EXPLANATORY NOTES

GOVERNMENT OF WESTERN AUSTRALIA

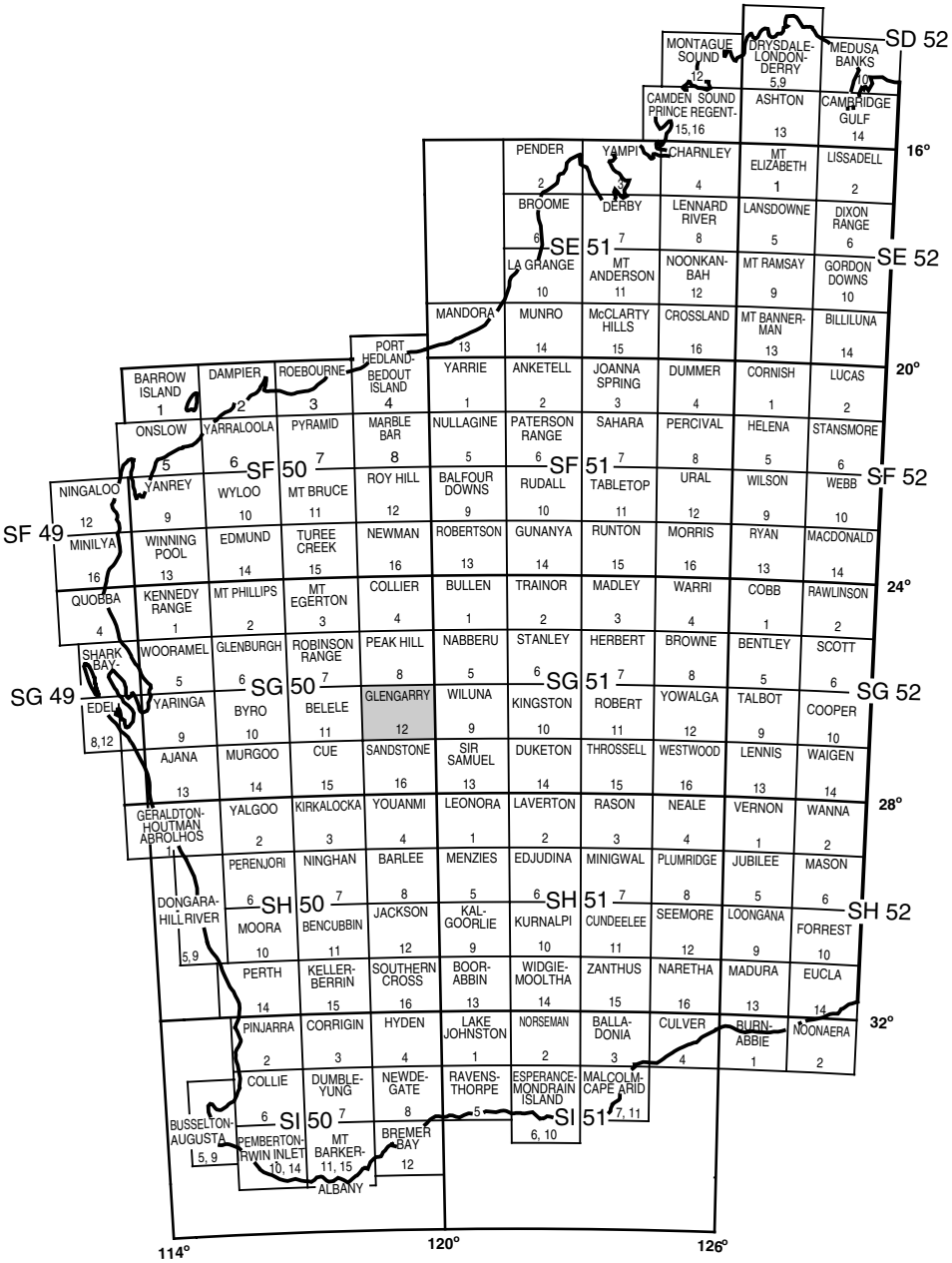
GEOLOGY OF THE GLENGARRY 1:100 000 SHEET

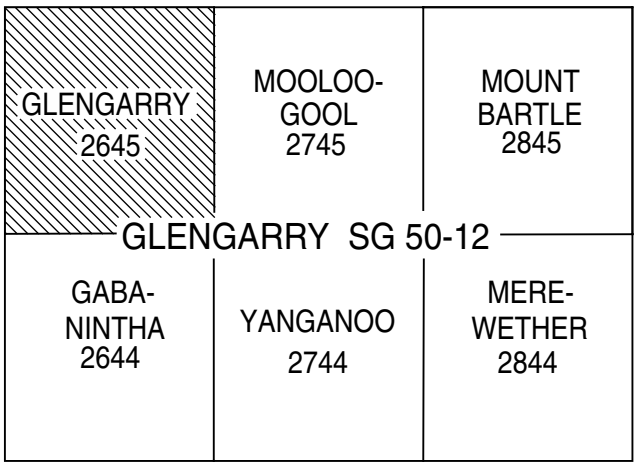
by F. Pirajno, N. G. Adamides, and D. D. Ferdinando

1:100 000 GEOLOGICAL SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

DEPARTMENT OF MINERALS AND ENERGY





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Cover photograph:
Well-bedded siltstone of the Maraloou Formation, 3 km south-southeast of Randal Bore.

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Geology of the Glengarry 1:100 000 sheet

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Introduction

The GLENGARRY * 1:100 000 sheet (SG 50-12, 2645) is located northeast of Meekatharra and bounded by latitudes 26°00' and 26°30' and longitudes 118°30' and 119°00'. Access to the area is by the Great Northern Highway. The unsealed road between Meekatharra and Wiluna traverses the southeastern corner of the sheet. Other parts of the area are accessed via pastoral station roads and tracks along fence lines.

The climate is arid with long hot summers and mild winters. Mean annual rainfall is estimated at 200–240 mm, with precipitation mainly due to cyclonic storms or winter rains between the months of January and July. Evaporation from a free water surface in the study area is estimated at 2400–3000 mm/y.

GLENGARRY was geologically mapped in the field season of 1995. Field observations were integrated with Landsat and aeromagnetic images.

Historical outline and previous work

Approximately the northeastern half of GLENGARRY is covered by the Palaeoproterozoic Yerrida Basin; there is a small portion of the Bryah Basin in the northwest, and Archaean granite–greenstone rocks occupy the southwestern half of the sheet (Fig. 1).

A brief account of the geology of parts of GLENGARRY is given by Elias et al. (1982), who mapped the area as part of the regional mapping of GLENGARRY (1:250 000). Bunting et al. (1977), Bunting (1986), and Gee (1990) included the area in a synthesis of Proterozoic stratigraphy within the broader area of the Nabberu Basin (Glengarry and Earaheedy Basins). Gee and Grey (1993) and Grey (1994, 1995) studied stromatolites from the Glengarry Basin and identified several species that, although of limited use in regional correlation, may be useful as local marker horizons.

The groundwater potential in the area between Wiluna and Meekatharra was discussed by Brookfield (1963), whilst the geomorphology of the same area was described by Mabbutt (1963). Hallberg et al. (1976) and Watkins and Hickman (1990) examined the geology and petrology of the Meekatharra–Wydgee Greenstone Belt, parts of which extend into GLENGARRY.

Physiography and vegetation

The area is mostly flat to undulating, with a mean elevation of 520 m above sea level. Local areas of higher elevation reflect the more resistant rock units. The most prominent of these is the Glengarry Range — a steep-sided plateau, capped by massive quartz arenite, which attains elevations greater than 600 m above sea level.

Shallow breakaways, commonly only a few metres high, are present over many granite outcrops. These form where the old plateau surface, which originally formed part of an extensive watershed (Mabbutt, 1963; Bettenay and Churchward, 1974), was subsequently elevated and dissected by later erosion.

The Yalgar River in the northwest drains eastward into the Hope River. Major drainage channels in the southern half of the area flow northwestward into or towards the Yalgar River, and in the north they drain to the southwest. The major drainage channels are commonly outlined by areas of groundwater calcrete (*Czk*) — a mixture of opaline silica and carbonate.

Numerous species of vegetation have been identified in the area, many of them characteristic of specific physiographic units. A detailed account of native shrubs of Western Australia is given in Mitchell and Wilcox (1994). The most abundant of the larger shrubs is Mulga (*Acacia aneura*), which is present in almost all habitats and commonly associated with broad-leaf acacia species. Gum trees, represented by the river red gum (*Eucalyptus camaldulensis*), commonly line the major watercourses. Species of eremophila, particularly Wilcox bush (*Eremophila forrestii*), are abundant as an understorey to the

* Capitalized names refer to standard map sheets. GLENGARRY implies the Glengarry 1:100 000 sheet unless otherwise indicated.

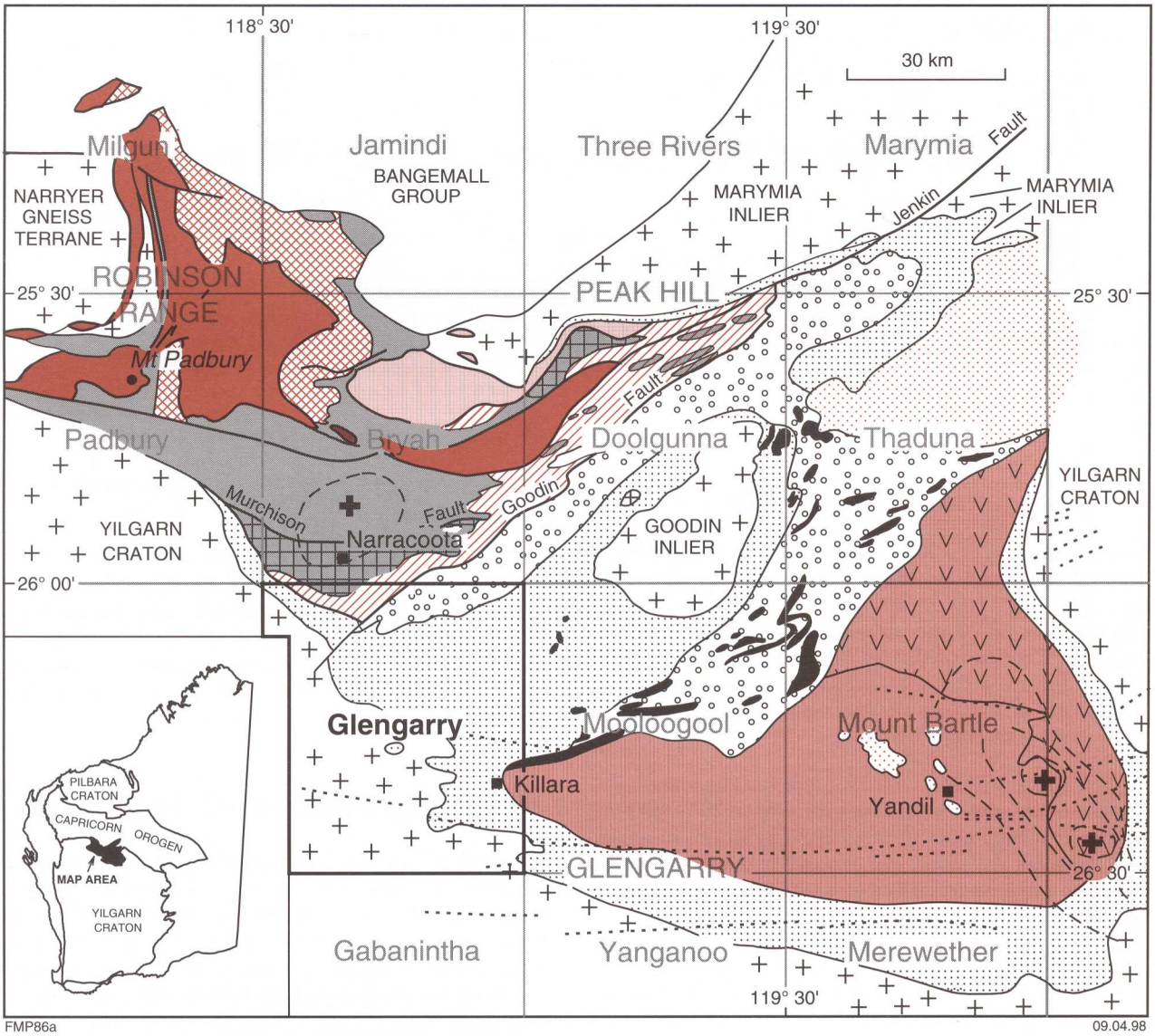

Figure 1. Simplified geological map of the Bryah, Padbury, and Yerrida Basins, showing the position of the GLENGARRY 1:100 000 sheet (modified from Pirajno et al., 1996)

Table 1. Stratigraphy of the Yerrida and Bryah Basins

Basin/Group		*Formation/Member*	*Rock types*
BRYAH BASIN (rift succession)			
Bryah Group		Horseshoe	BIF, wacke, shale
		Ravelstone	quartz-lithic wacke
		Narracoota	mafic–ultramafic volcanic rock, dykes, tuff, and intercalated sedimentary rock
		Karalundi	conglomerate, quartz wacke
~ *Faulted contact* ~			
YERRIDA BASIN			
Yerrida Group			
Mooloogool Subgroup (rift succession)	Intercalated	Maraloou	black shale, siltstone, carbonate
		Killara	aphyric mafic lavas and intrusives
		Doolgunna	diamictite, arkosic sandstone, siltstone, shale
		Thaduna (not on GLENGARRY)	lithic wacke, siltstone, shale, minor arkose
Windplain Subgroup (sag-basin succession)		Johnson Cairn	siltstone, shale, carbonate, minor lithic wacke
		Juderina	arenite, conglomerate, minor carbonate
		Bubble Well Member	silicified carbonate with evaporite units
		Finlayson Member	arenite
~ *Unconformity on Yilgarn Craton* ~			

NOTE: Modified from Pirajno et al. (1996)

mulga on richer soils. They are commonly associated with species of the Cassia group, particularly crinkled cassia (*Cassia helmsii*) and white cassia (*Cassia luersenii*). Spinifex (*Triodia* sp.) and scattered low mallee (*Eucalyptus* sp.) characterize the sandy plains. Several species of everlasting daisies associated with larger annuals (purple mulla mulla and cotton bush) make colourful displays during spring.

Regional setting and stratigraphy

The southwestern half of GLENGARRY is occupied by Archaean granite–greenstone terrane, and the northeastern half by unconformably overlying Proterozoic rocks of the Yerrida and Bryah Basins (Fig. 1).

The Archaean rocks on GLENGARRY are part of the 3.0 Ga Murchison Terrane (Myers, 1993) of the Yilgarn Craton. The Yerrida and Bryah Basins are part of the Capricorn Orogen, which formed as a result of the collision of the Yilgarn and Pilbara Cratons between 2.0 and 1.6 Ga (Myers, 1990, 1993; Myers et al., 1996). Overviews of the tectonic evolution of the Yerrida and Bryah Basins are given in Pirajno et al. (1996) and Pirajno (1996).

The stratigraphy of Archaean greenstone rocks on GLENGARRY is poorly constrained. Watkins and Hickman (1990) subdivided the rocks of the Meekatharra–Wydgee Greenstone Belt into two successions: the Luke Creek and Mount Farmer Groups. Of these, only the Luke Creek Group, which includes mafic–ultramafic, felsic, and metasedimentary rocks, is likely to be represented on GLENGARRY (Hickman, A. H., 1997, pers. comm.). A possible chronological sequence, based on field observations and the work of Elias et al. (1982), is (oldest to youngest) mafic and ultramafic rocks, felsic rocks, and metasedimentary rocks. The subdivision by Elias et al. (1982) into a lower mafic unit, lower felsic volcaniclastic unit, upper mafic unit, and upper felsic volcaniclastic unit cannot be confirmed on GLENGARRY due to poor exposures and extreme weathering.

The Proterozoic stratigraphy is reasonably well established for the Bryah and Yerrida Basins, which contain the Bryah and Yerrida Groups respectively (Table 1). The Yerrida Group is subdivided into the Windplain and Mooloogool Subgroups. The Windplain Subgroup is further subdivided into the Juderina and Johnson Cairn Formations; the Juderina Formation is characterized by siliciclastic rocks, silicified carbonate, and evaporitic rocks, while the Johnson Cairn Formation is mainly characterized by siltstone and shale. The Mooloogool Subgroup is subdivided into the Thaduna, Doolgunna, Killara, and Maraloou Formations. Regionally, there are interdigitating relationships between the first three formations, but the lower Thaduna Formation is not present on GLENGARRY. The Doolgunna Formation is characterized by clastic units mainly derived from granitic rocks, and the Killara Formation is represented by aphyric mafic extrusive units and dolerite sill-like bodies. The Maraloou Formation overlies the Killara Formation and consists of thinly bedded siltstone and carbonate rocks, locally intercalated with thin amygdaloidal basalts.

The Bryah Group is in faulted contact with rocks of the Yerrida Group (Pirajno et al., 1996), but on GLENGARRY this relationship is masked by Cainozoic cover. The Bryah Group is divided into the Karalundi, Narracoota, Ravelstone, and Horseshoe Formations, of which only the first two are represented on GLENGARRY. The Karalundi Formation contains lithic wacke and carbonate rocks and is overlain by, and locally interdigitates with, the mafic volcanic rocks of the Narracoota Formation. The volcanic rocks are metamorphosed to greenschist facies and include basaltic hyaloclastite with minor volcaniclastic units.

Archaean geology

Granitoid rocks (*Ag*, *Agm*, *Agn*)

Archaean granitoid rocks (*Ag*) occupy much of the southwestern half of GLENGARRY. Outcrops are poor, with a saprolitic veneer over most exposures. This veneer of kaolinized and silcretized granitoid rocks forms shallow breakaways, commonly 3–4 metres high.

Granitoid rocks (*Ag*) typically have a leucocratic appearance, are coarse- to medium-grained, and locally porphyritic. There are also a few fine-grained aplitic varieties. Elias et al. (1982) provided chemical analyses of a number of granitic rocks from the GLENGARRY 1:250 000 sheet, three of which are from the GLENGARRY 1:100 000 sheet (adamellite and granodiorite). The granitic rocks examined by Elias et al. (1982) have compositions ranging from calcium-rich to potassium-rich, consistent with a change from syntectonic (foliated) to post-tectonic granites.

Cataclastic deformation of granitoid rocks has resulted in assemblages of granular recrystallized quartz–K-feldspar or recrystallized aggregates of strained quartz, muscovite books, and fine-grained sericite–quartz stringers that define a deformation fabric (AMG 500227 *).

Monzogranite (*Agm*) outcrops west of the Great Northern Highway. At one locality (AMG 576730), field relations suggest that the monzogranite intrudes gneissic granitoid rocks (*Agn*). A northwest-trending fabric is well developed in monzogranite outcrops to the east of Cork Tree Well. Quartz veins, mafic dykes, and joints follow this same trend. The monzogranite is undeformed and porphyritic, with megacrysts of microcline, and has approximately equal amounts of microcline and plagioclase, with accessory quartz, biotite, and minor amounts of chlorite, sericite, and epidote. Euhedral allanite is present in places. Alteration, where present, has resulted in the sericitization of feldspars and chloritization of biotite — the latter associated with minor amounts of epidote. Chlorite and epidote, in association with minor amounts of calcite and clinozoisite, are also found in veinlets. In more advanced stages of alteration (AMG 591898), feldspars are replaced by aggregates of quartz and sericite.

Gneissic granitoid rocks (*Agn* — ?tonalitic gneiss) occupy areas in the southwestern part of GLENGARRY, west of the Great Northern Highway. These rocks contain biotite as the main mafic mineral and are characterized by gneissic banding, locally with augen texture. Enclaves of amphibolite (*Aba*) are included in places.

Amphibolite, mafic schist, ultramafic rock, and metapyroxenite (*Aba*, *Abf*, *Au*, *Aux*)

Greenstone rocks, including amphibolite (*Aba*), mafic schist (*Abf*), metapyroxenite (*Aux*), and undivided ultramafic rocks (*Au*), are present as small and scattered outcrops. However, aeromagnetic patterns indicate that these rocks form north-northeasterly and northerly trending zones, as shown in the **Simplified Geology** on the map. These zones continue beneath the Proterozoic sedimentary cover and represent the northern continuation of the Meekatharra–Wydgee Greenstone Belt (Watkins and Hickman, 1990). The rocks of this belt were assigned by Watkins and Hickman (1990) to the Golconda Formation, which is about 1500 m thick and includes mafic and ultramafic units interlayered with banded iron-formation (BIF).

Amphibolite (*Aba*) forms a north-northeasterly trending outcrop on the eastern side of the Great Northern Highway near Government Well in the southwestern corner of GLENGARRY. This unit may be the metamorphosed equivalent of basaltic rocks. Two and a half kilometres south of Karalundi, mafic schist (*Abf*) is associated with thin carbonate units and consists of an assemblage of plagioclase laths and chlorite in part replaced by quartz. Plagioclase microphenocrysts are present. This assemblage is overprinted by porphyroblastic biotite. Mafic schists also outcrop in the southwestern corner of GLENGARRY, where they have a northeasterly trend and are enclosed by granitoid rocks. The mafic schists may be derived from metamorphism of high-Mg basalt — a major component of the Golconda Formation (Watkins and Hickman, 1990).

Ultramafic rocks (*Au*) are present as small enclaves in gneissic granitoid rocks (*Agn*) and as a string of outcrops aligned in a northerly direction in the southern-central part of the area. The enclave is composed of amphibole, sericitized feldspar, quartz, and epidote. The outcropping ultramafic rocks form low-relief ridges, show a well-developed pencil cleavage, and consist of a felted ground-mass of actinolite and biotite with actinolite needles. Chlorite is a retrograde mineral that locally replaces biotite or actinolite. One sample of ultramafic rock contains garnet porphyroblasts. Meta-

* Localities are specified by the Australian Map Grid (AMG) standard six-figure reference system whereby the first group of three numbers (eastings) and the second group (northings) together uniquely define position, on this sheet, to within 100 m.

pyroxenite (*Aux*) outcrops 3 km northeast of Emerald Well (AMG 662803) and largely consists of clinopyroxene which has retrogressed along the margins to actinolite and/or chlorite.

Metasedimentary and metamorphosed felsic rocks (*As*, *Ac*, *Aci*, *Afs*, *Afp*)

Archaean metamorphosed sedimentary and felsic rocks are present mainly in the central parts of GLENGARRY. Unassigned fine-grained metasedimentary rocks (*As*) lie between Emerald Well and 14 Mile Well and on the southern boundary of the sheet. North of Munarra Homestead, subdued outcrops of weathered schistose metasedimentary rocks contain lenticular polycrystalline strained quartz, alternating with clay-rich layers of probably originally micaceous material. About 5 km south-southeast of Karalundi, conglomeratic beds overlie chloritic shale containing disseminated euhedral tourmaline crystals.

Quartz–magnetite BIFs (*Aci*) are steeply dipping units, typically lateritized and up to 5 m thick, with well-developed small-scale folds. These units extend discontinuously, steeply plunging in a northerly direction from Jones Well (AMG 635720) to Road Well (AMG 686050). They are locally offset by faulting and associated with lateritized rocks (*Czf* and *Czl*) derived from protoliths of greenstones (Golconda Formation). At one locality (AMG 662803), BIF is spatially associated with an outcrop of metapyroxenite (*Aux*). The BIF typically consists of alternating layers of polygonized quartz and martitized magnetite, with blades of iron hydroxides replacing original biotite. In other instances the BIF consists of alternating laminae of magnetite and quartz–magnetite, associated with sericite and aggregates of K-feldspar. An outcrop of banded chert (*Ac*) lies about 300 m south of Miralga Bore.

Felsic rocks on GLENGARRY include quartz–sericite schist (*Afs*) and metamorphosed porphyry (*Afp*). The quartz–sericite schist (*Afs*) is usually pale green and forms low-lying outcrops, west of Breakaway Well, that are cut by quartz veins. Metamorphosed and schistose felsic porphyritic rocks (*Afp*) form a northerly trending outcrop (about AMG 603758) to the east of an area of amphibolite (*Aba*). These porphyritic rocks are characterized by porphyroblastic acicular crystals of crossite, epidote (pistacite variety), and albite set in a fine-grained matrix of quartz and albite with minor amounts of apatite.

Proterozoic geology

Proterozoic rocks of the Yerrida and Bryah Groups occupy the eastern and northern parts of GLENGARRY, with the Yerrida Group lying unconformably on Archaean granite and greenstone. Details of Proterozoic stratigraphy are shown in Table 1.

Yerrida Group

Windplain Subgroup

Juderina Formation (PYj, PYjf, PYja, PYjb)

The Juderina Formation (*PYj*) is present mainly in the eastern parts of GLENGARRY, where it lies unconformably on granitic rocks. The unconformity is locally well exposed, particularly in the southeast and northwest. The lowermost units belong to the Finlayson Member (*PYjf*) — a pale-coloured, silica-cemented, well-bedded, and well-sorted quartz arenite that commonly shows ripple marks (Fig. 2), parallel laminations, and cross-laminations, including trough and herringbone cross-laminations. These sedimentary structures are indicative of a shallow-water (probably intertidal) environment. Subordinate quartz siltstone is interbedded with the arenites; the siltstone forms recessive units and is only rarely exposed. The Juderina Formation is intercalated with stromatolite-bearing cherty rocks of the Bubble Well Member*(*PYjb*).

In the extreme northwest, in an area known as Judges Patch, a detailed stratigraphy of the Juderina Formation was established by Crane and Dunn (1979) over a total thickness of about 1300 m. They recognized six units in this area, which are shown in Figure 3 and briefly described as follows: Unit 1 is a thickly bedded siltstone with lenses of cross-stratified and ripple-marked quartz arenite, and is the equivalent of the Finlayson Member; Unit 2 comprises a bedded chert, chert breccia, and tremolite-rich rock, and is probably part of the Bubble Well Member (see below); Unit 3 is a green to blueish black siltstone; Unit 4 consists of cross-stratified quartz arenite, siltstone, and minor conglomerate; Unit 5 is a grey to green sericitic siltstone; and Unit 6 contains chert breccia and chert with centimetre-scale domed surfaces (?stromatolites) overlain by quartz-pebble conglomerate and cross-stratified quartz arenite. Unit 6 is overlain by almost 1000 m of purple and green shale of the Johnson Cairn Formation.

The basal unconformity, as exposed in the area 6 km east of Munarra Homestead, is marked by a 2 m-thick zone of crudely bedded silcrete comprising angular quartz in a fine matrix. This is overlain by 1 m of flaggy, angular quartz arenite followed by cross-bedded quartz arenite.

In the southeastern part of GLENGARRY, the Finlayson Member (*PYjf*) outcrops dominantly as a poorly bedded to well-bedded, white to brown quartz arenite, with minor interbeds of fine-grained arenite and shale. Thin lenticular beds (up to 0.5 m thick) of conglomerate are also present, mainly at the unconformity but also as discrete lenses within the main body of the member. These conglomeratic units may represent erosional channels. In the southeast, the Finlayson Member is a medium- to coarse-grained unit with well-rounded quartz grains cemented by authigenic quartz overgrowths. Chlorite is present and is probably derived from metamorphism of an interstitial iron-rich

* The Bubble Well Member is incorrectly referred to as the 'Bubble Member' on the printed map.

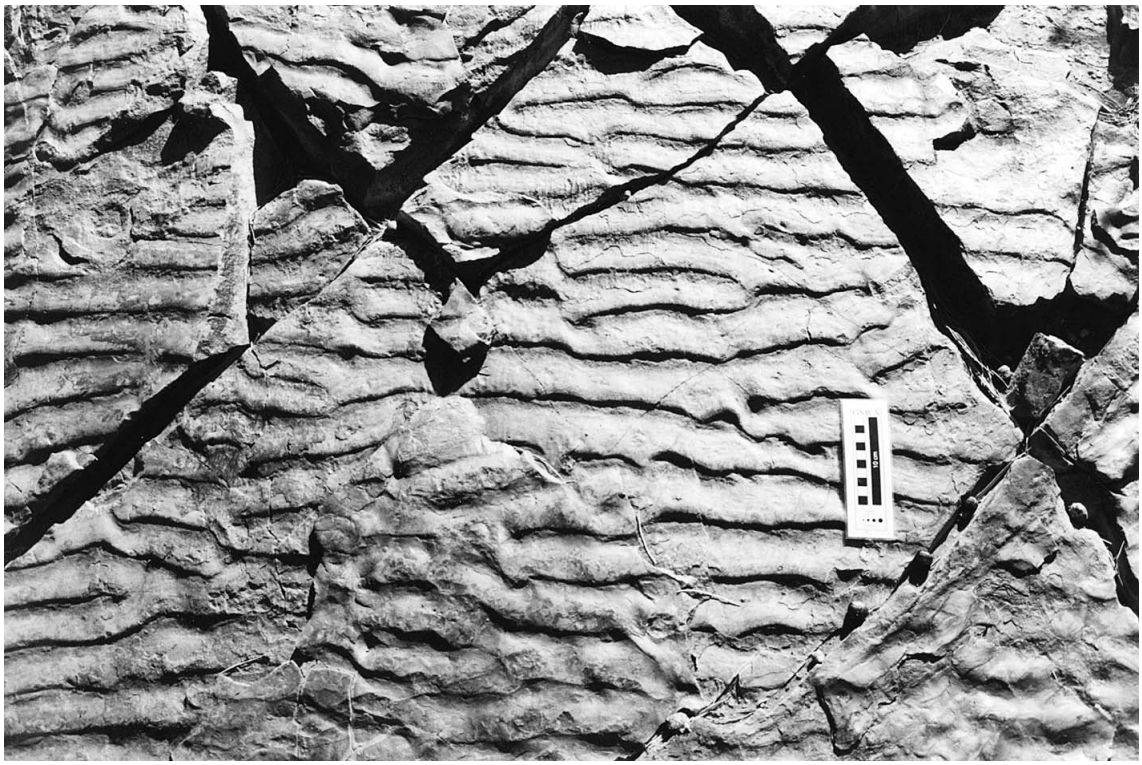

Figure 2. Quartz arenite with ripple marks from the Finlayson Member of the Juderina Formation (AMG 828084). The scale bar has a 1 cm graduation

clay in the original sediment. Bedding is typically parallel, with asymmetric and symmetric interference ripple marks on bedding surfaces. The ripple marks suggest south-southeasterly and west-southwesterly palaeoshoreline orientations (Fig. 4). Mudcracks and moulds of elongate ?gypsum crystals are locally present in fine-grained arenite.

One kilometre south of Hill Well, in the central part of GLENGARRY, cross-laminated, creamy quartz arenite at the unconformable contact with the granite is overlain by gently folded, impure, grey arenite containing lithic clasts. The clasts consist of creamy quartz siltstone and average 2 cm in length, with blocks exceptionally reaching 15 cm.

The Finlayson Member (*Pyjf*) also outcrops in two zones in the southwestern and central parts of the Glengarry Range (see below). In these areas, it comprises medium-grained, angular-textured, well-sorted, silica-cemented quartz arenite, with beds ranging from 50 to 70 cm in thickness and containing sparse weathered-out siltstone intraclasts.

Outcrops of thick-bedded sandstone (*Pyja*) in the Glengarry Range cannot be confidently assigned to a specific stratigraphic level of the Juderina Formation. These rocks were left unassigned by Elias et al. (1982), who put forward two possible alternatives: 1) the succession may be a correlative of the Earaheedy Group and equated with the Mount Leake Formation on BRYAH (Pirajno and Occhipinti, 1998) and DOOLGUNNA (Adamides, 1998); or 2) the succession is a facies variation of the Juderina Formation. Gee and Grey (1993), however, concluded that the succession is unconformable on the Juderina Formation based on evidence from the western end of the Glengarry Range and the Hill Well area. A clear-cut unconformity cannot be confirmed from the present mapping. Lithologically, the sandstone is more similar to arenite of the Finlayson Member than it is to glauconitic arenite of the Mount Leake Formation.

The sandstone in the Glengarry Range is typically thick bedded, dips more gently than the surrounding units, and contains siltstone clasts. The sandstone is interbedded with minor thin-bedded shale. There is evidence of a local unconformity between the sandstone and underlying silty rocks in several areas, although there is no evidence of a regional unconformity. In one area, 3.5 km southeast of Bennett Well (AMG 974009), the sandstone is underlain by a thick unit of hematitic brecciated siltstone associated with argillaceous rock and local ?tuffaceous layers. The tuffaceous layers consist of illitic or sericitic clays associated with fine-grained quartz and abundant detrital opaque minerals. Scattered within this fine matrix are coarser clasts of quartz and minor amounts of clastic muscovite. The basal unconformity with the Archaean granitoid rocks is poorly exposed about 4 km south-southeast of Bennett Well (AMG 968989). At this locality, weathered granite is overlain by creamy, silica-cemented, locally cross-stratified sandstone typical of the basal parts of the succession. Northward from this locality, across strike, the sandstones are successively

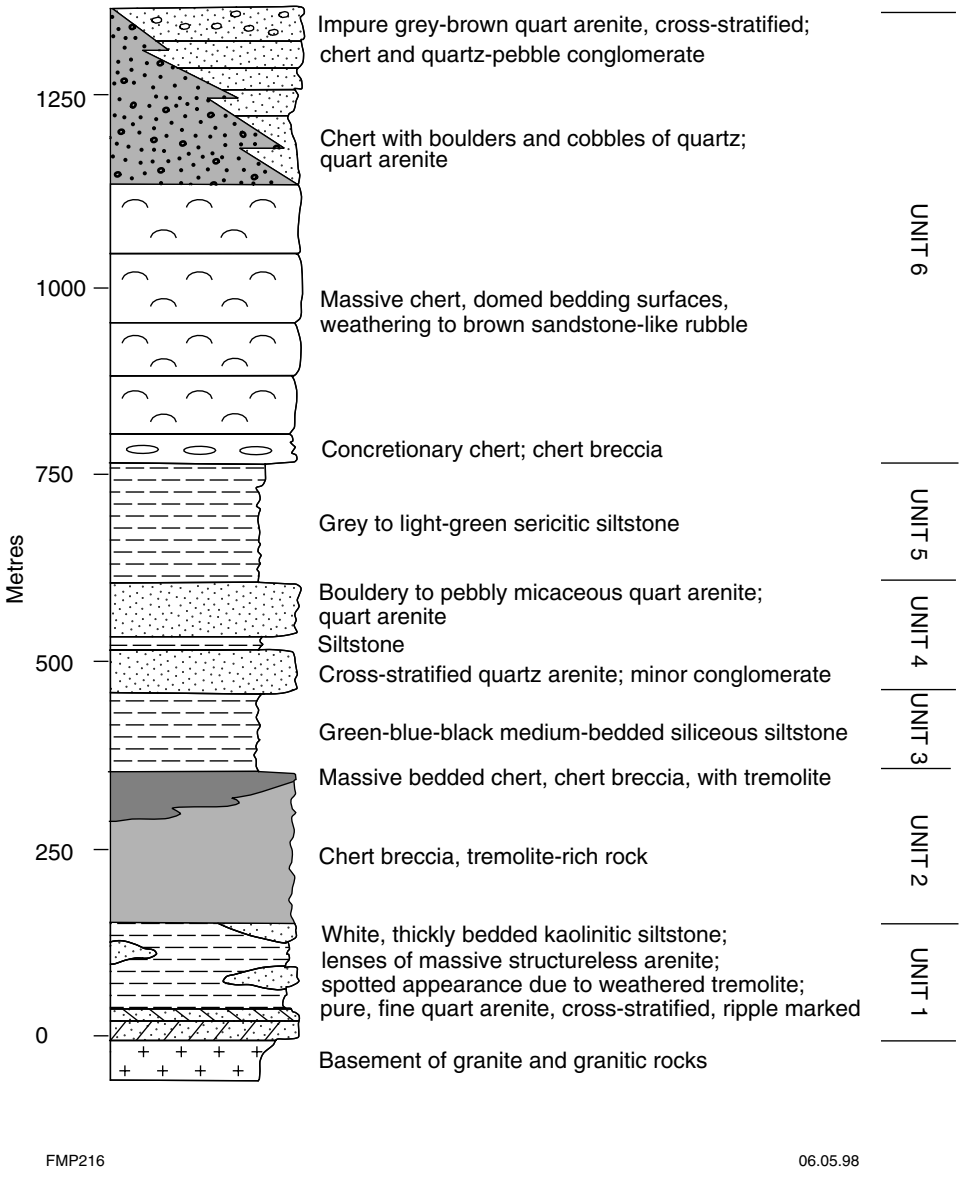

Figure 3. Stratigraphy of the Juderina Formation in the Judges Patch area. Modified from Crane and Dunn (1979)

overlain by quartz siltstone and a 20 m-thick sequence of chert breccia, with stromatolitic layers showing poorly preserved species of ?*Kussoidella Karalundensis* (Grey, 1994). This is overlain by laminated, well-sorted quartz arenite and thick-bedded quartz arenite units.

Rocks assigned to the undifferentiated Juderina Formation (*Pyj*) comprise quartz sandstone, subordinate siltstone, and parallel-laminated, thin-bedded kaolinitic quartz sandstone. In the area 6 km southeast of Randal Bore, these rocks are folded into mesoscale southeast-trending folds. Stratigraphically, they occupy an intermediate position between the Finlayson Member and the sandstone units (*Pyja*) of the Glengarry Range.

The Bubble Well Member (*Pyjb*) is exposed in a number of outcrops in the eastern part of GLENGARRY and at a locality about 5 km south of Karalundi, opposite the Mooloogool Road – Great Northern Highway junction. At this locality, the Finlayson Member is overlain by siltstone, laminated chert, and a crudely bedded chert breccia. The chert rocks contain bioherms of a new stromatolite form, *Kussoidella* (Gee and Grey, 1993). The Bubble Well Member of the Juderina Formation is typically a chertified sedimentary rock, probably after carbonate and fine-grained clastic rocks. Parallel laminations, soft-sediment deformation structures, cross-bedding, and planar bedding surfaces in the original sediments are commonly preserved. In addition, stromatolite structures are typically well preserved; these have been described by Gee and Grey (1993). About 4 km northeast of Killara, rectangular and square impressions, probably after evaporitic minerals such as gypsum and halite, are present within some of the beds, indicating that there were periods of hypersaline conditions during deposition of the member. The chertified sedimentary rock

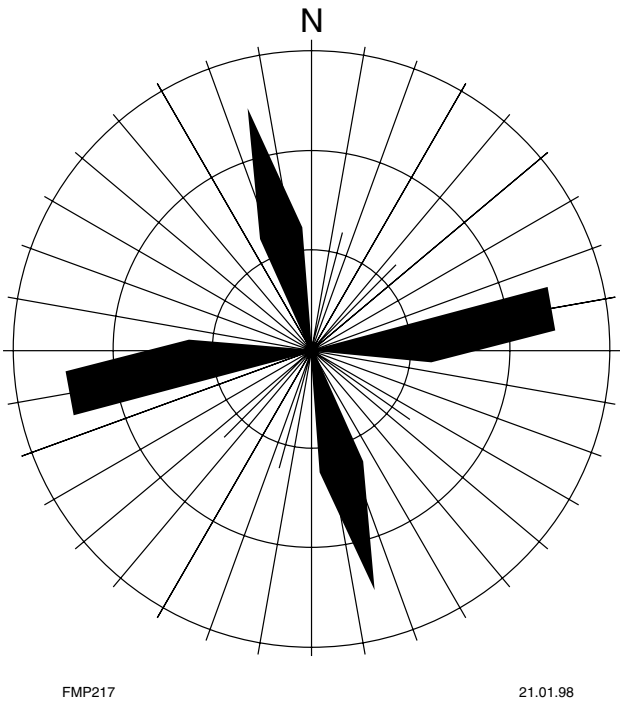

Figure 4. Rose diagram showing palaeoshoreline orientations, based on 12 measurements of symmetrical ripples

is characterized by cryptocrystalline and microcrystalline quartz, chalcedonic quartz, and minor amounts of iron oxides. The upper and lower contacts of the Bubble Well Member have not been directly observed; however, in one locality about 3 km north of Referendum Bore, the Bubble Well Member lies above the Finlayson Member.

Johnson Cairn Formation (PYc, PYck)

The Johnson Cairn Formation (originally Johnson Cairn Shale of Gee, 1987) is a succession, about 250 m thick, of varicoloured iron-rich shale with graded silty layers and thin dolomite bands. It overlies the Juderina Formation in the areas northeast of Thaduna (on THADUNA) and around the Goodin Inlier. The Johnson Cairn Formation has recently been redefined by Occhipinti et al. (1997).

The Johnson Cairn Formation is confined to the northeastern and northwestern parts of GLENGARRY; its dominantly argillaceous character results in subdued outcrops. The contact with the enclosing units of the Windplain Subgroup is not exposed; however, disconformable contacts with the overlying Doolgunna Formation are present on DOOLGUNNA (Adamides, 1998). The lower contact with the Juderina Formation is probably conformable and transitional. In the northwest, the Johnson Cairn Formation is in faulted contact with rocks of the Bryah Group.

On GLENGARRY, rocks of the Johnson Cairn Formation (*PYc*) are laminated argillaceous siltstones, purple to grey in colour, with a minor proportion of sandstone. Thin beds of dolomite are commonly present. Samples collected from wells (AMG 923189 and AMG 824148) consist of greenish grey, graded sandstone. The main components are plagioclase and K-feldspar, associated with abundant amphibole. Epidote, associated with minor amounts of muscovite and biotite, is present in the matrix and may be metamorphic. Quartz is present in minor amounts, as are sedimentary rock fragments dominantly composed of chert and siltstone. These units are attributed to the rapid erosion of a granite–greenstone dominated terrane. Carbonate units (*PYck* — mainly dolomite, shale, and marl) are present in the east (around AMG 850860), where they are intruded by dolerite.

Mooloogool Subgroup

Doolgunna Formation (PYd, PYds, PYdm, PYda)

Outcrops of the Doolgunna Formation (*PYd*) are confined to the northeastern part of GLENGARRY, where they lie in a east-northeasterly striking belt. The basal units (*PYds*), which are probably up to 1 km thick, are well exposed in a series of outcrops to the east of Ruby South Well. The dominant rock type is a thin-bedded quartz sandstone with interbedded, locally magnetite-rich, grey shale. Pyrite cubes, partly weathered to iron hydroxides, are present on some bedding planes. The quartz sandstone is associated with extensive pebble beds, particularly in the northeastern-most corner of GLENGARRY. Associated conglomerate is oligomictic, consisting almost exclusively of vein quartz, with clasts reaching up to several centimetres in length. The clasts are subangular to rounded and enclosed in a matrix of medium-grained quartz sandstone.

Associated with the quartz sandstone and pebble beds, particularly in the northeastern-most corner of GLENGARRY (AMG 980190), are zones of strong silicification and brecciation probably related to hydrothermal activity associated with faulting. The breccia (Fig. 5) consists of angular clasts of a grey, totally silicified rock, cemented by, and encrusted with, creamy crystalline quartz. Thin-section examination of these rocks suggests a history of fragmentation and recementing, possibly of a silty rock that is now pervasively chertified. Textural relationships indicate repeated periods of silicification, brecciation, and mineralization.

Basal units of the Doolgunna Formation (around AMG 989165) comprise well-bedded and parallel-laminated, brownish-grey, fine-grained quartz sandstone with associated granulestone bands and local interbedded silty, impure quartz sandstone. The gentle dips of these outcrops are in sharp contrast with the main belt and are probably due to increasing tectonic complexity towards the northwest.

A poorly exposed succession of coarse conglomerate outcrops along the northeastern boundary of GLENGARRY (AMG 913225). It is a belt of diamictite (*PYdm*) containing

Figure 5. Chert breccia (?hydrothermal) along a faulted contact between the Johnson Cairn and Doolgunna Formations (AMG 953188). The lens cap is 5.5 cm in diameter

rounded blocks of vein quartz, laminated Juderina Formation-type quartz sandstone, and laminated cherty units, possibly of the Bubble Well Member. It represents the continuation of similar units on BRYAH (Pirajno and Occhipinti, 1998) and is probably related to basement unroofing and the initiation of the turbidite phase of the Doolgunna Formation. A sample of chert collected from this conglomerate (GSWA 130996) displays alternating laminae and brecciated domains (all pervasively replaced by silica) suggestive of an evaporite precursor with synsedimentary brecciation. This diamictite unit is stratigraphically overlain by kaolinitic quartz wackes and is mainly developed on adjoining BRYAH (Pirajno and Occhipinti, 1998) and DOOLGUNNA (Adamides, 1998). Flanking the diamictites to the west are poorly exposed arkosic wackes, siltstones, and minor conglomerates (*Pyda*). These rocks consist predominantly of angular quartz and feldspar clasts in a kaolinitic matrix. They represent the main phase of turbidite activity associated with the erosion of granite basement.

Killara Formation (Pyk, Pykb, Pykd)

Rocks of the Killara Formation (*Pyk*) are present in the eastern part of GLENGARRY, 4–5 km north of Killara Homestead. They overlie the Juderina Formation and include mafic extrusive and intrusive rocks with minor intercalations of chertified volcaniclastic rock.

Dolerite dykes and sills (*Pykd*) outcrop as prominent hills. The dolerite contains augite, labradorite, and chlorite, with minor amounts of disseminated ilmenite and titanite.

Basaltic rock (*Pykb*) outcrops about 5 km northeast of Killara. The basalt is typically vesicular and consists of augite and labradorite in a microcrystalline groundmass of skeletal clinopyroxene, quartz, and plagioclase, with minor amounts of tremolite, chlorite, and titanite. In places the basalt is augite-phyric, with the augite phenocrysts ranging from 0.5 to 3 mm length.

Outcrops of volcaniclastic rock are too small to be represented on the geological map. Some are laminated chertified units consisting of granoblastic aggregates of quartz, microcline, and albite, overprinted by brown biotite and containing lithic fragments. In other outcrops, the rock is composed of an equigranular, lobate polygonal aggregate of quartz, albite, microcline, and disseminated rutile grains. These units are interpreted as fine volcaniclastic turbidites derived from the erosion of volcanic rocks and thermally metamorphosed (quartz–biotite hornfels) by subsequent eruptions of mafic lavas.

Maraloou Formation (Pym, Pymk, Pyms)

The Maraloou Formation (*Pym*) is a succession of fine-grained terrigenous sedimentary rocks, carbonate, and

chert. It was previously thought to conformably overlie the Juderina Formation (Elias et al., 1982), but unconformable relationships have been established during recent mapping of THADUNA (Pirajno and Adamides, 1997). This interpretation is consistent with the view of Guj and McIntosh (1984), who considered the Maraloou Formation to be a younger sedimentary sequence overlying the older members of the Yerrida Group.

Outcrops west of the Glengarry Range (AMG 930002) comprise well-bedded and laminated, light-grey felsic siltstones (*PYms*). Individual beds range in thickness from 150 mm to 1 m and commonly display well-developed parallel stratification and colour banding in shades of greyish brown and orange. These outcrops appears to lie unconformably on chert of the Bubble Well Member. The siltstone has a moderately developed schistosity, with grains of subangular quartz and minor amounts of muscovite in a matrix of clays (probably of the illite group) associated with fine-grained quartz. This siltstone is underlain in areas to the east (AMG 990860) by a carbonate unit (*PYmk*), dominantly composed of limestone, with minor intercalated fine-grained amygdaloidal basalt.

Isolated outcrops of a unit of uncertain stratigraphic position have been tentatively correlated with the Maraloou Formation (?*PYms*) and are present at two localities. North of Daulby Well (AMG 834080) it consists of parallel-laminated and well-bedded siltstone with individual beds ranging from 100 to 150 mm in thickness. Laminae in the thinner beds are of millimetre scale and enhanced by colour banding. Fossil mudcracks are present in places (Fig. 6). The siltstone contains detrital quartz grains (less than 0.05 mm in size) in a matrix of poorly crystalline clays and abundant disseminated euhedral magnetite crystals averaging 0.01 mm in diameter. Detrital muscovite is commonly scattered throughout the matrix, which is partly replaced by fine-grained glauconite.

The outcrop at the second locality (AMG 917123) consists of deformed siltstone of mafic appearance intersected by two sets of well-developed cleavages that are probably the result of local shearing. This outcrop is in apparent structural juxtaposition with quartz sandstone and associated pebble beds of the Juderina Formation. The rocks are fine grained to aphanitic with common diffuse laminations. Finely disseminated magnetite is abundant and gives the rock a high magnetic susceptibility (500×10^{-5} SI units).

Bryah Group

Rocks of the Bryah Group are present in the northwestern part of GLENGARRY, where they are represented by the Karalundi and Narracoota Formations (Table 1).

Karalundi Formation (*PAk*)

Quartz-lithic wacke, fractured and silicified arenite, and thin carbonate units of the Karalundi Formation (*PAk*) outcrop west of the Great Northern Highway, between 4 and 7 km west of 32 Mile Well. This locality was considered the type area for the Karalundi Formation by Gee et al. (1985). The succession, from base to top, consists of conglomerate, lithic wacke, a thinly banded chemical sedimentary (jasperoidal) unit, dolomite, silicified mafic tuff, and laminated siltstone. These rocks are intercalated with pyroclastic mafic units (*PAnt*) of the Narracoota Formation (described below). This is the only locality within the Bryah Basin where a depositional relationship can be observed between the Narracoota Formation mafic volcanic rocks and the sedimentary rocks of the Karalundi Formation.

Narracoota Formation (*PAn*, *PAnc*, *PAnh*, *PAnt*)

The Narracoota Formation is a newly defined stratigraphic unit (Occhipinti et al., 1997). It includes mafic and ultramafic schists (*PAn*), which are mostly exposed on BRYAH (Pirajno and Occhipinti, 1998) and PADBURY (Occhipinti et al., 1998), and metabasaltic hyaloclastite (*PAnh*), parts of which outcrop in the northwestern part of GLENGARRY. Minor units included in this formation are mafic volcaniclastic and autoclastic breccia rocks associated with microgabbro (*PAnt*) and jasperoidal chert (*PAnc*). The Narracoota Formation probably represents a substantial thickness of lavas and hypabyssal units. A total thickness ranging from 4 to 6 km was estimated by Hynes and Gee (1986) and Gee (1987).

Metabasaltic hyaloclastite (*PAnh*) forms an extensive outcrop area, partly covered by lateritic materials. Hyaloclastite is a term that denotes fragmentation (due to quenching) of lavas flowing in water or erupting under an ice sheet. This results in non-explosive fracturing and disintegration of the quenched lavas (Fischer and Schmincke, 1984; McPhie et al., 1993). In outcrop the metabasaltic hyaloclastites are typically unfoliated and have a characteristic breccia or jigsaw-fit texture outlined by epidote, carbonate, prehnite, and/or quartz veining. Jigsaw-fit textures may also be seen at microscale (Fig. 7).

The metabasaltic hyaloclastites (*PAnh*) are albite normative (13–23 wt%), typically aphyric, and composed mainly of acicular crystals of actinolite (forming sheaves with plumose textures), epidote, minor amounts of carbonate, prehnite, quartz, and titanite in a fine-grained groundmass of albite microlites, chlorite, and epidote. Coarse-grained equivalents have a metamorphic granoblastic texture and consist of actinolite, albite, quartz, and epidote with lesser amounts of chlorite, calcite, and titanite (altered to leucoxene). Albite is anhedral, poikiloblastic, and overprinted by actinolite.

In the northwest, about 4 km from the junction of the Narracoota Homestead road and the Great Northern Highway, basaltic hyaloclastites outcrop together with volcaniclastic rocks (*PAnt*). These rocks trend easterly along 2.5 km of strike length and are intercalated with rocks of the Karalundi Formation. The volcaniclastic rocks include laminated mafic units, autoclastic breccia, and other fragmental units, which, on the basis of texture and shape, resemble basaltic spatter and scoria material.

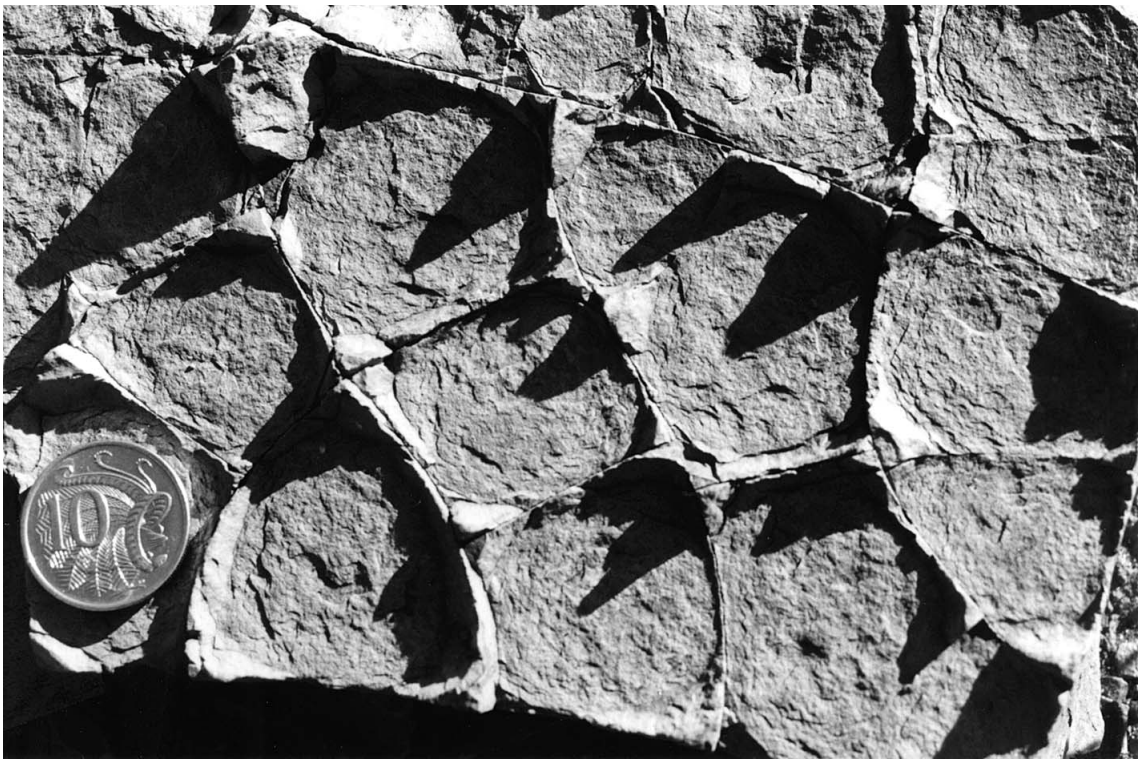

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Figure 6. Mudcracks in thin-bedded siltstone of the Maraloou Formation (AMG 834080). The coin is 23 mm in diameter

The laminated volcanic debris is highly magnetic (magnetic susceptibility of up to 4300 $\times 10^{-5}$ SI units) and exhibits cross-laminations reminiscent of pyroclastic surge deposits. The volcaniclastic rocks contain epidote, chlorite, quartz, and sericite with well-preserved vitroclastic textures (shards and pumice fragments).

These rocks are an important component of the Narracoota Formation because they indicate that volcanic activity began at the same time the Karalundi Formation was being deposited in a rift-basin setting.

Jasperoidal chert (*PAnc*) present as isolated pipe-like pods within rocks of the Karalundi Formation. These rocks have been assigned to the Narracoota Formation because they are interpreted to be a hydrothermal precipitate from hot-spring activity linked to the Narracoota volcanism.

Unassigned unit (*Ps*)

An unassigned succession comprising conglomerate, sandstone, and siltstone (*Ps*) of possible Proterozoic age outcrops about 2.5 km east of 3 Corners Well.

Dykes (*Pd*)

Easterly trending aeromagnetic lineaments are interpreted to be dolerite dykes (*Pd*) of Proterozoic age. Locally, these dykes cross-cut granitoid rocks in the western part of GLENGARRY.

Cainozoic geology

Extensive areas of calcrete (*Czk*) lie along the drainage channel of the easterly trending Yalgar River in the north-central part of GLENGARRY. The most extensive development of calcrete is around Karalundi. Lateritic materials (*Czl*, *Czf*) are well developed over Archaean BIF and areas of granitic rocks.

Plains covered by aeolian sands (*Czs*) are present north of the Glengarry Range and in the southern and south-eastern parts of GLENGARRY. The sand consists of ferruginous detritus and quartz, derived from the underlying lateritic materials and weathered granitoid rocks.

Areas adjacent to outcrops are commonly covered by coarse rock fragments mixed with finer material, and fragments of laterite and soil (*Czc*). The size of the fragments decreases and the proportion of soil increases with distance from the outcrop, merging at lower levels with floodplain deposits (*Cza*). The latter are commonly characterized by a striped pattern of vegetation, clearly seen on aerial photographs. Active stream channels contain alluvial material — mainly unconsolidated clay, silt, and gravel (*Qa*). There is commonly a gradation between the various colluvial and alluvial units. Claypans (*Qac*) form in limited depressions on the floodplains.

Quartz veins (*q*) are commonly surrounded by cobble and debris (*Czcq*). Extensive outcrops of silcrete (*Czz*) lie west of the Great Northern Highway in the northern part of GLENGARRY.

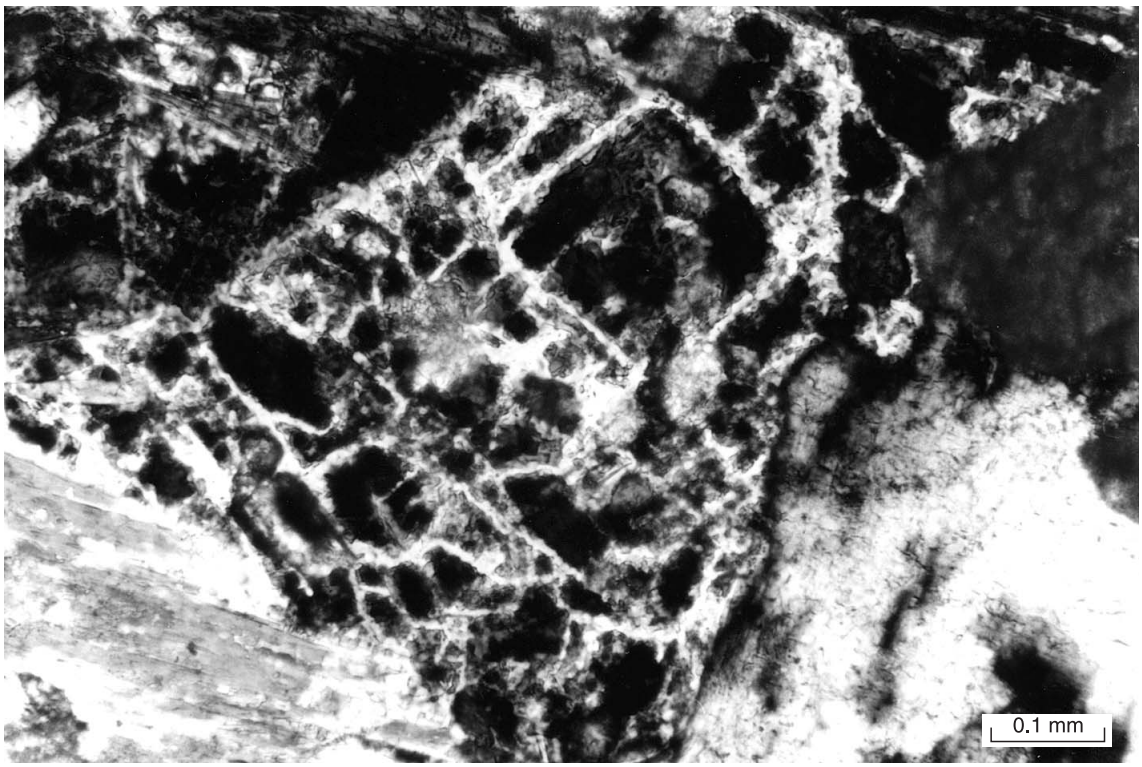

Figure 7. Photomicrograph of basaltic hyaloclastite showing jig-saw-fractured plagioclase crystals. Fractures are healed by fine quartz and sericite (GSWA 116490). Crossed nicols

Structure

Rocks of the Archaean Meekatharra–Wydgee Greenstone Belt are tightly folded into a south-plunging syncline (Watkins and Hickman, 1990). However, this folding is not detectable on GLENGARRY due to poor exposure.

Archaean rocks are cut by north-northwesterly and north-northeasterly trending faults associated with greenstone rocks. A well-developed foliation in granitoid rocks shows variable north-northwesterly, easterly, and northwesterly trends. Northeast-trending faults are associated with post-Archaean movements and primarily affect the Proterozoic rocks. Easterly, northeasterly, and northwesterly trends are generally associated with mafic dykes and/or quartz veins. In the northwest, north-northwesterly trending faults and shears affect the unconformity between the granitoid rocks and the Juderina Formation. The granitoid rocks themselves are extensively deformed and recrystallized to an assemblage of quartz and muscovite.

The Juderina Formation dips 10–20°S in the south-eastern areas. In the Glengarry Range, rocks of this Formation are deformed into mesoscopic-scale folds (tens of metres in wavelength) along northwesterly to westerly oriented axes. Dips are gentle and have a variety of orientations and the rocks are cut by steep faults, which are probably of predominantly reverse displacement. Movement along one of these faults is responsible for the exposure of granitoid rocks in the area.

The Doolgunna Formation exhibits tight folds along northeasterly trending axes, with beds showing steep and locally overturned dips with sheared limbs.

Metamorphism

Regional (static and dynamic) and contact metamorphism have affected the Archaean granite–greenstone rocks. The greenstones have been metamorphosed to lower amphibolite facies and locally retrograded to greenschist facies. Mineral assemblages of lower amphibolite facies in mafic rocks include hornblende, garnet, and Ca-plagioclase; corresponding assemblages in sedimentary and felsic rocks are quartz, oligoclase–andesine, muscovite, biotite, and garnet. Greenschist facies mineral assemblages are quartz, albite, epidote, chlorite, sericite, and tremolite–actinolite in both mafic and sedimentary rocks. Contact metamorphism on GLENGARRY is recognizable in the southwest, where amphibolite (*Aba*) and felsic porphyry (*Afp*) rocks adjacent to granitoid rocks have a granoblastic texture, with porphyroblasts of colourless clinopyroxene and crossite respectively.

Dynamic metamorphism of granitoid rocks resulted in development of undulose extinction and partial re-crystallization of quartz, associated with intense sericitization of feldspars. Cleavage planes are defined by newly formed chlorite, epidote, and titanite. In the northwest, granitoid rocks are dynamically recrystallized

Table 2. Trace-element analyses of selected samples

Sample no.	*130963*	*130966*	*130968*	*130972*	*130998*	*139203*	*139218*
AMG (E)	*698632*	*697912*	*697099*	*692590*	*682277*	*691526*	*653914*
AMG (N)	*7120917*	*7119533*	*7119131*	*7100620*	*7116144*	*7112663*	*7084182*
			Parts per million				
Ag	0.17	0	0.36	11	0.15	0	0.05
As	210	20	9.3	351	15	31	0.5
Au (ppb)	0	4	2	4	0	1	0
Ba	380	93	1 213	423	415	820	na
Bi	0	0	0.3	0	0.3	0.4	0.1
Cd	0.3	0	0.4	0.3	0.1	0.4	0.1
Ce	19	6.2	11	26	36	16	0.05
Cr	17	7	83	119	18	7	23
Co	61	25	0	0	7	215	6
Cu	999	28	235	367	667	830	10
Ga	13	3.6	51	21	19	30	0.05
In	0	0	0.07	0.06	0	0	0.05
La	147	4.4	7.7	18	24	11	0.05
Li	0	1.2	3.1	22	0	0	2
Nb	2	1.3	2.1	2.7	0.7	2.7	0.5
Ni	222	221	5	7	43	921	6
Mo	6	1.2	11	2.6	2.5	25	0.2
Pb	24	27	22	21	41	26	0.2
Pt (ppb)	0	0	10	6	0	0	0
Pd (ppb)	3	0	6	6	0	2	2
Rb	2.5	4.5	9.5	36	2.7	12	0.02
Sb	1.2	2.4	8.7	7.6	0.6	0	0.5
Sc	9.8	3.7	9.2	20	7.4	3.4	8
Se	2.4	0.9	8.6	30	1.4	1.6	0.5
Sn	1.1	0.6	1.4	1.1	0.6	0.3	0.1
Sr	25	4.7	14	23	36	8.3	0.1
Th	1.88	1.21	4.7	4.4	0.93	1.59	0.02
U	7.9	2.9	1.95	4.6	5.6	6.7	0.02
V	10	5	67	92	10	2	58
W	0.8	1.4	1.0	2.2	0	0.6	0.1
Y	37	8	7	9	19	34	6
Zn	932	435	18	41	174	553	3 664
Zr	0	0	64	60	6	12	64

NOTES: All values in parts per million unless otherwise specified
Analyses were performed at the AMDEL laboratories
na: not analysed

along northwest trends to an assemblage of quartz–muscovite, defining a mylonitic fabric.

Regional, low-grade, static metamorphism of the sedimentary rocks of the Yerrida Group is commonly represented by weak recrystallization of the clay matrix into finely crystalline acicular and moderately oriented clays, predominantly of the illite group. Coarser detrital components, predominantly quartz, feldspar, and white mica, retain their original form and composition. The arenite units are typically characterized by development of quartz overgrowths in crystallographic continuity with the host crystals.

Ocean-floor-type metamorphism is present in the metabasaltic hyaloclastites of the Narracoota Formation. The metamorphic mineral phases of these rocks include actinolite–tremolite, chlorite, epidote, albite, pumpellyite, titanite, prehnite, and calcite.

Mineralization

Mineral exploration

Extensive exploration for gold has been carried out throughout the Meekatharra–Wydgee Greenstone Belt and, at the time of writing, was in progress in areas around Breakaway Well. Exploration for gold in the northwestern part of GLENGARRY, south of Karalundi, has indicated a complex zone of block faulting between Archaean and Proterozoic rocks. Anomalous gold and copper values (up to 220 ppb Au and 550 ppm Cu) were detected in chlorite schist with minor quartz veining (Hanna, 1991).

Exploration over Proterozoic sedimentary rocks in the area north of Karalundi has not revealed any significant mineralization (Hanna, 1991). Exploration for base metals has been carried out 12 km north-northwest of Karalundi

in well-bedded volcaniclastic rocks, tuffaceous shales, and mafic volcanic rocks of the Karalundi and Narracoota Formations. A copper-bearing gossan within basaltic rocks is associated with local zones of silicification and epidotization. The gossans were interpreted as stratabound within a sedimentary sequence close to the mafic volcanic rocks. Subsequent sampling and the drilling of a single percussion hole did not return results worthy of follow-up work (Fitton, 1984).

During mapping, a limited number of samples was collected and analysed for a suite of trace elements for the purpose of evaluating possible evidence of mineralization. Results are shown in Table 2. Ironstone associated with a faulted contact between Juderina Formation sandstones and highly cleaved sericitic shales, probably of the Maraloou Formation (GSWA 139203), contains anomalous copper (830 ppm), nickel (921 ppm), zinc (553 ppm), and cobalt (215 ppm). Anomalous gold (5 ppb), copper (367 ppm), and arsenic (351 ppm) were obtained from brecciated, silicified, and ferruginized siltstone, also of the Maraloou Formation (GSWA 130972), associated with a northeasterly trending fault. Anomalous copper (667 ppm) and zinc (174 ppm) were detected in ferruginous quartz veins within rocks of the Johnson Cairn Formation. A sample collected from a zone of strong shearing within granitoid rocks assayed 3664 ppm Zn (GSWA 139218).

Sample GSWA 130968 (AMG 971191), collected from an area of strongly deformed siltstone in the Doolgunna Formation, contains elevated copper (235 ppm) and platinum group elements (10 ppb Pt, 6 ppb Pd). Sample GSWA 130963 (AMG 986209), collected from a 50 cm-thick ironstone band, assayed 999 ppm Cu, 222 ppm Ni, and 932 ppm Zn. Both of these samples come from what are interpreted (from aeromagnetic data) to be easterly to southeasterly trending splays of major northwesterly oriented structures. In association with interpreted hydrothermal breccia in the same area, these elevated values may signify structurally localized mineralization.

Mineral occurrences

The Mistletoe gold deposit, about 14 km east of Munarra Homestead, is hosted by sulphide-bearing quartz veins in an enclave of amphibole–chlorite schist within granitic rocks (Watkins and Hickman, 1990). No details of production are available. The Mistletoe area is covered by lateritic material, and the possibility exists for gold enrichment in the regolith.

An alluvial gold deposit was exploited in the northwestern corner of the sheet in the area known as Judges Patch. Gold was first discovered in the Judges Patch area in 1904, where dry blowing was carried out over a period of several years. No production records are available. The alluvial ground of Judges Patch covers the boundary between three map sheets: GLENGARRY, BRYAH, and PADBURY. The gold-bearing alluvial material appears to be associated with conglomeratic units of the Juderina Formation. A barite vein, about 0.5 m thick, was found in an area of dry blowing at Judges Patch (Crane and Dunn, 1979).

In the southwestern part of GLENGARRY, the Maid Marion gold prospect is hosted in BIF associated with mafic rocks (*Ab*).

Northeast of Killara, in an area that straddles the boundary between GLENGARRY and MOOLOOGOOL, a copper gossan is present within rocks of the Maraloou Formation. A small copper anomaly east of Referendum Bore, around outcrops of ferruginous material, has returned values in excess of 1000 ppm Cu and locally up to 1700 ppm Cu (Butt et al., 1976; Butt, 1978).

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OCCHIPINTI, S. A., GREY, K., PIRAJNO, F., ADAMIDES, N. G., BAGAS, L., DAWES, P., and LE BLANC SMITH, G., 1997, Stratigraphic revision of Palaeoproterozoic rocks of the Yerrida, Bryah and Padbury Basins (former Glengarry Basin): Western Australia Geological Survey, Record 1997/3, 57p.

OCCHIPINTI, S. A, SWAGER, C., and MYERS, J. S., 1998, Geology of the Padbury 1:100 000 sheet: Western Australia Geological Survey, 1:100 000 Geological Series Explanatory Notes, 29p.

PIRAJNO, F., 1996, Models for the geodynamic evolution of the Palaeoproterozoic Glengarry Basin, Western Australia: Western Australia Geological Survey, Annual Review 1995–96, p. 96–103.

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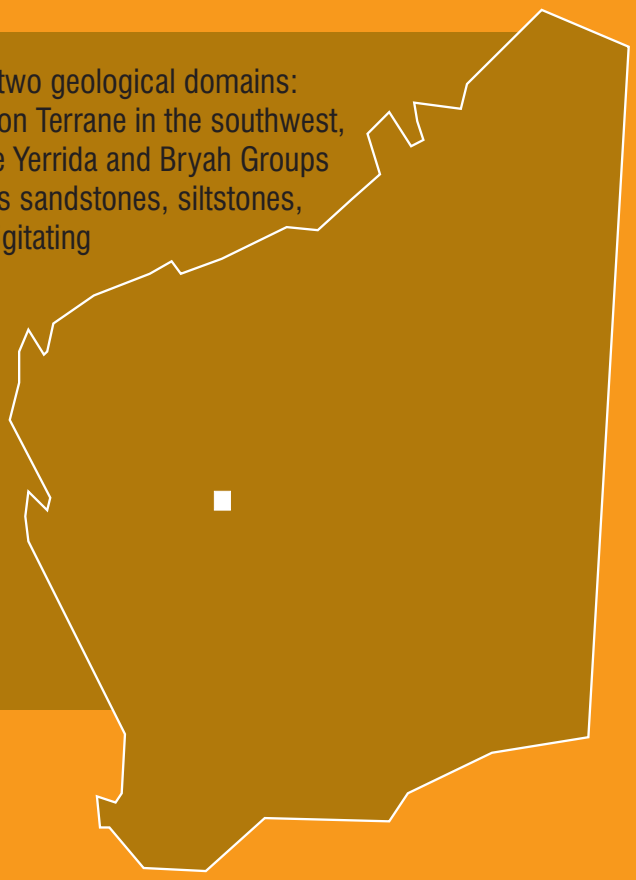
PIRAJNO, F., BAGAS, L., SWAGER, C. P., OCCHIPINTI, S. A., and ADAMIDES, N. G., 1996, A reappraisal of the stratigraphy of the Glengarry Basin: Western Australia Geological Survey, Annual Review 1995–96, p. 81–87.

PIRAJNO, F., and OCCHIPINTI, S. A., 1998, Geology of the Bryah 1:100 000 sheet: Western Australia Geological Survey, 1:100 000 Geological Series Explanatory Notes, 41p.

WATKINS, K. P., and HICKMAN, A. H., 1990, Geological evolution and mineralization of the Murchison Province, Western Australia: Western Australia Geological Survey, Bulletin 137, 267p.

The GLENGARRY 1:100 000 sheet broadly consists of two geological domains: Archaean granite–greenstones of the 3.0 Ga Murchison Terrane in the southwest, and unconformably overlying Proterozoic rocks of the Yerrida and Bryah Groups in the northeast. The Proterozoic stratigraphy includes sandstones, siltstones, shales, carbonates, and evaporites, with some interdigitating relationships with volcaniclastic and basaltic rocks. Dolerite dykes and sills outcrop as prominent hills where they cross-cut granitoid rocks in the western part of the sheet. Known gold mineralization on GLENGARRY is hosted by sulphide-bearing quartz veins within amphibolite–chlorite schists, banded iron-formation associated with mafic rocks, and alluvial material associated with conglomeratic units of the Juderina Formation. The potential for further mineralization is supported by anomalous copper, nickel, and zinc in various Proterozoic units.



Further details of geological publications and maps produced by the Geological Survey of Western Australia can be obtained by contacting:

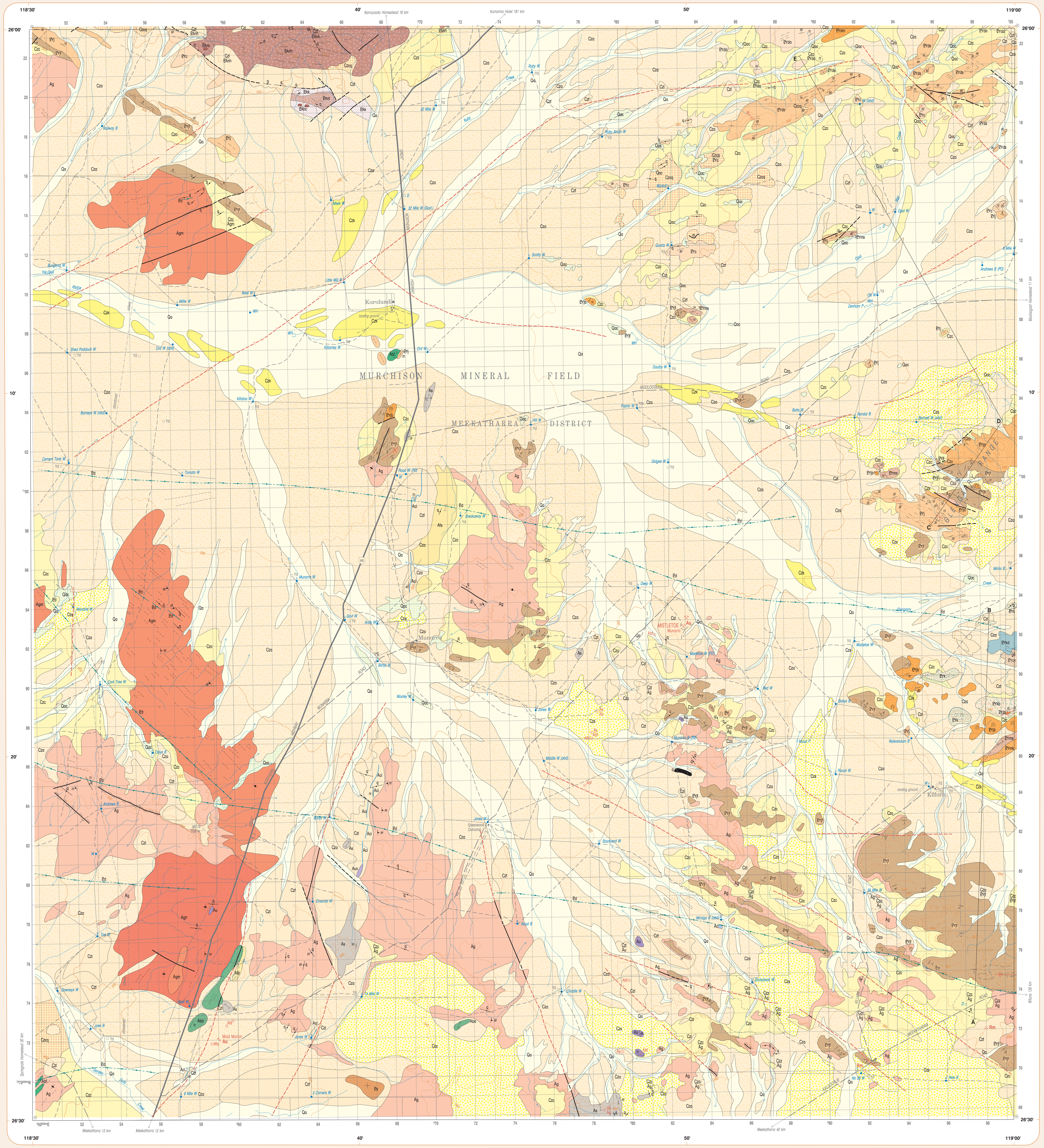
Information Centre
Department of Minerals and Energy
100 Plain Street
East Perth WA 6004

Phone: (08) 9222 3459 Fax: (08) 9222 3444

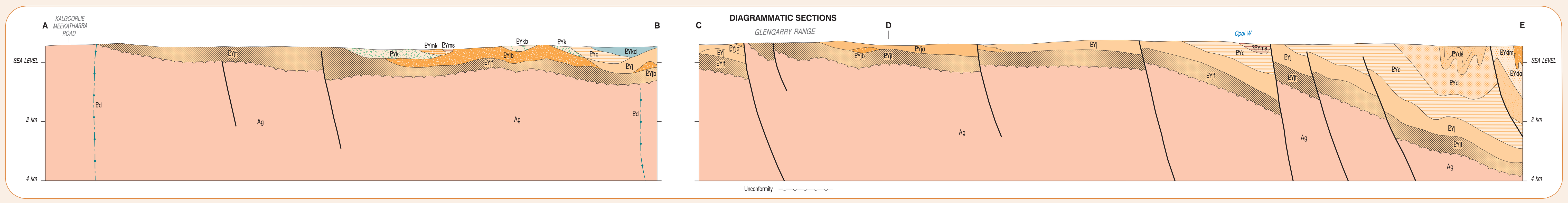
GLENGARRY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET 2645



DIAGRAMMATIC SECTIONS



Legend

PHANEROZOIC — CAINOZOIC — QUATERNARY

Qa — Alluvial deposits—sand and silt in channels and floodplains
Qac — Clay and silt in claypans

Cza — Sheetwash deposits—ferruginous clay, silt, and sand as extensive fans
Czc — Colluvium—gravel, sand, and silt as scree and sheetwash
Czcq — Quartz vein rubble and debris
Czf — Ferruginized rubble and colluvium—dominantly ferruginized pisolites and nodules, ferruginized rock, and ironstone rubble; degraded lateritic duricrust
Czk — Calcrete
Czl — Lateritic deposits—nodular and pisolitic laterite, and associated debris
Czs — Sandplain deposits—unconsolidated sand; minor silt and clay; includes low, vegetated dunes
Czz — Silcrete

PROTEROZOIC

q — Quartz veins and pods

Ꝑd — Dolerite dyke, dashed where interpreted from aeromagnetic data

go — Gossan, gossanous zone

Ꝑs — Conglomerate, sandstone, and siltstone

Bryah Group — BRYAH BASIN

ꝐAn — **NARRACOOTA FORMATION:** metabasaltic lava and mafic schist
ꝐAnc — Jasperoidal chert
ꝐAnh — Metabasaltic hyaloclastite
ꝐAnt — Metabasaltic hyaloclastite, metamicrogabbro, mafic pyroclastic rock, and autoclastic breccia

ꝐAk — **KARALUNDI FORMATION:** quartz-lithic wacke and silicified arenite; local carbonate rock; metamorphosed

Yerrida Group — YERRIDA BASIN

Mooloogool Subgroup

ꝐYm — **MARALOOU FORMATION:** undivided sedimentary rock (not on map)
ꝐYms — Thin-bedded siltstone
ꝐYmk — Fine-grained limestone; local intercalations of thin amygdaloidal basalt

ꝐYk — **KILLARA FORMATION:** undivided mafic intrusive and extrusive rocks, and intercalated thin chertified volcaniclastic rock
ꝐYkd — Medium- to coarse-grained doleritic dykes and sills
ꝐYkb — Aphyric tholeiitic lava

ꝐYd — **DOOLGUNNA FORMATION:** arkosic wacke and quartz sandstone; minor pebble conglomerate (section only)
ꝐYda — Arkosic wacke with subordinate kaolinitic quartz sandstone and siltstone; minor conglomerate
ꝐYdm — Diamictite: polymictic conglomerate and breccia in arkosic matrix
ꝐYds — Laminated quartz sandstone and siltstone; minor pebble conglomerate

Windplain Subgroup

ꝐYc — **JOHNSON CAIRN FORMATION:** argillaceous siltstone and thin-bedded dolomite; minor sandstone
ꝐYck — Dolomite, shale and marl

ꝐYj — **JUDERINA FORMATION:** quartz sandstone; minor siltstone, chert breccia, and pebble conglomerate
ꝐYjb — **Bubble Member:** stromatolitic chert and chert breccia
ꝐYja — Thick-bedded sandstone with widespread mudstone intraclasts; minor intercalated shale
ꝐYjf — **Finlayson Member:** quartz arenite and subordinate siltstone; planar bedded or cross-stratified, commonly ripple-marked

ARCHAEAN — YILGARN CRATON

Ag — Undivided granitoid rock; locally saprolitic
Agm — Monzogranite; K-feldspar megacrysts abundant locally
Agn — Gneissic granitoid rock; with local mafic enclaves

As — Metasedimentary rock
Ac — Chert and banded chert
Aci — Banded iron-formation
Afs — Felsic schist
Afp — Felsic porphyry; metamorphosed

Aba — Amphibolite
Abf — Mafic schist
Au — Ultramafic rock
Aux — Metapyroxenite

Symbols

Geological boundary
- exposed
- concealed

Fault or shear showing dip of fault plane
- exposed
- concealed
- interpreted from aeromagnetic data
- mylonite zone
- strongly foliated rock

Fold, showing trend
- anticline
- syncline

Minor fold, showing plunge
- anticline

Bedding, showing strike and dip
- horizontal
- inclined
- vertical
- overturned
- interpreted from aerial photographs; dip 15°-45°

Direction of movement of sediment-bearing current,
- from cross-bedding
- from asymmetrical ripple marks

Metamorphic foliation, showing strike and dip
- inclined
- vertical

Cleavage, showing strike and dip
- inclined
- vertical

Crenulation cleavage, showing strike and dip
- vertical

Fracture or joint, showing strike and dip
- inclined
- vertical

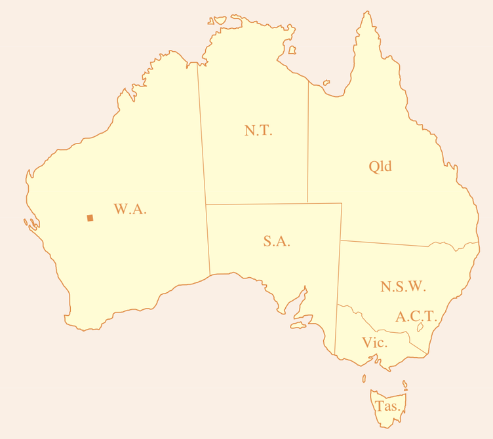
Stromatolite locality

Airphoto lineaments
- structural trend
- foliation or bedding trend
- foliation trend in granitoid rock

Highway with national route marker
Formed road
Track
Fence, generally with track
Homestead — Killara
Building
Yard — Yd
Microwave repeater station
Horizontal control, major
Breakaway
Sand dune
Contour line, 20 metre interval — 540

Watercourse, ephemeral
Waterhole — WH
Pool — P
Bore — B
Well — W
Windpump
Dam — D
Tank — T
Abandoned — (abd)
Position doubtful — (PD)

Mining centre — MISTLETOE
Mine (gold, unless otherwise indicated) — Munarra
Opencut
Prospect — Maid Marion
Mineral exploration drillhole or costean, showing subsurface data — As
Mineral occurrence
- Gold — Au
- Road materials — Rm



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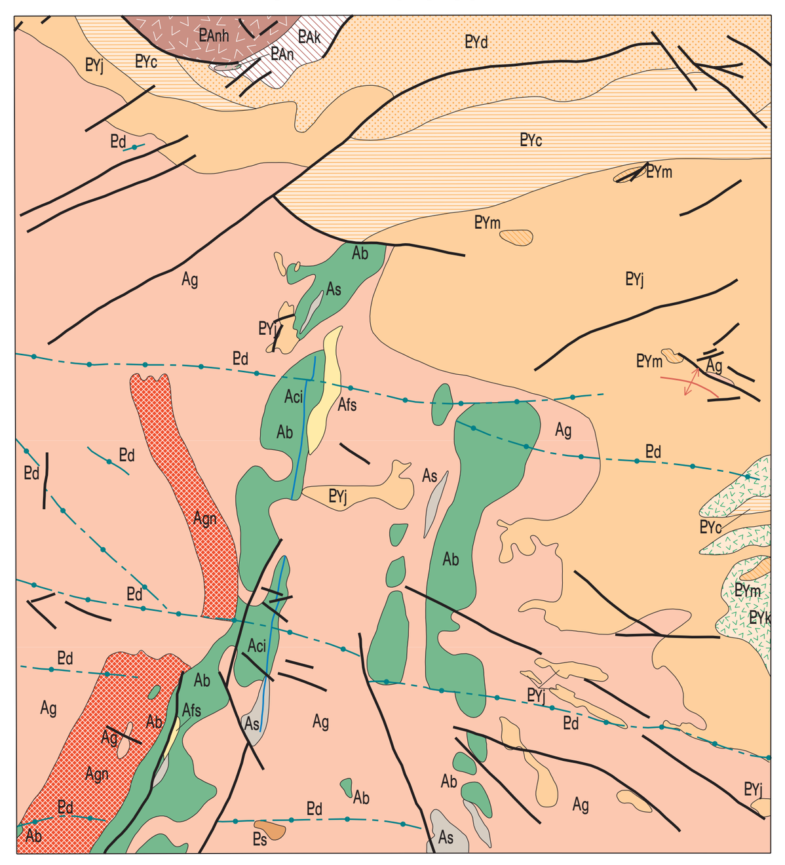
GOULD 2346	MOORARIE 2446	PADBURY 2546	BRYAH 2646	DOOLGUNNA 2746	THADUNA 2846
MILEURA 2345	KOONMARRA 2445	TIERACO 2545	GLENGARRY 2645	MOOLOOGOOL 2745	MOUNT BARTLE 2845
KALLI 2344	MADOONGA 2444	MEEKATHARRA 2544	GABANINTHA 2644	YAGANOO 2744	MEREWETHER 2844

ROBINSON RANGE SG 50-7; PEAK HILL SG 50-8; BELELE SG 50-11; GLENGARRY SG 50-12

1:100 000 maps shown in black
1:250 000 maps shown in brown

SIMPLIFIED GEOLOGY



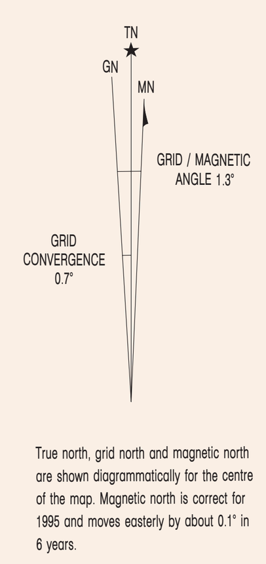
Ꝑs — Proterozoic sedimentary rocks; unassigned

Bryah Group — BRYAH BASIN
- ꝐAn — Narracoota Formation
- ꝐAnh — Metabasaltic hyaloclastite
- ꝐAk — Karalundi Formation

Yerrida Group — YERRIDA BASIN
- ꝐYm — Maraloou Formation
- ꝐYk — Killara Formation
- ꝐYd — Doolgunna Formation
- ꝐYc — Johnson Cairn Formation
- ꝐYj — Juderina Formation

YILGARN CRATON
- Ag — Granitoid rock
- Agn — Gneissic granitoid rock
- As — Metasedimentary rock
- Aci — Banded iron-formation
- Afs — Felsic schist
- Ab — Mafic and ultramafic schist

SCALE 1:500 000 — 0, 5, 10, 15, 20 Kilometres



True north, grid north and magnetic north are shown diagrammatically for the centre of the map. Magnetic north is correct for 1995 and moves easterly by about 0.1° in 6 years.

DEPARTMENT OF MINERALS AND ENERGY
L. C. RANFORD, DIRECTOR GENERAL

GOVERNMENT OF WESTERN AUSTRALIA
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MINISTER FOR MINES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
DAVID BLIGHT, DIRECTOR

SCALE 1:100 000

1000 Metres 0 1 2 3 4 5 6 7 8 9 10 Kilometres

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: GEOCENTRIC DATUM OF AUSTRALIA 1994
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Grid lines indicate 1000 metre interval of the Map Grid Australia Zone 50

GDA — The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94). GDA94 positions are compatible within one metre of the datum WGS84 positions

Reference points to align maps based on the previous datum, AGD84, have been placed near the map corners

Geology by F. Pirajno, N. G. Adamides, and D. D. Ferdinando 1995
Edited by D. Ferdinando, S. Willis, and G. Loan
Cartography by D. Ladbrook
Topography from the Department of Land Administration Sheet SG 50-12, 2645, with modifications from geological field survey
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The recommended reference for this map is: PIRAJNO, F., ADAMIDES, N. G., and FERDINANDO, D. D., 1997 Glengarry, W.A. Sheet 2645: Western Australia Geological Survey, 1:100 000 Geological Series

GLENGARRY

SHEET 2645 — FIRST EDITION 1997