EXPLANATORY NOTES

GOVERNMENT OF WESTERN AUSTRALIA

EDJUDINA

1:250 000 SHEET

WESTERN AUSTRALIA

SECOND EDITION

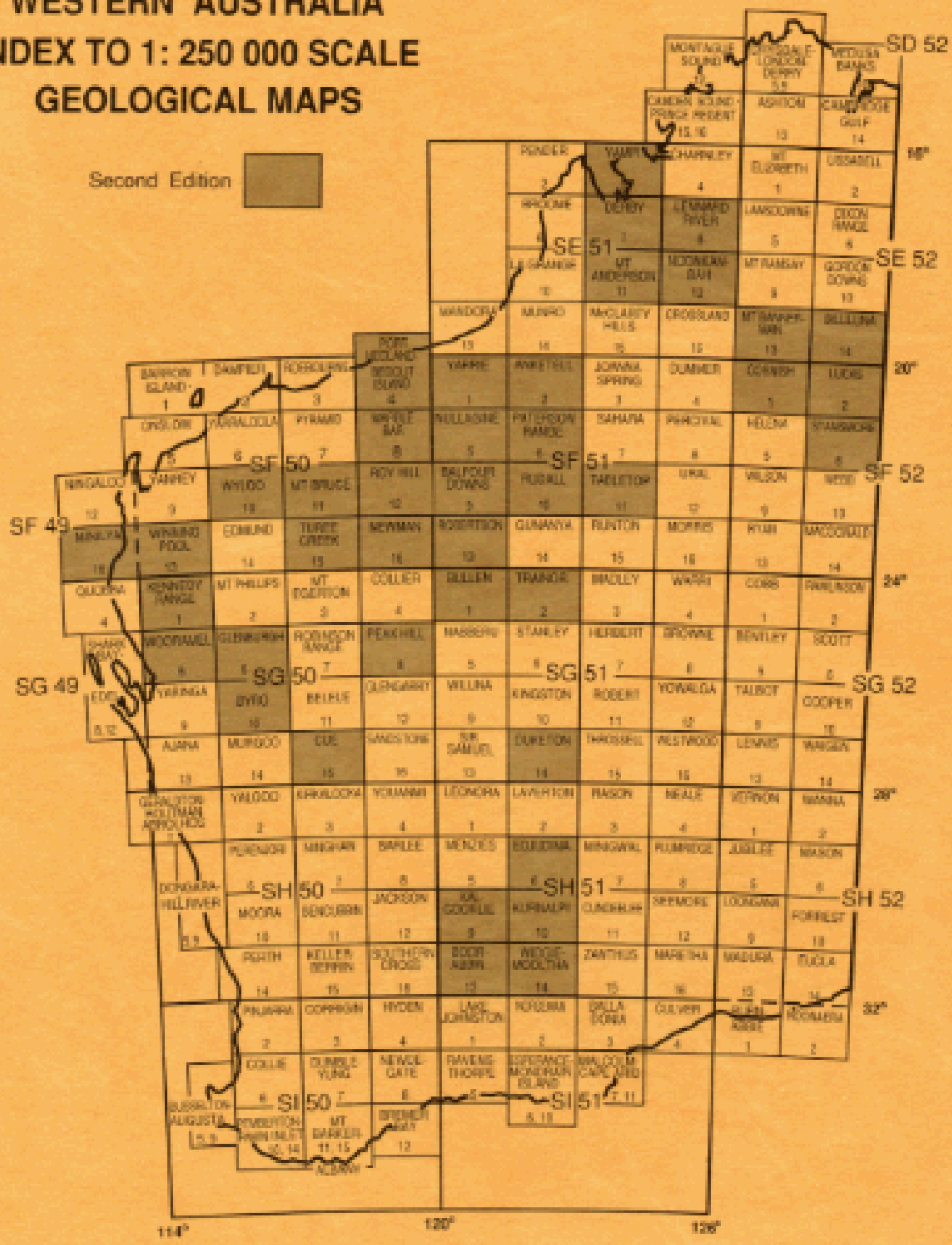
SHEET SH 51-6 INTERNATIONAL INDEX

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

DEPARTMENT OF MINERALS AND ENERGY

WESTERN AUSTRALIA
INDEX TO 1: 250 000 SCALE
GEOLOGICAL MAPS

Second Edition



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
1:250 000 GEOLOGICAL SERIES—EXPLANATORY NOTES

EDJUDINA

WESTERN AUSTRALIA

SECOND EDITION

SHEET SH51–6 INTERNATIONAL INDEX

by
S. F. CHEN

Perth, Western Australia 1999

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Explanatory Notes on the Edjudina 1:250 000 Geological Sheet, Western Australia (Second Edition)

by S. F. Chen

INTRODUCTION

The EDJUDINA* 1:250 000 geological sheet (SH 51–6) is bounded by latitudes 29°00'S and 30°00'S and longitudes 121°30'E and 123°00'E. The sheet is situated between KURNALPI and LAVERTON in the Eastern Goldfields Province of the Yilgarn Craton. The map sheet is named after Edjudina, a pastoral station and historical gold mining centre.

The sheet area is accessible from Kalgoorlie along the Yarri and Pinjin roads. Kookynie, a railway siding and settlement on the Kalgoorlie–Leonora railway line, lies just west of EDJUDINA. A formed road provides access from Kookynie to the Kalgoorlie–Meekatharra highway and to the town of Leonora. Principal formed roads within the sheet area include the Kookynie–Yarri, Kookynie – Mount Remarkable, and Glenorn–Yundamindera roads in the west, and the Mount Celia and Wilga roads in the east. Pastoral, exploration, and mining tracks provide ready access to most areas of greenstone outcrop.

The EDJUDINA sheet area is sparsely settled with the only permanent habitation in homesteads and near active gold mines.

PHYSIOGRAPHY, CLIMATE, AND VEGETATION

The physiography on EDJUDINA is controlled predominantly by three northwesterly trending, saline, lake drainage systems and related erosional and depositional areas — Lake Carey – Lake Minigwal, Lake Raeside, and Lake Marmion – Boomerang Lake – Lake Rebecca (Fig. 1). These lakes are elongate and mainly less than 10 km wide, with a maximum width of 20 km (Lake Carey). The present streams are commonly incised in the upper and middle reaches, and flood out in the lower reaches across the pediment towards the salt lakes. The broad valleys associated with salt lakes represent a southeast-flowing palaeodrainage system (van de Graaff et al., 1977).

The topography of EDJUDINA is characterized by low rocky ridges mainly less than 180 m in relief. Most areas lie 350–510 m above the Australian Height Datum (AHD), with elevation increasing slowly from south to north, and from west to east. The highest areas are remnants of plateaus in the eastern portion of EDJUDINA where elevation is typically more than 430 m AHD, with a maximum elevation of 513 m east of Lake Carey.

The physiography is closely related to the underlying rock types. Rocky hills and ridges that form divides are commonly underlain by greenstones, locally capped by laterite. The most prominent example is the Edjudina Range, which is composed of banded iron-

* Capitalized names refer to standard map sheets. Where 1:100 000 and 1:250 000 sheets have the same name, the 1:250 000 sheet is implied unless otherwise indicated.

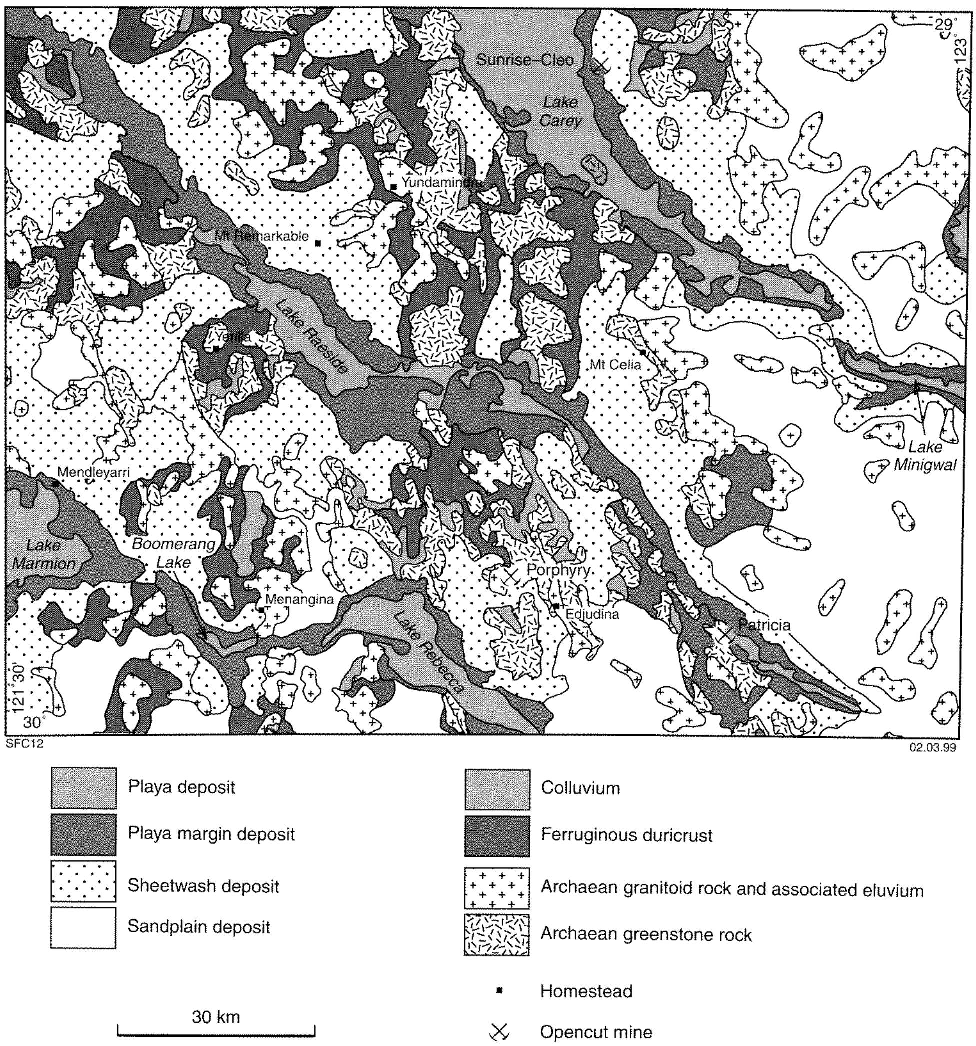

Figure 1. Physiography and Cainozoic geology of Edjudina

formation (BIF) and chert. Weakly dissected, broad areas are commonly underlain by granitoid rocks. Breakaways up to 15 m high are typically composed of deeply weathered and silicified granitoid or felsic rocks. The plateaus in eastern Edjudina are underlain by granitoid rocks and covered by sandplains.

The region has a semi-arid climate. Historical records show that Menzies, to the west, has an average annual rainfall of 249.5 mm with an average of 47.6 wet days per year (Commonwealth Bureau of Meterology, Australia, Department of the Environment and Heritage, 1998, pers. comm.). Laverton, to the north, has an average annual rainfall of 225.7 mm with an average of 40.5 wet days per year. The highest monthly rainfall averages are recorded between January and July. Temperatures commonly exceed 40°C in the hottest months (December–March) and there are occasional frosts in the coldest months (June–August).

The western three-quarters of EDJUDINA lies within the Murchison Region or Austin Botanical District of the Eremaean Province (Beard, 1990). The Austin Botanical District is characterized by extensive, typically dense woodland with locally more open areas over granitoid rocks and marginal to salt lakes. Mulga (*Acacia aneura*) is the dominant woodland species, but there are also other *Acacia* species. In stony areas less favourable to mulga, understory species of *Cassia* and *Eremophila* are larger and more abundant. Various types of gum trees (*Eucalyptus* species) are found along creeks and in the broad, sandy regions over granitoid rocks. Wind grass (*Aristida contorta*) is widespread and spinifex (*Triodia* species) grows locally, particularly in sandy areas. A variety of salt-tolerant plants, including saltbush (*Atriplex* species) and bluebush (*Maireana* species), occupy open areas around lake systems.

The eastern quarter of EDJUDINA lies within the Great Victoria Desert Region or Helms Botanical District of the Eremaean Province (Beard, 1990). This region is characterized by open country with extensive sandplains. Spinifex (*Triodia basedowii*) is the common grass species and typical tree species include mulga (*Acacia aneura*), marble gum (*Eucalyptus gongylocarpa*), and mallee (*Eucalyptus youngiana*).

PREVIOUS INVESTIGATIONS

Early geological investigations were mainly related to local gold mining activities (Maitland, 1903, 1904; Montgomery, 1905; Jutson, 1915a,b; Honman, 1916, 1917a,b; Jutson and Farquharson, 1921; Blatchford, 1927, 1935; Forman, 1931; Hobson and Miles, 1951; Berliat, 1956). The first regional geological description of a large part of EDJUDINA was presented by Honman (1917b). Williams et al. (1973, 1976) produced the first edition of the 1:250 000 geological sheet. Williams (1976) also produced an interpretative geological map of the southeastern part of the Yilgarn Craton, including EDJUDINA. Hallberg (1982a,b, 1985) subsequently published a set of geological maps and a geological description of the Leonora–Laverton area that included most of the northern half of EDJUDINA. Swager (1995a) produced a regional interpretation that included parts of WIDGIEMOOLTHA, KURNALPI, KALGOORLIE, MENZIES, and most of the southern half of EDJUDINA. The study of granitoid rocks in the southwestern part of the Eastern Goldfields by Witt and Davy (1997a) covered the western third of EDJUDINA.

Three 1:100 000 geological maps comprising the northern half of EDJUDINA — YERILLA (Oversby and Vanderhor, 1995), LAKE CAREY (Rattenbury and Swager, 1994), and MOUNT CELIA (Duggan, 1995) — were published by the Australian Geological Survey Organisation (AGSO). The sheets that comprise the southern half of EDJUDINA — the EDJUDINA and YABBOO (Swager, 1994a,b, 1995b) and BOYCE 1:100 000 geological maps (Chen and Witt, 1997) — were published by the Geological Survey of Western Australia (GSWA). All these maps, and those of Hallberg (1982a,b), were used extensively in the compilation of the second edition of EDJUDINA.

Aeromagnetic images derived from surveys carried out by AGSO (400 m line spacing) over EDJUDINA were used to prepare the second edition of the map sheet. Landsat Thematic Mapper images at 1:100 000 produced by the Remote Sensing Services, Department of Land Administration of Western Australia, were also used.

Company reports, including both unpublished maps and exploration data, are available in the public domain through the GSWA Western Australian Mineral Exploration database (WAMEX) open-file system.

NOMENCLATURE

All Archaean rocks described in these notes have been subjected to low- to medium-grade metamorphism, but for ease of description the prefix 'meta-' is omitted and protolith rock names are used.

Komatiite (*Auk*) refers to ultramafic volcanic rock with platy olivine-spinifex texture. High-Mg basalt (*Abm*) includes basaltic rock with relict pyroxene-spinifex texture. High-Mg basalt is called komatiitic basalt by some authors.

PRECAMBRIAN GEOLOGY

REGIONAL GEOLOGICAL SETTING

EDJUDINA is situated in the central Eastern Goldfields Province of the Archaean Yilgarn Craton (Williams, 1974; Gee, 1979). Griffin (1990) divided the greenstones on EDJUDINA and adjacent areas into the Malcolm, Murrin, Margaret, Merolia, and Edjudina greenstone belts.

Hallberg (1985) subdivided the Leonora–Laverton area, which includes the northern part of EDJUDINA, from west to east into the Keith–Kilkenny tectonic zone, Murrin–Margaret sector, Laverton tectonic zone, and Merolia sector. The geological sectors are characterized by open, upright folds, low metamorphic grade, and relative continuity in stratigraphy, whereas the tectonic zones are characterized by isoclinal folding, penetrative polyphase deformation, a range of metamorphic grades, extensive metasomatism, and discontinuous stratigraphy (Hallberg, 1985). The tectonic zones are not simple lineaments, but discontinuity zones with irregular geometry from a few kilometres to over 60 km in width. Hallberg (1985) also recognized two informal stratigraphic associations in this area: the lower (Association 1) contains mafic volcanic rocks and quartz-rich sedimentary rocks; and the upper (Association 2) contains mafic and ultramafic volcanic rocks, calc-alkaline andesite, and quartz-poor feldspathic sedimentary rocks.

In the first edition of the EDJUDINA explanatory notes, Williams et al. (1976) proposed a regional stratigraphic and structural interpretation based on the concept of volcanic cycles. More recently, Swager (1995a, 1997) produced a structural framework for the southern part of the Eastern Goldfields in which he divided the greenstones in the Kurnalpi–Edjudina area into a number of tectono-stratigraphic domains and terranes. From west to east, these are the Gindalbie Terrane between the Mount Monger and Emu Faults, the Kurnalpi Terrane between the Emu and Claypan Faults, and the Edjudina and Linden Terranes to the east of the Claypan Fault (Swager, 1997). This subdivision includes the southern half of EDJUDINA. Myers (1997) and Myers and Swager (1997) presented overviews of the Archaean geological setting of the Eastern Goldfields within the Yilgarn Craton.

For ease of description, EDJUDINA is described in terms of three subdivisions partly corresponding to those of previous authors. These subdivisions — here called the Malcolm, Murrin, and Laverton greenstones — are described below.

Malcolm greenstones

The Malcolm greenstones lie southwest of the Keith–Kilkenny Fault Zone (see cross section on map) and correspond to the Malcolm greenstone belt of Griffin (1990). The greenstones include parts of the Gindalbie and Kurnalpi Terranes of Swager (1997). The eastern part is dominated by ultramafic, mafic, and intermediate rocks, whereas the central and western portions contain a bimodal mafic–felsic volcanic sequence (Hallberg, 1986; Griffin, 1990).

The eastern part of the Malcolm greenstones, between the Yerilla and Glenorn Faults, consists of basalt, gabbro, ultramafic rocks, andesite, and sedimentary and felsic volcanic rocks. Rocks along the Yerilla Fault, which is mainly a deformed granite–greenstone contact, are intensely foliated and locally metamorphosed into amphibolite facies. Large-scale folds, such as the Bulyairdie and Yerilla Synclines, have north-northwesterly and northerly trending axes. Their geometric relationship with the Yerilla Fault suggests sinistral movement on the fault.

The central part of the Malcolm greenstones, between the Yerilla and Emu Faults, consists of basalt, mafic schist, felsic volcanic rocks, and large granitoid intrusions. Near Kurrajong Well the Emu Fault marks the eastern edge of a zone, up to 2 km wide, that contains intensely deformed, locally mylonitized, felsic volcanic and volcaniclastic rocks interleaved with minor basalt and amphibolite. In the western part, southwest of 6 Mile Well, large-scale tight folds containing quartz–feldspar–mica schist, gabbro sills, and basalt were refolded into northeasterly trending, open folds.

Murrin greenstones

The Murrin greenstones lie between the Keith–Kilkenny Fault Zone and the Claypan Fault (Fig. 2). They correspond to the Murrin greenstone belt of Griffin (1990), and the northern extension of the Mulgabbie Domain within the Kurnalpi Terrane of Swager (1997). The Murrin greenstones are characterized by a large volume of ultramafic rocks, high-Mg basalt, and mafic intrusive rocks; substantial andesite and felsic volcanic rocks; north-northeasterly to northerly trending, large-scale folds and reverse faults in the Mount Kilkenny – Eucalyptus area, and a west-dipping and west-younging homocline in the Porphyry and Yarri areas; low to very low metamorphic grade (Binns et al., 1976); and extensive intrusion of post-regional folding granitoid rocks.

In the area between Mount Kilkenny and Eucalyptus, mafic and ultramafic intrusive rocks are typically components of large sills with locally well defined igneous layering; for example, the tholeiitic Kilkenny Gabbro. They are commonly deformed, with the interlayered tholeiitic and high-Mg basalt, into large-scale, open folds with wavelengths of 3–4 km. The folds are shallowly to moderately plunging and north-northeasterly to northerly trending, with limbs truncated by reverse faults.

In the Porphyry and Yarri areas, the Murrin greenstones consist of mafic volcanic and intrusive rocks in the east, and intermediate to felsic volcanic rocks in the west, which form a west-southwesterly dipping homocline (Swager, 1995b). Felsic volcanic rocks adjacent to the western boundary of the greenstone belt, near the Kilkenny Fault, are intensely foliated into quartzofeldspathic schist. The Keith–Kilkenny Fault Zone coincides with a sedimentary basin containing polymictic conglomerate and greywacke (Hallberg, 1985; Swager, 1995b).

Laverton greenstones

The Laverton greenstones lie to the east of the Claypan Fault (Fig. 2) and include the Edjudina and Linden Terranes of Swager (1997). On EDJUDINA, the Laverton greenstones are characterized by the presence of abundant BIF, a rock type that is rare in most of the

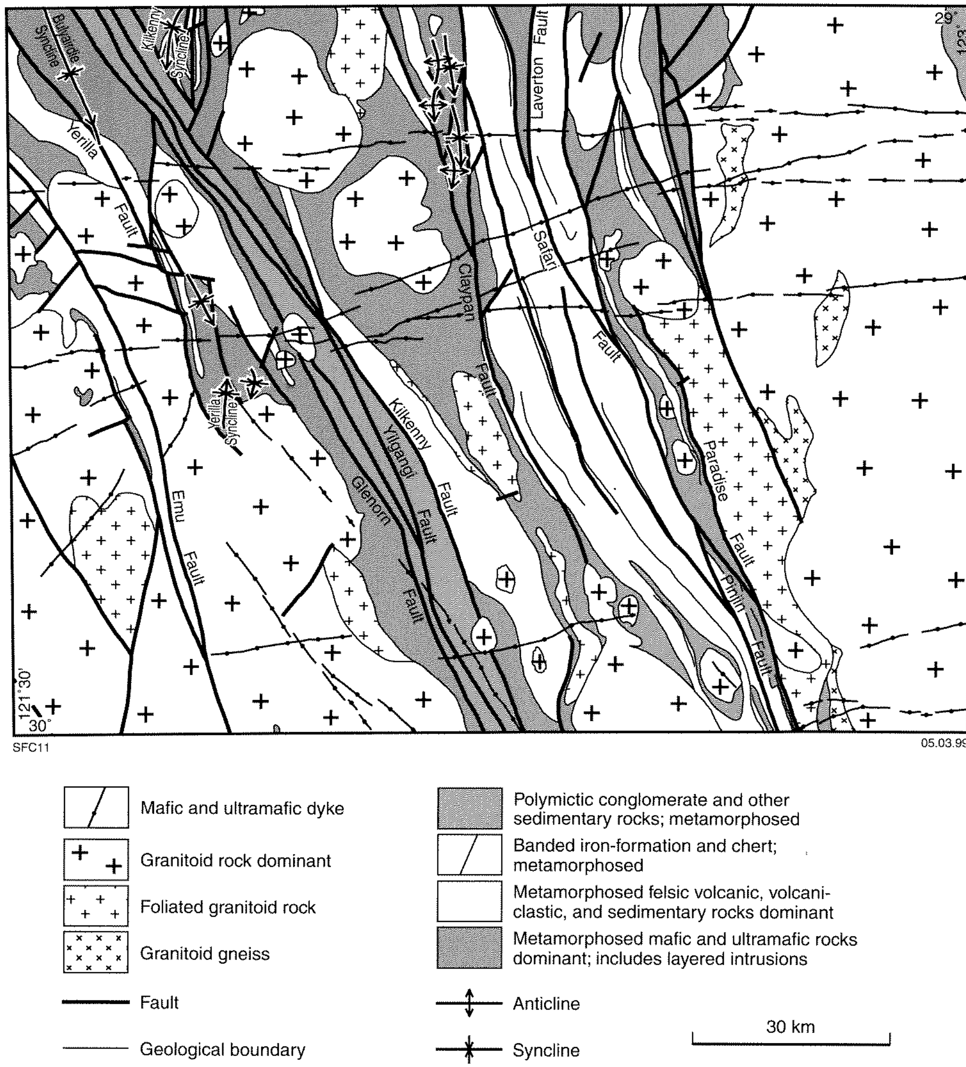

Figure 2. simplified geological map of EDJUDINA

Eastern Goldfields Province (Williams, 1974; Griffin, 1990). The Mount Celia Fault Zone, bounded by the Claypan and Safari Faults, forms the highly sheared, southwestern boundary of the Laverton greenstones.

In the area between the Claypan and Safari Faults, the iron content of the BIF units decreases northwards. The BIF units change along strike into chert horizons (Williams et al., 1976). Both the BIF and chert have been intensely deformed into tight and isoclinal folds. West-verging recumbent folds in the BIF suggest regional-scale repetition by easterly dipping thrusts (Swager, 1995a,b). Clastic sedimentary rocks associated with intermediate and felsic volcanic rocks are commonly intensely foliated. Greenstones in this area also contain subordinate tholeiitic basalt and ultramafic rocks.

There is a distinctive, narrow zone of amphibolite along the granite–greenstone contact that coincides with the Paradise Fault. Granitoid rocks adjacent to the contact are intensely foliated, with areas of banded granitoid gneiss further to the east. In the William Bore area, near the northern boundary of EDJUDINA, the presence of a large-scale, northeasterly trending fold containing mafic and ultramafic rocks is indicated by aeromagnetic data. The fold is truncated by a north-northwesterly trending fault that separates banded gneiss from foliated monzogranite.

ARCHAEAN ROCK TYPES

Ultramafic rocks (*Au, Auk, Aup, Aur, Aux*)

Ultramafic rocks on EDJUDINA are grouped into five units — undivided ultramafic rock (*Au*), komatiite (*Auk*), peridotite (*Aup*), tremolite schist (*Aur*), and pyroxenite (*Aux*). Of these, peridotite with an olivine-cumulate texture is the most abundant unit, whereas komatiite is uncommon. Ultramafic rocks typically form lenticular or sheet-like bodies that are mainly concordant with, but locally transgress, the igneous layering or bedding in the surrounding rocks. They commonly correspond to highs on aeromagnetic images due to the presence of abundant accessory magnetite. Distinctive light-brown silica caprock (*Czu*) forms over deeply weathered ultramafic rocks.

Undivided ultramafic rock (*Au*) comprises altered and intensely deformed ultramafic rocks, including tremolite–chlorite schist and talc–chlorite schist. In the Gardiner Well area, undivided ultramafic rocks are represented by serpentinite, derived from peridotite, interleaved with intensely foliated high-Mg basalt. In the serpentinite, olivine is pseudomorphed by serpentine, whereas interstitial pyroxene is altered to tremolite.

Areas of komatiite (*Auk*) were mapped in the eastern part of EDJUDINA. Around Safari Bore, the komatiite unit consists mainly of serpentinized olivine cumulate (peridotite, *Aup*), high-Mg basalt with acicular clinopyroxene-spinifex texture, and minor olivine spinifex-textured komatiite (Swager, 1995b). A thin unit of altered komatiite, with locally preserved relict olivine-spinifex texture, is exposed along a high-strain zone between greenstone and granitoid rocks east of Deep Well. Northeast of Relief Well, a northeasterly trending komatiite unit contains some tremolite–serpentine(–talc) schist.

Peridotite (*Aup*) is widespread on EDJUDINA and forms massive layers and lenses. Outcrops of peridotite are abundant west of Lake Carey between Pyke Hill and Duck Hill; in the Mount Kilkenny, 31 Well, and Wilga Well areas; and south of Yerilla Homestead. Cumulate olivine in peridotite is commonly pseudomorphed by serpentine, whereas pyroxene is commonly replaced by amphibole. Locally developed poikilitic textures consist of medium- to coarse-grained pyroxene oikocrysts (now largely altered to amphibole) with fine- to medium-grained olivine (Swager, 1995b).

West of Lake Carey between Pyke Hill and Duck Hill, areas of laterite over serpentinized peridotite have a distinctive smooth, dark tone on airphotos and Landsat images. Exploration drillhole chip samples indicate that the laterite is underlain by serpentinized peridotite. Scattered outcrops of ultramafic caprock with locally well preserved relict olivine-cumulate textures are found within the laterite and adjacent to peridotite outcrops. The peridotite, with associated pyroxenite and tremolite schist, forms an ultramafic unit with a thickness of up to 800 m and has been folded into a large-scale syncline. Lewis and Williams (1973) documented amygdales and spinifex textures in dominantly cumulate textured peridotite at a locality about 4 km northeast of Murphy Well. The presence of such textures indicates that these rocks were ultramafic lavas.

In the 31 Well area, the peridotite unit (*Aup*) is composed of serpentinized peridotite with subordinate dunite and tremolite schist. Cumulus olivine in the peridotite is altered into serpentine, and intercumulus orthopyroxene grains enclosing olivine are locally replaced by carbonate (Peers, 1970a). The dark-bluish-grey dunite contains serpentine granules (65–70%) with a well-preserved olivine-cumulate texture, which are separated by an angular network of calcite (25–30%) veinlets. Magnetite is the most abundant opaque mineral in the dunite. The dunite also contains minor hematite and other accessory minerals, including talc and chlorite (Peers, 1970a).

Where tremolite–chlorite and talc–chlorite schists dominate the outcrop, they are mapped as a distinct unit (*Aur*). These rock types are common in the high-strain zones adjacent to granite–greenstone contacts. The tremolite-bearing schists contain both needles and blades of pale-green tremolite, and a relict texture of medium-grained precursor pyroxene is preserved locally; for example, between Two Lids and Paradise bores (Swager, 1995b).

Pyroxenite (*Aux*) consists predominantly of recrystallized amphibole after clinopyroxene. In strongly deformed and recrystallized pyroxenite, chlorite and talc are more abundant. West of Jump Up Dam, a pyroxene layer is composed of medium- to coarse-grained, poikilitic amphibole after pyroxene (60%) and fine- to medium-grained olivine (40%; Swager, 1995b). Another pyroxenite unit is exposed 7 km east of Wilga Well, along the contact with monzogranite.

Fine-grained mafic rocks and amphibolite (*Ab, Aba, Abc, Abf, Abi, Abm, Abmf, Abp, Abv*)

Mafic extrusive rocks form a large part of the greenstone successions on EDJUDINA. Massive to locally pillowed basalt is mainly tholeiitic, but high-Mg basalt is locally prominent. Amphibolite is present in areas of higher metamorphic grade. Primary layering in basalt is marked by interlayered, fine-grained clastic rocks (slate, black shale, and siltstone), felsic schists, flow-top breccias, and hyaloclastite units. Carbonate-cemented, flow-top breccias and hyaloclastite form resistant, knobbly horizons within the mafic rocks. There are very good exposures of pillow structures in the basalt along the southwestern shore of Lake Raeside, east of the Yerilla Homestead (Honman, 1917b). Here, pillow margins are typically variolitic and amygdaloidal. Massive units of hyaloclastite are also present.

Undivided basalt (*Ab*) includes foliated and deeply weathered basalt with intercalated thin units of coarser grained mafic rocks, and felsic volcanic and volcaniclastic rocks.

Fine-grained, massive to weakly foliated mafic rock (*Abv*) is dominated by tholeiitic basalt, which is composed of fine-grained plagioclase and green hornblende, and is partly replaced by actinolite and tremolite with accessory chlorite, titanite, epidote, and opaque minerals. The tholeiitic basalt is mainly aphyric, but is feldspar-phyric with medium-grained plagioclase phenocrysts in places. Deformation of the basalt is heterogeneous; zones of mafic schist are present in less deformed to massive basalt. Quartz-filled amygdales are present locally within the basaltic successions, especially in flow-tops.

Coarse feldspar-phyric basalt (*Abp*) contains prominent plagioclase phenocrysts, locally with glomeroporphyritic texture. Plagioclase phenocrysts are up to 1.5 cm in diameter and constitute 5–35% of the rock. They are randomly scattered in a fine-grained hornblende and plagioclase matrix. Areas of coarse feldspar-phyric basalt, which are large enough to be shown at the map scale, are located at Mount Kildare, Kilmore Hill, Mount Catherine, north of McAuliffe Well, south of Westward Ho Well, and northwest of

Yilgangi Dam. The distinctive nature of this basalt makes it useful as a marker horizon at a local scale. Feldspar-phyric basalt is locally interlayered with feldspar-phyric gabbro.

Strongly foliated, fine-grained mafic rock (*Abf*) is distributed mainly along major faults, such as the Yerilla and Claypan Faults, or adjacent to granite–greenstone contacts. This unit is finely banded with layering defined by variations in the ratio of hornblende to plagioclase. Strongly foliated mafic rock is locally interleaved with amphibolite and mafic to felsic schist.

Carbonated basalt (*Abc*) north-northwest of Yilgangi Dam contains feldspar phenocrysts and abundant carbonate porphyroblasts. Weathering-out of the carbonate results in a characteristic pitted appearance (Swager, 1995b). There are more extensive areas of carbonated basalt and gabbro west of Wallbrook Hill, where the rocks have also undergone epidote alteration. Calcite grains, 3–5 mm in diameter, are preserved locally. Feldspar phenocrysts and quartz-filled amygdales are still recognizable despite intense carbonation. Pyrite is a common accessory mineral in both areas (Swager, 1995b).

Basaltic andesite (*Abi*) outcrops mainly in the intermediate volcanic belt east of Porphyry mine and adjacent to the granite–greenstone contact between Paradise and Red Hill wells (Swager, 1995b). This unit is light grey to greenish grey, massive to foliated, and consists of plagioclase and hornblende phenocrysts in a fine-grained groundmass that contains abundant plagioclase microlites with accessory leucoxene, sphene, and opaque minerals. Volatile exsolution structures, such as amygdales, circular to ellipsoidal vesicles, and more irregular gas cavities, are a characteristic feature of most basaltic andesite outcrops. Amygdales are filled by quartz (dominantly), epidote, chlorite, and carbonate. Basaltic andesite in the Paradise Well area is foliated, with hornblende and amygdales stretched to define a moderately (30–40°) south pitching lineation on the west-dipping foliation.

Amphibolite, hornfels, and mafic schist (*Aba*) outcrop in narrow zones or lenses on, and adjacent to, granite–greenstone contacts. Some of these contacts coincide with major high-strain zones or faults, such as the Paradise Fault. However, some amphibolite–hornfels zones surrounding granitoids have a semicircular geometry and are probably products of contact metamorphism.

Amphibolite on EDJUDINA is composed of fine- to medium-grained, prismatic amphibole and polygonal plagioclase, with little or no quartz. These rocks have a very pronounced schistosity, defined by the segregation and alignment of hornblende and plagioclase, and the primary texture has been completely destroyed. Along the Paradise Fault, amphibolite is interleaved with intensely foliated granitoid rocks and is composed of equant to slightly elongate amphibole and plagioclase grains, with epidote, clinopyroxene, and garnet in some layers. Amphibole defines a steep (50–60°), north-pitching mineral lineation. The main foliation (schistosity) has been tightly folded locally (Swager, 1995b). Adjacent to the Yerilla Fault, thin zones of fine-grained amphibolite are in intensely foliated hornfels and basaltic schist. There are shallow to moderate (10–35°) north-pitching mineral lineations on the steep, east-dipping, dominant foliation.

High-Mg basalt (*Abm*) includes basaltic volcanic rocks characterized by pyroxene-spinifex textures. These rocks typically contain 9–18% anhydrous MgO (Hallberg, 1985). High-Mg basalt is spatially associated with ultramafic rocks, mafic intrusive rocks, and tholeiitic basalt in the Mount Kilkenny, Linden, South Extension Bore – Wilga Well, and Red Hill Well – Safari Bore areas. The basalt is typically porphyritic with clinopyroxene phenocrysts pseudomorphed by tremolite, chlorite, and actinolite. The randomly oriented phenocryst needles, which are characteristic of a pyroxene-spinifex texture, range in length from a few millimetres to several centimetres. The groundmass is composed of tremolite, chlorite, and actinolite with subordinate plagioclase, chlorite, carbonate, epidote, quartz, and opaque minerals. Some high-Mg basalts contain varioles — pale-coloured spherules of radiating crystals of plagioclase and amphibole (Morris, 1993) — in a fine-grained groundmass of acicular amphibole with subordinate plagioclase and chlorite. Cryptocrystalline varioles, ranging from several millimetres to greater than 1 cm across, have a spherical to ovoid geometry.

Strongly foliated high-Mg basalt (*Abmf*) is abundant southwest of the Eucalyptus area, adjacent to the granite–greenstone contact. The basalt contains medium- to coarse-grained, spinifex-textured pyroxene phenocrysts pseudomorphed by tremolite and chlorite in a fine-grained, recrystallized groundmass. Flattened varioles are seen locally on foliation surfaces.

Medium- to coarse-grained mafic rocks (*Ao, Aod, Aog, Aogk, Aogl*)

Medium- to coarse-grained mafic rocks, with subophitic to ophitic textures, may form intrusions or represent coarser grained intervals in thick, mafic extrusive lavas (Swager, 1995b). Dolerite and gabbro typically form sills, lenses, and layers in ultramafic, mafic, and BIF-dominated sequences. They are mainly conformable with primary layering in greenstone sequences, but can be transgressive locally. Igneous layering is well preserved in places and primary younging directions can be determined.

Undivided dolerite and gabbro (*Ao*), including minor basalt, are widespread in the sheet area, especially in the Pyke Hill – Eucalyptus area and within the BIF-dominated sequences. Dolerite (*Aod*) is a medium-grained mafic rock, whereas gabbro (*Aog*) is a coarse-grained mafic rock. Like basalt, the coarser grained mafic rocks are composed of plagioclase and hornblende (after clinopyroxene). Leucogabbro (*Aogl*) is light coloured and contains medium- to coarse-grained plagioclase (>60%); clinopyroxene is pseudomorphed by hornblende and tremolite–actinolite. At Pyke Hill, a thick leucogabbro unit forms a prominent hill and has an ophitic texture consisting of tremolite–actinolite crystals (after clinopyroxene), up to 1 cm across, enclosing plagioclase laths up to 4 mm long. This unit also contains a small amount of quartz (Lewis, 1971).

Local areas of porphyritic dolerite — for example, east of Pyke Hill, northeast of Eucalyptus Bore, and around Mount Catherine — are too small to be shown separately. Saussuritized feldspar phenocrysts up to 5 cm across increase upwards in both abundance and size, and hence, the rock grades from non-porphyritic to densely porphyritic dolerite (Gower, 1971). Where the phenocrysts are numerous, they cluster to form glomerocrysts up to 10 cm in diameter. Feldspar buoyancy may be responsible for the phenocryst distribution (Gower, 1971; Hallberg, 1985).

The Kilkenny Gabbro (*Aogk*), a layered gabbroic sill with a thickness of about 600 m, is underlain by high-Mg basalt and overlain by metasedimentary rocks (Jaques, 1976). The sill is exposed over an area 8 km long and 2–3 km wide, and has a pronounced igneous layering that indicates the way-up direction, with a lower olivine–plagioclase cumulate zone and an upper augite–plagioclase cumulate zone. Discontinuous, thin, rhythmic layering is common in the lower zone, which has a thickness of about 150 m. The upper zone consists of three conformable layers — leucogabbro, gabbro, and ferrogabbro — in an upward sequence. Steady cryptic variation in the compositions of plagioclase and augite suggests fractional crystallization from a single magma pulse by gravity settling (Jaques, 1976; Hallberg, 1985).

A layered gabbro sill (*Ao*) at Linden is underlain by high-Mg basalt and overlain by tholeiitic basalt (Hallberg, 1985). Basal harzburgite is overlain by saussuritized norite and gabbro. The upper part of the sill is a coarse-grained leucogabbro composed of saussuritized plagioclase laths, coarse skeletal opaques, and interstitial quartz. Thin, discordant, chloritized leucodolerite dykes similar to the upper part of the sill are abundant near the upper contact and probably represent late-stage differentiates (Hallberg, 1985).

Felsic volcanic and volcaniclastic rocks (*Af, Afi, Afis, Afs, Aft, Afv*)

Felsic volcanic and volcaniclastic rocks are widely distributed on EDJUDINA, especially in the Malcolm and Murrin greenstones, but they are rarely well exposed. They consist of rhyolite and dacite, and include lavas, and pyroclastic and epiclastic rocks. It is difficult to distinguish primary volcanic features in these rocks because of deep weathering, intense deformation, and recrystallization. A Sensitive High-Resolution Ion Microprobe (SHRIMP) U–Pb zircon age of 2708 ± 7 Ma was obtained for a felsic volcanic rock in the Keith–Kilkenny Fault Zone, west of Yilgangi (Nelson, 1996). A bedded volcaniclastic rock from a felsic volcanic unit south of McAuliffe Well has a SHRIMP U–Pb zircon age of 2696 ± 6 Ma (Nelson, 1998).

Undivided felsic volcanic and volcaniclastic rocks (*Af*) are dominated by deeply weathered, kaolinized, and silicified rock. They are variously foliated and intensely altered. The most common alteration products are quartz, chlorite, kaolinite, and sericite. Relict quartz phenocrysts are commonly visible in hand specimen. In the Malcolm greenstones, poorly exposed felsic rocks are distributed in a long, north-northwesterly trending linear belt. In the Laverton greenstones, the volcaniclastic felsic rocks are interleaved with feldspathic sedimentary rocks, chert, and BIF.

Felsic volcanic rocks of mainly acidic composition (*Afv*) are typically quartz(–feldspar)-phyric and include well-layered rocks of possible tuffaceous origin, and massive to fragmental rocks. They contain medium-grained quartz and feldspar phenocrysts in a fine to very fine grained matrix, which is composed of quartz, feldspars, and mica. Fragmental felsic rocks locally form distinctive layers in fine-grained felsic successions, and include volcanogenic conglomerate in which fragments and pebbles up to several centimetres in size have the same overall composition (Swager, 1995b).

Felsic tuff (*Aft*) is dominated by rhyolitic ash and lapilli tuff and is probably ignimbritic. These rocks typically contain 20–30% of quartz and feldspar phenocrysts in a devitrified matrix. Fine-grained, thinly bedded tuffaceous successions are locally intercalated with coarse-grained, pyroclastic breccias. In the western part of EDJUDINA, felsic tuff probably represents proximal deposits of the Melita rhyolitic volcanic centre (Hallberg, 1985; Witt, 1994).

Intensely foliated and recrystallized felsic rocks (*Afs*) outcrop along the Emu, Kilkenny, and Pinjin Faults. They are locally interleaved with amphibolite and intermediate schist. The felsic schist contains various amounts of feldspar and quartz porphyroclasts in a foliated, fine-grained matrix composed of sericite, feldspar, and quartz with minor epidote, biotite, and chlorite. Layers dominated by medium-grained plagioclase are intercalated with very fine grained layers containing quartz or feldspar eyes or both (Swager, 1995b).

Felsic rocks between 50 Mile Well and Bobs Bore in western EDJUDINA represent the eastern part of the Melita Rhyolite of Witt (1994). The Melita Rhyolite consists of a subaerial succession of coarse pyroclastic rocks that grade, both to the north and south, into subaqueous tuff and fine-grained sedimentary rocks. At the centre of rhyolitic volcanism east and northeast of Mount Melita (MELITA 1:100 000), resistant, laterally discontinuous, lenticular units of poorly sorted lapilli tuff and tuff breccia are intimately interfingered with finer grained rhyolitic crystal and vitric tuffs, and flows of amygdaloidal dacite (Hallberg and Giles, 1986; Witt, 1994). Distal successions comprise more continuous units of crystal and vitric tuffs with interbeds of chert and pyritic black shales, which increase in abundance away from the Melita area. The rhyolitic rocks, which are underlain and overlain by mafic lavas, form a distinctive, bimodal volcanic succession that is indicative of accelerated extension in the crust (Hallberg and Giles, 1986).

On EDJUDINA, the Melita Rhyolite extends about 70 km from north of 50 Mile Well to south of Bobs Bore. Around 50 Mile Well, rhyolitic lapilli tuff (*Aft*) contains crystals and vitric fragments. Thin units of well-bedded, fine-grained ash tuff with local, poorly developed cross-bedding probably represent air-fall deposits. The rhyolitic tuff contains 20–25% quartz and feldspar phenocrysts (Oversby and Vanderhor, in prep.), mostly up to 3 mm across, in a microcrystalline groundmass of mainly quartz and plagioclase with accessory biotite, chlorite, epidote, and scattered opaque grains (Peers, 1970b). Quartz phenocrysts are embayed and partially recrystallized, whereas feldspar crystals are commonly pseudomorphed by sericite. Vitric lenticles are locally planar banded.

West of Dairy Corner Bore, the dominant rock type is grey, rhyolitic ignimbrite containing about 25% feldspar crystals, 2–4 mm across, and a slightly smaller proportion of quartz crystals, up to 1.5 mm across, set in a devitrified matrix of quartz and sericite (Oversby and Vanderhor, in prep.). The ignimbrite is weakly foliated with a locally preserved welding texture. An associated fine-grained, planar- to cross-laminated unit is either a pyroclastic deposit or a reworked air-fall tuff. The planar bedding dips 70° to the northeast and youngs in the same direction (Oversby and Vanderhor, in prep.). The felsic rocks are intercalated with sporadic layers and lenses of mafic schist. The presence of coarse, poorly sorted, volcanic breccia immediately to the west on MELITA (1:100 000; Witt, 1994), coupled with more laterally extensive fine-grained tuff, suggests that both pyroclastic flow and ash-fall deposits are present (Fisher and Schminke, 1984).

Between Dairy Well and Bobs Bore, deeply weathered, fine-grained felsic volcanic and volcaniclastic rocks with local quartz- and feldspar-rich intervals (*Af*) may represent deposits distal to the Melita volcanic centre. A thick unit of welded ignimbrite (*Aft*), containing quartz and feldspar crystals and lithic fragments, outcrops southeast of 6 Mile Well. Rounded quartz phenocrysts are set in a fine-grained, partially recrystallized matrix of quartz, feldspar, sericite, and carbonate.

Felsic volcanic rocks of intermediate composition (*Afi, Afis*) are concentrated in several discrete volcanic centres, such as the Bore Well and Soapy Head Well – Red Gate Well centres. Intermediate volcanic and volcaniclastic rocks (*Afi*) are dominated by massive to weakly foliated andesite and basaltic andesite. They are typically fine grained and light-grey rocks with various amounts of plagioclase and hornblende phenocrysts in a fine to very fine grained matrix of feldspar, clinopyroxene, mica, and minor opaque minerals. Amygdales, typically filled with quartz, are common but only locally prominent. Hornblende–feldspar(–quartz) intermediate schist (*Afis*) is derived from intensely foliated, altered, recrystallized andesite. Geochemical data suggest that the parent calc-alkaline melts for the intermediate volcanic rocks were produced by shallow, hydrous partial melting of large-ion lithophile (LIL) enriched mantle (Hallberg and Giles, 1986).

Intermediate and felsic rocks in the Bore Well volcanic centre form an east-dipping and east-younging succession (Hallberg, 1985; Hallberg and Giles, 1986). The lower part of the volcanic succession is composed of massive to intensely deformed andesitic flows intercalated with amygdaloidal dacite and rhyolitic to dacitic lapilli tuff lenses, whereas the upper part consists of massive andesitic lavas. The succession contains plagioclase phenocrysts (1–5 mm) in the lower part and is mainly non-porphyritic in the upper part. Amygdales (3–10 mm), filled with quartz, carbonate, chlorite, and epidote, are common at the top of andesitic lavas. There are several horizons of well-bedded, fine- to medium-grained epiclastic rock, several metres thick, in the lower part where they are associated with debris breccia. Clasts in the debris breccia, 1–10 cm across (commonly 1–5 cm), are typically angular, but are significantly flattened in high-strain zones. Pillow structures, locally observed in the andesitic lava, indicate an easterly younging direction. Pipe vesicles within the pillows are subperpendicular to the pillow margins. Andesitic rocks in the eastern part of the Bore Well volcanic centre are intercalated with various sedimentary rocks, such as feldspathic wacke, chert, and carbonaceous, pyritic black shales.

Another major calc-alkaline volcanic centre is between Soapy Head Well and Red Gate Well. The outcrop is poor and most rocks have been variously foliated, weathered, and altered. Quartz-filled amygdales, 5–50 mm in size, are locally prominent. Feldspar and hornblende phenocrysts (1–5 mm) typically constitute 10–20% of the andesite, but there are local concentrations up to 30–40%, especially along the eastern boundary of the unit. Hornblende phenocrysts are commonly altered to biotite in altered andesite, which may also contain chlorite and sericite. In places, the andesite contains two discrete foliations and breaks into numerous elongate rods.

In less altered andesite (*Afi*) between Soapy Head Well and Red Gate Well, the matrix consists of fine-grained, aligned plagioclase, light-green pleochroic hornblende, fine-grained quartz, sphene or rutile, and scattered sericite, chlorite, and epidote (Swager, 1995b). In intensely foliated and recrystallized intermediate schist (*Afis*), plagioclase is boudinaged and altered to sericite, chlorite, epidote, and carbonate; hornblende is pseudomorphed by biotite and chlorite. The fine-grained matrix of the intermediate schist consists of plagioclase, hornblende, and scattered quartz grains, which are aligned with the foliation. Intermediate schist, interleaved with felsic schist and amphibolite, probably represents a high-strain and higher metamorphic grade equivalent of the intermediate volcanic rocks. In higher grade metamorphic zones, fine- to medium-grained garnet forms both anhedral and euhedral porphyroblasts, and hornblende porphyroblasts enclose traces of matrix foliation (Swager, 1995b).

Some intermediate schists have been carbonated, particularly in the Edjudina Dam – Clymies Well area (Swager, 1995b). In these rocks, carbonate is distributed throughout the fine-grained matrix in small lenses parallel to the foliation, and in distinct aggregates with, or without, pyrite or magnetite. Carbonate porphyroblasts have overgrown the foliation. The most intense carbonation is associated with gold–pyrite mineralized zones, such as between the Penola and Margaret mines and along the 'Edjudina Line' of workings between the Glengarry and Neta mines (Swager, 1995b).

Andesitic rocks (*Afi*) between Mud Hut Well and Lake Raeside outcrop as semicircular features and probably represent an independent extrusive centre distinct from the Melita Rhyolite (Witt, 1994; Oversby and Vanderhor, 1995). Hallberg (1985) interpreted these rocks as granodiorite porphyry. The rocks are typically carbonated and consist of fine-grained plagioclase, hornblende, and quartz with accessory tremolite, epidote, sericite, and hematite.

Sedimentary rocks (*As, Asc, Asf, Asg, Ash, Ac, Aci*)

Sedimentary rocks on EDJUDINA can be divided into two groups according to their compositions: clastic sedimentary rocks ranging from conglomerate to shale (*As, Asc,* *Asf, Asg, Ash*), and chemical sedimentary rocks (Hallberg, 1985; siliceous rocks of Griffin, 1990) dominated by chert (*Ac*) and BIF (*Aci*).

Undivided sedimentary rocks (*As*) are deeply weathered and poorly exposed. The major components are fine- to medium-grained, planar-laminated and cross-bedded clastic sedimentary rocks, such as shale, siltstone, and sandstone, and may include intermediate and felsic epiclastic sedimentary rocks. Epiclastic sedimentary rocks are derived mainly from emergent andesitic volcanic complexes; consequently, they are feldspar rich and quartz poor (Hallberg, 1985). In the epiclastic successions, poorly sorted, oligomictic conglomerates represent proximal facies; finer, well-sorted, clastic sedimentary rocks represent distal facies (Hallberg, 1986; Griffin, 1990).

Intensely foliated sedimentary and volcaniclastic rocks (*Asf*) include quartzofeldspathic and micaceous schist, and foliated siltstone and sandstone. They are typically interleaved with intermediate and felsic volcanic rocks, chert, and BIF. Primary lamination and cross-bedding are locally preserved in the foliated sedimentary rocks.

Polymictic conglomerate (*Asc*) was deposited in a north-northwesterly trending, elongate sedimentary basin (Hallberg, 1985) bounded by the Glenorn and Kilkenny Faults. On EDJUDINA, the conglomerate exposed between Quondong Well and Seddon Bore is the Yilgangi conglomerate of Swager (1995b). Pebbles and boulders in the conglomerate, ranging mainly from 2 to 10 cm, but up to 40 cm across, are poorly sorted and subrounded to flattened. Intermediate and felsic volcanic and volcaniclastic pebbles are the most abundant varieties (up to 80%), although granitoid pebbles and boulders are also present along with minor basalt, gabbro, and chert pebbles. The conglomerate groundmass consists of fine- to medium-grained, detrital feldspar and quartz, and small lithic fragments, similar to the arkose and lithic greywacke that are intercalated with the conglomerate. The poor sorting, immature groundmass, and associated greywacke suggest that the conglomerate was deposited in a high-energy environment, probably close to the source area.

The polymictic conglomerate has been intensely foliated along its eastern and western boundaries. Clasts are typically flattened and aligned with the main foliation in the groundmass. Some of the flat clasts consist of felsic schist, some of which is andesitic in composition. The orientation of the foliation in these clasts is quite different from that of the groundmass foliation in places. This indicates that the clasts were derived from already deformed rocks, and the polymictic conglomerate is a syn- to late-D_2 folding deposit. The presence of massive, relatively undeformed conglomerate in the basin centre suggests that the strain was strongly partitioned in the region of the faulted boundaries. This indicates that there was movement on these faults, and that the movement post-dated the early deformation recorded in the conglomerate clasts.

Greywacke (*Asg*), with pebbly layers and minor siltstone, outcrops west of the polymictic conglomerate within the Keith–Kilkenny Fault Zone. This unit is composed of feldspar, small quartzofeldspathic fragments, quartz grains, chert fragments, and very fine grained sericite and chlorite (Swager, 1995b). The greywacke is intercalated with thinly bedded, grey to black shale and siltstone. Coarser grained beds contain small slate fragments and scattered pebbles. Sedimentary structures — such as graded bedding, scours, flame structures, and slump folds — were recorded in the greywacke at several localities (Swager, 1995b). The distribution of greywacke and conglomerate suggests that the greywacke represents a distal facies of the polymictic conglomerate. If this is correct, the polymictic conglomerate and greywacke are dominantly derived from the Murrin greenstones, east of the Keith–Kilkenny Fault Zone. This is consistent with the fact that most pebbles in the conglomerate are composed of intermediate and acid volcanic rocks.

Shale, siltstone, and chert (*Ash*) are commonly either finely laminated, grey and black shale in thin units (typically less than 3 m thick) in psammitic rocks, or interflow layers within mafic and felsic volcanic succesions. This map unit is variously foliated and recrystallized into feldspathic and micaceous slate and schist, and locally silicified into cherty bands.

Banded chert and silicified slate (*Ac*) and BIF (*Aci*) form strike-persistent ridges over considerable distances; for example, the Edjudina Range extends for about 100 km. Banded chert is relatively widespread in the sheet area, whereas BIF is restricted to the Laverton greenstones, east of the Claypan Fault. In the Edjudina Range, magnetic BIF units south of Lake Raeside gradually change along strike into non-magnetic, ferruginous chert horizons north of the lake (Williams et al., 1976). Hallberg (1985) noted that BIF units in the Edjudina Range tend to be thicker and more ferruginous when intruded by gabbro, although the reason for this is unknown. Both chert and BIF were multiply deformed.

Banded chert and silicified slate units (*Ac*) are mainly 1–30 m thick, but may be up to 100 m thick; for example, north of Broken Hill. They are grey to brown, highly siliceous, laminated to thinly bedded units. Chert and slate units are typically interleaved with BIF, quartz veins, and felsic volcanic and sedimentary rocks. One prominent banded chert unit within felsic volcanic and volcaniclastic rocks between Kurrajong Well and Jungle Pool ranges from 10 to 30 m in thickness and can be traced over a distance of 9 km. Banded chert also forms interflow sedimentary deposits within basaltic lava successions; for example, at Webb Hill and Wallbrook Hill. However, they are most abundant in the Edjudina Range where they are associated with BIF.

The banded iron-formation (*Aci*) is laminated to thinly bedded with alternating iron- and silica-rich bands on a millimetre to centimetre scale. In thin section, the BIF consists of granoblastic quartz bands, mosaic quartz bands with interstitial iron, and magnetite(–hematite) bands. The close spatial relationship between BIF, chert, and felsic volcanic rocks suggests that they were deposited contemporaneously.

Low- to medium-grade metamorphic rocks (*Ald*)

Where the protolith of low- to medium-grade metamorphic rocks cannot be recognized due to the high degree of deformation and recrystallization, the prefix *Al* is used with a suffix indicating the characteristic mineralogy. Quartz–aluminosilicate rock (*Ald*) forms resistant, discontinuous layers and lenses within felsic schist. Aluminosilicate minerals include andalusite, kyanite, and chloritoid (Swager, 1995b). Quartz–andalusite(–kyanite) rock outcrops west of Loafers Well and northwest of Deep Well. In these rocks, a fine layering is defined by variations in quartz grain size and aluminosilicate content. Quartz is polygonal, granoblastic, and only weakly oriented. Andalusite is poikilitic and anhedral. Kyanite forms distinct prisms mostly parallel to, but also oblique to, the layering. Quartz–chloritoid rock, characterized by many very fine to medium grained chloritoid sheaves in a fine-grained quartz and muscovite matrix, is exposed south of Seddon Bore (Swager, 1995b).

Granitoid rocks

Archaean granitoid rocks in the Eastern Goldfields are predominantly biotite monzogranite and granodiorite. The potassic composition of silica-rich granitoids (>68% SiO_2) suggests that the most appropriate source for the majority of granitoids is continental crust with a composition ranging from tonalite to granodiorite (Witt and Davy, 1997a,b). Textural and compositional trends of granitoid rocks follow the tectonic trends represented by greenstone belts and tectonic lineaments (Libby, 1978).

Granitoids on EDJUDINA are poorly exposed, with extensive areas of granitoid rocks covered by Cainozoic colluvial sediments and sandplains. Witt and Davy (1997a) divided the granitoid rocks in the southwestern part of the Eastern Goldfields into pre- and post-regional folding (D_2) granitoids based on regional geometry, tectonic and magmatic fabrics, and their structural relationship with greenstones. The pre-D_2 granitoids are dated at c. 2685–2675 Ma and the post-D_2 granitoids are dated at c. 2660 Ma (U–Pb zircon; Hill et al., 1989, 1992; Nelson, 1997b). The oldest SHRIMP U–Pb zircon age determination on EDJUDINA (2719 ± 5 Ma) was obtained from a foliated tonalite at Outcamp Bore (Nelson, 1996).

Pre-regional folding granitoids are deformed by a pervasive north-northwesterly trending foliation developed during the regional folding event (D_2). Their contacts with greenstones are characterized by zones of intense ductile deformation where granitoid rocks and greenstones are interleaved with each other (Witt and Davy, 1997a,b). The north-northwesterly trending granite–greenstone contacts are mainly subparallel to the primary layering in greenstones. On EDJUDINA, granitoids assigned to this group include strongly foliated granitoid rock (*Agf*), strongly foliated biotite monzogranite (*Agmf*), Yarri Monzogranite (*Agma*), and banded granitoid gneiss (*Ang*).

Post-regional folding granitoid plutons are circular to ovoid in plan and some are concentrically zoned with relatively magnetic margins (Witt and Davy, 1997a). They are mostly smaller plutons (<100 km^2) that are discordantly intruded into greenstones or locally intruded along major faults. They are undeformed to weakly foliated. The most abundant rock type in this group is biotite monzogranite with K-feldspar phenocrysts and megacrysts (*Agm*). On EDJUDINA, granitoids assigned to this group include the McAuliffe Well Syenite (*Agau*), Bulla Rocks Monzogranite (*Agbu*), Dairy Monzogranite (*Agda*), monzodiorite at Yilgangi (*Agdp*), Friday Monzogranite (*Agfr*), Galvalley Monzogranite (*Agga*), Menangina Monzogranite (*Agmm*), Jungle Monzogranite (*Agmn*), and Porphyry Quartz Monzonite (*Agop*). Unnamed syenite and quartz syenite (*Ags*) and undeformed porphyritic granitoid rock (*Agp*) were also included in this group.

Granitoid rocks that have not been assigned to pre- or post-D_2 groups are the undivided and deeply weathered granitoids (*Ag*), granodiorite, tonalite, and diorite (*Agg*), biotite monzogranite (*Agm*), and hornblende–biotite monzogranite (*Agmh*). These granitoid rocks outcrop mainly in the southwestern and eastern part of the EDJUDINA sheet. Their regional structural relationship with greenstones is unclear, although many of them are likely to be pre-regional folding granitoids. Unassigned granitoid rocks within the greenstone belts are probably post-regional folding granitoids.

Banded granitoid gneiss (Ang)

Banded granitoid gneiss (*Ang*) is exposed in the Barret Well, Moon Rock, and South Soak Well areas (Roddick and Libby, 1984; Swager, 1995b). The gneiss is a banded quartzofeldspathic rock of monzogranitic to tonalitic composition. Light and dark bands are mainly defined by variation in biotite content, and there are several thin aplite and pegmatite veins. The gneissic banding is deformed into tight, asymmetric folds with wavelengths ranging from several centimetres to 5 m. In the Barret Well area, small-scale ductile shear zones trend both northwesterly and northeasterly with sinistral and dextral shear senses respectively. Shear sense is indicated by the displacement of gneissic bands. A SHRIMP U–Pb zircon age of 2675 ± 2 Ma was obtained for the gneiss at Barret

Well (Nelson, 1995). The banded gneiss is regarded as the higher grade equivalent of the foliated monzogranite (*Agmf*) as they have the same age, similar composition, and a gradational contact (Swager and Nelson, 1997).

Granitoid rock types (Ag, Agau, Agbu, Agda, Agdp, Agf, Agfr, Agg, Agga, Agm, Agma, Agmf, Agmh, Agmm, Agmn, Agop, Agp, Ags)

Undivided and deeply weathered granitoid rocks (*Ag*), granodiorite, tonalite, and diorite (*Agg*), biotite monzogranite (*Agm*), hornblende–biotite monzogranite (*Agmh*), and porphyritic granitoid rock (*Agp*) were mapped mainly in the southern and eastern parts of EDJUDINA.

Intensely foliated to gneissic granitoid rocks (*Agf*) are dominated by monzogranite and locally interleaved with amphibolite. The foliation in the granitoid has been tightly folded north of Wandinnie Well (Swager, 1995b) and south of Pine Well. Intensely foliated and gneissic biotite monzogranite (*Agmf*) extends from Paradise Bore to Mount Celia. The foliation is defined by aligned quartz and biotite, and contains a prominent down-dip or steep, northerly plunging mineral lineation. A SHRIMP U–Pb zircon age of 2672 ± 6 Ma was determined for a foliated granodiorite within the foliated monzogranite at Two Lids Soak (Nelson, 1996). This is the same age determined for the banded gneiss at Barret Well, thus supporting the interpretation of Swager and Nelson (1997) that the Barret Well gneiss is a higher grade equivalent of the foliated monzogranite. Therefore, it is suggested that both rocks are pre-regional folding granitoids according to the scheme of Witt and Davy (1997a).

The Yarri Monzogranite (*Agma*) is an elongate, medium- to coarse-grained (4–7 mm) biotite monzogranite pluton about 20 km long and 1–2.5 km wide. This unit contains large basalt xenoliths and several quartz veins. A pervasive foliation trends north-northwesterly and dips steeply (60–85°) to both the east and west. Shear zones, 1–10 m wide and subparallel to the main foliation, contain left-lateral movement indicators. These shear zones contain quartz–feldspar–sericite schist, and are locally interleaved with quartz veins. Small-scale shear bands, indicating both dextral and sinistral movements, contain shallowly north pitching mineral lineations (Swager, 1995b). Contact-parallel foliations contain locally steep, down-dip lineations (Swager, 1995b). Some shear zones contain gold mineralization. The most significant of these is the 'Wallaby Line' at Yarri, which was mined over a strike length of about 1500 m (see **Economic geology**; Swager, 1995b; Witt and Westaway, in prep.).

The Bulla Rocks Monzogranite (*Agbu*) is a porphyritic biotite(–hornblende) monzogranite. The margin of the monzogranite is foliated and contains granitoid dykes and mafic xenoliths. The Dairy Monzogranite (*Agda*) is undeformed and has a SHRIMP U–Pb zircon age of 2680 ± 2 Ma (Champion, D. C., 1997, pers. comm.).

The Galvalley Monzogranite (*Agga*) and Jungle Monzogranite (*Agmn*) intruded along north-northwesterly trending, regional-scale faults. The Galvalley Monzogranite, described by Swager (1995b), is characterized by several K-feldspar phenocrysts and megacrysts (up to 8 cm-long prisms). In the Galvalley Monzogranite, the well-developed regional foliation is defined by the alignment of phenocrysts, elongate mafic inclusions, and biotite–quartz fabric in the matrix.

The Menangina Monzogranite (*Agmm*) is seen as a distinct ovoid outline on aeromagnetic images. It contains prominent K-feldspar megacrysts and is cut by pegmatite and aplite dykes. The Menangina Monzogranite has a SHRIMP U–Pb zircon age of 2658 ± 13 Ma

(Nelson, 1995) and intruded into a large granitoid batholith, which has a hornblende-bearing monzogranite (*Agmh*) with a SHRIMP U–Pb zircon age of 2675 ± 11 Ma (Nelson, 1995).

The Friday Monzogranite (*Agfr*) is a coarse-grained biotite monzogranite that intruded into intermediate to felsic volcanic rocks. It is cut by northerly, north-northwesterly, and north-northeasterly trending faults; some faults contain dolerite dykes and massive quartz blows (Hallberg, 1985).

The Porphyry Quartz Monzonite (*Agop*) contains about 15% K-feldspar phenocrysts (up to 1.5 cm across) in a matrix of plagioclase, K-feldspar, quartz, and biotite (Allen, 1987). Hill et al. (1992) reported a U–Pb zircon age of 2667 ± 4 Ma for the quartz monzonite.

Monzodiorite (*Agdp*) intruded polymictic conglomerate and greywacke as elongate stocks and dykes in the Yilgangi area. The monzodiorite has a characteristic porphyritic texture and contains plagioclase phenocrysts (1–4 mm), coarse K-feldspar megacrysts (5–20 mm), and small hornblende and biotite aggregates in a fine-grained matrix dominated by plagioclase (Swager, 1995b). The monzodiorite has a SHRIMP U–Pb zircon age of 2662 ± 5 Ma (Nelson, 1996).

The McAuliffe Well Syenite (*Agau*) is a quartz syenite consisting of K-feldspar (65%), plagioclase (15%), anhedral quartz, and ferromagnesian silicate. The syenite has a SHRIMP U–Pb zircon age of 2651 ± 5 Ma (Nelson, 1997a). The syenite intruded into a felsic volcaniclastic succession that was dated at 2696 ± 6 Ma (Nelson, 1998). Smaller syenite bodies (*Ags*) were mapped in the Tassy Well, 12 Mile Well, and Linden areas.

MINOR INTRUSIONS (*g, p, q*)

Granitoid (*g*), pegmatite (*p*), and quartz (*q*) veins and dykes intruded all Archaean rock types, but are most abundant adjacent to granite–greenstone contacts. Some prominent quartz veins are probably related to ductile shearing or brittle faulting. The orientation of these minor intrusions varies considerably.

MAFIC AND ULTRAMAFIC DYKES (*Ɇdy*)

Mafic and ultramafic dykes (*Ɇdy*) are poorly exposed, but are clearly visible on aeromagnetic images as linear anomalies (both positive and negative). They are composed predominantly of olivine dolerite or gabbro, although both ultramafic and felsic differentiates are also present (Hallberg, 1987). The dykes are massive, undeformed, and truncate all greenstone sequences and granitoids, which suggests that they were emplaced after stabilization of the Yilgarn Craton. According to Hallberg (1987), the dykes probably intruded into tensional fractures between 2400 and 2000 Ma. However, SHRIMP U–Pb zircon ages of felsic differentiates in some of these dykes, near Bardoc to the west and west of Leinster to the north, indicate that at least some of them may be Archaean (Nelson, 1998).

Two prominent mafic dykes that trend at 085° across the northern half of EDJUDINA contain many dyke segments arranged in a left-stepping pattern. Another suite of mafic dykes in the northern part of the map sheet area trends at 070°. In the southern half of the sheet area, several shorter, less prominent mafic dykes trend northwest and east-northeast. All mafic dykes on EDJUDINA, except the northernmost one, have a positive magnetic anomaly. Rare exposures — for example, near Camelback Bore — suggest that they are dominantly gabbroic in composition (Williams et al., 1976). The Pinjin dyke (*Ɇdyi*) consists of fine-grained dolerite, medium-grained gabbro, and quartz gabbro, and contains greenstone xenoliths (Swager, 1994c).

STRUCTURE

DEFORMATION SEQUENCE

A widely accepted deformation scheme for the Eastern Goldfields Province is described in terms of four main phases (Archibald et al., 1978; Platt et al., 1978; Archibald, 1987; Swager et al., 1995). The first phase (D_1), characterized by north–south thrusting accompanied by isoclinal and recumbent folding, is best documented in the southern Eastern Goldfields Province (Archibald et al., 1978; Swager, 1997). The second phase (D_2) is a regional east-northeast–west-southwest shortening event that has produced north-northwesterly trending, upright folds with steeply dipping, axial planar foliations (Swager et al., 1995; Farrell, 1997; Swager, 1997). The third phase (D_3) is a transpressional event, characterized by sinistral strike-slip movement within ductile shear zones and along well-defined brittle faults, with associated en echelon, steeply plunging folds (Witt and Swager, 1989; Swager et al., 1995). Continued shortening during the fourth phase (D_4) produced a crenulation cleavage, kink folds, and reverse faults (Farrell, 1997; Swager, 1997).

The deformation sequence on EDJUDINA has not been well established, but is broadly similar to that proposed in the southern Eastern Goldfields Province (Witt and Swager, 1989; Swager et al., 1995; Swager, 1997). Direct evidence of the D_1 thrusting event has not been documented. Possible D_1 folds are located north of Gardiner Well where igneous layering (S_0) is deformed into easterly trending tight folds (D_1) with a wavelength of 30 cm. These folds are refolded into a north-northwesterly trending D_2 open fold. Banding in granitoid gneiss may also be due to D_1 (Swager and Nelson, 1997).

The D_2 regional shortening event on EDJUDINA is marked by a north-northwesterly trending, steeply dipping foliation that is axial planar to both large- and small-scale folds. Both greenstones and pre-D_2 granitoid rocks contain an S_2 foliation. The foliation is pervasive adjacent to the north-northwesterly trending regional faults and becomes weaker towards the centre of the greenstone belts. In most cases, the S_2 fabric adjacent to the granite–greenstone contacts dips steeply towards the greenstones. Small-scale D_2 folds in BIF are locally preserved as north-northwesterly trending, shallowly plunging, tight, symmetrical folds. Intense shortening across the greenstone belts during D_2 was partly accommodated by reverse movement along north-northwesterly trending faults parallel to the S_2 foliation. Steeply pitching mineral lineations are locally preserved on S_2 surfaces adjacent to these faults. Examples of these lineations are seen south of Mount Boyce Bore and along the southern part of the Yerilla Fault.

Sinistral strike-slip movement on north-northwesterly trending faults and shear zones (D_3) was documented in various parts of the Eastern Goldfields Province (Witt and Swager, 1989; Williams and Whitaker, 1993; Swager et al., 1995). On EDJUDINA, fabrics associated with D_3 include numerous shallowly pitching mineral lineations, such as those near Mount Millicent, and locally preserved subhorizontal striations; for example, west of Seddon Bore. Locally observed S–C fabrics in the mylonite southeast of Bobs Bore and asymmetric feldspar porphyroclasts in the intensely foliated granodiorite south of Mud Hut Well suggest a sinistral shear sense in the nearby faults. The geometrical relationship between the Kilkenny Fault and the north to north-northeasterly trending, large-scale folds between Mount Kilkenny and Welcome Well (on LAVERTON) also suggests sinistral movement on that fault.

In BIF and chert units, several small-scale, steeply plunging folds, typically with an asymmetric geometry, may have been developed during D_3 and are locally superimposed on north-northwesterly trending, shallowly plunging D_2 folds. Examples of superimposed folds can be seen at Edjudina Soak. Southwest of 6 Mile Well, felsic schist (*Afs*) and interleaved gabbro sills were multiply deformed into large-scale folds with wavelengths up to 2.5 km. Large-scale, tight folds and associated axial planar foliation in felsic volcanic rocks and gabbro sills have been refolded by F_3 (Witt, 1994). The F_3 folds have a subvertical axial planar cleavage trending 10–35° and a fold hinge that plunges 50–60° to the north-northeast. The north-northwesterly trending S_2 foliation is locally overprinted by a subvertical, northeasterly trending S_3 crenulation cleavage, 4 km west of Tassy Well.

Foliated granitoid rock and banded granitoid gneiss in the eastern part of EDJUDINA, the 'eastern granitic gneiss complex' of Swager and Nelson (1997), are interpreted to be derived from c. 2675 Ma intrusions that were emplaced late during greenstone volcanism, possibly during early subhorizontal (D_1) deformation. Banding in the gneiss is attributed to this early deformation. Swager and Nelson (1997) suggested that the complex was subsequently uplifted across distinct shear zones associated with a sharp contrast in metamorphic grade, such as the Pinjin and Paradise Faults, and across wider zones characterized by constrictional strain and more gradual metamorphic gradients. Fabrics in the high-strain zone between the granitoid gneiss complex and greenstones, and kinematic indicators, such as asymmetric porphyroclasts and S–C fabrics in faults separating high-grade (amphibolite facies) from low-grade (greenschist facies) greenstones, indicate that emplacement, or uplift, of the complex was partly accommodated by west-block-down normal faulting. The complex contains voluminous and largely undeformed monzogranite correlated with widespread granite plutonism at c. 2660 Ma. The monzogranite was probably intruded during the last stage of uplift (Swager and Nelson, 1997).

NATURE OF THE NORTH-NORTHWESTERLY TRENDING FAULTS

The most prominent structural features in the Eastern Goldfields Province are the north-northwesterly trending faults and shear zones. Although poor outcrops make it difficult to study their geometrical and kinematic features, it is recognized that many craton-scale faults may have a long tectonic history. Major greenstone boundary faults were probably syndepositional normal faults that controlled the location, size, and shape of greenstone basins during greenstone deposition (Gower, 1976; Hallberg, 1985). These normal faults may have been reactivated as reverse and strike-slip faults during subsequent deformation, and focused igneous, tectonic, and hydrothermal activity (Swager et al., 1995).

The north-northwesterly trending faults include those at granite–greenstone contacts, faults developed predominantly within greenstone belts, and faults that lie mainly within granitoid rocks. Granite–greenstone contact faults, such as the Emu, Yerilla, and Paradise Faults, are associated with high-strain deformation, higher grade metamorphism, and probably dip towards the greenstones. Multiply and penetratively deformed greenstones and granitoids are interleaved along the contacts. Deformation intensity gradually decreases away from the contacts. Some regional-scale, north-northwesterly trending fault zones, such as the Keith–Kilkenny and Mount Celia Fault Zones, form prominent boundaries between greenstone belts with different stratigraphic and deformational features. These elongate tectonic zones, up to 10–20 km wide and more than 300 km long, are characterized by several faults and the presence of clastic sedimentary rocks.

Near Kurrajong Well, the Emu Fault marks the eastern edge of a zone, up to 2 km wide, of an elongate greenstone sequence dominated by rhyolitic rocks. Granitoid rocks adjacent to the Emu Fault and the fault on the western side of this zone are intensely foliated and locally interleaved with volcanic rocks. However, the Jungle Monzogranite (*Agmn*) intruded along the western boundary fault, and a coarse-grained syenite (*Ags*), intruded along the eastern boundary fault, are undeformed. Basaltic schist and hornfels, intercalated with thin units of fine-grained amphibolite (*Abf*), are exposed locally along both faults. Four kilometres southeast of Bobs Bore, rhyolitic volcanic and volcaniclastic rocks were deformed into quartz–feldspar–mica schist and mylonite (*Afs*) within high-strain zones adjacent to the contacts. The S–C fabrics and steeply plunging asymmetric folds within these high-strain zones indicate a sinistral shear sense. This is supported by the presence of shallowly (10–25°) plunging mineral lineations. Rhyolitic rocks away from the contacts are only weakly deformed.

The Yerilla Fault trends 335–350° and dips steeply to the east-northeast. The northern segment of the fault lies within an area of greenstones and truncates the axis of the interpreted Bulyairdie Syncline at an angle of about 20°. The southern part of the Yerilla Fault forms a granite–greenstone contact. The steep, east-northeasterly dipping main foliations in adjacent rocks contain both steep (60–75°) and shallow (10–25°), north-pitching mineral lineations. Thin layers of granitoid rocks parallel to the main foliation in greenstones and granitoids are locally boudinaged. Most feldspar porphyroclasts in the granodiorite south of Mud Hut Well are symmetrical and elongate parallel to the main foliation, indicating intense shortening across the Yerilla Fault. However, some asymmetric feldspar porphyroclasts show a sinistral shear sense. Between Mud Hut Well and Wandary Well, the Yerilla Fault is cut by a set of east-southeasterly trending faults with sinistral offsets up to 1 km.

The Keith–Kilkenny Fault Zone was first recognized as a regional linear structure by Williams (1974) and described by Gower (1976), Williams et al. (1989), Vanderhor and Witt (1992), and Passchier (1994). This zone can be traced as a clear, north-northwesterly trending, linear aeromagnetic feature for over 300 km. On EDJUDINA, the Keith–Kilkenny Fault Zone is bounded by the Glenorn and Kilkenny Faults (Fig. 2). Around Mount Kilkenny, the fault zone is readily recognized on regional aeromagnetic maps by the abrupt truncation of northeast trends. The Kilkenny Fault is locally exposed along the contact between the greywacke and felsic volcanic rocks west of Seddon Bore, where there are abundant shallow-pitching slickenlines on north-northwesterly trending fault surfaces.

The Keith–Kilkenny Fault Zone coincides with a 3–8 km-wide, fault-bounded, elongate sedimentary basin containing polymictic conglomerate and arkose (Gower, 1976; Williams et al., 1976; Thom and Barnes, 1977; Hallberg, 1985; Oversby and Vanderhor, 1995; Swager, 1995b). The polymictic conglomerate is exposed in the Pig Well area (on LEONORA) and contains pebbles of jaspilite, felsic and mafic volcanic rocks, and granitoid rocks in an arenaceous and schistose matrix (Thom and Barnes, 1977). In the Butcher Bore area (on LAVERTON), the polymictic conglomerate contains abundant clasts of granitic rock and jaspilite (Gower, 1976). On EDJUDINA, there are extensive outcrops of polymictic conglomerate (*Asc*) and quartzofeldspathic greywacke (*Asg*) in the Yilgangi – Quondong Well area. Pebbles and boulders of the conglomerate are composed mainly of granitoid and intermediate volcanic rocks in an arenaceous matrix. The polymictic conglomerate was intruded by porphyritic monzodiorite stocks and dykes with a SHRIMP U–Pb zircon age of 2662 ± 5 Ma (Nelson, 1996).

The Mount Celia Fault Zone, 8–18 km wide, is bounded by the Claypan and Safari Faults (see cross section on map). This zone contains abundant felsic to intermediate volcanic and volcaniclastic rocks, feldspathic sedimentary rocks, and BIF, which are multiply deformed and intensely foliated. Brittle thrusting in the Edjudina Range may have produced stratigraphic repetition of BIF horizons (Hallberg, 1985; Swager, 1995b). At Edjudina Soak, north-northwesterly trending, shallowly to moderately (5–30°) plunging, symmetric folds in BIF horizons are refolded into steeply (50–80°) plunging, asymmetric folds. Some north-northwesterly trending jaspilite layers have been intensely boudinaged. Quartz veins within a chert unit east of The Gap Bore are sinistrally truncated by small-scale brittle faults (1–5 cm displacement) that trend 345° and dip 70–85° to the east.

Chen (1998) suggests some compressional structures, such as the northerly and north-northeasterly trending folds and reverse faults in the Mount Kilkenny – Welcome Well area (Gower, 1976; Hallberg, 1985) and within the Laverton greenstones (mainly on LAVERTON), were produced by sinistral strike-slip movement on the regional-scale, north-northwesterly trending faults.

METAMORPHISM

The regional distribution of metamorphic grade in the Eastern Goldfields was described by Binns et al. (1976) who recognized two types of metamorphic domains. In static domains, or low-strain areas, rocks are metamorphosed predominantly to prehnite–pumpellyite and lower to middle greenschist facies. In dynamic domains, or high-strain areas, rocks are metamorphosed to upper greenschist and amphibolite facies. The static domains occupy the central parts of greenstone belts where they commonly correspond to high Bouguer gravity anomalies (Fraser, 1974; Binns et al., 1976); the dynamic domains are mainly along the boundaries between different greenstone belts and granite–greenstone contacts (Binns et al., 1976). The metamorphic zones are parallel to the regional structural zones.

On EDJUDINA, middle to upper amphibolite facies rocks are predominantly distributed along the western boundary of the 'eastern granitic gneiss complex' of Swager and Nelson (1997). The rocks in this higher grade metamorphic zone were almost completely recrystallized and primary textures largely destroyed. The common metamorphic mineral assemblage in the amphibolite is clinopyroxene–hornblende–plagioclase (Swager, 1995b). Changes in the metamorphic assemblage towards the granitoid contact indicate an increase in metamorphic grade. In the granitoid gneiss to the east, the presence of Ca-plagioclase is indicative of amphibolite facies metamorphism (Swager, 1995a). Along the Emu and Yerilla Faults, thin units of amphibolite are interleaved with mafic schist and hornfels. Rocks that have been metamorphosed to lower amphibolite facies are pervasively foliated and multiply deformed.

The strain in areas of prehnite–pumpellyite and lower greenschist facies metamorphism is typically lower than in areas of amphibolite facies metamorphism. Pervasive foliation is rare and there are local large-scale, open folds. Primary igneous and sedimentary textures, such as pillow structures in basalt, are commonly preserved in more massive and competent rocks. According to Binns et al. (1976), the characteristic metamorphic mineral assemblage in tholeiitic basalt consists of epidote–albite–chlorite–actinolite (–stilpnomelane–biotite–Ca-plagioclase).

The presence of andalusite in pelitic schist and cummingtonite in amphibolite suggests low to moderate metamorphic pressures up to 4 ± 1 kb (Yardley, 1989). Clinopyroxene–hornblende–plagioclase assemblages in amphibolite and partial melting textures in monzogranitic gneiss indicate metamorphic temperatures of 700°C or higher (Yardley, 1989; Swager, 1995b). As metamorphic zones are mainly parallel to the north-northwesterly trending, regional structural zones and porphyroblasts have grown across the main foliation and enclosed foliation trails, peak regional metamorphism probably occurred during D_2 to D_3 (Swager, 1995a).

PALAEOZOIC GEOLOGY

PERMIAN SEDIMENTARY ROCKS (*Ps*)

Permian sedimentary rocks (*Ps*) consist of coarse-grained quartz sandstone, pebbly sandstone, and siltstone. Outcrops are best seen in breakaways where bedding is flat-lying to very shallow dipping. Coarser intervals are typically thickly bedded. Breakaways at Bore Well and northwest of the abandoned Elora Homestead are capped by a veneer of silcrete. Similar rocks are preserved on small mesas to the southeast of Windy Well where they consist of poorly sorted, quartz pebble conglomerate, and coarse sandstone overlain by silcrete (Swager, 1995b). These sedimentary rocks are similar to the 'Wilkinson Range Beds' (Talbot and Clarke, 1917, 1918), and are interpreted as Permian fluvioglacial deposits (Williams et al., 1976; Swager, 1995b).

CAINOZOIC GEOLOGY

Ollier et al. (1988) and Chan et al. (1992) discussed the regolith and landscape evolution in the Eastern Goldfields region. Three major palaeodrainage systems — the Carey, Raeside, and Yindarlgooda Palaeorivers, now represented by salt lakes, alluvial channels, and areas of sheetwash — flow across EDJUDINA, from northwest to southeast (van de Graaff et al., 1977).

All rocks on EDJUDINA have been affected by weathering — particularly silicification, ferruginization, and calcification. Cainozoic units are distinguished mainly by photo-interpretation and interpretation of Landsat images.

Quaternary alluvium in ephemeral stream channels and floodplains (*Qa*) is composed of clay, silt, sand, and gravel. Salt lake or playa deposits (*Czp*) are dominated by evaporites interbedded with clay and sand. Stabilized dunes adjacent to playas (*Czd*) consist of sand, silt, and gypsum. Ephemeral lake and dune deposits (*Czb*) consist of evaporite, clay, silt, and sand in drainage basins, claypans, and channels adjacent to playas.

Sheetwash clay, silt, and sand (*Cza*) are relatively distal deposits in flat areas away from erosional areas, normally close to salt lakes. Colluvial gravel, sand, silt, and vein quartz scree (*Czc*) are proximal sediments adjacent to greenstone and granitoid outcrops. Ferruginous gravel and reworked laterite (*Czf*) were deposited on slopes and low hills in iron-rich source areas. Unconsolidated yellow sand in sandplains (*Czs*) forms both sheets and dunes, mainly over granitoids.

Lateritic duricrust (*Czl*) forms a hard ferricrete crust over various greenstones, especially mafic and ultramafic rocks, and obscures the greenstone geology in many areas. The crust can range in thickness from a few centimetres up to about 10 m. Complete weathering profiles can be over 100 m thick (Ollier et al., 1988). The silica caprock over ultramafic rocks (*Czu*) is commonly light brown and olivine-cumulate textures are locally well preserved. The silica caprock contains pockets of chrysoprase, some of which have been mined. Silcrete (*Czz*) is composed of angular quartz grains, which are cemented by siliceous materials. The silcrete is mainly derived from deeply weathered and silicified granitoids, and distributed predominantly along breakaways. Quartzofeldspathic sand (*Czg*), comprising medium- to coarse-grained quartz and feldspar grains, forms residual deposits over granitoids.

ECONOMIC GEOLOGY

EDJUDINA contains parts of the North Coolgardie and Mount Margaret Mineral Fields. Gold is the only economically significant commodity that has been mined. Chrysoprase was mined from a number of small openpits. Silver has been recovered as a byproduct of gold mining in places.

GOLD

Gold has been produced from all of the major greenstone areas on EDJUDINA. Details of production, host rocks, and structural and alteration features of the major mining centres and associated deposits are presented in Witt and Westaway (in prep.). The summary of controls on gold mineralization presented below is based on Witt and Westaway (in prep.) and Swager (1995b). Unless otherwise stated, the following data are from Witt and Westaway (in prep.).

The Yilgangi group of mines (Swager, 1995b) is in the Keith–Kilkenny Fault Zone. The major producing mines are hosted by quartzofeldspathic greywacke, sandstone, and siltstone (*Asg*). For example, 1095 kg of gold was mined from the Yilgangi Queen mine between 1935 and 1982, and there is a further demonstrated gold resource of 2222 kg. Mineralization is also sited in monzodiorite — 11 kg of gold was mined from the Yilgangi King mine — and in a syenite intrusion at Quondong mine. Gold is associated with quartz veining in brittle reverse faults that trend 330–350° and dip 70° to the west. Sedimentary rocks adjacent to the mineralized quartz veins are altered to quartz–muscovite–carbonate assemblages with idioblastic pyrite and arsenopyrite.

The Yarri mining centre (Swager, 1995b) falls within the Yarri Monzogranite (*Agma*), the Porphyry Quartz Monzonite (*Agop*), and the intermediate and mafic rocks in the adjacent greenstone sequences. Mineralization in the Yarri and Porphyry areas is commonly associated with hematite alteration of wallrocks, suggesting an ore fluid that is relatively oxidized compared to the commonly accepted composition for most Archaean gold ore fluids (Witt and Westaway, in prep.). Witt (1996) suggested this relatively oxidized state may be related to phase separation (boiling) of the ore fluid.

The Yarri Monzogranite is an elongate, pervasively foliated, pre-regional folding pluton that has produced about 460 kg of gold, mainly from the Wallaby Central and Yarri Proprietary mines. Mineralization within the monzogranite is predominantly concentrated on a north-northwesterly trending, subvertical to steeply westerly dipping, sinistral shear zone about 1500 m long. The shear zone is subparallel to the regional foliation and is associated with prominent quartz veins. Smaller amounts of gold were produced from mafic rocks just east of the monzogranite; for example, the Yarri South mine produced 39 kg of gold between 1902 and 1911.

The Porphyry mining area within the Yarri mining centre (Swager, 1995b) includes a series of deposits extending from Porphyry North to Wallbrook. The major greenstone rocks in this belt are andesite (*Afi*), hornblende–quartz–feldspar schists derived from andesitic rocks (*Afis*), and andesitic basalt (*Abi*). The greenstones have been intruded by several small granitoid plutons. The major gold deposits are hosted by the Porphyry Quartz Monzonite and andesite. Gold deposits in the Porphyry Quartz Monzonite are in east-dipping (20–25°) shear zones. The Porphyry deposit, at the eastern contact of the quartz monzonite with greenstones, occurs in en echelon lenses with highest grades contained within mylonite zones. Kinematic indicators suggest possible sinistral shear sense and minor reverse movement (Allen, 1987). This deposit, and the nearby Million Dollar deposit, have a combined production of more than 4 t of gold. The andesite-hosted gold deposits at Margaret, east of Porphyry, are related to north-northwesterly trending, possibly sinistral, shear zones.

The Edjudina mining centre (Swager, 1995b) comprises an almost continuous line of workings over 13 km named the Edjudina Line. The Edjudina mining centre has produced around 1300 kg of gold, of which more than 1000 kg was produced from the northern 3 km. Here, gold is mainly in intermediate and mafic schists. Gold mineralization is controlled by a series of narrow, quartz-filled shear zones trending 320–340° and dipping steeply to the northeast. Carbonate alteration is common in the schist.

The Patricia mining centre produced 167.4 kg of gold between 1930 and 1940. A recent openpit mine at Patricia yielded 50 kg of gold (Swager, 1995b). Gold mineralization is hosted by quartz–ankerite–pyrite–chalcopyrite(–arsenopyrite)–silver vein networks within banded talc–chlorite–ankerite schist (Swager, 1995b). The vein networks are parallel to the steeply easterly dipping to vertical regional foliation and also affect many altered and deformed felsic porphyries. Low-grade gold mineralization is also contained in sericite–quartz schist (Swager, 1995b).

Gold deposits in the Yerilla area coincide with a small granitoid intrusion (*Ag*). The district has produced about 350 kg of gold. Gold mineralization is hosted by mafic rocks adjacent to the margins of the pluton in a variety of brittle faults and ductile shear zones. Smaller deposits in the Mount Remarkable area are hosted in subvertical, northerly to north-northeasterly trending, veined shear zones.

The Yundamindera area has produced over 1500 kg of gold from granitoid host rocks. Orebodies are predominantly related to northwesterly to north-northwesterly trending shear zones that dip 40–60° to the northeast with steeply plunging, linear fabrics. The Pennyweight Point area to the east of Yundamindera, has produced about 100 kg of gold. Metabasalt (*Abv*) and amphibolite (*Aba*) are the major host rocks, but some small deposits are hosted by granitoid rocks. Gold mineralization is spatially related to a curvilinear fault, which is subparallel to the contact between greenstones and granitoids. Alteration assemblages in both mining areas indicate high-temperature (>550°) hydrothermal activity.

The Eucalyptus – Pykes Hollow area has produced about 150 kg of gold, mainly from the Pykes Hollow mine, with historical production of up to 10 kg from individual mines. Dollied and alluvial gold accounts for the greater part of this production. Most of the gold deposits around Pykes Hollow are hosted by thin units of felsic and metasedimentary rocks (*Af*) dominated by silicified, sericitic schist with idioblastic pyrite. Mineralization is associated with strike-parallel, brittle–ductile shear zones. Mafic-hosted mineralization in the Eucalyptus – Pykes Hollow area is associated with pyritic(–pyrrhotitic) quartz–sericite schists enveloped in an outer halo of chlorite–carbonate alteration.

The Linden area has produced about 2000 kg of gold. The larger deposits are hosted by ultramafic, mafic, and felsic volcaniclastic rocks. Gold mineralization is related to the pressure shadow at the northern end of a monzogranite intrusion and brittle–ductile shear zones on the western and eastern margins of the intrusion. Alteration assemblages that indicate a relatively low-temperature (300–400° C) environment include talc–chlorite–carbonate(–biotite) in ultramafic rocks and chlorite–carbonate–sericite in mafic rocks.

The Mount Celia area has produced about 100 kg of gold, with further identified resources at Deep Well and Kangaroo Bore. Gold is hosted by amphibolite in historical mines, and by BIF at Deep Well. At Kangaroo Bore, gold is hosted by quartz–pyrophyllite and mineralization is associated with a sinistral shear zone.

The Sunrise–Cleo deposit in the Sunrise Dam area, which is one of the most significant gold discoveries in Australia in recent years, has estimated gold resources of 91 065 kg at an average grade of 4.1 g/t gold (Mines and mineral deposits information (MINEDEX) database, Department of Minerals and Energy, Western Australia, December, 1997). Here, primary gold is associated with a shear zone in an Archaean sequence composed of BIF, sedimentary, and acid to intermediate volcanic and volcaniclastic rocks; there is also significant gold mineralization in the transported overburden (Newton et al., 1998). The Golden Delicious and Sunrise Dam Group, also in the Sunrise Dam area, have gold resources of 1873.2 kg and 29 816.9 kg respectively. The Red October deposit in Lake Carey has an estimated gold resource of 11 520 kg (MINEDEX database, Department of Minerals and Energy, Western Australia, December, 1997).

NICKEL

A number of low-grade, laterite-hosted nickel deposits have been identified in the Pyke Hill – Eucalyptus Bore area in the northern part of EDJUDINA. The Pyke Hill deposit has a resource (March 1995) of about 12 Mt ore containing 1.17% nickel with some cobalt enrichment (Gonnella, 1997).

SILVER

Williams et al. (1976) reported that more than 155.5 kg of silver was recovered as a byproduct of gold mining on EDJUDINA, with most production from the Yilgangi and Yarri districts. Much of the gold obtained from the Queen of the May mine at Yundamindera was in electrum, a natural alloy of gold and silver (Simpson, 1951).

COPPER

There are traces of copper minerals in several gold mines (Williams et al., 1976).

GEMSTONES

Chrysoprase, an apple-green, semi-precious form of chalcedony derived from weathering of ultramafic rocks, is locally associated with silica caprock (*Czu*). The colour is due to the presence of small amounts of nickel oxide. Although chrysoprase has been mined from several small openpits — at Boyce Creek, west of Jump up Dam, Duck Hill, and 1 km southeast of Eucalyptus Bore — there is no recorded production.

Williams et al. (1976) reported local occurrences of lace and honey opal about 3 km north of Pyke Well on Yundamindera Station.

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Appendix

Gazetteer of localities

Locality	*AMG coordinates* *Easting*	*Northing*	*Locality*	*AMG coordinates* *Easting*	*Northing*
6 Mile Well	362200	6749200	Patricia mine	464200	6697200
12 Mile Well	408500	6687500	Pennyweight Point	411600	6779200
31 Well	375800	6764900	Penola mine	433800	6701700
50 Mile Well	355700	6774000	Pine Well	367600	6719100
Barret Well	472800	6719000	Porphyry mine	430800	6705100
Bobs Bore	374700	6721000	Porphyry North mine	429500	6715200
Bore Well	435800	6696200	Pyke Hill	420100	6789900
Boyce Creek mine	395500	6731800	Pyke Hill mine	417000	6786200
Broken Hill	448000	6713500	Pykes Hollow mine	420400	6777800
Camelback Bore	430100	6769800	Queen of the May mine	405200	6776100
Clymies Well	447200	6708800	Quondong mine	421500	6703800
Dairy Corner Bore	359200	6761600	Quondong Well	419300	6706000
Dairy Well	359100	6754800	Red Gate Well	428900	6716600
Deep Well	456100	6732300	Red Hill Well	455000	6726900
Duck Hill	429800	6734700	Red October mine	443000	6767600
Edjudina Dam	450800	6704000	Relief Well	458300	6785000
Edjudina Soak	456800	6703200	Safari Bore	453300	6731700
Elora Homestead	483300	6733200	Seddon Bore	422100	6716200
Eucalyptus	419000	6773000	Soapy Head Well	436600	6692900
Eucalyptus Bore	420400	6766900	South Extension Bore	454700	6771500
Gardiner Well	408800	6774300	South Soak Well	466000	6764900
Glengarry mine	456900	6697300	Sunrise–Cleo mine	443800	6783000
Golden Delicious mine	445600	6789200	Sunrise Dam mine	445500	6785100
Jump Up Dam	410900	6712500	Tassy Well	375500	6734000
Jungle Pool	369800	6736600	The Gap Bore	435000	6737200
Kangaroo Bore	448000	6744200	Two Lids Bore	459000	6725600
Kilmore Hill	388600	6767400	Two Lids Soak	458800	6726600
Kurrajong Well	375700	6725800	Wallaby Central mine	438500	6705100
Linden	444000	6761800	Wallbrook mine	433900	6695300
Loafers Well	436700	6690400	Wallbrook Hill	433000	6695000
Margaret mine	433200	6705200	Wandary Well	378600	6743000
McAuliffe Well	395500	6736900	Wandinnie Well	412400	6689400
Million Dollar mine	430900	6703200	Webb Hill	407500	6716500
Moon Rock	476800	6743400	Westward Ho Well	386000	6733500
Mount Boyce Bore	404200	6723400	Wilga Well	454900	6777100
Mount Catherine	391100	6732500	William Bore	462500	6788300
Mount Celia	452000	6738500	Windy Well	444400	6694000
Mount Kildare	384400	6774600	Yarri mining centre	436000	6706000
Mount Kilkenny	378700	6789300	Yarri Proprietary mine	438800	6704300
Mount Millicent	437500	6734000	Yarri South mine	440000	6701600
Mount Remarkable	380500	6753600	Yerilla Homestead	386000	6739100
Mud Hut Well	378000	6755300	Yilgangi	419800	6707200
Murphy Well	421400	6759000	Yilgangi Dam	414700	6709800
Neta mine	449800	6706400	Yilgangi King mine	419800	6705700
Outcamp Bore	420800	6727300	Yilgangi Queen mine	418800	6712600
Paradise Bore	460700	6715500	Yundamindera	407000	6782500
Paradise Well	459300	6714800			