1:250 000 GEOLOGICAL SERIES—EXPLANATORY NOTES

KIRKALOCKA

WESTERN AUSTRALIA

SHEET SH/50-3 INTERNATIONAL INDEX

WESTERN AUSTRALIA
INDEX TO GEOLOGICAL MAPS
1:250 000 OR 4 MILE SCALE

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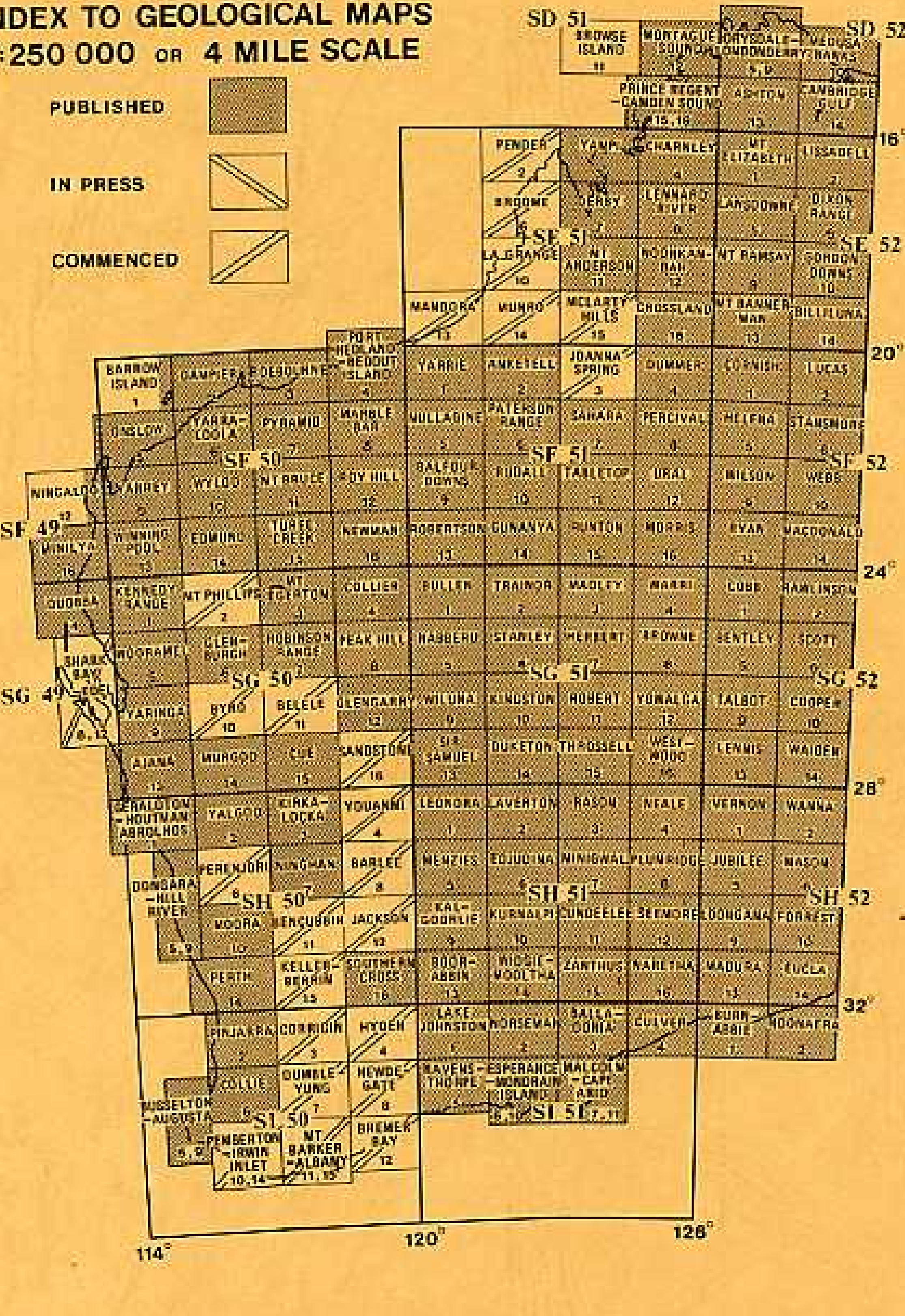

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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KIRKALOCKA

WESTERN AUSTRALIA

SHEET SH/50-3 INTERNATIONAL INDEX

COMPILED BY J. L. BAXTER, S. L. LIPPLE AND R. J. MARSTON

PERTH, WESTERN AUSTRALIA 1983

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DEPARTMENT OF MINES, WESTERN AUSTRALIA
Minister: The Hon. P. V. Jones, M.L.A.
Under-Secretary: D. R. Kelly

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
Director: A. F. Trendall

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Explanatory Notes on the Kirkalocka Geological Sheet

Compiled by J. L. Baxter, S. L. Lipple and R. J. Marston

INTRODUCTION

The KIRKALOCKA* 1:250 000 geological sheet, SH/50-3 is bounded by latitudes 28°00′ and 29°00′S, and by longitudes 117°00′ and 118°30′E. Mount Magnet, the only town in the sheet area, is 550 km north of Perth on the Great Northern Highway. The highway runs north through the central part of the sheet and is connected to pastoral station homesteads by graded roads. Station tracks give access to the remainder of the area. Many tracks are impassable during wet weather.

The climate is semi-desert mediterranean. The 250 mm isohyet passes through the centre of the area.

Most of the area is utilized by the pastoral industry.

The gold-mining centre of Mount Magnet has been described in several published accounts, the earliest by Gibson (1903), and the latest by Lewis (1965). Feldtmann (1924) and Esson (1926) reported on the Paynesville centre and de la Hunty (1966) described an ilmenite sand at Lake Boodanoo. Table 1 summarizes the unpublished exploration data obtained by mining companies and held by the Geological Survey of Western Australia.

Aeromagnetic maps (1:100 000 and 1:250 000 scale), a radiometric map (1:250 000 scale) and a Bouguer anomaly map (1:500 000 scale) have been prepared by the Bureau of Mineral Resources (Waller, 1971).

The geological mapping described herein was completed by J. L. Baxter, S. L. Lipple and R. J. Marston between June and September, 1978. Petrological descriptions were provided by J. D. Lewis.

REGIONAL GEOLOGICAL OUTLINE

KIRKALOCKA contains belts of deformed Archaean supracrustal rocks; gabbroid complexes, including some roof pendants and wall rocks associated with large, layered gabbroic intrusions; and deformed and undeformed granitoids. The distribution of these units is shown in Figure 1.

FOLD BELTS

In each of the better developed fold belts, the various major rock types show a similar sequence of extrusion and/or deposition. This similarity was noted by Hallberg (1976) and has been used to erect tentative stratigraphic schemes on some adjoining 1:250 000 sheets (Table 2).

* To avoid confusion with like place names, sheet names are given in full capitals.

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TABLE 1: MINERAL EXPLORATION ON KIRKALOCKA 1:250 000 SHEET

GSWA M No.	Operating company	Location	Principal exploration methods	Target	Rock units
248	Cominco	Mt. Magnet	Bedrock geology & soil geochemistry IP, aero- & ground magnetic	Ni	*Aus, Al*
318	Western Mining Corp.	Thundelarra	Geology	Fe	*Ai*
959	Cosmos Expl.	Narndee	Geology	Ni	*Abl, Aus, Aut*
1071(a)	International Nickel	Muleryon Hill	Drilling, IP geology, ground magnetic	Ni	*Aus, Abg, Aux*
1315	Hill 50	Mt Magnet	Geology, soil geochem, IP, drilling		*Ai, Ab*
1478	Westralian Nickel	Narndee	Drilling, Turair, geology, magnetic	Cu, Zn	*Afv*
1513	Westfield Minerals	Narndee Mulermurra	Sampling	Cu, Zn	*Asp*
1515	Westfield Minerals	Paynesville	Geology, soil, stream, rock geochem	Cu, Zn	*Afv*
1572/3	WMC	Windimurra	Scintillometer	U	*Czk*
1611	Exserv	Little Paris, Mt Magnet	Geology	Au	*Asp, Aut*
1794	Northern Mining	Hesperus Dawn, Three Boys, Mt Magnet	Geology, drilling	Au	*Ai*
1875(a)	Kennecott Exploration	Bigada Well	Geology, geochemistry, drilling	Ni-Cu	*Aut, Abl*
1971	Dampier	Narndee	Geology, geochemistry, percussion drilling	Cu, Zn	*Ai, Af*
2003(a)	Kia Ora	Narndee	Rock chip geochemistry	Cu, Zn, Ni	*Ai, Ab*
2010(a)	Newmont	Paynesville	Aeromag, geology	Cu, Zn	*Afv, Ai*
2282(a)	Carpentaria	Thundelarra	Geology, EM, drilling	Cu, Zn	*Afv, Ai*
2285	Newmont	Narndee	Geology, geochemistry, diamond drilling	Cu	*Afv*
2286	WMC	Windimurra	Geology, IP, geochemistry, percussion drilling	Ni, Cu	*Abg*
2332	Amax	Paynesville	Geology	Cu, Zn	*Afv*

(a) Open file report.
IP = Induced polarization
EM = Electromagnetic induction

TABLE 2: REGIONAL STRATIGRAPHIC CORRELATIONS AND LOCAL THICKNESSES OF SUPRACRUSTAL ROCKS

	KIRKALOCKA *fold belts (this Report)*			*Other stratigraphic schemes, Murchison Region*			
Unit	*Warriedar*	*Magnet*	*Wydgee*	*CUE (de la Hunty, 1973)*	*YALGOO (Muhling & Low, 1977)*	*NINGHAN (Lipple & others, 1980)*	*Murchison Regn. (Hallberg, 1976)*
Upper sedimentary association	2 km	1 km	absent	?absent	Association 3	Upper sedimentary association	Upper sedimentary succession
Upper mafic volcanic association	10 km	absent	absent	Ryansville Formation	Association 4	Upper mafic volcanic association (4 km)	Upper basic succession
Lower sedimentary volcanic association	2 km	absent	2 km	Cuddingwarra Formation	Association 2	Lower sedimentary association (0.5 km)	Lower sedimentary succession
Lower mafic volcanic association	2 km	4 km	3 km	Moyagee Formation	Association 1	Lower mafic volcanic association (2-5 km)	Lower basic succession

This scheme makes a useful framework in which to describe the geology, and is used in these notes. Essentially, four major rock units are recognized, each of which is termed an "association" following the definition proposed by Muhling and Low (1977). These are:

(4) an upper sedimentary association;
(3) an upper mafic volcanic association;
(2) a lower sedimentary association; and
(1) a lower mafic volcanic association.

The distribution of these associations is shown in Figure 1.

Because of the reconnaissance nature of this mapping, the commonly poor exposure of the rocks mapped, and the inherent complexity of Archaean geology, we consider that no more formal statigraphic nomenclature is warranted at present. Further work is needed to decide whether the apparently similar sequences in the various fold belts represent remnants of a formerly extensive series of layered rocks, or demonstrate parallel geological evolution within discrete but tectonically similar troughs. For these reasons, the formal scheme erected on CUE (de la Hunty, 1973) has not been used here.

On KIRKALOCKA, relationships between the four associations are not always clear. The three lower assemblages appear to be more-or-less conformable where in mutual contact, but the upper sedimentary association is clearly unconformable on the older associations.

The lower and upper mafic volcanic associations each consist largely of monotonous sequences of tholeiitic basalt and associated pyroclastic rocks. Some distinction between them can be made from the greater abundance of banded iron-formation in the lower association, and the larger amount of komatiitic basalt in the upper unit. However, it is commonly difficult to assign an isolated outcrop of mafic volcanic rocks to one or other of the associations.

The lower and upper sedimentary associations are predominantly fine-grained metasedimentary rocks. The lower association is mainly lacking in psammitic material whereas the upper one commonly contains sandstone and conglomerate near its base. Felsic volcanic rocks have been identified within the lower sedimentary association in a number of localities. The colinear Magnet and Wydgee Fold Belts form part of a disrupted greenstone tract which can be traced from Meekatharra in the north, through Cue and Mount Magnet, to Paynes Find in the south. Mafic volcanic rocks and banded iron-formation (BIF) of the lower volcanic association within this tract contain a number of important gold-mining centres.

The Warriedar Fold Belt in the southwestern part of KIRKALOCKA is more extensively developed on adjacent YALGOO and PERENJORI. The lower sedimentary association within the belt carries copper-zinc mineralization at Gossan Valley on KIRKALOCKA, and at Golden Grove on YALGOO.

The metamorphism in the supracrustal rocks is generally low grade (below amphibolite facies) with local areas of medium grade adjacent to granitoid batholiths. Metamorphism apparently outlasted deformation, as static overgrowths of dynamic fabrics occur in the Wydgee and Magnet fold belts.

GABBRO COMPLEXES

The Narndee and Windimurra Complexes are deformed gabbroic intrusions (termed respectively the Narndee and Windimurra Intrusions) with metamorphosed sedimentary and felsic volcanic roof pendants. The complexes are intruded by

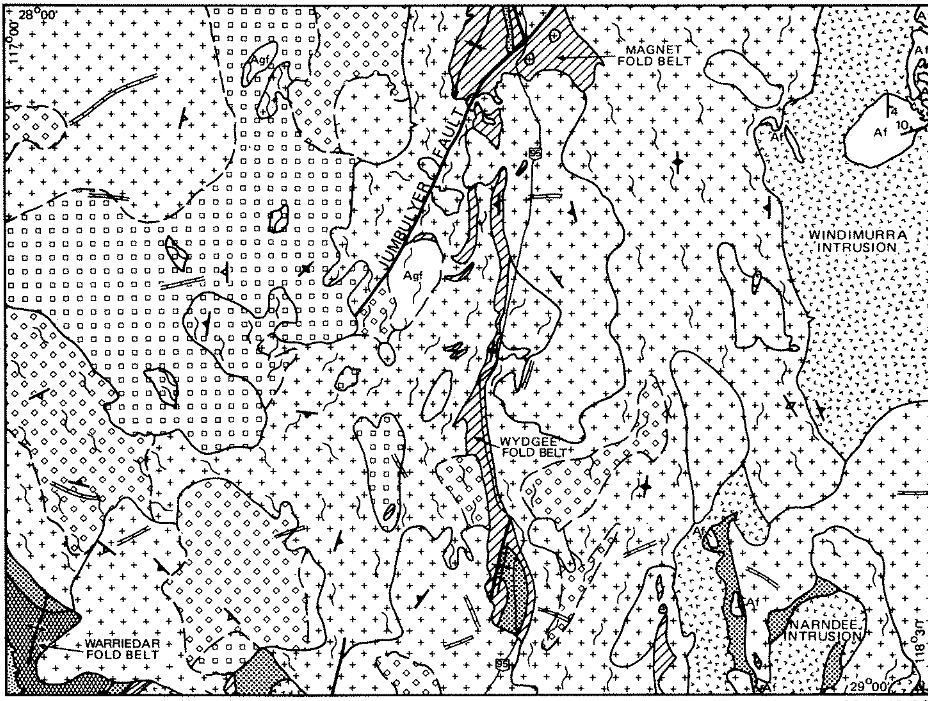

FIGURE 1

INTERPRETED PRECAMBRIAN GEOLOGY

KIRKALOCKA SHEET SH 50–3

0 10 20 30 km

REFERENCE

- Undeformed granitoid
- Deformed granitoid
- Texture:
  - Porphyritic
  - Seriate
  - Even-grained
  - Agf Medium-grained granodioritic
- Gabbro intrusion
- Af Felsic volcanic rocks
- Upper Sedimentary Association
- Upper Mafic Volcanic Association
- Lower Sedimentary Association
- Lower Mafic Volcanic Association

- Mafic dyke
- Fault
- Anticline
- Syncline
- Unconformity
- Intruded contact-barb toward intruded phase
- Strike and dip of bed
- Platy mineral foliation; vertical
- inclined
- Metamorphic foliation; vertical
- inclined

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deformed and undeformed granitoids, pegmatite and porphyry dykes. Whole-rock Rb-Sr radiometric age determinations on rocks intruding the Windimurra complex indicate an Archaean age, probably in excess of 2 600 m.y. (de Laeter, J. R. pers. comm., 1979). The Windimurra Complex is virtually unmetamorphosed whereas the Narndee Complex is metamorphosed to a low grade. In the Narndee Complex, steep dips are recorded in both the gabbro and the roof pendants, but in the Windimurra Complex, dips are generally less than 30 degrees.

GRANITOID ROCKS

Granitoid rocks intrude the fold belts and the gabbroic complexes. They vary from typically igneous through mildly recrystallized and deformed varieties to strongly recrystallized and deformed rocks. Recrystallized and deformed granitoids are common in the vicinity of the gabbroic complexes on the eastern part of the sheet and to the west of the Wydgee Fold Belt (Fig. 1).

Intensely deformed granitoids (Fig. 1), such as those west of Coolaloo Hill, include rocks considered to be the oldest granitoid intrusions in the sheet area. The deformed granitoids intrude both the gabbroic complexes and the fold belts. In places, such as the Magnet Fold Belt, the deformation in the granitoid can be shown to contain fabrics co-planar with the axial surface of the principal fold phase in the adjoining supracrustal rocks.

Undeformed granitoid batholiths (Fig. 1) occur throughout the sheet area. Deformation within the batholiths develops heterogeneously and, locally, may be of similar intensity to that in the deformed granitoids. Arriens (1971) has reported a radiometric (Rb-Sr) age of 2 608 ± 66 m.y. (corrected to $\lambda = 1.42 \times 10^{-11}y^{-1}$) from granitoid rocks which probably were obtained from the undeformed suite between Paynes Find and Cue.

ARCHAEAN ROCKS

SUPRACRUSTAL ROCKS

A brief description of individual rock types occurring within the greenstone belts is given in the map reference. The following notes are intended as a short synthesis of the geology of each of the main fold belts.

Magnet Fold Belt

The Magnet Fold Belt is a major north-trending sequence of basaltic and felsic volcanics; arenaceous and pelitic sediments; banded iron-formation and chert; ultramafic rocks; and minor gabbro and dolerite intrusions. It is centred on Mount Magnet township near which it is estimated to be 4 km thick and is exposed for a maximum of 25 km from west to east.

The belt is dominated by tholeiitic basalts. Numerous banded iron-formations have importance as marker beds and as host rocks to gold mineralization. The banded iron-formations form low ridges which contrast with the scant relief and poor exposure of other units. Colluvium, laterite and deep weathering mask much of the belt. Kaolinization and silicification commonly extend to at least 100 m below the surface.

Metamorphism, metasomatism and widespread deformation further obscure original textures. Many rocks have been completely altered to schists.

Metamorphism: The metamorphic grade is predominantly low, being in the mid-greenschist to greenschist-amphibolite transition facies.

In tholeiitic rocks, typical assemblages developed include actinolite-chlorite (±clinozoisite ± albite)-oligoclase. In the Boogardie area, Forman (1960) reported low-grade (greenschist facies) metamorphism associated with gold-sulphide mineralization.

Ultramafic rocks contain tremolite-chlorite ± clinozoisite ± talc. Pelitic rocks are now represented by quartz-sericite±chlorite±carbonate schists. Near the St. George gold mine, pelitic and felsic schists locally contain andalusite and chloritoid porphyroblasts, indicating a slightly higher grade, probably low amphibolite facies. Quartz-sericite-carbonate schist 2 km north of Mount Magnet exhibits euhedral pyrite porphyroblasts fringed by well-crystallized chlorite, both of which are superimposed on the schistosity indicating that metamorphism outlasted deformation here.

Elsewhere, adjacent to syntectonic granitoid, a discontinous zone up to 2 km wide of low-amphibolite-facies rocks is found. This is typified by the widespread development of granoblastic or foliated tremolite, some of which may pseudomorph coarse primary minerals.

Layering: Two associations are provisionally recognized (Table 2). The lower mafic volcanic association makes up most of the fold belt. Around Mount Magnet, it consists of lowermost tholeiitic basalt flows (*Abl*) with subordinate pyroclastic rocks (*Abc*) and banded iron-formations (*Aih*), overlain by a thick tholeiite sequence with ultramafic flows (*Auv*) at the top (e.g. north and east of Mount Magnet). Basalt is mainly fine grained, and may be massive, pillowed, or amygdaloidal. Relict plagioclase or pseudomorphed pyroxene phenocrysts may be present. Trachyte was reported from the Hill 50 mine by Forman (1960). Poorly preserved apparent quench textures were noted in basalt northeast of Warramboo. Fine- to medium-grained basalt flows with basal pyroxenite layers (*Aux*) were seen north of Mirrabarloo Hill, and 7 km southwest of Boogardie. Fine-grained amygdaloidal ultramafic flows form low, rubbly exposures east of Mount Magnet. They typically contain chlorite pseudomorphs after pyroxene phenocrysts. Near Hy Brazil homestead, these rocks have been altered to talc-chlorite schists. Tremolite schists with relict lenses of amygdaloidal texture also occur 5 km east of Wellara Bore. As suggested by Berliat (1958, p. 24), ultramafic rocks may underlie extensive alluvium south of Boogardie.

Several coarse-grained gabbro sills intrude the volcanic rocks. Some are differentiated and contain basal pyroxenite (e.g. east of Wellara Bore).

Basaltic tuffs are massive to moderately layered, with fine to lapilli-sized lithic, relict crystal (hornblende and plagioclase) and altered vitric fragments. Coarse agglomerate north of Warramboo Hill consists of angular to subrounded, basaltic and rare chert clasts and is finer grained towards the east. Weathered felsic clastic rocks southwest of Eclipse Hill probably represent lapilli tuffs and volcanogenic wacke. Forman (1960) noted conglomeratic and cross-bedded arenites near here. Well-laminated (?graded) felsic siltstones are poorly exposed west of Warramboo Hill.

Banded iron-formations are commonest in clastic and pyroclastic rocks. Near Eclipse Hill, up to forty distinct units crop out. At the surface, banded iron-formation is typically well bedded with white, brown, red and black bands of quartz and hematite after magnetite. At depth, some rocks contain up to 35 per cent calcite in bedded or nodular form (Forman, 1960). Some banded iron-formation such as that exposed at Warramboo, passes along strike into pale-coloured chert. Thickness changes are probably mostly a result of deformation.

The upper sedimentary association is confined to a narrow fault slice extending northwards from the St. George gold mine. The rocks include massive and well-laminated felsic and pelitic sediments, possibly partly of volcanogenic origin, with minor chert and pebbly chert-clast conglomerate. Brecciation and slump-folding of banded iron-formation into pebbly feldspathic sandstone is visible at Water Tank Hill. Pelitic siltstone and shale 1 km west of Mount Magnet is overlain by a thin bed of framework boulder conglomerate, with an irregular scoured (east-facing) contact. The conglomerate contains angular to subrounded clasts of shale, vein quartz, chert, banded iron-formation, basalt, and even-grained, foliated granite. Followed eastwards, the conglomerate grades rapidly into feldspathic grit and siltstone.

Structure: The structure of the Magnet Fold Belt is complex (Fig. 1) and resolution is hampered by poor and sparse exposures and the lack of facing evidence. Dips in the supracrustal rocks are steep, and may be overturned. Two main fold generations are postulated. Early major isoclinal folds (F_1), with well-developed axial-planar foliation but few parasitic folds, occur in some places. F_1 folds are refolded by widespread open to appressed, upright, similar-style folds (F_2) with a strongly developed, steeply dipping, axial-plane crenulation cleavage and a mineral lineation along the cleavage-bedding intersection. Interference structures with F_1 parasitic folds have developed locally. Later, minor kink folding (F_3) is probably related to faulting.

Closures of F_1 isoclinal folds are identified south of Mirrabarloo Hill and near Hillcrest mine from (i) the vergence of isoclinal and very tight similar-style parasitic folds delineated by banded iron-formation, and (ii) consistency with facing evidence.

The best example of F_2 folding is the Boogardie Synform (Syncline of earlier workers, e.g. Berliat, 1958), which trends southwest from 3 km east of Lennonville (de la Hunty, 1973). Vergence of the limbs tightens from 90° in the northeast to 20° in the southwest. Plunge varies between 90° and 50° to the southwest.

Several southeast-striking doubly plunging folds near Jimbulije Hill, although tightly appressed (5° vergence), are assigned to F_2 because parasitic folds here are less appressed than the main fold and resemble F_2 parasitic folds seen elsewhere. A similar situation exists for a tight synform trending northwest via Mirrabarloo Hill. The abnormal degree of appression is ascribed to widespread granitoid intrusion.

Extensive faulting (D_3) is an important feature of the Magnet Fold Belt. Details of many fault traces are depicted by earlier workers, including Berliat (1958), Forman (1960), Lewis (1965), and various companies (Table 1). Northeast-trending vertical faults ("Boogardie breaks") with mostly strikeslip, dextral movement (e.g. Hill 50 Fault, Jimbulyer Fault of Berliat, 1958) are dominant; but there are also subsidiary north-trending (e.g. Main Fault of Finucane, 1953) sinistral faults. Minor folding related to major faults is reported by Forman (1960). Well-developed spaced cleavage in the Warramboo - St. George mine area, strongly crenulated an F_2 schistosity/cleavage. Several east-trending vertical faults with sinistral movement occur in the Boogardie area; some are occupied by dolerite and leucogabbro dykes.

TABLE 3. SPECTROGRAPHIC EMISSION ANALYSES OF IRONSTONES FROM WYDGEE FOLD BELT

Sample No.	54851	54852	54853	54854A	54854B	54855
Latitude	28°32′15″	28°58′51″	28°57′50″	28°53′27″	28°53′27″	29°00′05″
Longitude	117°45′20″	118°04′02″	118°03′58″	118°03′46″	118°03′46″	118°04′21″
Ag	<5	<5	<5	<5	<5	<5
As	<10	<10	10	<10	<10	20
Ba	220	480	100	100	440	20
Ce	<10	10	<10	<10	<10	20
Co	5	750	90	25	15	70
Cr	180	21 000	4 800	360	360	3 600
Cu	45	40	15	180	120	35
Ga	12	4	<4	12	4	<4
La	<10	<10	<10	<10	<10	10
Mn	90	12 000	200	170	1 200	490
Mo	2.0	0.5	0.5	0.5	1.5	2.5
Nb	5	<5	<5	<5	<5	<5
Ni	20	4 000	1 400	35	430	1 400
Pb	10	5	5	5	10	<5
Rb	15	<5	<5	5	<5	<5
Sb	<10	<10	<10	<10	<10	<10
Sc	35	90	6	45	<2	16
Sn	<4	<4	<4	<4	<4	<4
Sr	50	30	<10	<10	10	<10
Th	10	<10	<10	<10	<10	<10
V	500	260	90	320	<10	60
Y	<10	10	<10	<10	20	<10
Zn	14	245	20	50	310	56
Zr	120	40	30	100	20	30

Analyst—Government Chemical Laboratories. Results in parts per million

Wydgee Fold Belt

The Wydgee Fold Belt is a conformable sequence of metamorphosed mafic and felsic volcanic rocks and associated sediments up to 10 km thick, which is intruded by a gabbroic complex. The belt extends 75 km north between Coolaloo and Wydgee homestead. It is similar to the Paynes Find Belt (Lipple and others, 1980) in the south and the Magnet Fold Belt in the north. The fold belt is intruded by granitoid batholiths on both sides. Mineral exploration has been cursory and, with the exception of a small gold mine northwest of Kirkalocka homestead, no economic mineral occurrences have been recorded. Analyses of several ironstones are given in Table 3.

Metamorphism: Metamorphic grade varies from low amphibolite facies in zones with dynamic fabrics to upper greenschist facies where static fabrics occur. In the static domains primary textures are commonly preserved. In the dynamic domains porphyroblasts of acicular pale amphibole cut the early near-layer-parallel fabrics.

Epidote-actinolite assemblages are common in basaltic rocks. Associated diopside-plagioclase-quartz rocks occur near Kirkalocka homestead. Ultramafic rocks contain a tremolite-talc-chlorite assemblage. Banded iron-formations show only weak recrystallization of quartz-magnetite laminae, and contain blue-green hornblende porphyroblasts with epidote and garnet in pelitic laminae. Felsic volcanics contain original quartz, plagioclase, microcline and hornblende, variously with metamorphic epidote, clinozoisite, blue-green hornblende, actinolite, biotite, muscovite, diopside and garnet. Thin quartz-muscovite schists occur in the sequence.

Layering: Both the lower volcanic and lower sedimentary associations (Table 2) are recognized. The first occurs throughout the belt, but the second is restricted to the southern, better developed sequence.

The lower volcanic association consists of moderately to poorly exposed tholeiitic basalt flows *(Abl, Abx)* and mafic agglomerate, lithic and crystal tuffs *(Abc)* with thin banded iron-formations. Basaltic komatiite is a minor component. Felsic tuffs are interlayered with basalt near the top of the association. The best exposure is 3 km west of Kia Well.

The lower sedimentary association is typified by dacitic volcanics, predominantly agglomerate and laminated-to-massive lithic and crystal tuffs. Crystal tuffs are exposed 1 km east of Canning Hill. Porphyritic flows (plagioclase ± hornblende phenocrysts) are best exposed 1.5 km east of Wydgee homestead. Some weathered flow-banded rhyolites were noted 2 km northwest of Four Mile Well. The volcanic rocks appear to be weakly pyritic in several localities. In two main horizons, tuffs grade up into immature volcanogenic wacke, siltstone and banded iron-formation. These exhibit graded and truncated bedding, slump folding and brecciation.

Gabbro and dolerite sills, similar to the Narndee Complex intrude the felsic volcanic succession. At least 11 sills have been recognized in the southern part of the belt. Toward the top of the succession here gabbro makes up most of the exposure. The gabbros are medium to coarse grained, commonly with a thin basal pyroxenite layer containing amphibole pseudomorphs after clinopyroxene phenocrysts. The uppermost sill contains large tremolite blades, pseudomorphing a feathery clinopyroxene quench texture, which are set in fine-grained tremolite and plagioclase. Interlayered felsic tuff and BIF remnants occur between the upper units, and are in part hornfelsed by the gabbro with the resultant growth of andalusite porphyroblasts.

Structure: The fold belt has been flattened parallel to its length, and uneven development of foliation has resulted. A large syncline, plunging steeply south, and a truncated complimentary anticline in the vicinity of Canning Hill, are the major structures in the belt. Further north, only one limb is preserved. At Coolaloo Hill refolded isoclinal folds and related foliation indicate a complex deformational history. Extension perpendicular to the foliation is indicated by emplacement of post-foliation quartz veins and porphyry dykes sub-parallel to the foliation. Strike-slip faulting parallel to the veins has displaced the sequence by up to 8 km in the area west of Canning Hill.

Dips are moderate to steep, and locally may be quite variable. Facing evidence for the syncline includes graded and truncated bedding, and igneous differentiation in gabbros and dolerites. Minor parasitic folds in metasedimentary rocks have a vergence consistent with the major folds. A crenulation cleavage, with a mineral lineation along bedding-plane intersections, is well developed parallel to the axial planes of the main folds. A weak to strong earlier foliation, which deforms primary textures, strikes parallel to layering but is more steeply dipping.

Warriedar Fold Belt

The Warriedar Fold Belt occupies the adjacent corners of the PERENJORI (Baxter and Lipple, 1979), YALGOO (Muhling and Low, 1977), NINGHAN (Lipple and others, 1980) and KIRKALOCKA sheets. The thickness of supracrustal rocks on KIRKALOCKA is in excess of 9.5 km.

Metamorphism: The widespread development of actinolite, epidote and sodic plagioclase in the mafic rocks, and the absence of cordierite and garnet in the pelitic rocks, indicate regional metamorphism of below amphibolite facies. Andalusite has developed in some pelitic rocks and hornblende in some mafic rocks, but this is taken to reflect local effects due to granitoid intrusions.

Layering: Four associations have been recognized in the fold belt (Lipple and others, 1980). However, only the upper three occur on KIRKALOCKA.

The lower sedimentary association is represented by a poorly exposed and generally deeply weathered sequence of fine-grained felsic volcanogenic sediments (*Afs*). Lenses of tuffaceous rocks and agglomerates occur southwest of Wilton Well.

The upper mafic volcanic association consists of a cogenetic basalt *(Abl, Abx)*, dolerite *(Abd)*, and gabbro *(Abg)* pile, which conformably overlies the felsic volcanogenic sequence. Thin banded iron-formations (*Aia, Aih*) separate basalt flows. Thin basal pyroxenite layers (now tremolite-actinolite rock) in the thicker flows *(Abx)* are common.

The upper sedimentary association is composed of a thin basal quartz wacke, fine-grained pelitic metasediment *(Asp)*, banded iron-formation *(Aih)* and chert *(Aic)*, overlain by a thick sequence of fine-grained felsic metasediments *(Afs)*. It unconformably overlies the older units. Large andalusite porphyroblasts are common and tourmaline locally indicates boron metasomatism. The base of the association is well exposed south of Chulaar Well.

Structure: The lower sedimentary association has a layer-parallel cleavage containing platy mica. No folds related to this cleavage have been seen.

The upper mafic volcanic association crops out in a large-scale, symmetrical, open cylindroidal anticline. Primary fabrics have generally been totally recrystallized.

The upper sedimentary association is undeformed at the unconformity. However, to the west, open angular, similar-style folds with a moderately developed axial-plane cleavage occur. Andalusite porphyroblasts pre-date cleavage formation.

Minor faults cut the folded sequence. They are more common on the fold limbs and tend to cut the layering at a large angle.

WINDIMURRA COMPLEX

The Windimurra Complex extends over 1 100 km^2 on the boundary between the KIRKALOCKA, CUE, SANDSTONE and YOUANMI 1:250 000 sheets. The complex consists of the mainly gabbroic Windimurra Intrusion and roof pendants made up of the Kantie Murdanna Volcanics. The western boundary of the complex has been intruded by syntectonic and post-tectonic granitoids. The available Rb-Sr geochronology on rocks intruding the Windimurra Intrusion indicates that it is older than 2 600 m.y. (J. R. de Laeter pers. comm., 1979). De la Hunty (1975) correlates the Narndee and Windimurra Intrusions.

Windimurra Intrusion

The exposed part of the Windimurra Intrusion on KIRKALOCKA is a weakly layered gabbro. To the east, the intrusion contains a lopolith of rhythmically layered gabbro, anorthosite, pyroxenite, peridotite and magnetite cumulates (Ahmat, 1971; Hallberg, 1976).

The metamorphic grade is very low: clinopyroxene and bytownite are unaltered and orthopyroxene has been only slightly altered to chlorite and serpentine.

Kantie Murdanna Volcanics

Between Carron Hill and Mount Ford a suite of weakly deformed and metamorphosed felsic volcanic rocks is preserved as roof pendants in the Windimurra Intrusion. Agglomerate, ash-fall tuff, ash-flow tuff, rhyolitic lava, and lapilli tuff interlayered with jaspilitic banded iron-formation make up a thickness of about 200 m. Kantie Murdanna Hill contains coarse-grained agglomerate and appears to be a volcanic centre.

Pumpellyite-quartz-chlorite assemblages in the felsic volcanic rocks indicate a very low grade of regional metamorphism. In general, primary fabrics are preserved, despite widespread silicification. The Windimurra Intrusion has produced up to one metre of hornblende-hornfels contact metamorphism in the felsic volcanics. Carville (1978) reports minor magnesium and iron metasomatism of the suite and anomalous lead in some of the volcanics.

The Kantie Murdanna volcanics are gently folded, resulting in the uneven development of a subvertical, spaced cleavage. Flattening perpendicular to the cleavage is the main deformation, and this has produced a gentle buckling of the layering. Pre-tectonic flow and slump folds occur in some units.

NARNDEE COMPLEX

This area is the northern continuation of the belt of the same name exposed on the adjoining NINGHAN 1:250 000 sheet (Lipple and others, 1980), and the geology is similar. Northerly striking and vertical or steeply west-dipping sedimentary rocks and minor felsic volcanics are intruded by north-striking gabbro of the Narndee Intrusion. These rocks are in turn intruded by fine to medium, even-grained biotite adamellite (*Age*) which contains a conspicuous north-northeast-striking foliation in the west (*Agef*). Outcrops of the gabbro and sediments are subdued and rubbly.

Sedimentary rocks (*Asa*) east of Narndee homestead consist of thinly bedded, fine- to medium-grained quartz sandstone and purple, micaceous silty sandstone with very thin, recrystallized, laminated chert bands. Cross-stratification in similar rocks at Deep Bore (north of the homestead), indicates a west facing. Nearby at Mulermurra Hill, massive grey-green dacitic agglomerate (*Afi*) forms a thick lens within the sedimentary rock tract. Rounded tephra, mostly 1 to 5 cm in diameter, of fine-grained felsic lava are set in a medium-grained feldspar-muscovite-quartz matrix.

The Narndee Intrusion is monotonous in outcrop, consisting of massive, medium- to coarse-grained, undeformed gabbro (*Abg*). Ultramafic differentiates (peridotite, pyroxenite) are present as thin units, but they crop out poorly or are deeply weathered and lateritized (e.g. north of Four Corners Bore).

A small remnant of deformed mafic to ultramafic volcanic rocks (*Abam, Aus*) occurs south of Kiabye Bore.

GRANITOID ROCKS

Granitoid rocks in irregularly shaped areas (Fig. 1) occupy just over 80 per cent of the sheet area. They are subdivided primarily on textural characteristics into equigranular (*Age*), seriate (*Agv*) and porphyritic (*Agp*) varieties. Some areas are complex mixtures of texture and composition, and were mapped as a composite unit (*Agm*). The original allotriomorphic igneous texture is commonly well preserved, but may be strongly recrystallized granoblastically, and is locally strongly deformed.

Microcline laths, some probably of porphyroblastic origin, commonly contain inclusions and may be orientated obliquely to mineralogical layering. Schlieren and mineral alignment, xenoliths of diverse composition, and minor dyke phases of pegmatite, aplite and leucocratic granitoid are common features. Undeformed granitoids in particular, show gradational relationships between textural types. Examples are seen north of Yarlot Well and south of Darn Hill, where equigranular granitoid (*Age*) grades into a seriate variety (*Agv*). Distinct intrusive relationships have also been noted, such as seriate granitoid (*Age*) at Doggar Hills.

The granitoid rocks have been further grouped into strongly foliated, usually banded, deformed varieties; and poorly foliated or massive types. Strongly foliated granitoids may be gneissic or even mylonitic. The proportion of deformed types slightly exceeds massive varieties (Fig. 1). Supracrustal remnants are more common in the deformed varieties. In a few localities, particularly on the east side of the sheet area, there appears to be a transition between massive and well-foliated types.

Greatest deformation and recrystallization have occurred west of the Windimurra and Narndee Complexes and west of the Magnet and Wydgee Fold Belts. The complex history recorded in some granitoids is illustrated by exposures 4 km northeast of South Cockara Well. Foliated amphibolite xenoliths are enclosed in mesocratic, fine-grained and fine- to medium-grained biotite grandodiorite, which contains thin leucocratic veins, subsequently disrupted by streaky medium- to coarse-grained megacrystic biotite adamellite and associated fine-grained leucocratic granitoid dykes and pegmatites. Intense deformation has imparted a prominent foliation; quartz veinlets have been folded into rootless isoclines, and leucocratic veins are ptygmatically folded. Flow banding in megacrystic adamellite is transposed into the foliation. A pervasive secondary foliation, picked out by biotite, quartz and perhaps feldspar, trends approximately north. It has crenulated the earlier foliation and, locally, has completely transposed pre-existing fabrics. Small sharp zones of granoblastic recrystallization obliterate foliation and banding.

Along the western margin of the Magnet Fold Belt, the early foliation in granitoid is parallel to foliation/cleavage considered to be related to D_2 folding in meta-volcanic rocks. Both are crenulated by much weaker north-trending D_3 cleavage. Hence the main period of deformation and recrystallization is considered to be equivalent to the major phase of folding (D_2) and metamorphism of the fold belts.

Contact migmatite, adjacent to fold belts, forms a very small proportion of rocks in the sheet area. It comprises supracrustal remnants enclosed in well-foliated granitoids.

MINOR INTRUSIONS

Mafic dykes, mainly dolerite, whose probable ages range from late Archaean to Proterozoic, intrude all the Archaean rocks exposed on the sheet area. Some are metamorphosed. The dykes mostly occupy fracture sets trending northeast, east-northeast and east-southeast, and a few trending east. At least some dykes cut quartz veins. A few leucogabbro (*di*) dykes were mapped.

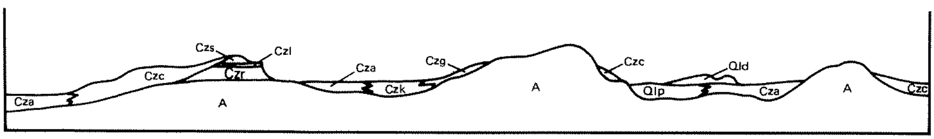
Pegmatite and aplite veins are common in granitoid rocks. Most are small and some have been notably affected by strong deformation evident in their granitoid host. Accessory beryl occurs in a pegmatite northwest of Wydgee Homestead.

Quartz veins (*q*) intrude both granitoid and supracrustal rocks. These veins trend mainly northeast, east-southeast, and east; northwesterly trends were rarely observed. Veins occupy dilational fractures, faults, or shear zones. A notable example, marking the Jimbulyer Fault trace, extends about 60 km northeast through Mount Magnet.

Quartz-feldspar porphyries (*p, Afo*) form dykes and, less commonly, sills in supracrustal sequences, particularly in the Magnet Fold Belt. Near Boogardie, porphyry dykes occupy north-northeast-trending faults, and appear to exert a control on location of subsequent gold mineralization. Porphyry dykes are common on the boundaries of post-tectonic granitoids (e.g. east of Narndee Homestead and at Mount Magnet).

CAINOZOIC

Deposits assigned to the Cainozoic era are extensive. They owe their origin to a complex of mass wasting, fluvial and eolian processes, and soil formation. Three broad categories have been established on the basis of geomorphic and lithologic characteristics. These are residual deposits (*Czr*), alluvial and colluvial deposits (*Czc*), and lacustrine deposits (*Ql*). Eolian reworking of all associations is widespread, and where well developed (e.g. west and northeast of Sugar Brother Well) dune traces are shown on the map. Figure 2 shows the distribution of units relative to topography. Underlying Archaean rocks are commonly exposed at the boundary between residual and colluvial units.



Not to scale

FIGURE 2

DIAGRAMMATIC CROSS-SECTION SHOWING RELATIONSHIP BETWEEN CAINOZOIC UNITS

KIRKALOCKA SHEET SH 50–3

REFERENCE

Ql [Qld | Qlp]

Ql Lacustrine deposits
Qld Dunes
Qlp Playas

Czc [Cza | Czk | Czg]

Czc Alluvial and colluvial deposits
Cza Alluvium
Czk Calcrete
Czg Lateritic gravel

Czr [Czl | Czs]

Czr Residual deposits
Czl Laterite
Czs Sandplain

A Archaean basement

GSWA 18631

The residual deposits include laterite (*Czl*), sandplain (*Czs*), silcrete (*Czi*) and minor lithified arkosic grit. All occur above the level of the "breakaway" (laterite escarpment) and form a degraded plateau. In many places, laterite and silcrete are absent. Up to one metre of arkosic grit may be present above the breakaway, forming a subsidiary scarp behind the main escarpment. In some places it is difficult to separate alluvial-colluvial sands (*Czc*) from sandplain (*Czs*). In these cases it has been the practice to refer units above the breakaway to sandplain (*Czs*) and all others to colluvium and alluvium (*Czc*). There does not appear to be a consistent relationship between the residual deposits and features such as deep weathering, laterite development, or underlying rock type. Monadnocks of supracrustal rocks (e.g. Mount Warramboo) project above residual deposits.

Alluvial and colluvial deposits are common in gently sloping valleys of active or infilled drainage channels. There are several distinct generations of alluvial deposits which in places show erosive relationships (e.g. Corryalga-Gullamilyarra Wells, Sugar Brother-Coondon Wells, Warramboo Hill). The sediments may have moved by soil creep, sheet flooding or confined channel flow. At least two generations of lateritic alluvial-colluvial crust have formed. The first is a ferruginous, cemented, partly nodular gravel (*Czg*) which commonly occurs in the upper reaches of the broad valleys. The second, known generally as "Murchison hardpan", is a ferruginous, cemented, quartz sandstone (*Czc*) containing local conglomerate lenses and limonitic gravel, which infills the major trunk drainages. Calcrete (*Czk*) is common in the lower reaches of the trunk drainages. Intermittently active streams dissect these older deposits. The composition of the sediment is unrelated to the underlying rocks. Clasts of durable rock such as banded iron-formation have been noted within conglomeratic hardpan (e.g. west of Wydgee homestead) over 15 km from the nearest source.

Lacustrine deposits (*Ql*) are associated with a saline drainage system (van de Graaff and others, 1977). The Lake Monger drainage is actively eroding older alluvial and colluvial deposits, but the Lake Boodanoo drainage appears to be more mature. Playas (*Ql*) tend to be infilled by alluvial and eolian deposits in Lake Boodanoo. Dunes (*Qld*) are developed at the shores of some playas.

No maximum age has been determined for these deposits. It is possible that the colluvial deposits of infilled drainage channels are older than the Tertiary, whereas some of the deposits are modern.

ECONOMIC GEOLOGY

METALS

Auriferous deposits within the Magnet Fold Belt have been worked since 1896, with a total production of 63 139.856 kg of gold. Although only minor production has been recorded since the major mine, Hill 50, closed in 1974, exploration for gold is continuing in the area. Despite widespread exploration for nickel and base metals, no important deposits of the commodities have yet been discovered. (Table 1). Mineral occurrences of mainly specimen interest were noted by Simpson (1948, 1951, 1952).

Gold (Au)

Investigations of gold-mining centres include published reports by Gibson (1903), Jutson (1914a, b), Maitland (1919), Feldtmann (1920, 1924), Esson (1925a, b, 1926) Forman (1933), Miles (1948), Johnson (1950), Finucane (1953), Edwards (1955), Berliat (1958), de la Hunty (1958a, b), Forman (1958, 1960 a, b) and Lewis (1965), and numerous unpublished articles (Table 1).

TABLE 4: GOLD PRODUCTION FROM THE KIRKALOCKA SHEET

Name	*Production Period*	*Alluvial (kg)*	*Dollied (kg)*	*Ore Treated (t)*	*Gold (kg)*	*Silver (kg)*
BOOGARDIE						
Hill 50	1902-1974		40.379	3 243 850.96	42 435.578	2 144.184
Jupiter	1897-1940	0.511	0.047	3 452.57	69.638	
Havelock Pty Ltd	1897-1899		1.267	43.67	2.079	
Saturn	1897-1949		4.926	47 076.90	284.429	
Havelock	1897-1946		4.921	9 875.28	115.162	
Aquaintance	1935-1936			64.52	0.797	
Result	1903-1904			253.00	5.025	
May Queen	1913-1915		0.208	113.54	1.492	
Blue Bell	1904			43.02	0.031	
Mars	1898-1942			14 058.98	98.846	
Neptune	1897-1934		29.066	3 344.14	134.767	
Perseverance	1904-1953		1.097	1 006.91	5.189	
Hesperian	1897-1915		3.354	4 396.88	116.199	
Eclipse	1897-1968		2.713	39 563.86	1 445.506	
Hesperus	1900-1912		0.058	122.93	1.885	
Federal	1897-1977		0.499	627.02	3.215	
Tucker Bag	1906-1908		0.069	197.62	5.547	
Boomer	1901-1941			5 073.90	15.810	
Three Boys	1906-1963		7.968	876.63	28.873	0.035
Hesperus Dawn	1899-1955		7.526	4 046.49	219.884	
Revenue	1898-1928		0.244	396.51	62.138	
Sunshine	1912		0.666	31.24	0.931	
Brown Hill	1905-1956			9 574.51	70.669	
George M.	1908-1957		42.255	283.22	54.210	
Golden Point	1897		0.129	20.32	0.662	
Lady Jean	1914-1938		8.647	155.46	17.804	
OK	1895-1903		1.097	113.09	4.604	
Lucky Wit	1932-1938			1 964.75	15.640	
Raymond 'C'	1911-1940		2.852	207.78	12.645	
Golden Stream	1897-1902			785.40	11.740	
Boogardie	1898			16.26	0.128	
Fine Cut	1935-1939			167.39	6.348	
Windmill View	1912			26.20	1.882	
Mayflower	1917-1918			209.85	8.358	
Hidden Treasure	1902-1944		2.119	428.77	16.415	
Wellington	1897-1929		2.062	18.29	0.816	

TABLE 4: GOLD PRODUCTION FROM THE KIRKALOCKA SHEET—*continued*

Name	*Production Period*	*Alluvial (kg)*	*Dollied (kg)*	*Ore Treated (t)*	*Gold (kg)*	*Silver (kg)*
BOOGARDIE						
Mercury	1912-1923		1.140	177.05	5.163	
Return	1898-1914		3.743	891.58	43.338	
Christmas Gift	1913-1939		35.178	537.44	125.363	
Ready Money	1914-1942		44.768	1 011.99	42.581	
Poverty King	1906-1948		5.220	1 350.38	29.416	
Hard Cash	1907-1915		5.604	122.68	5.515	
Three Star	1911-1916		1.711	265.44	18.218	
Star of the West	1897-1901		0.984	851.45	8.159	
Venus	1897-1903			323.10	44.692	
Comet	1898-1904		0.211	200.67	6.203	
Windbag	1897-1977			4 026.03	56.047	
General Roberts	1900-1901			75.18	1.455	
Top Not	1901-1944			383.05	8.581	
Federation	1898-1899		2.106	12.70	1.150	
Bonnie Jean	1935			90.43	0.190	
Exchange	1897-1959		0.076	252.49	8.650	
BRIARS	1901-1910			41.91	1.157	
JIMBULYER	1938-1964		5.293	1 677.96	20.616	
MORNING STAR						
Morning Star	1897-1961	0.044	0.864	170 113.49	2 725.032	0.048
Edward Carson	1898-1974	0.057		18 785.48	406.967	0.249
Coronet	1908-1910			905.19	7.971	
Dead Mans Hill	1940-1941			167.50	0.556	
Evening Star	1897-1974		4.279	19 483.23	410.671	
Broker Bond	1899-1974		15.519	9 657.94	166.637	
Cascade	1926-1953			232.50	2.722	
Nathan	1934-1941			3 289.72	17.562	
Monarch	1897-1973		1.957	1 137.62	42.893	
ST GEORGE						
St George	1904-1977		0.064	105 013.33	985.320	
New Chum	1906-1912			1 487.58	5.808	
Golden Age	1899-1936		1.400	340.41	20.426	
Don	1962-1971		0.320	333.51	2.020	0.047

TABLE 4: GOLD PRODUCTION FROM THE KIRKALOCKA SHEET—*continued*

Name	Production Period	Alluvial (kg)	Dollied (kg)	Ore Treated (t)	Gold (kg)	Silver (kg)
HILL 60	1897-1942			35 556.47	1 832.343	
PARIS	1899-1909			1 040.24	12.700	
CORONA	1897-1946		0.535	5 545.43	143.964	
TAME CAT	1897-1922			297.96	11.480	
WHITE ROSE No. 1	1898			51.82	0.164	
MABEL DOROTHY	1897-1943		0.348	4 497.00	80.346	
BLACK DIAMOND	1897-1898			213.37	1.957	
GAY PARISIENNE	1898-1904			1 533.05	13.689	
GOOD HOPE	1901-1946			1 077.18	7.629	
LEAP YEAR	1916-1947		0.203	2 317.10	55.846	
HILLCREST	1913-1938			4 938.26	29.523	
BRITTANIA	1901-1910	0.355		481.60	7.995	
KOPAI	1901-1903			82.30	1.043	
SOUTH LEASE	1935-1936			38.86	1.536	
MAYFLOWER						
Mayflower	1897-1958		3.881	2 182.41	91.318	
New Year	1912-1942		0.055	1 751.67	81.365	
Early Bird	1911-1918		3.622	1 250.65	55.327	
Easter Gift	1891-1914			658.80	18.033	
PAYNESVILLE						
South Australian	1899-1902		8.661	112.78	2.362	
Lady Margaret	1899-1900		0.684	4.06	0.180	
Elsie	1922-1928		44.616	59.18	14.916	
Lewis Find	1923-1924		0.808	19.58	1.334	
KIRKALOCKA						
April Fool	1936-1937			62.23	1.403	
SUNDRIES						
Poorly located	1898-1948	.094	.094	394.22	9.033	
Unlocated	1900-1915		3.080	181.61	3.127	
Unnamed	1898-1977	72.446	105.457	66 772.19	2 697.993	2.799

Mount Magnet: Table 4 lists gold production from the main centres, and indicates that production is almost entirely from the area west of Mount Magnet.

In this area (Boogardie) gold occurs as very fine-grained free gold, generally included in quartz, but commonly associated with pyrrhotite, and subordinate pyrite, and possibly chalcopyrite or galena, although the sulphides themselves may be devoid of gold. Sulphide-gold mineralization accompanies massive quartz-carbonate replacements of banded iron-formation, or occurs as veins within these units. Sulphides may form over 50 per cent of massive ore bodies. Forman (1960) states that original magnetite layering was replaced by pyrrhotite and subordinate pyrite, with varying recrystallization of quartz and carbonate layers. Gold rarely occurs in metavolcanic or other metasedimentary rocks.

The gold is located within banded iron-formations adjoining faults of the "Boogardie Break" system, particularly where intruded by porphyry dykes, which appear to have acted as aquicludes to mineralizing fluids moving along the faults. The greater competence of banded iron-formation relative to schistose metavolcanics has resulted in better defined fractures in the former (Lewis, 1965). Porphyry dykes and sills contain minor local mineralization, interpreted as indicating that they preceded mineralization (Forman, 1960). Ore occurrence increases with host-rock thickness (cf. Hill 50 BIF of Lewis, 1965), and is greatest in crests of minor folds related to the Boogardie Synform and equivalent folds. In the Hill 50 mine, north-trending faults (e.g. Main Fault), which shear-out the limbs of minor folds are also a controlling feature according to Lewis (1965).

The gold is probably derived from volcanic rocks, and then concentrated in favourable stratigraphic and structural locations during regional metamorphism and carbonate-sulphide metasomatism. Sections of quartz-sericite schist from the Morning Star mine, contain small lenses of quartz-pyrite and later quartz-carbonate-pyrite veins, which preceded formation of a pervasive schistosity and a subsequent crenulation cleavage, probably related to the second (F2) fold generation.

Secondary enrichment of gold during weathering which occurred up to 100 m below the surface permitted many otherwise uneconomic gold deposits to be mined.

Paynesville: Gold was first discovered at Paynesville in 1898 by Thomas Payne on the South Australian lease. The field has produced 195.735 kgs of gold, but most of this has been won from mines east of KIRKALOCKA (Esson, 1925a, 1926; Feldtmann, 1924). Production of gold from the field on the Kirkalocka sheet is listed in Table 4.

Gold occurs in quartz reefs, which have a general northwesterly trend and which were emplaced into sheared gabbro of the Windimurra Intrusion. The gold occurs in isolated, rich pockets in the reefs and is usually coarsely crystalline and intimately associated with quartz in geodes. Disseminated gold is reported in both the footwall and hanging wall of the veins. Gold of this type has been produced from the South Australian (GML 382M), Lady Margaret (GML 471M, 472M), Elsie (GML 1196M) and LPS (GML 1210M) leases.

Eluvial gold has been won from the South Australian, Elsie and LPS leases.

Kirkalocka: The April Fool mine, 4 km north-northeast of Kirkalocka homestead, has yielded 1.403 kg of gold from 62.2 t of ore. The gold was won from strongly foliated metabasalt next to a quartz-porphyry dyke.

Iron ore

Some thicker units of banded iron-formation (BIF) have potential as beneficiable iron ore. Connolly (1959) reports inferred resources of 9 Mt of BIF averaging 35.6 per cent Fe on Warramboo Hill, and 10 Mt averaging 36.3 per cent Fe at Jumbulyer.

Copper

A tract of felsic volcanic and felsic metasedimentary rocks containing base-metal mineralization at Golden Grove (Marston, 1979) on adjoining YALGOO (Muhling and Low, 1977), extends southeastwards on to the KIRKALOCKA sheet. Felsic lapilli tuffs and cherty tuffs at Gossan Valley, about 2 km west of Wilton Bore, contain copper-zinc sulphide mineralization.

Lead

Argentiferous cerussite in a quartz vein 11.2 km south-southwest of Paynesville was reported by Blockley (1971).

NON-METALS

Beryl

Wydgee: In 1971, a small beryl prospect (PA 2757) located 8 km northwest of Wydgee homestead, yielded 8.1 t of beryl. This contained 89.4 BeO units valued at $2 160. A small pit, 2 m deep, 10 m wide and 15 m long was excavated into flat-lying pegmatite, which trends northwest. The pegmatite is about 35 m long and up to 3 m wide, is discordantly emplaced within well-foliated, medium to coarse, equigranular adamellite, and along the eastern margin is cut by a large, quartz vein dipping steeply southwest. The pegmatite is strongly fractured by a regional northeast-trending cleavage, dipping steeply southeast. The pegmatite has a core of translucent white quartz and coarse-grained margins of perthitic microcline, quartz, muscovite, and accessory euhedral green beryl set in a fine to medium aplitic groundmass.

The pegmatite was probably derived from massive medium to coarse equigranular granitoid located nearby to the east.

Rising Fast Bore: During 1959-1962, 4.1 t of beryl was obtained from PA 2567 about 4 km north-northeast of Rising Fast Bore on Edah Station. The beryl contained 47.5 BeO units valued at $1 482. The bulk of the produced material is from colluvial soil over poorly foliated, equigranular granitoid.

Road-construction material

Sub base-course material has been obtained from most of the colluvial (*Czc*) and residual (*Czr*) group of units.

Dolomite

Blockley (1975) reports that metallurgical-grade dolomite was obtained from thin, surficial deposits over mafic volcanic rocks 1 km south of Mount Magnet.

WATER

In the alluvial and colluvial (*Czc*) group of units groundwater is fairly abundant. However, saline water predominates, particularly in the lower reaches of the drainages. Bores and wells established near rocky hills generally contain useful water. A list of typical wells and bores is given in Table 5.

TABLE 5: TYPICAL WATER SUPPLIES

	Depth (m)	*Water Table (m)*	*Salinity (mg/L)*
Bidda Bidda	9.8	2.8	2 900
Creek Well West	24.9	17.0	3 350
Cardabelway	2.8	2.0	4 800
Slavins	16.9	16.4	2 550
Yallabaranga	19.5		6 180
Tall Tower	9.8	4.8	1 025
Top Bundlejinnie	13.8	11.0	1 450
Brickys	34.2	20.4	1 540

All wells are in colluvial and alluvial (*Czc*) units

Water is obtained from consolidated alluvium to supply Mount Magnet. Exploration southeast of Thundelarra has identified reserves of water for the proposed treatment plant at Golden Grove, should a mine be established.

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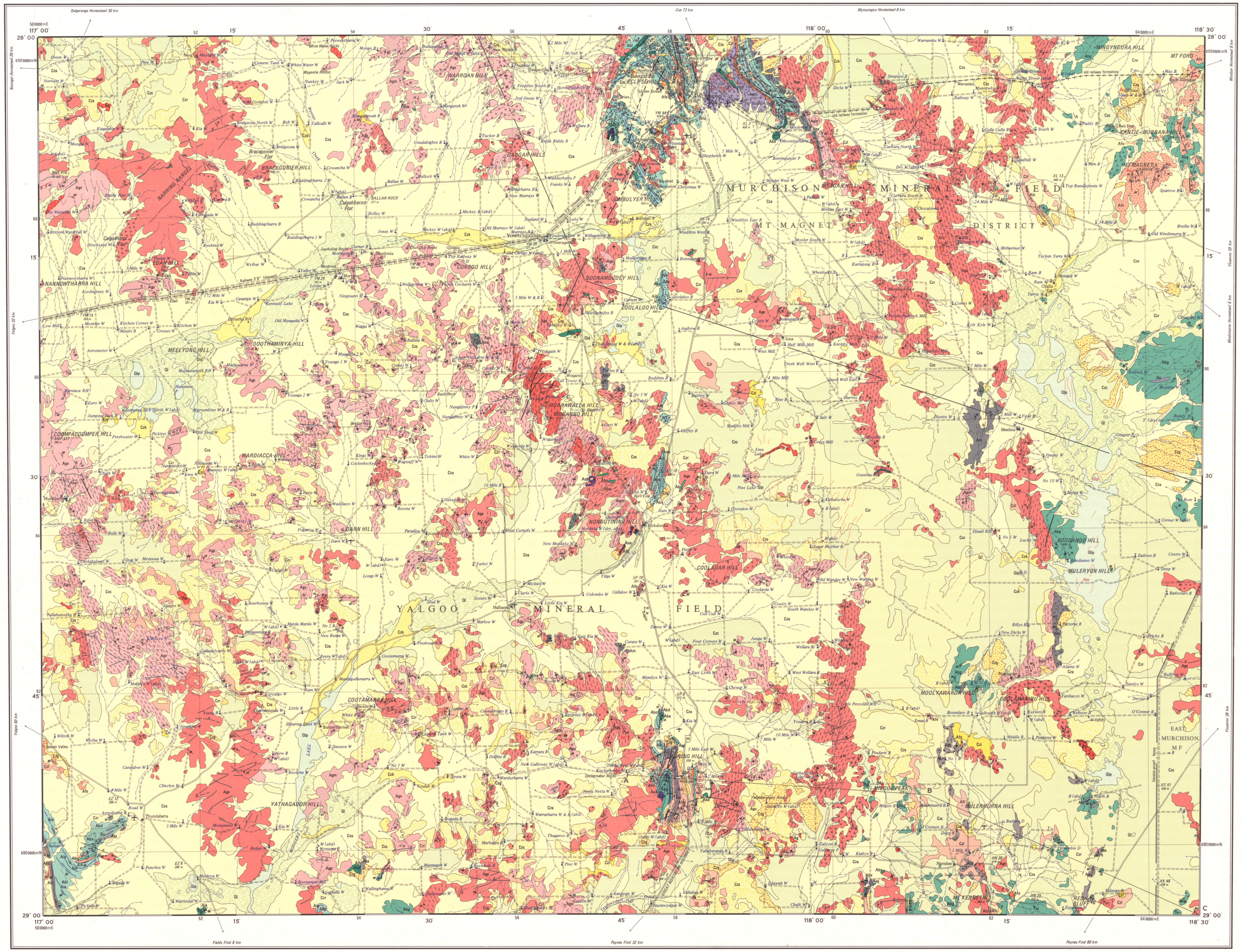
20929/8/82—3M—L/3274 WILLIAM C. BROWN, Government Printer, Western Australia

KIRKALOCKA

AUSTRALIA 1:250 000 GEOLOGICAL SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 50-3



SYMBOLS

- Geological boundary
- Fault
  - Accurate
  - Concealed
- Folds
  - Anticline, showing plunge
  - Syncline, showing plunge
  - Plunge of minor folds — 65
- Bedding
  - Inclined — 50
  - Vertical
- Trend line, air photo lineament
- Facing
  - General
  - Pillow lava
  - Graded bedding
  - Differentiation in igneous bodies
- Mineral foliation in igneous rocks
  - Inclined — 40
  - Vertical
  - Indeterminable
- Foliation in metamorphic rocks
  - Inclined — 70
  - Vertical
  - Indeterminable
- Second foliation in metamorphic rocks
  - Inclined — 85
  - Vertical
- Lineation
  - Penetrative — 10
  - Horizontal
- Radiometric sample locality — @

- Mineral field boundary
- Highway with national route marker — 95
- Formed road
- Track
- Railway (3'6") disused, with siding — Edah
- Townsite, gazetted, less than 1000 pop — Mt Magnet
- Homestead — Edah
- Building
- Locality — Gossan Valley
- Airfield
- Landing ground
- Horizontal control: major, minor
- Benchmark, height accurate — YM 15 352 m
- Sand dune

- Watercourse, intermittent
- Pool — P
- Well — W
- Bore — B
- Windpump
- Rockhole — RH
- Spring — S
- Soak — Sk
- Dam — D
- Tank — T
- Abandoned — (abd)

- Mine (may or may not be working) — Hill 50
- Prospect
- Mineral occurrence
  - Beryl — Be
  - Copper — Cu
  - Gemstone, common opal — Gs
  - Gold — Au
  - Gravel — Gr
  - Gypsum — Gp
  - Heavy mineral sands — Hm
  - Lead — Pb

REFERENCE

CAINOZOIC

- Ql — Lacustrine deposits — mixed playa and dune association, clay, silt and sand deposits; mainly saline
- Qld — Dunes — sand at lake margins, includes kopi marked as gypsum (Gp) mineral occurrence
- Qlp — Playas — clay, silt, sand; mainly saline

- Czc — Alluvial and colluvial deposits — transported clay, sand and lithic fragments; may be indurated
- Czg — Lateritic gravel, sand, includes minor clay
- Czk — Calcrete in mature drainage zones and around playas
- Cza — Sand and clay deposited in channels and adjacent flood plains

- Czr — Residual deposits — sand, clay, duricrust
- Czs — Sandplain — yellow sand commonly eolian reworked; includes some red colluvial sand on plateau remnants
- Czl — Laterite — commonly on top of breakaways; may include consolidated grit on a stripped surface
- Czi — Silcrete — siliceous duricrust

? PROTEROZOIC

- d, di — Dykes — d: mafic, commonly dolerite; di: coarse-grained leucogabbro

ARCHAEAN

GRANITOID ROCKS

- q, p, g — Veins — q: quartz; p: quartz-feldspar porphyry; g: granitoid; quartz diorite to adamellite
- Overprint indicating granitoid rocks strongly foliated, lineated and/or recrystallized

- Ag — Granitoid rock unassigned — most is variably recrystallized and some is deformed
- Age — Adamellite to granodiorite — medium even-grained; includes minor xenoliths
- Agv — Adamellite — medium-grained with less than 10 per cent feldspar megacrysts; includes megacrysts of quartz
- Agp — Granite to adamellite — medium to coarse-grained and porphyritic, megacrysts both idiomorphic and corroded
- Agm — Granite to granodiorite — even-grained and porphyritic; intimate mixtures of Age, Agp, Agv, and Agf
- Agf — Granodiorite — fine to medium even-grained; commonly contains abundant biotite and feldspar megacrysts; widespread xenolith phase
- Am — Contact migmatite — includes supracrustal remnants associated with various textural granitoid types; typically developed near to supracrustal belts

SUPRACRUSTAL ROCKS

- Af — Felsic (quartzo-feldspathic) volcanic and sedimentary rocks unassigned
- Afv — Felsic volcanic rocks — banded to massive, fine to medium-grained amygdaloidal lavas with tuffaceous and agglomeratic layers; rhyolite to dacite composition; may include minor sedimentary rocks
- Afc — Felsic tuff and agglomerate — banded and crystal tuffs
- Afs — Felsic sedimentary rocks — fine to medium-grained, laminated to massive; includes minor Asp units; may contain felsic volcanic rocks
- Afq — Quartz-muscovite schist — fine to medium-grained; occurs mainly in contact zones adjacent to granitoids, local biotite-hornblende tonalite gneiss
- Afo — Quartz-plagioclase porphyry — includes fine-grained massive dacitic rocks
- Afi — Intermediate agglomerate

- Ab — Mafic rocks unassigned — may include minor felsic and ultramafic rocks
- Abg — Gabbro — medium to coarse-grained actinolite-plagioclase rocks, some with accessory quartz; may contain minor ultramafic differentiates
- Abd — Dolerite — fine to medium-grained actinolite-plagioclase rocks; may contain minor ultramafic differentiates
- Abx — Differentiated flow and sill rocks with pyroxenitic or peridotitic bases
- Abl — Basalt — fine-grained to aphanitic plagioclase-pale amphibole rocks; includes massive, variolitic, amygdaloidal and pillowed varieties
- Abv — Mafic volcanic rocks — intermixed layers of felsic and ultramafic volcanic rocks common
- Abc — Basaltic agglomerates and minor tuffaceous rocks — may include minor felsic volcanic rocks
- Aba — Amphibolite — pale and dark amphibole-plagioclase rocks; commonly in supracrustal remnants; developed in zones of high strain

- Au — Ultramafic rocks unassigned — includes minor mafic rocks
- Aus — Serpentinite — serpentine-talc rocks commonly with relict texture preserved; formed after peridotite
- Aua — Pale magnesian amphibole-chlorite-talc rocks — some with minor serpentinite; commonly schistose
- Aut — Talc schist — includes minor chlorite and pale magnesian amphibole; some mafic rocks included
- Auv — Ultramafic volcanic rocks—predominantly pyroclastic varieties; mostly comprised of pale amphibole-chlorite; relict olivine
- Aux — Pyroxenite and peridotite — partly hydrated and altered

- Ai — Banded iron-formation — includes banded chert
- Aih — Hematite-magnetite-quartz band iron-formation
- Aia — Magnetite (hematite) -amphibole-quartz banded iron-formation — amphibole may be pale magnesian type or grunerite
- Aic — Chert
- Aij — Jaspilite — red and black banded iron-formation

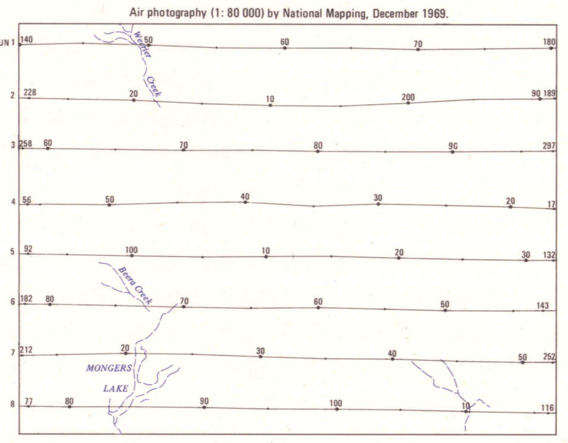
- As — Sedimentary rocks unassigned — includes quartz-muscovite semi-pelitic rock
- Asp — Pelitic to semi-pelitic quartz-feldspar rocks — includes siltstone, shale, phyllite and schist; may be laminated, graded or massive; andalusite and almandine present locally
- Asa — Psammitic rocks — includes minor quartzite cross-laminated, pebbly or graded; generally granular textured, but may be foliated
- Ass — Semi-pelitic rocks — includes quartz wacke; commonly graded with pebbly bands; andalusite and almandine present locally; volcanogenic component present

Regional metamorphism attains greenschist to amphibolite facies

- Overprint indicating deeply weathered or soil covered rock

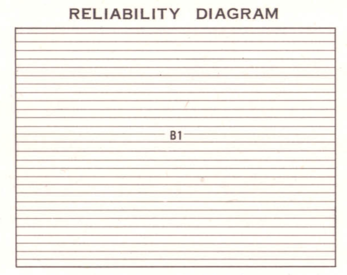
FLIGHT DIAGRAM

Air photography (1:80 000) by National Mapping, December 1969.



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 National Mapping, Canberra, A.C.T.
Copies of this map may be obtained from the Geological Survey of Western Australia, 66 Adelaide Tce., Perth.

RELIABILITY DIAGRAM



B1 Numerous traverses with air photo interpretation

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

SCALE 1:250 000

5 0 5 10 15 20 25 30 Kilometres

TRANSVERSE MERCATOR PROJECTION

ZONE 1 AUSTRALIA SERIES

Grid represents the 10000 metre superimposed Australian Map Grid

INDEX TO ADJOINING SHEETS

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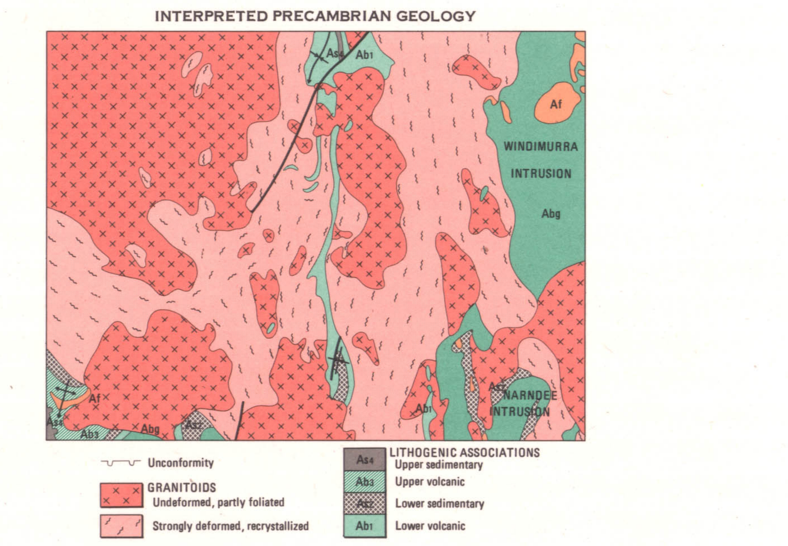
PERENJORI SH 50-6	NINGHAN SH 50-7	BARLEE SH 50-8

Geology by J.L. Baxter, S.L. Lipple and R.J. Marston, 1978

DECLINATION DIAGRAM

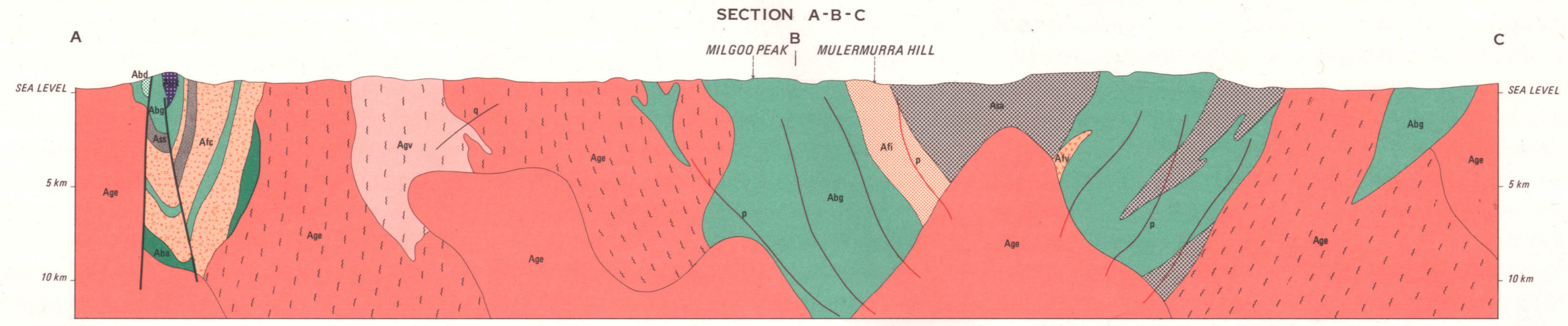
INTERPRETED PRECAMBRIAN GEOLOGY



DIAGRAMMATIC SECTION

NATURAL SCALE

SECTION A-B-C



KIRKALOCKA

SHEET SH 50-3

FIRST EDITION, 1982