1:250 000 GEOLOGICAL SERIES—EXPLANATORY NOTES

GLENGARRY

WESTERN AUSTRALIA

SHEET SG 50-12 INTERNATIONAL INDEX

WESTERN AUSTRALIA
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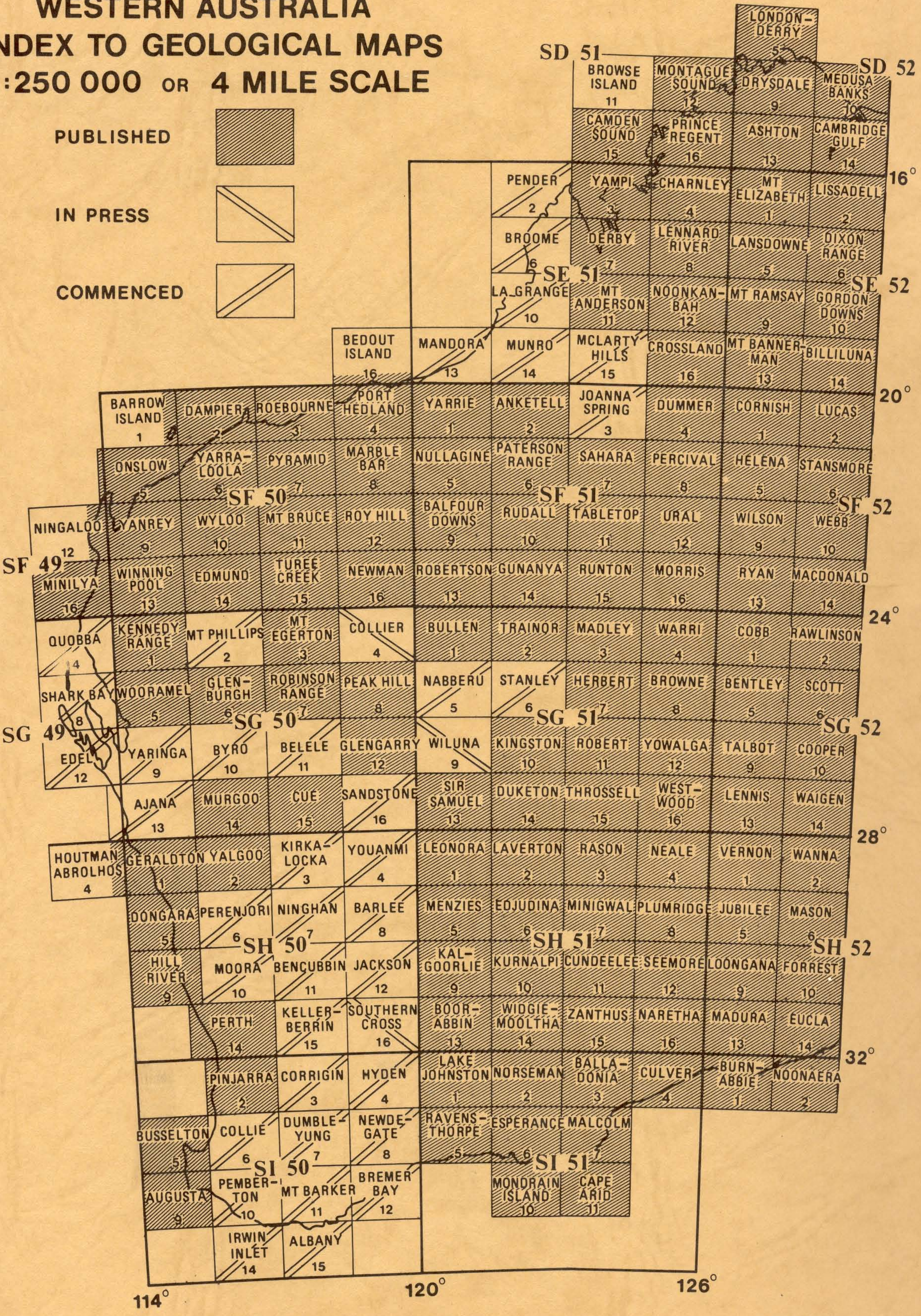

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

1:250 000 GEOLOGICAL SERIES—EXPLANATORY NOTES

GLENGARRY

WESTERN AUSTRALIA

SHEET SG 50-12 INTERNATIONAL INDEX

COMPILED BY M. ELIAS, J. A. BUNTING AND P. H. WHARTON

PERTH, WESTERN AUSTRALIA 1982

13925—1

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Explanatory Notes on the Glengarry Geological Sheet

Compiled by M. Elias, J. A. Bunting and P. H. Wharton

INTRODUCTION

The GLENGARRY* 1:250 000 Geological Sheet, reference SG50-12 of the International Series, is bounded by latitudes 26°00′S and 27°00′S and longitudes 118°30′E and 120°00′E.

The town of Meekatharra** which lies on the western margin of the sheet has a population of approximately 900, and is a service centre for the pastoral and mineral-exploration industries. The sealed Great Northern Highway passes through Meekatharra, and the graded Meekatharra-Wiluna road bisects the sheet. Other graded roads and station tracks allow access to most areas.

The climate is semi-arid to arid; summers are hot and winters cool to mild. Rainfall is highly irregular, but an annual average of 230 mm, which falls mainly in the months of January to July, is derived from both the northern cyclonic storms and the southern winter rains.

HISTORY OF GEOLOGICAL INVESTIGATIONS

Most of the early investigations were concerned with gold occurrences at Meekatharra and Gabanintha. The most comprehensive study was by Clarke (1916), who also described regional geology, physiography and some hydrogeology. He also detailed earlier work in the area. The earliest reference to other areas on GLENGARRY is Gibson (1908) on the Gum Creek area. Talbot (1920) briefly mentioned the "Comedy King belt" (herein called the Joyners Find belt), and he regarded the sediments and dolerite sills northwards from the Kimberley Range as a greenstone belt. More recently, Sofoulis and Mabbutt (1963) provided the first regional geological account of the area. Hallberg (1976) and Hallberg and others (1976) discussed geochemical variations in rocks of the greenstone belts; Butt and others (1977) described uranium occurrences in calcrete and associated sediments. An upsurge of interest in the Proterozoic rocks resulted in a number of regional studies of the Nabberu Basin, including northern GLENGARRY, by Bunting and others (1977) and Hall and Goode (1978). Aeromagnetic and gravity surveys of GLENGARRY have been carried out by the Australian Bureau of Mineral Resources, and Lambourn (1972) has interpreted the aeromagnetic map.

The present survey was conducted in 1976-77 by M. Elias and P. H. Wharton (Yilgarn Block) and J. A. Bunting and D. P. Commander (Nabberu Basin).

PHYSIOGRAPHY

GLENGARRY lies on the interior plateau of Western Australia, and ranges from 440 m above sea level in the southwest to over 640 m in the central part near Paroo Siding and on peaks of the Glengarry Range.

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* Upper case letters are used when referring to names of 1:250 000 sheets to avoid confusion with localities of the same name.

** Co-ordinates of localities mentioned in the text are given in Appendix 1.

The topography over outcrop areas of Precambrian rocks varies according to rock type. Resistant Proterozoic sediments and volcanics of the Glengarry Sub-basin and the Archaean greenstones generally show rugged hills, which are lithologically controlled. Granitoids form low outcrops beneath breakaways but rugged outcrops occur, such as northwest of Murchison Downs.

Outcrop areas are fringed by colluvium, grading from scree to coalesced alluvial fans and broad, gently sloping sheetwash plains.

An old erosion surface, now represented by extensive sheets of eolian sand with longitudinal dunes, covers much of GLENGARRY; this surface is best seen above granite breakaways and between hills of resistant Proterozoic sediments near the major drainage divides. Termed the old plateau by Jutson (1934), the broadly undulating surface formed by lateritization in a humid climate in the early Tertiary, and has subsequently been dissected and partly stripped away to expose fresh rock underneath.

Saline drainages formed after infilling of valleys that are the remnants of the extensive Cretaceous—Early Tertiary palaeodrainage network (van de Graaff and others, 1977) which developed on the old plateau. The major north-trending drainage divide shown on Figure 4 separates palaeodrainage systems that flowed westwards to the sea and southwestwards towards the Eucla Basin. Another major divide crosses the northeast corner of GLENGARRY; it is the head of a system which drained ultimately into the Canning Basin. Main saline drainage channels are shown in Figure 4.

TABLE 1. SUMMARIZED COMPARISON OF MAIN GREENSTONE BELTS

Meekatharra belt	*Gum Creek belt*	*Joyner's Find belt*
Synclinal structure south plunging, north to north-northeast trend	Synclinal structure, south plunging, north trend	Incomplete structure, north trend
Well-presented stratigraphy (bottom to top) 1. Amphibolite and metabasalt with BIF 2. Fine-grained sediments and felsic tuff, jaspilite at top 3. Tholeiitic and komatiitic basalt 4. Calc-alkaline volcanic and sediment complex	Probable stratigraphy (bottom to top) 1. Amphibolite and metabasalt with BIF 2. Fine-grained sediments and felsic tuff	No recognizable stratigraphy but two "associations" (a) Ultramafic and mafic schist with BIF and chert (b) Sediments with conglomeratic units
Extensive peridotitic ultramafics in lower mafic unit south of Talval and at Gabanintha-Copper Hills; minor ultramific rocks in upper mafic unit	Minor peridotitic and pyroxenitic ultramafics east of Gum Creek mine in mafic unit minor ultramafic sediment-felsic unit	Pyroxenitic ultramafics, little or no peridotitic ultramafics apparent
Metamorphism of lower units greenschist to low amphibolite facies, upper units very low greenschist facies	Greenschist to low amphibolite facies, slightly lower in felsic unit	Greenschist to low amphibolite facies throughout
Flanked by intrusive syn- and post-tectonic granitoid on E side, intrusive granitoid and gneissic rocks on NW side	Flanked by syntectonic granitoid on W side, ?faulted on E side	Flanked by gneissic and intrusive granitoids both sides
Minor intrusion of lower unit by late- and post-tectonic granitoid	Extensive intrusion of lower unit by pre- or syntectonic granitoid on W side	Extensive intrusion and fragmentation of belt by post-tectonic granitoid

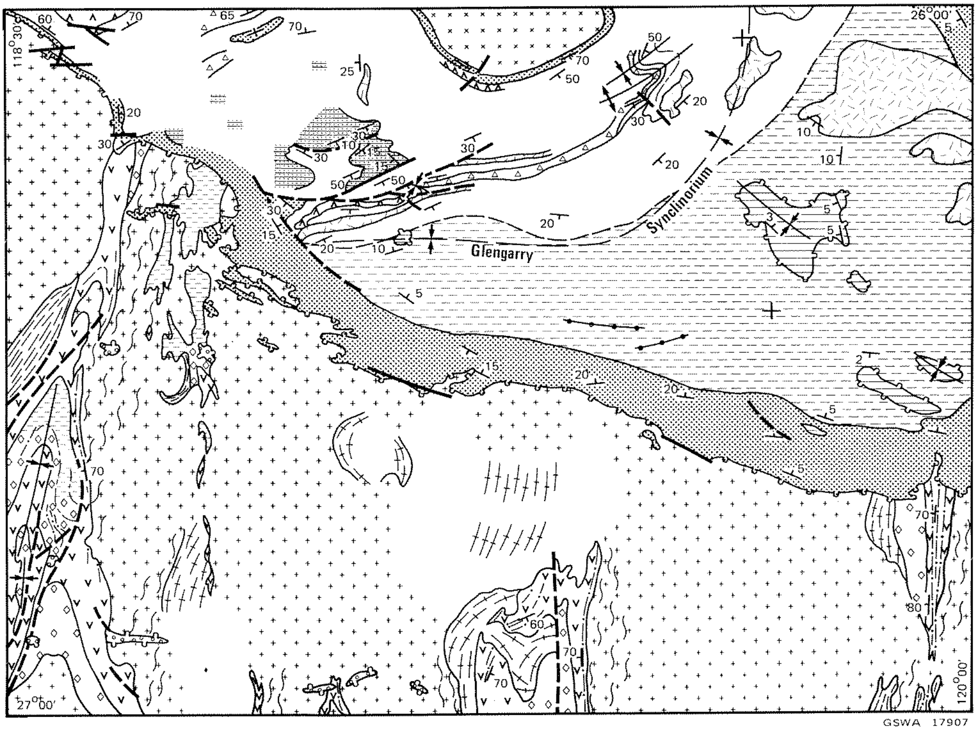
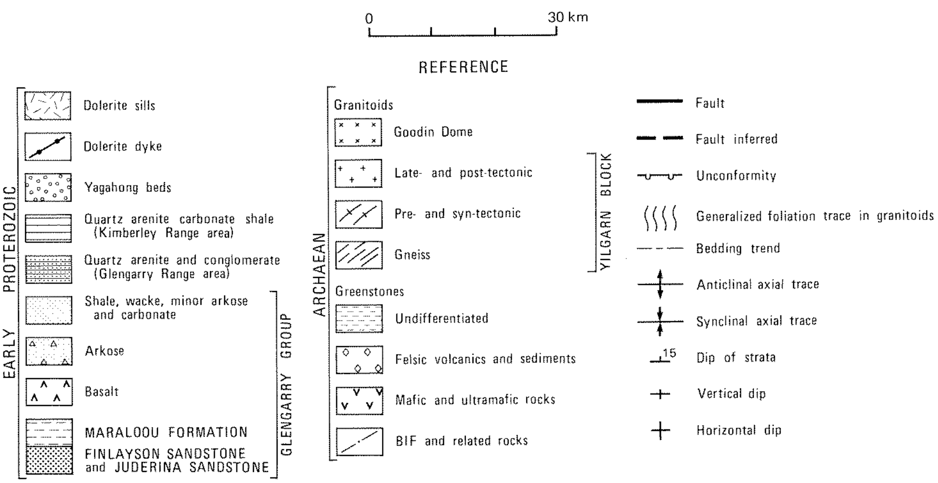


FIGURE 1

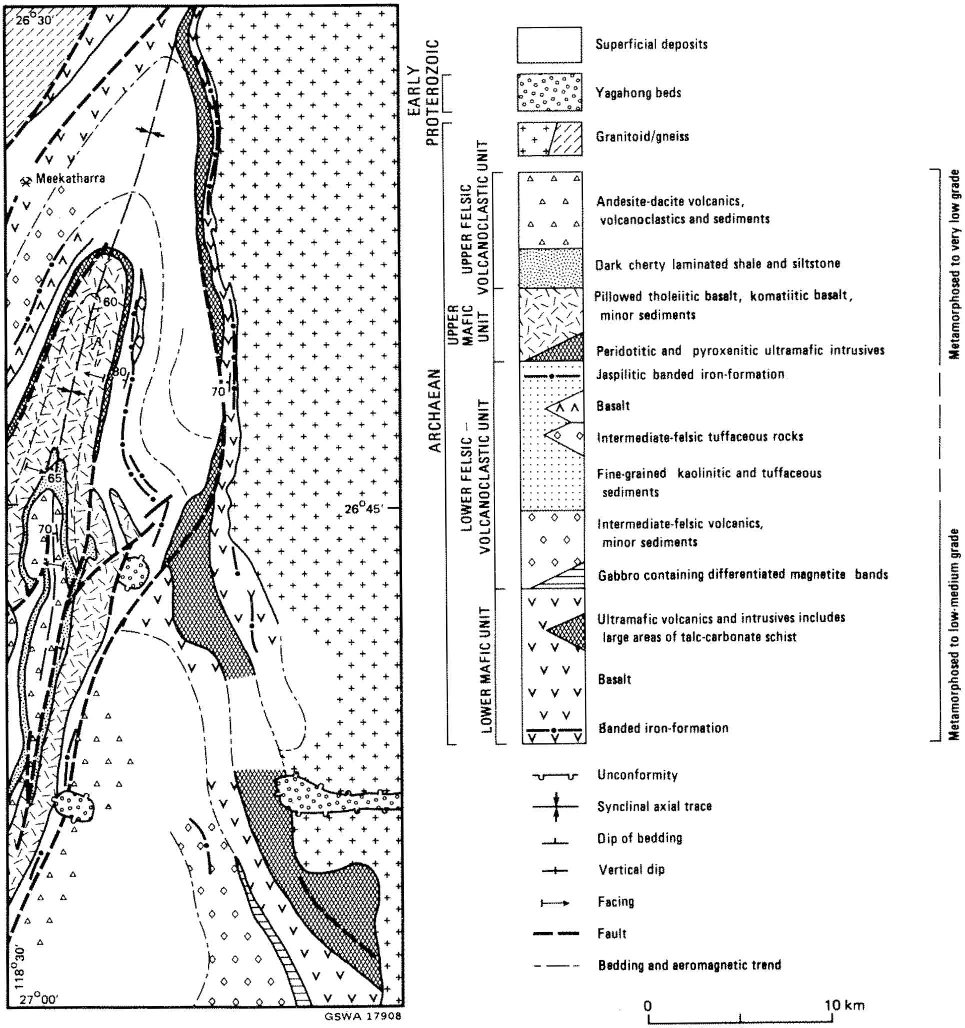
GEOLOGICAL AND STRUCTURAL INTERPRETATION

GLENGARRY SHEET SG 50–12



YILGARN BLOCK

Archaean rocks of the Yilgarn Block occupy over one half of the area south and west of the arcuate boundary of the Glengarry Sub-basin in the Nabberu Basin. Three north-trending greenstone belts, consisting of folded and metamorphosed mafic and ultramafic volcanics and intrusives, felsic volcanics and sediments are surrounded by various granitoid rocks. Contacts between greenstones and granitoids can be intrusive or faulted. The greenstone belts are, from west to east, the Meekatharra belt, the Gum Creek Belt, and the Joyners Find belt (Fig.1) the main features of which are tabulated in Table 1. Between the Meekatharra belt and the Gum Creek belt are a number of smaller, isolated greenstone remnants.



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According to subdivisions of the Yilgarn Block (Geological Survey of W.A., 1975), the boundary between the Murchison Province and the Southern Cross Subprovince passes between the Meekatharra and Gum Creek belts. These are gross regional subdivisions, the grounds for which are not really apparent on the scale of the present survey. Therefore there appears to be little difference between the two regions on GLENGARRY.

MEEKATHARRA BELT

The Meekatharra belt is a regional north-northeast-trending synclinal structure that extends on to adjoining BELELE. In contrast to the other greenstones on GLENGARRY, the Meekatharra belt displays a stratigraphy consisting of a lower mafic unit overlain by a lower felsic volcanoclastic unit, followed by an upper mafic unit and an upper felsic volcanoclastic unit. Repeated mafic to felsic volcanic cycles, such as these, occur in many greenstone belts of the Yilgarn Block (Williams, 1969; Muhling and Low, 1977). Facing evidence from pillowed lavas and sedimentary structures in the Meekatharra belt is confined to the upper units, but the broadly symmetrical disposition of the lower units around the upper units indicates that the lower units probably show the same regional facing. An interpretive map of the Meekatharra belt is shown in Figure 2. A geochemical and petrological study of the upper units has been carried out by Hallberg and others (1976).

Lower mafic unit

This unit is exposed in a north-trending belt from the southern margin of the sheet through Tal Val to north of Munarra, where it disappears under the Nabberu Basin. The unit consists of metamorphosed basalt, banded iron-formation, and ultramafic schist. Basalt, exposed near Swan Bore and east of Bourke Find, has been dynamically metamorphosed to foliated amphibolite (*Aba*); westwards, original igneous texture has been preserved, and metabasalt (*Abb*) consists of directionless green actinolite and sodic plagioclase. A mafic to ultramafic volcanic agglomerate west of Swan Bore has rounded clasts (50-100 mm across) of fine-grained chlorite and pale actinolite set in a fragmental matrix of similar composition. Banded iron-formation (*Aiw*), which is interbedded with metabasalt, consists of laminae of granoblastic quartz and magnetite, with thin bands of grunerite.

Ultramafic schist is intercalated with metabasalt and banded iron-formation, but it is virtually all concealed under a light-brown siliceous caprock (*Czj*). The amount of ultramafic rock increases southwards, culminating in thick sequences south of Tal Val, and in the Copper Hills ultramafic complex. In the Tal Val area, scattered small outcrops of talc-carbonate schist (*Aue*) and actinolite-chlorite schist (*Aur*) probably indicate the nature of much of the bedrock in this area. These fine-grained rocks could represent metamorphosed and deformed ultramafic lavas and thin intrusives with some associated sediments of ultramafic composition. Serpentinized peridotite (*Aup*) of intrusive origin with a preserved cumulus texture crops out southwest of No. 7 Bore.

Copper Hills Ultramafic Complex: In the Gabanintha-Copper Hills area, the lower mafic unit consists of a variously metamorphosed sequence of mafic and ultramafic intrusives, fine-grained mafic volcanics, and ultramafic actinolite-chlorite rocks. The intrusive rocks occur mainly in the Copper Hills area (an informal name for the low hills about 5 km southeast of Gabanintha), and include metagabbro (*Ado*), metapyroxenite (*Aux*) in which actinolite has replaced coarse pyroxene crystals, and metaperidotite (*Aup*) containing serpentine and actinolite, with rare remnant olivine. Two plugs of granular, serpentinized dunite (*Aud*) intrude metaperidotite and metabasalt in the central Copper Hills. The Amphibole-chlorite rocks (*Aur*) are, in most cases, fine-grained, directionless, or poorly foliated rocks, in which metamorphism has destroyed all relict textures. A notable exception is actinolite-chlorite fragmental rocks at Gabanintha townsite which contain crystal, lithic and vitric fragments of ultramafic composition. Vesicular and quench-textured ultramafic lavas are also seen.

Lower felsic-volcanoclastic unit

Between the lower and upper mafic units is a sequence of felsic volcanic and tuffaceous rocks with related kaolinitic sediments; these are collectively called the lower felsic-volcanoclastic unit. Marker horizons are provided by jaspilitic banded iron-formation (*Aij*). Basalt occurs in the unit south of Meekatharra. The sediments are cleaved, grey to light-coloured laminated shale and siltstone (*As*) with a probable tuffaceous component.

In the northeastern part of the syncline, lenses of kaolinized fragmental rocks with fine- to medium-grained angular clasts are interpreted as felsic tuff (*Afx*); they may be equivalent to fresh, andesitic fragmental rocks (*Az*) exposed 5 km south of Meekatharra on the opposite limb of the syncline.

Southwest of Gabanintha the lower felsic-volcanoclastic unit consists of felsic lava (*Afl*) and poorly exposed tuffaceous rocks (*Af*), with thin jaspilite beds. This sequence has been intruded, near its base, by a layered sill of gabbro, containing anorthosite and magnetite layers (*Adm*), which extends southwards on to SANDSTONE. The coarsely crystalline magnetite contains vandaium and titanium (*see* Economic Geology).

Upper mafic unit

This unit occupies the synclinal core of the Meekatharra belt, and crops out between Meekatharra and Polelle. Two types of volcanics occur: komatiitic basalt with acicular textures, and tholeiitic basalt.

Komatiitic basalt (*Abu*) is pale green, and contains phenocrysts of clinopyroxene, some altered olivine and orthopyroxene set in a quench-textured or glassy groundmass containing fine-grained feathery clinopyroxene, and plagioclase. The clinopyroxene phenocrysts are generally hollow needles, with cores of serpentine possibly after orthopyroxene. At the base of the komatiitic basalt in the northeastern part of the syncline is a sill of coarse-grained, unaltered websterite, which consists of orthopyroxene and clinopyroxene (*Aux*). Lenses and sheets of hypersthene dolerite and peridotite have intruded the komatiitic basalts.

Tholeiitic basalt of the upper mafic unit (*Abb*) is darker green than the komatiitic basalt, and contains unaltered clinopyroxene, saussuritized plagioclase, actinolite and chlorite. Pillow structures are abundant, and mafic pyroclastics occur.

The upper mafic unit is a three-part succession of komatiitic basalt followed by tholeiitic basalt and more komatiitic basalt. North of Stockyard Bore, only the lower two parts are seen. The two basalt types do not alternate on a small scale, indicating distinct periods of extrusion of each type. According to Hallberg and others (1976), the two types are chemically distinct, although, chemically, komatiitic basalt appears to grade into the tholeiitic basalt. However, it would seem from the reappearance of komatiitic basalt after the tholeiitic basalt, that there was no progressive differentiation in the magma source during the time of extrusion.

Upper felsic-vocanoclastic unit

The main part of this unit consists of andesite, dacite, and related volcanoclastic rocks (*Az*) that form the stratigraphically highest unit in the Meekatharra belt. The rocks are exposed in two discrete areas separated by a major fault: the core of the main syncline, and to the east near Polelle homestead.

Rock types in the two areas are lithologically and chemically identical (although there are more lavas in the Polelle area), and are considered to be stratigraphically equivalent. This conclusion agrees with that of Hallberg and others (1976). The alternative possibility, that the Polelle rocks are part of the lower felsic volcanoclastic unit, is unlikely because of lithological dissimilarity with rocks exposed in the lower unit near Gabanintha, and the lack of jaspilites, which are common in the lower unit.

In the core of the main syncline, the volcanics are underlain by a thin but laterally continuous sequence of dark, fine-grained, laminated, cherty sediments (*Ass*).

Porphyritic volcanic rocks (*Azl*) consist of phenocrysts of unaltered clinopyroxene, saussuritized plagioclase, and in some cases, altered hypersthene, set in a fine-grained chloritic groundmass. Interbedded with these lavas are a diverse group of clastic rocks ranging from coarse boulder beds through arenaceous rocks to laminated shale with graded bedding. The coarser clastic rocks (*Azv*) contain angular and rounded clasts of andesitic lava up to 0.3 mm across in an andesitic matrix consisting of smaller lithic fragments and euhedral crystals of clinopyroxene. Hallberg and others (1976) interpret these as immature sedimentary rocks resulting from degradation of a nearby volcanic pile in the Polelle area; however the combination of angular and well-rounded clasts and angular crystal fragments is more consistent with pyroclastic deposits such as vent agglomerate. Hallberg and others (1976), in fact, noted that most of the clastic rocks are chemically indistinguishable from the volcanics.

Metamorphic pattern

In metamorphic grade and structural style, the upper mafic unit differs markedly from the lower: the upper unit is characterized by textural preservation and some retention of the primary mineralogy. In the lower unit, all primary mafic minerals are altered, and metamorphic fabrics occur near granitoid contacts.

Regional metamorphic grade in the lower mafic unit is predominatly greenschist facies, as shown by sodic plagioclase and light-green amphibole. At the margin of the belt, east of Bourke Find, the presence of darker green amphibole probably indicates slightly higher grade, in the upper greenschist facies.

In the Copper Hills, metamorphic grade is greenschist facies in the northeastern parts; southwest of the northwest-trending fault shown on the map, grade is considerably higher; typical rocks are hornblende-plagioclase-clinopyroxene and hornblende-plagioclase-hypersthene hornfels, indicating the amphibolite-granulite transition. The reason for this high-grade zone is not apparent, although the abundance of peridotitic intrusions could have contributed to a local high geothermal gradient.

The metamorhpic grade in the upper mafic and higher units is very low in comparison with that of the lower units, suggesting a relationship between stratigraphic level and metamorphic grade, at least in the Meekatharra belt. The metamorphic minerals present in the upper units, and the distribution of relict phases, is comparable with the very low grade metamorphic domain (prehnite-pumpellyite and low greenschist facies) of Binns and others (1976) in the eastern Yilgarn Block.

GUM CREEK BELT

The Gum Creek belt is the continuation in GLENGARRY, of a major greenstone belt complex in the Southern Cross Subprovince of the Eastern Goldfields Province (Williams, 1975).

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Mafic and ultramafic rocks

Amphibolite derived from basalt (*Aba*) occupies most of the belt. Deformation accompanying metamorphism has destroyed most original textures and structures, although some outcrops contain elongate ovoid shapes resembling deformed pillows. Intercalated sediment occurs throughout the metabasalt, also implying submarine volcanicity. These sediments include banded iron-formation (*Aiw*) and chert (*Aic*), some containing grunerite; green cherty beds and graphitic shale.

In the northern part of the belt, east of Gum Creek mine, ultramafic intrusive and possibly some extrusive rocks occur in the basalt sequence. The ultramafic rocks are metaperidotite (*Aup*) with diffuse coarse-grained relict texture; and tremolite-chlorite schist (*Aur*) with a foliation, defined by aligned chlorite, cut by randomly oriented tremolite needles. Sills of dolerite and gabbro (*Ada*) intrude the sequence, but only in the eastern half of the belt. Like the host rock, most dolerite and gabbro is dynamically metamorphosed to foliated amphibolite.

Sediments and felsic tuff

Laminated shale (*Ass*) adjoins the metabasalt and passes westwards into felsic fragmental rocks. The shale is generally white and sericitic, and probably tuffaceous. Felsic tuff (*Afx*) is exposed 1 km south of Gum Creek mine. Despite being weathered, it shows rounded clasts of micaceous, kaolinitic fine-grained rock wrapped by a schistose groundmass.

Structure and metamorphism

The regional structure of the Gum Creek belt is a syncline with a southerly plunge. Although direct facing evidence is not apparent, the sequence of amphibolite and banded iron-formation passing upward into sediments and felsic tuffaceous rocks agrees with many established sequences elsewhere in the Yilgarn Block. Amphibolite has a penetrative south-plunging lineation defined by aligned metamorphic hornblende, reflected in outcrop as elongate boulders. Axes of minor folds in banded iron-formation are parallel to the amphibole lineation. Foliations and lithological contacts dip towards the axis of the belt. Structural trends are northerly on the eastern side of the belt; on the western side intrusion of a granitoid has caused disruption of trends. Parallel southerly plunging metamorphic lineations in both granitoid and amphibolite are the earliest recognized fabrics and indicate that the granitoid is pre- or syntectonic to the deformation in the greenstone belt.

The eastern contact of the belt is intensely sheared, and mylonite is developed in the adjacent granitoid. A north-trending aeromagnetic discontinuity containing a number of elongate anomalies, could reflect the existence of an axial fault in the Gum Creek belt (Fig. 1), perhaps intruded by ultramafic rocks.

The amphibolite contains green pleochroic hornblende and has been dynamically metamorphosed in the range of upper greenschist to lower amphibolite facies.

JOYNERS FIND BELT

The Joyners Find belt is a relatively narrow, north-trending belt with two subparallel banded iron-formations. The belt appears to have been continuous with the rocks of the Booylgoo Range on SANDSTONE, before the fragmentation of greenstone by granitoid intrusion.

Strong deformation and lack of facing evidence precludes recognition of a stratigraphic sequence in this belt. However, two components are recognized: an eastern section of mafic and ultramafic rocks containing the banded iron-formation units, and a western section of sediments.

The eastern section consists of actinolite-chlorite schist (*Aur*) derived from both mafic and ultramafic volcanics. At the Joyners Find mine, ultramafic schist consists of chlorite transgressed by pale tremolite needles. south of Coon Well, plagioclase-bearing schistose amphibolite (*Aba*) has developed from basalt. Primary quench textures are preserved in actinolite-chlorite schist 2 km northwest of Coon Well, indicating possibly a komatiitic derivation. Banded iron-formation (*Aiw*) and chert (*Aic*) form prominent strike ridges. The two main banded iron-formations converge slightly southwards; however, there is no evidence of a fold closure. The banded iron-formation has thin laminae of magnetite alternating with chert.

The western sediments consist of pebbly wacke (*Asg*) and conglomerate (*Asc*). The conglomerate contains stretched clasts of banded iron-formation, chert, mudstone and shale in a schistose matrix of wacke. A small exposure with graded bedding, and a sharp change from shale to coarse conglomerate constitute evidence for eastward facing; however, this may not be regionally significant.

Metamorphism in the Joyners Find belt is accompanied by planar or linear deformation fabrics. However, later static metamorphism is indicated by growth of tremolite needles across such fabrics at Joyners Find mine. This could indicate two separate metamorphic events, or, more likely, that static recrystallization continued after deformation ceased. A similar relationship exists in ultramafic schist east of the Gum Creek mine in the Gum Creek belt.

SMALLER GREENSTONE REMNANTS

Near Bundle Well, the greenstones form the northern end of a narrow, north-northwest-trending belt, most of which is on SANDSTONE. The rocks are fine to coarse-grained foliated amphibolite (*Aba* and *Ada*) derived from basalt and dolerite, with some banded iron-formation (*Aiw*) at the northern end.

Between Hillview and Mistletoe, greenstones occur as rafts and detached fold cores in both syn- and post-tectonic granitoids. Their distribution suggests a once-continuous belt now almost entirely engulfed by granitoid. Most remnants are amphibolite (*Aba*), metapyroxenite (*Aux*) and metaperidotite (*Aup*), and less commonly sediments (*As*) and felsic tuff and volcanogenic sediment (*Af*). Unusual layered quartzo-feldspathic rocks at the granite-greenstone contact east of Reserve Bore could be remnants of gneiss (*Ang*).

GRANITOIDS AND GNEISSES

Two groups of granitoid rocks are recognized: unfoliated, homogeneous post-tectonic granitoid forming large composite batholiths; and foliated to gneissic early tectonic granitoids occurring within greenstone belts, near greenstone belt margins, and between post-tectonic batholiths. The general distribution of gneiss and granitoid types is shown in Figure 1.

Post-tectonic granitoids are mostly adamellite and granodiorite, and are divided on the map into fine to medium-grained (*Age*) and medium to coarse-grained (*Agb*). Porphyritic granitoids are designated (*Agl*), and contain euhedral, tabular microcline phenocrysts. Biotite is the mafic mineral in all cases, but muscovite is also present in granitoids east of Hillview and in the No-ibla area.

Involvement of these granitoids in late tectonic activity is indicated by the development of a tectonite fabric adjacent to and parallel to some greestone belt margins. This fabric varies from a quartz elongation to a gneissic fabric involving all minerals.

A pluton of distinctive, post-tectonic granite (*sensu stricto*) occurs in the Murchison Downs area (*Agb*). This is a homogeneous, coarse-grained, undeformed rock with characteristically smoky quartz grains, and biotite in coarse books. Fluorite occurs with quartz in thin veins 7 km north of Murchison Downs. A west-trending vein of pegmatite (*a*) cuts the pluton for a distance of about 25 km.

Early tectonic granitoids and gneisses are more mafic and have a stronger fabric than post-tectonic granitoids. They are also more heterogeneous, showing a complex intrusive and deformational history. Both hornblende and biotite-bearing granitoids are represented. Their composition is predominantly granodiorite and tonalite.

In the western Gum Creek belt, early tectonic hornblende-biotite granodiorite and tonalite (*Agt*) intruded metabasalt; structural and petrographic evidence indicate it has undergone the regional amphibolite-facies metamorphism that affected the greenstones. Hornblende-bearing granitoids occur north of Hillview in a strip of foliated granitoid, which contains greenstone remnants. The occurrence of hornblende granitoids in or near greenstone belts could indicate that these granitoids are formed from crustal anatexis of basic igneous rocks in the root zones of greenstone belts. This is supported by trace element abundances (*see* Chemistry). Alternatively, they may represent mantle-derived granitoids which intruded the greenstone belts in zones of crustal weakness associated with the belts.

Outside the greenstone belts, early tectonic granitoids and gneisses contain biotite as the mafic mineral. Rocks with the symbol (*Agn*) have nebulitic banding; a recrystallized fabric, and eye-shaped microcline megacrysts are common. Biotite occurs as aligned flakes and in schlieren. Granitiod gneiss (*Ang*) has well-defined compositional banding, and contains elongate enclaves of granoblastic amphibolite (*Aa*) and calc-silicate rock (*Anc*). Calc-silicate rock is compositionally layered and contains diopside, plagioclase and quartz with minor potash feldspar and hornblende. Amphibolite has hornblende and plagioclase with clinopyroxene in places. The mineralogy and texture of the enclaves indicates that the gneisses have undergone middle amphibolite-facies metamorphism.

North of Meekatharra, a corridor of granodiorite and adamellite gneiss lies between the Meekatharra and the Abbotts (BELELE) greenstone belts. The gneiss has compositional banding, but remnants of a granitic texture suggest that it may represent a rock transitional between gneiss and granitoid.

Chemistry

Chemical analyses of 21 granitoids and gneisses from GLENGARRY are given in Table 2. On a CaO-K_2O-Na_2O diagram (Fig. 3) the analyses have a calc-alkaline trend similar to that on SIR SAMUEL (Bunting and Williams, 1976). Gneissic granitoids of tonalite and granodiorite composition fall in the basic end of the range, whereas post-tectonic adamellite and granite cluster around the potassic end of the trend. The fluorite-bearing Boreas-type potassic adamellites from DUKETON, LAVERTON and SIR SAMUEL are similarly clustered, and this, combined with the occurrence of fluorite in the alkalic GLENGARRY post-tectonic granites, indicates that these rocks may form a widespread suite of fractionated potassic granitoids in the northeastern Yilgarn Block.

TABLE 2 CHEMICAL ANALYSES OF GNEISSES AND GRANITOIDS

G.S.W.A. Number	47978	49948	49953	47985	47986	47989	46307	49913	54301	54318	54361	54403	54404	49945	54319	54321	54323	54365	50090	47991	47993	55906
SiO_2	69.2	66.6	70.7	70.2	63.4	70.7	76.6	73.9	75.4	70.5	71.4	72.8	73.0	69.9	69.9	74.5	73.4	67.9	67.2	67.8	63.1	62.1
Al_2O_3	14.9	15.0	14.3	14.0	16.7	14.7	13.3	13.5	12.9	13.7	14.3	13.1	12.9	14.3	14.8	13.0	13.3	15.3	15.5	13.9	14.5	16.0
Fe_2O_3	1.6	0.6	0.9	1.1	1.7	0.7	0.4	0.6	0.5	0.9	0.9	0.7	0.3	1.2	1.0	0.5	0.6	1.5	1.1	1.7	1.7	1.5
Feo (c)	2.06	1.67	1.54	1.87	2.57	1.74	0.13	1.09	0.84	2.06	1.97	1.29	1.29	1.74	1.93	1.12	1.48	2.25	2.96	2.32	3.99	3.60
Mgo (c)	0.91	2.77	0.70	0.51	1.69	0.49	0.04	0.18	0.15	0.44	0.60	0.20	0.32	0.73	0.66	0.17	0.32	1.28	1.08	1.26	2.72	2.07
CaO	3.10	5.23	2.17	1.47	2.46	2.27	0.30	0.67	0.36	1.48	2.14	1.04	0.63	1.58	2.22	0.77	0.97	2.16	3.07	2.71	4.05	4.82
Na_2O(c)	4.45	4.80	4.45	4.04	4.72	4.72	4.45	4.20	4.38	3.71	4.45	3.71	3.71	4.55	4.18	3.64	3.37	4.75	4.99	4.04	3.91	4.11
K_2O	1.5	1.2	2.9	3.7	1.7	1.9	4.8	4.0	4.3	4.1	2.6	4.7	4.8	3.4	3.0	4.7	4.6	2.4	1.4	3.2	2.6	1.8
H_2O+ (c)	0.68	0.83	0.61	0.67	1.37	0.42	0.70	0.48	0.31	0.78	0.46	0.44	0.69	0.71	0.66	0.36	0.53	1.04	0.69	0.74	1.12	1.61
H_2O- (c)	0.13	0.18	0.12	0.14	0.14	0.08	0.17	0.22	0.04	0.05	0.10	0.19	0.08	0.22	0.05	0.06	0.09	0.20	0.04	0.17	0.10	0.12
CO_2 (c)	0.08	0.14	0.21	0.13	0.15	0.08	n.d.	0.05	0.03	0.25	0.22	0.39	0.30	0.19	0.09	0.15	0.07	0.29	0.11	0.21	0.13	0.08
TiO_2	0.41	0.57	0.31	0.24	0.66	0.22	0.12	0.10	0.04	0.30	0.24	0.12	0.12	0.42	0.30	0.08	0.19	0.45	0.49	0.46	0.57	0.51
P_2O_5	0.07	0.06	0.06	0.06	0.12	0.04	0.06	0.03	0.01	0.04	0.05	0.02	0.02	0.06	0.05	0.01	0.02	0.08	0.09	0.08	0.11	0.08
MnO	0.01	0.04	0.02	0.02	0.05	0.02	*0.01	0.02	0.00	0.01	0.02	0.01	0.03	0.03	0.02	0.01	0.02	0.08	0.03	0.06	0.07	0.07
Total	99.1	99.7	99.0	98.1	99.2	98.1	101.1	99.0	99.3	98.3	99.5	98.7	98.2	99.0	98.9	99.1	99.0	99.7	98.7	98.6	98.7	98.5
Sb ppm	*10	*10	*10	*10	*10	*10	n.d.	*10	*10	*10	*10	*10	*10	*10	*10	*10	*10	*10	*10	*10	*10	*10
As	*10	*10	*10	10	*10	*10	n.d.	10	10	10	10	20	10	*10	10	*10	20	*10	*10	*10	*10	*10
Ba	600	260	750	1100	800	800	750	1000	240	1700	1000	650	600	2100	1300	600	1100	700	550	1100	1100	500
Ce	90	20	60	140	120	30	n.d.	50	30	160	40	80	80	140	80	70	100	80	50	80	100	70
Cr	200	210	220	230	170	230	10	230	210	220	280	210	180	210	180	240	200	180	190	190	180	200
Co	10	10	10	5	15	10	n.d.	*5	*5	10	10	120	10	10	10	*5	*5	10	10	5	20	20
Cu	25	40	20	30	25	20	10	20	60	35	20	25	25	30	30	20	25	30	25	35	60	50
F	370	380	360	520	1120	460	290	180	610	350	240	720	320	1130	730	230	370	790	890	570	550	310
Ga	16	16	20	16	24	20	20	16	20	16	16	16	16	16	16	16	16	20	20	16	16	16
La	30	*10	20	70	70	10	n.d.	30	*10	80	30	20	20	50	40	40	40	30	*10	40	60	10
Pb	10	20	30	40	40	20	n.d.	60	50	40	20	40	60	60	30	50	40	20	30	40	40	30
Li	45	8	22	45	95	80	4	52	5	35	45	30	35	32	55	35	80	39	100	15	30	55
Mn	300	450	300	300	600	350	n.d.	300	200	300	300	250	400	350	300	240	250	500	400	600	700	600
Mo	*1	*1	*1	*1	1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	2	*1
Ni	75	180	100	110	110	120	20	110	150	140	350	140	90	110	100	120	120	120	150	100	200	180
Nb	*5	*5	*5	*5	*5	*5	n.d.	*5	*5	*5	*5	*5	*5	*5	*5	*5	*5	*5	*5	*5	*5	*5
Rb	50	70	95	140	95	70	410	220	340	140	90	280	380	95	120	190	280	95	110	120	85	85
Sc	*2	8	2	2	*2	*2	n.d.	*2	2	2	*2	*2	4	2	2	*2	2	4	4	4	8	12
Sr	300	320	300	260	500	500	75	180	35	260	320	95	75	440	550	100	130	340	500	260	360	300
Sn	4	4	4	6	4	*2	6	4	8	6	4	6	2	6	2	6	4	4	2	6	4	2
Th	30	*10	20	30	20	*10	40	20	10	40	10	40	40	20	10	50	40	20	10	20	20	20
U	*1	*1	1	1	*1	*1	n.d.	2	5	3	1	7	7	*1	5	1	6	*1	*1	*1	1	*1
V	100	70	30	30	80	30	n.d.	10	10	20	20	40	20	20	30	*10	30	50	50	70	100	90
Y	*10	30	20	10	20	*10	n.d.	*10	50	20	10	20	10	*10	*10	*10	20	20	*10	20	20	20
Zn	53	26	46	48	90	44	n.d.	34	30	48	38	24	38	55	46	28	37	58	66	46	66	52
Zr	180	180	140	200	250	120	n.d.	90	80	300	140	120	140	220	200	100	160	220	200	160	180	140

n.d. = not determined (c) Analysis by chemical methods Analyses by Government Chemical Laboratories, Perth * Less than amount stated

		Lat. (S)	Long. (E)
47978	Tonalitic augen gneiss (Ang)	26°59′30″	119°51′30″
49948	Granodiorite gneiss (Ang)	26°26′45″	118°35′00″
49953	Adamellite gneiss (Ang)	26°25′30″	118°35′00″
47985	Gneissic adamellite (Agn)	26°44′15″	119°51′00″
47986	Gneissic tonalite (Agn)	26°42′30″	119°48′15″
47989	Gneissic adamellite (Agn)	26°50′15″	119°15′15″
46307	Leucogranite (Agb)	26°04′00″	119°14′00″
49913	Granodiorite (Agb)	26°54′45″	118°44′45″
54301	Muscovite—biotite adamellite (Agb)	26°57′00″	119°37′30″
54318	Foliated adamellite (Agb)	26°57′45″	119°10′45″
54361	Biotite adamellite (Agb)	26°59′30″	118°56′00″
54403	Granite (Agb)	26°43′45″	118°57′30″
54404	Granite/adamellite (Agb)	26°41′45″	118°51′00″
49945	Adamellite (Age)	26°27′00″	118°51′00″
54319	Porphyritic biotite adamellite (Agl)	26°57′15″	119°07′45″
54321	Porphyritic adamellite (Agl)	26°54′45″	119°01′15″
54323	Porphyritic granite/adamellite (Agl)	27°00′00″	119°01′00″
54365	Porphyritic biotite adamellite (Agl)	26°27′45″	119°03′00″
50090	Porphyritic biotite tonalite (Agl)	26°35′15″	119°06′30″
47991	Hornblende—biotite gneissic granodiorite (Agt)	26°51′15″	119°17′30″
47993	Hornblende—quartz granodioritic mylonite (Agt)	26°50′15″	119°17′45″
55906	Gneissic hornblende tonalite (Agt)	26°46′30″	118°47′30″

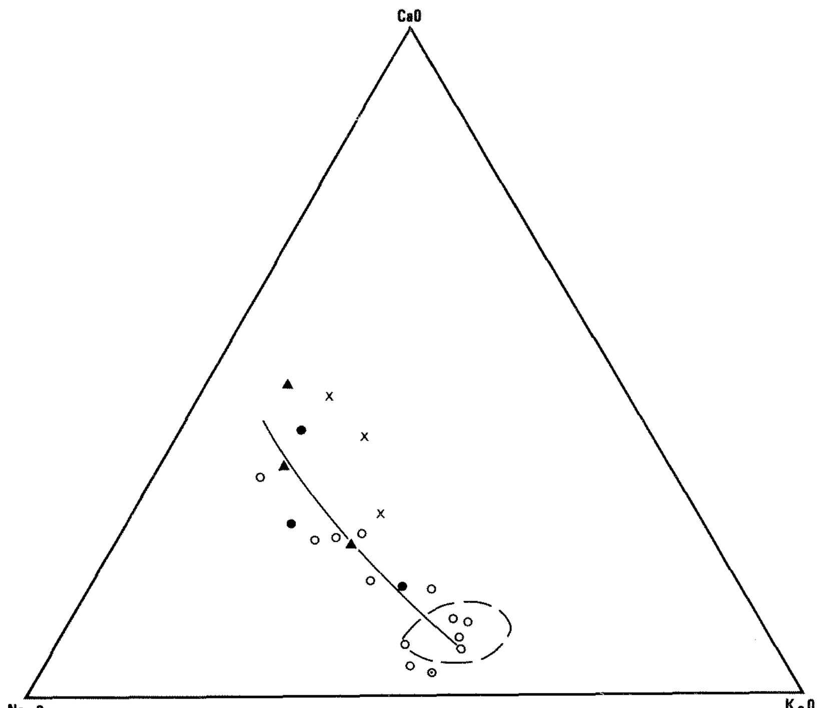

FIGURE 3

CaO – Na_2O – K_2O VARIATION DIAGRAM OF GRANITOIDS

GLENGARRY SHEET SG 50–12

REFERENCE

▲ Granitoid gneiss (map symbol Ang)

● Gneissic granitoid (Agn)

o Post-tectonic granitoid (Agb, Agl, Age)

x Hornblende granitoid (Agt)

Field of potassic granitoids, North Eastern Yilgarn Block (Bunting and Williams, 1976)

⊙ Granitoid from Goodin Dome (remainder from Yilgarn Block)

—— Calc-alkaline trend defined by biotite granitoids, GLENGARRY

GSWA 17909

The fractionated granites on GLENGARRY have K_2O values of 4% or greater whereas the majority of earlier granites contain less than 3%. One sample of "post-tectonic" granitoid (50090) plots chemically and mineralogically well within the range of tonalite and granodiorite of the earlier granitoids; the classification into syn- and post-tectonic has been made on the presence or absence of a metamorphic fabric, and this particular sample could be a syntectonic granitoid without fabric. Alternatively, early and late-tectonic granitoids could form separate overlapping series.

The hornblende-bearing tonalite-granodiorite (*Agt*) is depleted in Na_2O and enriched in CaO compared with biotite granitoid of the same K_2O content. Hornblende granitoids are enriched in Cu, Ni, Sc and V relative to the biotite granitoids. Basaltic rocks are enriched in the same trace elements suggesting that the hornblende granitoid was derived from a source containing significant mafic material. This is consistent with the observed relationship between hornblende granitoids and greenstone belts, mentioned above.

GOODIN DOME

The Goodin Dome (Bunting and others, 1977) is a body of granitic rock some 35 km across surrounded by outward-dipping sediments of the Glengarry Group. The southern third of the dome lies on GLENGARRY, and although there are several exposures only that at Utahlarba Spring is fresh. The rock is a pale-pink, medium to coarse-grained, unfoliated leucocratic granite, with alkali feldspar dominant over plagioclase. Accessories include muscovite, altered biotite and rare fluorite. A chemical analysis is given in Table 2.

The granite is cut by numerous mafic dykes, none of which cut the overlying sediments. The mafic dykes have been statically metamorphosed to an assemblage of green hornblende and plagioclase (andesine). The dome is considered to be a portion of Archean basement reactivated by block faulting during the Early Proterozoic (*see* STRUCTURE).

MINOR INTRUSIVE ROCKS

Thin mafic dykes (*d*), trending approximately east-west, cut the Yilgarn Block on GLENGARRY. Similar dykes, whose recorded ages range from 700 m.y. to 2 500 m.y. (Giddings, 1976), can be found through the entire Yilgarn Block. A range of ages on GLENGARRY is indicated by dykes cutting the Maraloou Formation of the Glengarry Group (*see* NABBERU BASIN), and by a dyke in the Yilgarn Block reportedly truncated by the Lower Proterozoic unconformity (Butt and others, 1976). The dykes in the Yilgarn Block cut across all fold structures, and record the final phase of magmatism in the Block, which occurred after cratonization. Quartz and other siliceous intrusive veins parallel to the mafic dykes could indicate that they relate to the same phase of intrusion. Mafic dykes in the Yilgarn Block on GLENGARRY were not examined petrographically.

PROTEROZOIC OUTLIERS ON THE YILGARN BLOCK

Flat-lying immature sediments of presumed Early Proterozoic age are exposed in a sinuous line of outcrops from Polelle to east of Bundle Well. The best exposure is on Mount Yagahong. Dark-green lithic arenite (*Pa*) predominates; it consists of grains of quartz, plagioclase, microcline, epidote, chert, and jasper. Cross-bedding and slump structures are common. Green and grey greywacke and shale form vertical cliffs about halfway up the southern face of Mount Yagahong, and alternate with lithic arenite to form terraced outcrop towards the top of the hill. Discontinuous beds of boulder conglomerate (*Pr*) contain rounded clasts, mainly of granite, with some of vein quartz, jaspilite, and felsic volcanic. They are not restricted to the base of the sequence. Rounded clasts of lithic arenite and conglomerate in the conglomerate indicate reworking of parts of the sequence.

Similar arenite and shale occur 50 km to the north, near Three Corners Well and Bunarra Bore.

Near Albury Heath gold mine, poorly bedded arkose and conglomerate, containing rounded clasts of jaspilite, felsic volcanic, chert and reef quartz, are tentatively equated with the Mount Yagahong rocks. However, the lack of a mafic component in the sediment, and the apparent truncation of bedding by the adjacent basalt raise the possibility that the sediment is part of the Archaean sequence, unconformably underlying the upper mafic unit.

The lithic arenite and conglomerate of the Mount Yagahong area show many similarities to the Kaluweerie Conglomerate about 200 km to the southeast, considered by Allchurch and Bunting (1976) to be of fluviatile origin.

NABBERU BASIN

The Nabberu Basin is Early Proterozoic (Hall and Goode, 1975), and contains a thick sequence of sedimentary and minor volcanic rocks deposited on Archaean basement. The Glengarry Group forms the bulk of the sequence, and it is unconformably overlain by various younger Proterozoic sequences. Only two formations (Finlayson Sandstone and Maraloou Formation) have so far been defined (Bunting and others, 1977), the remainder of the group being subdivided lithologically. Gee (1979) formalizes a stratigraphic subdivision of the Glengarry Group on PEAK HILL to the north. Although some of his units can be recognized on GLENGARRY, his stratigraphy cannot be applied conveniently, mainly because of facies changes.

GLENGARRY GROUP

Regional facies variation

On GLENGARRY, two depositional facies occur in the Glengarry Group. To the south, a shelf facies of shallow-water sandstone, shale, and carbonate was deposited on stable basement. To the north, this facies grades into a deeper water facies characterized by shale, greywacke, arkose and basalt. A trough formed by vertical block movements of the Archaean basement, and may have extended northeast towards the Thaduna area on PEAK HILL where thick turbidites are present. Northwest of the Goodin Dome, on PEAK HILL, a further facies change is evident by the rapid thickening of arkose and basalt, a feature which is present only in the extreme northwest of GLENGARRY. The arkose wedge is the result of rapid erosion from the rising Goodin Dome, followed by rapid transportation into deeper water. The area northwest of the dome is therefore typified by a large input of coarse clastics, accompanied by the extrusion of piles of basalt. Both indicate an active unstable tectonic environment. By contrast the deep-water facies south of the dome contains only minor arkose and basalt, and although the trough probably sank rapidly, there was a much lower clastic input. This may reflect less tectonic activity on the south side of the dome, but a contributing factor could be that the wide shelf to the south prevented the influx of coarse, immature sediment from the Yilgarn Block.

Shelf sequence

Finlayson Sandstone: This is defined as the unit of dominantly arenaceous rocks at the base of the Glengarry Group. It unconformably overlies Archaean basement and is overlain conformably by the the Maraloou Formation. The type section is taken between 26°41′20″S, 119°45′30″E and 26°35′10″S, 119°46′30″E, a line which approximately follows a north-south fence. The type section is probably about 500 m thick, rather than 1 000 m as suggested by Bunting and others (1977). The thickness is consistent along the southern edge of the basin, but decreases rapidly to the northwest, and is only about 50 m in the northwest corner of GLENGARRY.

The typical lithology is fine- or medium-grained, mature quartz arenite. Grains are sub-rounded and cemented by authigenic silica. Accessory minerals include feldspar, magnetite, tourmaline and clay, but in total these seldom amount to more than 5 per cent.

Shallow trough-style cross bedding is locally abundant. Ripple marks occur at most localities, and are generally of the symmetrical, oscillation type. Less common are asymmetrical (current), linguoid and interference ripples. Five kilometres northwest of Killara, ripple-marked surfaces are mud-cracked, indicating brief periods of emergence from the prevailing shallow-marine environment.

White, micaceous siltstone is interbedded with the arenite, but is generally not exposed. East of Paroo Siding, a broad belt of non-exposure, probably underlain by siltstone, divides the arenite into two units. On WILUNA, this division is more pronounced, and the gap is occupied by shale, siltstone, and silicified carbonate (Elias and Bunting, 1978).

The basal unconformity is well exposed at numerous localities, and is typically undulating. The basal beds are usually feldspathic for up to 0.5 m above the unconformity surface, although in some areas the granite passes directly into mature quartz arenite. Locally, quartz-pebble conglomerates are developed, such as near Paroo Siding and James Bore, but these are seldom more than 1 m thick.

Quartz arenite flanking the Goodin Dome is probably the continuation of the Finlayson Sandstone underneath the sub-basin, but in view of the lack of exposed continuity, it is placed in the unassigned part of the Glengarry Group, and will be described below.

Maraloou Formation: The Maraloou Formation is defined as the unit of fine-grained terrigenous sediments, carbonate rocks and chert, which conformably overlies the Finlayson Sandstone. The formation is overlain, probably unconformably, by unassigned arenaceous rocks, and is laterally equivalent to much of the trough sequence of the Glengarry Group. The base of the formation is taken at the top of the uppermost quartz arenite unit of the Finlayson Sandstone. Because of the poor exposure and large areal extent of the gently dipping sequence no type section is described; however a type locality is taken at Mount Russell, where about 60 m of marl and siltstone is unconformably overlain by unassigned quartz arenite. Total thickness of the formation is again impossible to measure, but is probably of the order of 1 000 m.

Various fine-grained rock types are present, including shale, dolomitic marl, and chert. The shale is grey or maroon, micaceous, and may be thinly laminated. It is commonly weathered, very poorly exposed, and accounts for about 80 per cent of the formation.

The dolomitic marl is massive to flaggy. It is pink, purple or brown, and is commonly flecked with manganese and/or iron oxide. The marl contains up to 80 per cent dolomite, the remainder being silt-sized quartz grains and clay minerals. Concentrically zoned nodules in marl beds at Mount Russell are now entirely hematite and chalcedonic silica, but may originally have been manganiferous. Also at Mount Russell, marl bands up to 1 m thick display a form of wavy bedding.

Carbonate bands are rare and, apart from some thin, grey sparry limestone beds 2 km east-northeast of Killara, are generally pink or brown dolomite. They are associated with the marly bands, and are seldom more than 1 m thick. More common, especially in the eastern part of the sub-basin, are chert bands, which are probably silicified carbonates. The chert is white to pale green or grey, laminated, commonly brecciated, and contains sporadic irregular jasper fragments. Near the base of the formation, 12 km southwest of Mount Russell, domal stromatolites have been silicified to chert. The domes are 3 to 4 m long and elongate in an 060° direction. In the northeast corner of GLENGARRY, chert and chert breccia are predominant. Some of these chert beds are black, with a thin, wavy lamination, and these may be primary chert rather than replaced carbonate.

The northern limit of the Maraloou Formation is somewhat arbitrary, where it passes laterally into the deeper water facies. The limit coincides approximately with the synclinorial axis of the sub-basin, and is marked by a change in lithology from shale-carbonate to shale-sandstone-basalt.

Trough sequence

This thick sequence constitutes a deep-water facies to the north of the shelf sequence. No formal subdivision has been attempted, although some units may be equivalent to formations defined by Gee (in press) on PEAK HILL. Because of lateral facies changes, the distinctive lithologies which characterize formations on PEAK HILL, such as arkose, basalt and thick greywacke, are of very limited extent on GLENGARRY, and most of the sequence is a monotonous mixture of shale and fine-grained greywacke.

Basal quartzite: The basal unit is a fine-grained orthoquartzite flanking the Goodin Dome. It is probably a correlate of the Finlayson Sandstone, but a lack of surface continuity with the Finlayson prompted Gee (1979) to call it the Juderina Sandstone around the Goodin Dome. It is only 30 m thick in its type area on PEAK HILL, but on the southeast side of the dome, a similar quartzite with interbedded shale is about 100 m thick.

The quartzite is white, and has a glassy or sugary texture. Bedding and other sedimentary structures have been largely destroyed by deformation, although some poorly preserved ripple marks remain. The relationship with the Goodin Dome is unconformable, although there is little positive evidence on GLENGARRY. Near Utahlarba Spring, tectonic slices of quartz arenite and shale occur in the granite. There is no evidence of an intrusive contact. Abundant dykes cut the granitic rocks, but none are present in the overlying quartzite.

Similar quartzite in the northwest corner of the sheet is overlain by the trough sequence. It is almost continuous with the Finlayson Sandstone to the southeast, and is therefore included in that formation.

Shale and wacke: Overlying the basal quartzite in most of the trough is an association of purple or brown, ferruginous, micaceous shale and greywacke with subordinate chert, carbonate, quartz wacke and quartz-arenite beds. Some of these lithological types are distinguished on the 1:250 000 map, but no attempt is made at a formal stratigraphy. The most extensive unit, designated *PG(w)* contains a thinly bedded mixture of laminated shale and fine-grained greywacke. The greywacke is grey, brown or purple, and contains a variety of lithic detritus (mostly shale, but including phyllite, feldspar and occasional volcanic fragments).

The quartz wacke and quartz arenite are fine or medium grained, usually poorly bedded, and occur as discontinuous lenses. The quartz wacke is dark grey or black, and consists of sub-rounded to subangular quartz in a ferruginous matrix which may contain detrital magnetite. This is best seen 10 km north of Karalundi, where quartz wacke is interbedded with shale and mafic tuffaceous rocks. An unusual feature here is the presence of isolated bodies of pink, jasperoidal chert surrounded by shale. These are considered by Gee (1979) to be hydrothermal and colloidal deposits in fumarolic pipes associated with the basaltic volcanism. This mixed unit in the northwest corner of the sheet forms part of the Karalundi Formation (Gee, 1979).

Arkose: Arkose appears in the sequence in two separate areas; along the northwest margin of the sheet, and in a discontinuous band from northwest of Diamond Well homestead to southeast of Glengarry Range. In both cases, the rock association is the same. The arkose ranges from fine- to very coarse-grained, and consists of sub-angular feldspar and quartz in a kaolinitic matrix. It is invariably deeply weathered, and superficially resembles kaolinized granitoid. Bedding is graded and of variable thickness. Soft-sediment deformation (flame structures, slumping) has affected both the arkose and interbedded, white kaolinitic shale.

The arkose in the northwest corner is a continuation of the Doolgunna Arkose (Gee, 1979), but unlike that unit on PEAK HILL, the arkose on GLENGARRY is underlain by a thick pile of shale and wacke. The Diamond Well—Glengarry Range arkose band wedges out to the southwest, but it too may be linked with the Doolgunna Arkose, around the eastern side of the Goodin Dome.

Basalt: Basaltic rocks occur in four areas. In the northwest corner they form part of the Narracoota Volcanics, which is a thick pile of basalt overlying the Karalundi Formation on PEAK HILL (Gee, 1979). The basalt on GLENGARRY is a fine-grained, green, directionless rock which is closely associated with mafic tuffs. The tuffs contain basaltic fragments and some shale and wacke fragments in a fine-grained flow-textured mafic groundmass. This may explain the unusual chemistry of the tuffs which are very high in sodium, silica and alumina (Table 3, sample 46444). Some pillowed basalt occurs in an isolated wedge south of, and stratigraphically below, the main body.

Two areas of basaltic rock, northeast of Killara homestead and northwest of Diamond Well homestead, have a stratigraphic position near the middle of the trough sequence. The basalt is up to 500 m thick. At the Diamond Well locality, basalt overlies arkose except in one small area.

The fourth occurrence lies at a lower stratigraphic level, immediately south of the Goodin Dome near Browny Well. Here the basalt overlies, and in one locality is interbedded with, the basal quartzite.

In the last three of these occurrences (Killara, Diamond Well and Browny Well) the basalt is a fine-grained to aphanitic, directionless, dark-green to black rock. Clinopyroxene occurs both as phenocrysts and as a feathery, "quench"-textured groundmass. It is more abundant than plagioclase (labradorite) which forms elongate laths or is thinly disseminated in the groundmass. Vesicles, filled with either quartz, calcite or chlorite, are normally present.

Chemically the basalt is a tholeiite with low potassium and aluminium (Table 3, samples 46456, 46577). A notable feature is the extreme variability of sodium, especially in the tuffaceous example, 46444.

UNASSIGNED PROTEROZOIC

Kimberley Range area

To the west and south of the Kimberley Range, overlying the gently dipping shale and marl of the Maraloou Formation, is a thin but extensive quartz arenite 20 m thick, with locally developed conglomerate at its base. The quartz arenite is medium grained, well bedded and cream to buff, with a pervasive secondary silicification. Trough cross-bedding is well developed.

The conglomerate contains clasts of buff chert and vein quartz in a quartz-arenite matrix, and is interbedded with lenses of quartz arenite. It is best developed along the eastern edge of the Kimberley Range northwest of Yandil, and at the top of Mount Russell. The clastic rocks are overlain by pale-grey sparry limestone and chert (silicified limestone) west of Corner Well, followed by a few metres of buff shale. The top of the sequence, which is well exposed 5 km north of Corner Well, consists of about 50 m of interbedded carbonate, marl and shale.

TABLE 3: CHEMICAL ANALYSES OF PROTEROZOIC MAFIC ROCKS

GSWA Sample No.	46444	46456	46577	46463	46449	46465
SiO_2 (per cent)	64.2	49.9	50.8	79.4	51.5	51.7
Al_2O_3	15.0	13.7	13.9	5.3	14.0	14.0
Fe_2O_3	2.3	1.8	1.4	1.2	1.4	3.4
FeO	3.67	9.74	8.48	1.87	7.90	7.11
MgO	2.07	6.44	7.10	0.39	6.61	6.83
CaO	2.22	12.28	9.56	8.20	9.35	11.34
Na_2O	7.41	1.24	2.95	0.03	2.63	1.36
K_2O	0.1	0.1	0.2	0.0	1.3	0.2
H_2O+	2.32	1.30	2.71	1.31	1.98	1.48
H_2O-	0.12	0.15	0.20	0.08	0.11	0.16
CO_2	—	0.14	0.28	1.55	0.27	0.09
TiO_2	0.70	1.17	0.58	0.20	0.66	0.87
P_2O_5	0.14	0.06	0.03	0.02	0.03	0.05
MnO	0.10	0.21	0.20	0.02	0.21	0.20
	100.35	98.2	98.3	99.6	97.9	98.8
Cr (ppm)	80	140	160	330	210	180
Cu	65	115	135	40	205	70
Ni	95	95	100	55	120	115
V	100	300	240	60	220	250

46444	Mafic tuff	Lat. 26°02′00″	Long. 118°38′20″
46456	Basalt	Lat. 26°06′40″	Long. 119°13′40″
46577	Basalt	Lat. 26°08′40″	Long. 119°28′50″
46463	Acid vein in basalt	Lat. 26°05′20″	Long. 119°31′10″
46449	Dolerite	Lat. 26°18′30″	Long. 118°59′40″
46465	Dolerite	Lat. 26°03′20″	Long. 119°13′30″

Five kilometres east of Phar Lap Well, the basal sandstone passes upwards, through a zone of interbedded carbonate and sandstone, into a thick sequence of stromatolitic dolomite. The stromatolites are upwardly expanding branching columns 250 mm high.

Despite the similarity of the shale and marl to the underlying Maraloou Formation, the unassigned rocks are thought to be unconformable on that unit. The quartz arenite is regionally discordant with the underlying rocks, being close to the base of the Maraloou Formation southeast of Mount Russell, but near the top west of Paroo homestead.

If the contact is unconformable, then the sequence could correlate with either the Yelma Formation in the Earaheedy Group (Bunting and others, 1977; Hall and others, 1977) or the Mount Leake Sandstone on PEAK HILL (Gee, 1979) both of which uncomformably overlie the Glengarry Group.

Glengarry Range area

A thick sequence of arenaceous rocks and interbedded shale in the Glengarry Range and adjacent areas has been left as unassigned (*Ꝑq*) because of its unusual lithology and uncertain stratigraphic position. The arenite is typically grey, medium grained, and quartz rich, but with a significant clay component in places. It is so thick bedded that it is often impossible to find a dip direction in outcrop.

A feature of the unit is the presence of thick, irregular beds of intraformational conglomerate, consisting of intraclasts of arenite and some shale, along with rounded chert fragments, in an arenite matrix. These clasts show no preferred orientation, although grading is occasionally present. These conglomeratic beds are more abundant in the western part of the area. They are possibly due to some type of mass-flow down the palaeoslope.

These rocks are more gently dipping than the surrounding trough sequence of the Glengarry Group, and display a less prominent cleavage. Indeed, southeast of Glengarry Range the prevailing northeast cleavage in underlying Glengarry Group shale is not present in the immediately overlying unassigned shale. The apparently continuous bedding trends (on aerial photographs) in the upper sequence follow the basal contact, whereas the bedding in the lower unit is apparently truncated at the contact. For these reasons, the contact is interpreted as an unconformity.

It is probable, therefore, that the rocks in the Glengarry Range are younger than the Glengarry Group, and may equate with either the Kimberley Range sequence (described above) or the Mount Leake Sandstone on PEAK HILL (Gee, 1979). However, a problem with the Glengarry Range sequence being unconformable on the Glengarry Group is that some rocks within the Glengarry Group, such as the thin arenite beds, are identical to those in the younger sequence.

An alternative hypothesis, that the Glengarry Range sequence is a facies variation of the Finlayson Sandstone or Juderina Sandstone at the base of the Glengarry Group, is considered possible but unlikely. It would mean that the sequence immediately south of Glengarry Range is unconformable beneath the Glengarry Group, and therefore unique in this area. The Glengarry Range sequence, for the moment, remains an enigma.

MAFIC INTRUSIONS

Dolerite sills in the Glengarry Group occur in a broad zone from Killara to north of Diamond Well homestead, then across to the eastern boundary of the sheet. They are absent from most of the shelf areas to the south, and, apart from some small sills in the northwest corner of the sheet, they are absent northwest of Glengarry Range.

Within the trough sequence of the Glengarry Group, the sills are broadly associated with the intermittent zone of basalt extrusion. Chemically, the basalt (*PGb*) and dolerite (*PGd*) are similar (Table 3), and a common magma source is likely. The sills have suffered the same folding and deformation as the surrounding sediments.

East of Large Gum Creek, dolerite sills have intruded the shelf sediments of the Maraloou Formation. Here, mafic volcanics are absent from the sequence, and because of the lack of deformation and shallow dips there is no evidence for the relative age of these sills; therefore, on the geological map, the symbol *b* is used.

Several small dolerite dykes intrude the Maraloou Formation south of Rainbow Well. They trend approximately east-west, and may represent the later reactivation of the tensional system which resulted in east-west trending dykes in the underlying Yilgarn Block at the beginning of the Proterozoic, prior to deposition of the Glengarry Group.

STRUCTURE

The two shelf and trough depositional facies of the Glengarry Sub-basin coincide approximately with two tectonic subdivisions, namely a stable platform and a fold belt (Fig. 1). Bunting and others (1977) and Hall and Goode (1978) regarded these areas as parts of the more extensive Kingston Platform and Stanley Fold Belt. These names are retained here for consistency and simplicity of presentation, but as they apply to the whole of the Nabberu Basin, they may require revision as the structure becomes better known. A third structural element is the Goodin Dome.

Kingston platform

This is the area south and east of the main synclinorial axis of the basin. It is characterized by gentle dips and a lack of penetrative cleavage. Folding is broad and open, and usually on a scale of a few metres.

Stanley Fold Belt

In the fold belt, which lies north of the axis of the Glengarry Synclinorium, dips are typically between 30° and 60°, although locally they are steeper or overturned. The fold belt is characterized by a well-developed slaty cleavage, which has a regional northeast to east-northeast trend. Only rarely, in the more deformed areas, is enough white mica developed to term the rocks phyllites.

Folding is generally tight and has elements of both concentric and similar styles. Folds in the more resistant quartzite beds are approximately concentric, whereas the intervening shale and slate display similar-style folds. Many folds at outcrop scale (wavelengths of several metres) are asymmetrical or irregular in shape. The asymmetry in such folds could not be related to major fold geometry, although axial surfaces are parallel to the regional fold and cleavage trends. Major northeast-plunging asymmetrical folds, north of Diamond Well homestead, and at the headwaters of Glengarry Creek, have S-asymmetry, which indicates a congruent relationship to the Glengarry Synclinorium.

Two directions of faulting are present. Northwest-trending normal faults typically have small displacements, and are approximately perpendicular to the dominant strike direction. A major northwest-trending fault is interpreted near Killara, where the strike of the trough sequence of the Glengarry Group terminates against the Finlayson Sandstone. This fault effectively cuts off the closure of the Glengarry Synclinorium.

A series of east-northeast-trending faults northeast of Killara has a major disrupting effect on the stratigraphy. The faults coalesce towards the west, and may turn northwest to merge with the major fault near Killara. Their sense of movement is not known.

Goodin Dome

The Goodin Dome is one of several reactivated basement highs which pierce the Lower Proterozoic rocks along the buried northern edge of the Yilgarn Craton (Bunting and others, 1977). The granite of the dome is considered to be older than the overlying Early Proterozoic sediments because:

(1) a probable unconformity is exposed on PEAK HILL;

(2) the mafic dykes do not cut the sediments;

(3) a thick wedge of arkose is associated with the dome on PEAK HILL; and

(4) there are no intrusive effects at the contact with the overlying quartzite.

The Goodin Dome began to rise as a fault-bounded horst during deposition of the Glengarry Group. Most movement occurred along northeast-trending faults on either side of the dome, forming a ridge-like structure which separated the sub-basin into two troughs. Erosion products from the rising dome were deposited as the thick arkosic wedge which flanks the northern and eastern side of the dome.

After deposition ceased, the northeast-trending flanks of the dome continued to be the loci for block movements resulting in strong deformation along the margins. These corridors of deformation (one stretching east-northeast from Killara to the southeast side of the dome, the other flanking the northwest side near Ruby Well South) contrast with the area immediately southwest of the dome, where deformation is less intense, and the strike is northwest with a gentle southwest dip off the dome.

SUPERFICIAL GEOLOGY

UNASSIGNED CAINOZOIC (*Cz*)

All these units, except calcrete (*Czk*), were formed from the weathering of bedrock during the period of Tertiary lateritization which produced the old plateau (*see* PHYSIOGRAPHY). Laterite (*Czl*) is a ferruginous, massive to pisolitic duricrust, formed over most rocks. Silcrete (*Czb*) is a siliceous duricrust capping some breakaways marginal to eolian sandplain, and has formed by silicification of kaolinized granite. West of the Kimberley Range silcrete has formed over Proterozoic carbonate rocks. A distinctive caprock formed over Archaean ultramafic rocks (*Czj*) is a brown, limonitic, siliceous rock which may contain chrysoprase, magnetite and opaline silica. Deeply weathered rock below the duricrust, designated by the symbol (*Czo*), generally preserves some original textures allowing identification of the original rock type.

Calcrete (*Czk*) occurs as elongate sheets along the axes of broad, shallow valleys in the internal drainage system and in the externally draining Yalgar River. Calcrete has formed by cementation and replacement of valley-fill by calcite precipitated from percolating carbonate-bearing groundwater.

QUATERNARY (*Q*)

Quaternary deposits are mostly unconsolidated detritus derived from bedrock and older Cainozoic units. Colluvium (*Qc*) is a poorly sorted deposit occurring adjacent to outcrop areas, and consists of angular rock and quartz fragments in silt and sand. Colluvium generally grades downslope into alluvium and colluvium (*Qz*), a clay and loam sheet-wash deposit; and alluvium (*Qa*), consisting of gravel, sand and silt deposited along drainage lines. All these units are underlain at shallow depth by hardpan, a red-brown, poorly-sorted, indurated colluvial and alluvial deposit which is exposed along many incised creek banks. The hardpan, which is not depicted on the map, forms a regional unit termed the Wiluna Hardpan by Bettenay and Churchward (1974).

Red-brown eolian sand (*Qs*) forms extensive sheets covering the old plateau as well as occurring on the younger colluvial and alluvial areas. The sand was derived mainly from reworking of surface deposits by water and wind. The red-brown colour is due to a thin ferruginous coating on the sand grains. The characteristic vegetation of eolian sand is spinifex.

ECONOMIC GEOLOGY

GOLD AND SILVER

The Meekatharra centre is the largest producer of gold and silver on GLENGARRY (production figures for all localities on GLENGARRY are quoted in Table 4), greatest production occurring in the period 1910-1920. Mining has decreased steadily since then, but recent increases in the price of gold have led to an upsurge in prospecting activity, and the re-opening of a number of small mines at Meekatharra. Nearly all the gold production has been from Paddy's Flat about 1.5 km east of the Meekatharra townsite, where gold was found in a network of quartz veins closely associated with a sheet of felsic porphyry (Noldart, 1962). The porphyry appears to have intruded along a strike fault in metabasalt, ultramafic schist, and abundant chlorite schist. In the Haveluck mines north of the townsite, the quartz veins intrude kaolinized schistose sediments, possibly also containing felsic porphyry. Descriptions of the mines in the Meekatharra area are given by Clarke (1916) and Forman (1934).

Another gold-producing area is the Gabanintha-Star of the East group. At Gabanintha, gold and associated copper appears to be related to a band of fragmental-textured ultramafic rock in a mafic-ultramafic sequence. The Star of the East Mine is in felsic volcanics. The gold deposits in the Meekatharra belt are restricted to the lower mafic unit and the overlying sedimentary unit.

TABLE 4: SUMMARY OF REPORTED GOLD AND SILVER PRODUCTION

Goldfield	District	Locality	Alluvial (g)	Dollied or specimens (g)	Ore treated (t)	Gold therefrom (g)	Average grade (g/t)	Total gold recovered (g)	Silver recovered (g)
		Gabanintha	889	6 133	39 360	788 973	20.05	795 995	25 937
		Gum Creek	922	5 500	4 703	139 218	29.60	145 640	—
		Meeka Pool[1]	—	88	351	8 947	25.51	9 035	—
		Meekatharra[2]	5 685	74 623	1 882 527	29 793 423	15.83	29 873 730	78 631
MURCHISON	Meekatharra	Mistletoe	3 835	33 346	444	15 186	34.22	52 366	—
		Star of the East	—	—	27 812	634 523	22.81	634 523	—
		From district generally[3]	382 168	9 268		1 360 943[4]	—	1 752 379	14 487
		Diorite	—	—	7 920	113 773	14.37	113 773	—
EAST MURCHISON	Wiluna	Joyner's Find	—	—	23 461	210 369	8.97	210 369	—
		Gum Creek	645	42	1 816	22 606	12.44	23 294	—
			394 143	129 000	1 996 058	33 086 961		33 611 104	119 054

1. Probable equivalent to Tal Val
2. Includes Mines on BELELE. Probably >95% production from GLENGARRY
3. i.e. not restricted to GLENGARRY
4. Mainly derived from the treatment of tailings.

In the other greenstone belts, the Gum Creek mine is located in basaltic amphibolite, and the Joyner's Find and Diorite mines are in ultramafic schists adjacent to banded iron-formation.

COPPER

Copper and cupreous ores have been mined at Gabanintha since 1906 from the Mountain View and Tumblegum mining groups (associated with gold and silver), and from the Lady Alma mining group, 5 km to the southeast in the Copper Hills ultramafic complex. Chalcocite and chalcopyrite occur in quartz veins in northerly trending shears in mafic and ultramafic schists, and 352.5 tonnes of contained copper (Marston, 1979) has come from the oxidized zone.

About 3 km northeast of Killara, a copper gossan is located in lateritized Glengarry Group (Butt and others, 1976). Ferruginous shale and wacke are interbedded with basalts and intruded by dolerite sills. This association of rock types occurs elsewhere in the Glengarry sub-basin, for example in the northwest corner of GLENGARRY, and north-northwest of Diamond Well homestead; consequently these areas have some potential for base-metal mineralization.

IRON ORE

Nearly pure hematite north of Joyner's Find is a secondary enrichment of Archaean banded iron-formation. Surface grab samples assay 68-69 per cent iron. Connolly (1959) estimated 2.3 million tonnes of ore above the level of the plain, although the high grade of surface samples could not be expected to continue to that depth.

Massive titaniferous magnetite occurs west of Gabanintha in a basic intrusive complex. Only small tonnages are present, and the high content of titanium and vanadium make it a more attractive prospect for these commodities. Iron content is around 54 per cent (Connolly, 1959).

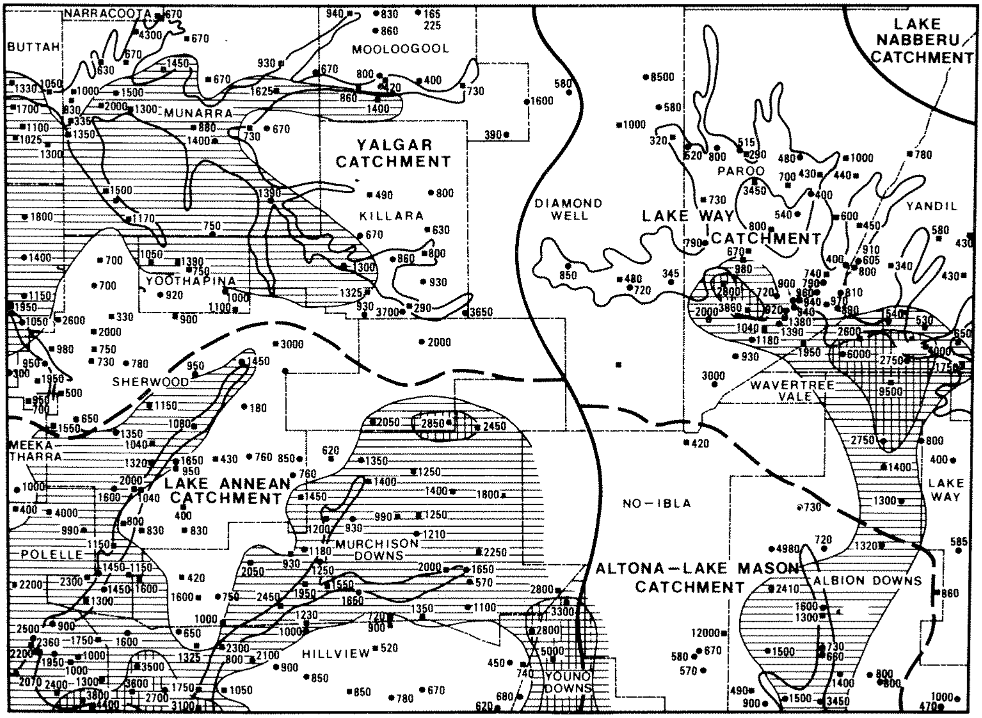

FIGURE 4

GROUNDWATER QUALITY

GLENGARRY SHEET SG 50–12

0 30 km

Pastoral lease boundary

SHERWOOD Pastoral lease name

Major drainage divide (see text)

Secondary drainage divide

Alluvial deposits in saline ancient drainages

• 1000 Bore, field salinity in mg/l total dissolved solids

▪ 1000 Well, field salinity in mg/l total dissolved solids

Fresh groundwater (up to 1000 mg/l)

Brackish groundwater (approximately 1000–2500 mg/l)

Stock-quality groundwater (above 2500 mg/l)

URANIUM

Uranium mineralization occurs in calcrete in a saline drainage that extends from southeast of Murchison Downs to south of Hillview. The deposit is of similar type to Yeelirrie, i.e. carnotite in voids in valley calcrete. Smaller uranium occurrences are in calcreted channels near Limestone Well and Gnaweeda Outcamp (Butt and others, 1977).

TITANIUM AND VANADIUM

Titanium and vanadium are contained in cumulate magnetite bands in anorthositic gabbro (*Adm*) west of Gabanintha. Indicated reserves are 8.56 million tonnes of ore containing 1.24 per cent V_2O_5 and 15.5 per cent TiO_2 (Baxter).

GRAPHITE

Graphite schist is interbedded in schistose amphibolite in the Gum Creek belt east of German Well. The schist, derived from carbonaceous shale, consists of fine-grained quartz, feldspar, chlorite and sericite, and contains 4.5 per cent free carbon in the form of minute graphite flakes.

WATER RESOURCES

Water supplies are almost entirely from groundwater. Surface water is contained in stream pools, rock holes and springs for only short periods after rainfall.

Over most of the area domestic and stock-water requirements are met from small supplies of fresh or brackish groundwater in colluvium, valley-fill alluvium and calcreted alluvium. Calcrete has the greatest potential for groundwater and large quantities of generally brackish water may be extracted from it. Sanders (1973) described the hydrogeology of the calcretes on Paroo Station (in the Lake Way catchment in Fig. 4) and has calculated that 3.62 million cubic metres per year of fresh water may be available without depleting the resource. Weathered granitic rocks, and fractured or jointed Archaean and Proterozoic rocks are unreliable as aquifers, but may yield groundwater. Depths to the water table vary from less than 5 m in the main trunk drainages to greater than 25 m in upland areas.

Figure 4 gives bore and well salinities measured during field mapping and some previously recorded measurements. An attempt has been made to show the general distribution of fresh, brackish, and stock-quality waters. It is difficult to relate salinities to geology and physiography, but generally salinities increased towards drainage lines from divides, and increase down the catchment.

Groundwater resources of the region are discussed in more detail by Brookfield (1963).

APPENDIX: CO-ORDINATES OF LOCALITIES MENTIONED IN THE TEXT

	Latitude (S)	Longitude (E)
Albury Heath mine	26°47′20″	118°34′30″
Bourke Find	26°40′15″	118°36′30″
Browny Well	26°07′00″	119°12′45″
Bunarra Bore	26°31′30″	118°48′00″
Bundle Well	26°58′30″	119°02′00″
Coon Well	26°50′15″	119°57′00″
Copper Hills	26°57′00″	118°41′00″
Corner Well	26°21′15″	119°44′10″
Diamond Well (homestead)	26°11′15″	119°32′00″
Diorite mine	26°43′10″	119°58′00″
Gabanintha	26°55′50″	118°38′45″
German Well	26°56′00″	119°21′00″
Glengarry Creek	26°16′00″	119°02′30″
Glengarry Range	26°11′30″	119°00′00″
Gnaweeda Outcamp	26°39′00″	118°44′00″
Gum Creek mine	26°50′00″	119°21′30″
Haveluck mine	26°34′30″	118°30′00″
Hillview (homestead)	26°54′30″	118°50′00″
James Bore	26°41′30″	119°48′10″
Joyner's Find mine	26°47′30″	118°57′00″
Karalundi	26°08′00″	118°41′00″
Killara (homestead)	26°21′00″	118°57′30″
Kimberley Range	26°19′00″	119°48′00″
Lady Alma Group	26°57′30″	118°41′00″
Large Gum Creek	26°06′30″	119°35′30″

	Latitude (S)	Longitude (E)
Limestone Well	26°52′00″	119°46′30″
Meekatharra	26°36′00″	118°30′00″
Mistletoe	26°16′30″	118°50′00″
Mount Russell	26°29′50″	118°50′30″
Mountain View Group	26°55′10″	118°38′30″
Mount Yagahong	26°53′50″	118°39′30″
Murchison Downs (homestead)	26°47′45″	118°59′00″
Munarra (homestead)	26°17′00″	118°41′30″
No-ibla (homestead)	25°55′00″	119°34′30″
No. 7 Bore	26°44′40″	118°37′30″
Paddy's Flat	26°35′30″	118°31′00″
Paroo (homestead)	26°15′45″	119°46′00″
Paroo Siding	26°37′00″	119°33′30″
Phar Lap Well	26°16′50″	119°35′10″
Polelle (homestead)	26°54′50″	118°33′00″
Rainbow Well	26°24′40″	119°29′00″
Reserve Bore	26°39′00″	118°46′00″
Ruby Well South	26°03′00″	118°47′10″
Stockyard Bore	26°42′40″	118°30′40″
Star of the East mine	26°56′30″	118°36′10″
Swan Bore	26°48′30″	118°53′45″
Tal Val	26°33′30″	118°37′15″
Three Corners Well	26°29′20″	118°38′30″
Tumblegum Mining Group	26°56′00″	118°38′45″
Utahlarba Spring	26°03′30″	119°14′00″
Yandil (homestead)	26°21′30″	119°49′10″

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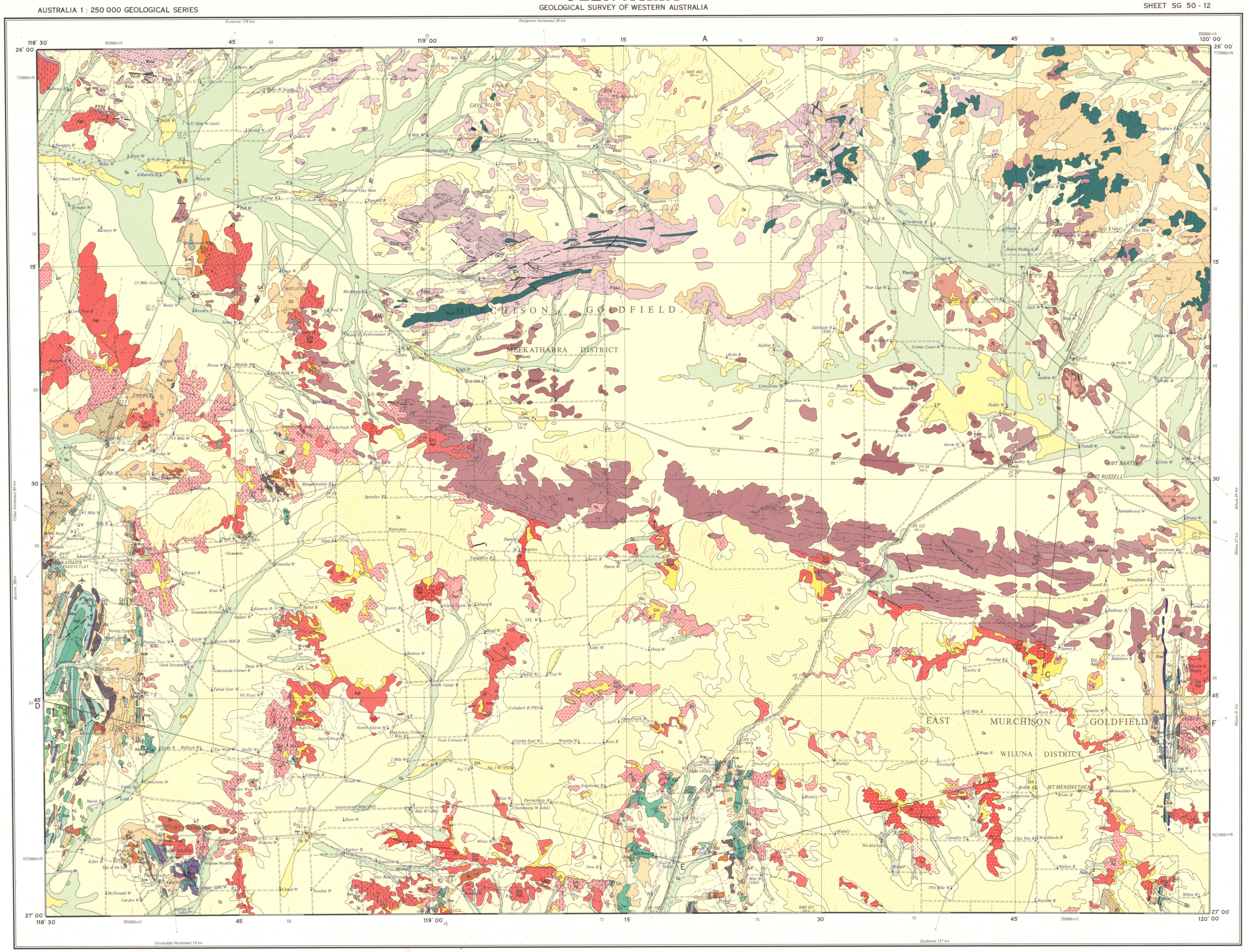
GLENGARRY

AUSTRALIA 1 : 250 000 GEOLOGICAL SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SG 50 - 12



SYMBOLS

Geological boundary
Fault
Accurate
Inferred
Fold
Syncline
Minor fold showing plunge
Parasitic fold (sense of asymmetry indicated), showing plunge
Bedding
Inclined
Vertical
Horizontal
Air photo interpretation of bedding
Dip < 5°
Dip 5°–15°
Dip 15°–45°
Trend line
Foliation, primary igneous
Inclined
Vertical
Trend
Foliation, gneissic banding
Inclined
Vertical
Foliation, metamorphic
Inclined
Vertical
Regional foliation, in granite
Cleavage
Inclined
Vertical
Lineation, metamorphic
Showing plunge
Horizontal
Facing indicated by
Graded bedding
Pillow structures
Shear zone
Air photo lineament
Stromatolite locality

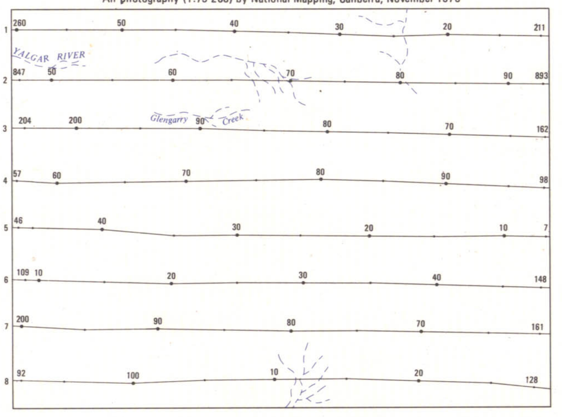
Goldfield boundary
Highway with national route marker
Formed road
Track
Townsite (gazetted; population < 1000) — Porllel
Homestead — Munarra
Building
Locality — Yanganoo
Horizontal control, major, minor
Bench mark, height accurate — ZY 63 524 m
Airport
Landing ground
Breakaway
Sand dune

Watercourse intermittent
Well — W
Bore — B
Windpump
Spring — S
Pool — P
Waterhole — WH
Rockhole — RH
Abandoned — (abd)
Position doubtful — (PD)

Mining centre — MISTLETOE
Mine, may or may not be working (gold unless otherwise indicated) — Bourke Find
Open cut mine or quarry, may or may not be working (gold unless otherwise indicated)
Prospect
Mineral occurrence
Building stone — Bs
Copper — Cu
Gold — Au
Graphite — Gt
Iron — Fe
Lithium — Li
Magnesite — Ms
Titanium — Ti
Vanadium — V

FLIGHT DIAGRAM

Air photographs (1:70 000) by National Mapping, Canberra, November 1970



REFERENCE

CAINOZOIC

QUATERNARY

- Qs Eolian sand in dunes and sheets, red-brown
- Qc Colluvium, quartz and rock fragments in loam, unconsolidated, grades into Qz
- Qz Colluvium and alluvium, red-brown sandy and clayey loam as sheetwash deposits, grades into Qs
- Qa Alluvium, unconsolidated sand, silt and gravel in drainage lines and adjacent flood plains

TERTIARY

- Czl Laterite, massive and pisolitic ferruginous duricrust, in places contains relict structures of parent rock
- Czb Silcrete, siliceous duricrust with angular quartz grains, over granitoid rock
- Czj Ferruginous siliceous capping over ultramafic rock, brown to orange-brown
- Czo Deeply weathered, kaolinized rock, may be subsequently ferruginized and silicified
- Czk Valley calcrete, sheet carbonate with minor chalcedony in lines of ancient drainage

PRECAMBRIAN
Age variable and/or uncertain

Veins and dykes

- q Quartz
- a Pegmatite; feldspar and mica altered to pale green fine-grained muscovite
- p Pegmatite, predominantly quartz-feldspar
- g Granitoid
- Ꝑd Dolerite
- Ꝑdm Dolerite, metamorphosed

EARLY PROTEROZOIC

Unassigned

- Ꝑc Chert, chert breccia, silicified carbonate
- Ꝑl Limestone, marl; stromatolitic
- Ꝑs Shale, marl
- Ꝑq Quartz arenite, intraclastic conglomerate, minor shale
- Ꝑa Lithic arenite, arkose, greywacke, minor shale and pebbly beds
- Ꝑr Conglomerate, rounded clasts in lithic and arkosic matrix, polymict, minor lithic arenite and arkose

Ꝑa, Ꝑr: Mt Yagahong area

Glengarry Group

- ꝐG(d) Dolerite sill
- ꝐG(c) Chert, chert breccia
- ꝐG(l) Limestone, dolostone, minor shale
- ꝐG(s) Shale, minor sandstone
- ꝐG(w) Quartz wacke, lithic wacke, shale
- ꝐG(a) Arkosic sandstone, minor shale
- ꝐG(b) Basalt, minor intermediate volcanic rocks
- ꝐG(q) Quartz arenite, minor conglomerate and shale
- ꝐGm **MARALOOU FORMATION:** shale, marl, chert, carbonate
  - ꝐGm(l) Limestone, dolomite, shale
  - ꝐGm(c) Chert, chert breccia
  - ꝐGm(s) Shale
- ꝐGf **FINLAYSON SANDSTONE:** mature quartz arenite, minor conglomerate, shale

ARCHAEAN

- Ag Undivided granitoid

Late and post-tectonic granitoids

- Agb Biotite adamellite, granite, minor granodiorite, medium to coarse-grained
- Age Biotite adamellite, granite, minor granodiorite, fine to medium-grained
- Agl Biotite adamellite and granite, porphyritic
- Agm Mixed granite, abundant Age intruding Agn

Pre- and syn-tectonic granitoids

- Agn Gneissic biotite granodiorite and adamellite, recrystallized with granoblastic texture, shows nebulous banding and augen structure
- Agt Hornblende granodiorite and tonalite, mylonitic fabric with minor recrystallization

- Ang Adamellite, granodiorite and tonalite gneiss, compositionally banded. Granoblastic quartz and feldspar, and aligned flakes of biotite
- Anc Calc-silicate rock containing plagioclase-quartz-diopside-hornblende-K feldspar assemblages, usually compositionally banded

- Az Undivided mafic, andesitic and dacitic lava, tuff, and minor fine-grained sediments
- Azv Coarse-grained agglomerate, blocks of mafic and andesitic lava in a fragmental matrix of similar composition
- Azl Extrusive andesite, dacite and minor basalt, mostly vesicular, in part pyroclastic

- Aiw Quartz-magnetite banded iron-formation, may contain mafic minerals
- Aij Jaspilite, red and black banded
- Aic Chert, banded, in part ferruginous

- As Undivided metasedimentary rock
- Ass Carbonaceous shale, mudstone, minor greywacke, often silicified to banded chert
- Asg Greywacke and shale, shows graded bedding
- Asc Conglomerate; chert and iron-formation clasts in a schistose greywacke matrix

- Af Undivided felsic volcanic rock, generally deeply weathered
- Afl Felsic lava, quartz-phyric, fine-grained to aphanitic, partly tuffaceous
- Afx Medium-grained felsic tuff containing crystal and lithic fragments

- Ad Undivided mafic intrusive rock
- Add Dolerite, medium-grained
- Ado Gabbro, coarse-grained
- Ada Amphibolite, medium to coarse-grained, dynamically metamorphosed dolerite and gabbro with foliation and amphibole growth
- Adm Layered gabbro and anorthosite containing magnetite layers

- Ab Undivided mafic extrusive rock
- Abb Basalt, fine-grained, locally vesicular, pillowed and/or porphyritic, mafic minerals generally pseudomorphed by actinolite
- Aba Amphibolite, fine-grained, schistose, derived from mafic volcanics
- Abu Komatiitic basalt, acicular and porphyritic texture, contains unaltered clinopyroxene, minor plagioclase
- Abx Mafic tuff and agglomerate, containing crystal and lithic fragments
- Aa Hornblende-plagioclase (-clinopyroxene) amphibolite

- Au Undivided ultramafic rock
- Aud Serpentinite derived from dunite, cumulate texture preserved
- Aup Peridotite, medium to coarse-grained, usually metamorphosed to serpentine-actinolite rock
- Aux Pyroxenite, coarse-grained, usually metamorphosed to actinolite rock
- Aur Actinolite-chlorite rock, generally schistose, metamorphosed mafic to ultramafic (including komatiitic) rocks
- Aue Talc-carbonate (-chlorite-serpentine) altered ultramafic rock, schistose

Compiled and published by the Geological Survey of Western Australia. Cartography by the Geological Mapping Section, Department of Mines. Topographic base from compilations by the Department of Lands and Surveys.

Copies of this map may be obtained from the Geological Survey of Western Australia, 66 Adelaide Tce., Perth.

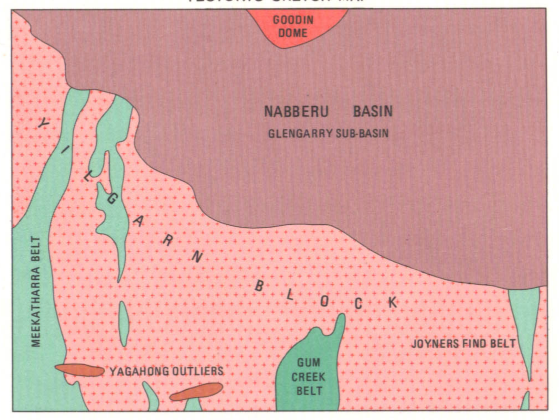
Geology by: J.A. Bunting 1976-77, D.P. Commander 1976, M. Elias and P.H. Wharton 1977.

HON. P.V. JONES, M.L.A.
MINISTER FOR MINES
A.F. TRENDALL, DIRECTOR, GEOLOGICAL SURVEY

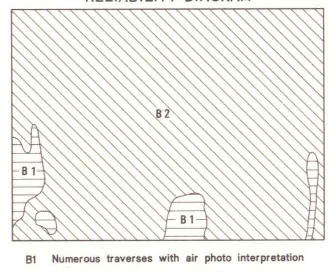
SCALE 1 : 250 000

TRANSVERSE MERCATOR PROJECTION
ZONE 50 AUSTRALIAN MAP GRID

TECTONIC SKETCH MAP



RELIABILITY DIAGRAM



B1 Numerous traverses with air photo interpretation
B2 Air photo interpretation with a few traverses

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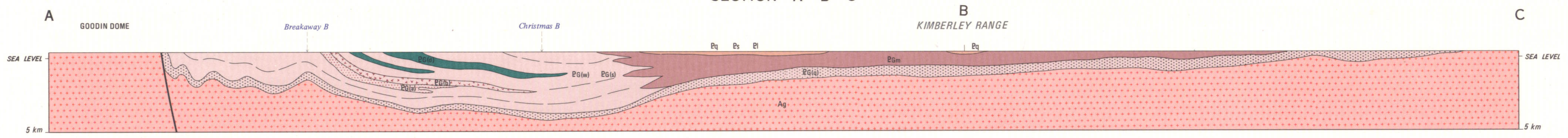
DECLINATION DIAGRAM

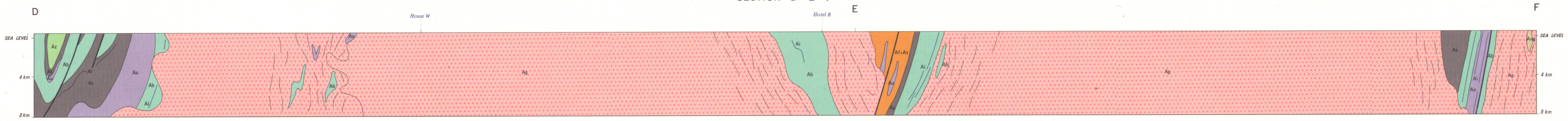
DIAGRAMMATIC SECTIONS

NATURAL SCALE

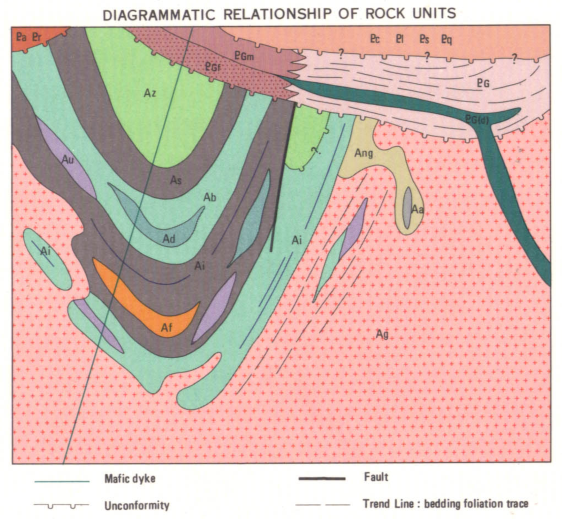
SECTION A - B - C



SECTION D - E - F



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



GLENGARRY
SHEET SG 50 - 12

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