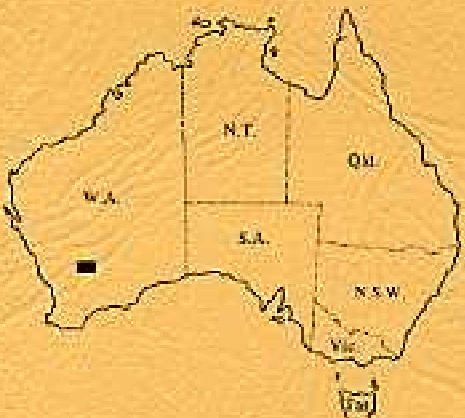
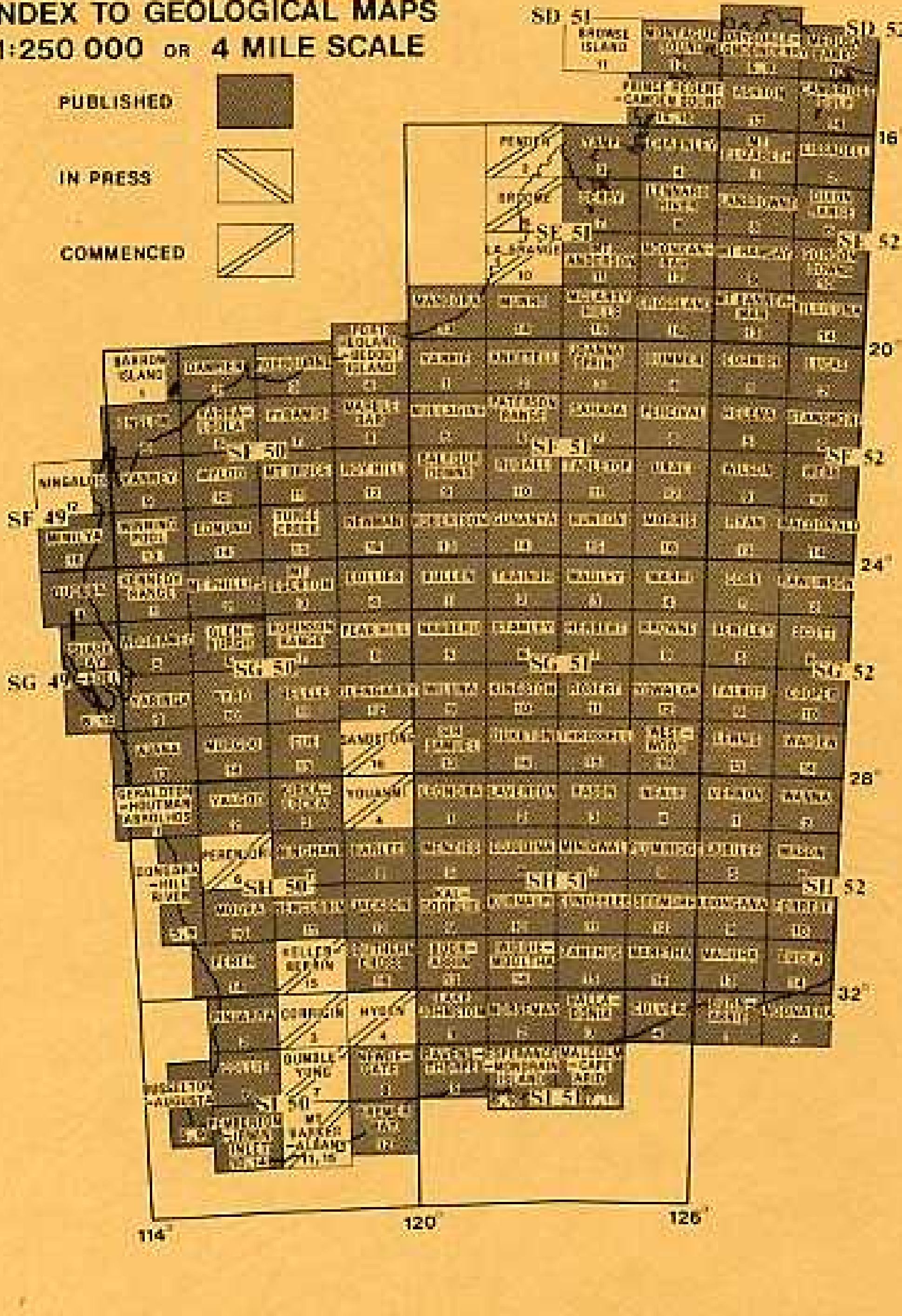
1:250 000 GEOLOGICAL SERIES—EXPLANATORY NOTES

JACKSON
WESTERN AUSTRALIA



SHEET SH/50-12 INTERNATIONAL INDEX

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



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

1:250 000 GEOLOGICAL SERIES—EXPLANATORY NOTES

JACKSON
WESTERN AUSTRALIA

SHEET SH/50—12 INTERNATIONAL INDEX

COMPILED BY R. J. CHIN AND R. A. SMITH

PERTH, WESTERN AUSTRALIA 1983

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DEPARTMENT OF MINES, WESTERN AUSTRALIA
Minister: The Hon. P. Dowding, LL.B., M.L.C.
Director General of Mines: D. R. Kelly

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
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Explanatory Notes on the Jackson Geological Sheet

Compiled by R. J. Chin and R. A. Smith

INTRODUCTION

The JACKSON* 1:250 000 sheet, SH 50-12 of the International Series, is bounded by latitudes 30°S and 31°S and longitudes 118°30'E and 120°E. The sheet is centred 370 km northeast of Perth and derives its name from Mount Jackson (607 m), named by A. C. Gregory in 1846 (Feeken and others, 1970). The iron-ore mining town of Koolyanobbing on the Transcontinental Railway line and the former gold mining centre of Bullfinch are the only towns on JACKSON.

Farms occupy a small portion of the southwestern part of JACKSON, and there has been intermittent grazing on parts of the uncleared remainder. The first station established was Eenuin, northwest of Bullfinch, soon after the discovery of gold nearby in 1887. Other stations currently under pastoral lease are Mount Jackson, Kuykara and the western part of Jaurdi. The Yilgarn (vermin) fence crosses JACKSON in an east-southeasterly direction and joins the north-south No. 1 fence (North). Access in the northern portion of JACKSON is poor due to the paucity of roads and tracks and to the thick vegetation.

The climate is semi-arid, characterized by high potential evaporation. Precipitation from light winter rains and occasional summer storms averages less than 300 mm/yr and decreases northeasterly to about 250 mm/yr. Average temperatures range from a daily minimum of 17°C to a maximum of 35°C during summer, and from a minimum of 4°C to a maximum of 16°C during winter.

The vegetation of JACKSON is described in detail by Beard (1972). It is chiefly characterized by open sclerophyll woodland on the red soil slopes and valleys, by thick acacia scrub on sandplains and ironstone ridges, and by saltbush with acacia scrub adjoining saline drainages and lakes.

PREVIOUS INVESTIGATIONS

H. P. Woodward was the first government geologist to report on the mining activity of the Bullfinch belt following his visit soon after gold was discovered at Golden Valley on 22 January 1888 (Woodward 1888a, b, c, 1889). In 1912, Woodward (1912a, b) made a reconnaissance survey of the Bullfinch belt and the country further north to ascertain the extent of the belt and explore for similar belts. Mapping in 1914-1916 by Blatchford and Honman (1917) outlined the geology on JACKSON at 4 miles to 1 inch scale and included sketches and descriptions of mining operations. In the same bulletin, Farquharson described petrological samples from selected mining centres. The mining groups on JACKSON were described by Matheson and Miles (1947). The playa lake gypsum deposits were assessed in 1958 by de la Hunty and Low (1958). Van de Graaff and others (1977) describe the palaeodrainages. Prior to the construction of the Koolyanobbing-Kalgoorlie railway, Sofoulis (1964) undertook a geological reconnaissance of the proposed route. The Bureau of Mineral Resources conducted an airborne magnetic and radiometric survey in 1957 (Spence, 1958; Bureau of Mineral Resources, 1965) and a reconnaissance gravity survey in 1969 (Fraser, 1974).

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*Sheet names are printed in full capitals to avoid possible confusion with place names.

PHYSIOGRAPHY AND CAINOZOIC GEOLOGY

The physiography of JACKSON is presented in Figure 1. The predominant landscape of gently undulating lateritic duricrust and elevated sandplain averaging 400 m AMSL is interrupted by broad palaeodrainages (320-330 m AMSL) which now contain the salt lake systems. The duricrust is at present undergoing erosion and, in part of the southwestern area, has retreated to leave a younger plain, above which protrude granite monadnocks such as Elachbutting Hill (407 m) and Baladjie Rock (377 m). Several ranges composed of banded iron-formation have relief greater than the duricrust surface. The highest of these is Bungalbin Hill (681 m).

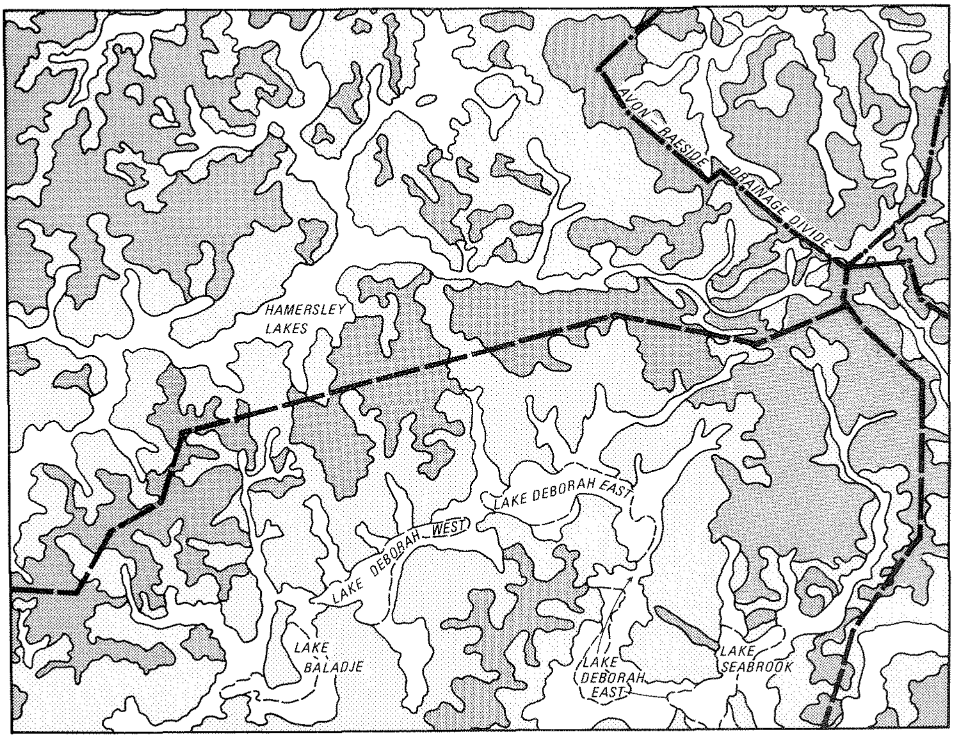

Figure 1

PHYSIOGRAPHIC FEATURES

JACKSON SHEET SH 50 – 12

0 20 km

REFERENCE

UNDULATING SANDPLAIN: Sand and laterite duricrust remnants with only minor rock outcrop

SLOPES: Rock outcrop and slope deposits of eluvium and colluvium

DRAINAGES: Alluvial valleys and salinas, valley fill, lacustrine deposits and adjoining eolian deposits

Major salina

Local drainage divide

Continental drainage divide

Palaeodrainage direction

The topography of the duricrusted surface developed under a higher rainfall regime than now exists and the once active drainages now form chains of salt lakes (van de Graaff and others, 1977). A major divide across the northeastern portion of JACKSON (see Fig. 1) separates the palaeodrainage system which flows north into Lake Barlee and northeast into Lake Ballard from the system which discharges westwards into the Avon network. Two tributaries make up the latter system: one flowing out through the Hamersley Lakes and south past Elachbutting Hill; the other flowing via a sinuous course through the lake Seabrook - Deborah - Baladjie chain. A lineament partly coincident with this chain of salt lakes is discussed in the Structure section.

The dissected surface of lateritic duricrust (*Tl*), with its mantle of yellow sand (*Ts*), is largely intact in the northern and central parts of JACKSON, but to the south less than half of it remains. Small breakaways, several metres or less in height, commonly occur at eroding edges of the duricrust.

The laterite is predominantly nodular and was formed as an *in situ* brown and yellow, ferruginous weathering profile during the higher rainfall climate of the Early Tertiary. Laterite developed over ultramafic rocks (*Tj*) contains abundant chalcedonic silica.

The overlying yellow sand is mostly medium grained and has undergone little sorting. Carroll (1939) considers that it is largely a residual fossil soil formed under a previous climate. However, more recent work by Brewer and Bettenay (1972) suggests that the yellow sand is derived by the physical disintegration of the mottled-pallid zone of the laterite and shows features of colluvial transport over relatively short distances.

Most Quaternary units occur in proximity to the ancient drainage courses. Salt lakes and samphire flats (*Ql*) are linked to valley fill and channelled alluvial deposits (*Qa*), the latter being loci for Holocene drainage. Flat areas and low slopes bordering the channels comprise a sheet-wash unit (*Qz*) which is transitional to the highest unit, the slope colluvium and eluvium (*Qc*) bordering areas of Tertiary and Precambrian outcrop. The lithological description of these units is incorporated into the reference of the map.

ARCHAEAN

JACKSON is situated near the centre of the Yilgarn Block, a stable Archaean craton consisting of belts of banded gneiss and layered sedimentary, volcanic and intrusive rocks, all of which are intruded by voluminous granitoids. Gee and others (1981) divided the Yilgarn Block into several provinces based on the composition and style of the greenstone belts. The greenstone belts on JACKSON fall into the Southern Cross Province which extends, in a northerly trending zone, from Ravensthorpe in the south to north of Sandstone.

Four major greenstone belts are situated on JACKSON. They are informally named the Bullfinch, Koolyanobbing, Marda and Hunt Range belts after local topographic features. Small portions of the Mount Manning and Yerilgee Tank belts also encroach on JACKSON. Between the greenstone belts are large complex bodies of banded gneiss and intrusive granitoid. In the southwestern corner, seriate adamellite forms a sea of late post-tectonic granitoid.

GREENSTONE BELTS

The rocks of the greenstone belts have been grouped into various lithological units. Where the metamorphic fabric is dominant and primary textures and mineralogy are not preserved, metamorphic rock terminology is used, but where orginal textures are preserved despite slight metamorphism or recrystallization, the parent rock name is prefixed by "meta-" or "metamorphosed". The unqualified primary rock name is used for granitoid bodies and for rocks such as those at Marda, where metamorphism and alteration are minimal.

The layered sequences of the greenstone belts are composed of metamorphosed ultramafic rocks (both extrusive and intrusive, including komatiitic varieties), tholeiitic mafic intrusive and extrusive rocks, pelitic metasediments and banded iron-formation. A complex of younger sediments, andesite and rhyolitic volcanics unconformably overlies the layered greenstone succession at Marda.

Ultramafic rocks

Intrusives: Intrusive ultramafic rocks derived from peridotite or dunite form a small proportion of the layered succession on JACKSON. The occurrences are restricted to small plug-like bodies in the Bullfinch belt and a large cross-cutting dyke 8 km southeast of Bungalbin Hill. The dyke does not crop out but is identified on the surface by siliceous caprock (*Tj*) along a strike length of 8 km and over a width of up to 800 m. The corresponding magnetic anomaly continues northeasterly for another 5 km.

The small elliptical plugs (up to 2 km in length) which intrude the Bullfinch belt are largely composed of serpentinized peridotite (*Aup*) with palimpsest cumulate olivine textures in various stages of preservation. The parent peridotite bodies have sheared margins and cross-cutting shear zones altered to talc schist (*Aue*).

A related plug of dunite, in a poorly exposed area 13 km north-northwest of Bullfinch, is described from drill core samples by Hallberg (1973). The core of the body consists principally of forsteritic olivine (partially serpentinized in some places) with interstices (5% of the rock volume) of serpentine, aluminous chromite and rare chlorite and carbonate. The outer zone is thoroughly serpentinized and partially carbonated dunite with a margin of strongly sheared talc-carbonate-magnetite schist. These bodies resemble tectonically emplaced crystal mushes (Alpine type ultramafics) rather than the typical komatiitic peridotite bodies of most greenstone belts.

Extrusives: Komatiitic ultramafic rocks form a large proportion of the Bullfinch belt but small proportions of the Marda and Koolyanobbing belts. This suite is similar to that described from the Diemals area on BARLEE (Walker and Blight, 1981).

Spinifex-textured peridotite (*Akp*), now pseudomorphed by serpentine, tremolite and chlorite, occurs within the lowermost preserved units in greenstone sequences 13 km north of Koolyanobbing and 12 km south of Mount Jackson. At the first locality an excellent lakeside exposure shows spinifex texture grading from a zone of massive peridotite into a zone of coarse spinifex texture (blades up to 0.3 m in diameter) and finally into fine spinifex texture (1 cm). Similar textural development is described in ultramafic lavas from Mount Clifford (Barnes and others, 1974). Several flows up to 2 m thick can be identified and all have the same sense of spinifex gradation, indicating a southwest facing. The volcanic pile also contains metabasalt flows and banded tremolite-chlorite schists (possibly of pyroclastic or epiclastic origin).

South of Mount Jackson thin (up to 1 m) units of spinifex-textured komatiitic peridotite, now a fine-grained chlorite-tremolite-serpentine rock, are interlayered with tholeiitic and komatiitic metabasalt. The pseudomorphed olivine blades are small (up to 2 cm) and, because of poor outcrop, regular gradation in size could not be confirmed.

Thin flows of komatiitic peridotite are sparsely distributed within komatiitic basalt piles in the Bullfinch belt. Primary mineralogy is completely altered to tremolite and chlorite. The primary spinifex texture is outlined by trains of opaque minerals.

Komatiitic basalt (*Akb*) is distributed irregularly throughout all greenstone belts on JACKSON with the exception of the Hunt Range belt. In the Bullfinch belt, well preserved komatiitic basalt, banded amphibolite and ultramafic schist form thick piles in volcanic centres situated 8 km northwest of Bullfinsh and 4 km south of Trough Well.

Many flows in the Bullfinch belt contain ovoids composed of fine-grained colourless tremolite with a small amount of interstitital plagioclase. These are interpreted as ocelli. The matrix is coarser grained green amphibole with a few percent of plagioclase. In the Koolyanobbing area, pillow basalts contain similar ocelli visible on weathered surfaces as raised light-coloured ovoids. The ocelli are up to 2 cm in diameter and, commonly, several have coalesced into large lobate masses. In one flow the ocelli were visibly derived from a 4 cm-thick band of light-coloured basalt. Structures resembling load casts at the base of this band suggest that the lighter coloured basalt (and hence, the ocelli) represents an immiscible fraction.

An unusual rock containing plagioclase, tremolite and subordinate quartz (*Akf*), forms a layer in the komatiitic basalt suite 6 km south-southeast of Currajong Tank. Plagioclase constitutes about 80 per cent of the rock and tremolite has replaced a primary mineral which formed intersecting bunches of parallel plates reminiscent of spinifex texture. The texture and composition suggest that the rock is possibly a leucocratic 'end member' of this suite. However, outcrop is insufficient to determine whether it is the uppermost part of an *in situ* differentiated flow or sill, or an individual by-product of a melt which was differentiated in the magma chamber.

Rare samples are breccias composed of komatiitic basalt fragments in a recrystallized matrix of fine-grained tremolite and chlorite. These are possibly pyroclastic rocks from a local vent, brecciated flowtops or pillow breccias.

Metamorphosed ultramafics: Metamorphism of komatiitic basalt produced chlorite-tremolite schist in which primary texture and structure is commonly obliterated. Chlorite-rich zones, which define the foliation, alternate with zones of poorly aligned tremolite porphyroblasts. Albite, quartz, epidote, biotite and iron oxide are common accessories.

However, in the Bullfinch belt, primary textures and structures are commonly recognizable despite deformation. In typical flows, the same metamorphic minerals are developed but a relict igneous texture is preserved. Acicular tremolite pseudomorphs skeletal and spherulitic clinopyroxene, while interlobate aggregates of chlorite replace stubby clinopyroxene and olivine phenocrysts. A few per cent of plagioclase is common in the matrix, but rare samples contain up to 30 per cent. Metamorphic olivine has been recorded in the area 2 km southeast of Trough Well. Many komatiitic basalts retain a relict quenched clinopyroxene-needle spinifex texture in a fine-grained tremolite-chlorite matrix, which possibly represents a recrystallized glass in chilled flow tops or thin flows.

Talc (-chlorite-carbonate) schist (*Aue*) occurs in all of the greenstone belts as thin, linear bodies and lenses beside banded iron-formation at the boundary with basaltic sequences. Strong deformation and alteration has destroyed any primary textures which would indicate origin. However, the nickel content is consistent with derivation from peridotitic rocks.

Coarse-grained tremolite (-chlorite-talc) schist (*Aur*) is common in the tholeiitic and komatiitic basalt sequences, and is variously derived from komatiitic basalt, ultramafic sediment or retrograded pyroxenite. Relict primary textures are rarely present. However, one sample from a lens on the eastern side of Hughes Hill has a palimpsest cumulate texture after clinopyroxene which is preserved as dusty brown cores in prismatic tremolite pseudomorphs. Relict skeletal textures suggestive of original pyroxenite are also preserved in cummingtonite-cordierite-anthophyllite schist 6 km south-southeast of Currajong Tank. Near Days Find, a banded variety forms lenses within the komatiitic basalt pile. It was originally either a layered cumulate pyroxenitic differentiate of the komatiite suite, or a sedimentary rock derived from the volcanic pile.

Mafic rocks

Basalts: Over half of the greenstone sequence is composed of variably metamorphosed mafic rocks. They are principally derived from tholeiitic basalt which built up thick, monotonous sequences in which it is difficult to identify individual flows. Thinner units and sequences are commonly interlayered with komatiitic ultramafic rocks and sedimentary rocks.

Hallberg (1976) presented analyses of about 500 volcanic and related rocks from the western half of the Yilgarn Block. Although the mafic rocks show considerable diversity in major and trace-element composition, AFM plots of the data collected from JACKSON show a strong tendency for basalts from the Marda belt to have higher relative total Fe than those from the Bullfinch belt. The Marda basalts also have relatively lower Cr values.

A chemical study through a sequence of basalt midway between Bungalbin Hill and Marda (Hallberg and others, 1976b) revealed an average composition similar to that of typical Archaean tholeiite. Differentiation of the lava, expressed by enrichment of SiO_2, FeO, TiO_2 and Na_2O together with corresponding depletion of Cr, CaO and MgO from south to north across strike, is consistent with northerly facing in this region.

Basalt (*Ab*) in the Marda area has experienced little deformation and metamorphism and retains most of its primary mineralogy and texture. Primary clinopyroxene and plagioclase (labradorite) with subophitic texture are the principal constituents. Secondary alteration is common; clinopyroxene is pseudomorphed by chlorite, and calcic plagioclase is replaced by a mixture of albite, epidote and carbonate. Other secondary minerals present include prehnite, pumpellyite and quartz, which indicate low metamorphic grade.

Vesicular and amygdaloidal flows are sparsely distributed throughout the pile. Vesicles are mostly infilled by cryptocrystalline quartz and epidote. Pillows are rarely observed in the basalt sequence, possibly due to rubbly outcrop. Some have been located in the upper part of the sequence, 16 km north-northwest of Bungalbin Hill. Rare brecciated basalt occurring in thin lenses throughout the sequence resembles pillow breccia.

Metabasalt and amphibolite: Metabasalt and amphibolite (*Aab*) are the metamorphic equivalents of basalt (*Ab*), and predominate throughout all of the greenstone belts except the Marda belt, where they are restricted to the areas of higher grade metamorphism at the margins of the belt.

Dominant textures tend towards granoblastic and blastophitic. Prismatic needles of amphibole (dominantly hornblende) have a fabric which varies from almost random to moderately aligned in a mosaic of interlobate plagioclase. Greenschist facies assemblages consist principally of actinolite-albite with subordinate epidote-chlorite-biotite. Higher metamorphic grades are characterized by greenish hornblende and calcic plagioclase (andesine to anorthite). In a contact zone adjoining leucocratic granodiorite 5 km north of Maries Find, small rounded grains of metamorphic clinopyroxene have been recorded. In zones of high strain, dynamic metamorphism has produced granoblastic-elongate textures in which amphibole needles are strongly aligned in a recrystallized plagioclase matrix.

Deformed pillow structures are commonly observed in good lakeside exposures in the Bullfinch belt, but are difficult to recognize elsewhere in rubbly outcrop. Amygdaloidal, vesicular and porphyritic varieties of metabasalt are rare. Weakly developed centrimetre-scale banding, defined by alternation of feldspar-rich and amphibole-rich phases, is common at some localities such as Maries Find and the southern end of the Koolyanobbing Ranges. Although some of this banding may be explained by incomplete mixing or flow differentiation in a lava, its presence may alternatively suggest a sedimentary or tuffaceous parentage for the amphibolite. Unfortunately, the primary textures necessary to resolve the problem have been destroyed by metamorphism.

The thick piles of metabasalt are broken by thin intervals of banded iron-formation, banded chert, pelitic sediments, chlorite schist and rare felsic agglomerate. This last rock type occurs at the Newfield (Carterton) Mine where it is host for the gold mineralization. The strongly altered agglomerate contains quartz, carbonate and fragments of altered basalt in a crystal-lithic tuff matrix.

Metamorphosed agglomerate with mafic amphibolite matrix (*Aax*) forms a prominent unit in an area of metamorphic rocks separated from the northeastern side of the Koolyanobbing belt as a result of granodiorite intrusion. The matrix is strongly foliated, fine-grained, banded amphibolite composed of idioblastic to xenoblastic amphibole in a mosaic of xenoblastic plagioclase.

Banded para-amphibolite (*Aap*) is common in the komatiitic volcanic pile 8 km northwest of Bullfinch. The rock has distinctive, continuous laminations of light and dark amphibolite which contain differing proportions of amphibole and plagioclase. Tremolite is the most common amphibole, which is consistent with a suggested origin of the rock as a pyroclastic or an epiclastic sediment derived from magnesium-rich material in the komatiitic pile. Actinolite and hornblende are also recorded in smaller amounts. Primary textures are replaced by nematoblastic tremolite. The para-amphibolite on JACKSON is more restricted and less diverse than similar rocks described on SOUTHERN CROSS (Gee, 1979). Unlike the SOUTHERN CROSS occurrences it does not appear to be host to gold mineralization.

Metagabbro and medium to coarse-grained mafic amphibolite (*Aad*) form complex intrusions which disrupt the layered greenstone sequences near Bullfinch and east of Koolyanobbing. Elsewhere, thin subordinate units form dykes and sills within the basaltic sequences. In the Bullfinch and Koolyanobbing areas, upper greenschist-facies metamorphism in relatively static zones produced porphyroblastic actinolite in a matrix of actinolite-chlorite-clinozoisite-albite-quartz. The texture is mostly

26783—2

metamorphic, but aggregates of amphibole (up to 5 mm) commonly pseudomorph stubby crystals of primary pyroxene. In high-strain areas, these minerals recrystallized and define a lineation. In areas of higher metamorphic grade, hornblende is the principal amphibole and has been recorded as blastophenocrysts up to 5 cm in diameter.

Banded iron-formation and chert

In all greenstone belts on JACKSON, the banded iron-formation (*Aiw*) stands out as prominent ridges outlining the major structures of the layered greenstone sequences. However, the composition and field relationships of the banded iron-formation in each greenstone belt are distinctive.

In the Bullfinch belt the banded iron-formation is relatively thin (up to 10 m), and is interbanded with ultramafic and sedimentary rocks in the upper portions of tholeiitic basaltic sequences. It is similar to finely laminated jaspilite recorded throughout most of SOUTHERN CROSS (Gee, 1979). Unusual compositions in the unoxidized parts of these units distinguish them from the quartz-magnetite assemblages of banded iron-formation in other areas of the Yilgarn Block. Gee (1979) reports that the proportion of iron-bearing minerals is relatively low and that characteristic mineral assemblages include different combinations of quartz, hornblende, biotite, epidote, plagioclase, calcic diopside, sphene, magnetite and grunerite in finely laminated units. There is little subsurface evidence to indicate whether similar mineral assemblages occur extensively at depth on JACKSON. In the oxidized zone banded iron-formation is composed of alternating dark-grey quartzite bands (bearing hydrated iron-oxide minerals after magnetite) and light-grey and buff quartzite bands. One sample of fresh banded iron-formation was obtained from a mine 0.5 km east of Hughes Hill. This is a banded granoblastic quartz-grunerite-magnetite rock with sparse hornblende and stilpnomelane. Acicular grunerite commonly occurs in radiating bundles of crystals. Magnetite constitutes about 15 per cent of the rock. Banding varies from 0.5 mm to 10 mm in thickness.

In contrast to the Bullfinch belt, banded iron-formation in the Koolyanobbing belt forms units which are normally up to 100 m in thickness, but which are up to 300 m where complexly folded. The units consist of alternating dark-grey to black, iron-rich bands and brown to red-brown quartz-rich bands in the order of 10 mm in thickness, with microbands at millimetre scale within each band. Chlorite schist, talc schist, tremolite-chlorite schist and pelitic metasediments are interlayered with the continuous banded iron-formation unit. Minor, thin, discontinuous banded iron-formation forms part of the basaltic sequence. Lenses of stratiform pyrite in the banded iron-formation at Dowds Hill were investigated by Ellis (1958) as a source for sulphur. Banding within the pyrite suggests a chemical-sedimentary origin.

Banded iron-formation in the Mount Jackson–Bungalbin area occurs at two stratigraphic levels separated by basalt. These two units, and thin banded iron-formation within the basalt, characteristically contain banded dark-grey to black iron-rich bands alternating with red jaspilite bands at centimetre scale. The red jaspilite is commonly boundinaged and disrupted due to mobilization of the iron-rich bands. The stratigraphically lower unit is the thicker (up to 100 m) and contains the iron-ore prospects near Mount Jackson and at Bungalbin Hill. This unit grades upwards to finely laminated white and buff chert (*Aic*) and passes eastwards from Bungalbin Hill into the thick chert ridge in the Yendilberin Hills.

The chert unit (*Aic*) contains few iron-rich bands and is predominantly composed of light-, mid- and dark-grey quartzite bands. Thin units of banded chert are also common in the basaltic pile south of Mount Jackson. These are characterized by alternating dark-, mid- and light-grey and buff banding at centimetre scale. Each band contains fine internal lamination. Ferruginous chert bands are common in some of the units.

Clastic sedimentary rocks

Clastic sedimentary rocks on JACKSON are broadly divided into two groups. The older group consists of quartzite and quartz-muscovite schist (*Asq*), pelitic phyllite and schist (*Alp*) and chert conglomerate (*Alg*), all of which occur within the mafic/ultramafic sequences. The other sedimentary group consists of younger conglomerate (*Asc*) and interbedded sandstone and siltstone (*Asa*). This sequence forms part of the Marda Complex which unconformably overlies the mafic/ultramafic sequence. It correlates with the Diemals Formation defined on BARLEE by Walker and Blight (1981).

Undifferentiated sedimentary rocks (*As*) include not only rocks of unusual composition, e.g. metamorphosed tuffs, for which it is impracticable to assign a separate symbol, but also rock types whose lithology is difficult to identify because of weathering. An example of the first type is a metamorphosed tuffaceous sediment, petrographically a fine-grained amphibole-biotite-quartz-epidote schist with xenoblastic albite in the groundmass. Several beds up to 5 m thick are interbedded with basalt flows stratigraphically underlying banded iron-formation in a thick basalt sequence 13 km northwest of Koolyanobbing.

Deeply weathered and poorly exposed sedimentary rocks (*As*) 3 km west of Mount Dimer overlie the basaltic sequence in the Hunt Range belt. They include foliated, poorly sorted mudstone containing elongate quartz pebbles, banded chert, and minor cross-bedded and ripple-marked quartzite.

Older clastics: Foliated quartzite and quartz-muscovite schist (*Asq*) occurs near the Mount Jackson homestead and 14 km north-northwest of Koolyanobbing. At the first locality, despite strong deformation, cross-bedding defined by flaggy partings is identifiable and indicates consistent easterly facing. This quartzite has a well developed granoblastic texture. Along strike 1 km south of Mount Jackson homestead, it is interbedded with fine and coarse-grained quartz-muscovite schist and micaceous quartzite, some of which contains outlines of stretched pebbles. Interfingering with these metasediments is a 2 m thick tongue of metabasalt, an indication that at least part of the basalt sequence was extruded into a shallow water environment.

Fourteen kilometres north-northwest of Koolyanobbing, finely-banded micaceous quartzite is interbedded with the mafic/ultramafic sequence. As was the case at the Mount Jackson homestead locality, this unit is close to the base of the exposed greenstone sequence. The lithology, and the stratigraphic position of the rocks at both localities is similar to that of quartzose metasedimentary rocks at the base of the Maynard Hills greenstone belt on YOUANMI (Stewart and others, 1981).

Pelitic phyllite and schist (*Alp*) are composed of fine-grained quartz, muscovite, opaque heavy minerals and rare chlorite and graphite. Lamination and larger scale bedding are poorly preserved and commonly transposed. Metamorphism has produced large porphyroblastic and poikiloblastic andalusite crystals in quartz-muscovite schists 5 km southwest of Ennuin homestead. Idioblastic tourmaline has been recorded from 11 km northwest of Koolyanobbing.

Conglomerate with schistose matrix (*Alg*) forms a prominent unit striking northwesterly from a point 2 km northwest of Mount Colreavy. The strongly flattened and stretched, rounded chert and fine-grained siliceous sandstone clasts are up to 200 mm in length. A fine-grained quartz-muscovite schist matrix forms the greater proportion of the rock. Interbedded with the conglomerate are pelitic phyllite, metasandstone containing chert and quartz clasts, and fine-grained siliceous sandstone. Disrupted and eroded beds of the last rock type suggest a possible source for at least some of the conglomerate, perhaps by slumping of unstable sediment.

Younger clastics: Unconformably overlying the sequence of mafic volcanics and banded iron-formation in the Marda belt is a thick sequence of conglomerate, sandstone and siltstone which, together with the conformably overlying andesitic to rhyolitic volcanics, form the Marda Complex. These sediments correlate with similar sediments of the Diemals Formation on BARLEE (Walker and Blight, 1981). The greatest outcrop width (3 km) is on the northern side of the Marda Complex, but stratigraphic thickness cannot be estimated in this region because of structural complications exemplified by the northward facing of some beds. A thickness of about 1 500 m is estimated for the sediments on the southern side of the complex.

The sedimentary sequence broadly fines upwards. The conglomerate (*Asc*) is mostly restricted to the basal part, and its composition is strongly dependent on the adjacent rock types. Banded iron-formation which encloses the sedimentary basin contributes the greatest proportion of clasts. Locally, dacitic porphyry, basalt, quartzite, vein quartz and felsic volcanics contribute to the conglomerate. Felsic volcanic clasts are thought to derive from contemporaneous volcanism within the Marda Complex. Clasts are all well rounded but commonly have low sphericity, and their size varies uniformly up to a diameter of 0.5 m. The matrix is generally poorly sorted lithic sandstone, and its proportion relative to the clasts is highly variable.

The conglomerate is interbedded with poorly sorted sandstone and lesser amounts of siltstone. The sandstone commonly has cross-bedding and ripple marks and, at some localities, is crudely graded.

On the northern slopes of the Mount Jackson banded iron-formation ridge a conglomerate of poorly sorted, angular and well-rounded blocky clasts of locally derived banded iron-formation and chert has been assigned to the Archaean sedimentary sequence. The clasts (up to 100 mm in diameter) form a closed framework whose interstices are filled by a fine-grained, recrystallized quartz matrix.

The basal conglomerate sequence (*Asc*) grades upwards into well-bedded lithic sandstone and siltstone (*Asa*). Siltstone interbeds increase towards the top of the sequence, reflecting the overall upwards-fining trend.

Excellent outcrop in a breakaway area 11 km north-northeast of Mount Jackson homestead reveals poorly sorted medium- and coarse-grained sandstone composed of subrounded grains of quartz and chert. The sandstone is well bedded, and contains abundant cross-bedded units from 100 mm to 200 mm thick and several units of laminated siltstone up to 3 m thick. Deformation has resulted in disharmonic folding and translation along slide surfaces in the sandstone and siltstone. Penecontemporaneous mobilization of some sandstone units resulted in injection of clastic dykes along faults and fissures.

Poorly sorted, well-bedded lithic sandstone 5 km east-northeast of Windarling Peak contains abundant scours and low-angle cross-bedding. Northerly facing towards the margin of the basin suggests complication of the regional structure by faulting or folding.

Volcanic rocks of the Marda Complex

The volcanic rocks of the Marda Complex form a pile of lensing and interfingering subaerial lavas, pyroclastics and minor sedimentary rocks, all of which are andesitic or rhyolitic in composition. The volcanics have been described and chemically analysed by Hallberg and others (1976b) and Bye (1968). The complex is intruded by dykes of porphyritic dacite (*Afp*) and a large body of granophyric granite (*Agf*). The latter intrudes the eastern part of the complex and possibly represents late emplacement of the magma which gave rise to the volcanics. Both intrusions are described in other sections.

The sedimentary and volcanic rocks of the Marda Complex occupy a large complex basin surrounded by an almost continuous rim of banded iron-formation. Genetically equivalent rocks occupy small outlying areas similarly surrounded by banded iron-formation. Such outliers are found 0.5 km north of Mount Jackson, 12 km north of Bungalbin Hill and on BARLEE 10 km north of Windarling Peak.

Hallberg and others (1976b) showed that the Marda volcanic rocks form a chemically continuous series which has a calc-alkaline affinity and is thus unrelated to the underlying tholeiitic basalts. Their chemistry resembles more closely that of the Andean type calc-alkaline rocks, rather than the island-arc types which are characterized by high K/Rb ratios, lower Ba, Rb and Zr values and higher proportions of basalt in the volcanic pile. The Marda volcanic rocks compare broadly with other calc-alkaline complexes within the Yilgarn Block, namely Polelle (dominantly andesites, Hallberg and others, 1976a), Spring Well (dominantly felsic volcanics; Bunting and Williams, 1979), Laverton (Gower, 1976), Rutter Soak-Yamarna (Davy, 1978), and Teutonic Bore (Davy, 1978). The last two areas, unlike Marda, are underlain by high-potassium basalts which form part of the calc-alkaline complex.

The age of the Marda Complex has been determined by the Rb/Sr whole-rock technique from 4 samples (Hallberg and others, 1976b), which yielded an isochron at 2636 ± 80 m.y. with an initial ratio of 0.7029 ± 0.0015.

Andesites: Andesite (*Az*) forms thick sequences of numerous individual flows, mainly in the lower part of the volcanic pile, and commonly overlies the basal sedimentary rocks. A complete flow may be uniformly composed of either massive, porphyritic or amygdaloidal andesite, although these types may grade into one another through a single flow. Flow boundaries and banding (due to compositional heterogeneity) within flows are difficult to find, and consequently the attitude and structural relationships of these rocks are rarely known.

The andesite is a fine-grained dark-grey rock which is readily distinguished in the field from more siliceous rocks by a reddish-brown skin which passes into fresh rock over several millimetres. Hallberg and others (1976b) have shown that the andesites form a continuous series from basaltic andesite (55 per cent SiO_2) to a silica-rich end member (up to 64 per cent SiO_2). Basaltic andesite has been identified 5 km north-northwest of Allens Find, 9 km northeast of Mount Jackson homestead and at Atkinsons Find.

The andesites are characterized by interlocking plagioclase laths (0.3 to 0.5 mm long) with interstitial clinopyroxene and subordinate potassic feldspar and opaques. The plagioclase is zoned from labradorite (in the core) to andesine. Fine granular chlorite, epidote, actinolite and iron oxide replace original brown glass. Porphyritic texture is common. The phenocrysts (rarely glomerophenocrysts) are most commonly zoned plagioclase (labradorite to andesine) up to 10 mm long. Other phenocrysts include clinopyroxene, which is partially or totally replaced by actinolite-chlorite pseudomorphs, hornblende, and magnetite, which is commonly replaced by leucoxene, sphene and iron oxides. Amygdales containing various proportions of quartz, epidote, actinolite and carbonate are abundant in some flows. They are commonly elongate in the direction of flow.

Diorite, compositionally similar to the andesite, has been recorded in dykes which intrude the Marda Complex. Larger dykes are differentiated from leucodolerite to quartz diorite. The dykes are probably feeders to the andesitic volcanics.

Rhyolites: Rhyolitic volcanics (*Af*) are largely composed of rhyolitic ignimbrite with minor tuff (*Afx*) and rhyolite (*Afl*), and form the greatest proportion of the Marda Complex. Thin beds of sedimentary rocks are sparsely distributed within the volcanic pile in the northern part of the Marda Complex. These are not shown separately on JACKSON. They are derived locally by minor reworking of the volcanics. Clasts range from angular, intermediate lithic fragments to single crystals of plagioclase, quartz or iron oxide in a matrix of fine-grained albite, biotite, quartz and iron oxide.

Rhyolitic ignimbrite with minor tuff and agglomerate (*Afx*) makes up the greatest portion of the rhyolitic volcanics. These lithologies usually occupy the central part of the complex overlying the basal andesite. The ignimbrite is characteristically a mid-grey siliceous rock in which angular and rounded fragments (up to 100 mm in diameter) of volcanic rocks, devitrified glass, pumice and shards are visible. Other fragments are composed of feldspar (dominantly albite) and, rarely, of crystal quartz. Most of the fragments have contact rims baked by the heat of the ash flow. The fine-grained siliceous matrix consists of recrystallized quartz and feldspar (dominantly potassic) with micropoikilitic texture, suggestive of devitrification of rhyolitic glass. Eutaxitic texture, evident in hand specimen as colour banding which bows around the fragments, is defined by variations in concentration of fine-grained chlorite and iron oxide.

Rhyolitic crystal-lithic tuff lacks the welding and large fragments characteristic of the ignimbrite. The matrix is recrystallized and is similar to that of the ignimbrite, but contains abundant crystals of quartz and albite (up to 2 mm) together with poorly outlined shards and lithic clasts.

Rhyolite (*Afl*), often extensively sericitized, occurs in flows within the ignimbrite pile. It mainly consists of flow banded porphyritic and spherulitic varieties. The rhyolite characteristically has a fine-grained quartz-feldspar (dominantly potassic feldspar) groundmass which also contains smaller amounts of fine-grained chlorite, colourless mica, prehnite, carbonate and iron oxide. Many samples are heavily sericitized. Phenocrysts are rounded plagioclase (mostly oligoclase) and rare embayed or euhedral quartz. Spherulites of radiating quartz and feldspar nucleated on phenocrysts and amygdales. Many of them are partially replaced by carbonate and chlorite. A sample from 7 km northeast of Atkinsons Find is rhyolite with orb texture defined by spheroidal domains (1 mm to 10 mm in diameter) which are free of chlorite or iron oxides. This texture is typical of devitrified volcanic glass. Perlitic texture in some samples also suggests devitrification of glassy rhyolite.

Felsic intrusive rocks

Dacitic porphyry (*Afp*) has been recognized in three distinct areas. It occurs in innumerable small dykes which intrude all of the rock types in the Marda Complex, and in large dykes which intrude the mafic/ultramafic sequences south of Mount Jackson and throughout the Koolyanobbing belt. Although the dykes cannot be separated according to time of intrusion, the existence of dykes older than those which intrude the Marda Complex is demonstrated by the occurrence of clasts of dacitic porphyry in the basal conglomerate of the Marda Complex.

The porphyry which intrudes the basalt sequence south of Mount Jackson may have contributed clasts to the overlying conglomerate. It is characterized by plagioclase phenocrysts up to 5 mm long, set in a fine-grained matrix of biotite, quartz and feldspar. Dacite porphyry also forms a network of dykes in the northeastern half of the Koolyanobbing belt. This rock contains plagioclase and quartz phenocrysts and common aggregates of biotite in an aphanitic biotite-quartz-feldspar matrix. The quartz phenocrysts commonly have a transparent bluish opaline appearance. This porphyry shows the same deformational history as the layered greenstone and is intruded by the adjoining granitoid rocks.

The dykes which cut the Marda Complex contain phenocrysts of embayed quartz and subhedral plagioclase in a fine-grained quartzo-feldspathic groundmass. Hallberg and others (1976b) showed that this dyke suite is chemically distinct from the volcanic rocks of the Marda Complex, and considered the suite to be unrelated to the volcanism.

Stratigraphy of the greenstone belts

Stratigraphy throughout the Southern Cross Province is broadly consistent although there are many local variations. It is, broadly, a single-cycle stratigraphy with mafic and ultramafic volcanics at the base and sedimentary rocks occupying the highest stratigraphic levels.

On JACKSON the least deformed stratigraphy is represented in the Marda greenstone belt. The lowermost exposed units consist of quartzose sedimentary rocks overlain by interlayered komatiitic basalt and peridotite, and tholeiitic basalt, which in turn passes upwards into a thick (up to 10 km) monotonous pile of tholeiitic basalt. A prominent banded iron-formation overlying this sequence provides a marker horizon to trace stratigraphy throughout the belt. From Bungalbin Hill through Mount Jackson homestead almost to Mudahdah Hill, a 2 km-thick sequence of tholeiitic basalt overlies the banded iron-formation. This basalt correlates with pelitic rocks which occupy the same stratigraphic position in the Yendilberin Hills and in the area of Mudahdah Hill where the sedimentary sequence is continuous with that on BARLEE. The highest units exposed on JACKSON below the Marda Complex comprise a second prominent banded iron-formation overlain by interlayered tholeiitic basalt and altered ultramafic rocks. These rocks possibly indicate the beginning of another mafic/ultramafic cycle.

The Bullfinch greenstone belt has essentially the same single cycle of greenstone development but because of stronger deformation, it is difficult to recognize the complete stratigraphic sequence. Some important differences between this greenstone belt and other belts on JACKSON have also been noted on SOUTHERN CROSS by Gee (1979), and appear to be a regional feature of the southwestern part of the Southern Cross Province. The occurrence of layered mafic para-amphibolite and banded iron-formation of varied and unusual composition is characteristic of this area. The lowest part of the sequence is a mixture of mafic and ultramafic volcanic rocks, in contrast to the thick, monotonous tholeiitic basalt of the Marda greenstone belt. Chemical data from Hallberg (1976), plotted on an AFM diagram, show that metabasalts and amphibolite from the Bullfinch belt form a cluster separate from the basalts of the Marda belt because of the relative depletion of Fe. Although the sampling was limited, the data may point to differences in geological environment or in the source material, but do not entirely eliminate the possibility of correlation. The pelitic sequence in the Bullfinch belt overlies the volcanic sequence at apparently the same stratigraphic level as the pelitic sequence in the Marda belt.

Younger sedimentary rocks at the base of the Marda Complex rest with angular unconformity on the older mafic sequence. They are correlated with the Diemals Formation (Walker and Blight, 1981) and are remarkably similar in composition to the Kurrawang Beds in the Kalgoorlie area described by Glikson (1971). The Kurrawang Beds comprise the stratigraphically uppermost unit but, in contrast to the sedimentary rocks of the Marda Complex, are apparently conformable with the underlying mafic/ultramafic sequence.

Metamorphism in the greenstone belts

Prehnite-pumpellyite facies and lower greenschist facies assemblages are recorded in the Marda greenstone belt and from the Marda Complex, several kilometres away from granitic contacts and north-northwesterly trending tectonic lineaments. The basalts are modified very little by metamorphism but in places have undergone deuteric alteration. The alteration products comprise an equilibrium assemblage of epidote-chlorite-prehnite-pumpellyite-carbonate indicating prehnite-pumpellyite facies metamorphism. Lower greenschist assemblages lack prehnite and pumpellyite, but otherwise the principal mineralogy and texture remain unchanged. North of Marda, fine-grained felsic volcanic rocks are slightly recrystallized but, in the northern part of the Marda Complex, the presence of green-brown biotite suggests upper greenschist facies. Metamorphism and deformation progressively increase towards the margin of the Marda greenstone belt. The upper greenschist facies is marked by the complete breakdown of clinopyroxene to actinolite and, at higher metamorphic grade, hornblende replaces actinolite. At this grade primary textures are replaced by granoblastic-elongate and nematoblastic textures.

In other greenstone belts, textures are entirely metamorphic and there is evidence for more than one episode of metamorphism. However, it is difficult to resolve the effects of individual episodes. In the Bullfinch belt, metamorphism ranges from upper greenschist facies in the south (near Bullfinch) where the mafic rocks contain assemblages of biotite-tremolite-actinolite-clinozoisite-albite, up to mid-amphibolite facies throughout most of the greenstone belt. The higher grade is characterized by hornblende and andesine-labradorite in mafic rocks, andalusite-muscovite-quartz in pelitic rocks, metamorphic olivine and cordierite-anthophyllite in ultramafic rocks and grunerite in banded iron-formation. Similar assemblages indicate low to middle amphibolite facies metamorphism in other greenstone belts.

Two generations of tremolite growth have been observed in a layered amphibolite (*Aap*) 9 km northwest of Bullfinch. The first forms a nematoblastic groundmass which is transected by second-generation growth at an angle to the early fabric.

Contact metamorphism has been observed around the margin of the even-grained granodiorite and tonalite (*Agt*). Amphibolite has recrystallized with granoblastic texture and has developed metamorphic clinopyroxene in equilibrium with hornblende and plagioclase (andesine). This assemblage is indicative of the hornblende-hornfels facies of contact metamorphism.

GRANITOIDS

Approximately 80 per cent of JACKSON is underlain by several types of granitoid with significantly different ages. For mapping purposes these are subdivided on the basis of chemical composition and texture into three broad groups. The group (*An*) consists of banded gneissic and recrystallized granitoids which possibly include the oldest rocks on JACKSON. This group is intruded by younger granitoids (*Ag*), some of which have developed foliation either synchronously with their intrusion, or during later deformation and metamorphism. The third group (*Am*) is mixed granitoid and agmatite composed of a granitoid of the group (*An*) intimately intruded by one of the younger granitoids (*Ag*). The contacts between the older granitoids and the greenstone belts are sheared, faulted, or intruded by the younger granitoids (*Ag*).

An alternative, three-fold kinamatic classification was adopted by Bettenay (1977) in an extensive study of granitoids from the southern part of the Southern Cross and Eastern Goldfields Provinces.

No ages have been obtained for granitoids on JACKSON. However, similar granitoids have been analysed from BARLEE using the Rb/Sr technique (Chapman and others, 1980). Banded gneiss from Cockatoo Rocks 70 km west of Diemals homestead gave a whole-rock isotopic age of 2665 ± 100 m.y., and foliated adamellite which intrudes the greenstone sequence at Pidgeon Rock 30 km south of Diemals homestead produced an age of 2540 ± 130 m.y. These are likely to be metamorphic ages representing homogenization and closure of the Rb/Sr system during an event later than the formation of the respective granitoids. The authors also report that other foliated granitoids from the general area yielded ages of 2700-2600 m.y., which equate with the modal average age for the younger granites throughout the Yilgarn Block.

Layered and recrystallized granitoid (An)

Granofels: Granofels (*Anh*) is restricted to isolated remnants intruded by the younger granitoids on the western side of the Southern Cross Province. It is a collection of compositionally diverse granitoids which are characterized by the presence of granoblastic texture resulting from static recrystallization.Granitoids with a similar texture are common throughout the central wheatbelt area of the Southwest Province.

The granitoid outcropping 18 km southwest of Chiddarcooping Hill is a strongly recrystallized nebulitic adamellite. Nebulitic banding is defined by concentrations of biotite in a heterogeneous seriate adamellite. The heterogeneites are variations in the primary igneous texture, from fine grained to medium grained and variations in the proportions of biotite outside the nebulitic bands. The granofels 13 km west-southwest of Kuykara homestead is dominantly medium-grained, allotriomorphic to granoblastic biotite adamellite, with a recrystallized foliation poorly defined by biotite preferred orientation. This outcrop contains abundant rafts of older biotite-rich granodiorite. A related granitoid 4 km southwest of Mount Jackson homestead is a recrystallized leucocratic adamellite with large (up to 5 mm) euhedral garnet porphyroblasts.

Banded gneiss: Banded gneiss (*Anl*) forms part of the large area bounded by the Bullfinch, Marda and Yendilberin Hills greenstone belts. The section between the Bullfinch and Koolyanobbing belts is the continuation of the Ghooli Dome defined by Gee (1979). The Ghooli Dome contains a wide variety of banded gneiss and younger granitoid plutons, in contrast to the area northeast of the Koolyanobbing belt, which is mainly occupied by mesoscopically banded gneiss extensively intruded by a stockwork of fine-grained adamellite.

Excellent exposures in railway cuttings 27 km southwest and 37 km east of Koolyanobbing show a range of granitic gneiss banded on scales of 10 mm to several metres. Both primary flow folds and folds resulting from later deformation can be recognized. The oldest phase is schistose, biotite-rich granodiorite gneiss largely composed of recrystallized, elongate grains of strained quartz and feldspar orientated parallel to a fabric defined by plates of biotite. Magnetite is abundant (up to 2 percent). Intrusive leucocratic phases, now metamorphosed to granodiorite and adamellite gneiss, occur as veins which commonly have biotite selvages. Lenses of medium-grained granoblastic mafic amphibolite are often interlayered with the banded gneiss, but there is no evidence to indicate whether these are metamorphosed and deformed dykes or xenoliths. In these exposures two phases of deformation can be recognized. The first produced boudinage and folds (including detached isoclines) in the banding, and an axial-plane foliation; the second was responsible for open folds in the banding and in the first-phase foliation, and formation of crenulation cleavage.

Banded gneiss on JACKSON lacks the fine-scale banding (millimetre to centimetre scale) described from gneiss on BARLEE (Walker and Blight, 1981) and YOUANMI (Stewart and others, 1981).

Large areas west and north of the Koolyanobbing greenstone belt are underlain principally by banded gneiss composed of parallel bands up to 1 m wide of alternating granitoid phases. All of the phases are of igneous origin and bear the same overprinted gneissic foliation with associated granoblastic-elongate texture. The banding is at a low angle to the foliation and thus is attenuated rather than folded. The oldest phase is biotite granodiorite and adamellite gneiss with relict phenocrysts of oligoclase, and common nebulitic biotite schlieren aligned parallel to the banding. This phase is intruded by regular parallel dykes, up to 2 m wide, of biotite adamellite gneiss, originally with coarse-grained seriate texture. The intruding phase contains biotite schlieren and rafts of the older granodiorite phase.

On the northeastern side of the Koolyanobbing greenstone belt the banded gneiss is intruded by coarse-grained leucocratic granodiorite, which also intrudes the greenstone belt, thus obscuring the relationship of the banded gneiss to the greenstone. Both the granodiorite and the banded gneiss are intruded by medium-grained adamellite to form the mixed granitoid (*Ame*).

Younger granitoids (Ag)

Granitoids in this class commonly form well-defined homogeneous bodies with sharp intrusive contacts. Some of this group possibly have primary protoclastic texture but most, with the exception of the seriate adamellite (*Agv*) west of the Bullfinch greenstone belt, contain overprinted foliation in discontinuous north to north-westerly trending zones. The younger granitoids have not been subdivided in areas which were not visited and for which reasonable interpretation could not be made.

Medium to coarse biotite granite and adamellite: Medium and coarse, even-grained biotite granite and adamellite (*Agb*) and its foliated equivalent (*Agg*), are ubiquitous in the northern part of JACKSON and probably form most of the unassigned granitoid. In the northern area no discrete plutons have been recognized.

However, in the southern part this adamellite forms discrete elongate domes 5 km south of Koolyanobbing and at Darrine Rock. At the former locality, the adamellite has a primary foliation defined by feldspar alignment and weak biotite banding.

The biotite granite and adamellite (*Agb*) is dominantly even-grained but there is some variation to seriate texture. Textures are characteristically allotriomorphic to hypidiomorphic and recrystallization is of minor importance. Zoned plagioclase and myrmekitic quartz/alkali-feldspar intergrowth indicate that crystallization was generally magmatic. Biotite, in discrete, randomly orientated books forms up to 10 per cent of the rock. Weak strain is shown in some samples by slight elongation of constituent minerals and, in places, by weak cataclasis.

Zones of high strain overprint the granite and adamellite (*Agb*) to produce foliated, medium- and coarse-grained biotite granite and adamellite (*Agg*). The fabric is produced by flattening and elongation of quartz and feldspar. There is a complete range from strained mineral grains with little recrystallization, to granoblastic, elongate grains formed by complete recrystallization. In the latter case, biotite is recrystallized and strongly orientated parallel to the fabric.

Discrete plutons of foliated adamellite within the Bullfinch greenstone belt have sharp contacts. Deformation, including some shearing, is most intense at the pluton margins. A strong sub-horizontal mineral lineation within the foliation is parallel to fold axes in the greenstone sequence, and suggests that the tectonic fabric resulted from the same deformation as that which folded the greenstone belt.

Fine to medium biotite granite and adamellite: Fine and medium even-grained biotite granite and adamellite (*Age*) is, in general, the fine-grained textural and compositional equivalent of the unit (*Agb*). Throughout JACKSON however, it forms only small bodies, most of which are genetically distinct from the larger bodies of (*Agb*). Notable exceptions include bodies south and southeast of Koolyanobbing which are integral parts of elongate plutons of dominantly coarse-grained adamellite (*Agb*). In the Bullfinch greenstone belt between Trough Well and the vermin-proof fence, medium-grained biotite adamellite was emplaced after the major deformation in the region. It is composed of hypidiomorphic-granular biotite adamellite, some of which contains accessory fluorite and muscovite. Accessory epidote and chlorite result from partial alteration of feldspar and biotite respectively.

Fine-grained granite and adamellite is an important constituent of the granitoid terrain northeast of the Koolyanobbing greenstone belt. Foliation throughout the greatest part of this area is weak but may be strongly developed in isolated zones. Thus, textures range from hypidiomorphic through granoblastic to microgranular. Biotite is the dominant mafic mineral, constituting up to 10 per cent of the rock, although the adamellite at Ullumbay Soak contains an equal portion of hornblende and biotite. A common feature of deformed, fine-grained adamellite is the occurrence of slightly coarser grained patches (up to 20 mm in diameter) which have not recrystallized to a finer, granular mosaic. These patches contain less biotite and stand out as leucocratic spots.

Fine-grained adamellite forms a complex stockwork invading the banded gneiss. Larger homogeneous areas have been mapped separately but, otherwise, the map unit (*Ame*) has been used. In most areas, the fine-grained adamellite intruded as dykes which cross-cut the gneiss but, in other areas, evidence of complex migmatic relationships is seen as partially assimilated banded-gneiss phases in swirls of schlieric adamellite.

Granodiorite and tonalite: Medium and coarse, even-grained granodiorite and tonalite (*Agt*) form a large, uniform body centred on Lake Deborah West. These rock types are dominantly leucocratic, with sparse biotite (up to 3 per cent). Near the western margin, adjoining the amphibolite of the greenstone belts, sparse hornblende is also present. Garnetiferous pegmatite intrudes the granodiorite in this area. The granitoid intrudes banded gneiss (*Anl*) and the eastern edge of the Bullfinch greenstone belt. However, its relationship to the other granitoids cannot be established. The body lacks tectonic fabric except along its western margin. The fabric present there belongs to the youngest group of north-northwesterly trending structures in the Bullfinch greenstone belt.

Heterogeneity within this body on outcrop scale is evidenced by nebulous biotite-rich banding and abundant rafts (up to 50 per cent by volume) measuring up to 1 m wide and several metres long. The elongation of the rafts together with the banding defines a primary flow foliation. These rafts are principally fine and medium, even-grained biotite tonalite gneiss, except near the contact with the greenstone belt where fine-grained amphibolite is dominant. The primary texture of the rafts is recrystallized to a granoblastic texture. The source of the gneissic tonalite is not exposed on JACKSON.

Hornblende-plagioclase porphyry: An isolated outcrop of fine-grained hornblende-plagioclase porphyry (*Agh*) occurs in the Hunt Range, 11 km north-northwest of Kurrajong Rockhole. Euhedral phenocrysts of plagioclase (now replaced by albite and epidote) and hornblende (now pseudomorphed by chlorite and actinolite) are set in a brown microcrystalline groundmass. Despite alteration, this rock does not have the cataclastic-style fabric characteristic of the adamellite which it intrudes. The porphyry probably is a small, high-level intrusion which post-dated the major development of the Archaean granitoids.

Coarse granite and adamellite: A large volume of medium and coarse-grained seriate granite and adamellite (*Agv*) occupies the area of JACKSON west of the Bullfinch greenstone belt. It is the most northeasterly occurrence of this granitoid, which extends throughout the Southwest Province. Textural variation is common even across a single outcrop. Although the texture is almost universally seriate, the size-range and abundance of potassic feldspar phenocrysts is highly variable. However, truly porphyritic types are rare. Textures range from allotriomorphic to hypidiomorphic and, rarely, are slightly recrystallized. Rare prehnite and chlorite are derived from the alteration of plagioclase and biotite respectively. Zoned plagioclase is common and indicates that crystallization was at least in part magmatic. Small grains of topaz were found in a loose boulder of altered granite 3 km west of Coorancoopin Hill. Segregations of graphic pegmatite, with microcline crystals up to 200 mm in length, occur in most outcrops.

Feldspar laths occur up to 50 mm in length and, together with rare biotite schlieren, define a primary foliation. Regular variation in the attitude of this foliation apparently outlines discrete cells or bodies within the large mass. Intrusive relationships between similar phases of seriate adamellite 2 km south-southeast of Chutawalakin Hill suggest that the vast area occupied by this granitoid comprises more than one intrusion. The similarity of the phases at this locality makes lateral tracing of the contact impossible.

Near Kuykara homestead, the seriate adamellite intrudes the Bullfinch greenstone belt and contains xenoliths stoped from it. The strong fabric development in the xenolith, identical to that in the adjacent greenstone belt, indicates that the adamellite intruded after the main tectonic development of the Southern Cross

Province. Bodies of seriate adamellite 16 km southeast of Mount Jackson homestead, and on the eastern side of the Hunt Range, have undergone some deformation which indicates that they may be older than adamellite in the southwestern part of JACKSON.

Granophyric granite and adamellite: Fine- and medium-grained granophyric granite and adamellite (*Agf*) intrudes the Marda Complex, but its age relative to other granitoids is not known. It is bounded by a sharp western contact, but other boundaries are not exposed. Porphyritic textures are most common. The phenocrysts are typically plagioclase (zoned andesine to oligoclase) and embayed quartz. They are commonly mantled by coronas of granophyric intergrowth of quartz and alkali feldspar, and enclosed by a matrix of fine-grained allotriomorphic quartz, albite, potassic feldspar and magnetite.

An average chemical composition from 5 samples (Hallberg and others, 1976b) shows that this adamellite is chemically similar to the felsic volcanic rocks that it intrudes. It is therefore considered that the granophyric adamellite and the rhyolitic volcanics were derived from the same magma, and that the adamellite moved up to a higher crustal level late in the history of the complex.

STRUCTURE

Doming of granitoid rocks as a response to regional stress or density inversion in the central Yilgarn Block has been recognized on SOUTHERN CROSS (Gee, 1979) and BARLEE (Walker and Blight, 1981), but interpretations differ with respect to timing and specific details. However, a second mechanism, namely concentration of crustal shortening and shear in linear zones, is important on JACKSON but was considered to be of minor importance on BARLEE and SOUTHERN CROSS.

The oldest structure on JACKSON is possibly the layering preserved in the oldest granitoid phases within the banded gneiss (*Anl*). Definitive evidence for this hypothesis is not found on JACKSON, but it has been argued for similar rocks on BARLEE (Walker and Blight, 1981) and YOUANMI (Stewart and others, 1981), where it was suggested that the older gneiss formed a basement to the layered greenstone sequence. Some younger phases within the banded gneiss on JACKSON intrude the basal part of the greenstone succession. These phases show structural histories which are identical to those of the greenstone belts.

All of the greenstone belts on JACKSON show evidence of at least two major phases of deformation. Although there is no direct evidence that the phases are equivalent in all of the greenstone belts, their sequential development and style can be considered equivalent for the purpose of description. The early deformation resulted from doming of the gneiss and older granitoids, while the later deformation involved concentration of strain in linear zones.

The early, pervasive metamorphic foliation in the Bullfinch, Koolyanobbing and Hunt Range greenstone belts is axial planar to tight folds in the layered sequence. The distribution of strain and fabric development in the thick, relatively massive basalt piles tended to concentrate into zones. Strike faults are common in zones of high strain. Foliation is well developed near the margin of the Marda greenstone belt but is less penetrative away from the margin. There is no recognizable fabric in the basalt more than about 5 km from the margin, although folds are still developed within the banded iron-formation. Strong mineral elongation and alignment parallels fold axes in areas of strong fabric development.

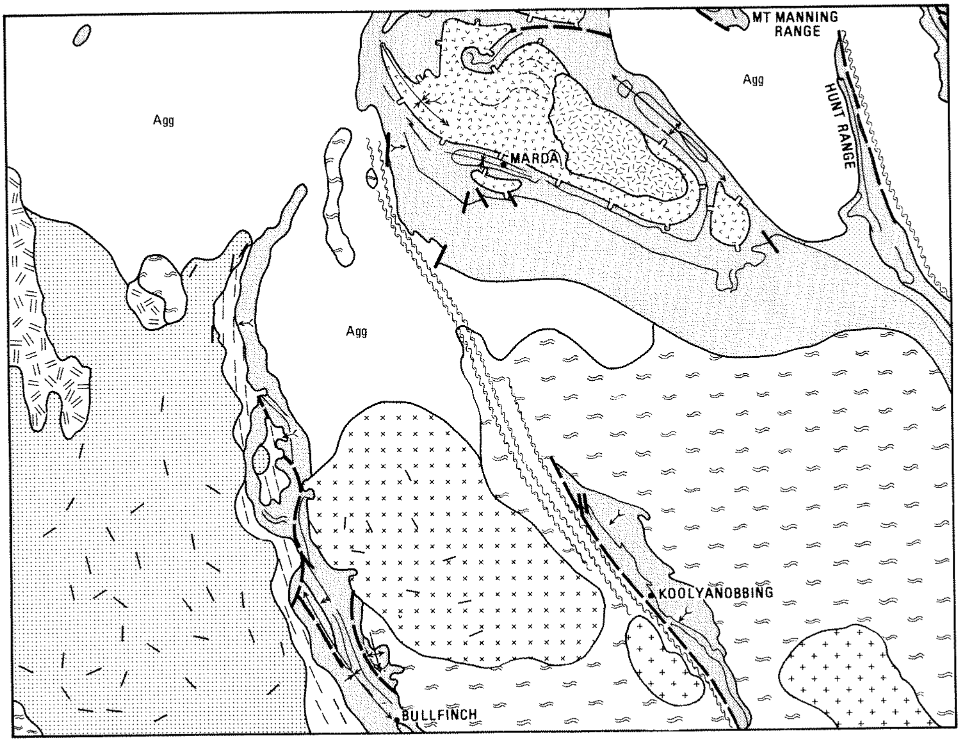

FIGURE 2

STRUCTURAL INTERPRETATION

JACKSON SHEET SH 50 – 12

0 20 Km

REFERENCE

- Seriate granite and adamellite
- Granofels intruded by seriate adamellite
- Granophyric granite
- Rhyolitic and andesitic volcanics and basal sediments
- Even-grained granite and adamellite
- Granodiorite
- Agg Foliated granite and adamellite
- Sedimentary rock
- Banded iron formation
- Mafic and ultramafic rocks
- Recrystallized gneiss, banded gneiss

- Geological boundary
- Unconformity
- Fault
- Trend line
- Interpreted facing of strata
- Shear zone
- Trend of primary igneous foliation
- First generation synform
- First generation antiform
- Second generation antiform
- Second generation synform.

Regional fold axes lie at a slight anticlockwise angle to the north-northwesterly trend of the greenstone belts, and thus intersect the belt margins. This angular relationship is also characteristic of folds in the Maynard Hills greenstone belt on YOUANMI (Stewart and others, 1981). The whole of the Marda greenstone belt may be an extreme example of such geometry. As a consequence of this pattern, large sections of the Bullfinch greenstone belt are simple, uniformly dipping sequences similar to those of the Koolyanobbing and Hunt Range belts. The pattern may be due to a regional shear-couple effect between the granitoid domes during deformation.

Granite and gneiss domes on JACKSON are poorly outlined, in contrast to those on SOUTHERN CROSS which are rimmed by greenstone belts. Contacts between domes are obscured by poor outcrop and intrusion of later granitoids at the margins. The weak northeasterly trending metamorphic foliation in the region between Koolyanobbing and Bungalbin Hill is one of the few pieces of evidence for dome structure on JACKSON. The granitoids which post-date the gneiss also transect the early foliation of the greenstone belts, and bear no protoclastic fabric. It is possible that these granitoids were generated during the doming of the gneiss, and subsequently intruded the greenstone belts and gneiss.

The dome structure has been greatly modified by intense deformation which produced north-northwesterly trending belts of strongly granulated and mylonitized rock. Faults are localized in linear zones of high strain along the western side of the Koolyanobbing greenstone belt and the eastern margin of the Hunt Range belt. Second generation deformation in all belts is considered to be synchronous with the formation of these zones, and resulted in folding and crenulation of the earlier metamorphic fabric. The first generation folds in the Bullfinch belt were tightened and, on the western side, the metamorphic fabric was deformed into a large-scale, vertically plunging fold. Second generation folds have axes at a low angle to the trend of the Koolyanobbing belt.

This deformation produced the first generation fabric in the Marda Complex. The fabric is penetrative near the western margin and locally developed elsewhere. Box folding and related sliding of the banded iron-formation ridge at Bungalbin Hill, together with intense crenulation of the metamorphic foliation in the mafic amphibolites south of Bungalbin Hill, resulted from this late deformation in a zone which intersects the greenstone belt. Second generation folding is common in small discontinuous zones in banded iron-formation throughout this belt.

The structure of the layered succession which surrounds the Marda Complex is difficult to interpret. To explain the discontinuous distribution of the banded iron-formation, it is necessary to rotate, or translate, large segments over great distances. The northern limb of the banded iron-formation which is folded at Marda, and the ridge at Windarling Peak, are examples of discontinuous units. The fact that the Marda Complex rests unconformably on the greenstones and does not show first generation structures supports the possibility that a large granitoid dome underlies this area and is responsible for the large-scale dislocation in the greenstone belt. However, the presence of such a dome is difficult to reconcile with the gravity high in this area.

The late, regional, seriate adamellite (*Agv*) on the western side of JACKSON cross-cuts all of the major structures in the Southern Cross Province. Except for minor local shears and joints this rock type is undeformed.

A major lineament, which trends west-southwesterly from Clarkson Flats, through Lake Deborah West and on to SOUTHERN CROSS controls the major drainage in the southwestern part of JACKSON. There is no outcrop along this lineament, but it appears to displace aeromagnetic anomaly trends within the greenstone belt. The lineament is parallel to the Proterozoic dyke suite on JACKSON and adjoining sheet areas, and transects all Archaean lithological boundaries, suggesting that it is related to the fracture system which controlled the dykes.

ECONOMIC GEOLOGY

PRECIOUS METALS

Gold

The first gold prospect on JACKSON was a small find by Anstey at Ennuin in 1887 (Woodward, 1895; Parker, 1904). Shortly afterwards Bernard Colreavy, following up the find by Anstey, found gold at Golden Valley. In 1888, as a consequence of his find, the Yilgarn Goldfield was declared and the first lease granted at Golden Valley. Prospecting activity spread rapidly in all directions from Golden Valley and by October 1894, two mines were also operating at the Jackson Centre (Blatchford

TABLE 1. TOTAL GOLD PRODUCTION TO 1978 FOR JACKSON

Mining Centre	*Ore Treated (tonnes)*	*Total Gold (kg)*
Bullfinch	3 961 716	20 932
Ennuin	14 094	401
Golden Valley	105 239	3 275
Koolyanobbing	2 533	41
Mount Jackson (a)	67 352	1 395
Total	4 150 934	26 044

(a) Includes mines in the southern part of BARLEE
Reference: Mines Statistics Branch

TABLE 2. PRODUCTION OF PRINCIPAL GOLD MINES ON JACKSON

Mining Group	*Mine*	*Period*	*Ore Treated (tonnes)*	*Total Gold (kg)*
Bullfinch	Bullfinch Leases	1910-21	486 682	5 510.97
	Easter Gift	1927-41	5 274	52.56
	Copperhead	1928-41	7 546	64.57
	Rising Sun	1928-42	37 655	337.16
	Copperhead Deeps	1931-40	13 773	127.62
	Goldfinch	1932-41	6 560	82.14
	Francis May	1932-41	8 823	104.17
	Copperhead	1952-66	3 373 163	14 243.00
Ennuin	Yellowdine	1934-42	7 460	236.54
Maries Find (Redwing)	Great Bingin	1938-43	17 040	318.78
	Stumpy Doodle	1940-44	2 317	25.66
Radio-Manxman	Radio	1916-78	57 335	2 209.65
	Radio Deeps	1924-46	5 812	195.86
Koolyanobbing	Chadwicks Reward	1934-38	1 012	15.58
Allens Find	Allens Find	1912-17	1 667	26.03
		1933-40	1 865	30.46
Atkinsons Find	Butcher Bird No. 1	1912-18	2 837	63.42
Riedels Find	Great Unknown	1911-47	2 562	141.51
Mount Jackson	Mount Jackson Leases	1897-1909	29 818	604.46

References: Mines Department Annual Reports; Bulletin 101; Mines Statistics Branch.

and Honman, 1917). There were lulls in mining activity in 1901 and 1907-10, in which year gold-bearing reefs were discovered at Marda. Bullfinch, which was found in 1909 by the Doolette Syndicate led by C. Jones, was initially very rich. This find increased the interest in the Bullfinch belt, which had been eclipsed by more important fields elsewhere.

Gold production from the 5 mining centres on JACKSON totals 26 044 kg from 4 150 934 tonnes of ore. Production figures for individual centres are shown in Table 1, and for selected mines and mining groups in Table 2.

Gold mines on JACKSON are located throughout the greenstone belts and, except for those workings in the northeastern area, the gold-bearing ores are found in a variety of geological settings. The geology and mine development of individual gold leases are described in numerous publications including Montgomery (1911), St Smith (1912), Blatchford and Honman (1917), Maitland (1919), Hobson (1936, 1937), Matheson (1936, 1937, 1939, 1940, 1941), Matheson and Miles (1947), Clappison and Zani (1953) and Noldart (1958a, b, c).

About 78 per cent of the total gold production on JACKSON came from the Bullfinch leases, of which the Copperhead Mine, operated by Great Western Consolidated N.L. from 1952 to 1966, was the leading producer. The gold is concentrated in quartz stringers which, in the northern part of the mine, occur in an alteration zone composed principally of dolomite, calcite and actinolite and which, in the southern part of the mine, occur within two jaspilite bands. The host rock to these lodes is komatiitic ultramafic schist. Sulphides, including pyrite and galena, are found with the gold below the oxidation zone from about 60 m depth (Blatchford and Honman, 1917; Matheson and Miles, 1947).

Another major producer was the Radio-Manxman Group, which operated from 1911 to 1978. The treatment plant on this site was still operating in 1979, treating ore from Marvel Loch. The mine is situated in ultramafic schist, mafic amphibolite and jaspilite, near the contact with banded gneiss and pegmatite. The gold is concentrated in quartz reefs which are emplaced in fissures trending north-northeasterly. The quartz veins are cut by pegmatite but their relationship with the banded gneiss is not clear.

Silver

Silver has been produced on JACKSON as a by-product of gold mining. Production, which has been recorded only from the centres of Bullfinch, Golden Valley and Jackson, is shown in Table 3.

TABLE 3. SILVER PRODUCTION ON JACKSON

Mining Centre	*Mines*	*Period*	*Total Silver (kg)*
Bullfinch	Copperhead	1952-66	3 949.27
	Bullfinch Pty	1911-21	865.70
Mount Jackson	Mount Jackson G.M.	1903-07	71.94
Golden Valley	Radio Leases	1946-69	62.33
		1970-78	1.40
		Total	4 950.64

Reference: Mines Department Annual Reports.

IRON ORE

Koolyanobbing area

Five large, and several smaller, iron ore deposits occur over a length of 14 km along the discontinuous Koolyanobbing Range. Several geological investigations have been carried out since the original discovery, which is thought to have been made by gold prospector Henry Dowd in 1887. Two deposits were first mapped and sampled by Blatchford (1917) and later by Hobson (1948a), who also located three new deposits. Iron-ore production commenced in 1950 from 'A' deposit (MacLeod, 1966). The Geological Survey of Western Australia undertook diamond drilling in 1952 to locate pyrite as a source for sulphur, and this evaluation is reported in detail by Ellis (1958). Descriptions of the geology have been made by Miles (1953), B.H.P. Staff (1975) and Griffin (1980).

There are three distinct types of iron-ore deposit within the same banded iron-formation. The first type results from the formation of limonite and hematite by the oxidation of carbonate- or sulphide-rich banded iron-formation during supergene alteration. The second type is an enrichment of oxide-facies banded iron-formation by the penetration of meteoric and groundwaters in zones made porous by deformation. The Dowd Hill orebody is a third type of deposit, characterized by massive goethite, coarse-grained specular hematite, limonite and minor magnetite, and confined between walls of chlorite and talc schist. It is thought to have formed principally by syntectonic, hydrothermal leaching and deposition restricted to zones of intense brecciation in fold cores in banded iron-formation. However it also shows some features of the first two types of deposit.

B.H.P. Staff (1975) report an average grade of 61.4 per cent iron (with 0.13 per cent phosphorus) for ore from the Dowd Hill orebody and similar grades for ore from the 'A' deposit (but with 0.04 per cent phosphorus). Reserves for both deposits together total 40 million tonnes. Total reserves for the Koolyanobbing area are given by Hallberg and others (1976c) and are shown in Table 4. Production from Dowd Hill, the largest of the deposits, commenced in 1967 and totalled 19.36 million tonnes to the end of 1978. Production from 'A' deposit between 1950 and the end of 1978 was 1.85 million tonnes.

TABLE 4. IRON ORE RESERVES ON JACKSON

Deposit	*Reserves (x 10^6 tonnes)*	*grade (per cent iron)*
Bungalbin Hill	61.0	58
Koolyanobbing	54.0	62
Mount Jackson	30.5	62
Windarling Peak	25.4	65

Other deposits

Iron-ore deposits have been located and tested in the Bungalbin Hill area, 2 km southwest of Mount Jackson, 6 km southeast of Mount Jackson homestead and 7 km north of Windarling Peak. All deposits are contained within banded iron-formation and result from the concentration of limonite and hematite in bedding and fractures. This concentration has been explored and sampled below the zone of supergene enrichment by means of deep shafts. Nevertheless, Tertiary supergene enrichment has been important in the formation of these deposits. Description and analyses of the Bungalbin Hill deposit are given by Sofoulis (1960) and the mineralogy of six samples is described by Vernon and Edwards (1959).

OTHER METALS

Nickel

There has been no production of nickel from JACKSON and despite extensive exploration only two prospects have been reported.

In 1970 International Mining Corporation N.L. announced the discovery of nickeliferous gossans over ultramafic rocks 5 km east of Trough Well. Marston (in press) describes this prospect in detail. Percussion and diamond drilling has revealed disseminated sulphide mineralization in three areas along the basal contact of the ultramafic sequence. The most important intersections suggest ore reserves of 20 000 tonnes at 2.5 per cent nickel in the southern area.

Exploration by BHP in the Koolyanobbing Ranges located nickeliferous gossans over serpentine-bearing, talc-carbonate and tremolite-chlorite rocks (Marston, in press). At the '90 zone' prospect, pyrite, violarite, chalcopyrite, millerite, covellite and smythite occur in irregular veins and layers within the ultramafic schist, and at the '125 zone' prospect nickel sulphides occur at the contact with sulphide-bearing banded iron-formation.

Copper

The earliest report of copper is from gold mines at Golden Valley (Maitland and Jackson, 1904). The occurrence of copper carbonate mineralization, in fractures and along the margins of quartz veins along sheared granite-greenstone contacts at Koolyanobbing and Mount Jackson, is reported by Blatchford and Honman (1917). The only recorded production was a parcel of 16 tonnes of ore which yielded 0.82 tonnes of copper from the Mount Jackson locality (Matheson and Miles, 1947). Copper mineralization has been explored in a shaft 4 km east of Currajong Well but no records of production have been found. The mineralization consists of abundant malachite and azurite which fill fractures in a quartz reef cutting through mafic amphibolite.

NON-METALLIC MINERALS

Alunite

Exploration in the Lake Brown drainage system by Forman (1932) yielded a sample from Lake Baladjie which was analysed to be 62.8 per cent alunite ($KAl_3(OH)_6(SO_4)_2$), and two samples from Lake Deborah West which contained 4.9 and 2.8 per cent alunite. However Hobson (1948b) reports that in 13 check samples around the original location, no trace of alunite was found.

Gypsum

Seed gypsum and kopi occur in dunes on the southeastern side of Lake Seabrook (de la Hunty and Low, 1958). The seed gypsum has been mined since 1926 and 525 909 tonnes removed up to the end of 1978. The reserves have been estimated at one million tonnes (Low, 1976). Crystal gypsum also occurs at Lake Seabrook and is reported from Lake Baladjie.

Salt

Simpson (1952) first reported a 6 inch layer of salt (96.5 per cent NaCl) on Lake Deborah suitable for curing hides and for stock licks. Salt is currently mined in Lake Deborah East 19 km northwest of Koolyanobbing, but no production figures are available.

Talc

Simpson (1952) mentions a talc occurrence at Bullfinch but its existence has not been confirmed.

WATER RESOURCES

Town water supplies on JACKSON are piped from Mundaring Weir in the Darling Ranges east of Perth. Small supplies for stock are obtained from dams and bores. The G.S.W.A. was involved with Drought-Relief-Program drilling in the south-western area of JACKSON in 1969 and 1970. Prospects for potable shallow groundwater are poor.

APPENDIX
Localities Mentioned in Text

Locality	*Latitude*	*Longitude*
Allens Find	30°11′	119°15′
Atkinsons Find	30°11′	119°17′
Baladjie Rock	30°57′	118°52′
Bullfinch	30°59′	119°06′
Bungalbin Hill	30°23′	119°38′
Chiddarcooping Hill	30°54′	118°40′
Chutawalakin Hill	30°55′	118°43′
Clarkson Flats	30°32′	119°36′
Coorancoopin Hill	30°52′	118°41′
Copperhead Mine	30°58′	119°08′
Currajong Tank	30°28′	118°52′
Darrine Rock	30°52′	119°51′
Day Mine	30°56′	119°04′
Diemals homestead	29°40′	119°18′
Dowds Hill	30°48′	119°31′
Eenuin	see Ennuin	
Elachbutting Hill	30°35′	118°36′
Ennuin	30°42′	118°58′
Golden Valley	30°53′	119°02′
Hamersley Lakes	30°26′	118°44′
Hughes Hill	30°54′	119°02′
Hunt Range	30°11′	119°52′
Koolyanobbing	30°49′	119°31′
Kurrajong Rockhole	30°11′	119°53′
Kuykara homestead	30°19′	118°52′
Marda	30°12′	119°16′
Maries Find	30°49′	119°03′
Mount Colreavy	30°53′	119°01′
Mount Dimer	30°21′	119°55′
Mount Jackson	30°15′	119°16′
Mount Jackson homestead	30°12′	119°06′
Mount Manning Range	29°58′	119°38′
Mudahdah	30°00′	119°11′
Newfield (Carterton) Mine	30°30′	118°53′
Pigeon Rocks	29°55′	119°17′
Radio Mine	30°55′	119°05′
Trough Well	30°39′	118°55′
Ullumbay Soak	30°49′	119°59′
Windarling Peak	30°04′	119°17′
Yendilberin Hills	30°24′	119°57′
Yerilgee Tank	30°04′	120°01′

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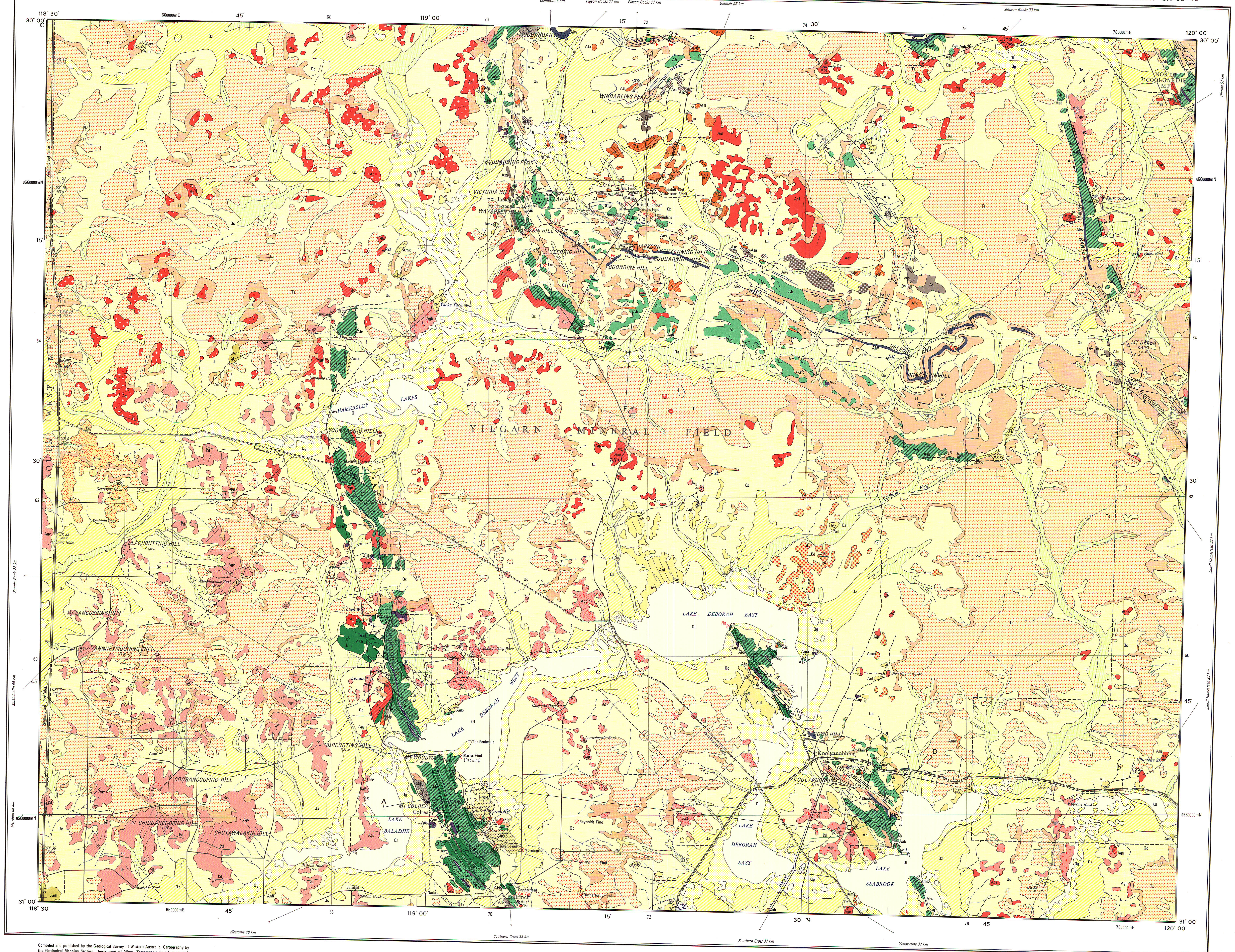
AUSTRALIA 1:250 000 GEOLOGICAL SERIES

JACKSON

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 50-12



SYMBOLS

Geological boundary	
Fault	
accurate	
inferred or concealed	
Shear zone	
Bedding (facing not implied)	
inclined	75
vertical	
Air photo lineament or trend line	
Facing	
interpreted from pillow structures	
interpreted from cross-bedding	
other	
Metamorphic foliation	
inclined	65
vertical	
indeterminable	
Crenulation cleavage	
inclined	80
vertical	
Primary igneous foliation	
inclined	80
vertical	
indeterminable	
Compositional layering in mixed igneous rocks	
inclined	80
vertical	
indeterminable	
Lineation	
mineral elongation	50
crenulation	70
Fold	
minor anticline	35
minor syncline	35
parasitic	65
Mineral field boundary	
Road	
Track	
Railway, 4'8"	
Townsite gazetted (population less than 1000)	Bullfinch
Homestead	Mt Jackson
Locality	Marda
Landing ground	
Horizontal control, major, minor	
Benchmark, height accurate	HJ 9 350 m
Watercourse intermittent	
Well	W
Bore	B
Rockhole	RH
Tank	T
Dam	D
Soak	Sk
Mining centre	GOLDEN VALLEY
Gold mine (may or may not be working)	Boondine
Prospect	
Quarry or open cut	
Battery (abandoned)	
Mineral occurrence	
Copper	Cu
Crushed rock aggregate	Rc
Gold	Au
Gypsum	Gp
Iron	Fe
Nickel	Ni
Salt	Na
Sand	Sd
Silver	Ag
Topaz	Tz

REFERENCE

CAINOZOIC

QUATERNARY

Ca Alluvium — silt, sand and gravel in stream channels
Cl Lacustrine deposits — saline and gypsiferous clay and silt in playa lakes
Cg Eolian and alluvial deposits — silt and sand in sheets and dunes; gypsiferous near playa lakes
Cs Sheet-wash deposits — silt and sand on gentle slopes marginal to Ca and Cl
Cc Colluvium — silt, sand and gravel on slopes adjoining rock and laterite outcrop

TERTIARY

Ts Remnant sandplain — yellow to white sand containing locally abundant limonite pebbles
Tl Laterite — limonite-cemented duricrust overlying deeply weathered bedrock
Tz Siliceous caprock — chalcedonic silica and siliceous limonite deposits over ultramafic rocks

PROTEROZOIC

Ed Dolerite dyke

q Quartz vein

ARCHAEAN

Ag Granitoid, photo-interpreted and unassigned
Agv Variably textured, medium and coarse-grained, seriate granite and adamellite; locally porphyritic
Agb Medium and coarse, even-grained biotite granite and adamellite; locally seriate
Age Fine and medium, even-grained biotite granite and adamellite; locally seriate
Agf Fine and medium-grained granophyric granite and adamellite; commonly porphyritic; intrusive into MARDA COMPLEX
Agh Fine-grained hornblende-plagioclase porphyry
Agt Medium and coarse, even-grained granodiorite and tonalite containing abundant biotite schlieren and xenoliths of fine-grained biotite tonalite
Agg Foliated medium and coarse-grained biotite granite and adamellite

Anh Granofels derived from mixed, banded or nebulously banded granitoid
Anl Banded granitoid consisting of phases of gneissic adamellite, granodiorite and tonalite
Ame Mixed granitoid consisting of the banded granitoid (Anl) extensively intruded by the fine-grained adamellite (Age)
Amv Mixed granitoid consisting of the granofels (Anh) extensively intruded by the seriate adamellite (Agv)
Amx Foliated heterogeneous granitoid containing abundant rafts of partly assimilated greenstone

As Metasedimentary rocks; unassigned
Asa Well-bedded quartzose and lithic, fine and medium-grained sandstone with rarely laminated siltstone interbeds
Asc Polymictic conglomerate with minor sandstone lenses
Asq Foliated quartzite and quartz-muscovite schist
Alp Quartz-muscovite (-andalusite -graphite) schist and phyllite
Alg Metamorphosed conglomerate with chert clasts in a quartz-muscovite schist matrix

Af Felsic volcanic rocks, unassigned; mostly deeply weathered
Afx Rhyolitic ignimbrite, minor tuff, agglomerate and tuffaceous sediment
Afl Rhyolite; commonly flow-banded and porphyritic
Afp Dacitic feldspar porphyry
Az Andesite; commonly porphyritic

Aic Banded chert
Aiw Banded iron-formation, quartz-grunerite-magnetite rock

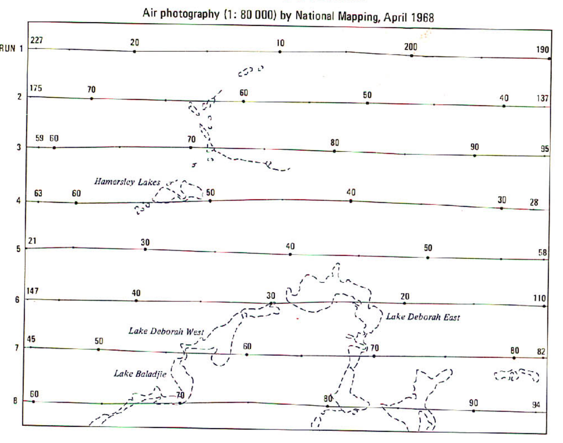
Ab Basalt; lower greenschist metamorphism
Aab Metabasalt, fine and medium-grained amphibolite containing plagioclase, hornblende and/or actinolite
Aad Metagabbro, medium and coarse-grained amphibolite containing plagioclase, hornblende and/or actinolite
Aap Banded para-amphibolite containing plagioclase, tremolite, actinolite and/or hornblende
Aax Metamorphosed agglomerate with mafic amphibolite matrix

Akf Metamorphosed leucocratic komatiitic basalt
Akb Metamorphosed komatiitic basalt; tremolite-chlorite (-talc) schist
Akp Serpentinized komatiitic peridotite with spinifex texture

Aur Coarse-grained tremolite (-chlorite -talc) schist, minor cummingtonite-cordierite-anthophyllite schist
Aup Metamorphosed peridotite and dunite with cumulate texture; partially or completely serpentinized
Aue Talc (-chlorite -carbonate) schist with minor talc-serpentine rock

FLIGHT DIAGRAM

Air photography (1:50 000) by National Mapping, April 1968



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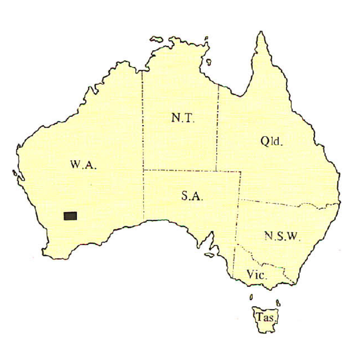
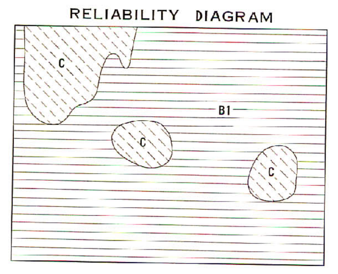


RELIABILITY DIAGRAM



B1 Traverses with air photo interpretation
C Air photo interpretation

HON. P. DOWDING, M.L.C.
MINISTER FOR MINES
A.F. TRENDALL, DIRECTOR, GEOLOGICAL SURVEY

SCALE 1:250 000

TRANSVERSE MERCATOR PROJECTION

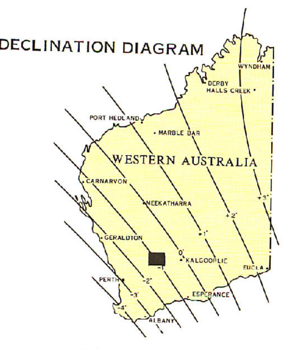
ZONE 50 AUSTRALIAN MAP GRID

Geology by R.J. Chin, R.A. Smith, J.A. Bunting 1978

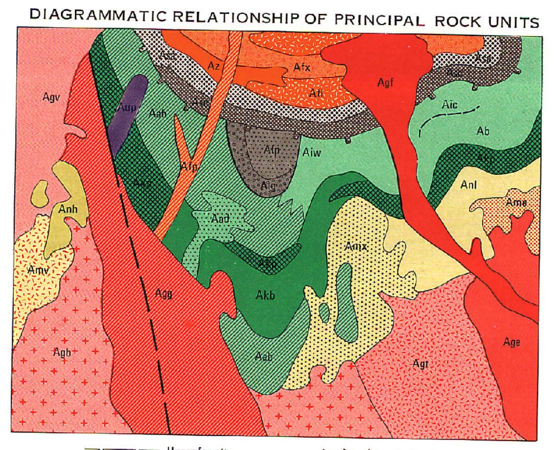
INDEX TO ADJOINING SHEETS

NINGHAN SH 50-7	BARLEE SH 50-8	MENZIES SH 51-5
BENCUBBIN SH 50-11	JACKSON SH 50-12	KALGOORLIE SH 51-9
KELLERBERRIN SH 50-15	SOUTHERN CROSS SH 50-16	BOORABBIN SH 51-13

DECLINATION DIAGRAM



DIAGRAMMATIC RELATIONSHIP OF PRINCIPAL ROCK UNITS



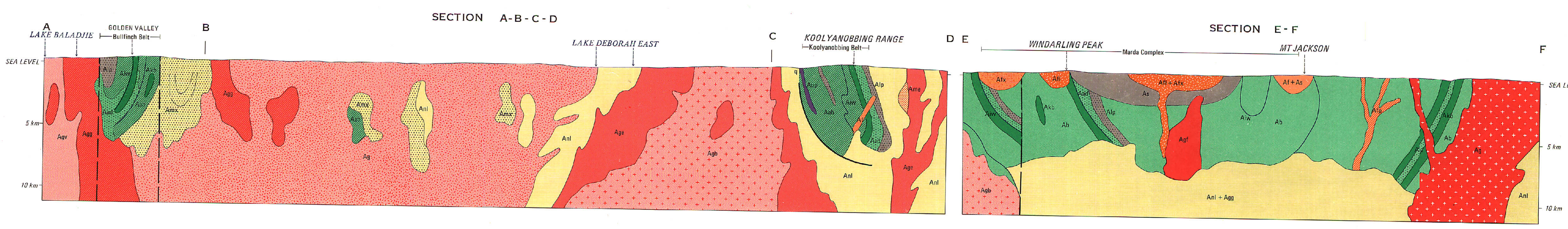
Unconformity
Facies change

DIAGRAMMATIC SECTIONS

NATURAL SCALE

SECTION A-B-C-D

SECTION E-F



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SHEET SH 50-12

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