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PRECAMBRIAN GEOLOGY OF THE DAJARRA 1:100 000 SHEET AREA, NORTHWESTERN QUEENSLAND - PRELIMINARY DATA

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CONTENTS

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SUMMARY

Precambrian rocks of the Dajarra Sheet area, in the southwest of the Mount Isa Inlier, belong to the Cloncurry Complex. The oldest are acid to intermediate gneiss and schist (mainly metavolcanics) and minor quartzite and metabasalt, which are mapped as Tewinga Group, and banded calc-silicates and amphibolitic metabasalt of the Corella Formation which are considered in this work to be equivalent to part of the Tewinga Group (in contrast to the generally accepted view that the Corella Formation is much younger than the Tewinga Group). These metamorphic rocks (upper greenschist to amphibolite grade) are steeply dipping and generally trend between north and northwest. They are intruded by massive to gneissic Kalkadoon Granite. The Tewinga Group and Kalkadoon Granite are overlain unconformably by rocks of lower metamorphic grade: in the west by the Haslingden Group and in the central part of the area by Standish package rocks.

The Haslingden Group comprises the conglomeratic Yappo Formation (new name) at the base, and overlying quartz arenites of the Mount Guide Quartzite, metabasalt and quartz arenite of the Eastern Creek Volcanics, and feldspathic and quartz arenites mapped as Myally Subgroup?. Rhyolitic tuff and quartz arenite mapped as Carters Bore Rhyolite? appear to conformably overlie Myally Subgroup? in the southwest. The Haslingden Group rocks are folded into major north-trending upright anticlines and synclines.

The basal unit of the Standish package, the Standish Volcanics (new name), consists of felsitic quartz-feldspar porphyry and local basic volcanics. It is intruded by the non-orogenic Wills Creek Granite (new name), and is overlain, possibly concordantly, by Stanbroke Sandstone (new name), which includes some carbonate beds, and Makbat Sandstone. The two sandstone units, possible correlatives of the Surprise Creek Beds in sheet areas to the north, are preserved in the keels of northerly to north-northwesterly trending synclines.

Innumerable basic dykes intrude the Precambrian units, and acid porphyry dykes cut the Tewinga Group and Kalkadoon Granite. A thick dyke consisting mainly of porphyritic microgranite, the Garden Creek Porphyry (new name), intrudes Mount Guide Quartzite.

Economic base-metal mineralisation is restricted to a few non-working copper mines. The mineralisation appears to be localised near contacts between amphibolitic basic dykes and rocks of the Tewinga Group, Corella Formation, or Kalkadoon Granite.

INTRODUCTION

Location

The Dajarra 1:100 000 Sheet area forms the southwestern part of the Duchess 1:250 000 Sheet area (SF 54-6) in northwestern Queensland. It is bounded by latitudes 21°30'S and 22°00'S and longitudes 139°30'E and 140°00E.

This data-record gives the results of geological fieldwork carried out during August, September, and October 1977, together with preliminary laboratory data, and is accompanies by the Dajarra 1:100 000 Preliminary Edition map. The work described is part of the Duchess project being carried out by the Bureau of Mineral Resources (BMR) and the Geological Survey of Queensland (GSQ). The aims of the project are to investigate the Precambrian rocks of the Duchess and Urandangi 1:250 000 Sheet areas and assess their mineral potential. The results of this work will be presented mainly in the form of 1:100 000 geological maps and accompanying reports. Preliminary reports and maps of the Malbon and Oban 1:100 000 Sheet areas are now available (Noon, 1978; Mock, 1978) and those for the Duchess 1:100 000 Sheet area are nearing completion (Bultitude, Blake, & Donchak, in prep.).

Access

Access to and within the Dajarra 1:100 000 Sheet area is generally good. The sealed Mount Isa/Boulia road, which passes through Dajarra township, crosses the southwestern part of the Sheet area. An unsealed road leads from Dajarra to Duchess, to the northeast. Another unsealed road connects The Monument, a newly developed township in the eastern central part of the Sheet area, with the Boulia road south of Dajarra. Numerous vehicle tracks to homesteads, bores, and cattle yards, and along fences, provide access away from the main roads. All roads and tracks are usually impassable after heavy rain.

Dajarra is the terminus of the Duchess-Dajarra railway, which joins the main Townsville-Mount Isa railway at Duchess. A new railway line, completed in 1976, connects phosphate workings near The Monument with the Townsville-Mount Isa railway east of Duchess. Landing grounds suitable for light aircraft are maintained at Dajarra and The Monument.

Population and Industry

The main population centres are the townships of Dajarra in the west, population 166 in 1976, and The Monument in the east, population about 120 in 1977. The only other habitation is at Stanbroke and Mayfield homesteads in the north of the Sheet area. The main local industries are cattle-raising and, since 1975, phosphate mining at Phosphate Hill, in the south-east. The phosphate is obtained from Cambrian rocks of the Burke River Outlier (de Keyser, 1968; Russell & Trueman, 1971), not described in this report. A few small copper mines and prospects are known in the Precambrian outcrop area, but none are being worked at present. Noon (1976) has summarised mineral exploration surveys undertaken in the area to February 1976.

Climate

The area has a semi-arid tropical climate (Slatyer, 1964). The average annual rainfall is about 375 mm, most of which falls during the period November to March. Mean monthly maximum and minimum temperatures range from about 35°C and 25°C in December to about 25°C and 10°C in July. Frosts occur locally in June and July. Relative humidity is generally low, mainly being in the 15 to 50 percent range. Further climatic details are given by Carter, Brooks & Walker (1961) and Slatyer (1964).

Topography and drainage

The Dajarra Sheet area lies in the southwest corner of the Leichhardt-Gilbert area, the geomorphology of which has been described by Twidale (1964, 1966). In the west, north-trending narrow dissected rocky plateaux and ridges generally less than 100 m high form the southernmost part of the Isa Highlands of Twidale. To the east are rolling to undulating plains with hills and ridges, mostly less than 50 m high, formed on the more resistant rock types, and mainly narrow flood plains along the major watercourses. Overall, the altitude decreases from north to south, the highest point, about 410 m, being in the northwest and the lowest, about 250 m, being in the south-east.

Most of the Sheet area lies within the catchment of Wills Creek, which drains southwards through the central part of the area from its headwaters northwest of Duchess. The eastern part, however, is drained by eastward-flowing tributaries of the Burke River.

There is a general absence of permanent surface water. A few small semipermanent rock holes occur in the northwest, and some semipermanent waterholes or 'soaks' are present along Wills Creek. Permanent supplies of water, of variable quality, are obtained only from bores.

Vegetation

The rocky plateaux, ridges, and hills, and the rolling to undulating terrain, support a vegetation of spinifex with sparse low trees and shrubs, minor low woodland, and scattered patches of dense to open scrub formed largely of 'turpentine' bush (Acacia lysiphloia). Trees, mainly eucalypts, grow along the main watercourses. Mitchell grass predominates on the plains of the Burke River Outlier in the east. For further details see Carter & others (1961) and Perry & Lazarides (1964).

Previous geological literature

A comprehensive account of the geology of the Precambrian Mount Isa Inlier has been given by Carter & others (1961). Explanatory notes for the Duchess 4-mile Sheet area (=1:250 000 Sheet area) were compiled by Carter & Opik (1963). These two works include the available literature on the geology of the Dajarra area to 1960. No subsequent work on the Precambrian geology of the Sheet area has been published. For details of the geology of the lower Palaeozoic Burke River Outlier, which covers the eastern part of the Dajarra Sheet area, the reader is referred to de Keyser (1968). A summary of mineral exploration in the Sheet area to February 1976 is given by Noon (1976).

Present investigations

The Precambrian rocks of the Dajarra Sheet area were mapped by D.H. Blake (BMR), P.J.T. Donchak (GSQ), and R.J. Bultitude (BMR) during the 1977 field season, using colour aerial photographs at a scale of about 1:25 000; these aerial photographs were taken in 1976 for the Department of National Mapping. Field observations were plotted on transparent overlays on the aerial photographs and transferred onto photo-scale compilation sheets by G.A. Young (BMR draftswoman) in the field. Following checking and corrections, the field compilation sheets were photographically reduced to 1:100 000 scale and then redrawn as the Preliminary Edition map which accompanies this data-record.

Shortly before the 1977 field season, W.J. Perry (BMR) made a preliminary airphoto-interpretation of the Dajarra Sheet area, to help the planning and execution of the survey. For this interpretation he used both the colour airphotos later used by the field geologist, and black and white RC9 air photographs, scale about 1:85 000. During the field season he spent two weeks checking aspects of his airphoto-interpretation on the ground.

Rock nomenclature

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 are laminated, less than 1 cm; thin-bedded, 1 to 50 cm; medium-bedded, 50 cm to 2 m, thick-bedded, over 2 m.

For plutonic rocks the classification recommended by Streckeisen & others (1973) is used. Grainsize descriptions are fine, less than 1 mm; medium, 1 to 5 mm; coarse, 5 mm to 3 cm.

Terms describing metamorphic facies are as defined by Turner & Verhoogen (1960). The name 'granofels', as suggested by Goldsmith (1959), is used for medium to coarse granoblastic metamorphic rocks which do not have a marked foliation or lineation.

OUTLINE OF GEOLOGY

The Precambrian rocks of the Dajarra Sheet area belong to the Cloncurry Complex of the Mount Isa Inlier (Geological Survey of Queensland, 1976), an area where joint BMR/GSQ field parties have been carrying out relatively detailed regional geological surveys since 1969. This work follows on from the broad reconnaissance survey by BMR/GSQ in the 1950s, the results of which were published as BMR Bulletin 51 (Carter, Brooks & Walker, 1961). Bulletin 51 and the Explanatory Notes for the Duchess 4-mile Sheet (Carter & Opik, 1963) give the only previous general accounts of the Precambrian geology of the Dajarra Sheet area. Descriptions of the Cambro-Ordovician sedimentary rocks of the Burke River Outlier, which crop out in the eastern part of the sheet area, are included in the explanatory notes by Carter & Opik (1963) and also in an unpublished BMR Record by de Keyser (1968).

The Precambrian stratigraphy of the Dajarra Sheet area is summarised in Table 1. The oldest rocks exposed are those of the Tewinga package, comprising the Tewinga Group, Corella Formation, and Kalkadoon Granite. (The term 'package' denotes an informal grouping of rocks spanning a certain time range and separated from other such groupings by regional unconformities or major changes in palaeoenvironment). The Tewinga Group in the area probably includes equivalents of the Leichhardt Metamorphics, Magna Lynn Metabasalt, and Argylla Formation, the three formations which make up the group in sheet areas to the north (Derrick, Wilson & Hill, 1976a), but it is not subdivided by us into any formally named units in the Dajarra Sheet area. It consists mainly of fine to coarse acid and intermediate gneiss and schist representing metamorphosed volcanics, probably mostly tuffs, and tuffaceous sediments. Also present are partly granitised migmatitic gneiss, quartzite representing meta-arenite, and massive to schistose metabasalt. Much of the acid gneiss contains both lensoid augen and euhedral to subhedral megacrysts of feldspar, mainly microcline. The Tewinga Group rocks show a pronounced foliation which is generally steeply dipping and has an overall north-northwesterly trend, commonly parallel or nearly so to original bedding.

The Corella Formation, exposed to the east of the Tewinga Group, consists mainly of banded calcsilicate rocks (metasediments) and amphibolitic metabasalt lava, and is considered to be equivalent to part of the Tewinga Group. This correlation is based largely on relationships seen north of

Mayfield homestead, just inside the Duchess 1:100 000 Sheet area (Bultitude & others, in prep.), where thin-banded amphibolitic calc-silicates of the Corella Formation interfinger with acid augen gneiss indistinguishable from that of the Tewinga Group. Supporting evidence is given firstly by the overall pattern of regional metamorphism - the Tewinga and Corella rocks are of similar relatively high metamorphic grade (upper greenschist to amphibolite grade) throughout the Dajarra and most of the Duchess 1:100 000 Sheet areas, and are of consistently higher grade than other Precambrian stratigraphic units in the area; and secondly, by the relationships of the Kalkadoon Granite. This granite intrudes and forms migmatites with Tewinga Group rocks, and a foliated granite mapped as a variety of Kalkadoon Granite, together with associated pegmatitic to aplitic veins, intrudes the Corella Formation; however, it is overlain by other Precambrian units. Hence the Kalkadoon Granite is regarded as part of the Tewinga package. Bodies of unnamed quartz-feldspar pegmatite and gneissic granite within the Corella Formation outcrop may be related to the Kalkadoon Granite or may be somewhat younger.

The Tewinga package rocks are overlain unconformably in the west by the Haslingden Group, and in the central part of the area by the Standish Volcanics, Stanbroke Sandstone, and Makbat Sandstone, three units grouped together as the Standish package. The Haslingden Group consists of, in ascending order, the largely conglomeratic and partly volcanic Yappo Formation at the base; the conformably overlying Mount Guide Quartzite formed mainly of cross-bedded quartz arenite; the Eastern Creek Volcanics, a unit of basic lava and interlayed quartz arenite; and, in the southwest, feldspathic and quartz arenites mapped as Myally Subgroup?. Rhyolitic tuffs and interbedded quartz arenite, mapped as Carters Bore Rhyolite?, appear to conformably overlie the Myally Subgroup?. These rocks have been folded into tight, north-trending, upright, major anticlines and synclines, and are locally overturned. They commonly show a well developed axial-plane cleavage, and are regionally metamorphosed to lower and middle greenschist grade.

The Standish package rocks crop out between, and are not seen in contact with, the Haslingden Group to the west and the Corella Formation to the east. The oldest unit of the package, the Standish Volcanics, consists mainly of massive felsitic quartz-feldspar porphyry, and may be a correlative of the Carters Bore Rhyolite. It is intruded by Wills Creek Granite and is overlain, possibly concordantly, by Stanbroke Sandstone in the west

and Makbat Sandstone in the southeast. The two sandstone units are preserved only in the keels of open to tight fault-bounded synclines trending north to north-northwest. The regional metamorphic grade of the Standish package rocks is mainly up to lower greenschist; it is generally lower than that of the Haslingden Group, and is much lower than that of any Tewinga package rocks. Similarity in general lithology, structural situation (in keels of synclines), and regional metamorphic grade indicate that the Stanbroke and Makbat Sandstones may be correlated with the Surprise Creek Beds in the north of the Duchess 1:100 000 Sheet area.

Innumerable basic dykes intrude the Tewinga package, Haslingden Group, and Standish package, although none has been found cutting Myally Subgroup?, Carters Bore Rhyolite?, or Stanbroke Sandstone. On the accompanying map only one is shown within the Corella Formation outcrop; this is because of the difficulty here of distinguishing basic intrusives from basic extrusives. Economic base-metal mineralisation, consisting of a few small copper shows, occurs in the immediate vicinity of some basic dykes intruding Tewinga package rocks. Acid porphyry dykes probably related to the Standish Volcanics intrude the Tewinga Group and Kalkadoon Granite in the central part of the area, and a thick dyke consisting mainly of porphyritic microgranite, the Garden Creek Porphyry, intrudes Mount Guide Quartzite in the northwest.

In the east the western boundary of the Cambro-Ordovician Burke River Outlier is marked by the Pilgrim Fault Zone. Displacements within the zone appear to be minor, probably less than 100 m. Several outliers of flat-lying Cambrian rocks occur to the west, the most westerly in the area being possible Mount Birnie Beds exposed in a small fault wedge within Mount Guide Quartzite in the northwest, at grid reference (GR) UB504150, and Beetle Creek Formation, containing abundant trilobite fossils, overlying Tewinga Group and Standish Volcanics east of the Dajarra-Boulia road in the southwest. Rocks of the Beetle Creek Formation within the Burke River Outlier in the southeast are being mined for phosphate.

Scattered outcrops of flat-lying, poorly consolidated, conglomeratic and finer-grained sedimentary rocks are mapped as possible Mesozoic. They generally occur as low mesas. Other small mesas are capped by laterite and partly lateritised but still identifiable bedrock; these are remnants of probably Tertiary weathering profiles. Unconsolidated residual and alluvial sand, silt, and gravel of Quaternary and probably Tertiary age are mapped together as an undivided Cainozoic unit, Cz. Residual sand also forms an impersistent cover on weathered rock in many areas shown on the Preliminary Edition map as outcrops of Precambrian rocks, especially in the south.

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

Rock unit (and max. thickness in metres)	Main rock types (and map symbols)	Relationships
Unnamed granite	Porphyritic biotite granite and non-porphyritic leucogranite (Pg)	Intrudes Tewinga Group; intruded by basic dykes. May intrude Standish Volcanics, but no contacts seen.
Wills Creek Granite	Biotite granite (Pgl)	Intrudes Standish Volcanics; intruded by basic dykes
Makbat Sandstone (300 +)	Feldspathic arenite and quartz arenite (Pum)	Overlies Standish Volcanics (unconformably?); inferred to be unconformable on Kalkadoon Granite; intruded by basic dykes
Stanbroke Sandstone (300)	Quartz arenite, feldspathic arenite, calcareous arenite, limestone (Pb)	Unconformable on Tewinga Group, and probably on Kalkadoon Granite; overlies Standish Volcanics (unconformably?)
Standish Volcanics (1000 +)	Massive felsitic quartz-feldspar porphyry (Psa); schistose quartz-feldspar porphyry (Psa_s); massive to schistose metabasalt (Psb)	Overlies Kalkadoon Granite, and inferred to be unconformable on Tewinga Group; intruded by Wills Creek Granite, basic dykes
Garden Creek Porphyry	Porphyritic microgranite (Pgp)	Intrudes Mount Guide Quartzite
Carters Bore Rhyolite? (200)	Rhyolitic tuff, quartz arenite (Phr?)	Inferred to be conformable on Myally Subgroup?
HASLINGDEN GROUP Myally Subgroup? (300 +)	Feldspathic arenite, quartz arenite (Phm?)	Conformable on Eastern Creek Volcanics
Eastern Creek Volcanics (1300)	Metabasalt (Phe); quartz arenite (Phe_q)	Conformable on Mount Guide Quartzite; intruded by basic dykes
Mount Guide Quartzite (2000)	Quartz arenite (Phg)	Unconformable on Tewinga Group, Kalkadoon Granite; conformable on Yappo Formation; intruded by Garden Creek Porphyry, basic dykes

Yappo Formation (500 +)	Conglomerate, greywacke (Phy)	Unconformable on Tewinga Group, Kalkadoon Granite; intruded by basic dykes
	MAJOR UNCONFORMITY	
Kalkadoon Granite	Medium to coarse, commonly porphyritic biotite granite and granodiorite (Pgk); fine to medium, even-grained biotite granite (Pgk_a); diorite, biotite-rich granodiorite (Pgk_d); foliated biotite granite and granodiorite (Pgk_f); migmatitic granodiorite/granite Pgk_m	Pgk and Pgk_f intrude Tewinga Group and Pgk_f intrudes Corella Formation; intruded by basic and acid dykes
Unnamed granite	Gneissic hornblende-biotite granite (Pg_f); tourmaline-bearing quartz-feldspar pegmatite (Pg_p)	Intrudes Corella Formation
Corella Formation (?1000 +)	Amphibolitic to siliceous calc-silicate granofels, metabasalt (Pkc); feldspathic granofels, feldspar porphyry (Pkc_a); quartzite (Pkc_q)	Intruded by Kalkadoon Granite (Pgk_f), unnamed granite (Pg_f, Pg_p), basic dykes
Tewinga Group (1000 +)	Interbedded fine-grained acid and intermediate gneiss, schist, and quartzite (Pe); quartzite (Peq); metabasalt (Pe_b); massive acid to intermediate gneiss and augen gneiss (Pe_t); migmatitic gneiss (Pe_m)	Intruded by Kalkadoon Granite, unnamed granite (Pg), basic and acid dykes

DESCRIPTIVE NOTES ON PRECAMBRIAN STRATIGRAPHIC UNIT

Tewinga Group

Map symbols: Pe, Pe_q, Pe_b, Pe_t, Pe_m

Nomenclature. Named after Tewinga County in the north of the Cloncurry 1:250 000 Sheet area (Derrick & others, 1976a). Previously mapped in the Dajarra Sheet area partly as Leichhardt Metamorphics, partly as Argylla Formation, and partly as Kalkadoon Granite with 'numerous metamorphic remnants' (Carter & others, 1961; Carter & Opik 1963).

Distribution. Crops out in broad north-trending belt through central part of the Sheet area; extends north and south into adjoining sheet areas.

Reference area. W of Duchess/Dajarra road about 15 km NNE of Dajarra, between GR UB530140 and GR UB570110; the five units of the group mapped in the Sheet area are represented here.

Thickness. Probably several thousand metres; base not exposed; no stratigraphic sequences deciphered within the group because of structural complexities, relatively high-grade regional metamorphism, and absence of facing evidence.

Topographic expression and airphoto characteristics. Group forms rugged to gently undulating terrain, with pale to dark tones on airphotos, reflecting the wide range of rock compositions in the group. Closely spaced trend lines commonly visible on airphotos; these indicate foliation/schistosity rather than bedding trends.

General lithology. Consists of metamorphosed acid, intermediate, and minor basic volcanics and associated metasediments; these are now mainly quartz + feldspar + biotite ± epidote ± hornblende rocks. Map units distinguished are -

Pe: mainly interbanded acid and intermediate gneiss, schist, and quartzite;

$\underline{Pe}_q$: schistose to massive quartzite; $\underline{Pe}_b$: schistose to massive metabasalt;
$\underline{Pe}_t$: mainly massive acid to intermediate gneiss and augen gneiss;
$\underline{Pe}_m$: migmatitic gneiss and subordinate granite.

Details of lithology: Pe: main rock types are pink and grey fine-grained gneiss (metamorphosed acid to intermediate pyroclastic rocks) which generally shows regular to streaky banding and commonly contains abundant to sparse augen and euhedral to subhedral megacrysts of pink and/or white feldspar 2 mm to over 10 mm long; grey medium to fine-grained mica schist (meta-sediments?); and grey to maroon quartzite (meta-arenite) which is generally fine-grained and commonly shows bedding. Minor rock types are acid porphyry containing euhedral to subhedral quartz and feldspar phenocrysts set in a fine-grained recrystallised groundmass; non-porphyritic greenish-grey flow-banded and autobrecciated rhyolite lava; weakly foliated fine to medium meta-arkose locally showing vague cross-bedding; and banded calc-silicate granofels. Small quartz boudins present locally may represent quartz pebbles.

$\underline{Pe}_q$: ridge-forming fine to medium quartzite (metamorphosed quartz arenite and minor feldspathic arenite); it is white, pale grey or maroon, locally glassy, mainly thin bedded to laminated but massive locally, variably schistose, and quartz-veined.

$\underline{Pe}_b$: mainly metabasalt which is pale to dark grey, greenish grey or bluish grey, fine to medium-grained, schistose to massive, and amphibolitic, chloritic, or biotite-rich; amygdales/vesicles and flow-margin breccias are present in places. Minor interlayered fine to medium epidotic quartzite represents both meta-arenite and silicified flow-margin breccia.

$\underline{Pe}_t$: mainly pink to grey, granitic to dioritic gneiss (metamorphosed tuff?) which is fine to coarse-grained, massive to banded, and commonly contains small streaky inclusions; augen and euhedral and subhedral megacrysts of pink and/or white feldspar, some over 10 mm long, are generally abundant, and garnet porphyroblasts are present locally in the east. The gneiss forms tors and rounded boulders, the boulders being ellipsoidal, rather than spheroidal, and somewhat flattened parallel to the general foliation. Also includes minor thin beds/layers of quartzite, meta-arkose, chloritic schist, and grey quartzitic metarhyolite in which small phenocrysts of quartz and feldspar and vague flow-banding are preserved.

$\underline{Pe_m}$: migmatic gneiss, generally similar to that of Pe_t, together with abundant veins and patches of granite; streaky and contorted compositional banding, schlieren, and cross-cutting veins of aplitic to pegmatitic leucogranite are common throughout; in many places concordant bands of arkose metamorphosed to medium-grained leucogneiss pass laterally into irregular cross-cutting aplitic to pegmatitic veins - these veins are interpreted as mobilisates formed by partial melting more or less in situ during regional metamorphism. Associated granite is medium to coarse, commonly contains euhedral feldspar megacrysts, is weakly foliated to massive, and has sharp to gradational contacts with gneiss. The unit also includes grey fine-grained quartzitic gneiss (= metarhyolite) showing vague flow-banding exposed on the west side of Wills Creek near the Dajarra/The Monument road.

Structure and metamorphism. The Tewinga Group has a generally steeply dipping foliation trending north to north-northwest and commonly more or less subparallel to bedding or primary layering; small crenulations, isoclinal minor folds, and mesofolds with limbs tens of metres long are present in places, but few major folds have been identified. The presence of only one long narrow band of ridge-forming quartzite in the northwest, rather than two or more such bands, indicates an absence of large-scale isoclinal folds here. Extensive zones of cataclastic deformation occur near many faults. Regional metamorphism is to upper greenschist or amphibolite grade, and probably took place during or shortly after explacement of Kalkadoon Granite. Some retrogression occurred during subsequent regional metamorphic events. The regional metamorphic grade is markedly higher than that of the Haslingden Group and younger units.

Relationships. The Tewinga Group is the oldest stratigraphic unit in the area, and its base is not exposed. It interfingers with Corella Formation in the Duchess 1:100 000 Sheet area to the north (Blake, Bultitude, & Donchak, 1978; Bultitude & others, in prep.), but all contacts between the Tewinga Group and Corella Formation in the Dajarra Sheet area are either faulted or concealed by superficial sediments. The group is overlain unconformably by Yappo Formation, Mount Guide Quartzite, Standish Volcanics, Stanbroke Sandstone, and Cambrian strata; is intruded by Kalkadoon Granite (with which it locally forms migmatite) and younger unnamed granite; and is cut by innumerable basic dykes and some quartz-feldspar porphyry dykes, as well as by veins

of pegmatite, aplite, microgranite, and quartz. The basic dykes range from schistose to massive, from fine to coarse, and from chloritic or amphibolitic to doleritic or gabbroic.

Age. Early Proterozoic and possibly early Carpentarian; acid volcanics to the north mapped as Leichhardt Metamorphics and Argylla Formation of the Tewinga Group give U-Pb zircon ages of about 1870 and 1780 m.y. respectively (Page, 1976).

Correlations. Considered to include not only correlatives of the Leichhardt Metamorphics, Magna Lynn Metabasalt and Argylla Formation which make up the Tewinga Group in sheet areas to the north (Derrick & others, 1976a, 1977b), but also correlatives of the Malbon and Mary Kathleen Groups; for example, part of Pe_q may be equivalent to the Ballara and Mitakoodi Quartzites, some outcrops of Pe_b may be correlatives of the Marraba Volcanics or of basalt lavas within the Corella Formation, and augen gneiss within Pe and Pe_t may be correlated with identical augen gneiss interlayered with the Corella Formation in the Duchess 1:100 000 Sheet area.

Mineralisation. Cu mineralisation occurs near some basic dykes. Economic deposits have been worked at the True Blue mine, 1.5 km east of The Monument, and at the Little Bit mine, 14 km to the southwest.

Remarks. Regionally metamorphosed and intruded by Kalkadoon Granite before Haslingden Group time.

Corella Formation

Map symbols: Pkc, Pkc_a, Pkc_q

Nomenclature. Formation originally defined by Carter & others (1961), revised by Derrick & others (1977a). The type section is in the Marraba 1:100 000 Sheet area. Previously mapped in the Dajarra Sheet area partly as Corella Formation and partly as Kalkadoon Granite (Carter & others, 1961; Carter & Opik, 1963).

Distribution. Crops out in northeastern part of Sheet area.
Thickness. Probably over 1000 m, as in sheet areas to north.
Topographic expression and airphoto characteristics. Forms low hills and strike ridges and gently undulating terrain; generally medium to dark tones on airphotos.

Lithology. Consists of Ekc: thin-banded to laminated, amphibolitic to siliceous calc-silicate granofels, massive to schistose metabasalt, biotite schist, and minor glassy quartzite and hematitic meta-arenite; Ekc_a: highly feldspathic granofels, which may represent metamorphosed acid volcanics, and feldspar porphyry; and Ekc_q: ridge-forming schistose quartzite. Cross-cutting veins of aplite and quartz-feldspar pegmatite are present locally.

Structure and metamorphism. Formation is generally steeply dipping, and has NNW trends. Tight to isoclinal minor folds and crenulations are common, but no large folds have been mapped. However, the disposition of Ekc_q outcrops west and northwest of Mount Birnie indicate that some major folds are probably present here. Regional metamorphism is probably amphibolite grade.

Relationships. Intruded by foliated granite mapped as Kalkadoon Granite (Egk_f) south of Mayfield homestead (e.g., at GR UB830107), by unnamed foliated granite (Eg_f) and quartz-feldspar pegmatite (Eg_p), and by basic minor intrusions; overlain unconformably by Cambrian sedimentary rocks of the Burke River Outlier; contact with Tewinga Group probably faulted.

Correlations. Outcrops in Sheet area are more or less continuous with amphibolite-grade calc-silicate rocks mapped as Corella Formation in the Duchess, Mary Kathleen, and Marraba 1:100 000 Sheet areas to the north (Bultitude & others, in prep; Derrick & others, 1971, 1977b).

Mineralisation. Copper mineralisation at Mount Birnie mine (GR 870100), in schistose amphibolite.

Remarks. Corella Formation rocks interfinger in the Duchess 1:100 000 Sheet area with acid gneisses typical of the Tewinga Group (Bultitude & others, in prep.); also the formation consists of amphibolite-grade metamorphic rocks, similar in grade to Tewinga Group rocks and much higher grade than the Haslingden Group and younger rocks. For these reasons, the Corella Formation is considered by us to be probably equivalent in age to part of the Tewinga Group, and hence to belong to the Tewinga package of rocks (Blake & others, 1978).

Haslingden Group

Yappo Formation (new name)

Map symbol: Ehy.

Nomenclature. Named after Yappo Creek, a westward-draining tributary of Moonah Creek in the Duchess and Oban 1:250 000 Sheet areas (Bultitude & others, in prep.). Name not yet published, so informal. Included within Mount Guide Quartzite by Carter & others (1961) and Carter & Opik (1963).

Distribution. Restricted to western part of Sheet area; crops out in the northwest and as a narrow strip on the eastern side of Mount Guide Quartzite; extends west and north into adjoining sheet areas.

Type section. In the northwestern part of the Duchess 1:100 000 Sheet area (Bultitude & others, in prep.).

Thickness. 0 to probably over 1500 m; thickest in northwest.

Topographic expression and airphoto characteristics. Forms gently undulating terrain in the northwest corner; elsewhere forms steep side-slopes and gentle footslopes along the eastern margins of Mount Guide Quartzite ranges. Generally darker-toned on airphotos than adjacent Mount Guide Quartzite.

General lithology. Consists of mainly schistose conglomerate and greywacke, and minor metabasalt lava, quartzite, and arkose.

Details of lithology. Sedimentary rocks are pale to medium grey, or bleached to ironstained (due to lateritic weathering, especially in the south). Conglomerate: made up of rounded to subangular pebbles, cobbles, and boulders, which are weakly to strongly deformed in places, enclosed in a greywacke matrix; most clasts are of sericitic acid volcanics containing small quartz and feldspar phenocrysts; also present are subordinate clasts of quartzite, vein quartz, and probably (as in Duchess 1:100 000 Sheet area) granite and gneiss; acid volcanic pebbles, but not other clasts, are invariably flattened, and may represent readily deformed pumice, implying penecontemporaneous volcanic activity; some sandstone lenses showing cross-bedding are commonly present. Greywacke: predominates over conglomerate only in the northwest; micaceous (both muscovite and biotite) and generally schistose. Metabasalt: interlayered with conglomerate and greywacke northeast of Dajarra; amygdaloidal, epidotic, amphibolitic. Quartzite: associated with metabasalt; variably epidotic; represents both quartz arenite and silicified basalt. Arkose: present locally at base of formation; medium to fine; may represent weathered granitic bedrock (fossil regolith).

Structure and metamorphism: Formation is steeply dipping, trends generally north. Regionally metamorphosed to greenschist grade, as commonly schistose and contains some metamorphic mica, but has sedimentary textures preserved.

Relationships. Unconformably overlies Tewinga Group and Kalkadoon Granite; overlain conformably by Mount Guide Quartzite; intruded by basic dykes. Unconformity at base is well exposed in south but is less obvious in northern and central parts.

Age. Carpentarian; probably about 1700 m.y.
Correlations. Oldest unit of Haslingden Group in Sheet area; no correlatives known to east (cf. Mount Guide Quartzite).

Mineralisation. None known in Sheet area.
Remarks. Probably represents outwash fan deposits derived from landmass to east. May be partly fluvial and partly shallow marine.

Mount Guide Quartzite

Map symbol: Bhg.

Nomenclature. Named after Mount Guide, 21°2'30"S, 139°31'10"E, Duchess 1:250 000 Sheet area (Carter & others, 1961). Subdivided by Derrick & others (1976b, 1978) into a lower unit (the Yappo Formation of this work) and an upper unit (the Mount Guide Quartzite of this work). Mapped in Sheet area as Mount Guide Quartzite by Carter & others (1961), Carter & Opik (1963), Blake & others (1978).

Distribution. Restricted to western part of Sheet area. Extends west and north into adjoining sheet areas.

Type section. 3 km west to 3 km east of Mount Guide, Oban and Duchess 1:100 000 Sheet areas (Carter & others, 1961).

Reference section in Sheet area. In the northwest, from GR UB458181 to GR UB484180, where Mount Guide Quartzite conformably overlies Yappo Formation to the west and is overlain conformably by Eastern Creek Volcanics to the east.

Thickness. Probably about 2000 m in the north (see section line A-B). Has maximum thickness outside Sheet area of more than 6000 m (Glikson, Derrick, Wilson, & Hill, 1976).

Topographic expression and airphoto characteristics. Forms prominent ranges of closely spaced planated strike ridges; generally pale on airphotos.

General lithology. Consists of quartz arenite and, near base, minor feldspathic arenite and quartz greywacke; commonly cleaved and locally schistose.

Details of lithology. Arenites and greywacke: white to pale grey or, mainly in the south, weakly to strongly ironstained (partly lateritised); mainly medium-grained and moderately to well sorted, though locally contains pebbles of quartzite, vein quartz, and acid volcanics, especially near base; varies from silica-cemented and quartzitic to sericitic (matrix and altered feldspar/lithic grains) and friable; mainly medium to thick bedded; cross-bedding,

generally low-angle type, common throughout, and ripple marks common near top; cleavage/schistosity weakly to strongly developed, generally more or less parallel to bedding.

Structure and metamorphism. Formation is generally steeply dipping to overturned; forms large, open to tight, mainly upright, north-trending folds; cut by numerous faults with mainly small displacements. Thermally metamorphosed to hornfels (glassy quartzite) adjacent to some basic dykes. Regionally metamorphosed to greenschist grade, as indicated by presence of cleavage/schistosity and metamorphic white mica; however, cross-bedding and sedimentary textures are generally well preserved.

Relationships. Unconformable on Tewinga Group and Kalkadoon Granite; conformable on Yappo Formation; conformably overlain by Eastern Creek Volcanics. Intruded by Garden Creek Porphyry and by innumerable concordant and cross-cutting basic dykes.

Age. Probably Carpentarian.

Correlations. No correlatives to the east; younger, in our opinion, than the Corella Formation, which is more highly metamorphosed, and older than Standish Volcanics and younger formations, which are generally less metamorphosed.

Mineralisation. None known in Sheet area.

Remarks. Represents mainly well sorted clastic sediments which were probably deposited in a shallow nearshore environment. Sediments derived at least partly from a nearby large landmass to the east, the Tewinga-Kalkadoon basement block.

Eastern Creek Volcanics

Map symbols: Ehe, Ehe_q

Nomenclature. Named after Eastern Creek, a tributary of Gunpowder Creek, Camooweal 1:250 000 Sheet area (Carter & others, 1961). Mapped in Sheet area as Eastern Creek Volcanics by Carter & others (1961) and Carter & Opik (1963).

Distribution. Confined to the western part of sheet area, mainly in the northwest and southwest. Extends west and north into adjoining sheet areas.
Type section. Along Barkly Highway east of Mount Isa, Mary Kathleen 1:100 000 Sheet area (Carter & others, 1961; Derrick & others 1976b).
Thickness. About 1300 m in southwest. Considerably thicker in sheet areas to north (e.g., up to 6000 m; Glikson & others, 1976).
Topographic expression and airphoto characteristics. Forms gently undulating terrain with dark tones (Ehe) and strike ridges with pale tones (Ehe_q).
General lithology. Massive to schistose metabasalt and minor thin layers of epidotic quartzite and rare greywacke (Ehe); quartz arenite and minor lithic and feldspathic arenite, locally schistose (Ehe_q).

Details of lithology. Ehe: mainly pale to dark green and bluish grey, schistose to massive metabasalt which is variably epidotic, amphibolitic, and silicified; amygdaloidal zones and flow margin breccias common; forms rubbly exposures; minor interlayered thin-bedded epidotic quartzite/quartz arenite and rare schistose greywacke (basaltic tuff?) which in places show cross-bedding. Ehe_q: arenite sequences tens of metres thick interfingering with Ehe in southwest; arenites are pale grey to ironstained, schistose to quartzitic, and medium to thick bedded; cross-bedding and cross-cutting quartz veins are common.

Structure and metamorphism. Formation is mainly gently dipping in the north, where it occupies the trough of a broad syncline; in the southwest, where it is exposed in a large north-plunging anticline, it is steeply dipping and somewhat contorted. Regional metamorphism is of greenschist grade.

Relationships. Conformably overlies Mount Guide Quartzite, its base being taken as the lowest basalt lava present; overlain conformably by Myally Subgroup? in southwest. Intruded by Sybella Granite to the west (Carter & others, 1961; Hill, Wilson, & Derrick, 1975; Mock, 1978).

Age. Probably about 1700 m.y. (Plumb & Derrick, 1975).

Correlations. Previously correlated with Marraba Volcanics and Soldiers Cap Formation/Group (e.g., Carter & others, 1961; Plumb & Derrick, 1975; Glikson & others, 1976), but considered by us to be much younger than these other units, and to postdate the Corella Formation (Blake & others, 1978).

Mineralisation. Traces of copper minerals common, but no economic mineralisation known in sheet area.

Remarks. The formation crops out extensively in the western part of the Mount Isa region, and has been regarded as a continental flood basalt unit (e.g., Glikson & others, 1976). However, many of the basalt lavas within the unit interfinger with waterlaid arenites, and they do not appear to show any evidence of weathering or subaerial erosion, hence they may have been extruded in shallow water.

Myally Subgroup?
Map symbol: Ehm?

Nomenclature. Myally Creek, a tributary of the Leichhardt River in the Dobbyn 1:250 000 Sheet area (Carter & others, 1961). The Myally Subgroup is defined by Derrick & others (1976b), and replaces the Myally Beds of Carter & others (1961). Previously mapped in Sheet area as part of Eastern Creek Volcanics.

Distribution. Southwest corner of Sheet area; extends west into the Ardmore 1:100 000 Sheet area.

Reference area. Northwestern side of north-plunging anticline in the southwest, at GR UA470780, where typical rock types of the unit are well exposed.

Thickness. At least 300 m and possibly over 500 m thick in Sheet area.

Topographic expression and airphoto characteristics. Forms steep-sided strike ridges. Pale to medium tones on airphotos, with trend lines generally prominent.

General lithology. Feldspathic arenite and quartz arenite; minor lithic arenite and conglomerate; schistose to quartzitic.

Details of lithology. Arenites: pale grey to ironstained; medium to fine; siliceous or sericitic matrix; medium-bedded to laminated; generally cross-bedded. Conglomerate: observed near base of unit; contains well-rounded pebbles and larger clasts of vein quartz and quartzite in poorly sorted arenite matrix.

Structure and metamorphism. Unit is exposed on steep limbs of broad northerly plunging anticline; contorted, brecciated and cut by quartz veins in hinge area of fold. Presence of schistosity indicates greenschist grade of regional metamorphism.

Relationships. Conformably overlies basic lavas and associated sediments mapped as Eastern Creek Volcanics; appears to be overlain concordantly by Carters Bore Rhyolite? No basic dykes found intruding unit.

Age. Carpentarian, as part of the Haslingden Group (Derrick & others, 1976b).

Correlations. Tentatively correlated with Myally Subgroup exposed to the northwest and north (Oban, Mount Isa, and Mary Kathleen 1:100 000 Sheet areas), as similar in lithology and relationships. Alternatively, may represent a sandstone unit within the Eastern Creek Volcanics; may be equivalent to the upper part of the Mount Guide Quartzite exposed elsewhere.

Mineralisation. None known.

Remarks. May represent shallow marine sediments, as generally similar in lithology and sedimentary structures to Mount Guide Quartzite. Provenance not known.

Carters Bore Rhyolite?

Map symbol: Ehr?

Nomenclature. Formation defined by Derrick, Wilson, & Hill (1978); named after Carters Bore on Black Creek 30 km SW of Mount Isa, Mount Isa 1:250 000 Sheet area.

Distribution. Forms low strike ridge in southwestern corner of Sheet area; previously mapped as Eastern Creek Volcanics.

Type section. About 45 km NW of Mount Isa, where the Carters Bore Rhyolite is about 200 m thick.

Thickness. About 200 m.

Lithology. Consists of interbedded blue-grey rhyolitic bedded tuff and quartz arenite. The bedded tuff contains small alkali feldspar and recrystallised quartz phenocrysts in a fine-grained siliceous groundmass.

Structure and metamorphism. Unit dips steeply east; way up uncertain. Regional metamorphism probably of greenschist grade.

Relationships. Inferred to overlie Myally Subgroup to the west and to be faulted against Mount Guide Quartzite to the east.

Correlation. Tentatively correlated with Carters Bore Rhyolite, an acid volcanic unit overlying the Haslingden Group, apparently concordantly, in sheet areas to the northwest (Mock, 1978; Hill & others, 1975).

Mineralisation. None known.

Standish Volcanics
(new name)

Map symbols: Psa, Psa_s, Psb.

Nomenclature. Named after the Standish Ranges southeast of Dajarra, at 21°45'S, 139°45'E. Previously mapped in Sheet area as part of Argylla Formation.

Distribution. Crops out extensively in north-south zone through central part of Sheet area; extends north and south into adjoining sheet areas.

Type locality. Along Dajarra/The Monument road east of Wills Creek, from GR UA670840 to GR UA740890.

Thickness. Not known, as no measurable stratigraphic sequences found; probably at least 1000 m thick in places.

Topographic expression and airphoto characteristics. Mainly forms low rounded hills and undulating terrain. Has pale to dark tones on airphotos and shows rectilinear joint patterns in places; trend lines are only rarely visible.

General lithology. Massive felsitic acid volcanics (Psa); schistose felsitic acid volcanics (Psa_s); basic volcanics (Psb).

Details of lithology. Psa: Predominantly quartz-feldspar and feldspar porphyry which is buff to pink, maroon, greenish grey, bluish grey, and dark grey; consists of sparse to abundant euhedral phenocrysts less than 1 cm across of glassy quartz and white to pink feldspar in felsitic (very fine-grained, cherty) groundmass; mainly massive, but may be sheared, brecciated, and quartz-veined near faults; some porphyry has eutaxitic structures and represents xenolithic ignimbrite, and some shows contorted flow-banding and probably represents lava. Also present are minor agglomerate, bedded fine to coarse tuff, quartz arenite, arkose, sericitic schist, basic schist and phyllite, and amygdaloidal basalt.

Psa$_s$: As Psa, but schistose and sericitic rather than massive and felsitic. Confined to central part of Sheet area east of Wills Creek.

Psb: Greenish grey to dark grey, massive to schistose, amygdaloidal amphibolite (= basic lava); grey medium to fine biotite schist and grey phyllite that may represent basic tuffs; interlayered beds and lenses of quartz arenite/quartzite in the northwest, and schistose greywacke and siltstone.

Structure and metamorphism. Attitude generally difficult to determine as bedding is rare. Formation may be tightly folded in the central and northern parts of Sheet area and broadly folded in the south. Regional metamorphism is probably up to lower greenschist grade.

Relationships. Overlies Kalkadoon Granite and is inferred to be unconformable on Tewinga Group; overlain, possibly concordantly, by Stanbroke Sandstone and Makbat Sandstone. Intruded by Wills Creek Granite and numerous basic dykes. Contact relationships generally poorly exposed and obscured by faulting.

An unconformity at base of Standish Volcanics is exposed northwest and west of Stanbroke homestead, at GR UB630210 and UB576132. At GR UB630210 sericitic schistose acid volcanics dipping 45^{o}E at the base of the Standish Volcanics directly overlie quartz-veined and somewhat altered Kalkadoon Granite; quartz veins in the granite terminate at the unconformity, which is undulating; felsitic porphyry is exposed a few hundred metres to the east. At GR UB576132 arkose of the Standish Volcanics directly overlies granite mapped as possible Kalkadoon Granite (Pgk?): the granite immediately below the unconformity is altered, but not sheared, and may represent a fossil weathering profile.

Contacts between Standish Volcanics and Tewinga Group rocks are poorly exposed and generally faulted. An unconformity between the two units, however, can be inferred 12 km west-northwest of Stanbroke homestead and also south of the Dajarra/The Monument road west of Wills Creek, where little altered non-foliated quartz-feldspar porphyry of the Standish Volcanics is exposed within a few metres of relatively high grade Tewinga Group gneiss.

A non-tectonic contact with Stanbroke Sandstone is exposed west of Stanbroke homestead, at GR UB570140, where agglomeratic quartz-feldspar porphyry is overlain to the west by about 3 m of conglomerate containing clasts of similar porphyry. The conglomerate passes upwards into cross-bedded quartz

arenite containing sparse volcanic clasts; both conglomerate and quartz arenite are mapped as Stanbroke Sandstone. A similar relationship is exposed 32 km SSE of Dajarra, at GR UA610706.

An intrusive contact between acid porphyry of the Standish Volcanics and Wills Creek Granite is evident near the Dajarra/The Monument road east of Wills Creek, at GR UA685890. The contact is highly irregular in a zone about 100 m wide, and acid porphyry within a few metres of the granite is mottled and hornfelsed.

Age. Proterozoic

Correlations. Tentatively regarded as part of the Stanbroke Sandstone/Makbat Sandstone sequence, as generally lower regional metamorphic grade than nearby rocks of the Haslingden Group, and much lower than the Tewinga Group; may be equivalent to part of the Surprise Creek Beds in sheet areas to the north.

Mineralisation. None known in Sheet areas.

Remarks. Presence of ignimbrite indicates unit is at least partly subaerial.

Stanbroke Sandstone

(new name)

Map symbol: Eb.

Derivation of name. Named after Stanbroke homestead; 21°33'S, 139°43'E; GR UB676145, Dajarra Sheet area. Previously mapped as Argylla Formation and unnamed Upper? Proterozoic (Carter & others, 1961; Carter & Opik, 1963).

Distribution. Confined to western part of Sheet area west of Wills Creek.

Type area. Range of hills west of Stanbroke homestead.

Type section. Across west limb of syncline in type area, from GR UB660143 to GR UB660143.

Thickness. At least 300 m thick in type area; top not exposed.

Topographic expression and airphoto characteristics. Forms strike ridges. Pale to medium tones on airphotos; trend lines generally visible.

General lithology. Consists of quartz arenite, feldspathic arenite, calcareous arenite, limestone, greywacke, siltstone, basal conglomerate.

Details of lithology. Quartz arenite and feldspathic arenite: main rock types in lower part of unit; white to pale grey, also ironstained to brown; medium to fine grainsize; silica cement; thin to thick bedded; cross-bedding common; ripple marks present locally; rare bedding planes with shale pellets.

Calcareous arenite: interbedded with other arenites; generally ironstained; medium to coarse grainsize; consists of quartz, carbonate? and other grains in a carbonate cement; medium to thick bedded; cross-bedded.

Limestone: present mainly in upper part of unit; pale grey to maroon or purple; fine-grained.

Greywacke: present mainly in upper part of unit; fine to coarse-grainsize; medium to thin-bedded; commonly micaceous.

Siltstone: locally interbedded with arenite and greywacke; brown; thin-bedded to laminated.

Basal conglomerate: observed 12 km WNW of Stanbroke homestead and 32 km SSE of Dajarra township; contains pebbles of acid porphyry derived from underlying Standish Volcanics; overlain concordantly by quartz and feldspathic arenites.

Outcrops mapped as possible Stanbroke Sandstone (Pb?) in south consist of sheared and silicified arenites, and minor chert that probably represents silicified carbonate.

Type section description. Lower part of unit, overlying Standish Volcanics to the west, consist of ridge-forming quartz and feldspathic arenites, about 200 m thick, which show cross-bedding and ripple marks; overlying upper part, about 100 m thick, consists mainly of greywacke, siltstone, and limestone.

Structure and metamorphism. Formation has mainly moderate to steep dips; outcrops represent keels of partly fault-bounded synclines. Metamorphism largely limited to shearing, brecciation, and silicification near faults.

Relationships. Unconformable on Tewinga Group in the northwest and probably on Kalkadoon Granite and Tewinga Group in the south; overlies Standish Volcanics, possibly concordantly. Contacts with older units commonly faulted and generally obscured by sand and scree. Inferred to be overlain unconformably by Cambrian strata in the south. Not seen to be intruded by basic dykes or by granite.

Age. Proterozoic.

Correlations. May be correlated with Surprise Creek Beds in the Duchess 1:100 000 Sheet area and Makbat Sandstone in the Dajarra 1:100 000 Sheet area, as similar to these units in general lithology, very low grade metamorphism, and occurrence in keels of northerly to north-northwesterly trending synclines.

Mineralisation. None known.

Remarks. Unit probably represents shallow marine sediments.

Makbat Sandstone

Map symbol: Pum

Nomenclature. Named by Carter & others (1961) after Makbat Creek, a southerly flowing creek 40 km southeast of Dajarra township.

Distribution. Southern central part of Sheet area east of Wills Creek; extends south into the Buckingham Downs 1:100 000 Sheet area.

Type section. From 21°58'40", 139°45'00"E (GR UB710680) east for 4 km to (GR UB750680) (Carter & others, 1961), Dajarra Sheet area.

Thickness. At least 300 m; top not exposed.

Topographic expression and airphoto characteristics. Forms ranges consisting of strike ridges and valleys. Mainly dark tones on airphotos owing to lateritic weathering; bedding trends commonly visible.

General lithology. Feldspathic arenite, quartz arenite, greywacke, sandy siltstone; dark brown shale and a conglomerate bed 15 m thick reported by Carter & others (1961).

Details of lithology. Feldspathic arenite and quartz arenite: fine to medium-grainsize; silica cement; thin to medium bedded; cross-bedding common; local ripple marks; rare shale pellets. Greywacke and siltstone: generally micaceous; less resistant than arenites to erosion. Rocks are white to pale grey or, more commonly, ironstained to pinkish, purplish or brownish colours.

Structure and metamorphism. Formation crops out in upright, north-northwest-trending synclines, and has mainly gentle to moderate dips (generally less than 45^{o}). Does not appear to be regionally metamorphosed, but is silicified and quartz-veined near faults.

Relationships. Inferred to be unconformable on Kalkadoon Granite; overlies, possibly concordantly, acid porphyry of the Standish Volcanics. Intruded by at least one dolerite dyke. Actual contacts with older rocks invariably concealed by superficial deposits.

Age. Proterozoic.

Correlations. Previously thought to be possibly equivalent to the Mount Birnie Beds of the Lower Palaeozoic Burke River Outlier to the east, but considered more likely to be equivalent to Stanbroke Sandstone to the west, and to Surprise Creek Beds in the northwest of the Duchess 1:100 000 Sheet area. Makbat Sandstone is similar to these two units in general lithology and induration, and occurs in similar structures. The Mount Birnie Beds are less indurated than Makbat Sandstone, are more or less flat-lying, except near faults, and are not cut by any basic dykes.

Mineralisation. None known.

Remarks. Probably represents shallow marine deposits.

DESCRIPTIVE NOTES ON INTRUSIVE ROCK UNITS
Kalkadoon Granite

Map symbols: Pgk, Pgk_a, Pgk_d, Pgk_f, Pgk_m.

Nomenclature. Defined by Carter & others (1961); named after Kalkadoon copper mine, in the Dobbyn 1:250 000 Sheet area. Not as widespread in the Dajarra Sheet area as mapped previously (Carter & others, 1961; Carter & Opik, 1963).

Distribution. Extensive exposures occur between Haslingden Group rocks to the west and Cambrian rocks of the Burke River Outlier to the east; continues north of Sheet area for over 150 km.

Reference area. West of the Dajarra/Boulia road 20 km S of Dajarra, near GR UA510800, where Kalkadoon Granite intrudes Tewinga Group in the east and is overlain by Haslingden Group in the west.

Topographic expression and airphoto characteristics. Forms moderately rugged terrain with tors to gently undulating plains with scattered spheroidal boulders. Outcrop areas have close to open dendritic drainage patterns; pale to dark tones on airphotos (depending on degree of weathering and lateritisation).

General lithology. Massive to weakly foliated, medium to coarse and generally porphyritic biotite granite and granodiorite (Pgk); massive, fine to medium non-porphyritic biotite granite (Pgk_a); diorite and biotite-rich granodiorite (Pgk_d); moderately to strongly foliated biotite granite and granodiorite (Pgk_f); migmatitic granodiorite/granite (Pgk_m); minor aplite pegmatite, microgranite. Primary biotite crystals are commonly recrystallised to aggregates of much smaller crystals.

Details of lithology. Pgk: grey, rarely pink, biotite granite and granodiorite; colour index generally less than 20; mainly medium to coarse, locally finer-grained near intrusive contacts; commonly contains abundant to sparse, euhedral, tabular megacrysts of white to pink feldspar up to 5 cm long which in places show some apparent flow alignment; biotite-rich xenoliths and some chloritic alteration common; mainly massive or weakly foliated, but sheared and strongly foliated near some faults; cut by aplite, quartz-feldspar pegmatite, leucogranite, and microgranite veins; includes some small patches of diorite.

Pgk_a: fine to medium non-porphyritic biotite granite exposed in the southwest; pale pink to greyish; colour index generally less than 5; sharp irregular contacts with Pgk.

Pgk_d: diorite and biotite-rich granodiorite: medium to fine, generally non-porphyritic; small dark xenoliths common; massive to locally sheared and schistose; cut by leucogranite veins.

Pgk_f: foliated biotite granite and granodiorite, minor aplite and pegmatite; similar to Pgk except mainly moderately to strongly foliated; present in east part of area only.

Pgk_m: highly heterogeneous (migmatitic) biotite granodiorite and granite; massive to weakly foliated; fine to coarse grainsize; euhedral to anhedral feldspar megacrysts common; abundant large and small gneissic xenoliths and cross-cutting veins of aplite, pegmatite, leucogranite, and microgranite.

Relationships. Intrudes Tewinga Group rocks and in the east, Corella Formation; overlain by Yappo Formation, Mount Guide Quartzite, Standish Volcanics, and probably by Stanbroke Sandstone and Makbat Sandstone, and also by Cambrian and younger sediments; intruded by innumerable basic dykes, by quartz-feldspar porphyry dykes related to the Standish Volcanics, and, in the southwest, by a composite dyke consisting of basic margins and acid porphyry centre. During the intrusion of some basic dykes the immediately adjacent granite was melted and remobilised, so that it was able to back-vein the dyke rock, which chilled against the granite; contacts between such granite and dyke rock are highly irregular, crenulated and cumulose.

Age. Lower Proterozoic; samples dated by Page (1976) give U-Pb zircon age of 1860 m.y.

Correlations. Correlated with Kalkadoon Granite mapped in sheet areas to north, as part of the same general batholith.

Mineralisation. Three known copper shows in Sheet area: St Mungo, Little Monastry, and Gossan No. 1.

Remarks. Part of a complex composite batholith comprising the oldest granites known in the region. The occurrence of foliated varieties and the close association with migmatitic and gneissic rocks of the Tewinga Group indicate that some parts of the Kalkadoon Granite probably represent late syntectonic intrusions emplaced during the amphibolite-grade regional metamorphism that affected the Tewinga Group. The granite shows typical features of mesozonal intrusions (Buddington, 1959), and must have been emplaced several kilometres below the surface.

Wills Creek Granite

(new name)

Map symbol: Pgl.

Nomenclature. Named after Wills Creek, the main watercourse in the Dajarra 1:100 000 Sheet area. Previously mapped as Argylla Formation (Carter & others, 1961; Carter & Opik, 1963) and unnamed granite (Blake & others, 1978).

Distribution. Crops out in central part of Sheet area on east side of Wills Creek.

Type area. North side of the Dajarra/The Monument road, 25.5 km south of Stanbroke homestead, near GR UA682892. Here typical Wills Creek Granite is seen to intrude and thermally metamorphose quartz-feldspar porphyry of the Standish Volcanics.

Topographic expression and airphoto characteristics. Forms mainly low hills, including some small mesas, and gently undulating terrain; highest ridges in outcrop area are formed by thick cross-cutting quartz veins. Pale to dark tones on airphotos, as granite ranges from bleached to strongly ironstained; mesas have dark-toned cappings.

Lithology. Biotite granite: pale pink where fresh but generally bleached to ironstained owing to lateritic weathering; mainly medium to coarse and even-grained, except that some feldspar is commonly slightly coarser than the other constituents; some patches and cross-cutting veins of fine-grained granite; biotite, the main dark mineral, generally forms less than 5 per-cent of the rock and is commonly partly altered to chlorite; no xenoliths recorded; quartz-veining common.

Structure and metamorphism. Massive (not foliated); does not appear to have been regionally metamorphosed - primary biotite flakes are not recry-stallised to crystal aggregates.

Relationships. Intrudes and thermally metamorphoses Standish Volcanics; intruded by basic dykes. Highly irregular intrusive contact with hornfelsed Standish Volcanics in type area.

Age. Proterozoic; younger than Standish Volcanics.

Correlations. May be equivalent in age to part of Sybella Granite in the Oban Sheet area, to the northwest (Mock, 1978).

Mineralisation. None known.

Remarks. Probably a post-tectonic mesozonal granite, emplaced at a depth of several kilometres.

Garden Creek Porphyry

(new name)

Map symbol: Pgp.

Nomenclature. Named after Garden Creek, a southerly to southeasterly flowing tributary of Wills Creek northeast of Dajarra. Previously mapped as Kalkadoon Granite.

Distribution. Has long, narrow, north-trending outcrop within the Mount Guide Quartzite range north of Dajarra, in the northwest part of the Sheet area. Also crops out to the north, in the southwest of the Duchess 1:100 000 Sheet area (Bultitude & others, in prep.).

Type locality. 5.5 km NE of Dajarra, at GR UB503039, Dajarra 1:100 000 Sheet area.

Thickness. Forms dyke-like body up to about 250 m wide.

Topographic expression and airphoto characteristics. Forms relatively low ridges and undulating terrain, strewn with spheroidal boulders, bounded by higher ridges of Mount Guide Quartzite. Slightly darker-toned than Mount Guide Quartzite on airphotos.

General lithology. Porphyritic microgranite; minor associated amphibolitic dolerite.

Details of lithology. Microgranite: massive to locally sheared and quartz-veined; pink to dark grey; fine-grained; contains euhedral phenocrysts of pink feldspar (both andesine and microcline), some more than 1 cm across, and smaller rounded phenocrysts of glassy quartz (strained and granulated); small dark biotite-rich xenoliths common; groundmass consists of quartz, microcline, biotite, sodic plagioclase, opaques, secondary chlorite and epidote, and accessory apatite and zircon.

Amphibolitic dolerite: generally poorly exposed, as more readily eroded than microgranite; dark grey to black; fine to medium, non-porphyritic; massive to locally schistose; consists of vaguely ophitic green hornblende aggregates, sodic plagioclase, and minor epidote, quartz, opaques, sphene, and carbonate.

Structure and metamorphism. Forms steeply dipping dyke-like body, cut by numerous faults; locally sheared and quartz-veined. Chloritic and epidotic alteration indicates probable greenschist facies regional metamorphism.

Relationships. Intrudes Mount Guide Quartzite, apparently more or less concordantly (so could be a sill rather than a dyke); actual contacts invariably obscured by superficial debris. Probably intrudes Tewinga Group at depth.

Age. Probably Carpentarian.

Correlations. Microgranite is much younger than the Kalkadoon Granite (which is overlain unconformably by Mount Guide Quartzite), and may be related to part of the Sybella Granite exposed in the Oban 1:100 000 Sheet area, to the west (Mock, 1978); it is possibly comagmatic with acid porphyries of the Standish Volcanics exposed to the east.

Mineralisation. None known.

Remarks. May represent a composite intrusion, as the porphyritic microgranite body almost invariably has margins of amphibolitic dolerite in places up to about 30 m thick; if so, the acid and basic components were intruded more or less together (Blake & others, 1965).

Unnamed granites

Map symbols: Eg, Eg_f, Eg_p

Distribution. Two outcrop areas of Eg in the north, 8 km south-southwest and 2 to 10 km south-southeast of Stanbroke homestead, and one in the far south, east of Wills Creek. Small outcrops of Eg_f near GR UB880000, and of Eg_p in the area around GR UB865040. None of these granite outcrops were shown on previous maps.

Topographic expression and airphoto characteristics. The granitic rocks form low hills and undulating terrain which have mainly pale tones on air-photos.

Lithology. Eg: in north consists of medium to coarse leucocratic biotite granite with feldspar phenocrysts; mainly massive but foliated near faults; in south consists of massive medium-grained non-porphyritic leucocratic granite.

Eg_f: recrystallised gneissic hornblende-biotite granite; foliation folded and crenulated; mafic xenoliths common; some pegmatite veins.

Eg_p: tourmaline-bearing quartz-feldspar pegmatite; some graphic intergrowths; recrystallised in part to aplitic leucogranite.

Relationships. Eg in the north intrudes Tewinga Group gneisses and is cut by basic dykes; its relationship to Standish Volcanics is not known. Eg in the south is also cut by basic dykes, but is not seen in contact with adjacent units. Eg_f and Eg_p intrude Corella Formation.

Age. Proterozoic; younger than Corella Formation.

Correlations. Eg may be related to the Wills Creek Granite. Eg_f and Eg_p may represent phases of either Kalkadoon Granite or of Wonga-type, or Burstall-type granites exposed in sheet areas to north; pegmatitic leucogranite similar to Eg_p is common within the Corella Formation in the Duchess 1:100 000 Sheet area, as, for instance, near the Trekelano mine.

Mineralisation. None known.

Remarks. Eg is not foliated, and is probably post-tectonic. Eg_f is probably syntectonic, as it is strongly foliated; Eg_p may be late syntectonic, as though generally not foliated it has been partly recrystallised.

Basic dykes

Map symbol: largest dykes as dl; otherwise as ordinary dyke symbol.

Distribution. Found throughout Precambrian part of Sheet area; many more present than shown on 1:100 000 map.

Thickness. Commonly less than 10 m, but some over 100 m wide.

Topographic expression and airphoto characteristics. More readily eroded than most adjacent rocks, so basic dykes tend to occupy narrow depressions. They form prominent dark-toned linear features on airphotos.

Lithology. Chloritic schist, schistose amphibolite, massive amphibolite, dolerite; minor porphyritic dolerite.

Structure and metamorphism. Steeply dipping to vertical, and mainly sub-parallel to bedding or foliation; general trend north to northwest. Some metamorphosed to greenschist grade, some probably to amphibolite grade; youngest dykes, such as those intruding Makbat Sandstone and at least some of those intruding Standish Volcanics, are not regionally metamorphosed.

Relationships. Numerous basic dykes intrude Tewinga Group, Kalkadoon Granite Mount Guide Quartzite, and Standish Volcanics. Some also intrude Corella Formation, Yappo Formation, Eastern Creek Volcanics, Wills Creek Granite, and unnamed granite, and at least one intrudes Makbat Sandstone. None found intruding Myally Subgroup?, Carters Bore Rhyolite?, Stanbroke Sandstone, or Cambrian units.

Age and correlations. Proterozoic. Inferred to include intrusive equivalents of basalt lavas of the Tewinga Group, Haslingden Group, and Standish Volcanics. Dykes intruding Makbat Sandstone have no known extrusive equivalents.

Mineralisation. Some associated Cu mineralisation locally.

Remarks. Some dykes probably represent feeder channels for the various Proterozoic basalt lavas.

Acid dykes

Map symbol: dyke symbol labelled po.

Distribution. Central part of Sheet area south of Stanbroke Homestead; more present than shown on 1:100 000 map.

Thickness. Commonly about 1 m, generally more irregular than basic dykes.

Topographic expression and airphoto characteristics. Do not form distinctive topographic or airphoto features.

Lithology. Quartz-feldspar porphyry: small euhedral phenocrysts enclosed in very fine-grained felsitic groundmass.

Structure and metamorphism. Form thin irregular bodies with no marked preferred orientations; commonly cut across one another. Not obviously regionally metamorphosed.

Relationships. Intrude Kalkadoon Granite and also Tewinga Group. Some in Oban Sheet area, to the northwest, intrude Mount Guide Quartzite (Mock, 1978).

Age and correlations. Proterozoic. May be intrusive equivalents of Standish Volcanics.

Mineralisation. None known.

Remarks. Represent high-level sub-volcanic minor intrusions.

Composite dyke

A composite dyke intrudes Kalkadoon Granite, in the southwest, at GR UA524760. It has a central acid component, consisting of quartz-feldspar porphyry, flanked by non-porphyritic basic margins, and is over 20 m thick.

STRUCTURE AND REGIONAL METAMORPHISM

Folding

In this section, fold events (F) and associated cleavages (S) which affect the basement rocks - the Tewinga Group, Corella Formation and Kalkadoon Granite of the Tewinga Package - are denoted by the subscript 't', those affecting the Haslingden Group by the subscript 'h', and those affecting younger Precambrian rocks (Standish package) by the subscript 's'. The numerical part of the subscript indicates 1st, 2nd, or 3rd generation of folding and cleavage affecting 't'. 'h', or 's'.

Basement rocks

Evidence for three folding events can be recognised with the rocks of the Tewinga Group. The first event, F_{t1} produced a penetrative northerly to northwesterly trending, steeply dipping, slaty cleavage and foliation, S_{t1}, defined by a marked preferred alignment of mineral aggregates, phenocrysts, and porphyroblasts. This cleavage is generally parallel to regional lithologic trends. Mesoscopic F_{t1} folds are rarely apparent in the mainly massive and competent Tewinga Group rocks, except in outcrops of thin banded quartzites and calc-silicate rocks, which locally show tight to isoclinal minor folds, and in areas of well-layered gneisses, where folds with limbs tens of metres in length can be seen in places. Tight to isoclinal mesoscopic F_{t1} folds, however, are common in the more incompetent. thin-banded rocks of the Corella Formation. The Kalkadoon Granite generally does not show any evidence of mesoscopic F_{t1} folding, although it is strongly foliated in places.

A second folding event, F_{t2}, is evident locally within the augen gneisses of the Tewinga Group. It is indicated by open to tight crenulations of S_{t1}, the crenulations having wavelengths averaging about 18 cm. In the tightly compressed limbs of the crenulations the individual augen are streaked out subparallel to the F_{t2} axial planes, but in the hinge zones the augen remain roughly equidimensional. S_{t2} is subvertical and generally trends north. Fold axes of F_{t2} generally plunge north at about 45^{o}, but anomalous easterly plunges occur in gneisses west-southwest of Mayfield homestead near a major northwest-trending dextral strike-slip fault.

The third folding event, F_{t3}, is related to essentially strike-slip movements along northwesterly trending faults which cut the augen gneisses. The F_{t3} folds are mainly open large-scale flexures which give way to intense shearing immediately adjacent to the fault. F_{t3} folding is best developed south of the major fault southwest of Mayfield homestead, where the asymmetry of the folds indicates a dextral fault movement.

The Tewinga and Kalkadoon basement must have been subjected to the deformation events which affected the overlying Haslingden Group and younger rocks. However, it may have behaved as a rigid mass when the younger cover rocks were deformed, so may not show any obvious effects of the younger deformations.

Haslingden Group and younger Precambrian rocks

The earliest folding event affecting the Haslingden Group, F_{h1}, postdates F_{t1}, and is less intense. It may be older, but is considered more likely to be the same age as, the F_{s1} event of the Standish package. F_{h1} is characterised by open to tight major folds with steeply dipping north-trending axial planes. The associated S_{h1} ranges from a brittle fracture cleavage to a slaty cleavage; in general it has not obliterated primary sedimentary structures such as cross-bedding. The equivalent or possibly younger F_{s1} event caused open to tight folding about subhorizontal northerly to northwesterly-trending axes. The Stanbroke and Makbat Sandstones are now preserved only in the keels of major synclines formed during this event. S_{s1} ranges from a poorly developed slaty cleavage to a fracture cleavage which is strongly developed in some shear zones and in the most easterly belt of Standish Volcanics (mapped as Esa_s).

Faulting

Three main groups of faults are present in the area.

1. Northerly to northwesterly trending faults. Many of these faults follow lithological boundaries, such as between the Corella Formation and Kalkadoon Granite in the east, between the Myally Subgroup? and Mount Guide Quartzite in the southwest, and between the Stanbroke Sandstone or Makbat Sandstone and older units in the central part of the area. They exhibit dominantly vertical movements, and probably result from slippage along litho-

logical boundaries during F_{t1}, F_{h1}, or F_{s1} events. Many more are probably present than shown on the 1:100 000 map, as some shearing and brecciation have taken place along most contacts between different rock types.

2. Northwest-trending and less well-developed northeast-trending faults within the outcrop area of the Haslingden Group. These form a conjugate system of strike-slip faults, well developed in sheet areas to the north, which postdates the folding of the Haslingden Group.

3. The Pilgrim Fault Zone, a major north-trending fault zone in the east along the western margin of the Cambro-Ordovician Burke River Outlier.

Regional Metamorphism

Basement rocks

The precise metamorphic grade of the Tewinga Group rocks is difficult to determine because of a general lack of diagnostic metamorphic minerals. The group consists largely of partly to completely recrystallised gneissic rocks, and these are made up mainly of biotite, microcline, sodic plagioclase (albite to andesine composition), quartz, epidote, and less commonly hornblende and muscovite. Apatite, sphene, zircon, opaques, calcite, fluorite, and metamict allanite? occur as accessory minerals. The mineral assemblages may indicate middle greenschist to middle amphibolite grade rocks. Chlorite and sericite are common secondary minerals, and indicate some later retrograde metamorphism.

The metamorphic grade can be assessed to some extent by the amount of recrystallisation that has taken place. In the Tewinga Group gneisses, feldspar megacrysts range from completely recrystallised composite grains forming augen streaked out parallel to the foliation (S_{t1}) to euhedral relict phenocrysts which are commonly oblique to the foliation. Recrystallisation/metamorphism of the gneisses is also associated with the growth of strongly aligned biotite flakes. The strong alignment need not indicate growth in high-stress conditions, but may simply be a result of post-deformational mimetic growth parallel to bedding planes. Marked differences in the degree of recrystallisation in the gneisses occur within distances of less than 5 m, and indicate that the initial deformation was inhomogeneous, and probably did

not involve very high stresses. In quartzites, which represent meta-arenites, the original detrital grains are rarely recognisable, and the rock has generally been completely recrystallised into a quartzose mosaic. At a few localities some recognisable quartz-feldspar porphyry is present, but the original euhedral phenocrysts now have irregular margins intergrown with mineral grains of the completely recrystallised but still fine-grained groundmass. In all these rocks the general amount of recrystallisation is much greater than in rocks of the Haslingden Group and younger units.

Recrystallisation/metamorphism of the Kalkadoon Granite is indicated by the breakdown of medium to coarse biotite flakes into relatively fine-grained aggregates. These aggregates tend to be randomly oriented, even where the granite is strongly foliated. This suggests that high stresses were not involved in secondary biotite crystallisation, and that this crystallisation took place either after the initial deformation event or in its waning stages. The presence of biotite plates in some dislocation cracks in feldspars is not inconsistent with this idea. The Kalkadoon Granite is largely recrystallised only in the east, where it is moderately to strongly foliated (Pgk_f). Deformed feldspar showing ductile flow (curved twin lamellae), rather than brittle fracture, as in granite near the Little Bit mine, indicates that initial deformation involved compression rather than extension.

The rocks of the Corella Formation in the east are similar in lithology and metamorphic grade to those of the same formation in the southeast part of the Duchess 1:100 000 Sheet area to the north, where the characteristic rock type - banded calcsilicate granofels - consists of calcite $\pm$ quartz $\pm$ sodic plagioclase $\pm$ potassium feldspar $\pm$ scapolite $\pm$ biotite/phlogopite $\pm$ diopside/salite $\pm$ amphibole $\pm$ epidote $\pm$ sphene. In the same part of the Duchess Sheet area the Corella Formation also includes some sillimanite-biotite-quartz-feldspar schist.

The mineral assemblages and amount of recrystallisation together suggest that the basement rocks forming the Tewinga Package have been regionally metamorphosed to upper greenschist/middle amphibolite grade. This regional metamorphism probably took place during the F_{t1} folding event. The retrograde metamorphism indicated by the presence of secondary chlorite and sericite was probably associated with much younger events.

Haslingden Group and younger Precambrian rocks

Unlike the Tewinga and Corella rocks, the Haslingden Group and younger Precambrian rocks have not been extensively recrystallised, and they are clearly of general lower metamorphic grade. Arenites retain primary mesoscopic sedimentary features such as cross-bedding and also original microscopic textures. Feldspar and quartz phenocrysts in acid volcanics generally have their original euhedral shapes preserved, especially in the Standish porphyries, where they are typically enclosed in a very fine-grained felsitic groundmass representing devitrified glass. In every case the groundmass of the Standish Porphyries is much finer-grained than that of any porphyries within the Tewinga Group. Some fine-grained metamorphic biotite, chlorite, white mica, and epidote, however, are commonly present in small amounts in both sedimentary and acid volcanic rocks. Basic volcanics within the Haslingden Group and Standish Volcanics show more marked regional metamorphic effects, and are generally represented by epidotic amphibolite and biotite schist in which few primary igneous features other than amygdales are preserved.

Overall, the Haslingden Group and younger Precambrian rocks appear to be regionally metamorphosed to lower and middle greenschist grade. The lowest grade rocks are in the south, east of Wills Creek, where acid porphyries of the Standish Volcanics, and the overlying Makbat Sandstone, appear to be virtually unmetamorphosed. The regional metamorphism is presumed to have taken place during the F_{h1} and F_{s1} fold events. The similar metamorphic grade of the Haslingden Group and younger rocks indicates that the metamorphism may have taken place during a single event, rather than during two separate events, hence F_{h1} and F_{s1} may be time equivalents.

ECONOMIC GEOLOGY

Economic base-metal mineralisation in the Dajarra Sheet area is limited to a few small copper mines, most of which ceased production in the early half of the century. All copper mineralisation seems to be localised near contacts between amphibolite (probably metadolerite) and granite, gneiss, or calc-silicates of the Tewinga package (Tewinga Group, Corella Formation, and Kalkadoon Granite).

The most significant economic deposit in the Sheet area is the Cambrian sedimentary phosphate being mined at Phosphate Hill, in the south-east.

Main copper deposits

Mount Birnie

The mine is 17 km north of The Monument. The orebody strikes northeasterly and is contained within schistose amphibolite of the Corella Formation. Main ore minerals are cuprite and chalcocite and secondary malachite and chrysocolla. Some chalcopyrite masses and disseminated pyrite are also present. Mining was carried out by shaft and trenching during the early 1900s, after which production ceased. Some recent costeans were observed near the mine in 1977, but no resumption of activity has been reported. Total recorded production is 13 tonnes of ore, averaging 12 percent Cu. Some ore parcels contained more than 0.01 percent Ni.

True Blue

This mine is 1.5 km east of the township of The Monument, very close to the unconformity between Tewinga Group metamorphics and Cambrian sedimentary rocks. Syvret (1966) described the copper mineralisation as occurring at the contact of amphibolite inliers and the middle Cambrian Inca Formation, and that the host rocks also include siliceous shales and cherts of the Beetle Creek Formation. He reported that three 'en echelon' lodes are present, apparently representing siliceous mineralised infillings of gash faults associated with a major northeast-trending fault 0.5 km to the east; that the ore minerals are chrysocolla, chalcocite, pyrite, minor malachite, and rare azurite; and that the mine was worked in 1909 and 1922-1927, the total production reaching 134.8 tonnes of ore, of which 104.3 tonnes averaged 11.8 percent Cu.

St Mungo

This mine is 15 km east-southeast of Stanbroke homestead. Mineralisation occurs at the contact of amphibolite and Kalkadoon Granite. The main ore shoots, as described by Carter & others (1961), trend northeast and consist of massive chalcopyrite localised around intersecting horizontal and vertical fault planes. One ore shoot trends at right-angles to the main body. The mine was worked between 1910 and 1918, and has a total recorded production of 7129 tonnes of ore, of which 6702 tonnes contained 23 percent Cu.

Little Bit

This mine is 2 km south of the Dajarra/The Monument road, and about 13 km southwest of The Monument. Brooks (1965) described the host rocks as chlorite, biotite, and hornblende schist (metabasalt of the Tewinga Group), gneissic Kalkadoon Granite, and metadolerite which intrudes both the granite and schist. The copper lode strikes northeast, cutting across the main north-south foliation, and dips to the southeast. The ore consists of malachite, chrysocolla, cuprite, native copper, pyrite, chalcopyrite, and minor covellite and chalcocite. A limonitic jasper gossan with a little chrysocolla and malachite is visible at the surface. The mine produced 1328 tonnes of ore averaging 9.8 percent Cu between 1962 and 1964.

Little Monastry

The position of this mine is uncertain, and it was not visited during the 1977 survey. It is reported to be situated within the Kalkadoon Granite about 4 km south of St Mungo mine. The mine was worked during 1971, when 43.74 tonnes of ore, averaging 4.7 percent Cu, was produced.

Gossan No. 1

Little is known about this mine, as it has no recorded production, and was not located with certainty during the 1977 survey.

Phosphate

Extensive primary phosphate deposits occur in Cambrian siltstones, shales, and cherts of the Beetle Creek Formation in the Phosphate Hill area, in the southeast (Russell & Trueman, 1971). Smaller deposits occur as far north as Mount Birnie. Large-scale open-cut mining operations were well under way at Phosphate Hill in 1977. Production commenced in 1975, and up till the end of June 1978, when mining operations ceased, BH South had produced just over 1 million tonnes of marketable phosphate rock.

SUMMARY OF GEOLOGICAL HISTORY

The oldest unit exposed in the area, the Tewinga Group, represents a thick complex sequence of volcanic and sedimentary rocks. The volcanism, which must have spanned a considerable period of time, consisted largely of eruptions of acid pyroclastic material, possibly from mainly subaerial centres, but also included emissions of acid lavas and probably several periods of basic lava extrusion. It was accompanied by deposition of sediments, most of which were derived from the volcanics. The Corella Formation in the east, which is regarded by us as a lateral equivalent of part of the Tewinga Group, represents mainly interlayered impure calcareous sediments and basic lavas. The Corella sediments may have been deposited in a shallow lagoonal environment, as they include, at least to the north, some probable evaporitic deposits which are now thin-banded scapolitic granofels. Many of the Corella sediments probably contain basic tuffaceous material.

An age of about 1870 m.y. for the acid volcanics within the Tewinga Group is given by U-Pb zircon total-rock systems in samples of Leichhardt Metamorphics from sheet areas to the north (Page, 1976).

After volcanism and sedimentation, the Tewinga Group and Corella Formation were tightly to isoclinally folded and regionally metamorphosed to upper greenschist or amphibolite grade. Gneissic and schistose rocks were formed at this time. The regional metamorphism was accompanied by intrusion of Kalkadoon Granite. Much of this granite is not foliated, so it was probably emplaced after the main folding event, but in places it was involved in the development of syntectonic migmatites. The Kalkadoon Granite is a relatively deep-level intrusion, mesozonal rather than epizonal in the classification of Buddington (1959), and was probably emplaced many kilometres below the surface.

The tectonism represented by the folding, regional metamorphism, and granite emplacement was accompanied by uplift, and the area probably became a mountainous landmass. Then followed a long phase of subaerial erosion, sufficiently long for the landmass to be eroded to such an extent that in the west large areas of Tewinga Group gneisses were exposed and the deep level Kalkadoon Granite batholith was unroofed. A major unconformity (Bultitude, Gardner, & Noon, 1977) now separates these crystalline rocks from overlying Precambrian units.

Sedimentation resumed in the western part of the area with the deposition of the Haslingden Group on the western margins of an extensive landmass formed of Tewinga package rocks. The basal Haslingden Group sediments, mainly Yappo Formation but locally Mount Guide Quartzite, were deposited unconformably on an irregular surface. Sedimentation during Haslingden Group time was accompanied by both basic volcanism, as shown by basic lavas in the Yappo Formation and much more extensively in the Eastern Creek Volcanics, and some acid volcanism, indicated by the occurrence of abundant pebbles of probably altered pumice in conglomerate of the Yappo Formation and by the presence of rhyolitic tuff in the Carters Bore Rhyolite? conformably overlying Myally Subgroup? in the southwest. The Haslingden Group sediments, which are at least 3000 m thick in the Dajarra Sheet area and much thicker to the north (Glikson & others, 1976), appear to be shallow-water deposits, and may be partly fluvial and partly marine. At least some were derived from the landmass to the east, which probably persisted as a source area throughout Haslingden Group time.

Like the Haslingden Group, the Standish package to the east was laid down unconformably on Kalkadoon Granite and Tewinga Group metamorphics. It is probably younger than the Haslingden Group, as it is generally less metamorphosed, but whether or not a major time break separates the two packages is uncertain. The oldest rocks of the Standish package, the Standish Volcanics, represent a period of widespread acid and local basic volcanic activity, possibly contemporaneous with the Carters Bore Rhyolite volcanicity. Acid intrusions associated with the volcanism may be represented by porphyry dykes cutting Tewinga package rocks east of Wills Creek and by the Garden Creek Porphyry, a dyke-like body within the Mount Guide Quartzite, in the northwest. The volcanism was succeeded, perhaps after a break of considerable duration, by deposition of the Stanbroke and Makbat sandstones, probably in shallow water. Like the Haslingden Group sediments, these

clastic units may be partly fluvial and partly marine. Some carbonate sedimentation locally accompanied the sandstone deposition.

Some time after the Standish package rocks were laid down, another major phase of folding and regional metamorphism took place. This may have been about 1400 m.y. ago: this is the minimum age for the regional metamorphism in the Mount Isa area indicated by K-Ar mica age determinations (Richards, Cooper, & Webb, 1963). It was during this major tectonic event, the last to greatly affect the area, that the large open to tight folding of the Standish package rocks, and probably also that of the Haslingden Group, occurred. Most of the faults mapped in the area may have been active at this time. The regional metamorphism was mainly of low to middle greenschist grade, and it probably caused some retrograde metamorphism of the higher grade, previously metamorphosed, Tewinga package rocks. The tectonism may have been accompanied by the emplacement of the Wills Creek Granite; however, this granite is not foliated and is likely to be either pretectonic or post-tectonic rather than syntectonic.

The many basic dykes in the area were intruded at various times during the Precambrian. They include probable hypabyssal equivalents of basic lavas within the Tewinga Group, Corella Formation, Haslingden Group (Yappo Formation and Eastern Creek Volcanics) and Standish Volcanics, and also some dykes, such as the one or more intruding Makbat Sandstone, which have no known extrusive equivalents. The minor copper mineralisation known in the area is probably genetically related to some of the basic dykes.

The next sedimentary event recorded in the area, following a long period of erosion, was the deposition of the mainly shallow marine Burke River Outlier succession. This Cambro-Ordovician sequence probably blanketed the Sheet area, but has been largely removed by subsequent erosion from the western and central parts. The Lower Palaeozoic rocks remain more or less flat-lying, although they have been displaced and locally deformed by later faulting. They indicate that no major tectonism has occurred in the area since the Precambrian.

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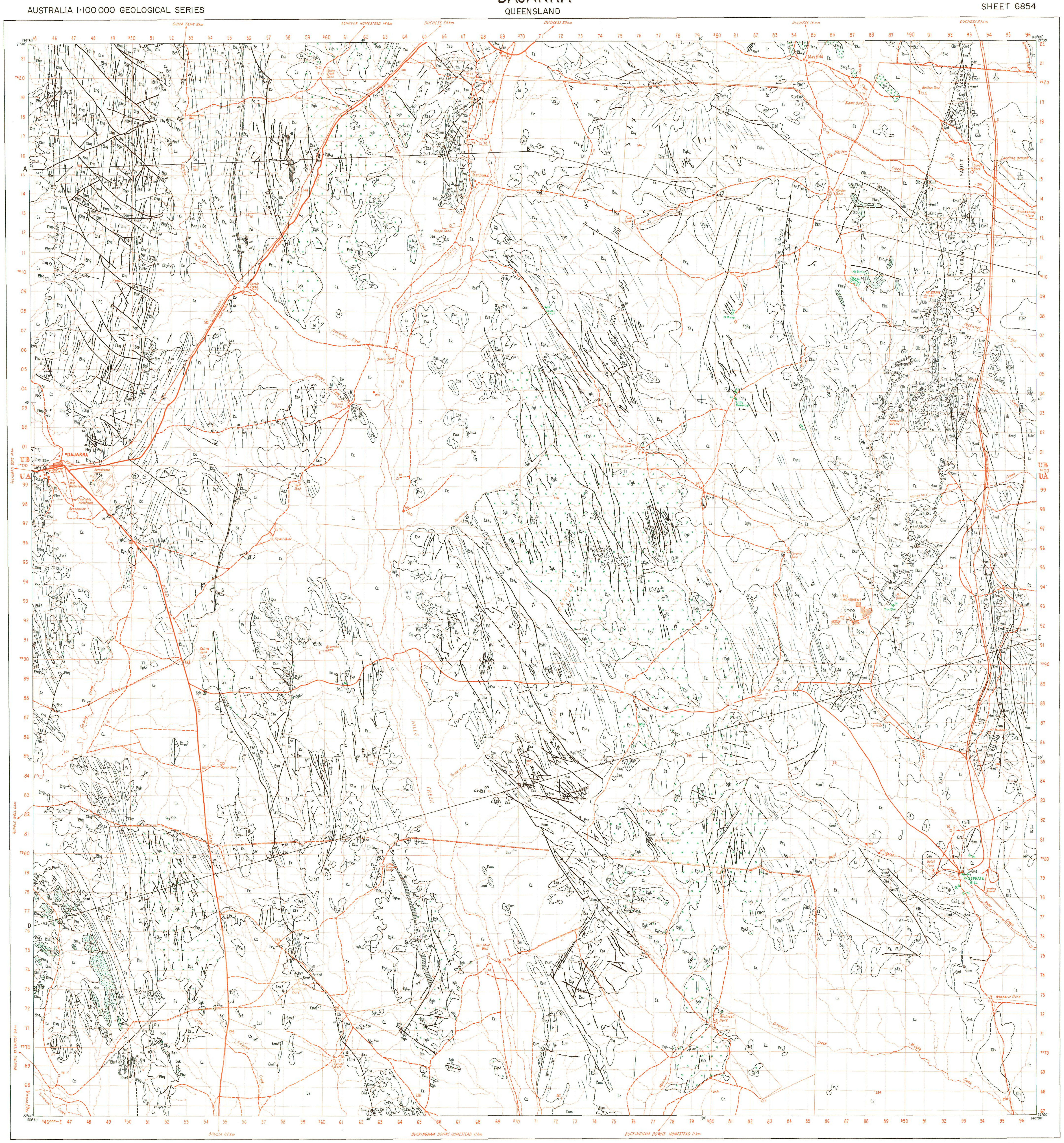
AUSTRALIA 1:100 000 GEOLOGICAL SERIES

DAJARRA

QUEENSLAND

SHEET 6854



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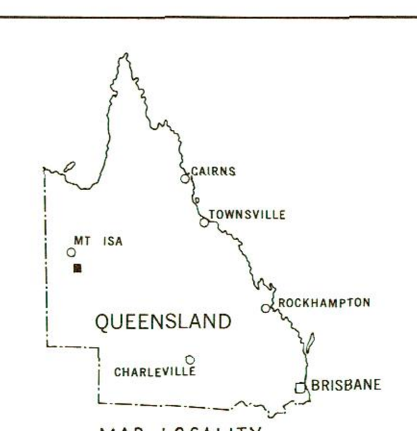


MAP LOCALITY

SCALE 1:100000

1 0 1 2 3 4 5 6 7 8 9 10 Kilometres

INDEX TO 1:100 000 MAPS

1:250 000 maps shown in brown

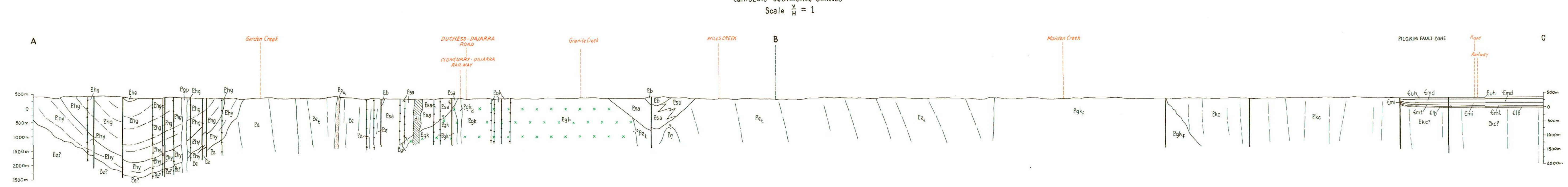
WOOROONA 6557	YELVERTOFT 6657	KENNEDY GAP 6757	PROSPECTOR 6857	QUAMBY 6957	CLONAGH 7057
MOUNT ISA SF54-1			CLONCURRY SF54-2		
BULLECOURT 6556	TEMPLETON 6656	MOUNT ISA 6756	MARY KATHLEEN 6856	MARRABA 6956	CLONCURRY 7056
HEADINGLY 6555	GOA CREEK 6655	OBAN 6755	DUCHESS 6855	MALBON 6955	MOUNT ANGELAY 7055
URANDANGI SF54-5			DUCHESS SF54-6		
URANDANGI 6554	CARANDOTTA 6654	ARDMORE 6754	DAJARRA 6854	MOUNT MERLIN 6954	SELWYN 7054

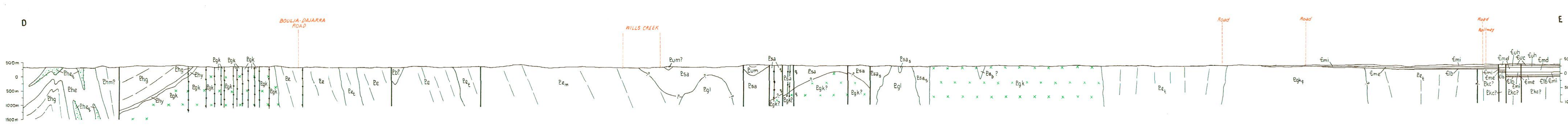
Geology 1967 by F. de Keyser, J.H. Shergold, C.G. Gatehouse, R. Thieme BMR; C. Murray GSQ
1977 by D.H. Blake, R.J. Bultitude BMR; P.J. Donchak GSQ
Compiled 1977-78 by D.H. Blake, R.J. Bultitude, G.A. Young BMR; P.J. Donchak GSQ
Design and drafting by Cartography Section, BMR
Drawn by G.A. Young

Schematic Sections

Cainozoic sediments omitted

Scale $\frac{V}{H} = 1$





Legend

Cz	Sand, silt, gravel	TERTIARY / CAINOZOIC
Ts	Limestone, siliceous sinter, chalcedony	
Tc	Partly lateritised bedrock: weathered capping	
Tl	Laterite, lateritic rubble	
M	Conglomerate, siltstone, mudstone, sandstone, grit	MESOZOIC?
SWIFT FORMATION Ols	Siltstone, sandstone, chert	ORDOVICIAN
CHATSWORTH LIMESTONE €uc	Limestone, oolite, breccia, marl; minor coquina	CAMBRIAN / PALAEOZOIC
O'HARA SHALE €uh	Siltstone; minor chert, fine sandstone	
DEVONCOURT LIMESTONE €md	Impure limestone, calcilutite, bituminous limestone, marl	
ROARING SILTSTONE €mr	Siltstone, fine sandstone; minor chert, siliceous shale	
INCA FORMATION €mi	Siltstone, siliceous shale, fine sandstone, chert, limestone	
BEETLE CREEK FORMATION €me	Siltstone, chert, siliceous shale, phosphorite, phosphatic siltstone, fine sandstone; ▴▴▴▴ Breccia	
€mt	Black and grey convoluted chert, nodular chert; ▴▴▴▴ Breccia	
THORNTONIA LIMESTONE $€mt_t$	Thick bedded yellowish dolomitic limestone and dolomite; bedded and nodular chert	
MOUNT BIRNIE BEDS €lb	Massive ferruginous sandstone, cross-bedded sandstone, conglomerate, red and green shale, mudstone, dolomite, tilloid	
dl	Dolerite	PROTEROZOIC
Ꝑg	Medium to coarse porphyritic biotite granite; leucogranite	
WILLS CREEK GRANITE* Ꝑgl	Medium to coarse biotite granite	
MAKBAT SANDSTONE Ꝑum	Feldspathic arenite, quartz arenite, greywacke, siltstone; minor shale, conglomerate	
STANBROKE SANDSTONE* Ꝑb	Quartz arenite, feldspathic arenite, calcareous arenite, limestone, greywacke, siltstone; local basal conglomerate	
STANDISH VOLCANICS* Ꝑsa	Felsitic quartz-feldspar porphyry; minor agglomerate, bedded tuff, arenite, sericitic schist, phyllite	
$Ꝑsa_s$	Schistose quartz-feldspar porphyry, sericitic bedded tuff	
Ꝑsb	Massive to schistose metabasalt, biotite schist, phyllite; minor quartz arenite, greywacke, siltstone	
GARDEN CREEK PORPHYRY* Ꝑgp	Porphyritic microgranite; minor amphibolite	
CARTERS BORE RHYOLITE? Ꝑhr?	Porphyritic rhyolitic tuff, interbedded quartz arenite	
HASLINGDEN GROUP: MYALLY SUBGROUP? Ꝑhm?	Feldspathic arenite, quartz arenite; minor lithic arenite, conglomerate	
HASLINGDEN GROUP: EASTERN CREEK VOLCANICS Ꝑhe	Massive to schistose metabasalt, amygdaloidal metabasalt; minor epidotic quartzite	
$Ꝑhe_q$	Quartz arenite; minor lithic arenite, feldspathic arenite. Schistose to quartzitic	
HASLINGDEN GROUP: MOUNT GUIDE QUARTZITE Ꝑhg	Quartz arenite; minor feldspathic arenite and greywacke near base. Schistose to quartzitic	
HASLINGDEN GROUP: YAPPO FORMATION* Ꝑhy	Conglomerate, greywacke; minor metabasalt, quartzite, arkose. Mainly schistose	
dl	Dolerite	
$Ꝑg_p$	Tourmaline-bearing quartz-feldspar pegmatite	
$Ꝑg_f$	Gneissic hornblende-biotite granite; minor pegmatite	
KALKADOON GRANITE Ꝑgk	Massive to locally foliated medium to coarse biotite granite and granodiorite, commonly porphyritic; minor aplite, pegmatite, microgranite	
$Ꝑgk_f$	Foliated biotite granite and granodiorite, commonly porphyritic; minor aplite, pegmatite	
$Ꝑgk_a$	Fine to medium even-grained biotite granite	
$Ꝑgk_d$	Diorite, biotite-rich granodiorite	
$Ꝑgk_m$	Massive to foliated xenolithic granite, migmatitic gneiss; aplite, pegmatite, leucogranite and microgranite veins	
CORELLA FORMATION Ꝑkc	Thin-banded amphibolitic to siliceous calc-silicate granofels; amphibolitic metabasalt, biotite schist; minor quartzite	
$Ꝑkc_a$	Feldspathic granofels, meta-arkose, feldspar porphyry	
$Ꝑkc_q$	Schistose quartzite	
TEWINGA GROUP Ꝑe	Interbanded fine quartzofeldspathic gneiss, augen gneiss, mica schist, quartzite; minor acid porphyry, meta-arkose, banded calc-silicate granofels	
$Ꝑe_t$	Granitic to dioritic gneiss and augen gneiss, massive to thick-banded; minor quartzite, basic schist	
$Ꝑe_m$	Migmatitic gneiss; minor granite, quartzite	
$Ꝑe_b$	Schistose to massive amygdaloidal metabasalt; minor epidotic quartzite	
$Ꝑe_q$	Massive to schistose quartzite	

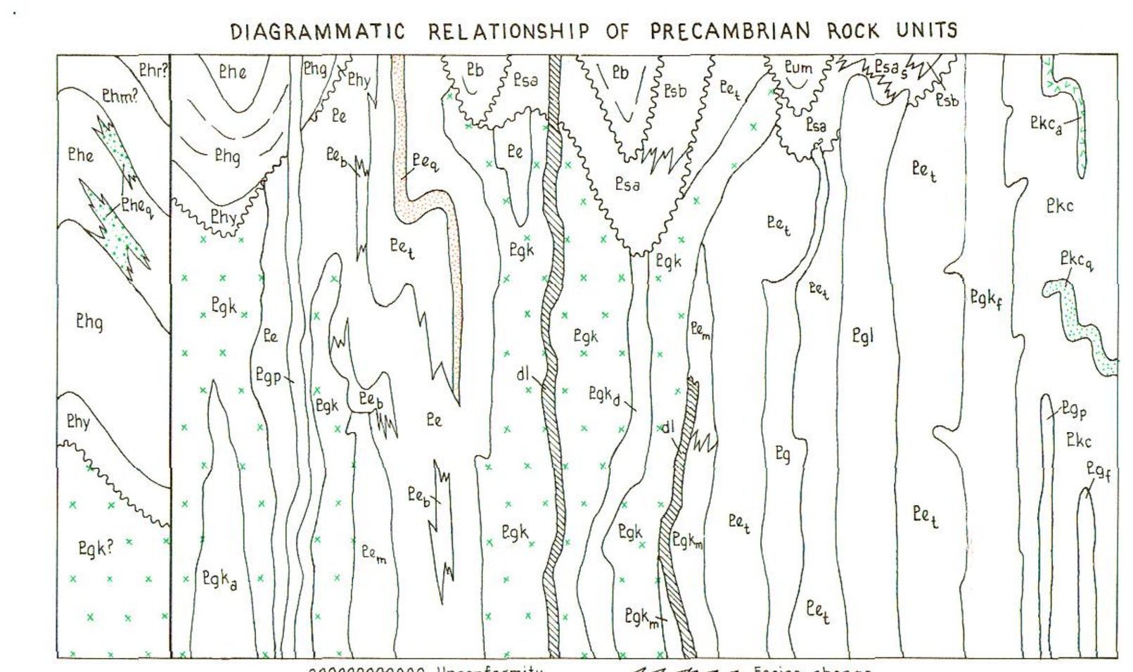
Metamorphic boundary
* Name not yet approved

- Geological boundary
- Anticline, showing plunge
- Syncline, showing plunge
- Fault (q indicates quartz filled)
- Fault, showing relative horizontal movement

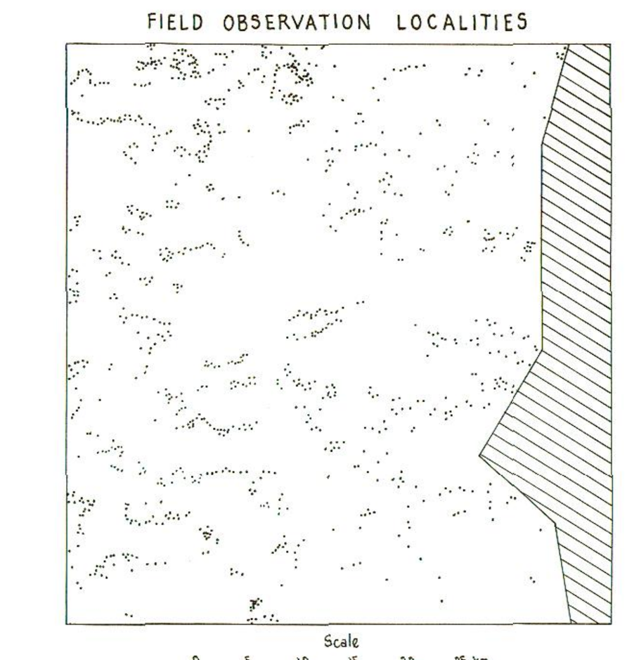
Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

- Plunge of minor syncline
- Shear zone
- Facies change
- Strike and dip of strata
- Prevailing strike and dip of strata
- Strike and dip of strata, facing not known
- Vertical strata
- Horizontal strata
- Strike and dip of overturned strata
- Dip < 15° } airphoto interpretation
- Dip 15°-45° } airphoto interpretation
- Trend line } airphoto interpretation
- Lineament } airphoto interpretation
- Joint pattern } airphoto interpretation
- Top of bed, indicated by cross-bedding, arrow shows facing
- Strike and dip of foliation
- Vertical foliation
- Strike and dip of cleavage
- Vertical cleavage
- Strike of bedding and cleavage coincident
- Strike and dip of foliation with plunge of lineation
- Macrofossil locality
- Dolerite dyke
- Dyke; q - quartz, po - porphyry
- Prospect not worked
- Open cut; Ph - Phosphate rock
- Mine not worked; Cu - Copper
- Costean
- Bore with windpump
- Abandoned well
- Windpump
- Earth tank or dam
- Water tank
- Waterhole
- Spring
- Secondary road
- Minor road
- Vehicle track
- Railway, with station
- Built-up area
- Mayfield Homestead
- Building
- Yard
- Fence
- Trigonometrical station
- .322 Elevation in metres, accurate
- .327 Elevation in metres, approximate
- abd Abandoned

DIAGRAMMATIC RELATIONSHIP OF PRECAMBRIAN ROCK UNITS

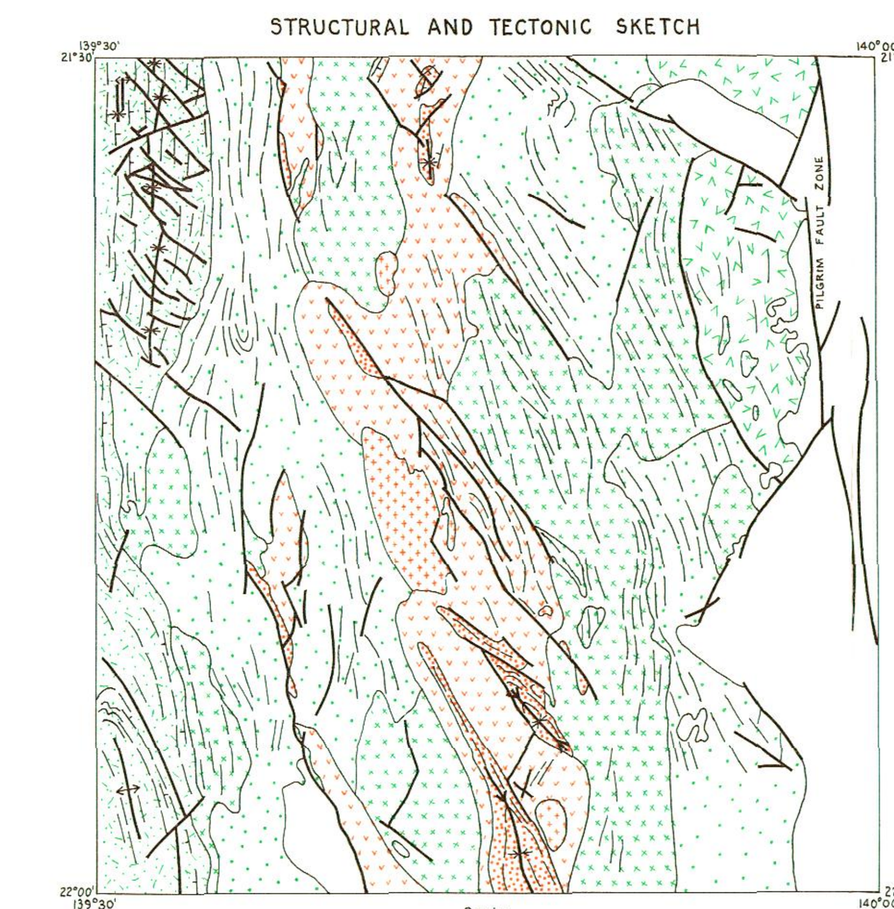


FIELD OBSERVATION LOCALITIES



Geology, 1967, by F. de Keyser and others - detailed reconnaissance, numerous traverses, and airphoto interpretation

STRUCTURAL AND TECTONIC SKETCH



Sedimentary rocks	Cambro-Ordovician of Burke River Outlier succession
Wills Creek Granite, unnamed granite	Younger Precambrian granite
Stanbroke and Makbat Sandstones	Younger Precambrian cover
Standish Volcanics	Younger Precambrian cover
Haslingden Group	Older Precambrian cover
Kalkadoon Granite, unnamed granite	Tewinga-Kalkadoon basement
Corella Formation	Tewinga-Kalkadoon basement
Tewinga Group	Tewinga-Kalkadoon basement

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PRELIMINARY EDITION MAY 1978

SUBJECT TO AMENDMENT

DAJARRA

SHEET 6854