QUATERNARY
Czs Colluvial and alluvial sand, silt, gravel
Leached bedrock: mesa capping
JKg Conglomerate, grit, sandstone, siltstone — MESOZOIC



Ꝑgp Porphyritic, medium to coarse biotite, hornblende, and hornblende-biotite granite
Ꝑgi Medium to coarse biotite, hornblende and hornblende-biotite granite; minor porphyritic, granodioritic, and foliated phases; xenoliths common near margins
Ꝑgi$_d$ Xenolithic hornblende-bearing diorite, granodiorite
Ꝑg Fine to medium leucogranite and pink hornblende granite; minor foliated phases; xenoliths common
di Metadolerite; minor amphibolite
Ꝑpr Cross-bedded feldspathic arenite and quartzite; minor micaceous siltstone
Ꝑkm Black to grey slate, arenite, siltstone, minor phyllite, chert, and siliceous to calcareous breccia
Ꝑkm$_l$ Limestone
Ꝑkk Ripple-marked feldspathic arenite and quartzite
Ꝑkc$_u$ Fine to medium calcareous granofels, calcareous to non-calcareous feldspathic arenite, quartzite and siltstone; minor bedded breccia
Ꝑkc$_{br}$ Brecciated calcarenite and quartzite; minor bedded calcareous granofels and arenite
Ꝑkc Banded to massive calc-silicate granofels; minor calc-silicate breccia
Ꝑkc$_m$ Calc-silicate breccia; minor banded to massive calc-silicate granofels
Ꝑkc$_p$ Biotite-muscovite schist
Ꝑkc$_s$ Black slate
Ꝑkc$_l$ Calcareous to non-calcareous, laminated, feldspathic quartzite; minor calc-silicate granofels
Ꝑks Grey to black slate, minor banded calc-silicate granofels
Ꝑkr Mica schist commonly garnetiferous; meta-arkose; minor micaceous quartzite, banded ironstone
Ꝑkr$_g$ Micaceous metagreywacke, feldspathic quartzite, mica schist, minor breccia, banded ironstone
Ꝑo Mica schist, feldspathic gneiss, meta-arenite, pegmatite, banded iron formation; minor metarhyolite
Ꝑo$_s$ Massive, banded, and brecciated calc-silicate granofels
Ꝑo$_c$ Chert
Ꝑoy Schistose amphibolite: metabasalt and metadolerite
Ꝑot Mica schist, metasiltstone, quartzite
Ꝑot$_d$ Amphibolite: metabasalt and metadolerite
Ꝑon Quartzite, garnet-andalusite-mica schist, micaceous meta-arenite; minor conglomerate and metagreywacke
Ꝑon$_d$ Amphibolite: metabasalt and metadolerite
Ꝑon$_q$ Quartzite
Ꝑol Mica schist, commonly andalusite-bearing, phyllite, metasiltstone
Ꝑol$_d$ Amphibolite: metabasalt and metadolerite

Geological boundary
Antiform, showing trend and plunge of axis
Antiform, second folding episode
Synform, showing trend and plunge of axis
Synform, second folding episode
FA Trend of plunge fold axis, second folding episode
FA Trend of plunge fold axis, third folding episode
Fault (q indicates quartz filled)
Fault showing relative horizontal movement
80 Normal fault showing dip of fault plane

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

Shear zone
70 Plunge of minor anticline
65 Plunge of minor anticline, second folding episode
60 Plunge of minor syncline
70 Plunge of drag fold
70 Strike and dip of strata
45 Strike and dip of strata, facing not known
75 Strike and dip of overturned strata
Vertical strata
Horizontal strata
Strike and dip of strata, dip 15°-45° — airphoto interpretation
Strike and dip of strata, dip >45° — airphoto interpretation
Trend line — airphoto interpretation
Lineament — airphoto interpretation
Joint pattern — airphoto interpretation
Top of bed indicated by cross-bedding, arrow shows facing
60 Strike and dip of foliation
50 65 Strike and dip of foliation with plunge of mineral elongation
60 Strike and dip of foliation, second folding episode
Vertical foliation
Vertical foliation, second folding episode

80 Strike and dip of cleavage
80 Strike of bedding and cleavage coincident
Vertical cleavage
Dyke: dolerite, metadolerite, amphibolite
q Dyke; ap-aplite, gr-granite, peg-pegmatite, q-quartz

DD Diamond drillhole
Mine not being worked
Prospect
Costean
Cu Minor mineral occurrence
Au Gold
Cu Copper
Fe Iron

Windpump
Bore with windpump
T Water tank
E Earth tank or dam
WH Waterhole
Spring
Highway
Vehicle track
Landing ground
Fence
Abandoned railway
Maronon Homestead
Building
Yd Yard
Trigonometrical station
255 Elevation in metres, approximate
337 Elevation in metres, accurate

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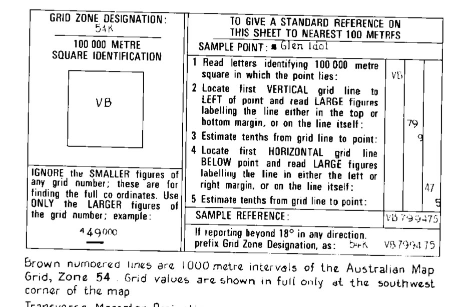

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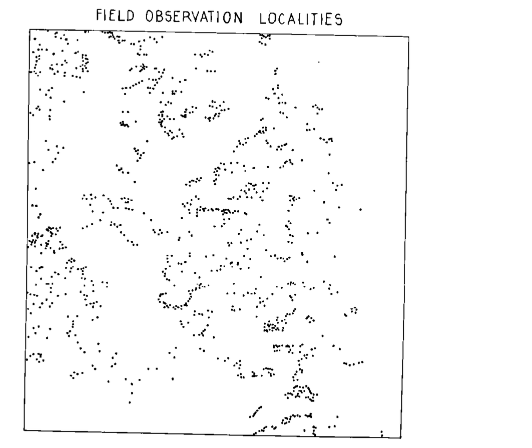

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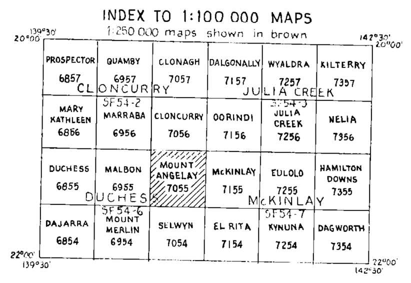

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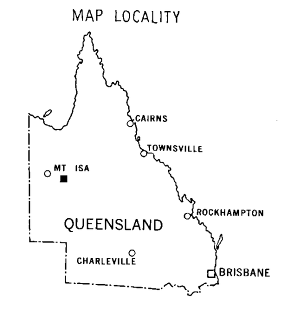

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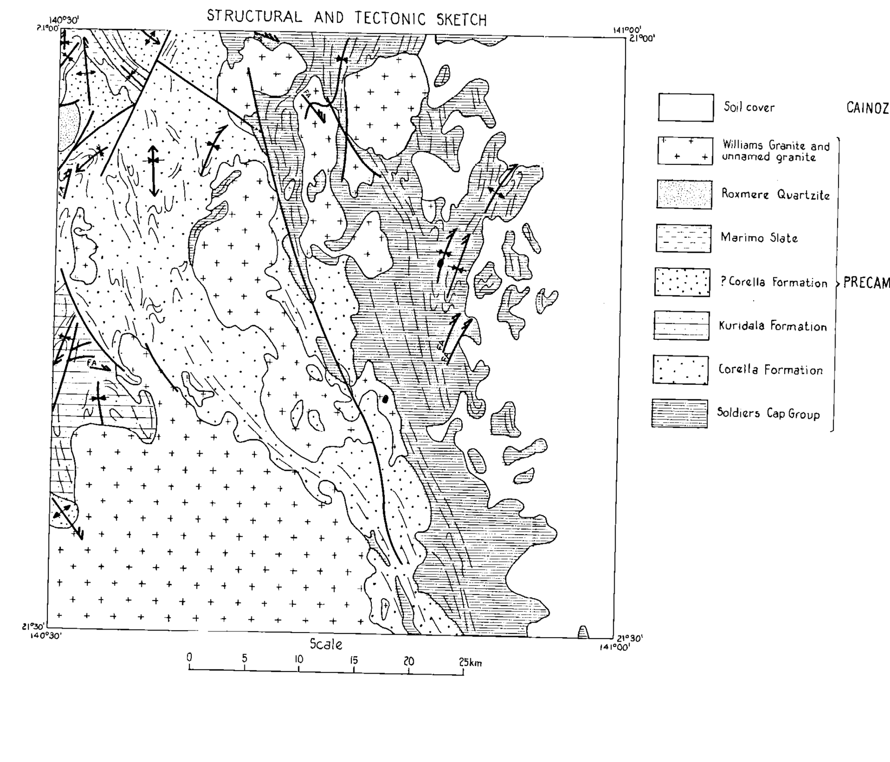

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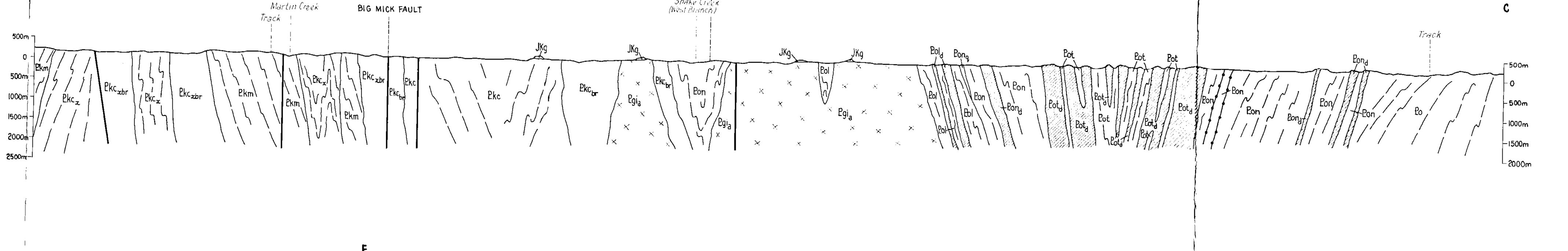

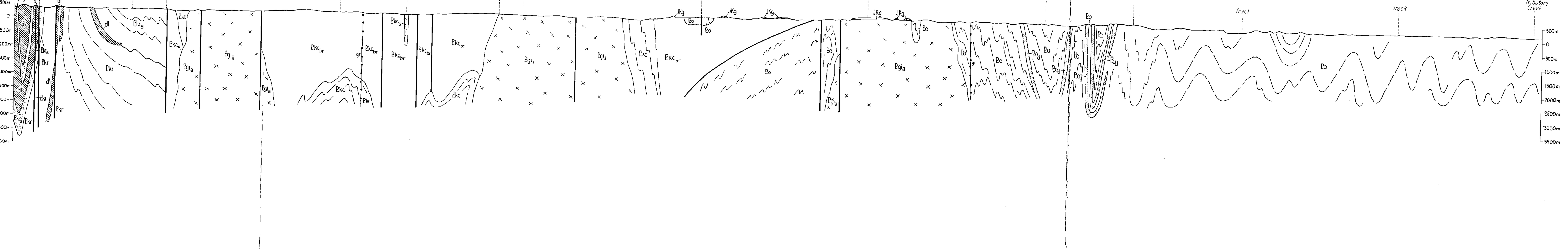

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