EXPLANATORY NOTES

GOVERNMENT OF WESTERN AUSTRALIA

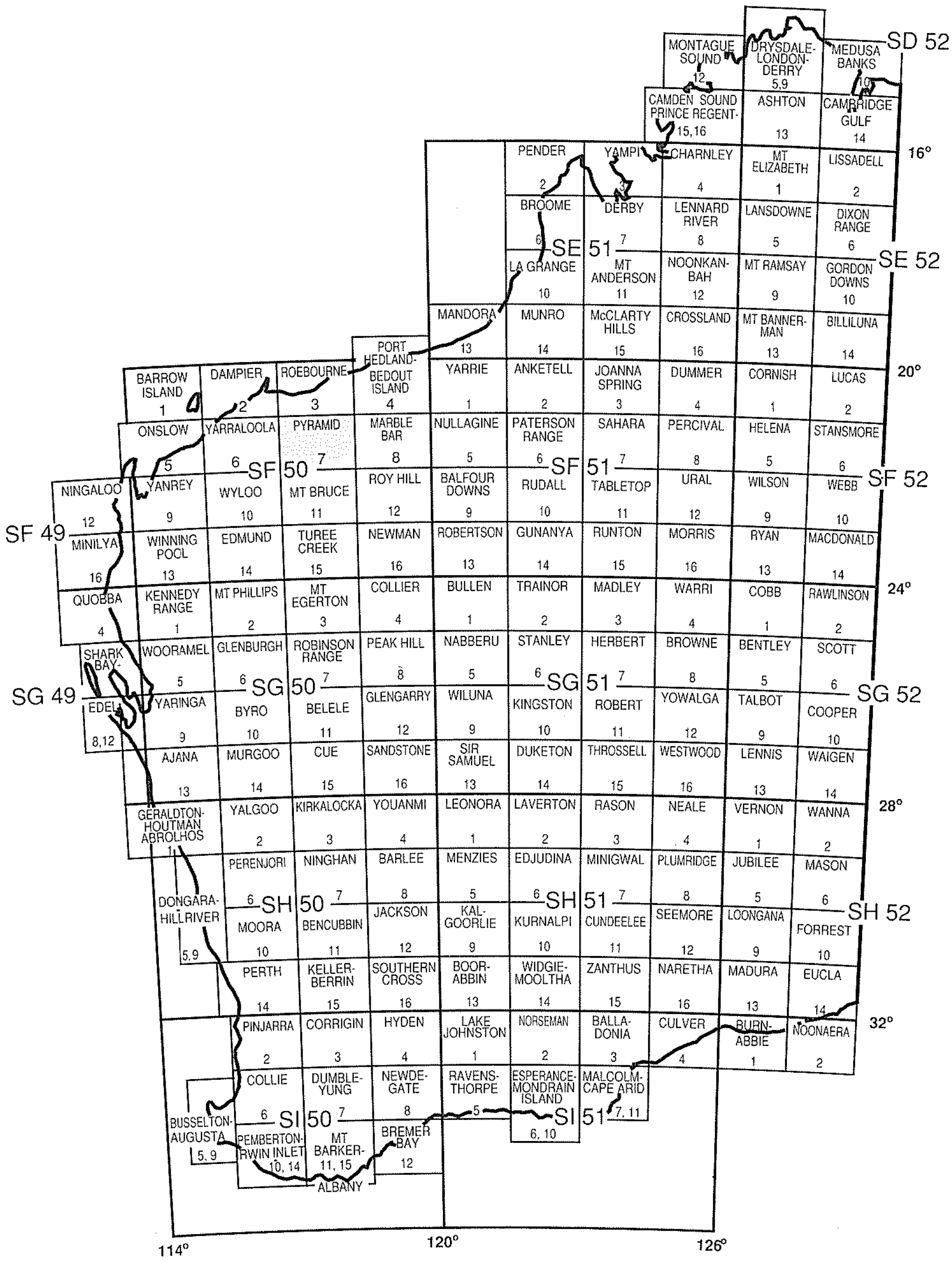
GEOLOGY OF THE MOUNT WOHLER 1:100 000 SHEET

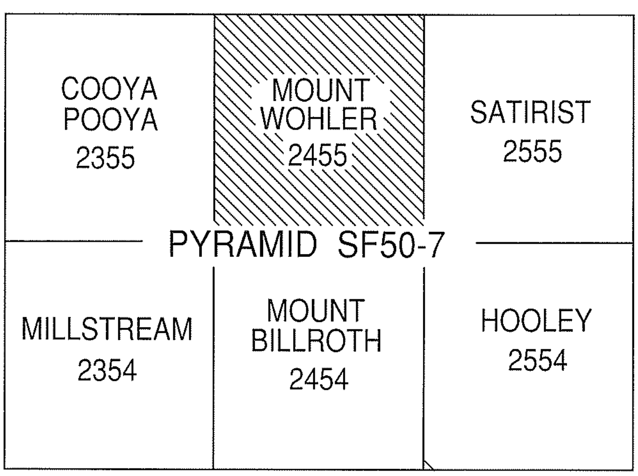
by R. H. Smithies

1:100 000 GEOLOGICAL SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

DEPARTMENT OF MINERALS AND ENERGY





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GEOLOGY OF THE MOUNT WOHLER 1:100 000 SHEET

by
R. H. Smithies

Perth 1998

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Cover photograph:
View from chert ridge at Nunyerry Gap looking north-northeast.

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Geology of the Mount Wohler 1:100 000 sheet

by

R.H. Smithies

Abstract

The MOUNT WOHLER 1:100 000 sheet lies in the northwestern part of the Archaean Pilbara Craton and contains rocks assigned to the Pilbara granite–greenstone terrane that are unconformably overlain by much less deformed rocks of the late Archaean Fortescue Group of the Hamersley Basin.

Rocks of the Whim Creek Group outcrop immediately north of MOUNT WOHLER and were previously thought to comprise the youngest units of the Pilbara Supergroup. Clastic sedimentary rocks of the De Grey Group dominate the supergroup on MOUNT WOHLER and recent geochronology has shown that these sedimentary rocks were deposited at the same time (~3000 Ma) as the Whim Creek Group. Locally, the De Grey Group is subdivided into the Constantine Sandstone (coarse- to fine-grained litharenite, subarkose, wacke, and shale) and the overlying Mallina Formation (medium- to fine-grained wacke and shale). In the southern part of the sheet area, boulder conglomerates overlying a banded chert unit mark the base of the De Grey Group. A series of mafic, ultramafic, and layered mafic to ultramafic sills intruded the De Grey Group dominantly near the top of the Constantine Sandstone prior to folding. Four folding events have resulted in large-scale and typically north-trending folds and interference fold structures. Deformation, producing northerly structural trends occurred before intrusion of granodiorite dated at c. 2950 Ma. Northeasterly trending structures, which are also prominent in the Whim Creek Group, developed in that granodiorite, but not in granitoid rocks dated at c. 2940 Ma.

No major mines have been developed on MOUNT WOHLER, although gold mineralization lies within tightly folded outcrop of the Mallina Formation (in the northwest of the sheet area) and small-scale copper mining took place at Croydon. The copper mineralization is located along the contact between shales of the Constantine Sandstone and a mafic–ultramafic sill, in the core of the major, north-trending Croydon Anticline. The present stratigraphic interpretation correlates this horizon with that hosting important base-metal mineralization at Whim Creek.

KEYWORDS: Archaean, Pilbara Craton, regional geology, Whim Creek Group, Mallina Formation

Introduction

The MOUNT WOHLER* 1:100 000 geological sheet (SF50-7, 2455) is bounded by latitudes 21°00' and 21°30'S and longitudes 117°30' and 118°00'E (Fig. 1), and lies in the West Pilbara Mineral Field (Fig. 1). MOUNT WOHLER occupies the central-north part of the PYRAMID (1:250 000) sheet in the western Pilbara region.

The northeast half of MOUNT WOHLER forms part of the granite–greenstone succession of the Archaean Pilbara Craton. Three distinct granitoid bodies are recognized, all of which intrude the greenstones, and the areal extent of outcrop of the granitoid rocks and greenstones is roughly equal. The greenstones are assigned to the Pilbara Supergroup (Hickman, 1983). The southwestern part of the Whim Creek Belt (Hickman, 1977) extends southward from SHERLOCK onto the northwest corner of MOUNT WOHLER, where mafic and ultramafic rocks of the Louden and Mount Negri Volcanics form the youngest component of the local greenstone succession. Outcrop at Nunyerry Gap in the southeast of the sheet area, provides the most southerly exposure of rocks of the granite–greenstone succession of the Pilbara Craton. The greenstone sequence between the Whim Creek Belt and ferruginous chert at Nunyerry Gap, in the southeast of MOUNT WOHLER consists predominantly of fine- and coarse-grained clastic rocks of the Mallina Formation and the Constantine Sandstone, together with mafic to ultramafic schist derived from intrusive sills and dykes. The oldest greenstones on MOUNT WOHLER are c. 3015 Ma felsic volcaniclastic

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

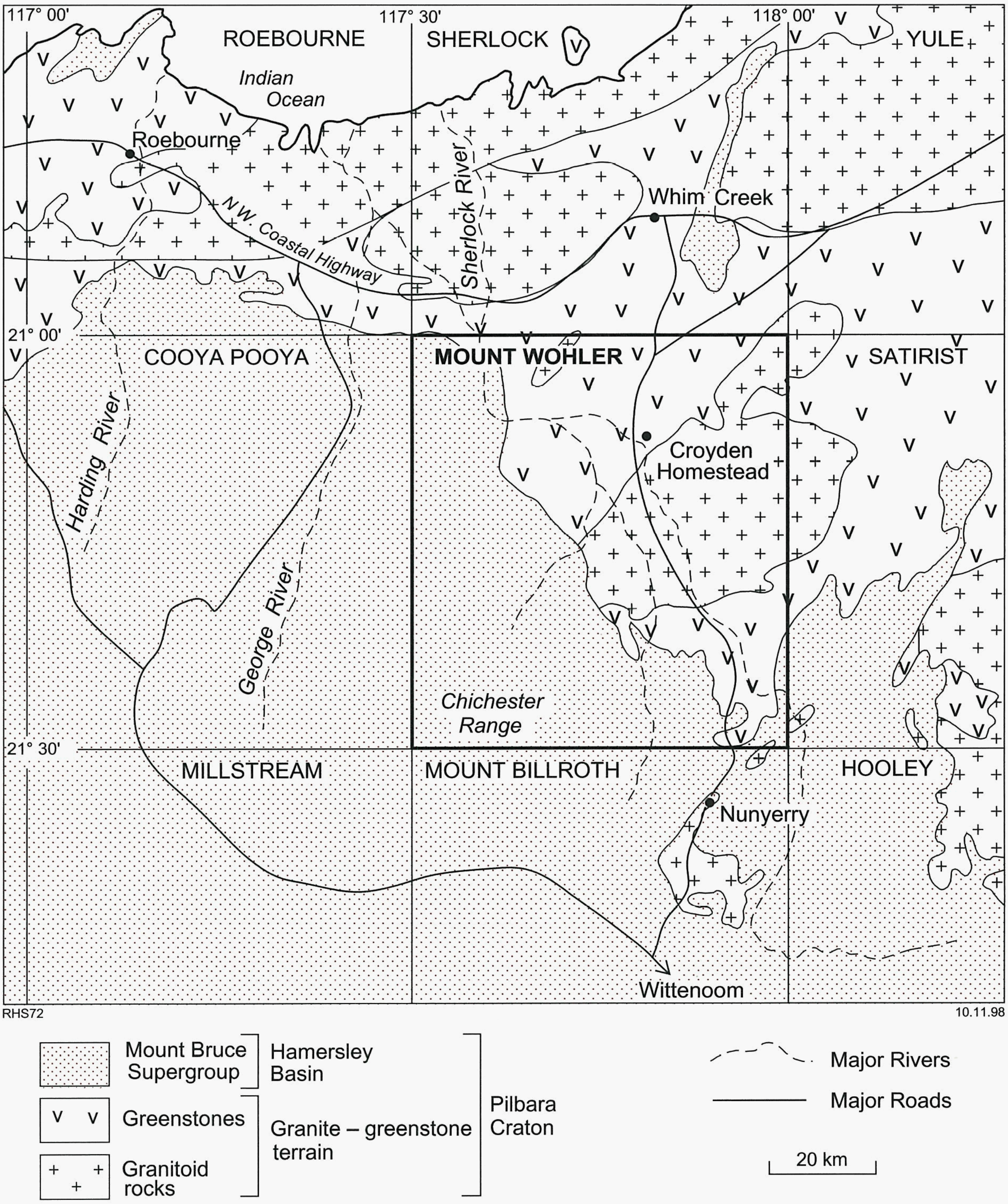


Figure 1. Location of MOUNT WOHLER within the western part of the Pilbara Craton, showing main geological divisions

rocks (Nelson, 1998) that underlie ferruginous chert at Nunyerry Gap.

The volcano-sedimentary sequences (Fortescue Group) of the 2770–2300 Ma Hamersley Basin (Arndt et al., 1991) dominate the southern half of MOUNT WOHLER. These rocks dip gently to the southwest, exposing almost all of the stratigraphy of the Fortescue Group within MOUNT WOHLER.

Access and landuse

Access to MOUNT WOHLER is provided by the road linking Nunyerry to the south and Whim Creek to the north (Fig. 1). This road intersects the North West Coastal Highway approximately 1.5 km to the east of Whim Creek, and intersects the Roebourne–Wittenoom road approximately 90 km northwest of Wittenoom. The abandoned Croydon Homestead lies on MOUNT WOHLER, along the Nunyerry–Whim Creek road, approximately 37 km south of the North West Coastal Highway.

There is no permanent habitation on MOUNT WOHLER. Much of the southwestern part of the sheet area is a rugged, dissected plateau that forms the northeastern part of the Chichester Range, which falls within the Millstream–Chichester National Park. The majority of the remaining area belongs to Croydon Station, except the extreme northeast, which belongs to Mallina Station, and the area to the west of the Sherlock River, which belongs to Pyramid Station. Grazing is the primary agricultural activity on all three stations.

There are no active mines on MOUNT WOHLER, although minor amounts of gold were extracted from the area around, and to the southwest of, Croydon Top Camp in the northwest of the sheet area. Antimony was extracted from workings on the east bank of the Sherlock River, in the northwest corner of the sheet area, and copper was mined from the Evelyn and Quamby deposits, approximately 5 km northeast of Croydon Homestead.

Physiography

The northwesterly flowing Sherlock River is the only large drainage system on MOUNT WOHLER (Fig. 2). River flow typically occurs during the summer wet-season. Numerous major tributaries form northeasterly trending gorges through the Chichester Range. In central MOUNT WOHLER, the Sherlock River and its tributaries form a broad floodplain up to 13 km wide.

Physiographic divisions on MOUNT WOHLER closely coincide with major geological divisions. Rocks of the Fortescue Group, in the southwestern half of the sheet area, form a prominent land surface ('plateau and dissected plateau'; Fig. 2) ranging in elevation between about 260 and 320 m above sea level; representing a Tertiary peneplain referred to by Campana et al. (1964) as the 'Hamersley Surface'. The Pilbara granite–greenstone terrane outcrops as the 'range' and 'low hills' divisions on Figure 2.

Previous investigations

Ryan and Kriewaldt (1964) suggested that the volcano-sedimentary stratigraphy of the west Pilbara Craton developed as a single subsiding trough in which clastic material was derived from essentially contemporaneous stable volcanic margins. The northwestern margin lay in the Mons Cupri – Roebourne region (SHERLOCK, ROEBOURNE) whereas the Teichmans region (SATIRIST) represented the southeastern margin. The entire volcano-sedimentary sequence was defined as the Roebourne Group, and appears as such on PYRAMID (1:250 000). The group was correlated with the 'Warrawoona succession' of the east Pilbara.

Further mapping in the western Pilbara region (Fitton et al., 1975) led to a major revision of the stratigraphy. The felsic to intermediate volcano-sedimentary rocks on SHERLOCK were shown to lie unconformably on the 'Warrawoona succession', and were redefined as the Whim Creek Group. An unconformity was also recognized between the group and overlying voluminous basalts and high-Mg basalts — the Mount Negri and Louden Volcanics defined by Hickman (1990).

A thick but poorly outcropping sequence of slate and fine- to coarse-grained sandstone, immediately south of the Whim Creek Belt, was called the Mallina Formation. An underlying sandstone was called the Constantine Sandstone (Fitton et al., 1975), and both were correlated with the Whim Creek Group.

Hickman (1977, 1983) has remapped the Whim Creek area. He suggested that the Mallina Formation and the Constantine Sandstone were older than the Whim Creek Group and placed them in the Gorge Creek Group, which lies between the redefined Whim Creek Group and the Warrawoona Group. Subsequent studies (Krapez, 1984; Horwitz and Guj, 1986) confirmed earlier suggestions (Fitton et al., 1975) of a regional unconformity within the Gorge Creek Group, leading Hickman (1990) to relocate the Mallina Formation and the Constantine Sandstone into the newly defined De Grey Group. However, recent geochronological studies have shown that the Whim Creek Group was deposited at c. 3010 Ma, earlier than or synchronous with deposition of the c. 3000 Ma Mallina Formation (Nelson, 1997 and in press), supporting earlier stratigraphic correlations between the Constantine Sandstone and the Cistern Formation of the Whim Creek Group (Fitton et al., 1975; Horwitz, 1990).

Regional geological setting

The Pilbara Craton is the oldest exposed major crustal element of Australia. The Archaean rocks can be divided into two components (Fig. 3): a granite–greenstone terrain that formed between c. 3600 and c. 2800 Ma (Barley, 1997), and the unconformably overlying volcano-sedimentary sequences (Mount Bruce Supergroup) of the 2770–2300 Ma Hamersley Basin (Arndt et al., 1991). The granite–greenstone terrain is exposed mainly in the north and northeast, where erosion has removed all but local remnants of the Mount Bruce Supergroup.

The granite–greenstone terrain of the Pilbara Craton consists of large granitoid–gneiss complexes partially surrounded by belts of tightly folded and near-vertically dipping volcanic and sedimentary rocks that are typically metamorphosed to greenschist facies. Based on correlations between well exposed rock successions in the eastern part of the craton and lithologically similar sequences in the western part (Fitton et al., 1975; Hickman, 1983), the greenstones were collectively assigned to the Pilbara Supergroup by Hickman (1983). Four lithostratigraphic groups were defined, recording c. 600 Ma of greenstone evolution. From oldest to youngest, these include the predominantly mafic and ultramafic volcanic rocks of the Warrawoona Group, and the predominantly sedimentary and felsic volcanic rocks of the Gorge Creek, De Grey, and Whim Creek

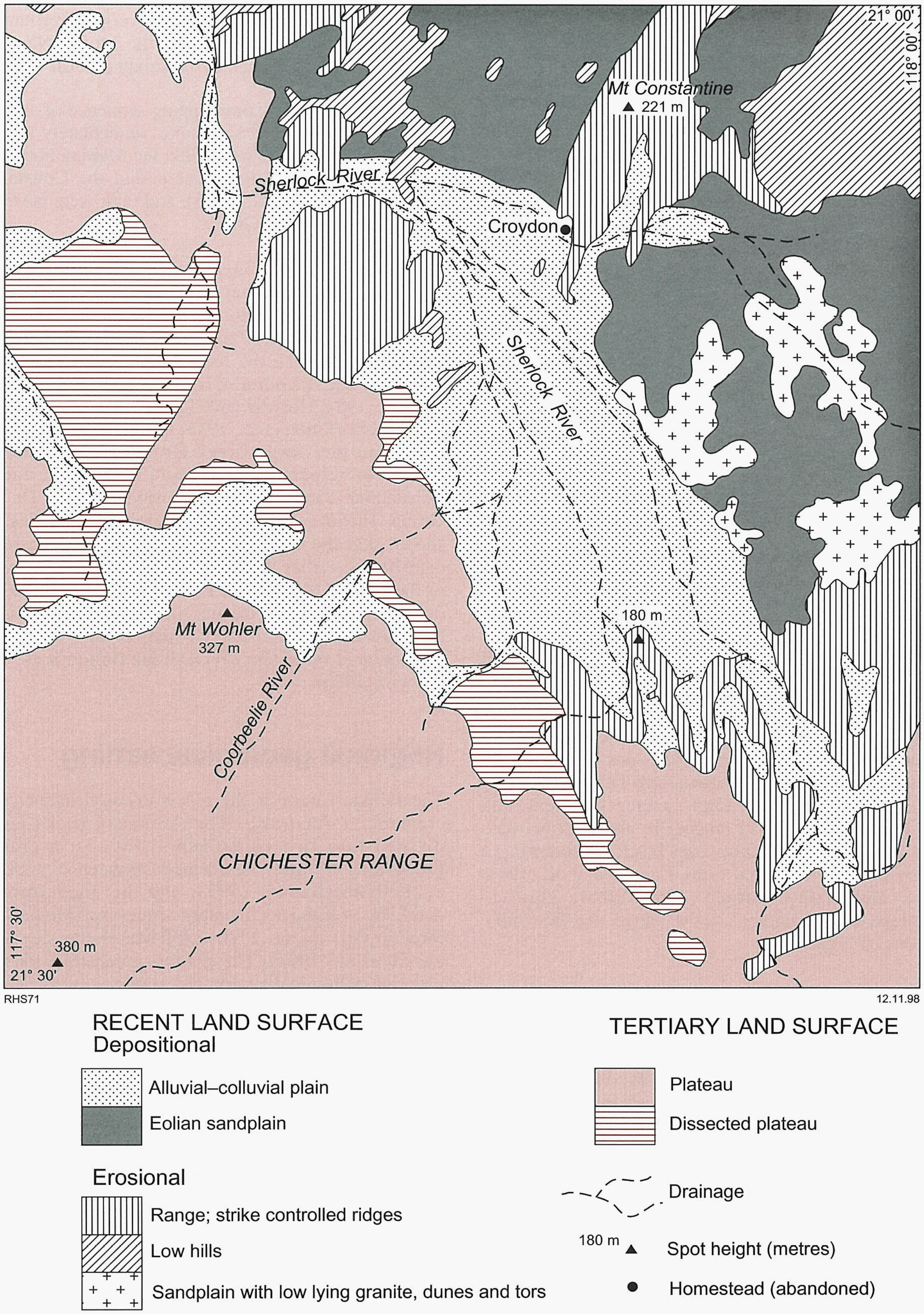


Figure 2. Physiographical features of Mount Wohler

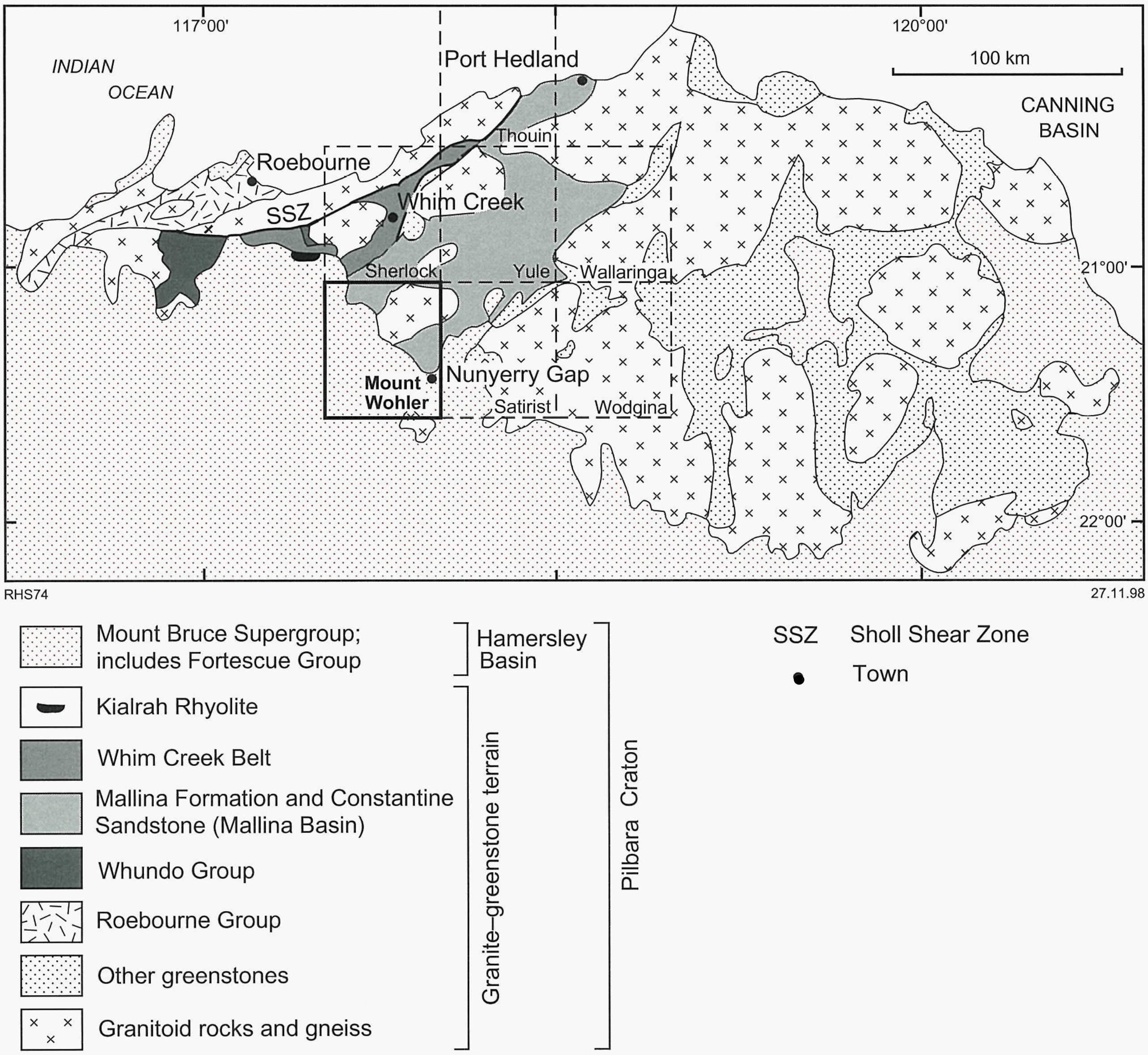


Figure 3. Regional geology of the Pilbara Craton

Groups. The validity of these craton-scale correlations has been questioned (e.g. Krapez, 1993; Barley et al., 1994; Hickman, in press). The Warrawoona Group now appears to be restricted in outcrop to the east Pilbara Craton, and Krapez (1993) considered that the major banded iron-formation (BIF) horizon in the Gorge Creek Group could not be correlated across the craton. Recent mapping and Sensitive High-Resolution Ion Microprobe (SHRIMP) U–Pb dating have led to major revisions of the stratigraphy of the western part of the Pilbara Craton (Hickman, in press; Smithies et al., in press). Most pertinent to the present study is the geochronological evidence that the Whim Creek Group pre-dates deposition of the upper part (at least) of the De Grey Group (Nelson, 1997, 1998). For descriptions of the regional geology of the Pilbara granite–greenstone terrane, see Hickman (1983, 1990) and Krapez (1993), whereas Thorne (1990) and Blake (1993) provide detailed descriptions of the Fortescue Group.

Archaean geology

The geology of MOUNT WOHLER is summarized in Figure 4, and the stratigraphy of the Pilbara Supergroup and Fortescue Group on MOUNT WOHLER is given in Table 1.

Although all of the rocks of the Pilbara granite–greenstone terrain on MOUNT WOHLER have been metamorphosed, most retain primary textures and accordingly the rocks are described according to their inferred protolith (for brevity the prefix 'meta' is omitted).

Table 1. Stratigraphic relationships on Mount Wohler

Formation/unit	*Group*	*Age (Ma)*	*Contact*	*Intrusions*
				Powereena Dyke
Maddina Formation		c. 2717		
Tumbiana Formation				
Kylena Formation	Fortescue Group			
Hardey Formation				Cooya Pooya Dolerite
Mount Roe Basalt				Tourmaline leucogranite (c. 2765 Ma)
~ ~ ~ ~ ~ ~ ~	~ ~ ~ ~ ~ ~ ~	~ ~ ~ ~ ~ ~ ~	*unconformity*~	~ ~ ~ ~ ~ ~ ~
Mount Negri Volcanics				
			local unconformity	Peawah Granodiorite,
				Satirist Granite (c.2950–2930 Ma)
				Plagioclase porphyry intrusions, gabbro sill
			?faulted	Millindinna Intrusion
Louden Volcanics		c. 2970–3010 Ma		
Mallina Formation	De Grey Group	<c. 3000		
Constantine Sandstone		<c. 3015		
~ ~ ~ ~ ~ ~ ~	~ ~ ~ ~ ~ ~ ~	~ ~ ~ ~ ~ ~ ~	*unconformity*~	~ ~ ~ ~ ~ ~ ~
Chert, ferruginous chert		c. 3015		
Felsic volcaniclastic rock				

Where primary textures have been destroyed metamorphic rock names are used.

Unassigned units stratigraphically below the De Grey Group

Felsic volcaniclastic rock (*Afv*)

Felsic volcaniclastic rock, including volcanic sandstone and siltstone (*Afv*), underlies chert (*Ac*) at Nunyerry Gap. It is the oldest supracrustal rock unit identified on Mount Wohler, with a maximum age of c. 3015 Ma (Nelson, 1998), and contains massive beds of poorly sorted sandstone, up to 3 m thick, and graded beds that fine upwards from sandstone to laminated siltstone. Ripple marks are observed locally in the siltstones. The main constituents of the rock are angular to subrounded detrital fragments of very fine-grained, K-feldspar-rich felsic volcanic rocks, and minor angular grains of K-feldspar and quartz. Detrital components are cemented by chalcedony and a fine quartz mosaic. The unit does not appear to contain any coherent felsic volcanic facies, although a proximal source of rhyolite is inferred from the angular nature of the detrital grains. Contacts with the overlying chert are sharp, although slices of volcaniclastic rocks are locally faulted into the base of the chert unit.

Chert (*Ac*)

Chert (*Ac*), locally includes ferruginous chert, banded iron-formation (BIF), and shale, and forms a ridge up to 500 m wide at Nunyerry Gap. Alternating bands of grey and white chert up to 20 cm wide form the bulk of the rock. Some layers contain abundant dispersed magnetite and Fe-hyroxides, and in rare instances the rock shows a distinct centimetre-scale banding, characterized by alternating layers of white and red chert (jasper), or layers containing up to 70% magnetite (BIF). The unit contains layers of ferruginous chert up to 10 m thick. The chert unit is unconformably overlain by coarse-grained clastic rocks of the Constantine Sandstone.

De Grey Group

The De Grey Group on Mount Wohler includes the fine- to coarse-grained clastic rocks of the Constantine Sandstone (*ADc*) — exposed in the Croydon and Powereena Anticlines — and the overlying Mallina Formation (*ADm*), forming extensive outcrop west of the Croydon Anticline. Both formations are interpreted to be of turbiditic origin (Hickman, 1977; Eriksson, 1982; Barley, 1987; Horwitz, 1990). Also included within the De Grey Group are two minor, unassigned units (*ADhe* and *ADs*).

Unassigned units (*ADhe, ADs*)

Ferruginous shale, locally with abundant layers of white chert and subordinate layers of sandstone, BIF, and mafic schist (*ADhe*), is exposed in the cores of interference fold structures within the Powereena Anticline. The shale contains quartz, biotite, sericite, clay minerals, chlorite, and zoisite, and locally contains 1–2 cm-thick interbeds of poorly sorted, fine- to medium-grained sandstone containing quartz, biotite, feldspar, and chlorite. This unit underlies subarkose and shale units (*ADcq, ADch,* and *ADcs*) of the Constantine Sandstone but is interpreted here to overly the coarse-grained, proximal-fan, facies of the Constantine Sandstone (*ADco* and *ADca*) observed at Nunyerry Gap. The unassigned shale unit possibly represents an interchannel facies of an upper- to mid-fan environment, which, according to Eriksson (1982), is characterized by finely laminated shale with intercalated chemical sedimentary layers.

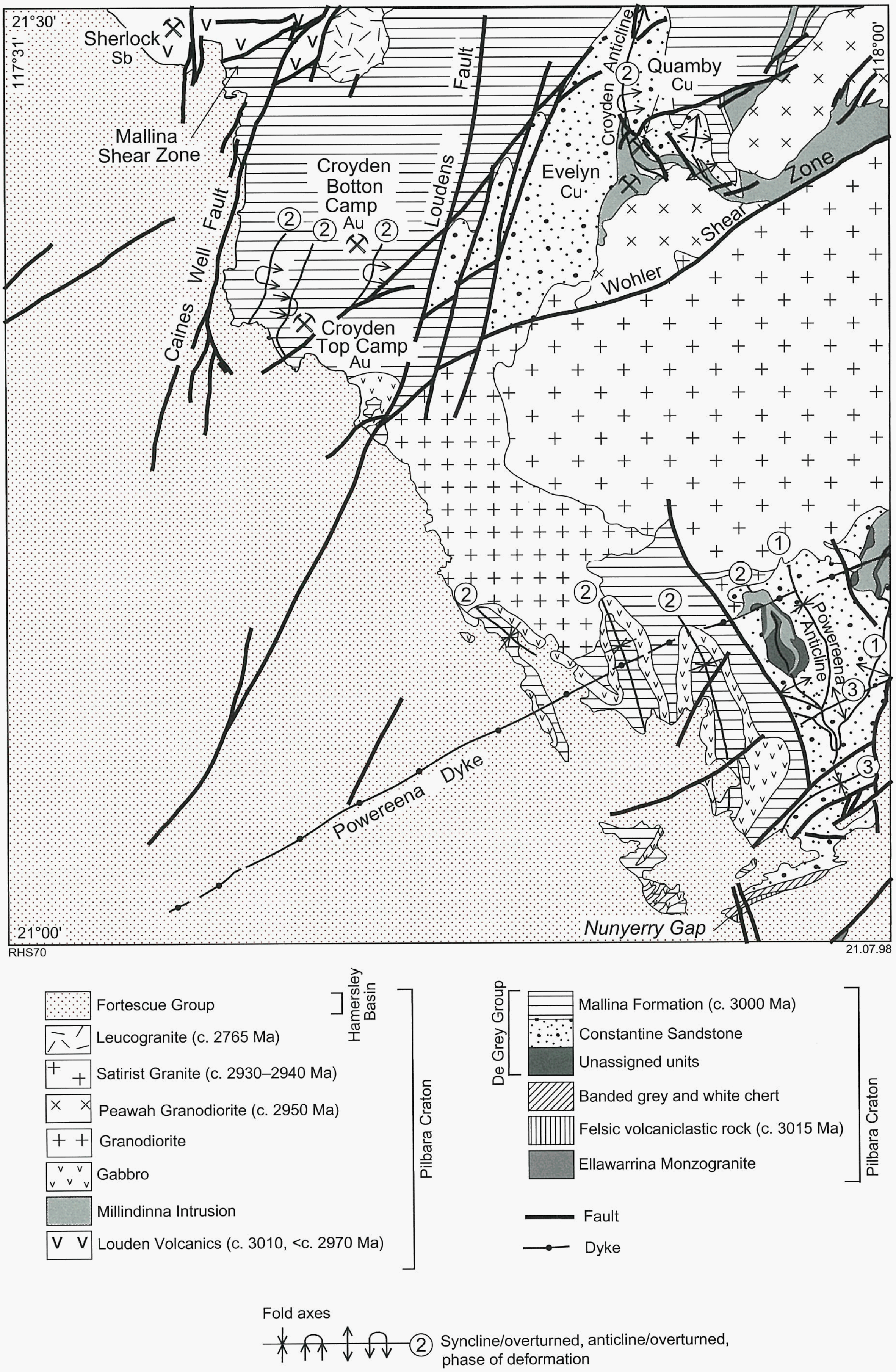


Figure 4. Solid geology interpretation of Mount Wohler. North-northeasterly and north-northwesterly faults are D_4 structures

Outcrop of the unassigned shale unit in the Powereena Anticline shows increasing degrees of contact metamorphism northwards, towards the granitoid rocks, where highly ferruginous rocks are transformed to para-amphibolite and shale is recrystallized into a quartz–biotite–garnet assemblage. Metamorphosed layers of highly ferruginous shale contain abundant garnet and actinolite, and minor biotite. Rare layers of banded iron-formation (?silicified and ferruginized shale) show a progression from quartz–garnet–actinolite to quartz–grunerite–garnet–actinolite assemblages with increasing metamorphic grade. Retrograde alteration of these assemblages is particularly pronounced along fractures, where it has produced abundant actinolite.

A unit containing abundant serpentine- and tremolite-rich schist, but dominated by fine-grained clastic rocks, with locally abundant 1–2 cm-thick interbeds of poorly sorted, fine- to medium-grained sandstone (*ADs*), forms mappable units in the northeast of the sheet area between the Peawah Granodiorite and the Satirist Granite. The clastic rocks have undergone various degrees of contact metamorphism. The resulting hornfels typically contains metamorphic garnet and biotite, but may also contain cordierite (now pinitized) and andalusite or sillimanite, and rocks along contacts with granitoid intrusions locally contain a granulite-facies assemblage of biotite–garnet–cordierite–orthopyroxene. The unit possibly belongs either to the Mallina Formation (*ADm*) or to the interbedded shale and poorly sorted, medium- to coarse-grained subarkose and wacke unit (*ADcs*) of the Constantine Sandstone. The associated medium-grained tremolite- and serpentine-rich schist represents tectonically interleaved slices of the mafic–ultramafic Millindinna Intrusion (see below).

Constantine Sandstone (*ADc, ADch, ADchi, ADcs, ADca, ADcq, ADcc*)

The rocks that comprise the Constantine Sandstone (Fitton et al., 1975) range from a conglomerate in the south (around Nunyerry Gap) to medium- to coarse-grained sandstone in the Powereena and Croydon anticlines. There are three rock-types unique to the Nunyerry Gap area: conglomerate (*ADco*), poorly sorted litharenite (*ADca*), and ferruginous shale and BIF (*ADchi*). These rocks mark the base of the De Grey Group and form an upward-fining, proximal, submarine-fan accumulation that grades northward into thick sequences of subarkose (*ADcq*), laminated shale (*ADch*), and interbedded subarkose, wacke, and shale (*ADcs*) that comprise the Constantine Sandstone elsewhere on MOUNT WOHLER. The section exposed at Nunyerry Gap has a maximum thickness of about 1.3 km, while the section exposed on the west limb of the Croydon Anticline reaches about 3.5 km in thickness.

Two types of conglomerate are found at Nunyerry Gap, which have been mapped together (*ADco*). A conglomerate containing randomly oriented (chaotic) subangular to angular blocks of chert, up to 2 m in diameter (Fig. 5), supported in a matrix of medium- to coarse-grained, poorly sorted litharenite, marks the unconformity with the underlying chert (*Ac*). The chert blocks are derived from the chert layer (*Ac*), and the lithic component of the matrix comprises chert and subordinate fragments of silicified komatiite. Overlying the chaotic conglomerate is a pebble-rich, coarse-grained, poorly sorted, litharenite that contains numerous lenses of polymictic conglomerate that are up to 800 m long and 150 m wide. The polymictic conglomerate contains subrounded cobbles of chert up to 20 cm in size, smaller pebbles of silicified komatiite, and rare pebbles of felsic volcaniclastic rock (*Afv*) petrographically similar to those that underlie the chert ridge. The matrix consists of medium- to coarse-grained, poorly sorted litharenite. The pebble-rich, coarse-grained, poorly sorted litharenite that encloses the conglomerate lenses is similar in composition to the matrix.

Poorly sorted litharenite (*ADca*) typically overlies the conglomerate (*ADco*). The litharenite is dominantly composed of well-graded beds, up to 2 m thick, that fine upward from medium-grained and pebble-rich sandstone to siltstone, but also includes massive units up to 2 m thick with rare trough cross-beds. This litharenite is identical to the poorly sorted litharenite that encloses the conglomerate lenses (*ADco*) and that forms the matrix of the conglomerate.

A layer of ferruginous shale (*ADchi*) up to 200 m thick is interbedded with the poorly sorted litharenite (*ADca*) near the top of the Constantine Sandstone at Nunyerry Gap. Approximately half the outcrop has been ferruginized to the extent that the rock is now BIF.

Poorly sorted, medium- to coarse-grained, subarkose (*ADcq*) forms the most prominent outcrops of the Constantine Sandstone north of Nunyerry Gap. In the Croydon Anticline, the subarkose forms a continuous unit that is mappable for over 30 km. Grains of quartz and minor feldspar are angular to subrounded, and typically supported by a matrix of quartz, sericite, chlorite, feldspar, and clay minerals. Fuchsitic and black chert fragments are common locally.

Well-laminated shale, including minor interbeds of poorly sorted subarkose (*ADch*), forms layers up to 300 m thick in the Croydon and Powereena Anticlines. The shale consists of fine-grained angular quartz, abundant chlorite and biotite, and minor sericitized plagioclase. Variations in the ratio of quartz to mica define a primary bedding lamination, whereas a preferred orientation of mica defines a slaty cleavage. Some layers are ferruginous and contain chlorite- and magnetite-rich laminations. Muscovite locally overprints the slaty cleavage and is a result of contact metamorphism. Quartz–biotite–cordierite–muscovite–garnet schists reflect the highest grades of contact metamorphism.

Interbedded shale and poorly sorted, medium- to coarse-grained subarkose and wacke (*ADcs*) forms layers up to 1 km thick in the Croydon and Powereena Anticlines, and at these localities forms the stratigraphic top of the Constantine Sandstone. The proportion of shale and wacke increases upwards towards a gradational contact with the Mallina Formation. The wacke contains angular to subrounded grains of quartz, plagioclase and perthitic K-feldspar, and abundant chert fragments, in a

Figure 5. Conglomerate unit within the basal portion of the Constantine Sandstone at Nunyerry Gap

chlorite-rich matrix containing sericite, clay minerals, and minor amounts of tourmaline.

The lower, coarse-grained, clastic sequence of the Constantine Sandstone (*ADco* and *ADca*) at Nunyerry Gap, shows many features in common with upper-fan channel deposits described by Eriksson (1982) from submarine-fan sequences elsewhere in the Pilbara Craton. The sequence grades upwards into rocks that are characteristic of the Constantine Sandstone elsewhere on MOUNT WOHLER, and which Eriksson (1982) interpreted as turbidite deposits that formed in a proximal lobe environment (e.g. *ADcq*), and deposits associated with progradation across a basin plain (*ADch*).

Mallina Formation (*ADm, ADmf*)

The Mallina Formation (*ADm*), originally named and defined by Fitton et al. (1975), comprises a succession of interbedded wacke and shale — considered to be turbiditic in origin (Hickman, 1977; Barley, 1987; Horwitz, 1990). It forms the bulk of outcrop of pre-Fortescue rocks to the west of the Croyden Anticline, overlies the Constantine Sandstone in the Croydon Anticline, and also lies in the southeast of the sheet area. Contacts between the Mallina Formation and the upper unit of the Constantine Sandstone (*ADcs*) appear to be conformable. Estimates of the maximum thickness of the Mallina Formation vary from 2.5 (Fitton et al., 1975) to 10 km (Miller, 1975), and a maximum depositional age of 2997 ± 20 Ma was inferred from detrital zircons in a sample of the Mallina Formation from SHERLOCK (Nelson, 1997).

Shale within the Mallina Formation is generally laminated and ferruginous. Angular silt-sized grains of chert and quartz are common whereas ?plagioclase (pseudomorphed by calcite) is rare. Clay minerals comprise the bulk of the groundmass, and are accompanied by abundant chlorite, sericite, quartz, and minor zoisite. There is a prominent slaty cleavage defined by the alignment of mica. The shale is strongly carbonated locally, and carbonate minerals overprint the slaty cleavage and may comprise up to 50% of some rocks.

The wacke component of the Mallina Formation ranges in grain size from sand to silt, and individual beds commonly fine upward. The rocks are commonly poorly sorted, and grains range from angular to subrounded. The abundance of quartz typically exceeds that of feldspar. Lithic fragments are abundant (particularly in the coarser grained rocks), and are dominantly composed of grey chert, although fragments of fine-grained and tuffaceous felsic volcanic rocks, shale, and basalt are also present. The matrix is rich in clay minerals and chlorite, with minor amounts of quartz, plagioclase, biotite, epidote, zoisite, and pyrite. The rocks are commonly iron stained, and some are strongly carbonated.

In the northwest of MOUNT WOHLER, sedimentary rocks of the Malina Formation outcrop in the contact aureole of a late granitoid intrusion, adjacent to the Loudens Fault. Contact metamorphism has produced biotite-rich rocks containing abundant rosettes of sillimanite, and less common porphyroblasts of cordierite. Close to the Peawah Granodiorite, the shale of the Mallina Formation also shows the effects of contact metamorphism, with highest grades represented by quartz–garnet–cordierite–sillimanite–biotite schists.

The Mallina Formation in the northeast of MOUNT WOHLER includes minor layers of feldspar(–hornblende) porphyry of andesitic composition, interbedded with shale and wacke (*ADmf*). The porphyry consists of subhedral to euhedral phenocrysts of hornblende (commonly rimmed by biotite) and plagioclase (up to 3 mm and 5 mm in size respectively), in a fine-grained groundmass of quartz and plagioclase. Hornblende is partially altered to chlorite and actinolite, whereas plagioclase and groundmass phases are partially altered to sericite, carbonate, chlorite, and epidote. Most layers of porphyry probably represent sills, although some may be of volcaniclastic rock.

Quartz arenite (*Asq*)

Coarse-grained quartz arenite (*Asq*) forms a small outcrop in the northwest of MOUNT WOHLER. It is tectonically interleaved with rocks of the Louden Volcanics and is bounded to the south by the Mallina Shear Zone. Similar rocks to the northeast, on SHERLOCK, mark the trace of the east-northeasterly trending Mallina Shear Zone. The rock is a moderately well sorted, grain-supported quartz arenite containing subrounded quartz grains, and clasts of black chert, in a matrix of quartz and clay minerals. Trough cross-bedding is locally well developed.

Louden Volcanics (*Ae, Ael, Aey, Aeb, Aet, Aem, Aeh, Aeo*)

The Louden Volcanics (*Ae*), first defined by Hickman (1977), is confined to the northwestern part of MOUNT WOHLER, north of the Loudens Fault. The unit is best developed on SHERLOCK, where it is up to 1.3 km thick and includes an upper unit of clastic rock. The Louden Volcanics overlies the c. 3010 Ma (Nelson, 1998) Whim Creek Group, which outcrops on SHERLOCK, and is overlain by the c. 2970 Ma (Nelson, 1998) Kialrah Rhyolite on ROEBOURNE.

Mafic- to ultramafic-rocks with a well-developed, coarse pyroxene spinifex-texture (*Aem*) are distinguished from those with fewer and randomly orientated acicular pyroxene phenocrysts (*Aeh*). Rocks with olivine spinifex texture are associated with the pyroxene spinifex-textured rocks, but form layers that are not sufficiently thick or continuous to be represented at map scale. Some rocks have been altered and sheared by movement along the Loudens Fault, and are now serpentine–chlorite schists (*Aet*).

Aphyric basalt (*Aeb*) is common near the top of the sequence, forming individual flow units up to around 110 m thick. Most rocks of the Louden Volcanics are locally vesicular and some units near the top of the sequence are characterized by their vesicularity (*Aey*). Both aphyric basalt and vesicular basalt are locally associated with hyaloclastite.

Pillow basalt (*Ael*) also lies at the top of the sequence. The transition upward from hyaloclastite-bearing (*Aeb*, *Aey*) to pillow basalts indicates submergence of a land surface.

Scattered units of peridotite (*Aeo*) within the Louden Volcanics may be sills or dykes, or may represent the slowly cooled portion of thicker high-Mg basalt or komatiite flow units.

Most rocks of the Louden Volcanics contain a microcrystalline groundmass of devitrified glass, pyroxene, and plagioclase partially altered to chlorite, carbonate, Fe-hydroxides, and clay minerals. Phenocrysts are commonly acicular pyroxene (up to 4 cm in length), but olivine is abundant in some samples. Pseudomorphs after euhedral pyroxene phenocrysts commonly show a distinct chloritized core rimmed by carbonate or clinopyroxene. The original mineralogy probably comprised orthopyroxene or olivine, rimmed by clinopyroxene. Some peridotite (*Aeo*) contains abundant phenocrysts of olivine, commonly enclosed in orthopyroxene which is then rimmed by clinopyroxene. Most rocks have well-developed pyroxene spinifex textures, indicative of high-Mg basalts or of pyroxene-rich portions of komatiite flows. However, rocks with olivine spinifex textures are uncommon, suggesting that the Louden Volcanics is predominantly a high-Mg basalt, with minor komatiite. Most rocks are at least partially chloritized and carbonated, and commonly also contain actinolite and epidote.

Millindinna Intrusion (*AaMo, AaMoe, AaMoep, AaMu, AaMum, AaMut*)

Medium-grained gabbro (*AaMo*), melanogabbro and pyroxenite (*AaMoe*), porphyritic melanogabbro (*AaMoep*), talc–carbonate schist (*AaMut*), and ultramafic schist (mainly after peridotite; *AaMu*) have intruded the Constantine Sandstone, or fine- to medium-grained clastic rocks (*ADs*) and ferruginous shale (*ADhc*) below the Constantine Sandstone. The mafic and ultramafic rocks are exposed in the core of the Croydon Anticline, and in the cores of fold interference structures in the Powereena Anticline. These rocks are part of the 'Millindinna Complex' (Fitton et al., 1975; renamed here the Millindinna Intrusion) and are generally more melanocratic and more strongly foliated than gabbro (*Aog*) intruded near the base of the Mallina Formation. Use of the name 'Millindinna Complex' has been discontinued because intrusions previously assigned to that unit are now known to lie at various stratigraphic levels, and may not represent a single intrusive event. Gabbro (*AaMo*) assigned to the Millindinna Intrusion has been intruded by the Peawah Granodiorite, so is older than c. 2950 Ma.

The melanogabbro and pyroxenite (*AaMoe*) typically consist of 50–60% and 60–85% pyroxene (now actinolite) respectively. The porphyritic melanogabbro (*AaMoep*) contains around 5% phenocrysts (up to 1.5 cm long) of plagioclase. Alteration and greenschist-facies metamorphism have resulted in partial to complete replacement of plagioclase by epidote and sericite, and pyroxene by actinolite, chlorite, and epidote. Contact metamorphism near the Peawah Granodiorite and the Satirist Granite has produced amphibolite. Deformation is typically greater in rocks of ultramafic composition. Some highly sheared samples contain serpentine and talc, suggesting olivine-bearing protoliths.

Ultramafic schist (*AaMu*) is dominated by medium-grained, tremolite- and serpentine-rich rock, with minor interlayers of gabbro, fine-grained clastic rock, and chert, and forms mappable units up to 400 m thick. The tremolite- and serpentine-rich schist has a range of mineralogies that reflect variations in contact metamorphic conditions and variations in primary compositions. Samples showing no contact metamorphism range from serpentinite (serpentine–talc–chlorite schist) through chlorite–serpentine–tremolite schist to tremolite–chlorite–epidote–plagioclase schist, reflecting a corresponding variation in protolith composition, from ultramafic (peridotite) to mafic. Contact metamorphism of the ultramafic rocks has produced cummingtonite whereas contact metamorphism of (less common) mafic rocks has produced hornblende. Pyroxene spinifex textures are a feature of some fine-grained samples, whereas some medium-grained samples include preserved olivine cumulate textures. In some well exposed outcrops (e.g. AMG* 035465), minerological layering is observed on a 10–20 m scale from serpentine–chlorite–tremolite schist to tremolite–plagioclase–epidote schist. The wide compositional variation, mineralogical layering, and the close association with gabbro intrusions may imply that most of the schist is derived from layered mafic–ultramafic intrusions, but the presence of pyroxene spinifex texture indicates that some rocks included within the ultramafic schist (*AaMu*) are deformed high-Mg basalt.

A unit containing extensively sheared and finely intercalated layers of medium-grained tremolite- and serpentine-rich schist, and locally abundant fine-grained clastic rock (*AaMum*) is a tectonically intercalated mixture of ultramafic schist (*AaMu*) and medium-grained clastic rocks (*ADs*), and outcrops in the northeast of the sheet area, around the Peawah Granodiorite.

Talc–carbonate schist (*AaMut*) forms a small outcrop in the core of the Powereena Anticline (AMG 970461), and represents metamorphosed peridotite.

Mafic intrusive rock (*Aog*)

Medium- to coarse-grained mafic and ultramafic rock has intruded the greenstones at two stratigraphic levels: within the Mallina Formation, and within and below the Constantine Sandstone. These intrusions are assigned to two suites, the ultramafic–mafic intrusions of the Millindinna Intrusion (*AaM*) and gabbro (*Aog*).

* Localities are specified by the Australian Map Grid (AMG) standard six figure reference system whereby the first group of three figures (eastings) and the second group (northings) together uniquely define position, on this sheet, to within 100 m.

Medium- to coarse-grained mesocratic to leucocratic gabbro (*Aog*) intrudes as a sheet up to 700 m thick near the base of the Mallina Formation. The rock is massive to weakly foliated. Subhedral to euhedral clinopyroxene is the primary mafic phase and commonly forms an interlocking network with euhedral plagioclase, or less commonly displays a sub-ophitic texture. Quartz and patches of quartz–plagioclase granophyric intergrowth are intergranular phases. Most of the rocks show at least partial recrystallization to epidote, actinolite, and chlorite. Local amphibolite-facies metamorphism at the contact with the later intrusive granodiorite has resulted in recrystallization of clinopyroxene and actinolite to hornblende.

Felsic intrusive rocks

Three granitoid bodies, and a suite of plagioclase-porphyry dykes and sills, intruded the greenstones of MOUNT WOHLER prior to deposition of the Fortescue Group. Feldspar porphyry (*Afp*) intruded the Constantine Sandstone and the Millindinna Intrusion, and is particularly abundant immediately north of Nunyerry Gap. The Ellawarrina Monzogranite (*AgYel*), a medium- to coarse-grained biotite monzogranite, is exposed as an inlier through dip-slip movement along a major northeasterly trending fault through the Fortescue Group. The Peawah Granodiorite (*Agpe*), and its associated porphyritic phase (*Agpep*), has intruded much of the central-eastern part of the sheet area, and petrographically similar rock (*Agg*) outcrops at the basal unconformity of the Fortescue Group, in central MOUNT WOHLER. This granodiorite, dated at 2948 ± 5 Ma (Nelson, 1997), has subsequently been intruded by the Satirist Granite (*Agsa*), a metamorphosed biotite(–hornblende) granite, which contains porphyritic (*Agsap*), equigranular (*Agsae*), seriate (*Agsas*), and leucocratic (*Agsal*) phases dated between c. 2930 Ma and c. 2940 Ma (Nelson, 1998).

Feldspar porphyry (*Afp*)

The feldspar porphyry (*Afp*) generally forms sills up to 300 m thick, but also forms dykes less than 3 m wide. The sills are found in the Nunyerry Gap region. The rock consists of euhedral to subhedral plagioclase phenocrysts up to 1 cm in size, and smaller subhedral phenocrysts of hornblende. The phenocrysts lie in a fine-grained groundmass of stumpy subhedral plagioclase crystals and anhedral quartz crystals. Greenschist-facies metamorphism has resulted in partial replacement of plagioclase by epidote and sericite, and hornblende by chlorite. The rock is granodioritic to tonalitic in composition.

Ellawarrina Monzogranite (*AgYel*)

Medium- to coarse-grained biotite granodiorite, assigned here to the newly named Ellawarrina Monzogranite (*AgYel*), has a sparsely porphyritic texture with euhedral plagioclase crystals up to 1 cm in size. Mafic minerals comprise less than 10% of the rock with subhedral biotite crystals interstitial to plagioclase, and partially enclosing smaller euhedral crystals of hornblende. Plagioclase is normally zoned, and microcline forms a late subhedral groundmass phase. Accessory minerals include titanite, apatite, zircon, rutile, and opaque minerals.

Peawah Granodiorite (*Agpe, Agpep*)

The Peawah Granodiorite (*Agpe*) consists of mesocratic medium- to coarse-grained, generally equigranular, hornblende–biotite granodiorite, and subordinate tonalite. The rock contains up to 15% mafic minerals with subhedral hornblende either interstitially to plagioclase, or as aggregates with biotite, magnetite, and titanite. Biotite forms subhedral to anhedral crystals, in places partially surrounding hornblende. Microcline microperthite forms as a late, minor to accessory phase. Accessory minerals include titanite, apatite, zircon, rutile, and magnetite. A porphyritic phase of the Peawah Granodiorite (*Agpep*) intrudes the core of the Croydon Anticline and differs from the equigranular variety in that it contains plagioclase phenocrysts up to 1.5 cm in size, and locally contains up to 20% mafic minerals.

Satirist Granite (*Agsae, Agsas, Agsal, Agsap*)

The Satirist Granite has a multiphase marginal zone of early equigranular to slightly porphyritic granitoid rock (*Agsae*), seriate-textured granitoid rock (*Agsas*), and late leucosyenogranite (*Agsal*), and a relatively homogeneous core of porphyritic syenogranite (*Agsap*). Equigranular to slightly porphyritic granitoid rock (*Agsae*) has been dated at 2938 ± 4 Ma whereas porphyritic syenogranite (*Agsap*) has been dated at 2931 ± 5 Ma (Nelson, 1998).

The equigranular to slightly porphyritic granitoid rock (*Agsae*) is a biotite-bearing, leucocratic monzogranite to syenogranite, containing rare tabular phenocrysts of microcline microperthite up to 2 cm in size. These phenocrysts contain inclusions of plagioclase, biotite, and quartz. The rock contains up to 10% biotite, usually as aggregates of subhedral crystals. Plagioclase is normally zoned and, in places, partially rimmed by K-feldspar, which is a late interstitial and locally poikilitic phase. Seriate-textured granitoid rock (*Agsas*) is a textural variant of the equigranular granitoid rock, and forms inclusions and rafts within the later porphyritic granitoid rocks and leucogranites. The porphyritic syenogranite (*Agsap*) differs from the equigranular granitoid rock in that it contains more K-feldspar (microcline microperthite), mostly as abundant tabular phenocrysts up to 2 cm in size. The leucosyenogranite (*Agsal*) differs from the equigranular granitoid rock as it contains only very little plagioclase, up to 5% anhedral muscovite, and accessory amounts of biotite. Accessory minerals within the rocks of the Satirist Granite include apatite, zircon, rutile, muscovite, fluorite, allanite, and magnetite (now leucoxene).

The granitoid rocks on MOUNT WOHLER show evidence of very low greenschist-facies metamorphism. Plagioclase has been partially replaced by epidote and sericite, biotite by prehnite and chlorite, and hornblende by chlorite.

Mount Negri Volcanics (*Atv*)

On MOUNT WOHLER, the Mount Negri Volcanics (Hickman, 1977, 1990) is restricted to variolitic basalt (*Atv*) that unconformably overlies the Louden Volcanics, and forms a small outcrop in the far northwest of the sheet area. The basalt contains abundant, dark green, pea-sized varioles consisting of acicular clinopyroxene, along with interstitial plagioclase and devitrified glass. The varioles rest in a light-green groundmass of clinopyroxene, plagioclase, and devitrified glass. Euhedral clinopyroxene phenocrysts up to 2 mm in length are distributed randomly throughout the varioles and groundmass. Epidote, actinolite, carbonate, and chlorite are common replacement minerals.

Late Archaean granitoid rocks (*Agl, Ag*)

Biotite- and tourmaline-bearing, medium-grained leucogranite (*Agl*) forms an elliptical body that intrudes rocks of the Mallina Formation southeast of the inter-section of the Loudens Fault and the Mallina Shear Zone (central-north MOUNT WOHLER). The granite has been dated by Nelson (1997) at 2765 ± 5 Ma, establishing that its intrusion occurred during deposition of the lower part of the Fortescue Group. The rock ranges in composition from syenogranite to monzogranite. It contains subhedral to euhedral phenocrysts of early plagioclase up to 5 mm in size (now sericitized), and late-crystallizing microperthite that poikilitically encloses plagioclase, quartz, and biotite. Biotite also forms an anhedral interstitial groundmass phase, or aggregates of larger subhedral grains associated with plagioclase. Tourmaline forms discontinuous veins or stringers, or occurs as poorly formed orbicules up to 3 cm in diameter.

Dykes of leucogranite (*Ag*), with or without biotite, intrude the rocks of the Millindinna Intrusion along the northern margin of the Satirist Granite.

Fortescue Group

The Fortescue Group is a c. 2770–2680 Ma dominantly basaltic succession which extends across much of the Pilbara Craton. An angular unconformity exists between the Fortescue Group and the granite–greenstone terrain. A polymictic conglomerate containing subrounded clasts derived from the Mallina Formation, granitoid rocks, and the Whim Creek Group, locally marks the base of the Fortescue Group on MOUNT WOHLER, but is too thin and irregular to be represented at map scale. The regional stratigraphy of the group was reviewed by Hickman (1983).

Mount Roe Basalt (*AFr, AFrb, AFrs*)

The Mount Roe Basalt (*AFr*) is the basal unit of the Fortescue Group. The bulk of this unit on MOUNT WOHLER is composed of either vesicular or glomeroporphyritic basalt. The former contains quartz–calcite filled vesicles and rare, squat, subhedral phenocrysts of plagioclase and clinopyroxene in a groundmass rich in plagioclase laths, with interstitial chlorite and epidote (after mafic phases and glass). The glomeroporphyritic rocks differ from the vesicular variety in that they contain abundant aggregates of plagioclase up to 2 cm in size. Both the vesicular and glomeroporphyritic basalt have locally preserved pillow structures. Some outcrops of basalt are brecciated with common development of hyaloclastite (*AFrb*). Sedimentary rocks are interlayered with the basalts and include well-laminated mudstone and siltstone, and fine- to medium-grained, poorly sorted, and matrix-supported arkose (*AFrs*). These sedimentary rocks commonly contain well-developed graded-bedding, ripple cross-bedding, and mud cracks.

Hardey Formation (*AFh, AFhc, AFhs, AFhy*)

Conformably overlying the Mount Roe Basalt are poorly to moderately sorted, medium- to coarse-grained, subarkose, conglomerate, and interbedded fine- to medium grained, tuffaceous sedimentary rocks of the Hardey Formation (*AFh*). It was originally referred to as the Hardey Sandstone, but was later renamed by Thorne et al. (1991). In the northwest of MOUNT WOHLER, a matrix-supported polymictic conglomerate (*AFhc*) containing clasts derived from the Pilbara Supergroup forms a layer up to about 20 m thick at the base of the Hardey Formation. The conglomerate is overlain by a sequence consisting of poorly to moderately sorted, medium- to coarse-grained subarkose, interbedded with well-laminated siltstone, fine-grained tuffaceous sedimentary rock, and conglomerate (*AFhs*). Felsic agglomerate and tuff (*AFhy*), assigned to the Lyre Creek Member, is a persistent unit (up to 30 m thick) that forms the top of the Hardey Formation on MOUNT WOHLER. The unit consists of a chaotic mixture of angular crystal fragments, locally derived lithic fragments, and glass shards in a fine-grained chloritic matrix.

Kylena Formation (*AFk*) and Cooya Pooya Dolerite (*AFdc*)

The Hardey Formation is conformably overlain by the Kylena Formation (*AFk*), a formation previously referred to as the Kylena Basalt, but now renamed and redefined by Kojan and Hickman (in press). Contacts between the Hardey Formation and the volcanic rocks of the Kylena Formation are well preserved in the south and southeast of MOUNT WOHLER. On MOUNT WOHLER, the Kylena Formation consists of flows of massive to amygdaloidal basalt and andesite. In the western and central part of the sheet area, dolerite sills intrude the contact between the Hardey Formation and the Kylena Formation, and the middle to upper levels of the Hardey Formation. These intrusive rocks form the Cooya Pooya Dolerite (*AFdc*), an olivine–orthopyroxene–clinopyroxene–plagioclase bearing cumulate in this area.

Tumbiana Formation (*AFt, AFtk*)

The Tumbiana Formation (*AFt*), which conformably overlies the Kylena Formation, is a layered sequence that includes volcanic sandstone of mafic to intermediate composition, fine-grained clastic rocks, basalt, chert, and dolomite. On MOUNT WOHLER, a stromatolitic dolomite and carbonate-rich tuffaceous sedimentary rock (*AFtk*) unit has been defined on the basis of distinctive aerial photographic and radiometric patterns, that show it to be the strike equivalent of stromatolitic dolomite and carbonate-rich tuffaceous sedimentary rock exposed on PINDERI HILLS (Kojan, C., 1997, pers. comm.).

Maddina Formation (*AFm, AFmf*)

A sequence of flows and breccias of amygdaloidal basalt, shoshonitic basalt (Kojan, C., 1997, pers. comm.), andesite, and high-Mg basalt (*AFm*) form the Maddina Formation (Kojan and Hickman, in press), which marks the top of the Fortescue Group on MOUNT WOHLER. On MOUNT WOHLER, an andesite unit (*AFmf*) has been defined on the basis of distinctive aerial photographic and radiometric patterns that show it to be the strike equivalent of andesite exposed on PINDERI HILLS (Kojan, C., 1997, pers. comm.).

Archaean–Proterozoic dykes and quartz veins (*d, q*)

Massive dolerite (*d*) of variable, but dominantly late Archaean age, forms northerly and north-northeasterly trending dykes within the Satirist Granite, and the east-northeasterly trending Powereena Dyke in the southern half of the sheet. Intrusion of the dykes post-dates the deposition of the Pilbara Supergroup. Some may be related to volcanism within the Mount Bruce Supergroup. However, the Powereena Dyke post-dates deposition of the Maddina Formation on MOUNT WOHLER and intrudes the Marra Mamba Iron Formation (Kriewaldt and Ryan, 1963) of the Hamersley Group to the southwest of the sheet area.

Veins of massive to schistose quartz (*q*), up to 20 m thick, follow a northerly or northeasterly trend in the east of MOUNT WOHLER. These most probably mark the trace of minor faults.

Cainozoic deposits

Calcrete (*Czrk, Czak*)

Massive, nodular, and cavernous calcrete (*Czrk*), formed in situ and was extensively developed over rocks of the Mallina Formation. Similar alluvial calcrete (*Czak*) also formed in old drainage channels.

Quaternary alluvial and lacustrine deposits (*Qaa, Qab, Qac, Qao*)

Present-day drainage channels contain alluvial clay, silt, sand, and gravel (*Qaa*). Alluvial sand, silt, and clay form overbank deposits (*Qao*) on the floodplain associated with the Sherlock River, and locally includes gilgai (*Qab*). Gilgai is a clay-rich silt or sand deposit characterized by the development of numerous cracks and sinkholes. Lacustrine deposits (*Qac*) are also present on the floodplain associated with the Sherlock River and consist of clay, silt, and evaporites in shallow depressions.

Quaternary colluvium and outwash-fan deposits (*Qc, Qwb, Qws*)

Yellow- to red-sand (*Qws*), and silt and clay, including gilgai (*Qwb*), have been deposited as fine outwash in fans. Locally reworked by wind action, they have typically been stabilized by extensive grass and shrub cover. These units cover much of the plains in northern MOUNT WOHLER.

Colluvium consisting of gravel (*Qc*) is locally derived from elevated outcrops and deposited as sheetwash and talus.

Quaternary eolian sand (Qs)

Eolian sand (*Qs*) forms rare, unstable dunes east of the Croydon Anticline.

Structure

At least four phases of deformation can been recognized on MOUNT WOHLER, and these events are referred to as D_{1-4} (Fig. 4). However, some may only be of local significance and no correlation with regional deformational events is proposed.

An east-northeasterly trending aeromagnetic feature, interpreted as a shear zone, lies in the northeast of the sheet area, and is referred to here as the Wohler Shear Zone. Although supracrustal rocks within this zone are sheared, granitoid rocks and granitoid contacts are only locally sheared.

The first recognizable folding event in the area is assigned to D_1, which folded the Constantine Sandstone and underlying rocks in the Powereena Anticline. The original D_1 anticlinal axial plane was steeply dipping and easterly to northeasterly trending. Minor thrust planes, trending approximately eastward, are found in the chert at Nunyerry Gap and may also relate to D_1 compression.

Subsequent major, tight, upright to overturned folds with northerly trending axial planes and axes that plunge to the south and north (typically between 50° and 70°) are assigned to D_2. The dominant steeply dipping and northerly trending schistosity of the greenstones in the eastern part of MOUNT WOHLER is axial planar to these folds. This event (D_2) refolded D_1 to produce the Powereena Anticline and associated fold interference structures, which expose the older cores of serpentine-rich schist. The Croydon Anticline, major folds in the Mallina Formation (northwest MOUNT WOHLER), and folds in the gabbro (*Aog*; southeast MOUNT WOHLER), are also D_2 structures. The trend of the axial plane of D_2 folds changes across the Satirist Granite, from north-northeasterly to the north of the granite, to south-southeasterly to the south of the granite. Immediately to the west of Nunyerry Gap, the folds again trend north-northeastward. It is possible that doming associated with intrusion of the elongate east-northeastward trending Satirist Granite has locally rotated D_2 fold axes, but this does not explain rotation of fold axes immediately to the north of Nunyerry Gap.

The D_2 event pre-dates intrusion of the Peawah Granodiorite and the Satirist Granite, but post-dates deposition of the Mallina Formation, so must have occurred between c. 3000 and c. 2950 Ma.

Deformation associated with D_3 is characterized by large-scale open folds with steeply dipping, east-northeasterly trending axial planes, and axes that typically plunge less than 45° in an east-northeasterly or west-southwesterly direction. This deformation event clearly refolded the (D_2) Powereena Anticline, and may have interfered with major D_2 folds on a regional basis to produce the observed rotation of D_2 fold axes. The Satirist Granite may have intruded into a major west southwestward plunging D_3 anticline. Similarly oriented folds characterize the main phase of deformation within the Whim Creek Belt to the north (SHERLOCK), and have produced the Whim Creek Anticline (Smithies et al., in press). This main phase of deformation of the Whim Creek Belt probably corresponds to D_3 on MOUNT WOHLER. The Peawah Granodiorite features a schistosity axial planar to D_3, indicating that this deformation event post-dates intrusion of the granodiorite (c. 2950 Ma). However, the Satirist Granite (c. 2930–2940 Ma) shows no such schistosity, although tabular perthite phenocrysts have a strong east-northeasterly trending preferred alignment, which may reflect crystallization during syn-kinematic emplacement at D_3.

The last phase of deformation recognized on MOUNT WOHLER (D_4) involved faulting of the Fortescue Group, dominantly along major north-northeasterly trending fault planes. The best examples of these faults are in the northwest of the sheet area. The faults extend northward onto SHERLOCK (Fig. 4), where they join the Loudens and Kents Bore Faults that define the northerly trending part of the Whim Creek Belt.

Economic geology

Although there are no mines currently operating on MOUNT WOHLER, the area has produced minor amounts of Cu (Pb–Zn–Ag), Sb, and Au, with some exploration for U.

Approximately 11.03 t of Sb was extracted from workings on the east bank of the Sherlock River (AMG 628752), where stibnite-bearing quartz veins (Finucane and Telford, 1939) lie within sheared rocks of the Louden Volcanics.

Copper was mined from the Evelyn (AMG 878667) and Quamby (AMG 886704) deposits in the core of the

Croydon Anticline between 1898 and 1959. Gossan at Evelyn, the larger of the two deposits, contains up to 33.5% Cu, 15% Pb, 2.5% Zn, and 490 ppm Ag. A total of 118.4 t of Cu was extracted from approximately 703 t of ore. Both deposits are located on, or near, the contact between the subarkoses of the Constantine Sandstone and strongly sheared mafic and ultramafic rocks tentatively correlated with the Millindinna Intrusion (Hutton, 1977). At Evelyn, mineralization is localized in ore shoots (approximately 1 m wide) that plunge about 40° in a northerly direction, commonly following the hinge zone of local drag folds. These drag folds relate to D_3, so mineralization is late- to post-D_3.

Gold has been extracted from the area around, and to the southwest of, Croydon Top Camp (AMG 688578; Chalmers, 1981). The mineralization lies in a prominent exposure of tightly folded Mallina Formation. The cores of anticlines expose thin (<2 m) and discontinuous layers of auriferous carbonate-rich wacke and ferruginous chert (ironstone). These, and surrounding alluvial sediments, have been extensively worked by dry blowing. There is a recorded production of 0.2 kg of Au.

Traces of Au have been found by trenching deposits of alluvium in southern MOUNT WOHLER (Mullumby, 1989), near Croydon Outcamp (AMG 938437), Tardarinna Hill (AMG 872397), and Muckeracoondaner (AMG 955397).

Conglomerate within the Hardey Formation of the Fortescue Group is locally uraniferous. One prospect in the central-west of the sheet area (AGM 682553), about 5 km south-southwest of Croydon Top Camp, has been prospected, but without encouraging results (Tuite, 1977).

The present stratigraphic interpretation of the greenstone sequence in the SHERLOCK and MOUNT WOHLER sheet areas is similar to that of Fitton et al. (1975) and Horwitz (1990), and equates the Cistern Formation of the Whim Creek Group to the Constantine Sandstone (Smithies et al., in prep). This interpretation places significant base-metal mineralization within the Whim Creek Belt, on the same stratigraphic horizon as mineralization at Evelyn and Quamby, and also Egina, to the east on SATIRIST.

References

ARNDT, N. T., NELSON, D. R., COMPSTON, W., TRENDALL, A. F., and THORNE, A. M., 1991, The age of the Fortescue Group, Hamersley Basin, Western Australia, from ion microprobe zircon U–Pb results: Australian Journal of Earth Sciences, v. 38, p. 261–281.

BARLEY, M. E., 1987, The Archaean Whim Creek Belt, an ensialic fault-bounded basin in the Pilbara Block, Australia: Precambrian Research, v. 37, p. 199–215.

BARLEY, M. E., 1997, The Pilbara Craton, *in* Greenstone belts *edited by* M. J. De WIT and L. ASHWALL: Oxford University Press, 809p.

BARLEY, M. E., McNAUGHTON, N. J., WILLIAMS, I. S., and COMPSTON, W., 1994, Age of Archaean volcanism and sulphide mineralization in the Whim Creek Belt, west Pilbara: Australian Journal of Earth Sciences, v. 41, p. 175–177.

BLAKE, T. S., 1993, Late Archaean crustal extension, sedimentary basin formation, flood basalt volcanism, and continental rifting: the Nullagine and Mount Jope Supersequences, Western Australia: Precambrian Research, v. 60, p. 185–241.

CAMPANA, B., HUGHES, F. E., BURNS, W. G., WHITCHER, I. G., and MUCENIEKAS, E., 1964, Discovery of the Hamersley iron deposits: Australasian Institute of Mining and Metallurgy, Proceedings, no. 210, p. 1–30.

CHALMERS, D. I., 1981, Progress report Croydon Joint Venture: West Coast Holdings and Command Minerals: Western Australia Geological Survey, M-series, Item 2706.

ERIKSSON, K. A., 1982, Geometry and internal characteristics of Archaean submarine channel deposits, Pilbara Block, Western Australia: Journal of Sedimentary Petrology, v. 52/2, p. 383–393.

FINUCANE, K. L., and TELFORD, R. J., 1939, The antimony deposits of the Pilbara Goldfield: Aerial Geological and Geophysical Surveys of Northern Australia, Report Western Australia 47.

FITTON, M. J., HORWITZ, R. C., and SYLVESTER, G. C., 1975, Stratigraphy of the early Precambrian of the west Pilbara, Western Australia: Australia CSIRO, Mineral Research Laboratory, Division of Mineralogy, Report FP11, 41p.

HICKMAN, A. H., 1977, Stratigraphic relations of rocks within the Whim Creek Belt: Geological Survey of Western Australia, Annual Report 1976, p. 68–72.

HICKMAN, A. H., 1983, Geology of the Pilbara Block and its environs: Western Australia Geological Survey, Bulletin 127, 278p.

HICKMAN, A. H., 1990, Granite–greenstone terrain, *in* Third International Archaean Symposium. Excursion Guidebook No. 5 — Pilbara and Hamersley Basin *edited by* S. E. HO, J. E. GLOVER, J. S. MYERS, and J. R. MUHLING: University of Western Australia, Geology Department (Key Centre) and University Extension, Publication 21, p. 2–13.

HICKMAN, A. H., 1997, A revision of the stratigraphy of Archaean greenstone successions in the Roebourne–Whundo area, West Pilbara: Western Australia Geological Survey, Annual Review 1996–97, p. 76–81.

HORWITZ, R. C., 1990, Palaeogeographic and tectonic evolution of the Pilbara Craton, northwestern Australia: Precambrian Research, v. 48, p. 327–340.

HORWITZ, R. C., and GUJ, P., 1987, Re-accreditation of the Whim Creek Group: Australia CSIRO, Division of Mineral and Geochemical Research, Review, 1985, p. 6–7.

HUTTON, G., 1977, Evelyn and Quamby copper–lead–zinc prospects, West Pilbara Goldfield, Western Australia: Aquitaine Australia Minerals: Western Australia Geological Survey, M-series, Item 3231.

KOJAN, C., and HICKMAN, A. H., in prep., Re-assessment of Archaean volcanic formations of the Fortescue Group based on new radiometric, geochemical, and field data from the northwest Pilbara Craton: Western Australia Geological Survey, Annual Review 1997–98.

KRAPEZ, B., 1984, Sedimentation in a small, fault-bounded basin — the Lalla Rookh Sandstone, east Pilbara Block, *in* Archaean and Proterozoic basins of the Pilbara, Western Australia — evolution and mineralization potential: University of Western Australia, Geology Department (Key Centre) and University Extension, Publication 9, p. 89–110.

KRAPEZ, B., 1993, Sequence stratigraphy of the Archaean supracrustal belts of the Pilbara Block, Western Australia: Precambrian Rresearch, v. 60, p. 1–45.

KRIEWALDT, M., and RYAN, G. R., 1963, Pyramid, W.A. Sheet SF 50-7 International Index: Australia BMR, 1:250 000 Geological Series.

MILLER, L. J., 1975, Mons Cupri copper–lead–zinc deposit, *in* Economic geology of Australia and Papua New Guinea 1. Metals *edited by* C. L. KNIGHT: Australasian Institute of Mining and Metallurgy, Monograph 5, p. 195–202.

MULLUMBY, B. G., 1989, Report on Croydon alluvial gold prospect, West Pilbara Mineral Field, Western Australia: Western Australia Geological Survey, M-series, Item 7005.

NELSON, D. R., 1997, Compilation of SHRIMP U–Pb zircon geochronology data, 1996: Western Australia Geological Survey, Record 1997/2, 189p.

NELSON, D. R., 1998, Compilation of SHRIMP U–Pb zircon geochronology data, 1997: Western Australia Geological Survey, Record 1998/2, 242p.

RYAN, G. R., and KRIEWALDT, M., 1964, Facies changes in the Archaean of the West Pilbara Goldfield: Western Australian Geological Survey, Annual Report 1963, p. 28–30.

SMITHIES, R. H., 1997, Sherlock, W.A. Sheet 2456: Western Australia Geological Survey, 1:100 000 Geological Series.

SMITHIES, R. H., HICKMAN, A. H., and NELSON, D. R., in press, New constraints on the evolution of the Mallina Basin, and their bearing on relationships between the contrasting eastern and western granite–greenstone terranes of the Archaean Pilbara Craton, Western Australia: Precambrian Research.

SYLVESTER, G. C., and de LAETER, J. R., 1987, Geochronology of the Mons Cupri Archaean Volcanic Centre, Pilbara block, Western Australia J. Roy. Soc. Western Aust.; 70/2, p. 29-34.

THORNE, A. M., 1990, Geology of the Pilbara Craton, *in* Third International Archaean Symposium, Excursion Guidebook No. 5 — Pilbara and Hamersley Basin *edited by* S. E. HO, J. E. GLOVER,

J. S. MYERS, and J. R. MUHLING: University of Western Australia, Geology Department (Key Centre) and University Extension, Publication 21, p. 13–36.

THORNE, A. M., TYLER, I. M., and HUNTER, W. M., 1991, Turee Creek, W.A. (2nd edition): Western Australia Geological Survey, 1:250 000 Geological Series Explanatory Notes, 29p.

TUITE, M., 1977, Annual report of Temporary Reserve 6404H, Langwell, Pyramid sheet, Western Australia, for the period 10th December 1976 to 19th December 1977: Western Australia

Geological Survey, M-series, Item 662.

Appendix 1

Gazetteer of localities

Locality	*AMG co-ordinates* *Easting*	*Northing*
Croydon Homestead	583700	7664200
Croydon Outcamp	593800	7643700
Croydon Top Camp (Golden Valley)	570600	7660300
Evelyn mine	587700	7666700
Kangan Pool	565100	7666700
Mons Cupri	583800	7690600
Mount Negri	587900	7701200
Muckeracoondaner	595500	7639700
Nunyerry Gap	595700	7623500
Quamby mine	589900	7670600
Tardarinna Hill	587200	7639700
Whim Creek	586500	7694700

Appendix 2

Definition of stratigraphic names on Mount Wohler

Millindinna Intrusion

(redefined)

Name derivation: Fitton et al. (1975)

Distribution: Extensive mafic and ultramafic sills within rocks of the De Grey Group, on the eastern side of Mount Wohler and western side of Satirist, and between rocks of the Whim Creek Group and the Caines Well Granitoid Complex on Sherlock.

Type locality: 2 km north-northeast of Mount Satirist Homestead (21°04'30"S, 118°08'40"E)

Lithology: Medium-grained gabbro, melanogabbro and pyroxenite, peridotite, porphyritic melanogabbro, talc–carbonate schist, and ultramafic schist (mainly after peridotite). Sills are up to 200 m thick and are commonly layered from a base of peridotite to a top of gabbro.

Relationships: Forms sills within the rocks of the De Grey Group, typically near the top of the Constantine Sandstone, and intrudes between rocks of the Whim Creek Group and Caines Well Ganitoid Complex.

Age: Intruded by Peawah Granodiorite, dated at c. 2950 Ma (Nelson, 1997).

Comments: The name 'Millindinna Complex' was originally used by Fitton et al. (1975) for a regional suite of mafic and ultramafic intrusions, but has been discontinued because intrusions previously assigned to that unit are now known to occur at various stratigraphic levels, and may not represent a single intrusive event.

References:

FITTON, M. J, HORWITZ, R. C., and SYLVESTER, G. C., 1975, Stratigraphy of the early Precambrian of the west Pilbara, Western Australia: CSIRO Australia Mineral Research Laboratory, Report FP11, 41p.

NELSON, D. R., 1997, Compilation of SHRIMP U–Pb zircon geochronology data, 1996: Western Australia Geological Survey, Record 1997/2, 189p.

Ellawarrina Monzogranite

Name derivation: Ellawarrina Spring (21°37'15"E, 117°51'45"S)

Distribution: Small outcrop on the southeastern corner of Mount Wohler (21°30'00"E, 117°58'10"S). Also occurs to the south of Nunyerry Mine (21°33'25"E, 117°54'30"S)

Type locality: 21°30'00"E, 117°58'10"S

Lithology: Biotite-bearing monzogranite

Relationships: Intrudes greenstones that stratigraphically underlie the De Grey Group which have been dated at c. 3015 Ma (Nelson 1998).

Age: Younger than c. 3015 Ma.

References:

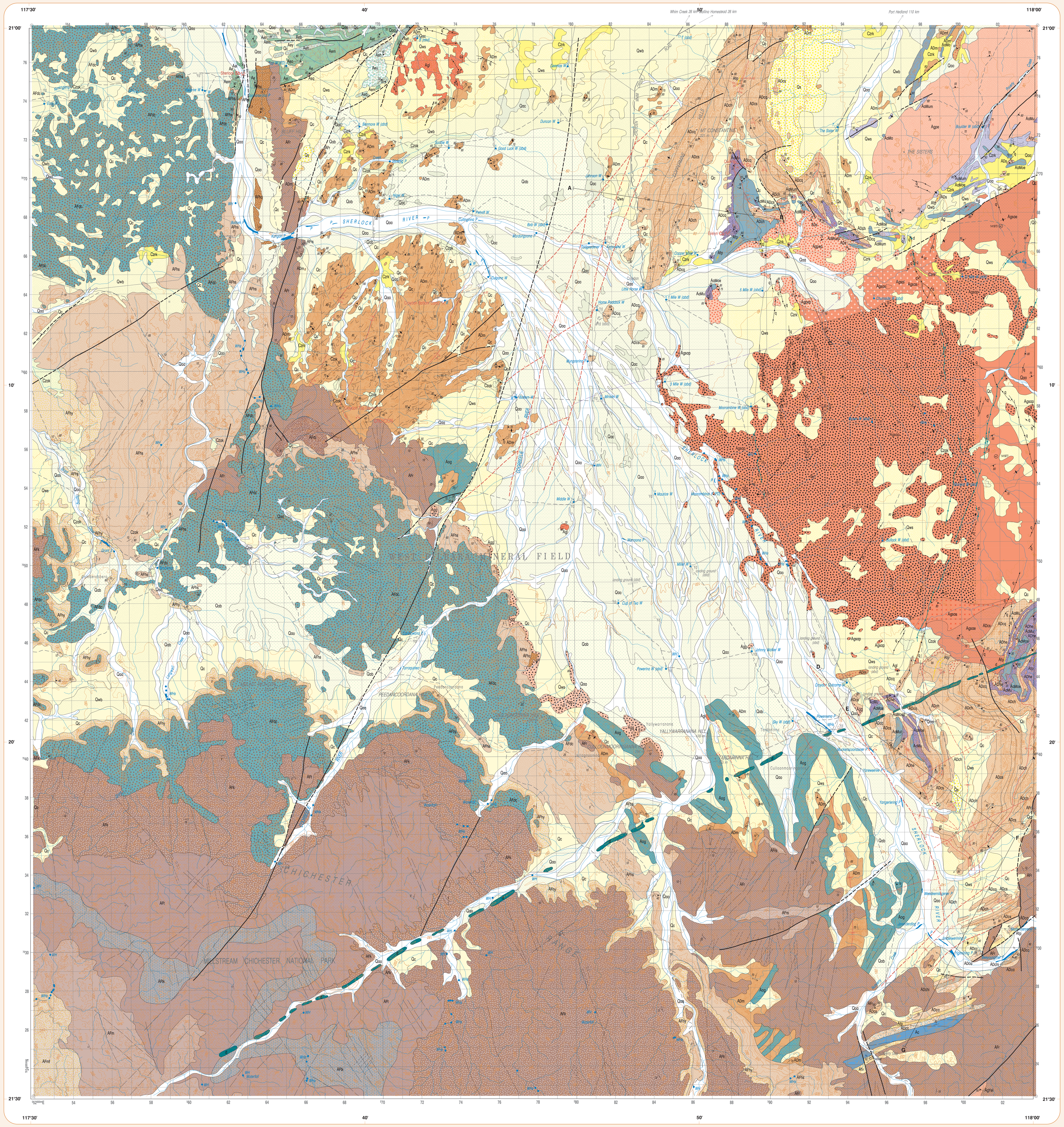
NELSON, D. R., 1998, Compilation of SHRIMP U–Pb zircon geochronology data, 1997: Western Australia Geological Survey, Record 1998/2, 242p.

MOUNT WOHLER

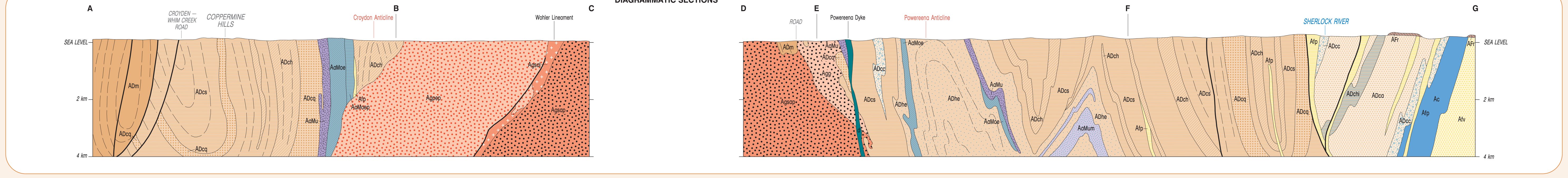
AUSTRALIA 1:100 000 GEOLOGICAL SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET 2455



DIAGRAMMATIC SECTIONS



CAINOZOIC — QUATERNARY

Qaa	Qac	Qao	Qab	Qc	Qs	Qwb	Qws

Qaa Alluvium—sand and gravel in rivers and creeks; clay, silt, and sand in channels and on adjacent floodplains
Qac Claypan deposits on floodplains
Qao Alluvial sand, silt, and clay in floodplains
Qab Alluvial sand, silt, and clay in floodplains, with gilgai surface in areas of expansive clay
Qc Colluvium—sand, silt, and gravel in outwash fans and scree
Qs Eolian sand—red-yellow, wind blown sand; locally forms ridges
Qwb Sheetwash—sand, silt, and clay in distal outwash fans, with gilgai surface in areas of expansive clay
Qws Sheetwash—quartzofeldspathic sand derived from sandstone and siltstone

Czak Calcrete—massive, nodular, and cavernous limestone, variably silicified; alluvial origin
Czrk Calcrete—massive, nodular, and cavernous limestone, variably silicified; residual origin

d — Dolerite dyke

q — Quartz vein

ARCHAEAN — Mount Bruce Supergroup — Fortescue Group — Hamersley Basin

c. 2717 Ma

AFm **MADDINA FORMATION:** massive, vesicular, brecciated, and amygdaloidal basalt, shoshonitic basalt and andesite; minor high-Mg basalt and felsic volcanic rock
AFmf Andesite
AFt **TUMBIANA FORMATION:** mafic to intermediate volcanic sandstone, tuff, and fine-grained clastic sedimentary rock; minor basalt, chert, dolomite, and limestone
AFtk Dark-grey siliceous dolomite and limestone, stromatolitic dolomite, and carbonate-rich tuffaceous sedimentary rock
AFk **KYLENA FORMATION:** massive, vesicular, and amygdaloidal basalt and andesite
AFdc **COOYA POOYA DOLERITE:** fine- to medium-grained dolerite; includes rafts of quartzite derived from HARDEY FORMATION
AFhy Lyre Creek Member: felsic agglomerate and felsic tuff
AFh **HARDEY FORMATION:** undifferentiated sandstone and tuffaceous grit
AFhs Medium- to coarse-grained poorly sorted sandstone, well laminated siltstone, felsic tuff, and minor conglomerate
AFhc Conglomerate; polymictic
AFr **MOUNT ROE BASALT:** undifferentiated mafic volcanic and volcaniclastic rock, and tuffaceous sedimentary rock
AFrb Basaltic breccia
AFrs Well laminated mudstone and siltstone, fine- to medium-grained arkose, and fine-grained felsic tuff

c. 2765 Ma — Agl Leucogranite; medium- to coarse-grained; biotite- and tourmaline-bearing; coeval with **Fortescue Group**

Ag — Granite dyke

Pilbara Supergroup — Atv **MOUNT NEGRI VOLCANICS:** variolitic basalt; metamorphosed

PILBARA CRATON

c. 2930 Ma, *c.* 2940 Ma

SATIRIST GRANITE: metamorphosed biotite(–hornblende) granite
Agsap Porphyritic granite
Agsae Equigranular granite
Agsas Seriate granite
Agsal Leucogranite

Contact metamorphic rock; abundant porphyroblasts of andalusite, corderite, and/or garnet; related to intrusions of **SATIRIST GRANITE and PEAWAH GRANODIORITE**

c. 2950 Ma

Agpe **PEAWAH GRANODIORITE:** metamorphosed hornblende–biotite granodiorite and tonalite; mesocratic
Agpep Porphyritic phase
Agg Hornblende–biotite granodiorite; medium- to coarse-grained; metamorphosed

Pilbara Supergroup

Aog Metagabbro; medium- to coarse-grained

Afp Feldspar porphyry; metamorphosed plagioclase–hornblende porphyry

Millindinna Intrusion

AaMo Gabbro; metamorphosed
AaMoe Melanogabbro and pyroxenite; metamorphosed
AaMoep Melanogabbro, plagioclase phenocrysts; metamorphosed
AaMu Ultramafic schist, tremolite- and serpentine-rich schist; serpentinite after peridotite; includes minor metachert, metasedimentary rock, and serpentinized high-Mg basalt
AaMum Tremolite- and serpentine-rich schist mixed with locally abundant metachert and metasedimentary rock
AaMut Talc–carbonate schist; after peridotite

> 2970 Ma

Ae **LOUDEN VOLCANICS:** undifferentiated metamorphosed basalt and high-Mg basalt; contemporaneous with part of the De Grey Group
Ael Pillowed basalt; local spinifex-textured pyroxene; metamorphosed
Aey Vesicular basalt; local abundant aphyric basalt and high-Mg basalt; metamorphosed
Aeb Aphyric basalt; metamorphosed
Aet Serpentine–chlorite schist and sheared metamorphosed high-Mg basalt
Aem High-Mg basalt; spinifex-textured pyroxene; metamorphosed
Aeh High-Mg basalt; acicular textures; metamorphosed
Aeo Peridotite; olivine cumulate texture; metamorphosed

Asq Quartz arenite; medium- to coarse-grained; subangular clasts and pebbles of black chert; metamorphosed

De Grey Group

< 3000 Ma, > 2950 Ma

ADm **MALLINA FORMATION:** interbedded shale, siltstone, and medium- to fine-grained wacke; minor layers of chert; metamorphosed
ADmf Shale, siltstone, and sandstone; includes layers of feldspar(–hornblende) porphyry; metamorphosed

ADc **CONSTANTINE SANDSTONE:** undifferentiated coarse- to fine-grained clastic rocks; metamorphosed (Simplified Geology only)
ADch Shale, commonly ferruginized and/or silicified, lesser interbeds of poorly sorted arkose; minor banded iron-formation; metamorphosed
ADchi Ferruginized shale and banded iron-formation; metamorphosed
ADcs Poorly sorted subarkose and wacke, lesser interbeds of shale; metamorphosed
ADca Poorly sorted litharenite; well developed graded units; abundant chert clasts; metamorphosed
ADcq Poorly sorted subarkose; rare graded beds; metamorphosed
ADcc Conglomerate; rounded to subangular chert clasts; metamorphosed

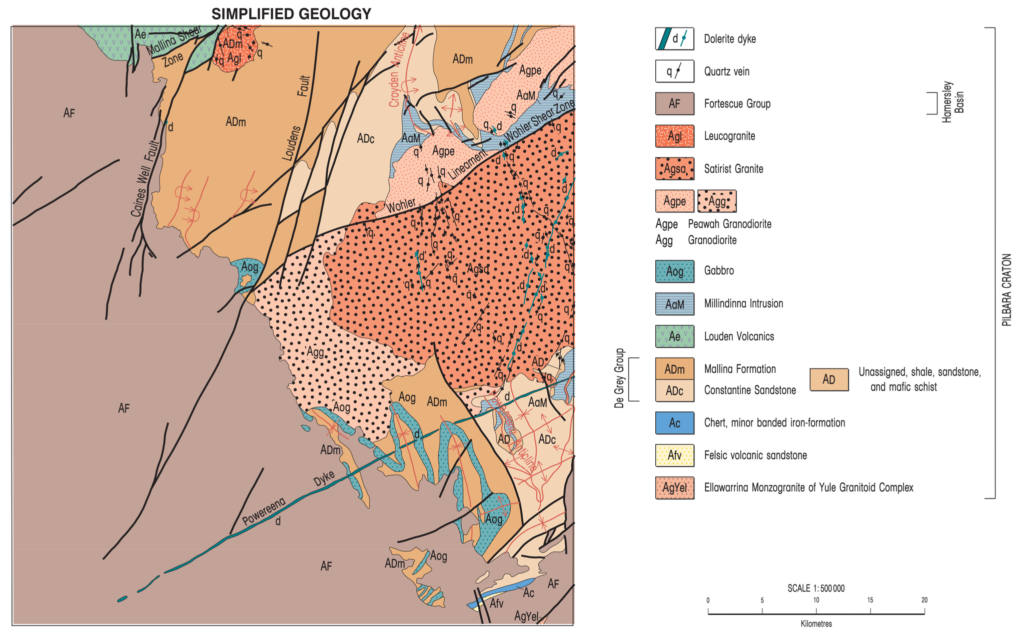
ADs Metamorphosed fine-grained clastic sedimentary rock and abundant serpentine- and tremolite-rich schist
ADhe Metamorphosed ferruginous shale; locally abundant chert and mafic schist, and minor quartz–mica schist and metamorphosed banded iron-formation

Ac Banded grey and white chert, locally abundant ferruginous chert, and minor banded iron-formation and fine-grained clastic rocks; metamorphosed

c. 3015 Ma — Afv Felsic volcaniclastic rock, volcanic sandstone, and siltstone; metamorphosed

AgYel **ELLAWARRINA MONZOGRANITE:** monzogranite; medium- to coarse-grained biotite–hornblende bearing; leucocratic; part of YULE GRANITOID COMPLEX

SIMPLIFIED GEOLOGY

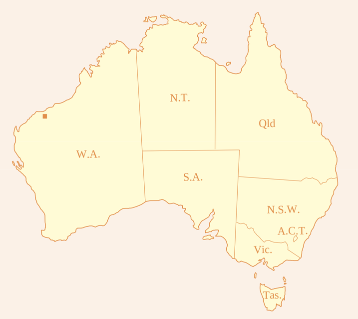


Geological boundary
exposed
Structural symbols are numbered according to the sequence of local deformation events, where known
Pre-Fortescue Group
D_3
D_2
D_1
Fault
exposed
concealed
concealed, interpreted from aeromagnetic data
horizontal relative displacement
Fold, showing axial trace and generalized plunge direction
anticline; exposed, concealed
syncline; exposed, concealed
overturned anticline; exposed, concealed
overturned syncline; exposed, concealed
Small-scale fold axis showing trend and plunge
S-vergence
Z-vergence
M-vergence
Bedding, showing strike and dip
inclined
vertical
overturned
strike and dip estimated from aerial photography
0–15°
trend of bedding
Way-up indicator
graded bedding
Metamorphic foliation, showing strike and dip
inclined
vertical
Cleavage, showing strike and dip
inclined
vertical
Airphoto lineament
prominent trend, possible fault
joint
Aeromagnetic lineament
Isotopic age determination site with GSWA identification number — 141973

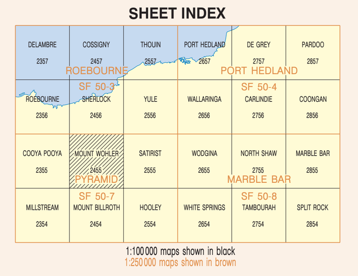
Road; unsealed
Track
Fence, generally with track
Locality — Cumberabbera
Building
Yard — Yd
National park boundary
Breakaway
Contour line, 20 metre interval — 240

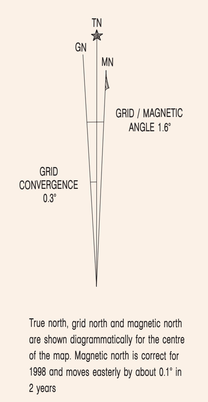
Watercourse; pool — P
Waterhole, spring — WH, S
Well — W
Windpump
Abandoned — (abd)
Position doubtful — (PD)

Mining centre — CROYDON
Mine (gold, unless otherwise indicated) — Evelyn
Mine, abandoned (except for gold)
Alluvial workings
Mineral occurrence
Antimony — Sb
Copper — Cu
Uranium — U



SHEET INDEX





True north, grid north and magnetic north are shown diagrammatically for the centre of the map. Magnetic north is correct for 1998 and moves easterly by about 0.1° in 2 years

GOVERNMENT OF WESTERN AUSTRALIA
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DEPARTMENT OF MINERALS AND ENERGY
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GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
DAVID BLIGHT, DIRECTOR

SCALE 1:100 000

1000 Metres 0 1 2 3 4 5 6 7 8 9 10 Kilometres

TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: AUSTRALIAN GEODETIC DATUM 1984
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Grid lines indicate 1000 metre interval of the Australian Map Grid Zone 50

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94)
GDA94 positions are compatible within one metre of the datum WGS84 positions

Reference points to align maps based on the previous datum, AGD84, have been placed near the map corners

Geology by R. H. Smithies 1996

Edited by N. Tetlaw, C. Strong, and G. Loan

Cartography by S. Coldicutt and E. Green

Topography from the Department of Land Administration Sheet SF 50-7, 2455, with modifications from geological field survey

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MOUNT WOHLER

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