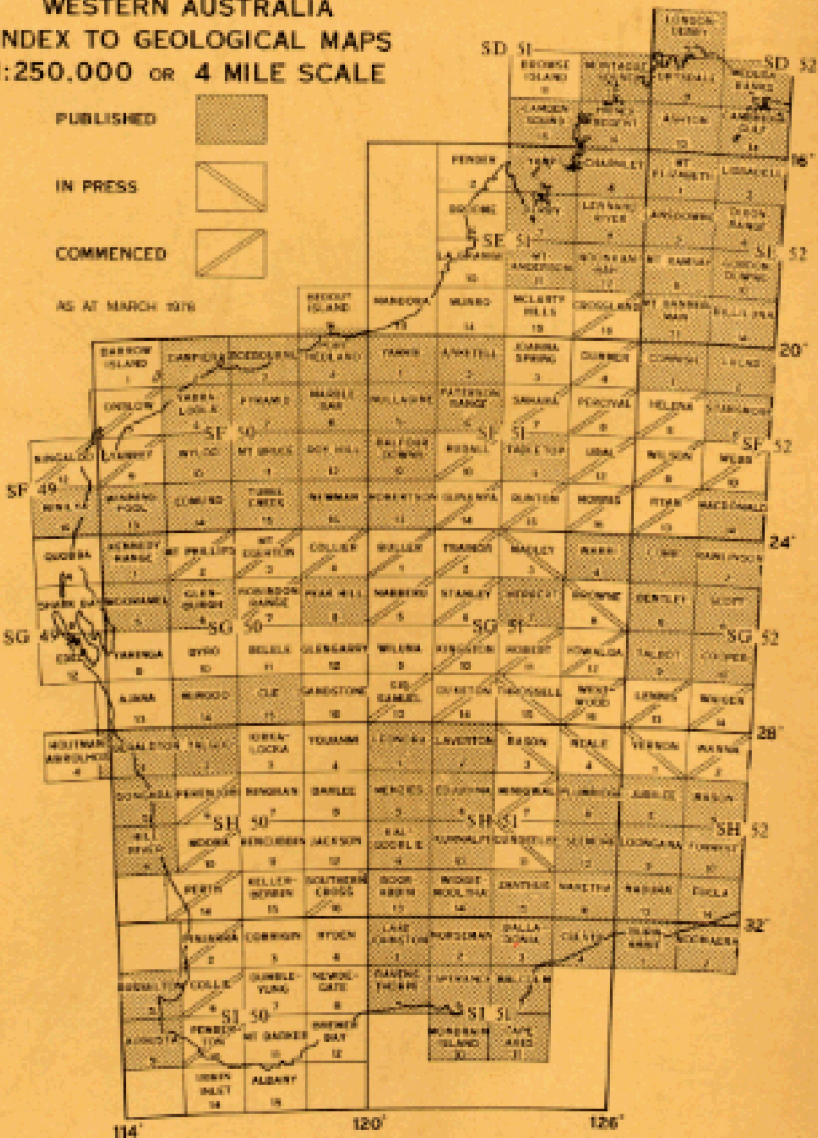
1:250 000 GEOLOGICAL SERIES—EXPLANATORY NOTES

LEONORA

WESTERN AUSTRALIA

SHEET SH/51-1 INTERNATIONAL INDEX

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



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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LEONORA

WESTERN AUSTRALIA

SHEET SH/51-1 INTERNATIONAL INDEX

COMPILED BY R. THOM & R. G. BARNES

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Explanatory Notes on the Leonora Geological Sheet

Compiled by R. Thom and R. G. Barnes
(Geological Survey of Western Australia)

INTRODUCTION

GENERAL

The Leonora 1:250 000 Sheet, SH/51-1 on the International Grid, is bounded by latitudes 28°00′ and 29°00′S and longitudes 120°00′ and 121°30′E. The Sheet is located within the Eastern Land Division, and straddles the boundaries of three goldfields—the East Murchison, North Coolgardie, and Mount Margaret Goldfields. The Sheet area takes its name from the town of Leonora in the southeast corner.

The population of the Sheet area was at its peak early in the century during the gold mining boom. Since the cessation of mining, towns such as Lawlers and Kurrajong have disappeared. With the closure in 1963 of the Sons of Gwalia gold mine (the largest outside the Golden Mile), Gwalia has become a 'ghost town'. Leonora (pop. 600) and Agnew (pop. 7), the only remaining towns within the Sheet area, have also declined, but remain as centres serving the region. The only other permanent habitation is confined to pastoral stations, but there is also a small transient population, mainly involved in mineral exploration.

The Sheet area is traversed by the Kalgoorlie-Wiluna road, and good graded roads lead from Leonora to Darlot and to Copperfield. Linked with these are graded roads to station homesteads. In addition, most fence lines have adjacent tracks, and tracks made by companies to facilitate mineral exploration allow good access to parts of the greenstone belt. Away from tracks travel by four-wheel drive vehicle presents little difficulty.

The field work was carried out between May and November, 1972. Petrological work was done mainly by R. Peers, with additional contributions by J. D. Lewis and Dr W. G. Libby, of the Geological Survey of Western Australia.

PHYSIOGRAPHY

Physiographic features of the Leonora Sheet area fall into three broad groups: (1) areas of outcrop, including erosional areas marginal to outcrop; (2) units derived from 1; (3) major saline drainages. These are shown on Figure 1.

Most of the physiographic relief coincides with areas of outcrop of fresh and weathered rock (unit 1). The main greenstone belt forms a range of hills stretching from Leonora to Agnew; some of the peaks are of metamorphosed basalt (Mount Ross, Mount Stirling), while others (Mount George, Mount Davis, Mount Leonora) owe their prominence to a resistant chert band within the felsic-clastic sequence. Differential erosion of chert bands within mafic and felsic-clastic sequences emphasizes the strike of the succession in the south of the Sheet area, whereas at Lawlers (where cherts are rare) the curvature of elongate hills of gabbro marks the closure of the Lawlers anticline

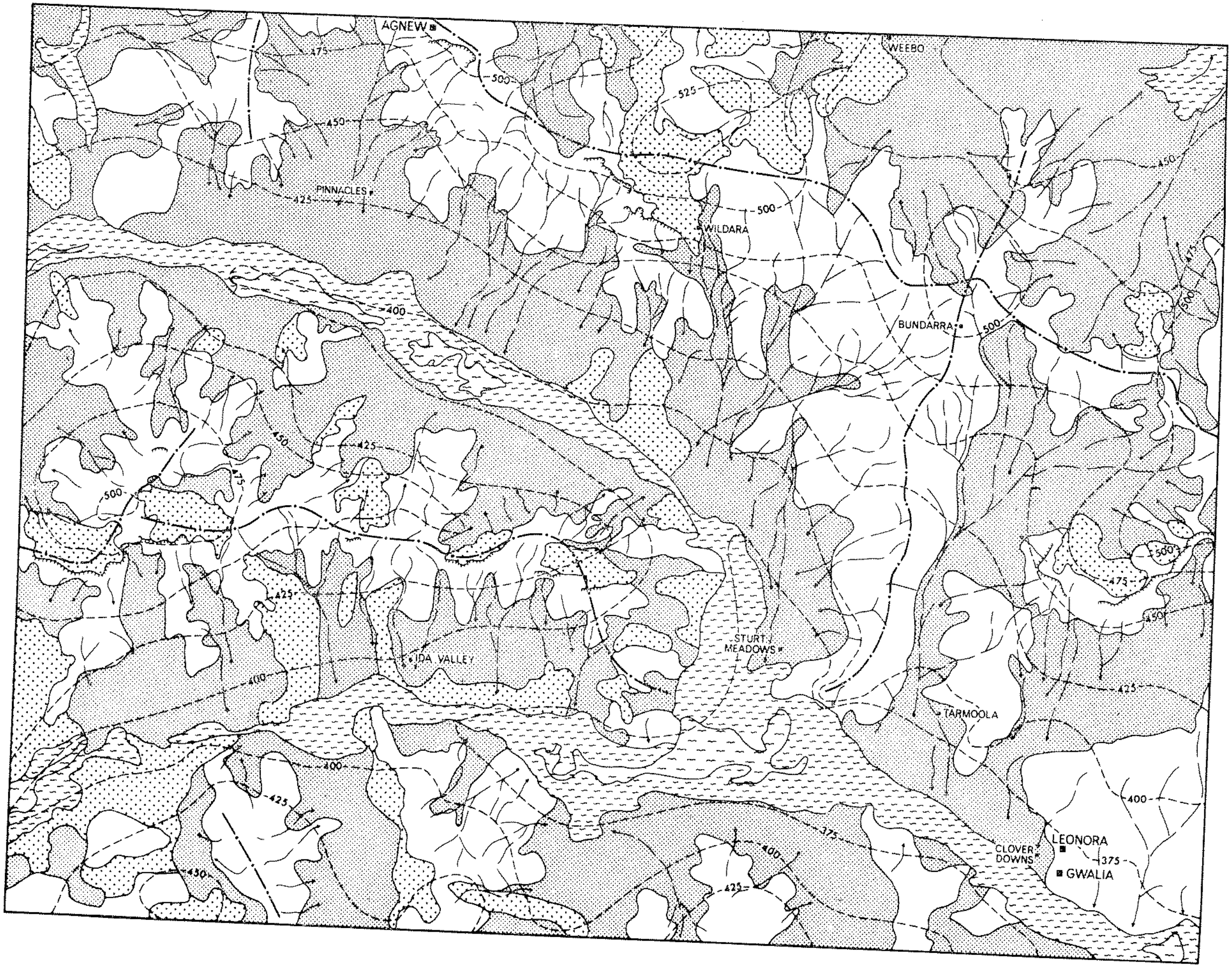

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FIGURE 1

PHYSIOGRAPHIC FEATURES

LEONORA SHEET SH 51-1

SCALE

5 0 5 10 15 20 25

KILOMETRES

REFERENCE

ERODING AREAS

1 Outcrop and areas of erosion marginal to outcrop

TRANSITIONAL AREAS

2a Alluvial and colluvial deposits derived from 1 (Qpv, Qqz, Qqc)

2b Eolian deposits derived from 1 & 2a (Qps)

SALINE DRAINAGES

3a Alluvial deposits derived from 1 & 2 (Qra)

3b Eolian and alluvial deposits derived from 1, 2 and 3a (Qrd, Qpk, Qrm, Qrs, Czk)

Watercourse

Breakaway

Watershed

400 Topographic contours (in metres)

WEEBO Homestead

Town

Fresh granite may take the form of rounded hills, such as Mount Adamson, or spectacular tors such as the porphyritic adamellite at Munjeroo; but granite usually crops out in more subdued form as flat sheets or bouldery outcrops. Migmatite at Maroon Range forms elongate hills parallel to strike. Deep-weathered granite gives rise to prominent south-facing breakaways, such as The Terraces, and to mesas, such as Table Hill. Agnew Bluff, a duricrust over mafic and ultramafic rocks, rises to 557 m above sea level and is the highest known point within the sheet.

Unit 2 includes colluvium and alluvium derived from the weathering of unit 1. In contrast to the high relief of unit 1, these deposits mainly form flat, mulga-covered plains with wide, poorly-defined drainages recognizable only by the density of vegetation (Qpv), or the complete absence of it (Qpw). Usually these water-courses are dry, but heavy rain causes flooding and sheet wash. Large creeks with deep, well-defined channels are also a feature of the Sheet area. Eolian deposits (Qps) of physiographic unit 2b (Fig. 1) occasionally form distinct dunes, as at Wildara homestead, but more commonly have a gently undulating surface.

The major saline drainage (unit 3) is Lake Raeside, which forms a 'Y'-shaped confluence across the Sheet area. Saline alluvium (Qra) forms bare expanses of clay and silt, surrounded by tracts of saltbush and scrub, the typical vegetation of Qrd and Qrm. Fringing dunes of gypsiferous silt and sand (Qpk) and red to yellow saline sand (Qrs) form the only physiographic relief in such terrain.

Climate

The climate is arid to semi-arid, with an average annual rainfall of 200 mm. Usually the first half of the year is the wetter, but rainfall is unreliable and the area is subject to drought.

Summers are hot and dry, the average maximum temperature (January) being about 35°C, with an average minimum for the same months of about 20°C. Occasionally temperatures reach 46°C. Winters are cool to mild, the average minimum temperature (July) being about 5°C, and the average maximum about 18°C.

Mapping technique

Mapping is of detailed reconnaissance quality. Almost all tracks have been traversed by vehicle. Foot traverses across strike have been made in areas of good outcrop at spacings ranging from 0.5 to 4 km depending on structural and stratigraphic complexity. Geological boundaries have been interpolated between traverse lines by air-photograph interpretation (photograph scale 1:31 680) with minor assistance from aeromagnetic maps.

In areas where several narrow units are present the major unit is shown on the 1:250 000 map, but many minor units in monotonous sequences, for example, cherts in basalts, or thin ultramafic rocks in sediment, have been exaggerated.

There is a general continuity along strike of the associations represented by the groupings in the reference. Variation along strike on the 1:250 000 map may indicate a facies change, or mistaken field identification where units are similar, or differing judgments of which unit is the major one of a group.

Previous investigations

The earliest regional geological report of the area is by E. de C. Clarke (1925), whose investigation of the Leonora-Duketon district included the eastern half of the Leonora 1:250 000 Sheet area. Although the geology is described in general terms, detailed observations at particular localities are often still valid. Petrological descriptions of main rock types are presented, together with several chemical analyses.

Noldart and Bock (1960) describe an area of about 1100 km^2 centred on Mount Leonora and the adjacent Sons of Gwalia gold mine. Much structural data were collected, and a structural interpretation presented.

More recently, the geology of an area near Marshall Pool—or, more exactly, at Hangover Bore—was the subject of a University thesis (Leishman, 1969). Ultramafic rocks and the synclinal structure containing them are described in detail.

There have been numerous reports of the economic aspects of localities within the Sheet area. Auriferous deposits at Leonora were investigated by Jackson (1904), and between Leonora and Wiluna by Montgomery (1904). Gibson (1907) described the geology and mineral resources of an area including Lawlers, with descriptions of individual mines. Molybdenite at Dodgers Hill was investigated by Clarke (1919), and Larcombe (1929) made petrological determinations on drill core from the Harbour Lights gold mine. Much later, Ward (1950) described the Emu gold mine at Agnew, and Noldart (1962) and de la Hunty (1960) reported on diamond drilling at the Waroonga Extended South GML in the same area. On the Gwalia area, the most recent reports are by McMath (1951a, b), Tattam (1953), and Finucane (1965).

Sanders (1969) carried out a hydrogeological reconnaissance of calcrete areas throughout the region, primarily to assess the water supply potential.

Aeromagnetic and radiometric surveys of the Sheet area were carried out in 1964 by the Bureau of Mineral Resources (Tipper and Young, 1966).

The information contained in this publication has previously been released as an unpublished G.W.S.A. Record (Thom and Barnes, 1974).

Regional setting

The Leonora Sheet area lies within the Yilgarn Block (Daniels and Horwitz, 1969), a stable nucleus of gneiss and granite that encloses elongate greenstone belts. These greenstone belts, which trend north-northwest, consist of alternating mafic and felsic-clastic associations which comprise the Archaean layered succession. The succession is strongly deformed by large folds with north-northwest axes. A protracted period of granitic magmatism has been defined, but most of the gneiss and granitic rocks were emplaced in the period 2700 to 2550 m.y. ago (Arriens, 1971), and are younger than the layered succession.

ARCHAEAN GEOLOGY

Lithology of the Archaean Succession

Ultramafic intrusive and extrusive rocks

Most of the ultramafic rocks are subdivided into five groups, with unassigned ultramafic rocks denoted *Au*.

TABLE 1. CHEMICAL ANALYSES OF AN ULTRAMAFIC FLOW AT MOUNT CLIFFORD

	1	2	3	4	5	6	7	8	9	10	11	12	13	
	15156E	15157A	15157E	15158C	15159A	15159E	15160G	15161C	15163A	15164A	15164D	15165D	15165E	A
SiO_2	45.1	41.6	41.8	42.3	43.2	42.8	44.6	43.3	43.5	43.3	42.5	44.2	42.1	42.89
Al_2O_3	6.4	7.6	7.6	7.2	7.4	7.3	6.3	5.0	5.3	5.9	7.1	6.6	7.6	6.76
Fe_2O_3	2.1	3.4	3.8	2.9	2.6	3.3	2.8	2.7	2.9	3.4	4.5	3.1	4.1	3.20
FeO	6.87	7.96	8.56	8.35	8.73	8.66	6.11	6.95	6.58	6.38	7.73	3.00	7.52	7.78
MgO	24.6	24.9	23.9	23.4	22.9	22.8	25.9	29.3	27.7	26.4	25.2	24.7	24.9	24.95
CaO	7.49	5.70	6.03	7.96	6.99	7.43	6.24	3.40	4.09	5.20	6.28	6.82	5.63	6.11
Na_2O	.49	.49	.46	.63	.49	.45	.40	.40	.46	.38	.51	.65	.38	.48
K_2O	.1	.1	.0	.0	.1	.1	.1	.2	.2	.1	.0	.0	.0	.09
TiO_2	.32	.28	.38	.36	.37	.37	.28	.22	.26	.27	.34	.32	.36	.32
MnO	.17	.16	.19	.20	.20	.20	.15	.17	.16	.15	.17	.17	.15	.18
H_2O+	6.50	7.65	7.24	6.51	6.63	6.56	6.81	8.90	8.24	7.67	6.92	6.76	7.59	7.01
H_2O-	.43	.46	.38	.22	.3	.34	.68	.93	1.02	.93	.29	.33	.40	.49
CO_2	.62	.51	.27	1.15	.26	.91	.25	.20	.11	.27	.28	.36	.27	.52
P_2O_5	.03	.04	.04	.05	.02	.06	.03	.01	.01	.03	.05	.04	.04	.03
Total	101.2	100.8	100.6	101.6	100.3	101.2	100.7	101.7	100.5	100.3	101.9	101.1	101.1	100.8
Trace Elements (ppm)														
Cr	2680	2490	3070	2960	3050	3070	2460		2680	2480	2900	2770	300	
Co	85	90	90	85	90	90	75		100	90	85	90	95	
Ni	980	1050	840	880	870	840	1110		1390	1260	890	1060	930	
Cu	35	350	30	25	20	60	30		20	45	30	45	80	
Zn	80	60	70	60	60	60	90		70	60	50	70	50	
S	250	460	80	80	70	100	290		480	410	70	230	150	
Ba	5	5	5	5	5	5	5		5	5	5	5	5	
Sr	50	30	30	80	50	60	20		20	20	30	30	20	
Zr	40	40	10	50	20	40	20		30	10	30	10	50	

Note:
Norms calculated on volatile-free basis and after adjusting Fe^{3+}:Fe^{2+} ratio to 1:9.
Analyses by W.A. Government Chemical Laboratories. FeO, Na_2O, CO_2 and H_2O by chemical methods, remainder by X.R.F.
1. Base of overlying flow. 2. Chilled and fractured flow top. 3, 4, 5 and 6. Pyroxene peridotite from spinifex-textured zone. 7, 8, 9 and 10. Olivine peridotite from massive zone. 11 and 12. Basal chilled zone. 13. Top of underlying flow. A. Weighted average of analyses 2-12 (Barnes and others, 1974).

TABLE 2. ADDITIONAL ANALYSES FROM THE MOUNT CLIFFORD AREA

	1	2	3	4	5	6	7	8	9	10
	32773	32775	38280	32778	38282	32771	35962	38281	25960	32772
SiO_2	42.3	44.6	42.2	40.9	40.5	40.5	42.9	41.9	43.4	49.8
Al_2O_3	6.1	7.3	5.8	2.9	2.9	3.8	1.8	2.1	6.8	12.4
Fe_2O_3	5.8	2.2	5.7	3.3	3.9	3.6	2.9	2.8	6.6	2.4
FeO	3.49	7.38	4.22	4.65	4.10	4.53	4.00	1.99	5.73	8.55
MgO	29.5	25.2	29.2	36.3	36.5	36.6	38.0	39.9	26.9	11.8
CaO	5.59	6.84	5.05	.11	.17	.73	.08	.14	4.29	7.23
Na_2O	.30	.22	.24	.0	.01	.05	.03	.02	.21	4.09
K_2O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TiO_2	.28	.44	.28	.18	.17	.18	.07	.09	.54	.81
MnO	.17	.20	.18	.16	.15	.07	.09	.08	.20	.21
H_2O+	7.68	6.50	7.54	11.57	11.53	11.00	11.70	11.91	6.89	2.86
H_2O-	.54	.36	.36	.70	.85	.37	.44	.70	.40	.31
CO_2	.05	.04	.03	.02	.02	.03	.02	.04	.06	.06
P_2O_5	.04	.06	.02	.0	.0	.01	.02	.0	.06	.10
Total	101.8	101.3	100.8	100.7	100.7	101.6	101.4	100.7	102.1	100.6
Trace Elements (ppm)										
Cr	2570	1780	1030	1860	1530	1290	1440	1720	2280	1090
Cu	10	10	10	10	10	10	10	10	50	60
Ni	1400	1240	1420	1850	1910	1840	1670	2190	1400	350
Zn	50	80	90	50	200	50	60	90	60	90
S	60	50	40	40	80	30	50	180	70	60

Analyses by Government Chemical Laboratories; FeO, H_2O and CO_2 by chemical method, all other elements by X.R.F.

1. Spinifex-textured pyroxene peridotite, Mount Clifford.
2 and 3. Olivine peridotite, Marriot Prospect, Mount Clifford.
4, 5 and 6. Olivine peridotite, Mount Clifford.
7. Olivine peridotite, near Bannockburn Well, Mount Clifford.
8. Olivine peridotite, Mount Clifford.
9. Intrusive peridotite, Mount Fouracre.
10. High-Mg basalt, Mount Clifford.

Aus denotes fine-grained ultramafic rocks, now usually altered to serpentine-tremolite-chlorite assemblages, and presumed to be after ultramafic lavas. Frequently rocks of this group exhibit spinifex texture. Such rocks are particularly well exposed in the Mount Clifford area where there is a thick pile of ultramafic lavas similar to an occurrence at Munro township, Ontario (Pyke and others, 1972). The zones of the individual flows at Mount Clifford include a thin, brecciated flow top; an upper spinifex-textured zone; and a lower, fine-grained massive serpentinite zone. The spinifex zone, which may comprise half the total flow thickness, displays a gradation in the size of blades from coarse at the bottom to fine at the top. This variation, together with the asymmetry of the flow unit, provides a facing indicator. Further work (Barnes and others, 1974) has shown that the spinifex zone is pyroxene peridotite and the massive zone is porphyritic olivine peridodite. Samples from a flow were analyzed, and chemical and modal variations 'indicate that the chilled margins are undifferentiated and that the olivine peridotite formed by crystal settling from a highly fluid magma containing about 12 percent phenocrysts'. Some analyses are presented here in Table 1. Similar spinifex-textured rocks elsewhere in the Sheet area rarely form recognizable flows.

Coarse-grained ultramafic rocks, sometimes with well-preserved granular or cumulous texture (despite serpentinization), are grouped as *Aup*. These are mainly peridotites and pyroxene peridotites. A few dunitic types consist almost entirely of serpentinized olivine. In the centre of the Hangover Syncline is an olivine peridotite consisting of serpentinite pseudomorphs after euhedral and skeletal olivine.

Ar denotes tremolite-chlorite rocks ranging in composition from mafic to ultramafic, sometimes with a bladed texture or texture similar to spinifex texture. At Hangover Bore, this rock type exhibits a hackly fracture resulting from the acicular habit of tremolite. Such rocks have been described by Lewis (1971) and Williams (1971) and have been termed high-Mg basalts.

The altered ultramafic rocks, *Ae,* are talc-carbonate-chlorite-serpentine rocks, which are usually soft, greasy and schistose in hand specimen. Generally they occur in narrow bands or pods and form a small proportion of the ultramafic group.

In the Agnew area, sills of pyroxenite, *Aux,* occur within the mafic succession. Typically, these contain a large proportion of euhedral clinopyroxene together with alteration products such as tremolite-actinolite and sphene. Textures usually indicate a cumulate rock. Some pyroxenites are porphyritic, although generally the phenocrysts, which may be clinopyroxene or orthopyroxene, have been replaced by amphibole.

Mafic extrusive rocks

Most of the mafic extrusive rocks of the Sheet are included under the general symbol *Ab*. Typically, they are featureless basalts, being non-vesicular, non-pillowed, and non-porphyritic. In thin section, some of the basalts are relatively fresh, containing original pyroxene and retaining some of the primary texture. Secondary minerals include prehnite, carbonate and abundant epidote. In other cases, basalts have been metamorphosed to fine-grained amphibolite, composed mainly of plagioclase and actinolite, with evidence of recrystallization. Minor quartz, secondary carbonate and clinozoisite are common in these amphibolites.

Pillow-form mafic extrusive rocks are not abundant within the Sheet area. Where recognized on traverse, they are distinguished on the map as *Ai.* In a few cases, the form of the pillows is sufficiently well preserved to indicate a facing direction. *Ab* may include pillowed basalts not recognized during the mapping. Petrologically, *Ai* resembles *Ab.*

Porphyritic mafic extrusive rock was recognized at only one locality, near Mount George. The rock is fine grained, similar to *Ab,* with plagioclase phenocrysts of variable size and abundance. One sample contained numerous phenocrysts averaging 6 cm across, but elsewhere the rock is less impressive. Associated with this porphyritic basalt is porphyritic dolerite, similar to that described by Gower (1971). Both of these porphyritic rocks are grouped as *An.* It seems likely that this is the outcrop described by Noldart and Bock (1960) as 'a flow breccia consisting of large whitish fragments caught up in a fine-grained basaltic matrix'.

Mafic extrusive rock adjacent to granitic intrusions has frequently undergone contact metamorphism to hornfels, *Ah.* This symbol also includes the dark-coloured mafic rocks with a platy parting, usually intensively cut by granite veins and stringers, which are found near basalt contacts with granitic rocks. Large rafts of basaltic material within the granites, particularly near Lawlers and north of Mount Alexander, form such an intimate mixture of granitic and mafic rock that the mixture has been included as *Ah.* Minerals in hornfelsed rocks include metamorphic clinopyroxene and prehnite.

Mafic intrusive rocks

Mafic intrusive rock, *Ad,* is abundant within the Sheet area. Thick gabbro sills in the layered succession at Agnew form about one third of the exposed greenstone. The gabbros are partly uralitized. Plagioclase is commonly recrystallized to oligoclase, though retaining the original tabulate shape. In other sills, tremolite-actinolite pseudomorphs are original pyroxene, and the material between the amphibole has recrystallized to a blebby mixture of quartz and plagioclase with amphibole and clinozoisite. Occasionally, ophitic and subophitic textures remain.

Similar but less abundant gabbro sills intrude the mafic succession throughout the remainder of the greenstone belt, except around Mount Stirling, where gabbro is markedly subordinate to metabasalt.

Contact metamorphosed mafic intrusive rocks are denoted *Am.* Intimate mixtures of granite/metamorphosed gabbro at the contact of intrusive granites are also included under *Am.* Mafic bands within the migmatite-gneiss zone at Ida Valley are represented on the map in a simplified form. Although much of the material in these bands is coarse-grained amphibolite, there is frequently in association a fine-grained amphibolite and mafic hornfels, *Ah,* which is not distinguished.

A sporadic colour banding, whereby the lighter coloured bands have a higher proportion of feldspar and quartz, is exhibited in some large mafic sills in the vicinity of Agnew. This may be due to flow differentiation or crystal settling. The amphibole crystals which are tremolite-actinolite in the lighter bands and actinolite-hornblende in the darker bands, weather in positive relief. The amphibole crystals are aligned parallel to strike, imparting to the rock a distinct foliation. Metamorphosed pyroxenite at the base of the sills may indicate compositional layering, and there appears to be an increase in the proportion of feldspar towards the top of the gabbro. However, thin section examination of the gabbro body failed to show any differentiation and the pyroxenites may not be part of the same intrusion. Consequently, these large mafic sills, which have been distinguished as *Aj,* may be more correctly regarded as *Ad.*

Felsic extrusive and pyroclastic rocks

Felsic extrusive and pyroclastic rocks are largely confined to the area east of Leonora and to the east of the Keith-Kilkenny Lineament. Generally, they are difficult to identify and classify because of alteration, silicification, shearing and gradational relationships between rock types. However, three groups are recognized, namely felsic lava (*Al*), coarse felsic pyroclastic rocks (*Ax*), and altered felsic extrusive and pyroclastic rocks (*Ao*).

Most of the felsic volcanic rocks, *Al,* occur east of the Keith-Kilkenny Lineament, commonly forming north-northwest-trending hills of significant relief. In hand specimen these rocks usually show prominent quartz phenocrysts, and less commonly altered feldspar phenocrysts, in a fine-grained matrix which is often extremely altered and silicified. Many of these rocks are dacitic; some contain up to 20 percent albite phenocrysts with far fewer quartz and microcline phenocrysts, whereas in others, the proportions are reversed. Some of the rocks are granophyric.

The pyroclastic rocks grouped as *Ax* are mostly coarse grained. Fine-grained tuffs are not easy to recognize in the field and many such tuffs are mapped as *Al* or *Ao.* In the Mount Germatong area northeast of Leonora, a prominent ridge 3 km long consists of agglomerate *Ax* with coarse, angular felsic fragments in a fine-grained matrix. A similar rock several kilometres further east may be the equivalent band on the eastern limb of the anticline. An agglomerate band near the Royal Arthur gold mine consists of a quartz, microcline and plagioclase crystal fragments in a very fine-grained matrix of quartz, chlorite and kaolinized feldspar. The plagioclase fragments are in the form of laths of albite, and are more abundant than microcline. The quartz fragments are irregular in shape, show strained extinction, and appear to be marginally recrystallized.

A felsic agglomerate (*Av*) near the eastern boundary of the Sheet area at Gambier Lass Well consists of rounded clasts of porphyritic felsic material in a matrix of similar composition, and in outcrop bears a superficial resemblance to oligomictic conglomerate.

Ao includes both extrusive and intrusive types, usually altered beyond positive identification of the original rock type. They are schistose rocks, and frequently consist of quartz and sericite. Silicification commonly masks the true nature of the rock. When viewed microscopically in plane-polarized light, the original texture is occasionally detectable. By this method features such as two generations of quartz and the preservation of ferromagnesian mineral grain boundaries by hematite grains may be observed.

Felsic intrusive rocks

Elongate pods of porphyry, *Ap*, occur within the eastern adamellite near its contact with the greenstone belt in the Wilsons Patch area. These felsic intrusive rocks contain quartz and albite phenocrysts in a matrix of quartz, albite, quartz-feldspar granophyre, K-feldspar, sericite and magnetite.

Clastic rocks

As includes black shale, mudstone, greywacke, and minor sedimentary bands such as those within the mafic/ultramafic succession. At Mount Leonora, sedimentary rocks have been metamorphosed to quartz-kyanite schist, andalusite-chlorite schist, sericitic schist, and cherty quartzite. The latter forms a prominent chert band which continues northwards for about 60 km. The clastic rocks gradually assume a volcanogenic character, and are denoted *At*. At Mount George a felsic schist consisting of biotite, chlorite, feldspar and quartz is typical of *At*. Other types in this unit at Mount George include quartz-sericite rocks of unknown origin and possible cherty metasiltstones. Where several lithologies occur in association, and where identification is hampered by alteration and silicification, the distinction between *As* and *At* is arbitrary.

In the migmatite-gneiss zone at Ida Valley there are occasional bands of kyanite-bearing quartz-mica schist, *Acm*. This rock consists of quartz muscovite, biotite (or phlogopite), chlorite and kyanite. Small rounded grains of rutile and zircon occur. Within this pelitic schist at Maroon Range and Segies Bore there are deformed granitoid inclusions, thought to represent stretched granitic clasts in a metamorphosed oligomictic conglomerate. Several layers of conglomerate (*Acp*) occur near Pig Well, east of Leonora. The matrix is arenaceous and schistose and the pebbles are well rounded and deformed. Pebble types include jaspilite, felsic and mafic volcanic rock, and granitic rock. Oligomictic conglomerate, *Aco*, occurs west of Agnew. Here the majority of clasts are of adamellite, similar in appearance to adamellite around Lawlers. The Agnew conglomerates are associated with arkosic sediments, some of which are pebbly and grade into conglomerate. These arkoses, *Aa,* exhibit excellent sedimentary structures such as cross-bedding, which indicate facing directions within the sequence. A polymictic conglomerate containing clasts of mafic and ultramafic rock is exposed near the Emu mine at Agnew. Just east of the main chert at Station Creek is an oligomictic conglomerate consisting of small, rounded pebbles of mafic lava and quartzose rock in an acicular mafic matrix. Immediately east of this is a polymictic conglomerate containing pebbles of chert, banded chert, mafic volcanic rock, porphyritic felsic volcanic rock, and biotite-plagioclase porphyry.

Banded iron-formation and related rocks

Banded quartz-magnetite rock, *Aw,* and banded chert, *Aq,* are included under the heading of banded iron-formation (BIF) and related rocks.

Banded quartz-magnetite rock is restricted to west of the Ida Lineament (Fig. 2). At Mount Alexander, this rock type, together with banded chert, occurs on the western side of a mafic sequence. A pronounced aeromagnetic anomaly is associated with the quartz-magnetite rock. Similar rocks in the Brooking Hills in the adjacent Youanmi 1:250 000 Sheet area are separated from those at Mount Alexander by an adamellite pluton. West of Agnew, isolated occurrences of banded quartz-magnetite rock appear to be completely surrounded by granite. Originally these may have been continuous with those at Mount Alexander. At Mount Ross, two minor occurrences of banded quartz-hematite rock have been included under *Aw.*

Banded chert is the predominant type elsewhere in the Leonora Sheet area. It forms important marker layers within the felsic clastic associations of the main greenstone belt, and conveniently indicates structural trends in areas of poor outcrop.

STRATIGRAPHY

General

Formational names were introduced into the Archaean stratigraphy of the Kurnalpi 1:250 000 Geological Sheet (Williams, 1970). This nomenclature was retained for the Edjudina Geological Sheet (Williams and others, 1971), as structures were considered to be continuous or sufficiently understood to permit correlation. Gower (1974) tentatively correlated the main lithological units in the Laverton Sheet area with those of the Edjudina Sheet area.

Correlation has not been extended to the Leonora Sheet area. Outcrop is poor in the southeastern corner and in the adjoining corners of the Edjudina and Menzies Sheet areas, so that the structural interpretation of that area is speculative, and correlation with the Edjudina Sheet area has not been attempted. Structures are not continuous across the Keith-Kilkenny Lineament, thus precluding direct correlation with the Laverton Sheet area.

It is possible, however, to divide the Archaean layered succession in the Leonora Sheet area into lithological associations which have been shown elsewhere in the Eastern Goldfields to have some stratigraphic significance.

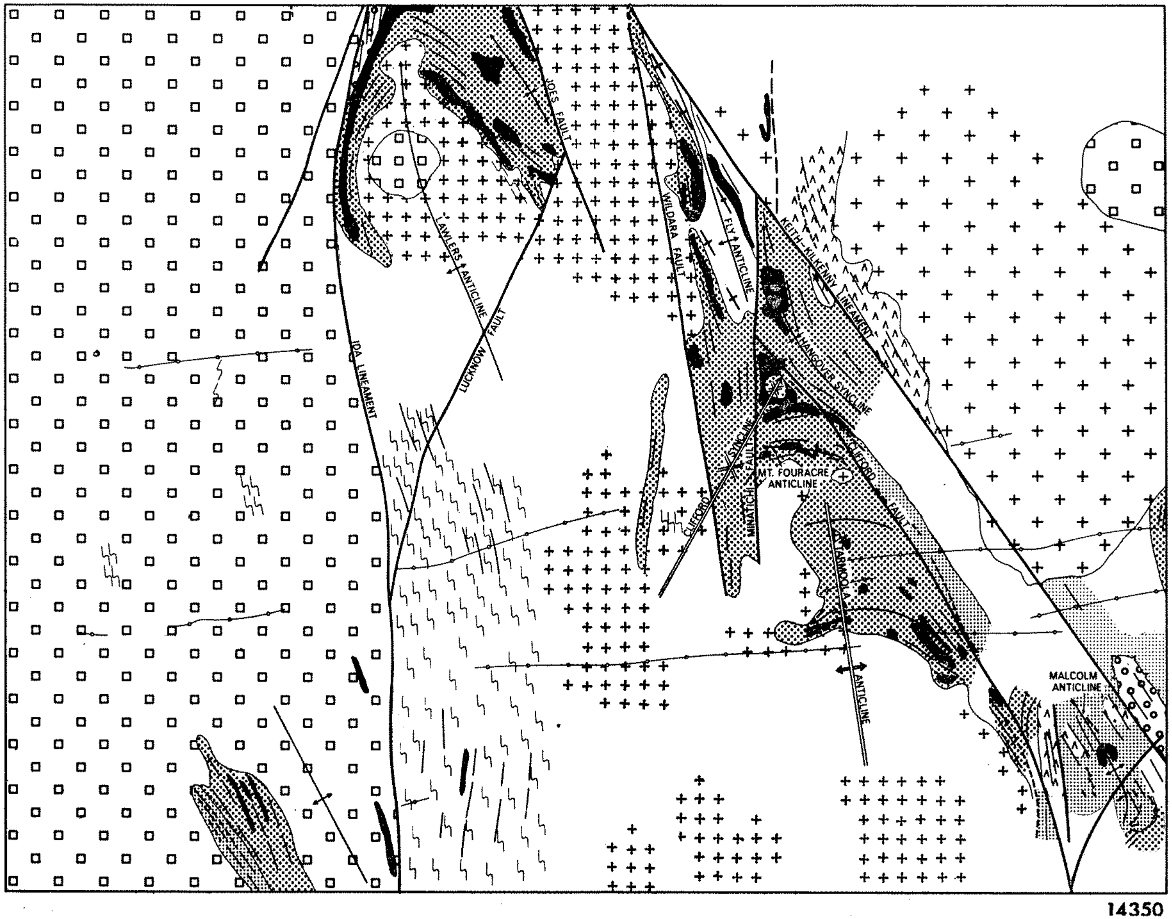

FIGURE 2

SOLID GEOLOGY AND STRUCTURAL INTERPRETATION

LEONORA SHEET SH 51-1

SCALE

5 0 5 10 15 20 25 KILOMETRES

REFERENCE

- Porphyritic granitic rock
- Adamellite to granodiorite
- Granite to adamellite
- Strongly sheared granitic rock
- Migmatite
- Banded iron and banded chert formation
- Conglomerate & arenaceous sediments
- Felsic lava
- Sedimentary & tuffaceous rock
- Mafic rocks—extrusive & intrusive
- Ultramafic rocks—extrusive & intrusive
- Post-granite mafic dyke or related aeromagnetic lineament
- Unconformity
- Fault or tectonic lineament
- Trace of anticline
- Trace of syncline
- Trend of possible fold trace
- Trace of refold syncline
- Trace of refold anticline
- Trends

Mafic-ultramafic associations

In the Agnew-Lawlers area, this association includes large gabbro sills, more abundant here than in any other greenstone portion of the Sheet area. Thin but continuous pyroxenite sills are another distinctive feature of the association in this area. The mafic rocks are mainly amphibolite and metabasalt of greenschist facies; high-Mg basalt and pillow-form mafic lavas are not recorded. The ultramafic suite is believed to be mainly intrusive.

The only known feldsparphyric mafic rocks within the Sheet area occur with ordinary metabasalt and metagabbro east of Mount George.

Elsewhere, the mafic-ultramafic association consists of amphibolite or metabasalt, high-Mg basalt, gabbro, and peridotite flows and intrusions. The metabasalt may form featureless expanses devoid of intrusives, in which case the basalt is non-pillowed. Pillow lava is not abundant, but does occur in the Jungle Well, Clifford Bore, Mount Davis, Pig Well Bore, and Malcolm areas. Feldsparphyric mafic lavas are absent. Pyroxenite is rare, but a felsic dyke at Victory mine does contain xenoliths of pyroxenite. These rock types characterize the mafic-ultramafic associations east and west of the Clifford Fault, and at Mount Alexander.

It is not known whether the presence or absence of feldsparphyric mafic lava, high-Mg basalt, and pillow basalt is diagnostic of the formations established in previously mapped sheets in the Eastern Goldfields. The three areas of mafic associations just described are separated by faults, and could belong to different formations.

Felsic-clastic associations

The conglomerate (both oligomictic and polymictic) and arkose at Agnew, Station Creek, and Pig Well are considered to belong to the same formation, because they occur at stratigraphically high positions, and they occur adjacent to major lineaments or faults.

Between the Keith-Kilkenny Lineament and Wilsons Patch, most of the rocks of the felsic-clastic association appear to be lavas, although a few sedimentary rocks have been identified. Chert is rare. Similar felsic volcanics just east of Leonora are also devoid of chert. All felsic lava piles in the Sheet area appear to be bounded by a fault or lineament.

The area between Mount Germatong and the eastern Sheet area boundary is underlain by agglomerate, quartz-sericite rock, schistose felsic rock, and sheared felsic volcanic rock. Within this succession, cherts are prominent.

Similar important chert bands occur in a line from south of Mount Leonora to Mount Newman, where they are sheared out by faults parallel with or very acute to the regional strike. At Mount Leonora chert occurs with andalusite-schist, kyanite-schist, and chloritic schist; these may not be directly continuous with the chert/felsic-volcanoclastic sequence northwards to Mount Newman. It is possible that a fault passes through the area of no exposure between Mount George and Mount Davis, and that Jasper Hill is the continuation of the Mount George chert. This explanation is preferred to a facies change along strike from Mount Leonora to Mount Newman.

The banded quartz-magnetite rock at Mount Alexander, and the isolated islands of similar rock within the adamellite to the west are unique within the Sheet area.

They occur to the west of the Ida Lineament, which marks the western boundary of the BIF-free zone (Williams, 1974). The eastern boundary of the BIF-free zone is the Celia Lineament, and banded quartz-magnetite rock occurs again to the east of this, in the Laverton Sheet area. These rocks may be facies variations of banded cherts, and could belong to the same formation.

In the Edjudina Sheet area (Williams and others, 1971) and Kurnalpi Sheet area (Williams, 1970), the main chert, banded quartz-magnetite rock, and jaspilite bands occur in the Gindalbie Formation or the base of the Mulgabbie Formation. Conglomerate continuous with that at Pig Well has been assigned by Gower (1974) to the Gundockerta Formation. Agglomerate (*Ax*) to the west of the Keith-Kilkenny Lineament may not belong to the same formation as the agglomerate (*Av*) to the east.

GRANITIC AND RELATED ROCKS

Granitic rocks

The Sheet area can be divided into three main granitic sectors, namely the western, central, and eastern sectors, separated by the Ida Lineament and the Keith-Kilkenny Lineament respectively.

The *western sector* consists almost entirely of adamellite, which is frequently porphyritic. The abundance of phenocrysts ranges from profuse to rare. The rock is coarse grained, with groundmass crystals commonly 0.5 to 0.8 cm across. It consists of microcline phenocrysts in a matrix of quartz, microcline, and plagioclase, with biotite (partly altered to chlorite and muscovite), and magnetite. Grain size may vary considerably and abruptly within a single outcrop; this is regarded as textural variation within the same adamellite mass. Finer grained adamellite does occur, for example near Mount Alexander, but in the absence of detailed sampling no boundaries have been drawn and all the adamellite has been symbolized *Agl.* The coarse-grained adamellite immediately west of the conglomerate at Agnew is presumed to be part of the main porphyritic adamellite intrusion; that is, younger than the conglomerate. The pebbles within the conglomerate are believed to derive from the core of the Lawlers Anticline.

In the Tragedy Well area, fine-grained granodioritic rock occurs within the porphyritic adamellite, but is always subordinate. It may represent remnants of an older granodioritic rock caught up during emplacement of the adamellite.

The *eastern sector,* too, seems to consist mainly of adamellite. The adamellite is coarse grained, but in contrast to that in the western sector, it is never porphyritic. Even where it is deeply weathered, the rock can be recognized by the large quartz crystals. It is identical with some cobbles in the conglomerate at Pig Well, and is probably the source of the cobbles. At Dodgers Hill, the adamellite has a deep pink colour, but has the texture of the more usual paler adamellite. The feldspar is a mesoperthite in which microcline and albite are in about equal proportion. The albite is fresh but the microcline is dusted with iron-stained kaolinitic material and it is this that gives the rock its dark pink colour. This zone of pink adamellite is in the vicinity of the King of the Hills Dyke, which elsewhere has had considerable contact metamorphic effects. On strike with the dyke and parallel to it, the adamellite crops out as lines of rounded boulders. Molybdenite occurs within the pink adamellite, near Dodgers Hill.

Dykes of porphyritic granodiorite near Wandery Well stand out in relief against the weathered adamellite country rock. This granodiorite contains euhedral zoned plagioclase phenocrysts up to 2 cm long. Smaller subhedral albite phenocrysts up to 0.5 cm across comprise about 20 percent of the rock. Some phenocrysts have been almost pseudomorphed by epidote. Phenocrysts of amphibole (hornblende), microcline and sphene are present. The matrix is equigranular and allotriomorphic granular, with an average grain dimension of 0.05 mm. It is composed of quartz, plagioclase, K-feldspar, epidote, apatite, sphene and chlorite.

In the Bundarra and Ford Run Plateau areas, rafts of mafic rock are common within the adamellite near its contact with the greenstone belt. Adjacent to the rafts, the granitic rock is quite mafic. Quartz diorite and clinopyroxene tonalite are found in this setting. Also common in this contact zone are pods of porphyry and microgranite of either granite or granodiorite composition.

Aeromagnetic anomalies over the eastern sector indicate the presence of mafic or ultramafic rock. These may be poorly exposed remnants and were not detected during the mapping.

Within the *central sector*, granitic types range from diorite to adamellite. They are usually fine to medium grained, and are commonly foliated.

The commonest granitic type is fine to medium-grained adamellite, consisting of quartz, well twinned fresh microcline, saussuritized plagioclase (albite), and olive-green biotite. The two feldspars are present in about equal proportions. Minor minerals include chlorite (pseudomorphous after biotite), muscovite, epidote, zircon, and opaque grains surrounded by sphene. Some of the plagioclase is myrmekitic, but the overall texture is allotriomorphic granular. Next to the Proterozoic dyke at Top Well, the adamellite is pinkish in colour. Near Table Well, Fourteen Mile Well, Hicks Well, Peperill Hill, and Wilbah, granitic rock contains appreciable muscovite, in many cases with biotite. Within the zone of strong foliation adjacent to the migmatite zone, and within the migmatite zone itself, muscovite-bearing rocks are more common. It has been suggested (R. D. Gee, pers. comm.) that some of these granitic-looking muscovite-bearing rocks may be metamorphosed sedimentary rock, and the presence of tiny garnets in some of them lends support to this idea.

Fine-grained granodioritic rock occurs throughout this sector, but its distribution appears to be random. Granodioritic rock occurs in 'mixed granite', along with adamellite; in such cases, the granodiorite appears to be the earlier intrusion.

Southwest of Mount Adamson and in the Blue Well area is porphyritic adamellite. It is not known whether these types form separate plutons or are porphyritic phases of even-grained adamellite. Fluorite is present interstitially in a sample from Gum Well; this is the edge of an area of impressive granitic outcrop, reminiscent of that at Munjeroo. Pronounced east-northeast jointing at both localities shows clearly on the air-photographs. Although the adamellite at Gum Well is not porphyritic, it may belong to a discrete pluton younger than the surrounding adamellite.

The slightly porphyritic granitic core of the Fly Anticline is well foliated and strongly lineated. Foliations are horizontal in the middle of the body and dip outwards from the axis of the anticline, indicating an arch-like form. The texture shows strong deformation. The granite lies on line with the Clifford Fault, and may have been emplaced along the northern extension of the fault. In a mildly-deformed sample from Heather Well, the phenocrysts are irregular grains of fresh microcline and plagioclase (oligoclase). The matrix consists of an interlocking mosaic of quartz, well twinned microcline and plagioclase. At Fly Bore itself, the granitic rock is so deformed that its original texture has been lost.

Between the main greenstone belt at Fly Bore and the greenstone mass at Lawlers, the granitic rocks appear to differ little from those elsewhere in the central sector. At Pink Well and No. 2 Well, the rock is medium-grained biotite adamellite, whereas at Joes Bore there is fine-grained granodiorite similar to that at Union Jack Well. It is believed that the two greenstone masses have been separated by a dilational granitic intrusion emplaced along a fault or lineament—perhaps the proposed Wildara Fault (Fig. 2). This need not imply a close match of the structures of the greenstone masses, for there may have been movement along the fault before emplacement of the granite. The differences in lithology between the greenstone masses might support the idea of considerable relative displacement; nevertheless, the structures on either side of the granite seem broadly compatible with simple separation. Aeromagnetic anomalies over the area between Outcamp Well and Schmitz Well suggest that an elongate sliver of mafic-ultramafic rock has been wedged off the main greenstone mass to the east.

Migmatite

A broad zone of migmatite 3 km wide and 10 km long occurs to the east of the Ida Lineament. On the air photographs, the zone shows prominent banding with a northerly strike, slightly bowed to the east (Fig. 2). On the ground, the dark bands are amphibolite or amphibolite-rich, and are believed to be derived from fine-grained and coarse-grained mafic igneous rock. The intervening granitic bands are strongly foliated and schistose and contain both biotite and muscovite. Concordant and discordant pegmatites are abundant. In places, there is banding on a finer scale, with alternating mafic and felsic bands a few centimetres across. The elongate amphibolite-rich zones have been shown in simplified form on the map, each pod of *Am* representing a prominent dark band on the air photographs. The intervening foliated granitic rock is denoted *Agg,* and *Agm* where it is migmatitic. Within this migmatite zone there is also some granodorite gneiss, which has not been separated on the map. Rarely, cap-rock typical of the weathering product over ultramafic rock was recognized, and is believed to overlie ultramafic slivers within the migmatite zone. Bands of metamorphosed pelitic sediment and conglomerate have been found within this zone. These relict lithologies suggest that the migmatite zone results from the invasion of greenstones by granitic rock, or that it is a zone of anatexis. The greenstones may represent the missing western limb of the Lawlers Anticline.

Syenite

A small intrusion of quartz syenite occurs near Pig Well*. In outcrop, two rock types are apparent, medium-grained, even-grained syenite being cut by minor intrusions of porphyritic microsyenite.

The texture of the microsyenite is inequigranular, with phenocrysts of microperthite several millimetres across in a fine-grained groundmass of oligoclase, orthoclase and accessory minerals. Microperthite phenocrysts form about 25 percent of the rock. Fractures within some of these phenocrysts are infilled with groundmass material. Oligoclase and orthoclase together form about 70 percent of the rock, the oligoclase being slightly in excess of orthoclase. The groundmass has a granoblastic texture and has probably recrystallized under low-grade metamorphic conditions.

The medium-grained syenite has an allotriomorphic granular texture, and contains about 80 percent microperthite (orthoclase with exsolved albite), with accessory quartz, plagioclase and apatite.

Both of the samples examined are weathered, and contain secondary carbonate and limonitic material. No ferromagnesian minerals have been preserved, although their former presence is obvious in hand specimen.

The syenite pod occurs near the assumed position of the Keith-Kilkenny Lineament.

STRUCTURE

Faults and lineaments

The structural development of the rocks of the Leonora Sheet has been influenced by major faults and lineaments (Fig. 2).

The Kilkenny Fault in the Edjudina 1:250 000 Sheet area (Williams and others, 1971), and the Mount Keith Lineament in the Sir Samuel 1:250 000 Sheet area are both part of a major linear disruption zone (Williams, 1974) for which the name Keith-Kilkenny Lineament is proposed (Gower, 1974). Within the Leonora Sheet area the position of the lineament is not always clear. In places there is no obvious expression on the ground or the air photographs, nor any mismatch which need be attributed to faulting. However, most of the rocks of the main greenstone belt occur to the west of the lineament and adjoining either granitic rock, felsic rock or conglomerate at the approximate position of the lineament. Strong aeromagnetic anomalies near the southern end of the lineament in the Leonora Sheet area may indicate the presence of ultramafic rock, perhaps associated with the lineament.

Parallel to the Keith-Kilkenny Lineament is the Clifford Fault, which passes through Mount Clifford and east of Mount George. This is believed to have considerable displacement. The fault trace is marked by a zone of strong shearing and by the truncation of easterly-trending structures that lie on the western side of the fault. Small outcrops of polymictic and oligomictic conglomerate near Mount Davis lie approximately on the line of the fault. The Clifford Fault is coincident with a fault in the Menzies Sheet area (Kriewaldt, 1970), about 6 km east of Desdemona, where it is sometimes referred to as the Desdemona Fault.

Another major linear disruption zone passes west of Agnew and east of Mount Ida (Williams, 1974) and is here termed the Ida Lineament. On the Leonora Sheet the position is taken as the boundary between the adamellite of the western sector and the greenstone/migmatite of the central sector. Its position in the south may be coincident with a large quartz reef. Immediately to the west of this quartz reef, for example at Bayes Soak, coarse-grained adamellite is virtually unfoliated and contains amoeboid-shaped quartz grains. This suggests that most of the movement along the lineament occurred before emplacement of the western adamellite.

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* This intrusion has not been distinguished as syenite on the Preliminary Edition of the 1:250 000 map, but has been grouped with *Agb*.

Other lesser faults have been proposed, including the Minatichi and Wildara Faults, which seem to be offshoots of the Keith-Kilkenny Lineament, and the Lucknow Fault, an offshoot of the Ida Lineament.

Folds

In the Agnew-Lawlers area, the Lawlers Anticline is indicated on the air photographs and on the ground by the curvature of large, continuous gabbro sills within the mafic layer. Igneous differentiation within small gabbroic bodies indicates outward facing. The core of the anticline is occupied by adamellite. Conglomerate occurs on the western side of the anticline; it is considered to be younger than the greenstones, because it contains abundant clasts of adamellite that can be matched with that in the core of the anticline. The conglomerate is considered to be related to the Ida Lineament rather than the Lawlers Anticline, although exploration companies have reported similar conglomerate on the eastern limb. In the conglomeratic sequence west of Agnew, arkosic sediments with well-preserved cross-bedding indicate that the sequence youngs to the west (Durney, 1972). Unless a tight syncline is present between the western adamellite and the most westerly west-facing horizon so far established (Fig. 2), the sequence cannot have been deposited unconformably on an erosion surface of the western adamellite. We believe that a fault separates the adamellite from a west-facing sedimentary sequence, which rests unconformably on an older mafic-ultramafic succession. This unconformable contact is probably faulted.

The complementary syncline to the east of the Lawlers Anticline has been located in the Sir Samuel Sheet area by exploration companies, but in the Leonora Sheet area all that is apparent is a slight curvature in strike before the rock units are cut off by Joes Fault (Fig. 2).

The next structure eastward is the Fly Anticline. Although no facing evidence was found, the succession dips outward from a granitic core. There is also some symmetry in distribution of rock types.

The syncline in the Marshall Pool area is described by Leishman (1969) and McCall and Leishman (1971). This syncline is here called the Hangover Syncline, after Hangover Bore. Photolineaments and the closure of individual rock units define a fold, and sedimentary structures within metasiltstone bands in the sequence are inward facing.

The structure of the Mount Clifford lava pile is an asymmetrical syncline plunging at about 45° northeast. The way up of the succession is indicated by the flow zonation described previously. The syncline may be the result of cross-folding, on a northeast axis, of rocks which originally trended northerly and dipped northeast.

At Mount Fouracre, large gabbro sills form a distinct curvature resembling the closure of a fold. The structure is regarded as an anticline, although this is not established. Assuming that the structure is a fold, then it must be truly isoclinal. The fold is terminated to west by the Minatichi Fault, and to the south is an arcuate line of quartz blows which may represent a fault. South of this fault are a few exposures of granitic rock in an area of poor outcrop. To the east, the Mount Fouracre structure is terminated by the Clifford Fault.

Within the mafic succession of the Mount Stirling area, trends are indistinct and no facing evidence was obtained. The structure proposed below is conjectural.

There is curvature of the strike trends of mafic and ultramafic rocks in the Tarmoola area from northwest to southwest indicating a broad antiformal structure. The main chert horizon, however, continues from Mount George to Mount Newman in a northwesterly trend without an antiformal swing. Rather than attribute the resulting wedge shape to an increase in thickness of the succession, it is considered that the apparent thinness of the succession at Tarmoola is the result of faulting out by the Clifford Fault.

The Mount Fouracre fold and other possible related folds were probably originally northwest trending, and attained their present attitude through cross-folding. The antiformal structure west of the Clifford Fault is considered to be a northerly-plunging anticlinal cross-fold, and is referred to here as the Tarmoola Anticline (Fig. 2). The axis of the Mount Clifford Syncline is probably coincident with that of a larger synclinal cross-fold, a complementary structure to the Tarmoola Anticline. The cross-folding has affected only the succession west of the Clifford Fault, and may have been induced by emplacement of granite in the south, causing northward slip along the Clifford Fault.

The presence of an anticline, here referred to as the Malcolm Anticline, is postulated in the southeastern corner of the Sheet area, between Mount Germatong and the Keith-Kilkenny Lineament. The evidence for this is as follows:

(1) a horseshoe-shaped area of metabasalt with a granitic core;

(2) rodding in deformed cherts, with a northerly plunge;

(3) coarse agglomerate at Mount Germatong and near Harriston are considered to be the same band;

(4) a distinct curvature within feldsparphyric metabasalts which occur east of Mount George.

This fold would contain felsic volcanic rocks *Ao, Ax,* in the core, overlain by metabasalt. The eastern limb would be truncated by the Keith-Kilkenny Lineament, and the western limb by the Clifford (Desdemona) Fault. It is suggested that the distortion of the cherts in the eastern limb of the fold is the result of pushing aside by a granitic pluton in the core.

Little is known of the structure and inter-relationships of the islands of mafic, ultramafic and banded quartz-magnetite rock and the Mount Alexander greenstones, west of the Ida Lineament. From evidence in the Menzies Sheet area (Kriewaldt, 1970), an anticlinal axis has been extended through Shallow Bore. The complementary syncline to the east may have been lost through faulting or anatexis. The banded quartz-magnetite rock at Mount Alexander resembles the next non-granitic rock westwards—the banded quartz-magnetite rock of the Brooking Hills in the Youanmi 1:250 000 Sheet area. The presence of islands of this rock within the adamellite in the Leonora Sheet area suggests that its present spatial distribution may have been influenced more by granitic activity than by folding.

PROTEROZOIC

Post-granite mafic dykes

General

Several easterly-trending mafic dykes were encountered during the mapping. Most of the dykes are only a few metres wide, and are expressed by linear outcrops of fresh dolerite which is easily distinguished from the metamorphosed mafic rock of the Archaean succession. In general they are not extensively exposed along strike, although aeromagnetic anomalies suggest that some of the dykes are regionally continuous. They are usually dolerite or gabbro; a dyke near View Hill is olivine dolerite, and the dyke through Skippys Bore and Jackies Bore is olivine gabbro. A pod of similar rock at Marsoak Well is a northwest-striking sheet with a shallow easterly dip.

North of Mount Newman is a fine-grained, unmetamorphosed dolerite containing rounded xenoliths of foliated adamellite and angular xenoliths of quartz. The adamellite contains an interstitial intergrowth of quartz and feldspar, perhaps due to remelting at the time of intrusion of the dolerite. The dyke intrudes mafic rock of the Archaean succession, and strikes northwest.

The dyke which crops out between Skippys Bore and Schmitz Well is the most continuous along strike. It is in fact a double dyke for much of its length. The southernmost of the dyke pair, however, contains occasional xenoliths of granitic rock, whereas the other apparently does not.

King of the Hills Dyke Pair

Introduction: Two adjacent, parallel dykes are so similar to each other that they are regarded as the same intrusion, and the intrusion is called the King of the Hills Dyke Pair. The dyke is over 30 km long, and commonly forms hills of significant relief. It contains a spectacular abundance of quartz xenoliths and a lesser number of adamellite xenoliths for the whole of its length across the greenstone belt. Eastwards it crosses the Keith-Kilkenny Lineament without displacement and passes into adamellite, still maintaining the same characteristics. This xenolithic dyke was not encountered in the Laverton 1:250 000 Sheet area (Gower, 1974), although there is an extension of the magnetic anomaly.

Xenoliths: The King of the Hills Dyke contains many rounded xenoliths of adamellite, the roundness being attributed to resorption during emplacement of the dyke. As in the case of the smaller xenolithic dykes, the adamellite xenoliths have a pre-existing foliation. The overwhelming majority of the xenoliths of this dyke, however, are irregular fragments of quartz. These vary in shape and size from thin plates to very elongate, swallow-tail pieces. Occasionally, adjacent fragments appear to be matching pieces of an originally larger block, but the overall impression is of a thorough mix of fragments and matrix. Pieces of quartz larger than 1 m across are rare. Towards the margin of the dyke, xenoliths decrease in abundance, the margins being virtually xenolith-free, suggesting a flow concentration in the centre. There is a weak preferred orientation of the long dimension of the xenoliths along the strike of the dyke. A few rare fragments of cherty material were observed, but, although the dyke cuts the full width of the greenstone belt, no other rock types were found.

Discussion: The King of the Hills Dyke is a relatively late east-west structure which post-dates the intrusion of the Archaean granitic rocks. It is presumed to be related to the Widgiemooltha Dyke Suite of age about 2400 m.y. The adamellite xenoliths are similar in appearance to adamellite occurring east of the Keith-Kilkenny Lineament, though there is no evidence that this is in fact the source. The quartz xenoliths are thought to be fragments of a quartz reef which existed prior to the intrusion of the dyke. Fragmentation of the quartz reef is, however, difficult to envisage without fragmentation of the country rock; and the presence of adamellite rather than greenstone xenoliths is similarly puzzling, unless the original country rock with respect to the quartz reef was adamellite. This hypothesis requires that the quartz and adamellite xenoliths were picked up from outside or from below the greenstone belt, with emplacement into the present position.

Contact metamorphism

Just north of the Diorite King mine, the King of the Hills Dyke has metamorphosed the basaltic country rock to pyroxene hornfels facies. The hornfels forms a zone of darker coloured rock about 15 m wide beside the dyke. It is a dense and extremely fine-grained rock, with a rough, pitted appearance which makes it distinctive in the field. Thin section and XRD examination showed the hornfels to contain labradorite, orthopyroxene and olivine. A hornfels of similar appearance from near a dyke at Schmitz Well contains plagioclase, orthopyroxene, olivine and abundant spinel. At Breakaway Bore a rock containing quartz, plagioclase, clinopyroxene, clinozoisite, sphene, prehnite, microcline and garnets, is thought to be a pyroxene hornfels. No dyke outcrop was located, but the hornfels is on strike with the King of the Hills Dyke.

CAINOZOIC GEOLOGY

GENERAL

Mapping of Cainozoic units is based on lithology and morphological expression. Although many symbols have been retained for the same Quaternary units as on previous 1:250 000 geological sheets, no significance is implied here by the middle letter of a 'Q' unit symbol. The stratigraphy of Cainozoic units is expressed diagramatically in Figure 3.

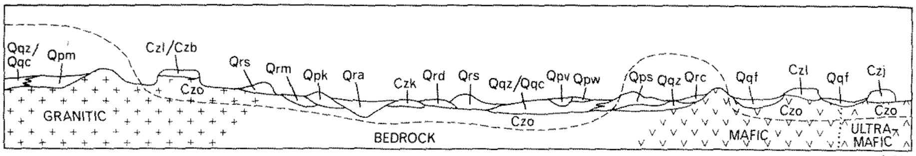


FIGURE 3

CAINOZOIC ROCK UNIT RELATIONSHIPS

LEONORA SHEET SH 51-1

Unit symbols as in Leonora Geological Sheet

CZ UNITS

Czo denotes deep-weathered, kaolinized rock which has undergone intense weathering. In the case of granitic rocks, complete kaolinization of the feldspars results in a soft, white rock studded with quartz (which usually indicates the grain size and the presence or absence of foliation of the original rock). Above the kaolinized zone in granitic terrain, silcrete (*Czb*) may form. More commonly, however, the duricrust over deep-weathered rocks of all kinds is *Czl*. This varies from pale brown pisolitic limonite to black, metallic-looking, hematitic cap. The latter type usually overlies mafic or ultramafic rock (the source of the iron enrichment) and often grades into *Qqf*. *Czj* includes jasperoidal chalcedony, chrysoprase, magnesite, and limonite deposits over ultramafic rock. At Joes Bore an extensive deposit consisting only of magnesite is considered to overlie ultramafic rock.

Calcrete (*Czk*), is freshwater limestone deposited in ancient drainages, and is found at the margins of present-day salt lakes which occupy these relict river courses. Calcrete units may be up to 40 m thick.

Q UNITS

The term 'salt lake' is commonly used to refer only to the bare expanses of saline alluvial (*Qra*), but several other units are restricted to the saline environment of ancient drainage courses. *Qrm* denotes saline alluvial flats vegetated with halophitic flora (such as samphire and saltbush); it is probably a modification of *Qra*, which is gradually receding. There are two eolian lake units: *Qpk*, which consists of gypsum and clay in sheets and dunes and is always adjacent to *Qra*; and *Qrs*, slightly saline and gypsiferous sand dunes flanking the saline drainage course. *Qrd* is used for the composite marginal areas not separable into individual units. It is mainly alluvium and colluvium, with abundant small gypsiferous dunes, patches of *Qra*, *Qrm*, and *Qrs*. Despite its composite nature, Qrd can be recognized, particularly on air-photographs, as a regional unit. In the Laverton 1:250 000 Sheet area (Gower, 1974), the tendency for *Qrs* and *Qpk* to occur on the east side of saline drainages has been attributed to the influence of prevailing winds. This tendency is not apparent in the Leonora Sheet area, because the salt lake systems are aligned roughly east-west and the influence of prevailing winds is minimal.

Erosional material marginal to outcrop, consisting of scree and colluvium, is grouped under *Qrc*. Quartz and feldspar sand, *Qpm*, is found adjacent to or overlying granitic rock. It grades into *Qqz*, the most extensive Quaternary unit within the Sheet area, which is the loam or clay soil forming the monotonous mulga plains. *Qqc* is similar to *Qqz*, but usually less vegetated and with a mixed angular to rounded rock float. Deflation of the soil (generally over mafic or ultramafic rock) has produced the eluvial deposit *Qqf*, a maghemite gravel. Eolian deposits (*Qps*) are widespread, but only occasionally, for example at Wildara, form distinct dunes. Spinifex is the characteristic vegetation over *Qps*. Broad, ill-defined drainage and well-defined creeks are grouped as *Qpv*. Sheetwash adjacent to major creeks has formed extensive barren surfaces, *Qpw*. Recognizable on the ground by the absence of vegetation, *Qpw* is distinguished on air-photographs by its blotchy photo-pattern.

MINERAL DEPOSITS

GOLD

Approximately 95 000 000 gm (3 000 000 fine ozs) of gold have been won from within the Sheet area. Most of this was from one mine, the Sons of Gwalia, which produced 83 000 000 gm (2 670 000 fine ozs) and was reputed to be the richest mine outside the 'Golden Mile'. The Sons of Gwalia closed in 1963. The only other important producer was the East Murchison United leases at Lawlers, which yielded almost 5 000 000 gm (160 000 fine ozs). Production from the numerous other mines scattered throughout the area is comparatively small. Production from the mining centres is given in Table 3.

TABLE 3. SUMMARY OF REPORTED GOLD AND SILVER PRODUCTION TO 1973

Goldfield	*District*	*Centre*	*Alluvial (gm)*	*Dollied (gm)*	*Ore treated (tonnes)*	*Gold therefrom (gm)*	*Average grade (gm/tonne)*	*Total gold recovered (gm)*	*Silver recovered (gm)*
		Diorite	—	39 746	43 970	1 233 364	28.05	1 273 110	1 030
		Dodgers Well	30	2 675	2 832	88 355	31.20	91 060	—
		Leonora	1 182	87 982	7 458 523	85 309 259	11.44	85 398 423	5 876 221
MOUNT MARGARET	MOUNT MALCOLM	Mt Clifford	1 679	113 391	15 344	626 199	40.81	741 269	—
		Pig Well	—	1 088	16 649	494 552	29.70	495 640	1 990
		Wilsons Creek	30	125	657	13 342	20.31	13 497	—
		Wilsons Patch	156	4 789	30 870	450 421	14.59	455 366	62
		TOTALS	3 077	249 796	7 568 845	88 215 492	11.66	88 568 365	5 879 303
EAST MURCHISON	LAWLERS	Part of Lawlers	13 282	29 924	43 679 387	1 464 638	29.82	1 507 844	35 000 approx.
NORTH COOLGARDIE	MENZIES	No production within sheet area							

The Sons of Gwalia mine is in sheared mafic rock, part of a sequence of mafic intrusive and extrusive rocks which include east-facing pillow lavas. These are overlain by metamorphosed sedimentary rocks which include the prominent Leonora chert horizon. To the west, the mafic rocks have been intruded by granite. Along this same granite contact lie other gold mines, such as Tower Hill, Trump, and Gold Blocks. Similarly, East Murchison United leases, Mount Stirling, Teutonic and Wilsons Patch mines are located at granite-greenstone contacts, whereas others, such as McCafferys and Waroonga, are within mafic or metasedimentary rock. East of Leonora and at Mount Malcolm are numerous mines in felsic volcanic and pyroclastic rocks.

Nickel

In the past few years nickel exploration within the Sheet area has been extensive, and is still continuing. Several important nickel sulphide deposits occur to the north in the Sir Samuel 1:250 000 Sheet area and they lie in the vicinity of the Keith-Kilkenny Lineament. This structure may prove to be a favourable location for nickel in the Leonora Sheet area, as the Weebo Bore prospect indicates. Exploration is not confined to the lineament, however, but extends to ultramafic rocks in general. Western Mining Corporation Limited have encountered nickel sulphide in four of their prospects in the Mount Clifford area. The best intersection of nickel sulphide announced so far is 17 m of 2.2 percent Ni.

Molybdenum

Molybdenite occurs in quartz veins within granitic rock at Dodgers Hill, near Mertondale, 27 km northeast of Leonora (Clarke, 1919). The host rock is a pink microcline granite-adamellite. Although a shaft was sunk in 1918, there has been no official production.

Uranium

Recent exploration for uranium in the calcrete deposits of ancient drainages and salt lakes led to the discovery of a substantial uranium deposit at Yeelirrie in the Sir Samuel/Sandstone 1:250 000 Sheet areas. The uranium is mainly in the form of carnotite. Calcretes in the Leonora Sheet area have been prospected for uranium, but no significant occurrences have been reported.

Magnesite

A considerable quantity of magnesite occurs at Joes Bore, east of Lawlers (Thom, 1974). The main deposit, which is about 1.6 km long and 400 m wide, is of unknown depth. The magnesite, which is believed to overlie ultramafic rock, is free from siliceous weathering products and weathered rock, but the isolation of the deposit reduces the economic potential. There has been no production from this locality.

Lead

Small amounts of galena have been recorded at Wilsons Patch (Gibson, 1907). Also reported from this locality are argentite, cerussite, blende and pyromorphite (Simpson, 1948).

WATER RESOURCES

The region has low, unreliable rainfall and is characterized by internal drainage which originated in Tertiary times. Infrequent surface run-off is channelled into ephemeral drainage lines leading to extensive salt lake systems, where ponded water soon evaporates.

Despite this saline internal drainage and arid environment, the groundwater prospects are good over much of the area, and provide the main source of water for domestic and stock purposes.

Aquifers may be divided into three main groups:

(a) Colluvial aquifers situated at or near the base of outcrop hills;

(b) alluvial aquifers situated in ephemeral drainage lines;

(c) calcrete aquifers situated in ancient river channels leading to the salt lakes which form the centre of present-day internal drainage.

Colluvial sources are often small and unreliable, whereas calcrete deposits can yield vast quantities of water, possibly sufficient for industry. On the other hand, colluvial aquifers contain fresher water, typically about 500 ppm total dissolved solids (TDS), while calcrete aquifers yield water ranging from about 1000 to 10 000 ppm/TDS. Most of the wells and bores, however, are sited near drainage channels, and the yield and salinity, though generally much less than those for calcrete, are variable.

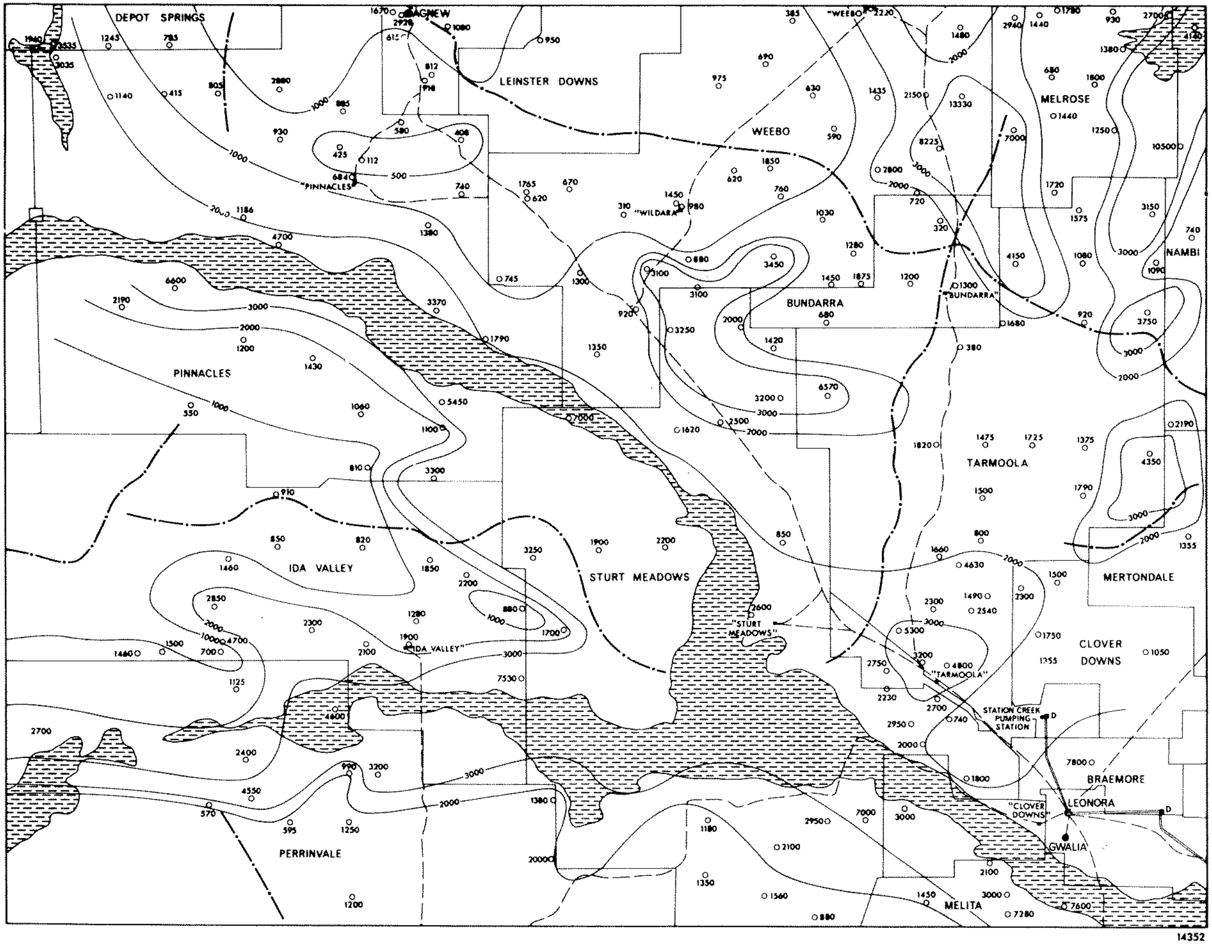
TABLE 4. REPRESENTATIVE CHEMICAL ANALYSES OF GROUNDWATER

Well Name	*Rainbow Well Bundarra Station*	*Doyle Well Sturt Meadows Station*	*Little Mill Well Nambi Station*
Depth of hole	—	—	4.1 m
Standing water level (beneath natural surface)	—	—	3.8 m
Total dissolved solids (by evaporation)	320 ppm	620 ppm	4080 ppm
Sodium Chloride (calculated from chloride)	97	199	2760
Total hardness (calculated as $CaCO_3$)	96	352	704
Total alkalinity (calculated as $CaCO_3$)	60	265	278
Calcium	19	42	102
Magnesium	12	60	109
Sodium	39	79	1140
Potassium	9	3	70
Iron (in solution)	<0.05	<0.1	<0.05
Bicarbonate	73	323	339
Carbonate	Nil	Nil	Nil
Sulphate	19	48	513
Chloride	59	121	1680
Nitrate	37	51	131
Silica	88	71	75
Remarks	Colluvial aquifer, near granite outcrop and drainage divide	Alluvial aquifer on major drainage	Calcrete aquifer adjacent to salt lake

FIGURE 4

WATER RESOURCES

LEONORA SHEET SH 51-1



SCALE

5 0 5 10 15 20 25

KILOMETRES

REFERENCE

- Saline alluvial & eolian deposits in ancient drainages
- Watershed
- 685 Field salinity of wells & bores in parts per million total dissolved salts
- D Dam
- Pipeline
- Station homestead
- Pastoral lease or government reserve boundary
- Formed road
- 1000 Salinity contour (generalized)

Water samples were collected from 190 bores and wells. Total dissolved solids (TDS) were measured for all of these, and full chemical analyses were carried out on 23 of the samples. The results are shown on an isohaline map (Fig. 4), and representative samples have been tabulated (Table 4). The isohaline map is only a general guide to the pattern of groundwater quality, because of the limited number of sample points. However, it can be seen that there are two major controls on groundwater salinity:

(a) distance from salt lake bears a direct relationship to groundwater quality; hence the best quality water is found in elevated areas adjacent to drainage basin divides;

(b) rock type influences the salinity to some extent; thus areas adjacent to granitic or felsic outcrop are favourable for obtaining good quality water.

TABLE 5. LOCALITIES CITED IN TEXT WITH LATITUDINAL AND LONGITUDINAL REFERENCE

Agnew	28°01′S	120°31′E
Agnew Bluff	28°02′	120°32′
Bayes Soak	28°38′	120°31′
Blue Well	28°45′	120°50′
Breakaway Bore	28°35′	121°29′
Brooking Hills	28°59′	119°59′
Bundarra	28°19′	121°11′
Calamity Well	28°38′	120°34′
Clifford Bore	28°21′	121°02′
Copperfield	29°06′	120°27′
Cow Paddock Well	28°42′	121°57′
Cummings Bore	28°32′	120°20′
Darlot	27°53′	121°15′
Dodgers Hill	28°37′	121°21′
Doyle Well	28°31′	120°57′
Duketon	27°38′	122°16′
Emu Gold mine	28°01′	120°30′
Fly Bore	28°11′	120°54′
Ford Run Plateau	28°13′	121°03′
Fourteen Mile Well	28°13′	120°39′
Gambier Lass Well	28°44′	121°28′
Goanna Patch	28°08′	121°01′
Gold Blocks gold mine	28°50′	121°17′
Gum Well	28°58′	120°57′
Gwalia	28°55′	121°20′
Hangover Bore	28°19′	121°02′
Harbour Lights gold mine	28°52′	121°19′
Harriston gold mine	28°48′	121°29′
Heather Well	28°17′	120°57′
Hicks Well	28°45′	121°06′
Ida Valley	28°42′	120°30′
Jackies Bore	28°43′	120°11′
Jasper Hill	28°46′	121°13′
Jindardie Creek	28°13′	121°16′
Jindardie Well	28°12′	121°19′
Joes Bore	28°06′	120°40′
Jungle Well	28°25′	121°01′
Kurrajong	28°47′	121°06′
Lawlers	28°05′	120°01′
Leonora	28°53′	121°20′
Little Mill Well	28°01′	121°29′
Little Pete Well	28°32′	121°05′
Malcolm	28°56′	121°31′

TABLE 5. LOCALITIES CITED IN TEXT WITH LATITUDINAL AND LONGITUDINAL REFERENCE—*continued*

Maroon Range	28°28′	120°32′
Marshall Pool	28°20′	120°56′
Marsoak Well	28°27′	120°14′
McCafferys gold mine	28°02′	120°33′
Mertondale	28°40′	121°32′
Mount Adamson	28°09′	120°33′
Mount Alexander	28°55′	120°16′
Mount Clifford	28°28′	121°03′
Mount Davis	28°43′	121°14′
Mount Fouracre	28°31′	120°59′
Mount George	28°49′	121°18′
Mount Germatong	28°51′	121°23′
Mount Leonora	28°54′	121°20′
Mount Malcolm	28°53′	121°27′
Mount Newman	28°30′	121°05′
Mount Ross	28°42′	121°03′
Mount Stirling	28°37′	121°04′
Munjeroo	28°15′	120°07′
No. 2 Well	28°17′	120°48′
Outcamp Well	28°28′	120°50′
Paperill Hill	28°34′	120°39′
Pig Well	28°47′	121°28′
Pig Well Bore	28°47′	121°24′
Pink Well	28°20′	120°47′
Rainbow Well	28°31′	120°42′
Schmitz Well	28°36′	120°49′
Segies Well	28°48′	120°34′
Shallow Bore	28°51′	120°25′
Skippys Bore	28°42′	120°04′
Sons of Gwalia gold mine	28°55′	121°20′
Table Hill	28°10′	120°36′
Tarmoola	28°43′	121°09′
Teutonic gold mine	28°24′	121°11′
The Terraces	28°35′	121°26′
Top Well	28°41′	120°31′
Tower Hill gold mine	28°54′	121°19′
Tragedy Well	28°06′	120°20′
Trump gold mine	28°51′	121°18′
Union Jack Well	28°43′	120°48′
View Hill	28°24′	120°07′
Wandery Well	28°17′	121°15′
Waroonga gold mine	28°00′	120°30′
Waroonga Extended South gold mine	28°00′	120°30′
Weebo Bore	28°03′	120°47′
Wilbah	28°56′	120°41′
Wildara	28°13′	120°51′
Wildara Pinnacle	28°16′	120°46′
Wilsons Patch	28°19′	121°11′
Yeelirrie	27°17′	120°04′

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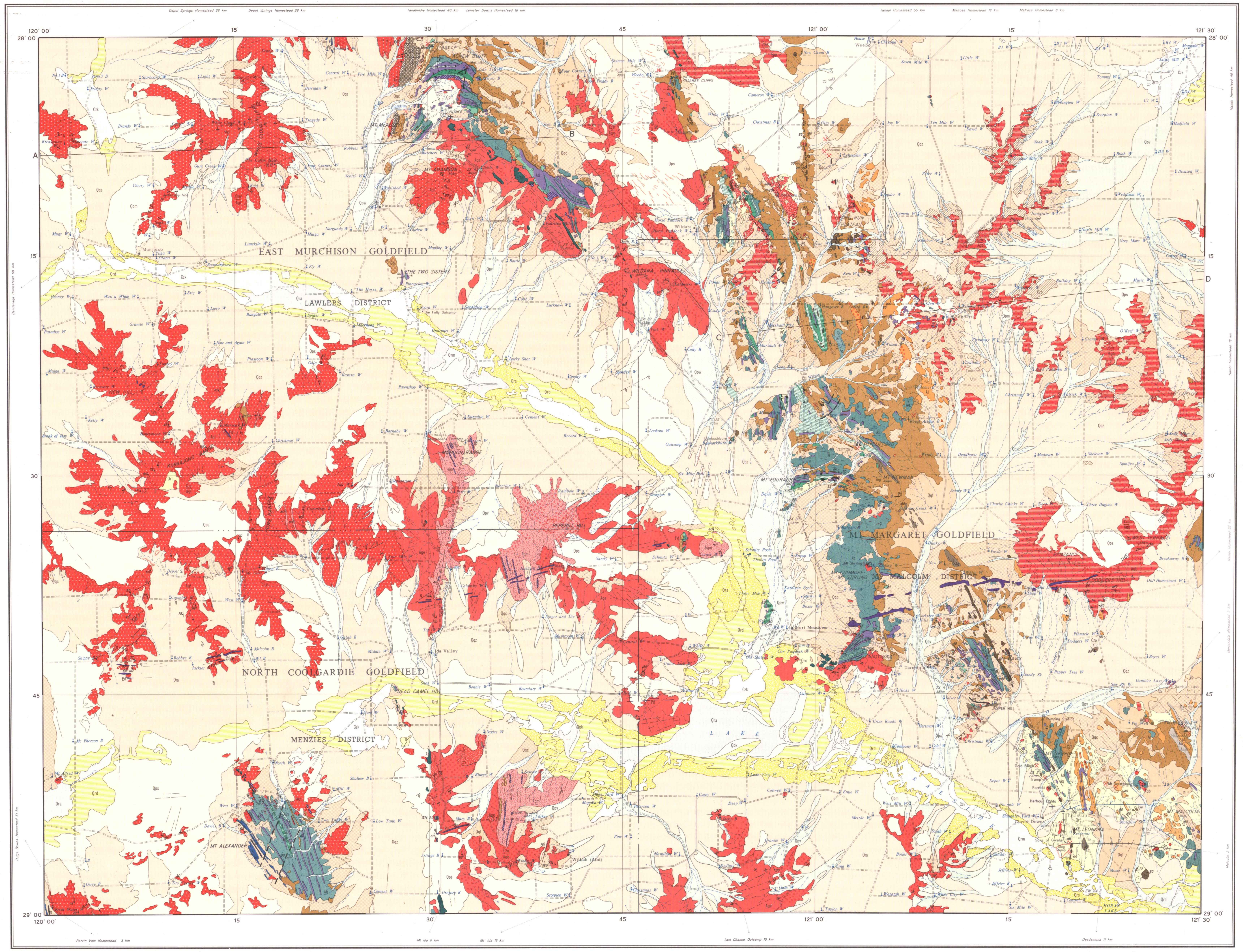
R74/1564 (14) Cat. No. 76 3321 9

LEONORA

AUSTRALIA 1 : 250 000 GEOLOGICAL SERIES

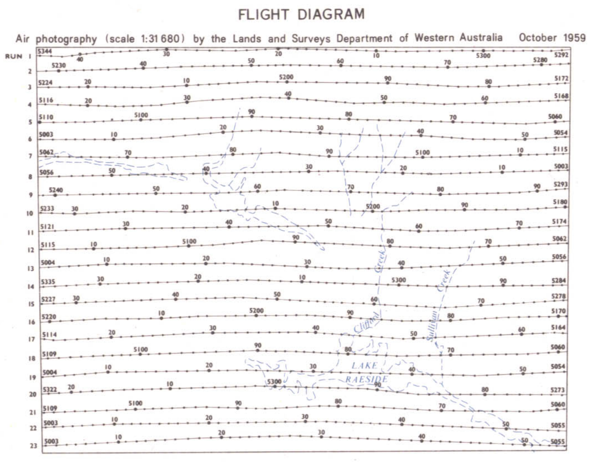
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-1



SYMBOLS

FLIGHT DIAGRAM



REFERENCE

CAINOZOIC — QUATERNARY

Qra Alluvium—clay and silt in salt lakes; saline and gypsiferous
Qrm Alluvium—silt, sand and gravel in samphire flats adjacent to Qra
Qrd Colluvium and alluvium—pale red-brown to buff silt and sand; calcareous and gypsiferous in part; marginal to salt lakes
Qrs Eolian deposits—white to yellow quartz sand, red-brown silty sand; in sheets and dunes marginal to salt lakes; saline and gypsiferous in part
Qrc Colluvium—silt, sand and gravel; quartz pebble veneer and angular rock float

Qpv Alluvium—poorly sorted dark red clay to pebble deposits; contains most present-day drainage; grades into Qqz
Qpw Sheet wash; barren surfaces adjacent to Qpv
Qps Eolian deposits—mixed red, brown and yellow sand in sheets and dunes
Qpk Eolian deposits—Kopi, gypsum and clay in sheets and dunes
Qpm Colluvium—pale red silt and sand with quartz and feldspar grains; marginal to granitic rocks; grades into Qqz

Qqc Colluvium—mixed angular to rounded rock fragments in loam, calcareous in part; veneer on fresh and weathered bedrock
Qqz Colluvium and alluvium—dark red to brown clay, loam and sandy loam; contains kankar or clay hardpan
Qqf Eluvium—clay and silt with ironstone pebble veneer, calcareous in part; mantles low hills

TERTIARY

Czl Limonite deposits—cemented ironstone gravel and laterite
Czb Silcrete—sub-vitreous siliceous rock with angular quartz grains
Czj Jasperoidal chalcedony, chrysoprase, magnesite, limonitic deposits over ultramafic rocks
Czk Calcrete and kankar; massive, nodular and sheet carbonate; contains minor chalcedony
Czo Deeply weathered rock; kaolinized, subsequently ferruginized and silicified

PROTEROZOIC OR ARCHAEAN

Pd Mafic dykes; quartz diorite, gabbro, olivine-gabbro. Pdx contains numerous quartz xenoliths

ARCHAEAN

Dykes: g: granite and porphyry, q: quartz

Agb Biotite granite to adamellite, medium to coarse even-grained
Age Biotite granite to granodiorite, fine to medium even-grained
Agl Granite to adamellite, medium to coarse-grained porphyritic, phenocrysts sparse to abundant
Agg Strongly foliated granitic rocks
Agm Migmatite and gneiss
Ags Syenite

As Black shale, mudstone and minor greywacke, siliceous shale; in part pyroclastic; schistose
Aa Shale, siltstone, sandstone and minor conglomerate, often showing graded and cross bedding
At Fine-grained felsic volcanoclastic rocks; bedded, schistose
Acp Conglomerate, polymictic; contains clasts of granite, jaspilite, chert, sediment, felsic to mafic extrusive rocks
Aco Conglomerate, almost oligomictic; contains clasts of granite to adamellite with a few mafic pebbles
Acm Metapelite; quartz-muscovite-kyanite assemblages with deformed granitoid inclusions; regionally metamorphosed Aa and Aco

Aw Banded quartz-magnetite rock, minor chert
Aq Banded chert, ferruginous chert

Al Felsic extrusive rocks; rhyolite to dacite, fine-grained, some porphyritic
Av Agglomerate—contains rounded felsic igneous clasts; derived from and marginal to Al
Ao Altered felsic pyroclastic and extrusive rocks; schistose
Ax Pyroclastic rocks—agglomerate and tuff-breccia

Ap Quartz-feldspar porphyry in sills, dykes and irregular bodies

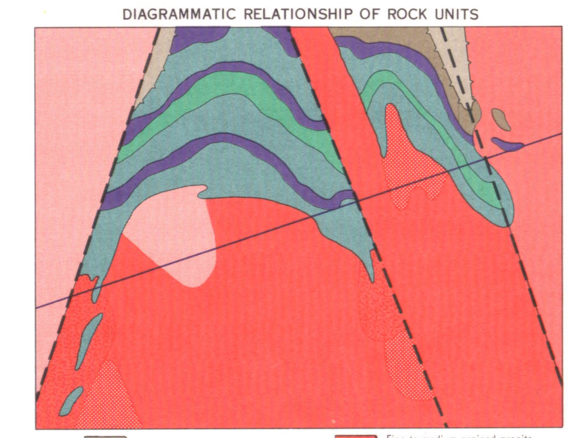
Ab Mafic extrusive rocks; fine to medium-grained
Ai Mafic extrusive rocks; similar to Ab but with variolitic texture and pillow structure
Ah Mafic hornfels and fine-grained amphibolite (contact metamorphic rock)
An Similar to Ab, contains phenocrysts of altered feldspar, includes some porphyritic dolerite

Ad Mafic intrusive rocks; gabbro to diorite; medium to coarse-grained
Am Amphibolite, banded amphibolite, epidiorite; coarse-grained (contact metamorphic rock)

Au Ultramafic rock, unassigned
Aup Serpentinite after coarse-grained and porphyritic olivine-rich ultramafic rock
Aus Serpentinite after fine-grained ultramafic rock; commonly exhibits spinifex texture
Aux Pyroxenite sills; medium to coarse-grained clinopyroxene with orthopyroxene phenocrysts
Ae Altered ultramafic rocks—talc-carbonate-chlorite-serpentine assemblages; schistose
Ar Altered mafic to ultramafic rocks—tremolite-chlorite-actinolite assemblages; high magnesium basalts

Regional metamorphism attains greenschist or amphibolite facies

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Conglomerate, arkose
Chert, sediments, tuffs, felsic volcanics
Mafic intrusive rocks
Ultramafic intrusive and extrusive rocks
Mafic extrusive rocks
Porphyritic adamellite
Coarse-grained granite
Fine to medium-grained granite to granodiorite
Strongly sheared granite
Migmatite
Tectonic lineament or fault
Mafic dyke
Unconformity

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

Published by Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, Canberra, A.C.T.

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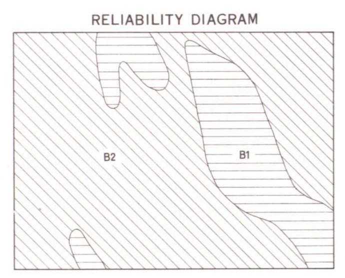
RELIABILITY DIAGRAM



HON. A. MENSAROS, M.L.A.
MINISTER FOR MINES
J. H. LORD, DIRECTOR, GEOLOGICAL SURVEY

SCALE 1 : 250 000

0 5 10 15 20 25 30 Kilometres

0 5 10 15 Miles

TRANSVERSE MERCATOR PROJECTION
ZONE 2 AUSTRALIA SERIES

INDEX TO ADJOINING SHEETS

SANDSTONE SG 50-16	SIR SAMUEL SG 51-13	DUKETON SG 51-14
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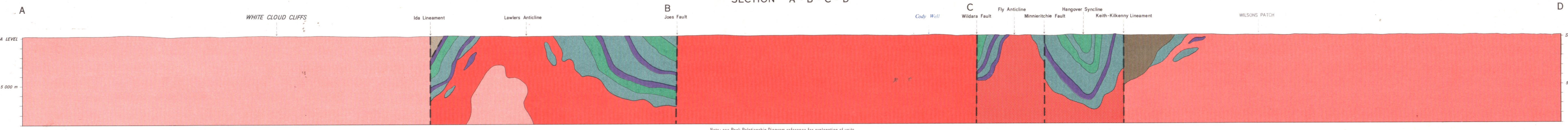
DECLINATION DIAGRAM

DIAGRAMMATIC SECTION

NATURAL SCALE

SECTION A - B - C - D



LEONORA
SHEET SH 51-1

FIRST EDITION 1975