Geology of the De La Poer (3443) and Urarey (3343) 1:100 000 Sheet areas, Yilgarn Block, Western Australia

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RECORD 1999/33

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CANBERRA 1999

Department of Industry, Science and Resources

Minister for Industry, Science, & Resources: Senator the Hon. N. Minchin, MP
Parliamentary Secretary: Warren Entsch
Secretary: Russell Higgins

Australian Geological Survey Organisation

Chief Executive Officer: Neil Williams

ISSN 1039-0073
ISBN 0 642 39794 5

Bibliographic reference: Stewart, A.J., 1999. Geology of the De La Poer (3443) and Urarey (3343) 1:100 000 Sheet areas, Yilgarn Block, Western Australia. Australian Geological Survey Organisation, Record 1999/33.

Abstract

DE LA POER and URAREY 1:100 000 Sheet areas are located in the north of the Eastern Goldfields Province of the Archaean Yilgarn Craton, Western Australia, and include parts of the Gerry Well, Duketon, and Ulrich Range greenstone belts. In the northeast of DE LA POER, the Archaean rocks are unconformably overlain by thin siliciclastic and minor carbonate sedimentary rocks of the Palaeoproterozoic Eeraheedy Basin. Outliers of Permian clastic rocks of the Officer Basin overlie the Archaean and Proterozoic rocks.

The greenstone belts are very poorly exposed. Rock types include: tholeiitic basalt, quartz-biotite and quartz-muscovite schist after felsic volcanic rocks, ultramafic schist, banded iron formation, jaspilite, chert, and siliciclastic rocks, intruded by small bodies of dolerite and gabbro. The greenstones are metamorphosed to middle and upper greenschist facies transitional to amphibolite facies. Voluminous poorly exposed and highly weathered monzogranite surrounds and intrudes the greenstone belts. Two major sinistral strike-slip faults with displacements of 15-30 km trend northwesterly across the area. Numerous major fractures cut the greenstones and granite; those striking northwest and east to east-northeast may have been injected by Proterozoic mafic dykes.

Sedimentary rocks of the Eeraheedy Basin are about 55 m thick, and include feldspathic and glauconitic sandstone, stromatolitic dolostone, siliceous to hematitic oolitic sandstone, and siltstone.

Outliers of flat-lying siltstone, sandstone, and claystone, totalling about 14 m in thickness, are commonly boulder-bearing, and may be glacial in origin. They are assigned to the Permian Paterson Formation of the Officer Basin.

The area has no known mineral deposits as yet. There is potential for concealed epigenetic gold lodes in breccias, vein arrays, and shear zones in favourable sites such as faults and fault-jogs, large-scale fold hinges, and regions of low mean stress at curved granite-greenstone contacts.

Contents

Introduction

DE LA POER and URAREY 1:100 000 sheets make up the northeastern third of the Duketon 1:250 000 sheet area (SG51-14) in the north of the Eastern Goldfields Province of the Yilgarn Craton (Fig. 1). Talbot (1920, 1926) and Clarke (1925) made the first geological reconnaissance maps of the area, and Bunting & Chin (1977, 1979) mapped and described the geology at 1:250 000 scale. The Australian Geological Survey Organisation (AGSO) mapped the area in 1994 at 1:100 000 scale using black and white 1:50 000-scale aerial photographs flown in 1989 as part of the joint National Geoscience Mapping Accord between AGSO and the Geological Survey of Western Australia. The area includes part of the gold-bearing Duketon greenstone belt, but has produced no gold as yet.

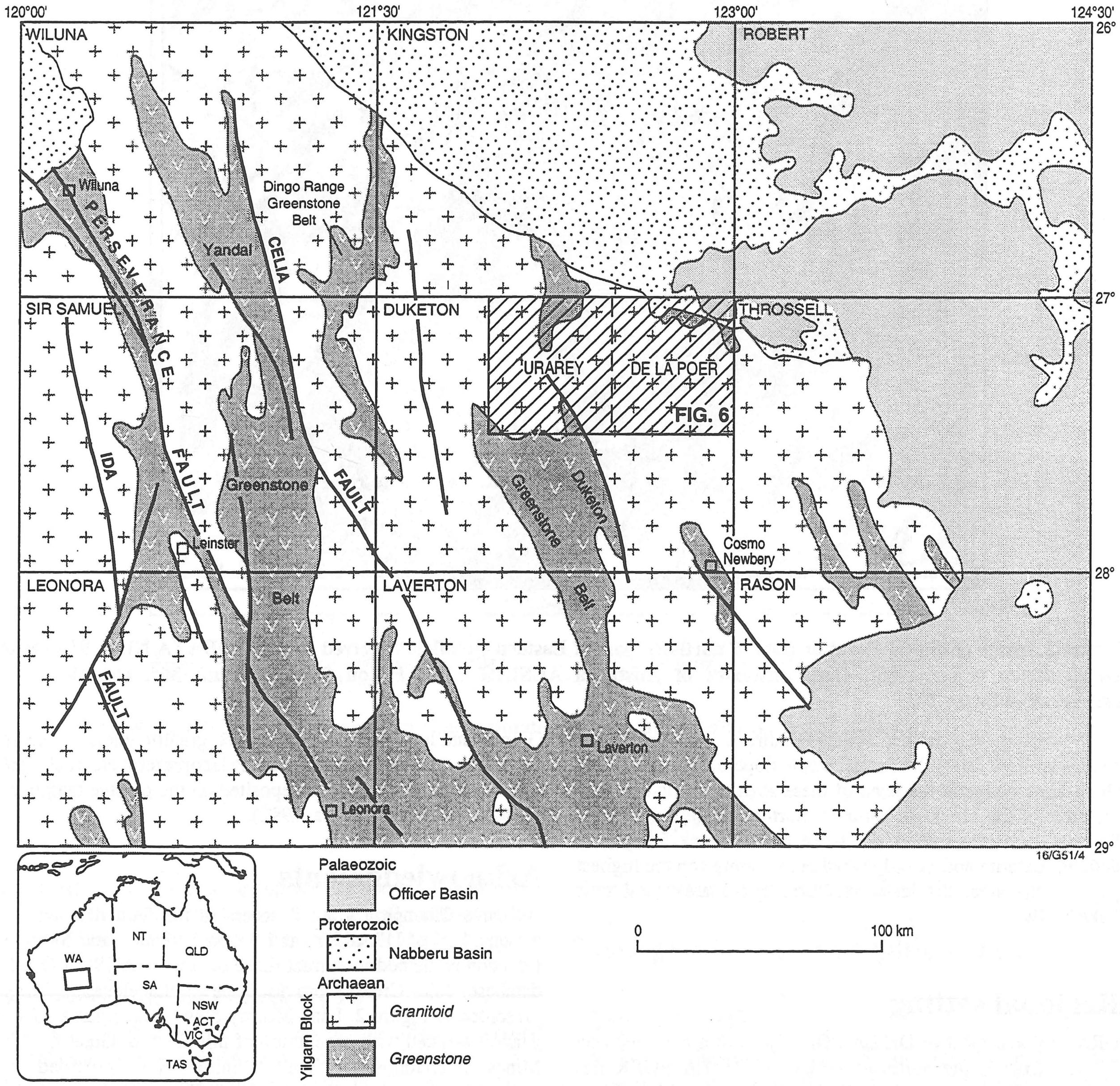

Figure 1. Regional geology of the northern part of the Eastern Goldfields Province, Western Australia, showing location of DE LA POER and URAREY 1:100 000 Sheet areas in Duketon 1:250 000 Sheet area.

A formed road provides access from Laverton to Deleta homestead in the north of URAREY. In DE LA POER, the Cosmo Newbery – Perenti Downs road crosses the eastern part of the area. The Lake Wells vehicle track connects these two roads in the south of DE LA POER, and a track from Deleta to Lake Wells provides access to the north of DE LA POER; another track heading west from Deleta provides access to northern URAREY.

The area lies between 600 m above sea level (a.s.l.) in the west and 450 m a.s.l. in the east. The highest areas are the crestal remnants of a large gently northeast-dipping tilt block, now eroded, that trends northwest across Duketon. The block is one of several that segment the Eastern Goldfields (Figs. 2, 3). Its crest extends from the Sandstone Range in the southeast to Mount Tate in the northwest. Lake Wells, in the east, lies at the lowest point of the dip slope of the block.

Figure 2. Image of digital elevation data of northern part of Eastern Goldfields derived from GEODATA NINE SECOND DEM, which is copyright, Commonwealth of Australia AUSLIG 1996. Pelton filter, azimuth 30°, elevation 45°, exaggeration factor 10.

Numerous well-defined southwest-directed streams in the southwest flow down the former scarp slope of the block. The Grant Duff Range at the head of these streams coincides with the crest of the block. In contrast, northeast-directed streams flowing down the former dip slope of the block are poorly defined. Laterite and heavily weathered granite cap the highest parts of the area; the least weathered rocks are found near Lake Wells.

Regional setting

URAREY and most of DE LA POER lie within the Archaean Yilgarn Craton; the northeast corner of DE LA POER lies within the Palaeoproterozoic Eeraheedy Basin, and includes outliers of Permian rocks of the Officer Basin. The Archaean rocks comprise weakly metamorphosed greenstone and granite 2750-2600 Ma old. The greenstones comprise mainly mafic lavas, shale, and banded iron formation, with minor mafic intrusions in the south and ultramafic schist in the north. Granite and lesser amounts of banded granitic gneiss make up the major part of the area. The Palaeoproterozoic rocks are siliciclastic shelf sediments deposited on the passive margin of the Yilgarn Craton (Myers, 1992).

Acknowledgments

Dave Champion granted access to his field data for the western half of URAREY, and Aaron Sedgmen and Suzanne Edgecombe helped to extract those data from AGSO's Oracle database. John Creasey provided the digital elevation image presented in Figure 2. Lana Murray drew the diagrams. Geoff Bladon assisted with production of this Record. Great Central Mines N.L./Johnson's Well Mining N.L. provided an interpretative geological map of the Gerry Well greenstone belt previously prepared by MIM Exploration Pty Ltd. Frank Syrch, Berlinda Crowther, Veronica Brown and Ben Bogard provided willing field assistance. WMC Resources allowed use of their accommodation at Camp 2, Leinster.

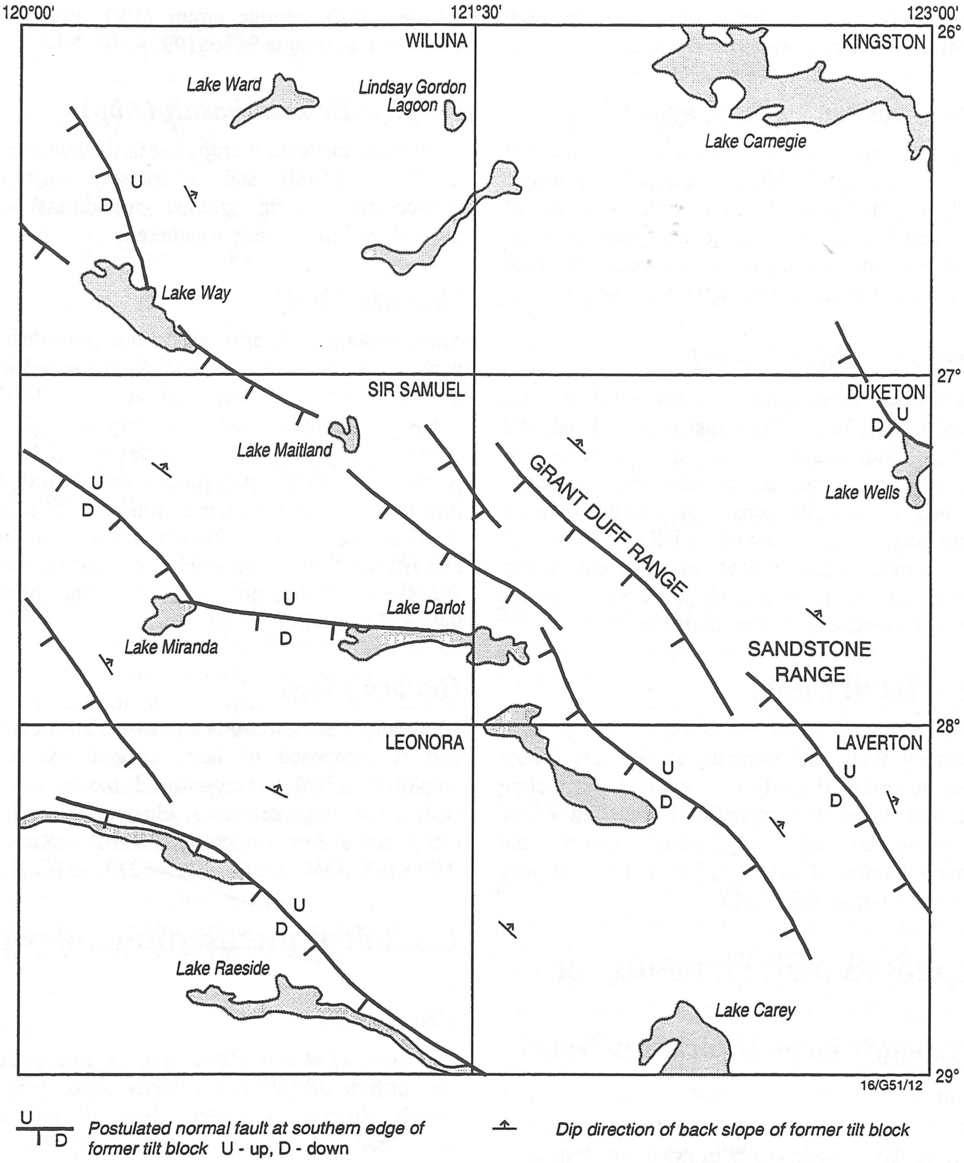

Figure 3. Sketch map of same area showing postulated normal faults defining former (Cainozoic?) tilt blocks.

Archaean geology

Archaean rocks underlie about 95 percent of the area, but because of the extensive Cainozoic cover and wide separation between exposures, no stratigraphic sequence is known.

Weathered Archaean rock (Aw)

Weathered Archaean rock of unrecognisable origin is exposed in the southwest of URAREY around AMG 050580 and 170590. The exposures adjoin recognisable fine-grained mafic igneous rocks and metadolerite, and so are probably derived from these and/or other greenstones.

Metamorphosed ultramafic rocks

Talc-carbonate rock (Auc) and talc-chlorite schist (Aut)

Legge (1972) recorded small patches of talc-carbonate rock and talc-chlorite schist a few centimetres high in the Gerry Well greenstone belt in northern URAREY.

Low-grade metamorphic rocks

Clay rock (Alb)

Massive to schistose clay rock with or without a small amount of quartz is exposed in the southwest of URAREY around AMG 040580, 020595, and 170590, and in the northwest around AMG 195975. The rock is ferruginised and kaolin-rich and generally equigranular but in places has pseudomorphs after plagioclase (to 3 mm). Quartz veins are common at some localities. The rock is probably weathered basalt.

Quartz-feldspar schist (Alf)

Quartz-feldspar (or clay) schist with muscovite crops out in the northwest of URAREY around AMG 190045. It is fine-grained, and thin quartz layers parallel the foliation. The rock is heavily weathered to limonitic kaolin and silica.

Schistose clay rock with quartz eyes (Alfq)

Exposures of schistose clay rock with quartz eyes form a belt trending north for 5 km around AMG 180660 in the southwest of URAREY. The rock is fine-grained, and composed of quartz (30-40%) and kaolin. In places it has quartz-rich and quartz-poor layers (< 5 mm thick), and is silicified. The rock may be metasedimentary or felsic meta-igneous in origin.

Quartz-muscovite schist (Alqm)

Yellow-weathered fine-grained quartz-muscovite schist crops out 4 km west of Urarey Well. The schist is crenulated, and encloses numerous boudins and lenticles up to 1 m long of partly recrystallised vein quartz, which emit hydrogen sulphide when broken, and rare lenses of weathered mafic rock up to 50 cm long. In the southwest of URAREY, around AMG 050583, the rock is ferruginised, and has concordant and folded quartz veins up to 2 m thick. In places it grades into slate, and may be metasedimentary in origin.

Quartz-biotite schist (Alqb)

Fine-grained quartz-biotite schist crops out 3.5 km west-northwest of Urarey Well, and consists of elongate biotite aggregates, elongate grains of partly recrystallised plagioclase with muscovite, and lenses of recrystallised quartz in a very fine-grained groundmass of recrystallised quartz and plagioclase (sample 94968214, AMG 310643). The rock may originally have been a porphyritic dacite.

Metamorphosed mafic igneous rocks

Fine-grained mafic igneous rock, undivided (Ab)

Metamorphosed fine-grained mafic igneous rock (originating from lavas, tuffs, or dykes) forms rafts in granite in four areas in URAREY (AMG 135780, 163583, 294673, and 390043). In the northern area, around AMG 135780, foliated to locally banded amphibolite occurs as pods and lenses up to 2 m across over areas about 100 m in extent, and is intruded by veins and dykes of granite, pegmatite, and aplite up to 1 m wide. The amphibolite is slightly to moderately weathered, and composed chiefly of plagioclase (40-60%) and hornblende grains (± actinolite and epidote) up to 8 mm long. Quartz, titanite pseudomorphous after amphibole, and K-feldspar porphyroblasts at AMG 135780 indicate reaction with the host granite.

At AMG 163583, the rock is heavily weathered and ferruginised, with only small areas of fresh outcrop preserved. At AMG 294673, heavily weathered mafic rock is fine-grained and massive to weakly cleaved; it is associated with a porous quartz rock which may be leached shale or siltstone.

The Ab outcrop at AMG 400068 is labelled in error; the rock is typical very fine-grained metabasalt (Abb).

Metabasalt (Abb)

Metamorphosed basalt is the most abundant greenstone rock type in the area, and is generally weathered to hackly clay. Unweathered metabasalt in the south of URAREY (Duketon greenstone belt) and northeast of DE LA POER (Ulrich Range greenstone belt) is a fine-grained assemblage of blue-green amphibole (69%), recrystallised mosaic plagioclase (20%), titanite (10%), opaque grains (1%), and isolated grains of quartz (<1%; sample 94968199, AMG 298617).

Porphyritic metabasalt (Abp)

Porphyritic metabasalt crops out in the northwest of URAREY at AMG 195980, and is sparsely plagiophyric (2 mm phenocrysts in a fine-grained groundmass) to equigranular, foliated, and moderately weathered.

Dolerite (Aod)

Metamorphosed dolerite crops out immediately east of the gabbro 5 km west of Urarey Well, and also 2 km to the south, among basalt exposures, and at AMG 170584. The rock comprises prisms of blue-green amphibole (75%), cloudy red-brown laths of calcic andesine (23%) substantially recrystallised to fine polygonal mosaic grains, skeletal rods of ilmenite (2%), and scattered biotite (<1%; sample 94968198, AMG 301611). Metadolerite in a RAB hole in the northwest consists of blue-green amphibole (52%), sericitised middle andesine (41%), opaque grains (7%), and chlorite (<1; sample 94968274, AMG 378054).

Gabbro (Aog)

Metamorphosed gabbro is exposed 5 km west of Urarey Well, and is composed of large ragged prisms of blue-green amphibole (58%), recrystallised mosaic plagioclase (40%) with a few large remnants, clusters of small opaque grains (2%), and a few scattered flakes of biotite (<1%; samples 94968193, AMG 305611; 94968213, AMG 297639).

Chemical metasedimentary rocks

Chert (Ac)

Chert crops out as isolated beds in greenstone sequences. In the north of URAREY, the largest exposure is a ridge of grey steeply dipping laminated chert 19 km west of Deleta homestead. The ridge is surrounded by flat-lying siltstone of the Paterson Formation, and appears to have formed a small island in a Permian lake. Black chert crops out at ground level below a laterite cap 2.8 km north-northwest of Bettys Bore. Brown laminated to thin-bedded chert is discontinuously exposed over 50 m across strike 4.5 km northeast of Bettys Bore; the chert is gently folded around steeply plunging axes. In the central south, gently folded blue-grey to black laminated chert is associated with shale and slate at two localities 5 km southwest and 4.5 km west of Urarey Well.

Banded iron formation, oxide facies (Aci)

Banded iron formation is exposed in eight areas:

- In the north of URAREY, a north-trending ridge of weathered shale exposes red, grey and white hematite-bearing iron formation at its crest.
- In the centre of URAREY, 15 km north-northwest of Quongdong Well, two ridges of brown, yellow and black banded iron formation are enclosed in and steeply folded with granite (Fig. 4). Magnetic susceptibilities ranging up to 23 700 x 10^{-5} SIU indicate the iron is present as magnetite.
- Hematitic banded iron formation is exposed as in situ fragments in a basalt sequence 4 km northwest of Urarey Well.
- Two ridges of banded iron formation crop out in the porphyritic basalt sequence at AMG 200980 in URAREY.

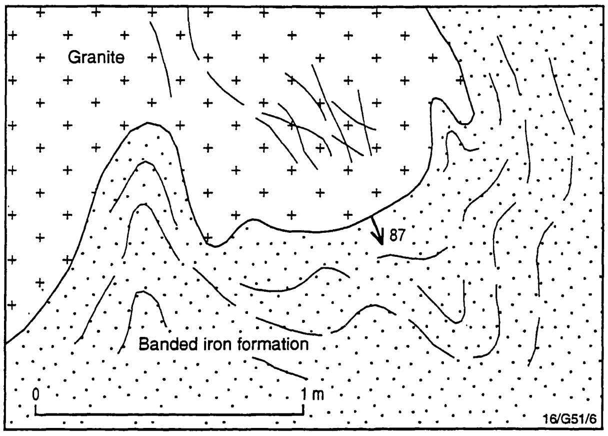

Figure 4. Sketch of steeply plunging fold in banded iron formation and granite. AMG 330815.

- A single ridge of banded iron formation adjoins micaceous schist and silica caprock on ultramafite in the southwest corner of URAREY.
- Several masses of previously unrecorded magnetite-bearing banded iron formation, one forming a prominent hill, are exposed over an area of several square kilometres in the west of DE LA POER, 16 km west-southwest of Mount Gerard.
- Two small ridges of weathered (goethite-bearing) banded iron formation surrounded by granite are exposed 18 km south of Deleta homestead in URAREY. Euhedral cavities after pyrite are present in one bed.
- Doubly folded magnetite-bearing banded iron formation surrounded by laterite forms ridges 12 km north-northwest of Mount Gerard, in the north of DE LA POER.

Jaspilite (Acj)

Very fine-grained jaspilite striped red, yellow, and brown, and several metres thick, forms the crest of a ridge of shale in the north of URAREY.

Clastic metasedimentary rocks

Metasedimentary rock (As)

Metasedimentary rock (undivided) forms a small exposure at AMG 055580 in the southwest of URAREY. It is fine to very fine-grained, schistose, and composed of muscovite, quartz, kaolin, and iron oxide (strongly ferruginised). It may be metasedimentary, or of fine-grained felsic igneous origin. The contact with granite to the north is intrusive or multiply faulted. The exposure at AMG 258822 near the centre of URAREY has not been visited, and is photo-interpreted as sedimentary because it has prominent trend lines.

Sedimentary and felsic volcanic rocks (Asfv)

Undivided sedimentary (non-volcanic) and felsic volcanic rocks crop out in the southwest of URAREY around AMG 020605. The rocks comprise muscovite-quartz schist and foliated quartz-kaolin rock. In both types, the quartz is present as eyes up to 4 mm long.

Shale and slate (Ash)

Grey shale and dark grey to blue-grey slate with minor black chert crop out 5 km west and west-southwest of Urarey Well. The rocks are gently folded with steep axes. Brownish yellow steeply dipping silicified shale several metres thick is exposed next to a laterite breakaway 11.5 km southwest of Deleta homestead. Several ridges 16 km west of Deleta homestead consist of shale, chert, and 'sediments generally' (Barnes, 1989; Smith, 1989); no other details were recorded. Heavily weathered shale or siltstone is exposed 19.5 km west-southwest of Deleta homestead, and consists of kaolin and quartz; a 2 m-thick interbed of fine-grained non-bedded quartzite may be recrystallised chert.

Quartzite (Asq)

A bed about 3 m thick of grey to white fine-grained quartzite crops out 3.5 km west-northwest of Urarey Well, and consists of fine granuloblastic aggregates of quartz in a very fine-grained groundmass of recrystallised polygonal quartz (sample 94968216, AMG 311644). The rock is laminated to thin-bedded, gently folded, and in contrast to recrystallised quartz veins in the vicinity, emits no hydrogen sulphide when broken.

Sandstone (Ass)

Purplish red steeply dipping sandstone is exposed 12 km southwest of Deleta homestead. The rock is fine-grained, laminated, has small low-angle cross beds, and is composed of quartz, clay, and iron oxide.

Gneiss

Banded gneiss (An)

Heavily weathered fine to coarse-grained banded gneiss is exposed in central and southwestern DE LA POER and in eastern URAREY. The layers range from a few centimetres to several metres thick, and result from changes in grainsize and mineral proportions. Quartz is everywhere strongly flattened. Folds in the layering are common, and range from gentle to close to ptygmatic. Nebulous agmatitic structure is visible in the northernmost exposures. At several localities the gneiss forms xenoliths and rafts in granite (Fig. 5), suggesting the gneiss could be derived from an older deformed intrusion, or from a pre-greenstone basement.

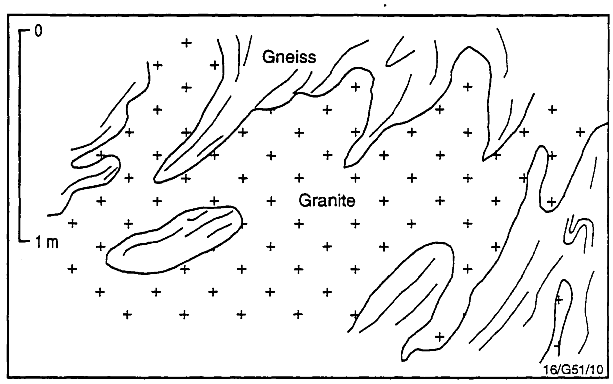

Figure 5. Gneiss inclusions in granite exposed below breakaway, AMG 463936, DE LA POER.

Granite (Ag, Agc, Age, Agf, Agg, Agm, Agmc, Agmf)

Almost all granite exposures in the area are heavily weathered to kaolin studded with residual quartz grains. Fresh biotite granite is exposed in four areas: the southeast of DE LA POER; the southern part of the De La Poer Range; 6 km east-southeast of Urarey Well; and 15 km north of Quongdong Well on the Laverton – Deleta road in URAREY. In the southeast of DE LA POER, the granite is mostly fine to medium-grained, but in places coarse-grained. At AMG 855585, dykes of fine-grained granite intrude the coarse. Pegmatite and microgranite veins are abundant in places. In the southern part of the De La Poer Range, pavements of slightly weathered granite expose inclusions several metres across of weakly banded biotite gneiss. A small turtleback 6 km east-southeast of Urarey Well displays fresh coarse-grained granite accompanied by numerous pegmatite veins and dykes. The granite is strongly banded in one area 20 m by 0.5 m in extent; this may be a gneiss inclusion. Corestones of fresh fine-grained homogeneous granite are exposed on the eastern side of the Laverton – Deleta road, 15 km north of Quongdong Well. Two thin-sectioned samples (94968123, AMG 810800; 94968162, AMG 770748) are both allotriomorphic monzogranites, consisting of partly recrystallised quartz (20%), sodic andesine (45-47%), microcline (30%), biotite or chlorite (1-3%), opaque grains (1%), and traces of epidote, allanite, and secondary muscovite in plagioclase.

Strongly foliated granite (Agn)

Strongly foliated granite with weak layering and mafic lenses crops out extensively in southwestern URAREY. It is generally pink to white, less commonly brown or red. Grain-size is generally fine to medium, rarely coarse, and commonly varies in a single outcrop. Quartz is almost everywhere flattened, but elongate to anhedral where not deformed. Feldspar grains reach 6 mm long, or 1 cm as sparsely distributed phenocrysts, and is anhedral to subhedral. Biotite ranges from 5-10%. The foliation arises from flattening and alignment of quartz, alignment of biotite, and in places from schlieren of biotite-rich or quartz-free composition from 1 mm to 2 cm thick. The schlieren grade locally into layering; elsewhere layering is caused by grain-size changes. The granite contains rare pods of fine to medium-grained amphibolite and foliated granite, and is intruded by numerous dykes or veins of fine to medium-grained massive granite, pegmatite, aplite, and quartz.

Microgranite (Agl)

Very fine-grained felsitic microgranite forms an isolated exposure in the northeast of DE LA POER (AMG 970941).

Dykes and similar rocks

Dykes of microgranite intrude metabasalt at AMG 972927 in DE LA POER, and a dyke of white fine to medium-grained granite intrudes foliated granite at AMG 143784 in URAREY. Goethite-quartz breccia is exposed at AMG 397059 in northeast URAREY, and comprises angular clasts and fractured masses of milky vein quartz in a goethite cement.

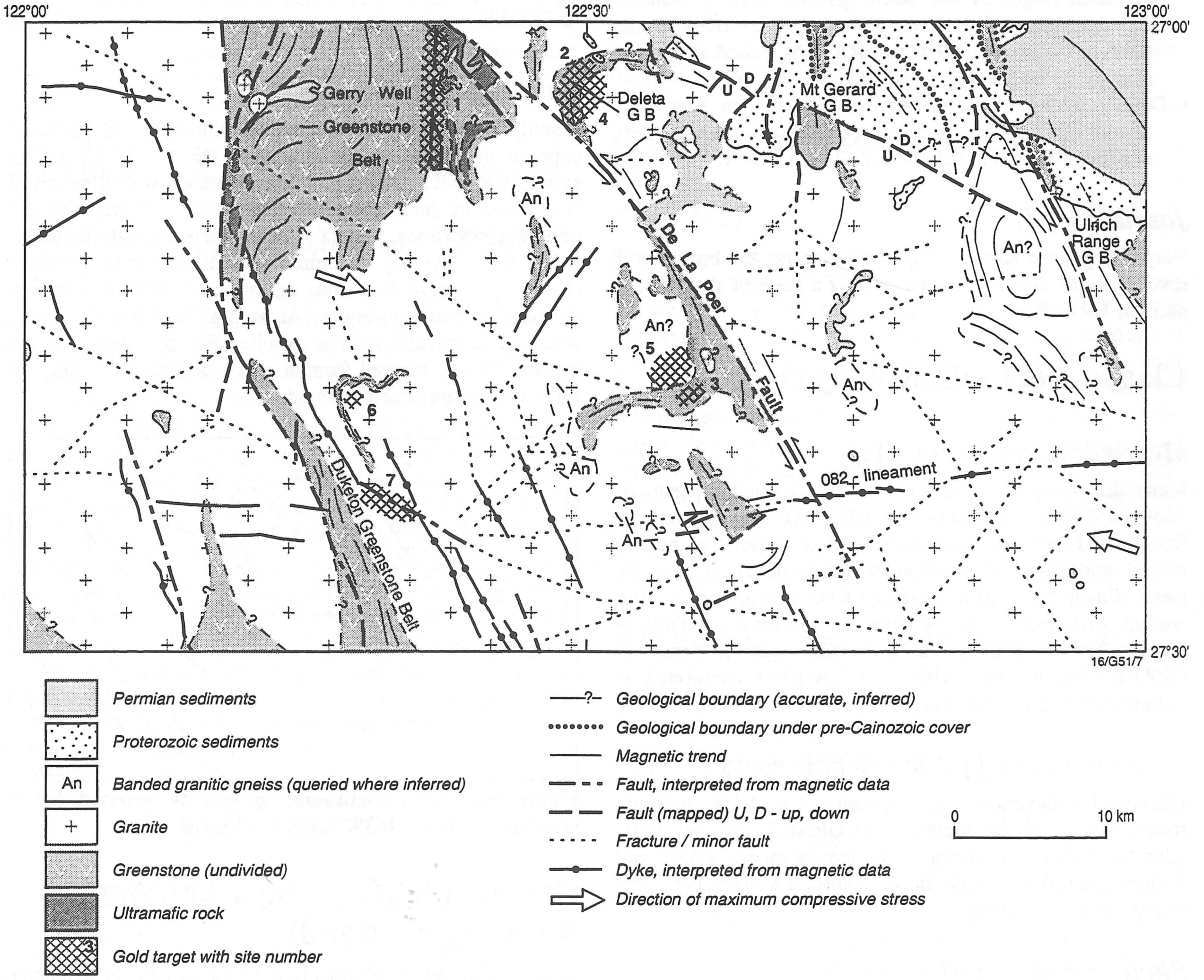

Figure 6. Solid geology map of DE LA POER and URAREY. Compiled from: 1994 geological mapping and aeromagnetic interpretation by AGSO; unpublished maps by BHP Minerals Ltd et al. (1991) and MIM Exploration Pty Ltd (Johnson's Well Mining, N.L., 1998), with modification.

Structure

Figure 6 is a solid geological map of DE LA POER and URAREY, and shows the distribution of pre-Cainozoic rocks and major structures compiled from outcrop geology and aeromagnetic data. The major elements are:

- Archaean greenstone, granite, and gneiss, which make up 85% of the region
- Proterozoic sedimentary rocks of the Eeraheedy Basin in the northeast
- Permian sedimentary outliers of the Officer Basin scattered over the area.

Aeromagnetic data reveal several masses of compositionally banded strongly magnetic rock. Several coincide with mapped outcrops of banded iron formation and/or basalt, and so those concealed by Cainozoic cover may also be portions of greenstone belts.

Two major faults interpreted from the magnetic data strike northwesterly across the area. The western one – the De La Poer Fault (Farrell, 1998) – cuts one of the previously unknown greenstone belts (named the Deleta greenstone belt after Deleta homestead, which is located at the margin of the northern portion of the belt) into two. The parts are sinistrally offset by 30 km. Large-scale bending and drag are clearly evident, indicating major strike-slip. Offset along the eastern fault is less clear, but greenstone remnants on either side of the fault appear to be sinistrally separated by 15 km.

The magnetic data also show a network of fractures, which cut through the granite and greenstone areas. In places these fractures coincide with small but steep gradients, interpreted as dykes; no exposures of dyke rocks are known, however. Dykes in the lineament striking 082° in the south are pulled apart and rotated clockwise, indicating dextral slip along the fracture.

The faults and fractures are clearly different in age, although both are younger than the granite in the area, which is presumably about 2.66 Ga old. The major northwesterly-striking faults are older, as movement along the De La Poer Fault ceased before the 082°-striking lineament formed. Any dykes in the fractures are probably mafic and coeval with the Widgiemooltha dyke swarm, which is dated at 2.4 Ga-old (Myers 1990); if so, this date would set the younger limit on the age of the fractures. It is possible that the fractures formed during waning of the tectonism that produced the major sinistral shears, and that the same stress-field caused both. If so, the sinistral slip along the De La Poer Fault, and the dextral slip along the 082°-striking lineament indicate that the maximum compressive stress was oriented west-northwest during the late Archaean (Fig. 6).

Metamorphism

In the Duketon and Ulrich Range greenstone belts, the occurrence of:

- blue-green amphibole in metabasalt, metadolerite, and metagabbro
- biotite in metagabbro, and
- biotite and muscovite in quartz biotite schist

indicate low-grade metamorphism (Binns et al. 1976) ie, the rocks belong to the middle greenschist to transitional greenschist-amphibolite facies.

The Gerry Well greenstone belt is similar or of slightly lower-grade, based on:

- talc in talc-carbonate rock
- blue-green amphibole in metadolerite, and
- interstitial chlorite and white mica in plagioclase in metadolerite.

Proterozoic geology

Palaeoproterozoic

Horizontal to gently northeast-dipping shelf sediments of the Eeraheedy Basin non-conformably overlie Archaean granite and basalt in the northeast of DE LA POER. Basal feldspathic sandstone (Ꝑq) is overlain by stromatolitic dolostone (Ꝑl), oolitic sandstone (Ꝑo), and siltstone (Ꝑa). Total thickness is about 55 m (Bunting & Chin, 1979)

Feldspathic sandstone (Ꝑq)

The basal feldspathic sandstone is about 10 m thick. The best exposure is at AMG 795994, 9 km north-northeast of Mount Gerard, where the sequence is horizontal, and comprises:

TOP

Variegated white to buff clayey quartz sandstone, coarse-grained, medium to thick-bedded, massive, poorly sorted, subrounded to subangular

Clayey quartz siltstone, fine-grained, laminated

Grey-green glauconitic (20%) sandstone, medium-bedded, indurated, massive, moderately well sorted, well rounded

Glauconitic feldspathic (40%) sandstone, very fine-grained, well sorted

Buff feldspathic sandstone, fine to medium to coarse-grained, thin to medium-bedded, hummocky cross-bedded, poorly sorted, subrounded, coarsening upward, with mudflake intraclasts

BOTTOM

A thin-sectioned sample (94968035) from the grey-green glauconitic sandstone interval comprises well rounded clastic grains of quartz, glauconite (very fine-grained aggregates), spherulitic chalcedony, and chert, in a heterogeneous cement of optically continuous quartz around quartz grains, cherty quartz around glauconite, and prisms and crusts of single-crystal quartz lining voids and interstices together with small masses of amorphous red-brown iron oxide.

Away from here the unit is similar; in the gently northeast-dipping cuesta 15 km northeast of Mount Gerard, angular to subangular granules, pebbles, and cobbles of vein quartz are common at the base.

Isotopic dates on glauconite from the basal sandstone are about 1700 Ma (K-Ar) and 1620-1500 Ma (Rb-Sr; Preiss et al., 1975).

Oolitic sandstone (Ꝑo)

Oolitic sandstone (about 15 m thick) is red-brown, brown, or yellow, medium-grained, massive, moderately well sorted, and well rounded. The oolites range in composition from yellowish chert, to microcrystalline quartz cores rimmed with hematite, to hematite with partial internal concentric shells of quartz. The matrix is microcrystalline quartz. In places the

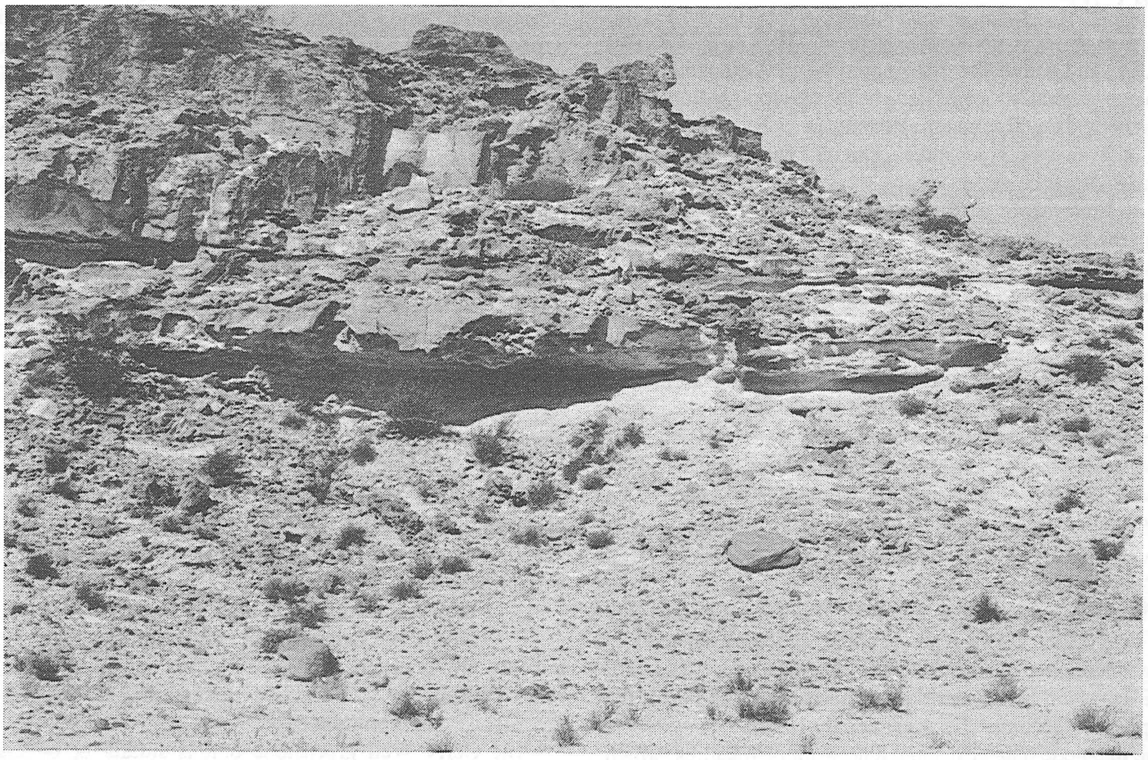

Figure 7. Typical exposure of Paterson Formation, showing subangular boulders weathered out of siltstone (bottom), overlain by interbedded sandstone and siltstone below overhanging ledge, thick-bedded sandstone forming ledge, and very thick-bedded siltstone above ledge. Locality same as Figure 10a, AMG 603028.

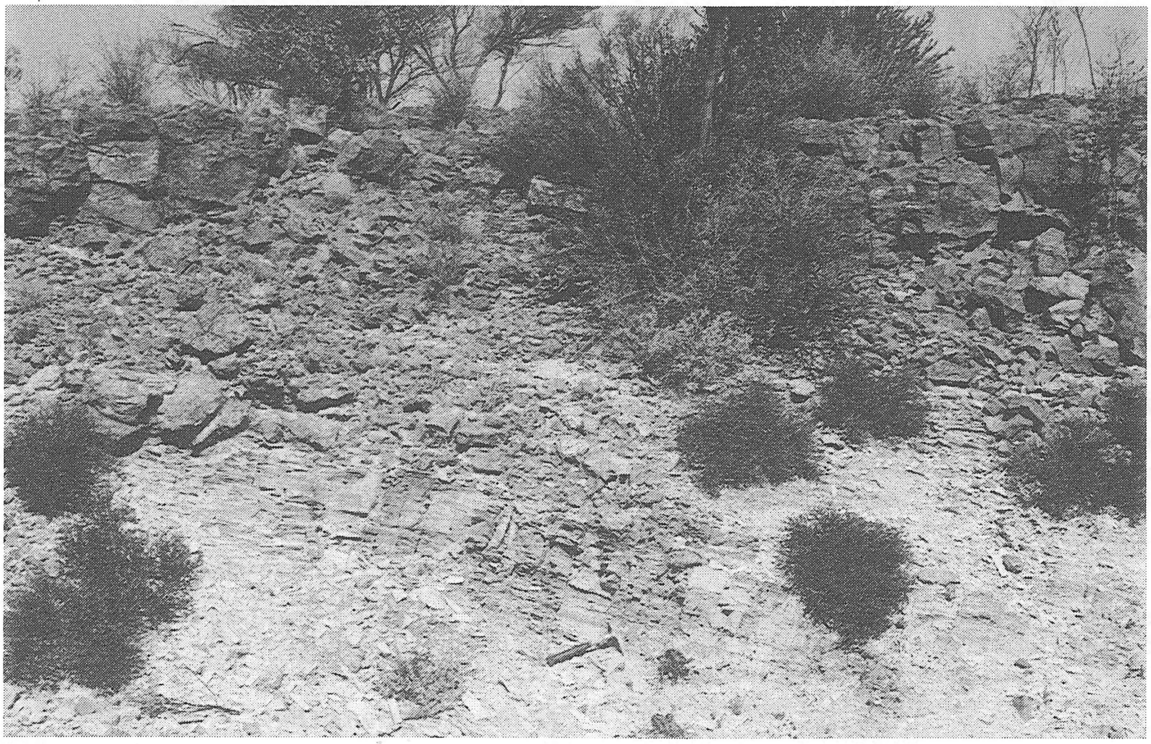

Figure 8. Low-angle unconformity between Proterozoic siltstone dipping gently right (below) and horizontal conglomerate and sandstone of Paterson Formation (above). AMG 876048. Hammer 35 cm long.

oolitic texture has been destroyed, and the rock consists wholly of microcrystalline quartz. A thin-sectioned sample (94968011, AMG 880017) consists of oolites ranging from multicrystalline aggregates of chert to large single grains of quartz to grains of cryptocrystalline silica. Some oolites are hollow, with chalcedonic crusts lining the hollow followed by clear single-crystal quartz on one and the same side of each hollow in the thin section. Red-brown amorphous iron oxide forms rings inside oolites, and coats the outside of some. Cement between the oolites is very fine-grained cryptocrystalline quartz partly crystallised to polygonal mosaic patches, and very fine-grained red-brown amorphous iron oxide dust.

Stromatolitic dolostone (Pl)

This unit was not observed during the 1994 survey, but according to Bunting & Chin (1979), it is a 5 m-thick lens characterised by the stromatolite form *Tarioufetia yilgarnia*.

Siltstone (Pa)

Siltstone (about 25 m thick) is white, grey, red, or yellow, very fine to fine-grained, laminated, compact, and composed mostly of angular clastic quartz, rare detrital muscovite, and accessory minerals such as monazite, zircon and rutile, in a matrix of clay. The siltstone is commonly folded (open to close) about gently plunging axes.

Structure

The Proterozoic sedimentary rocks are bounded by the nonconformity at their base, or by normal faults of small throw. Dips are almost everywhere horizontal to very gentle. Anomalous bedding attitudes in places – such as a dip of 60° SW in the northwest of DE LA POER and a northerly striking outcrop 9 km to the east of there – are probably the result of tilting beside these faults. The Proterozoic sediments are too thin to mask the strong magnetic anomalies and trends in the underlying Archaean basement below.

Palaeozoic geology

Permian

Flat-lying siltstone, sandstone and claystone, commonly boulder-bearing (Fig. 7), are assigned to the Permian Paterson Formation of the Officer Basin in view of their probable glacial origin (Bunting & Chin, 1979). The sediments unconformably overlie Archaean and Palaeoproterozoic rocks (Fig. 8). The sediments are everywhere heavily weathered and kaolinised, and vary widely in character and sequence. Sorting is poor, and the basal unconformity is irregular; in places the sediments have been deposited in steep-sided hollows about 1 m deep (Fig. 9). Sandstone and siltstone (PAf) are the most abundant rock types in DE LA POER; claystone (PAl) is abundant in the northwest of URAREY. Maximum total thickness is about 14 m. Figure 10 portrays various well exposed sections through the Paterson Formation in DE LA POER.

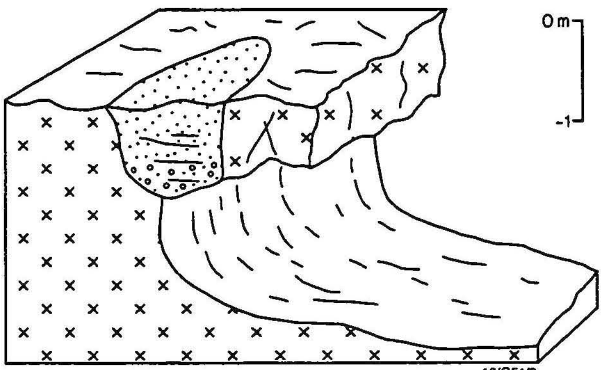

Figure 9. Perspective sketch of pebbly sandstone (dots) of Paterson Formation in 1 m-deep steep-sided hollow in heavily weathered granite (crosses). AMG 725844.

Sandstone and siltstone (PAf)

Sandstone low in the sequence is typically coarse-grained and pebbly, thin to medium-bedded, friable, massive to low-angle trough cross-bedded, and poorly sorted; grains are angular and fine upwards. Higher up, the sandstone is better sorted, medium to fine-grained, thick-bedded and horizontally stratified. Siltstone is generally thick to very thick-bedded, friable, and massive. Clasts range from pebbles to boulders, are generally subangular to angular (Fig. 11), and characteristically the larger ones have some concave faces; rock types include quartzite, vein quartz, feldspathic sandstone, hematitic oolitic sandstone, shale, and granite.

A thin-sectioned sandstone sample (94968029, AMG 670030) comprises subangular to well-rounded quartz grains, some with concavities, in a matrix of fine angular chips and slivers of quartz. Secondary cement consists of laths of subhedral prismatic quartz, concentrically zoned masses of spherulitic chalcedony which intrudes and splits clastic grains, and red-brown amorphous iron oxide lining cavities.

At AMG 886066, cobble and boulder-bearing sandstone unconformably overlies Palaeoproterozoic siltstone. The siltstone is gently dipping at the base of the exposure, but becomes progressively more folded upwards, being tightly folded immediately below the overlying sandstone (Fig. 12). The contortions may be the result of glacial drag.

Claystone (PAl)

Claystone is found mainly in the north of URAREY. It is white or purple, massive, and grades into siltstone. At AMG 264068 it surrounds a ridge of steeply dipping Archaean chert, which appears to have formed an island in a Permian lake.

Conglomerate, sandstone, and siltstone (PAg)

Conglomerate, sandstone, and siltstone are exposed in the far west of URAREY at AMG 010840

Structure

Outliers of Paterson Formation are distributed seemingly at random across the area. The base of the formation at some localities is several metres below the top of weathered granite only a few hundred metres away, indicating an undulating unconformity.

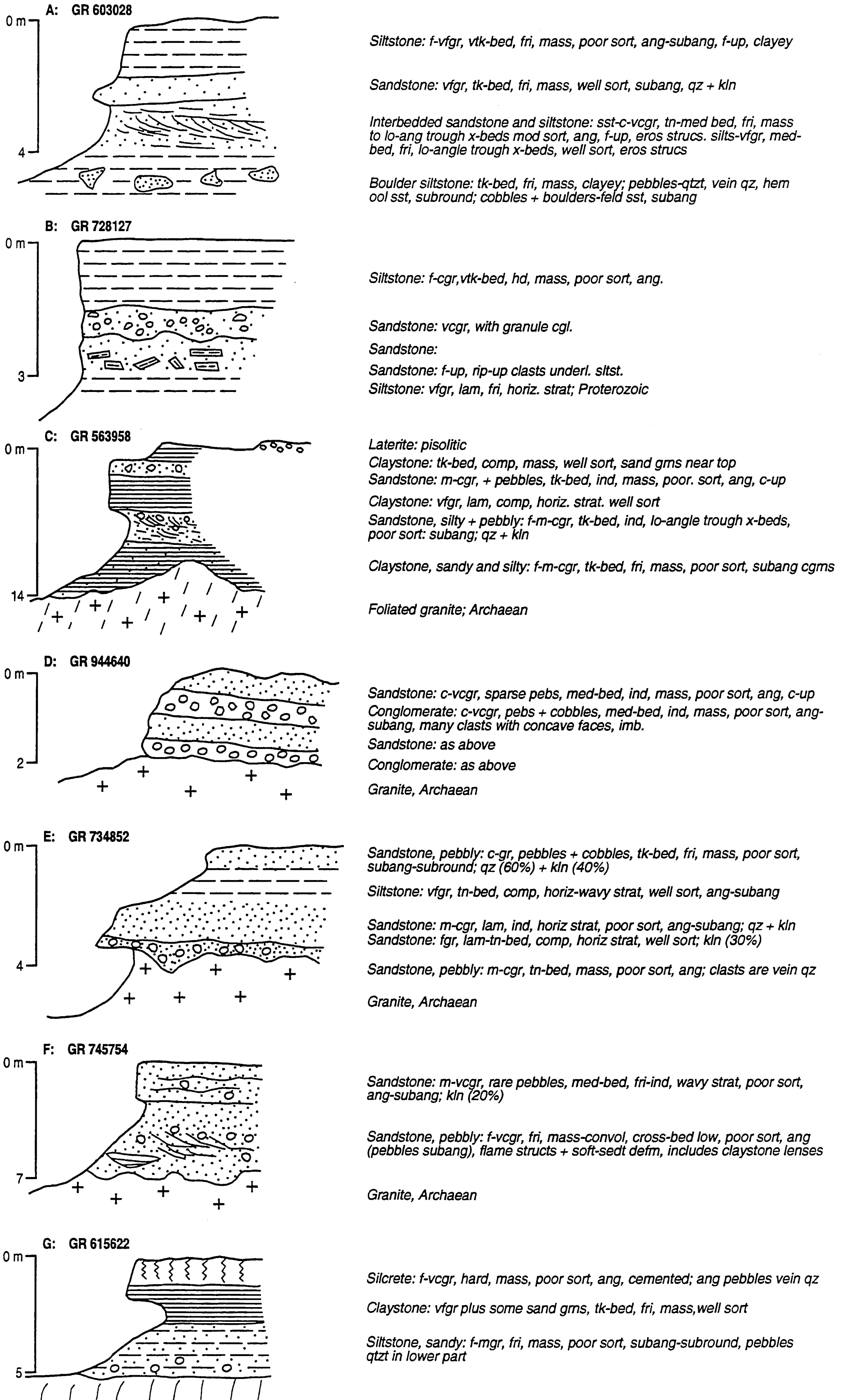

Figure 10. Field sketches of breakaway exposures of Paterson Formation, DE LA POER. (a) 17.5 km east-southeast of Deleta homestead. (b) 28 km east of Deleta homestead. (c) 18 km southeast of Deleta homestead. (d) 19 km southeast of Karo Soak. (e) 6 km south of Mount Gerard. (f) 4 km northwest of Karo Soak. (g) 20 km southwest of Karo Soak. Abbreviations are as follows:

ang angular	**bed bedded**	**c coarse**
c-up coarsens upwards	**comp compact**	**congl conglomerate**
convol convoluted	**defm deformation**	**eros erosive**
f fine	**f-up fines upwards**	**feld feldspathic**
fri friable	**gr grained**	**grns grains**
hd hard	**hem hematite**	**horiz horizontal**
imb imbricated	**ind indurated**	**kln kaolin**
lam laminated	**lo low**	**mass massive**
med medium	**mod moderately**	**ool oolitic**
pebs pebbles	**poor poorly**	**qtzte quartzite**
qz quartz	**round rounded**	**sdst sandstone**
sedt sediment	**silts siltstone**	**sort sorted**
strat stratification	**strucs structures**	**tk thick**
tn thin	**underly underlying**	**v very**
X cross		

Cainozoic geology

Cainozoic deposits cover about 90 percent of the area. Relationships of the units are shown in Figure 13. Lateritic duricrust (Czl) is most extensive in northern and southern URAREY, where it forms low hills and breakaways on greenstone, together with rare patches of silcrete on ultramafic rock (Czu). Silcrete (Czz, Czzg) is most abundant in the centre and southwest of DE LA POER, and overlies kaolinised granite. In several places, heavily weathered and silicified granite surrounds cauldron-sized hollows filled with ferricrete pisoliths (eg. at AMG 615600; Fig. 14a, b). All these units are remnants of an extensive peneplain of presumably Tertiary age. Related units of somewhat younger age are: pebbly colluvium and alluvium (Czf) forming aprons around laterite hills and breakaways; pebbly colluvium and gravel (Czc) derived from hills and rises of granite, gneiss, and sedimentary rocks of Proterozoic and Permian age; colluvial sand and gravel (Czg) derived from underlying granite and gneiss, mostly in the southeast of DE LA POER; and quartz-rich talus (Czq) flanking vein quartz ridges. The pebbly deposits grade outwards from their source areas to extensive sheets of sand, silt, and clay (Cza); this unit also surrounds many granite rises where pebbly colluvium is absent. Sand plain and dunes (Czs) are the most extensive unit in the area; clay and silt (Cza) occupy numerous isolated low areas in the sand plain. Calcrete (Czk) has been deposited from groundwater in low-lying areas near Deleta homestead, in the Urarey Well – Quongdong Well area in the southeast of URAREY, and on the northern side of Lake Wells in the east of DE LA POER. Lake Wells itself is the site of extensive deposits of evaporites, sand and clay (Czp) in playas, separated by quartz and gypsum dunes (Czd) and bordered by silt, sand and gravel in halophyte flats (Czh), or by clay, sand and minor dunes (Czb).

Alluvium (Qa) is being transported and deposited in present-day stream channels. Claypans (Qac) are commonest in the northeast of DE LA POER, and are part of a drainage system that flows southeast towards Lake Wells.

Economic geology

There has been no gold production from DE LA POER or URAREY. Nevertheless, the existence of Archaean greenstone and granite, major faults, and fractures suggests there is some potential for gold. The metamorphic facies of the greenstone belts is at or just below the greenschist-amphibolite transition, so they have potential for epigenetic gold lodes hosted in breccias, vein arrays, and shear zones (Groves et al. 1995).

Breccia-type lodes are a possibility in the Gerry Well greenstone belt, where chlorite in mafic rocks could be indicative of a very low-grade environment. No faults where breccias could be sought are visible on the ground, however, owing to poor exposure. A fault interpreted from aeromagnetic data strikes north through the belt, and a similarly interpreted fracture strikes northwest through the southern part of the belt. Both these areas could warrant investigation for breccias (site 1, Fig. 6).

Shear zone deposits in stockworks or parallel sets of quartz veins accompanied by alteration zones are possible in competent rocks in the area. Sinusoidal bending of the two parts of the Deleta greenstone belt along the De La Poer Fault demonstrates significant shear along the fault. Bending of relatively competent banded iron formation in the southern portion of the belt during shear along the fault could have allowed the emplacement of quartz vein stockworks (sites 2 and 3, Fig. 6). The aeromagnetic data indicate that similar folded rock types make up the northern portion of the belt, 30 km to the northwest, and so this area, too, has potential for auriferous stockworks.

The stress field inferred from slip directions on faults and lineaments during the late Archaean can be used to predict sites of low mean stress where fluid flow and hence gold deposition could have been enhanced (Groves et al. 1995). Possible sites in northern Duketon are:

- granite in the concave regions of the Deleta greenstone belt (both portions, sites 4 and 5) and of the unnamed greenstone belt in the west (site 6). These belts are folded, and the granite in the hinge regions could have acted as relatively rigid bodies, which deflected the stress field and produced regions of low mean stress.
- a dyke-filled fracture in the southwest (site 7), which appears to be sinistrally offset by several kilometres along an east-southeast-striking fault. The jog so formed could have dilated during later movement along the fracture containing the dyke, and focused ore-fluid flow.

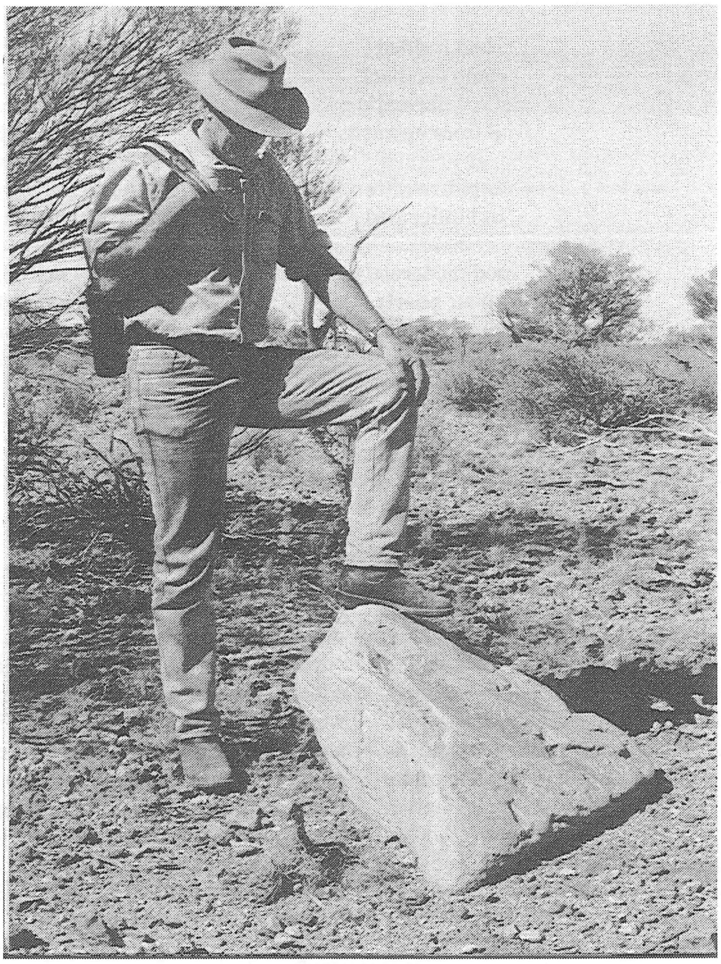

Figure 11. Subangular boulder of Proterozoic feldspathic sandstone exposed on surface of weathered sandstone of Paterson Formation. AMG 886066.

Figure 12. Tight fold (glacial drag?) in Proterozoic siltstone below Permian Paterson Formation. AMG 886066.

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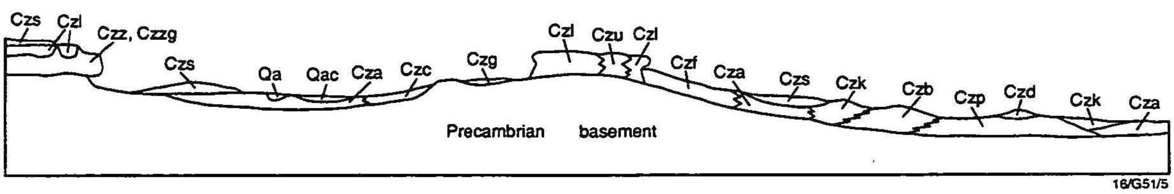

Figure 13. Cainozoic rock unit relationships. Letter codes as in DE LA POER and URAREY map legends.

Figure 14a. Partly eroded 'cauldron' of weathered and silicified granite – the upstanding masses to left, top, and right – containing ferricrete pisoliths (centre). AMG 555790. Scale 15 cm long.

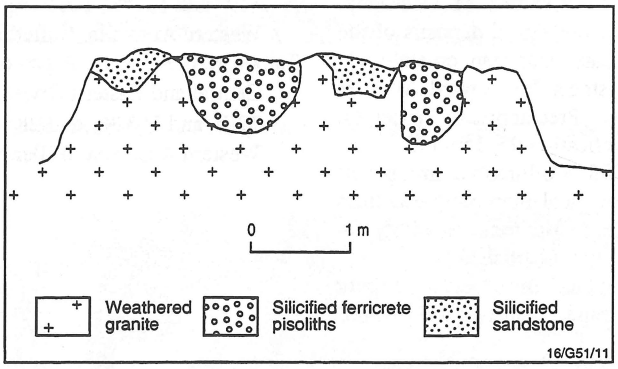

Figure 14b. Sketch of weathered granite exposure at same locality showing 'cauldrons' of siliceous ferricrete pisoliths. Granite is weathered to pisolitic silcrete containing quartz grains. Two hollows containing silicified sandstone also shown.