EXPLANATORY NOTES

GOVERNMENT OF WESTERN AUSTRALIA

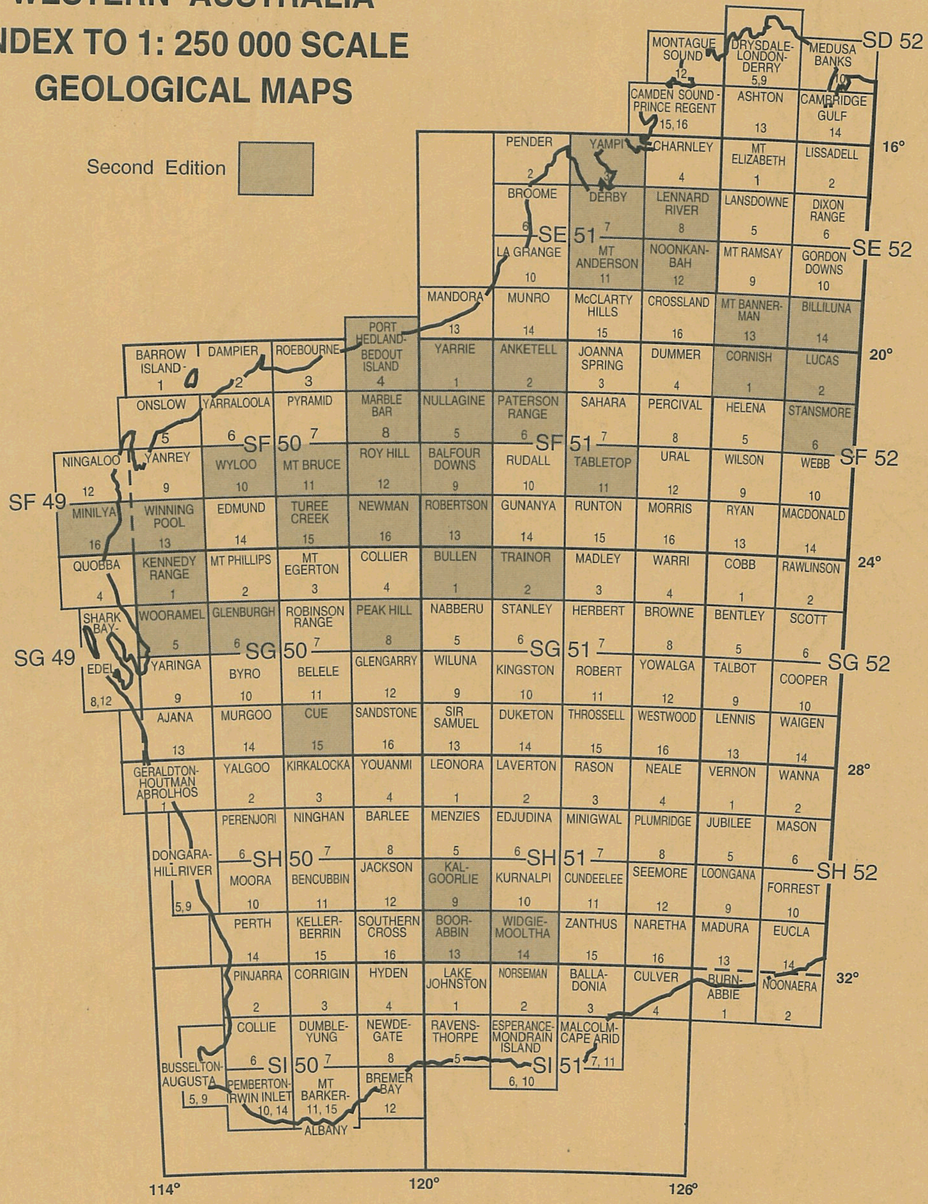
ROY HILL
1:250 000 SHEET
WESTERN AUSTRALIA

SECOND EDITION

SHEET SF 50-12 INTERNATIONAL INDEX

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
DEPARTMENT OF MINERALS AND ENERGY

WESTERN AUSTRALIA
INDEX TO 1: 250 000 SCALE
GEOLOGICAL MAPS



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

ROY HILL

WESTERN AUSTRALIA

SECOND EDITION

SHEET SF50-12 INTERNATIONAL INDEX

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

by A. M. Thorne and I. M. Tyler

INTRODUCTION

The ROY HILL* 1:250 000 map sheet (SF50–12) is bounded by latitudes 22°00'S and 23°00'S and longitudes 118°30'E and 120°00'E. There are no towns within the map sheet area, the nearest population centres being Newman (pop. 5000), Nullagine (pop. 150), Tom Price (pop. 3600) and the abandoned town of Wittenoom. Pastoral stations, wholly or partly within the map sheet area, are Bonney Downs, Hillside, Juna Downs, Marillana, Mulga Downs, and Roy Hill. The sealed Great Northern Highway, linking the towns of Newman and Port Hedland, crosses the western part of ROY HILL, whereas the eastern section is traversed by a gravel road (the former route of the Great Northern Highway) joining Newman and Nullagine. In addition, the centre of the map sheet is traversed by the unsealed Roy Hill–Wittenoom road, which crosses the single track Newman–Port Hedland railway in the area west of Marillana Station. The Karijini National Park covers the far western part of ROY HILL.

The climate is arid: annual rainfall is between 200 and 300 mm. Most rain falls from January to June. Summers are very hot: January maxima range from 36 to 44°C, minima from 24 to 28°C. Winters are mild: July maxima range from 20 to 25°C, minima from 5 to 11°C. Evaporation from a free water surface is about 3600 mm per year.

Most of ROY HILL forms part of the Fortescue Botanical District (Beard, 1975). Granitic rocks in the north are colonized by sparse shrubs, mainly Mulga (*Acacia aneura*) and snakewood (*A. xiphophylla*), and Buck Spinifex (*Triodia wiseana*). Elsewhere, outcrops of basaltic rock are characterized by a mosaic of *A. aneura, A. pyrifolia,* and *Triodia*, with *Eucalyptus brevifolia* on the steepest, rockiest areas. Iron formations of the Hamersley and Chichester Ranges are covered by the Snappy Gum (*E. brevifolia)–T. wiseana* association, and *E. gamophylla* is present locally. Most of the valley plains carry *A. aneura*; *E. camaldulensis* occurs along the major watercourses. Colluvium and sheetwash plains along the northern margin of the Hamersley Range are colonized by *T. basedowii, Hakea suberea,* and *E. gamophylla.* This association gives way to *A. aneura* woodland along much of the Fortescue River valley.

ROY HILL can be divided into three main physiographic zones corresponding broadly to the areas of granite–greenstone rocks, Hamersley Basin rocks, and Cainozoic deposits.

Granite–greenstone basement rocks form areas of low, rugged hills and ridges, and sandy valleys in north-central ROY HILL. Maximum elevation in this region is about 500 m and local relief is less than 100 m. Hamersley Basin rocks underlie most of the remaining map sheet area and give rise to a varied topography of high, rounded hills, plateaus, and strike ridges.

* Names of 1:100 000 and 1:250 000 scale map sheets are printed in capitals

Fortescue Group rocks outcrop in the Chichester Range, which forms the principal watershed separating the Fortescue and Shaw drainage systems. The most extensive upland areas are associated with the iron formations of the Hamersley Group that outcrop in the southern part of Roy Hill. Here, steep-sided gorges characterize the northern margin of the Hamersley Group outcrop, whereas further south the topography consists of a series of easterly trending hills and lowlands that reflect gentle fold patterns of the underlying geology. Folds which are cored with resistant Brockman Iron Formation give rise to the highest areas, e.g. Mount Meharry (1245 m) at 22°58'55"S, 118°35'11"E, whereas broad synclines containing Weeli Wolli Formation result in areas of relatively low relief, e.g. the central and eastern part of Marillana Creek (22°46'04"S, 119°12'05"E). Extensive areas of Cainozoic deposits form gently sloping plains, and broad valleys between the main outcrop areas. The largest of these is the Fortescue River valley, which transects the central part of the map sheet area and separates Hamersley Basin rocks in the Chichester Range from those in the Hamersley Range.

Early geological investigations in the area are summarized in the first edition explanatory notes for the Roy Hill 1:250 000 geological sheet (MacLeod and de la Hunty, 1966). More recent accounts are discussed in the following text.

TECTONIC SETTING

The main tectonic features of Roy Hill are shown in Figure 1. The map sheet area forms part of the Pilbara Craton, a region of Precambrian rocks that can be divided into two tectonic components: a granite–greenstone terrain, formed between 3.5 and 2.8 Ga, and an unconformably overlying volcano-sedimentary succession belonging to the Hamersley Basin. Granite–greenstone basement rocks outcrop in the extreme northern part of Roy Hill and 2.75 to 2.4 Ga Hamersley Basin rocks underlie the remainder of the map sheet area.

TERMINOLOGY

Hamersley Basin rocks have been subjected to greenschist facies metamorphism, but for the sake of brevity, the prefix 'meta' is not used in the description of these rocks.

PILBARA CRATON GRANITE–GREENSTONE ROCKS

Pilbara Craton granite–greenstone rocks are confined to the northern part of Roy Hill and comprise metamorphosed ultramafic rock, gabbro and hornblende schist, basalt and pyroxene spinifex-textured basalt; quartzofeldspathic and quartz–chlorite schist; banded iron-formation; biotite monzogranite and granodiorite; pegmatite and dolerite. On Roy Hill, the minimum age of these rocks is fixed by the ~2750 Ma age of the overlying lower Fortescue Group. Their maximum age is unknown, although comparison with similar granite–greenstone assemblages elsewhere in the Pilbara Craton (Hickman, 1990) indicates that they formed between 3.5 and 2.8 Ga.

Granite–greenstone rocks on Roy Hill have been subject to greenschist to amphibolite facies metamorphism (Hickman, 1983).

SERPENTINITE AND TREMOLITE–CHLORITE SCHIST (*Au*)

Localized occurrences of massive serpentinite and tremolite–chlorite schist are associated with metabasaltic rocks in the Western Shaw Belt (Fig. 1), e.g. at 22°00'07"S, 119°12'06"E.

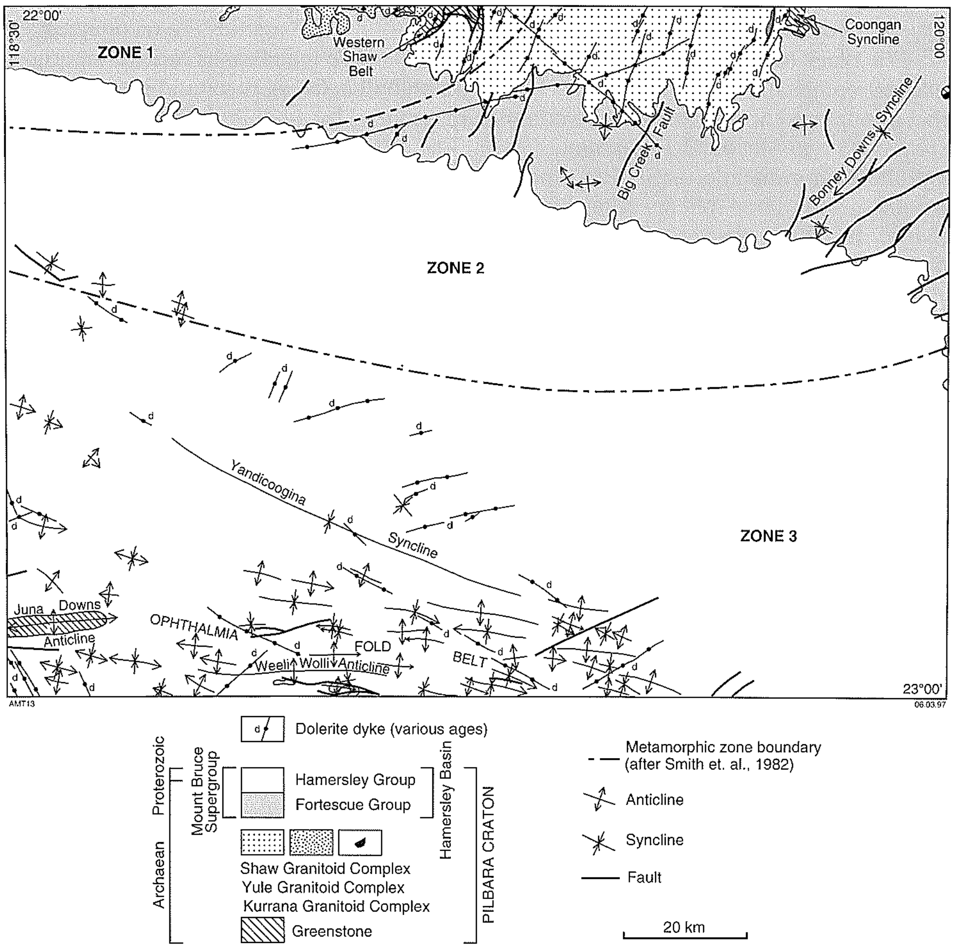

Figure 1. Simplified geological map of ROY HILL showing the main tectonic units

These ultramafic bodies are apparently concordant or sub-concordant within the basaltic succession although structural complexity makes it difficult to determine the boundary relationships. In thin-section massive serpentinite consists of a medium- to coarse-grained assemblage of serpentine (antigorite) with subordinate chlorite, tremolite, carbonate, and iron oxide.

METAMORPHOSED BASALT (*Ab*) AND PYROXENE SPINIFEX-TEXTURED BASALT (*Abm*)

Metamorphosed, moderately to strongly foliated basalt and pyroxene spinifex-textured basalt are the dominant rock types in the Western Shaw Belt, and also outcrop in the southern extremity of the Coongan Syncline (Hickman, 1983) around 22°01'S, 119°08'E and 22°02'S, 119°45'E (Fig. 1).

Metabasalt forms massive, generally non-vesicular flows which occur interbedded with metamorphosed pyroxene spinifex-textured basalt and metadolerite. The metabasalt is commonly schistose and may have been subject to carbonitization and silicification. Where former igneous textures are preserved, aphyric or porphyritic varieties are recognized, and variolitic types occur locally. The present mineralogy of the metabasalts reflects an original tholeiitic composition and the greenschist to amphibolite facies metamorphism such that relict clinopyroxene phenocrysts are completely replaced by amphibole, and plagioclase is extensively saussuritized (Hickman, 1983). The general mineralogy of these rocks is amphibole (hornblende, actinolite, and tremolite), quartz, albite, epidote, chlorite and carbonate, and minor sphene, clinozoisite, prehnite, and pumpellyite. Textures range from basaltic, in which phenocrysts of relict pyroxene are set in a fine-grained intergranular groundmass, to metamorphically recrystallized, in which large fibrous to bladed subhedral actinolite or hornblende crystals commonly make up over half the rock.

Metamorphosed spinifex-textured basalts are usually pale grey and medium-grained. Most are non-vesicular, and schistose. The present mineralogy of these rocks reflects a former high-Mg basalt composition and the lower greenschist to amphibolite facies metamorphism, and comprises recrystallized acicular to plumose tremolite in a finer grained matrix of chlorite, epidote–clinozoisite, and sphene.

METAGABBRO AND HORNBLENDE SCHIST (*Aog*)

Strongly foliated metagabbro and hornblende schist outcrop within the greenstone succession in the Western Shaw Belt around 22°01'00"S, 119°15'30"E. In areas where the level of deformation is relatively low, the outcrops either comprise massive leucocratic or melanocratic gabbro or else consist of ~5 m thick alternations of these two rock types. Metadolerite is also associated with the metagabbro locally.

Despite the effects of metamorphism and subsequent saussuritization and carbonatization, original igneous textures are preserved in some outcrops. Former pyroxene is replaced by hornblende or actinolite, which is itself partially or completely converted to chlorite. Large crystals of calcic plagioclase are partially altered to epidote/clinozoisite and carbonate, and former ilmenite is replaced by granular sphene.

The small area of metagabbro and metadolerite which intrudes the Kurrana Granitoid Complex at 22°07'00"S, 119°59'40"E post-dates the major deformation and metamorphic events within the greenstone succession. It forms part of the Black Range Dyke Suite (Hickman, 1983), and is coeval with lower Fortescue Group deposition (Wingate, 1994).

SCHIST DERIVED FROM IGNEOUS ROCKS (*Al*)

Quartzofeldspathic schist, quartz–chlorite schist, and quartz–muscovite schist outcrop in a narrow zone adjacent to a southeasterly trending sinistral strike-slip fault in the southeastern part of the Western Shaw Belt (22°01'30"S, 119°14'30"E). Quartzofeldspathic schist is strongly foliated, porphyroclastic, and may develop a mylonitic fabric locally. Relict textures suggest that these rocks formed from a porphyritic monzogranite protolith.

Quartz–chlorite schists are generally fine- to medium-grained and contain lenticular, or ribbon-like, porphyroclasts of recrystallized quartz set in a matrix of strongly aligned chlorite and leucoxenized opaques. Quartz–muscovite schist occurs tectonically interleaved with the other rock types, and contains isolated lenses of less deformed coarse-grained metasandstone protolith in some outcrops.

BANDED IRON-FORMATION (*Aci*)

Banded iron-formation (BIF) and ferruginous chert occur interbedded with metabasaltic rocks in the Western Shaw Belt. The BIF units are about 40 m thick and thinly bedded, and comprise dark grey or black, magnetic, iron-rich layers interlayered with lighter coloured chert-rich bands. In thin section the rock consists of millimetre to centimetre thick layers of anhedral magnetite and microcrystalline quartz alternating with layers composed dominantly of anhedral microcrystalline quartz.

METAMORPHOSED GRANITOID ROCKS

Although affected by low-grade metamorphism, granitoid rocks on ROY HILL show the mineralogy and textures that are typical of intrusive granitoids.

Granitoid rocks on ROY HILL are assigned to 3 tectonic units — the Shaw, Yule, and Kurrana Granitoid Complexes — which equate to the Shaw, Yule, and Kurrana Batholiths of Hickman (1983). The contact between the Shaw and the Yule Granitoid Complexes is marked by a northeast-trending shear zone, whereas the Shaw and Kurrana Granitoid Complexes are separated by Fortescue Group rocks.

Kurrana Granitoid Complex (*AgKm*)

On ROY HILL, the Kurrana Granitoid Complex is exposed in a small area around 22°07'20"S, 120°00'00"E. Here it consists of foliated monzogranite (*AgKm*) in which the principal rock-forming minerals are oligoclase, quartz, microcline, and minor biotite (Hickman, 1983).

Yule Granitoid Complex (*AgYa, AgYm*)

The Yule Granitoid Complex outcrops to the west of the Shaw Granitoid Complex and is represented by two major rock units on ROY HILL: the Tambourah Granodiorite (*AgYa*) and metamorphosed biotite monzogranite and granodiorite (*AgYm*).

The Tambourah Granodiorite (Hickman, 1983) outcrops around 22°01'00"S,119°01'00" where it contains amphibolite pods and is extensively intruded by late-stage pegmatite. In most outcrops the rock is a well-foliated, medium- to coarse-grained biotite granodiorite, the foliation being defined by the alignment of biotite, feldspar, quartz grains and leucosome veins. Typically, the mineralogy comprises oligoclase, quartz, microcline, biotite, and hornblende locally, whereas accessory minerals include apatite, zircon, and allanite (Hickman, 1983).

Metamorphosed biotite monzogranite and granodiorite (*AgYm*) are confined to a small area close to the Fortescue Group unconformity around 22°00'30"S, 118°52'00"E. The contact between these rocks and the Tambourah Granodiorite is not exposed on ROY HILL, but on neighbouring MARBLE BAR this boundary is an arcuate, northeast-trending shear zone (Hickman, 1983).

Shaw Granitoid Complex (*AgSm, AgSb*)

The Shaw Granitoid Complex forms the largest area of granite–greenstone rocks on ROY HILL. Two major rock units are recognized in the map sheet area: metamorphosed biotite monzogranite and granodiorite (*AgSm*) and the Bamboo Springs Monzogranite (*AgSb*). Both these rock units are extensively intruded by late-stage pegmatite, and aplite veins are also present in many outcrops.

Metamorphosed, medium- to coarse-grained biotite monzogranite and granodiorite are the dominant rock types in the Shaw Granitoid Complex on ROY HILL. They intrude the greenstone succession in the Western Shaw Belt and around 22°02'S, 119°45'E, and are separated from the Yule Granitoid Complex by a northeast-trending shear zone. No contact relationships with the Bamboo Springs Monzogranite were observed.

Biotite monzogranite and granodiorite are weakly to strongly foliated and have been metamorphosed at low grade. The mineralogy of the monzogranite consists of quartz, orthoclase and microcline (both commonly perthitic), plagioclase (oligoclase or albite), and variable amounts of biotite, which is partially or completely replaced by chlorite. Accessory minerals include zircon, apatite, and sphene. Granodiorite is composed largely of plagioclase (mostly oligoclase), quartz, orthoclase, microcline, variable amounts of hornblende, and minor biotite, commonly altered to chlorite. Quartz and oligoclase are locally intergrown to produce a myrmekitic texture. The principal accessory minerals are sphene, epidote, apatite, and zircon.

The Bamboo Springs Monzogranite (*AgSb*) is equivalent to the Bamboo Springs Adamellite of Hickman (1983) and outcrops to the northeast of Hillside outcamp at 22°05'00"S, 119°18'30"E, and in a small area around 22°04'40"S, 119°28'10"E. It consists of medium- to coarse-grained porphyritic biotite monzogranite and has been metamorphosed under low-grade conditions. Some of the feldspar phenocrysts are up to 20 mm in length. The monzogranite outcrops are either massive or else show a steep 060° trending fabric defined by a combination of the distribution and alignment of feldspar phenocrysts and the metamorphic foliation. In thin section the rock consists of microcline phenocrysts set in a matrix of anhedral oligoclase, microcline, quartz, and biotite.

Pegmatite veins

Irregular pegmatite veins and pods, ranging in width from a few centimetres to several metres, intrude all granitoid rock types on ROY HILL but are not shown on the accompanying map sheet. Few exposures fail to exhibit pegmatites of some variety, and at many localities several phases of pegmatite are evident from cross-cutting relationships (Hickman, 1983). The principal minerals are quartz, K-feldspar and plagioclase, and mica, and most crystals vary in diameter up to about 150 mm. The low-grade metamorphism that has affected all the felsic intrusive rocks generally has resulted in only very minor recrystallization in the pegmatites.

GRANITE–GREENSTONE STRUCTURE

The principal tectonic units within the granite–greenstone succession on ROY HILL are shown in Fig. 1. Granitic rocks make up the Shaw, Yule and Kurrana Granitoid Complexes whereas greenstone rocks form the southern parts of the Western Shaw Belt and Coongan Syncline (Hickman, 1983). Within the map sheet area, contacts between the Shaw Granitoid Complex and the Coongan Syncline are intrusive, whereas the boundary between these granitic rocks and the Western Shaw Belt is either intrusive or structural. Contacts between the Yule Granitoid Complex and both the Western Shaw Belt and the Shaw Granitoid Complex are structural.

Three major pre-Fortescue Group deformation events (D_1–D_3) are recognized within the granite–greenstone succession on ROY HILL. The D_1 and D_2 structures described here appear to correspond to the Main Deformation (D_2) of Hickman (1983) whereas the D_3 structures probably equate to his D_3 event.

In the Western Shaw Belt the earliest fabric recognized formed during D_1 and is a steeply dipping, moderate to strong schistosity (S_1) developed parallel or sub-parallel to bedding. This schistosity is defined by the alignment of platy metamorphic minerals such as actinolite, chlorite, serpentine, and tremolite, and also by secondary quartz. In the extreme southwestern part of the Western Shaw Belt, bedding and the S_1 foliation are refolded about steeply northeastward plunging, upright, open folds formed during a subsequent deformation, D_2. These fold axes are associated with a weak to strong, steeply dipping, northeast-trending crenulation cleavage (S_2). Intrusion of the biotite monzogranite within the Shaw Granitoid Complex post-dates the S_1 foliation, but the timing of this event relative to D_2 is unknown.

Most of the eastern boundary between the Western Shaw Belt greenstones and the main body of biotite monzogranite within the Shaw Granitoid Complex is marked by a series of northeast to north-northwest trending curvilinear shears and associated splays which formed during the subsequent deformation event, D_3. These faults cross-cut both the S_1 and S_2 foliations within the greenstones and are themselves associated with a moderate to strong, steeply dipping S_3 foliation, developed parallel to the main shear planes. The principal north to northeast trending foliation developed throughout the Shaw Granitoid Complex is also attributed to D_3 deformation. This foliation pre-dates the intrusion of the youngest pegmatite vein network in the complex.

The eastern boundary of the Yule Granitoid Complex is a major north-northeast trending, easterly dipping, curvilinear shear which is also interpreted as a D_3 structure. Shear-sense indicators associated with this fault record an east-block down sense of movement. The strong north northeast-trending S_3 foliation in the adjacent Tambourah Granodiorite is cross-cut by an extensive network of late-stage pegmatite veins.

HAMERSLEY BASIN

The Hamersley Basin is a late Archaean to early Proterozoic (2765–2470 Ma) depositional basin which is exposed over most of the southern part of the Pilbara Craton. Three major stratigraphic units (collectively referred to as the Mount Bruce Supergroup) are recognized within the basin; these are, in ascending order, the Fortescue, Hamersley and Turee Creek Groups. Of these, only the Fortescue and Hamersley Groups outcrop on Roy Hill.

FORTESCUE GROUP

The Fortescue Group is the lowermost stratigraphic unit of the Hamersley Basin and was deposited between 2765 and 2687 Ma (Arndt et al., 1991). It is exposed throughout the Chichester Range, in the northern part of Roy Hill, where it rests with angular unconformity upon granite–greenstone basement, and it also forms small inliers in the southern part of the map sheet area. In the Chichester Range the Fortescue Group is about 1.8 km thick and consists of low-grade volcanic and sedimentary rocks. Four formations are recognized on Roy Hill: they are, in ascending order, the Kylena Basalt, Tumbiana Formation, Maddina Basalt, and Jeerinah Formation. Lower formations of the Fortescue Group, namely the Mount Roe Basalt and the Hardey Formation, which occur in other areas of the Pilbara, do not outcrop on Roy Hill.

Kylena Basalt (*AFk*)

The Kylena Basalt outcrops in the eastern part of the Chichester Range where it unconformably overlies the irregular granite–greenstone surface. It has an estimated maximum thickness of about 75 m on Roy Hill and comprises dark grey to grey-green basalt and minor volcaniclastic rock. Thin, lenticular bodies of feldspathic quartz sandstone, lithic quartz sandstone and conglomerate mark the base of the Kylena Basalt locally.

Most Kylena Basalt flows are 3–10 m thick and show massive to sparsely vesicular lower and middle levels while upper parts are moderate to strongly vesicular. Some flow tops are transitional upwards into thin beds of basaltic breccia. Most of the basalt is aphyric to sparsely feldspar-phyric.

Tumbiana Formation (*AFt*)

The Tumbiana Formation ranges in thickness from 0 m around 22°12'S, 119°37'E to about 150 m in the Bonney Downs Syncline. The formation either overlies the Kylena Basalt with apparent conformity, or else unconformably rests on granite–greenstone basement. The Tumbiana Formation consists largely of reworked, fine- to coarse-grained, mafic to intermediate volcaniclastic rocks; stromatolitic carbonate rock; basalt, and minor chert. In addition, thin lenticular quartzofeldspathic sandstone and conglomerate units occur locally in areas where the Tumbiana Formation rests directly on granite–greenstone basement.

Volcaniclastic sandstone and siltstone form friable, grey-green weathering units up to 30 m thick. Units are tabular bedded and internal structure generally consists of horizontal lamination and ripple cross-lamination; small stromatolitic buildups and isolated accretionary lapilli occur within some beds. Thin (0.02–0.25 m) beds of closely packed accretionary lapilli tuff also occur within many volcaniclastic units. Most beds have sharp, non-erosive bases and sharp or gradational tops; some are ungraded, others show normal or reverse grading. Accretionary lapilli generally range in size from 2–10 mm and most are characterized by a concentric internal structure.

Stromatolitic and fenestral dolomite and limestone quartz-lithic calcarenite and dolarenite, and minor dolorudite occur as thin interbeds within the volcaniclastic rocks and also form the major component of the 60 m-thick Meentheena Member (*AFtc*) in the upper part of the formation.

Stromatolitic and fenestral carbonates display a variety of primary and diagenetic sedimentary structures including: straight-crested symmetrical and asymmetrical ripples, teepee structures, pebble rosettes, desiccation cracks and evaporite pseudomorphs (Packer, 1990). Many beds have also undergone varying amounts of silicification. Quartz-lithic calcarenite and dolarenite display a variety of stratification styles including horizontal, and low-angle planar cross-stratification, small- to medium-scale trough cross-stratification, undulatory lamination, and ripple cross-lamination.

Packer (1990) described four stromatolite types (A to D) from the Tumbiana Formation. Her type A stromatolite corresponds to *Alcheringa narrina* (Walter, 1972) and forms individual columns and domed to tabular biostromes. The type B stromatolite forms biostromes and bioherms with relief locally in excess of 0.5 m. Individuals are columnar in shape and column attitude is erect to slightly inclined. Type C, or tufted stromatolites, form domed to tabular biostromes. The shape of individuals is linked conical to cumulate; in thin section they resemble the outline of a pine tree. Type D stromatolites form domed mushroom-shaped bioherms and the shape of individuals is columnar layered to pseudocolumnar with divergent branches.

Fenestrae occur in stromatolitic and non-stromatolitic carbonates. They are irregular spherical to laminoid in shape and are infilled by various combinations of sparry calcite, chert, and megaquartz crystals. Packer (1990) noted that some fenestrae contain chert pseudomorphs after gypsum.

Basalt flows are a minor component of the Tumbiana Formation and occur interbedded with volcaniclastic facies. Flows range in thickness from less than a metre to 35 m. The thickest flows (*AFtl*) occur in northwest Roy Hill around 22°01'30"S, 118°51'00"E. Here they develop columnar and tortoiseshell jointing locally. Thin flows are laterally discontinuous over hundreds of metres and are bounded by parallel or sub-parallel flow surfaces that exhibit gentle, irregular undulations. Flow tops generally exhibit irregular to broadly symmetrical undulations and are rarely scoriaceous. Flow bases are generally smooth and follow irregularities in the underlying surface. Most flows are aphyric and massive in the middle levels. Lower parts of the flows contain 5–25% of spherical amygdules, whereas upper levels are characterized by a much greater proportion (30–65% of the rock) of large, spherical to irregularly rounded or streaked amygdules. Amygdules usually range in size up to about 30 mm and occur either scattered randomly throughout the rock or concentrated in flow-aligned clusters. Most amygdules are filled by quartz, carbonate, and chlorite.

The variety of rock types and their associated primary and diagenetic structures indicates that the Tumbiana Formation was deposited in a low-energy coastal setting during a period of intermittent volcanic activity.

Maddina Basalt (*AFm*)

The Maddina Basalt conformably overlies the Tumbiana Formation except for the area around 22°12'00"S, 119°38'00"E where it is unconformable on granite–greenstone basement. In these notes the Maddina Basalt is equivalent to the combined Nymerina Basalt, Kuruna Siltstone, and Maddina Basalt of Hickman (1983). The formation has a maximum thickness of about 350 m and comprises thin or thick basaltic lava flows interbedded with sedimentary units (*AFms*) . The upper and more persistent of these units is here referred to as the Kuruna Member (*AFmk*) and is equivalent to the Kuruna Siltstone of Hickman (1983).

Thick (5–30 m), massive to amygdaloidal basalt flows are the most abundant flow type in the Maddina Basalt. These are characterized by a high proportion (20–65% of the rock) of large spherical to irregularly rounded or streaked amygdules in upper parts of the flows. These upper levels contrast with lower and middle parts of flows which commonly contain only a few percent of amygdules. Most amygdules range in size up to about 30 mm and occur either scattered randomly throughout the rock, or concentrated in folded, flow-aligned clusters and plumes or bedding-parallel layers. Vertical amygdule cylinders, up to 0.15 m in diameter and >1.0 m long, are recorded in the lower parts of some flows whereas upper levels may contain bedding-parallel, blister-like cavities with abundant gas escape structures on the cavity floor. The majority of amygdules are filled by various combinations of quartz, carbonate, and chlorite.

Thick basalt flows are bounded by tabular flow surfaces which exhibit gentle, irregular undulations at outcrop scale. Flow tops generally exhibit irregular to broadly symmetrical undulations and may be scoriaceous; flow bases are sharp and irregular. Most thick basalts show little systematic jointing, although columnar joints and bedding-parallel partings have been observed locally. In addition, some flows are cross-cut by an irregular network of small fractures and bedding-parallel joints. Their combined effect is to give the flow a bedded, pseudobrecciated appearance.

Thick, massive-to-amygdaloidal flows are fine- to very coarse-grained (generally 50–3000 µm) and aphyric, although Smith (1975) noted the presence of plagioclase-phyric varieties locally. Intersertal and intergranular textures dominate most basalts whereas ophitic clinopyroxene is present in some of the thickest flows.

Thin (< 5 m thick) flows contain a significant volume (10–20 %) of amygdules in their lower parts and 30–65% amygdules in upper levels. Amygdules are spherical to irregularly rounded or streaked, and occur scattered randomly throughout the rock or concentrated in flow-aligned clusters. Flow tops generally exhibit irregular to broadly symmetrical undulations and are rarely scoriaceous; flow bases are generally sharp and irregular. No systematic jointing was observed in these flows.

Three distinctive sedimentary units, ranging in thickness up to 30 m, are recognized on northeastern ROY HILL. Of these, only the uppermost unit, the Kuruna Member, can be traced west of the Big Creek Fault (22°11'30"S, 118°30'40"E). In addition, all 3 sedimentary units appear to die out east of a north northeast-trending fault near Deep Well (22°18'35"S, 120°02'20"E) on neighbouring BALFOUR DOWNS.

The sedimentary units comprise mafic to intermediate volcaniclastic sandstone and siltstone, accretionary lapilli tuff, stromatolitic carbonate rock, and quartz sandstone. Volcanic sandstone and siltstone, and lapilli tuff occur in friable, grey-green weathering units up to 30 m thick. Bedding is tabular, and internal structure generally consists of horizontal lamination and ripple cross-lamination; small stromatolitic buildups and isolated accretionary lapilli occur within some beds. Thin (0.02–0.25 m) beds of closely packed accretionary lapilli tuff occur within all three sedimentary units. Most beds are laterally persistent, but some are discontinuous and fill hollows and cracks in the underlying surface. Beds have sharp, non-erosive bases and sharp or gradational tops; some are ungraded, others show normal or reverse grading. Accretionary lapilli generally range in size from 2–12 mm, and most are characterized by a concentric internal structure.

Fine- to coarse-grained quartz sandstone, or quartzitic calcarenite, occurs in tabular units up to 7 m thick. Lower contacts, where observed, are erosional, upper contacts sharp and usually overlain by a subaerial basalt flow. Internal structure is dominated by planar to undulatory parallel lamination, small- to medium-scale trough cross-stratification, or ripple cross-lamination. Current lineation is present on some bedding surfaces.

Stromatolitic carbonate, often partially silicified, forms beds 0.05–0.4 m thick or small lenticular buildups within volcanic sandstone and siltstone units. Beds are commonly characterized by very irregular, horizontal to inclined lamination which merges laterally into small domical, bulbous, or nodular stromatolites. Larger, bulbous forms are similar in gross morphology to *Alcheringa narrina* Walter (1972).

In northeast ROY HILL the Kuruna Member is up to 30 m thick and can be subdivided into three divisions: a lower silt- to sand-sized mafic volcaniclastic division; a middle division consisting of thin beds of packed accretionary lapilli, alternating with layers of partly silicified stromatolitic carbonate; and an upper division of silt- to sand-sized mafic volcaniclastic rock, capped locally by quartz sandstone or quartzitic calcarenite. In outcrops west of the Big Creek Fault, the member's thickness is reduced to less than 10 m, and it consists largely of quartzitic calcarenite.

Jeerinah Formation (AFj)

In the Chichester Range, on northern ROY HILL, the Jeerinah Formation conformably overlies the Maddina Basalt and is conformably overlain by the Marra Mamba Iron Formation of the Hamersley Group. Although there are considerable lithological differences between the Jeerinah Formation and underlying parts of the Fortescue Group in this area, there appears to be no evidence of significant post-Maddina Basalt–pre-Jeerinah Formation erosion, and the contact between these units is regarded as a non-erosional, marine flooding surface (Thorne and Trendall, in prep.).

Throughout the Chichester Range the Jeerinah Formation has a maximum thickness of about 150 m and comprises a basal quartz sandstone (Woodiana Member (*AFjo*)) overlain by carbonaceous pelite, chert, and minor thin-bedded sandstone. Thin-bedded dolomite and pelite (*AFjd*) characterize middle and upper parts of the Jeerinah Formation in the east of the map sheet area.

The Woodiana Member ranges in thickness from about 20–60 m and comprises silicified fine- to coarse grained quartz sandstone, conglomerate, and argillite, the latter becoming more dominant in upper levels. Sandstone beds are mostly 0.05–1.5 m thick and display a range of sedimentary structures including trough and planar-tabular cross-stratification, undulatory stratification and hummocky cross-stratification, and symmetrical and asymmetrical straight-crested ripples. Some bedding surfaces are marked by chert granule or pebble lags.

The overlying pelitic units are generally parallel-laminated or, more rarely, ripple cross-laminated, and weather to a white, pink, or red colour. Fresh material is black and finely laminated with thin layers of chert, sandstone, carbonate and massive sulfide. Thin-bedded sandstones are interlayered with argillite although the proportion of these coarser layers decreases up section. Sandstone beds are tabular to sub-lenticular with sharp erosive bases and gradational tops. Many are normally graded. The thickest beds have undulatory lamination, others are planar parallel-laminated, and low-angle ripple cross-lamination is observed locally. Tabular to nodular dolomite beds occur interbedded with carbonaceous pelite around 22°21'S, 119°59'E. Most are recrystallized and show wavy stylolitic lamination; however, some appear to contain relict domical stromatolites, ripple cross-lamination, and structureless dolorudite.

Only the upper part of the Jeerinah Formation is exposed in the Hamersley Range on southern Roy Hill. Here, the formation consists of mudstone and siltstone; chert; and basaltic lava. Interlayered, massive, medium-to coarse-grained dolerite (*AFd*) is a feature of this area.

HAMERSLEY GROUP

Marra Mamba Iron Formation (*AHm*)

The Marra Mamba Iron Formation is the lowest unit of the Hamersley Group, and conformably overlies the Jeerinah Formation. It has been divided into three members (Kneeshaw, 1984; Blockley et al., 1993), but because of their limited thickness and the generally poor quality of exposure of these units on Roy Hill this subdivision is not shown on the map.

The Nummuldi Member is the lowest unit and is estimated to be 60–100 m thick in the Roy Hill area. It consists of alternating yellow to yellow-brown chert and brown to black iron-formation mesobands. Podding of the banding is commonly seen. The overlying MacLeod Member is about 45 m thick, and comprises interlayered thin shales, chert and BIF. The contact between the Nammuldi Member and the MacLeod Member is marked by a distinctive podded chert layer known as the 'potato bed'. The uppermost division, the Mount Newman Member, is estimated to be about 60 m thick and consists dominantly of BIF with thin shale intervals.

Wittenoom Formation (*AHd*)

The Wittenoom Formation (formerly Wittenoom Dolomite) is one of the most heterolithic units of the Hamersley Group, and is estimated to vary between 300 m and 600 m thick on ROY HILL. It is subdivided into 3 members: a lower West Angela Member, a middle Paraburdoo Member, and an upper Bee Gorge Member (Simonson et al., 1993; Blockley et al., 1993). This subdivision is not shown on the map.

The West Angela Member has a maximum thickness of about 100 m and consists primarily of dolomite and dolomitic argillite. Chert is abundant in lower parts of the member but forms only a minor component towards the top. Sedimentary structures within the argillaceous beds include reverse graded-bedding and flame structures. Pyrite occurs in argillite beds as blebs and bedding-parallel stringers, and as fracture fillings (Blockley et al., 1993).

The Paraburdoo Member (Simonson et al., 1993) is estimated to be between 50 m and 250 m thick on ROY HILL. It consists of thin- to thick-bedded dolomite with minor amounts of chert and argillite, and almost always displays even, tabular bedding. Most dolomite beds are a few centimetres to several decimetres thick; argillite layers are thinner on average, occurring in the form of sub-millimetre partings to thin beds up to a few centimetres thick.

The Bee Gorge Member (Simonson et al., 1993) is estimated to be between 150 m and 250 m thick in the map sheet area. Thinly laminated graphitic argillite is the main lithology, together with subordinate thicknesses of carbonate, chert, volcaniclastic rock, and iron-formation. Many of the non-argillite lithologies display clastic textures and current-formed structures. Simonson (1992) and Simonson et al. (1993) interpreted a layer of sand-sized potassium feldspar spherules that occurs within the Bee Gorge Member as melt droplets that were originally part of a strewn field generated by a major bolide impact.

Mount Sylvia Formation and Mount McRae Shale (*AHs*)

The Mount Sylvia Formation conformably overlies the Wittenoom Formation and varies in thickness from 30–50 m. The formation consists of shale, dolomitic shale and three prominent BIF layers, two of which mark, respectively, the base and top of the unit. The upper BIF is the distinctive Bruno's Band which serves as a prominent marker throughout the map sheet area.

The Mount McRae Shale conformably overlies the Mount Sylvia Formation and is usually between about 60–90 m thick. Argillite and dolomitic argillite dominate much of the stratigraphy, although thin-bedded chert is also abundant in upper levels. Between Mount Lockyer (22°27'40"S, 118°45'40"E) and the western boundary of ROY HILL a persistent chert band, about 2 m thick, occurs in the middle part of the Mount McRae Shale.

Brockman Iron Formation (*EHb*)

The Brockman Iron Formation is the main iron-formation within the Hamersley Group and has been described in detail by Trendall and Blockley (1970). It has an estimated maximum thickness of 600 m and consists of four members that are recognized throughout ROY HILL: the Dales Gorge Member, the Whaleback Shale Member, the Joffre Member, and the Yandicoogina Shale Member.

The Dales Gorge Member ranges in thickness from 110–140 m and consists of an alternating sequence of 17 BIF and 16 argillite macrobands (Trendall and Blockley, 1970). Compston et al. (1981) reported a U–Pb zircon age of 2490 ± 20 Ma from the S13 macroband of the Dales Gorge Member.

The Whaleback Shale Member overlies the Dales Gorge Member and is composed predominantly of interlayered chert and shale with two BIF bands occurring near the base. The thickness of this member on ROY HILL is about 50 m. The Joffre Member overlies the Whaleback Shale and consists of 350 m of BIF with minor thin shale horizons. The 60 m thick Yandicoogina Shale Member has a sharp contact with the underlying Joffre Member in the Yandicoogina Creek area (22°49'S, 119°11'E) and comprises alternating chert and thin shale.

Weeli Wolli Formation (*ɆHj*)

The Weeli Wolli Formation is estimated to be between 300 and 450 m thick and consists of 5–10 m thick, typically jaspilitic, iron-formation, together with shale and chert. The formation has been intruded by several dolerite sills giving a distinctive, broadly striped appearance to the outcrops. The most prominent of these sills (*ɆHt*) intrudes the upper part of the Weeli Wolli Formation in the Marillana Creek (22°44'S, 119°08'E) and Weeli Wolli Spring (22°54'S, 119°12'E) areas.

Woongarra Rhyolite (*ɆHw*)

The Woongarra Rhyolite (formerly Woongarra Volcanics; Trendall, 1995) overlies the Weeli Wolli Formation and is itself conformably overlain by the Boolgeeda Iron Formation. The total thickness of this unit is about 300 m on adjacent parts of NEWMAN and is divisible into 3 units: a lower massive rhyolite; a median raft of BIF, shale, and dolerite; and an upper massive rhyolite. Only the lower rhyolite unit is exposed on ROY HILL, outcropping in a small area around 22°52'30"S, 119°29'20"E. Here, the Woongarra Rhyolite overlies a 30 m thick columnar jointed dolerite and consists of massive, fine- to medium-grained rhyolite to rhyodacite.

Trendall (1995) argued that both the upper and lower units of the Woongarra Rhyolite were emplaced as sills, having been injected via a comparatively small feeder pipe in the central part of the Hamersley Basin.

Reported multi-grain U–Pb zircon ages of 2470 ± 30 Ma (Compston et al., 1981) and 2439 ± 10 Ma (Pidgeon and Horwitz, 1991) — the latter includes single-grain analyses — provide the best estimate for the age of the Woongarra Rhyolite (Trendall, 1995).

Boolgeeda Iron Formation (*ɆHo*)

The Boolgeeda Iron Formation, the uppermost formation of the Hamersley Group, is confined to the southeastern part of ROY HILL, at around 23°00'S, 119°40'E. It comprises fine-grained, black to dark yellow-brown, finely laminated, magnetic BIF and has a preserved thickness of about 60 m. The top of the formation is not exposed in this area.

METAMORPHISM

It was thought initially that rocks in the Hamersley Basin were little affected by regional metamorphism (Trendall and Blockley, 1970). A study by Smith et al. (1982), however, established a four-fold zonal pattern of very low- and low-grade metamorphism, based mainly on assemblages observed in mafic volcanics from the Fortescue Group.

On ROY HILL Hamersley Basin rocks lie within the lower 3 metamorphic zones of Smith et al. (1982). Zone 1, the prehnite–pumpellyite zone, is the lowest grade recognized and covers the northwestern Chichester Range (Fig. 1). Zone 2, the prehnite–pumpellyite–epidote zone, includes the northeastern Chichester Range and northern part of the Hamersley Range. Zone 3 is defined by the assemblage prehnite–pumpellyite–epidote–actinolite and covers the southern part of ROY HILL.

The overall zonal pattern observed by Smith et al. (1982) showed that metamorphic grade increased towards the southern margin of the Hamersley Basin. This is coincident with a general increase in stratigraphic thickness of Hamersley Basin sedimentary rocks, and the zonal pattern was interpreted as the product of a regional burial metamorphism (M_h). The appearance of lower grade rocks at the southern margin of the basin was explained by Smith et al. (1982) as the result of local thickening of the Fortescue Group and thinning of the Hamersley Group. Tyler (1991) considered their presence to be the result of later burial metamorphism beneath the Ashburton Basin.

The isograds and zones identified by Smith et al. (1982) are based on assemblages in the Fortescue Group, in the lower part of the Mount Bruce Supergroup. Stratigraphically higher units reached correspondingly lower grades (Smith et al., 1982, fig. 3). When all the units in the Hamersley Basin are considered, the isograd pattern is more complex than that interpreted by Smith et al. (1982) and appears to reflect the fold pattern, with lower grade rocks in the synclines and higher grade rocks in anticlines. Metamorphic conditions were between 300°C at 120 MPa and 470°C at 250 MPa (Smith et al., 1982).

CAPRICORN OROGEN STRUCTURE

The southern part of ROY HILL forms part of the northern margin of the Capricorn Orogen (Fig. 2), a major zone of deformed, low- to high-grade metamorphic rocks and granitoid intrusions formed during continental crustal collision between the Pilbara and Yilgarn Cratons about 2000–1700 Ma (Gee, 1979; Myers, 1990a; Tyler and Thorne, 1990; Thorne and Seymour, 1991)

Previous interpretations of structural development in the northern Capricorn Orogen have been based on 1st edition mapping and are summarized in MacLeod et al. (1963), Halligan and Daniels (1964) and MacLeod (1966). In general, an increasing intensity of deformation was recognized from the Fortescue Valley southwards with two fold periods, the Ophthalmian and the Rocklean, inferred from the presence of large-scale dome-and-basin structures interpreted as fold interference patterns. Folding was regarded as passive, formed as a response to essentially vertical movements in the basement. Due to the absence of small-scale folds that could be attributed to the Rocklean fold period, Gee (1979) re-interpreted the fold pattern as a single set of folds with curvilinear axes. Trendall (1979) documented an unconformity between the Wyloo Group and the Mount Bruce Supergroup. This enabled Gee (1979) to separate structures into two fold belts: the Ophthalmia Fold Belt, and the younger Ashburton Fold Belt.

In the southwestern part of the Hamersley Basin the Ophthalmia Fold Belt is characterized by broad-scale, open fold structures having a mainly northwesterly trend, which corresponds to the central structural zone of MacLeod et al. (1963). Tyler (1991) identified a regional-scale foreland fold-and-thrust belt in the southeastern Hamersley Basin characterized by easterly trending, close to tight folds with short wavelengths, corresponding to the southern structural zone of MacLeod et al. (1963). Structural and stratigraphic relationships along the margin between the Ophthalmia and Ashburton fold belts suggest that these two groups of folds represent different events (Thorne and Tyler, in press). Deformation to produce the open fold structures was attributed by Tyler (1992) to dextral transpression along the southern Pilbara margin during the early stages of the Capricorn Orogeny of Gee (1979),

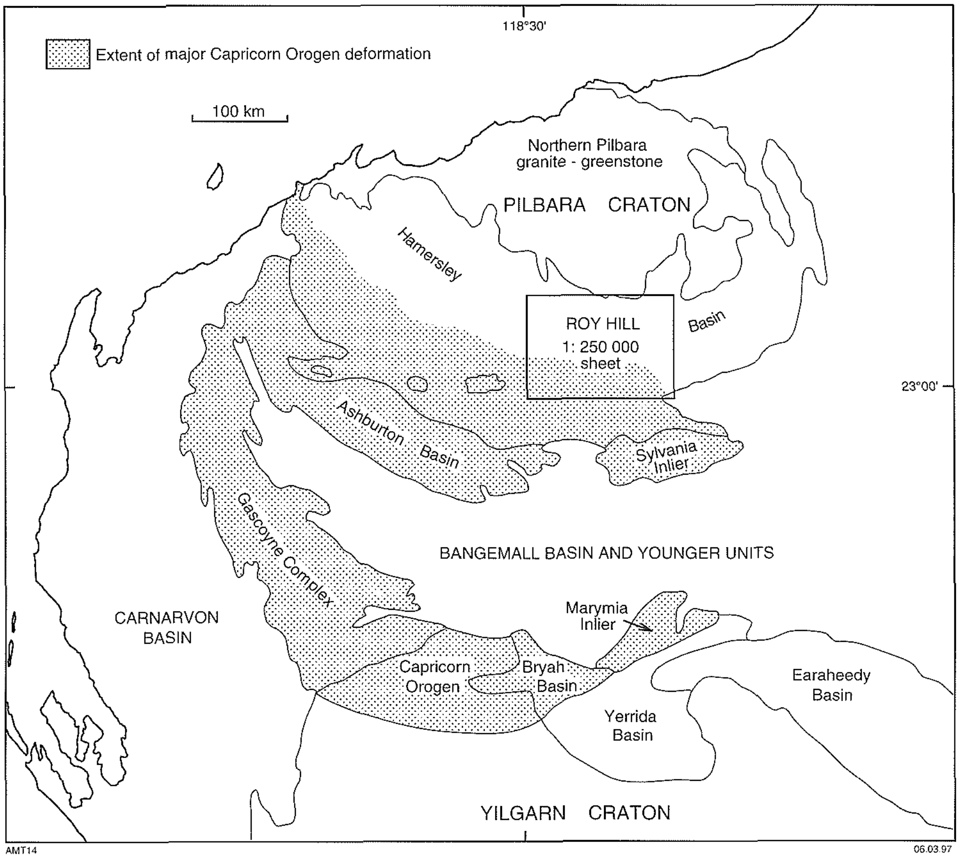

Figure 2. Map showing the main tectonic units of the Pilbara Craton, the northern Yilgarn Craton, and the Capricorn Orogen

while the foreland fold-and-thrust belt developed during collision between the Yilgarn and Pilbara Cratons in the latter stages of the orogeny at c. 1840 Ma (Tyler, 1991; Tyler and Thorne, 1990, 1994). Horwitz and Powell (1992) and Blake and Barley (1992), however, have suggested that deformation was related to an earlier collision, with deformation occurring during the development of the McGrath Trough (Horwitz, 1982) which was initiated either as a foreland basin or a backarc compressive cratonic basin sometime after c. 2440 Ma.

Tyler and Thorne (1990, 1994) regarded the collision between the Pilbara and Yilgarn Cratons at c. 1840 Ma as oblique, taking place in the east first and migrating westwards. Uplift of the Sylvania Inlier supplied granitic sediment to the Ashburton Formation in the Ashburton Basin. Initial deformation of the Ashburton Basin to form the Ashburton Fold Belt was attributed to thrusting. Associated uplift provided sediment to the Mount Minnie Group and the Capricorn Formation. Later deformation was related to a dextral wrench fault system produced by the extrusion of material westwards from between the two approaching craton margins.

In contrast, Horwitz and Powell (1992) regarded the widespread occurrence of northwesterly oriented mafic dykes as evidence of a period of extension during upper Wyloo Group time.

OPHTHALMIA FOLD BELT

On Roy Hill, most of the post-Fortescue Group structures belong to the Ophthalmia Fold Belt. Tyler (1991) recognized 2 groups of structures within this zone of deformation: an older set of localized, small-scale layer-parallel folds (D_{1c}); and a younger set of structures, formed during a subsequent major regional folding event (D_{2c}). Although D_{1c} structures have been recognized on Newman (Tyler et al., 1990) and subsequently on Mount Bruce (Thorne and Tyler, in press), these folds have not been recognized on Roy Hill.

Mappable folds that belong to the regional folding event (D_{2c}) of the Ophthalmia Fold Belt affect Hamersley Basin rocks in southwestern Roy Hill. Here, the major structures are the Weeli Wolli and Juna Downs Anticlines, and the Yandicoogina Syncline (Fig. 1). Typically, folds are open to tight in the south but become more open in the north and they show linear to curvilinear trends that vary from east-northeast to southeast. Most folds are upright, though generally asymmetric, and face north. The majority of minor folds also face north, but south-facing structures are present in some places, e.g. around 22°55'30"S, 118°49'10"E. An axial-plane cleavage is developed in the southern part of Roy Hill, but the cleavage is not pervasive and is best seen in the shale units.

ASHBURTON FOLD BELT

The Ashburton Fold Belt has been described by Thorne and Seymour (1991) and affects Wyloo Group and Hamersley Basin rocks on Turee Creek, Wyloo and in the southwestern half of Mount Bruce.

The Coppin Fault is a major Ashburton Fold Belt dextral wrench fault that cuts basement and Hamersley Basin rocks on southeastern Mount Bruce (Thorne and Tyler, in press). It is probable that the easterly extension of this fault continues south of the Juna Downs Anticline before it dies out in the area north of Mount Meharry (22°58'55"S,118°35'11"E).

Unequivocal Ashburton Fold Belt structures have not been recognized on the remainder of Roy Hill during this study. This is due in part to the effects of the younger deformation dying out towards the Fortescue River valley but it also reflects the general difficulty encountered in separating Ashburton Fold Belt from Ophthalmia Fold Belt structures in the southeastern Pilbara. Here, folding was essentially co-planar, with the later deformation tightening pre-existing folds and reactivating earlier-formed faults.

POST-CAPRICORN OROGEN STRUCTURE

East-northeasterly to north-northeasterly trending faults with an apparent east-block-down sense of movement cross-cut Capricorn Orogen folds in the southeastern Hamersley Range including the Roy Hill area (Fig. 1). These structures are parallel to a prominent set of fractures which post-date the Bangemall Basin on Balfour Downs and Newman (Williams, 1989; Williams and Tyler, 1991).

In the Chichester Range, faults of similar trend which cut Fortescue and Hamersley Group rocks are also thought to be related to the post-Bangemall Basin deformation. Here, the principal structures are parallel to the trend of the major syn-Fortescue Group growth faults and dolerite dykes developed in the northern Pilbara Craton (Blake, 1993) and appear to represent reactivation of these older lines of weakness. An example is the Big Creek Fault, which had a controlling influence on the preservation and/or deposition of sedimentary units within the Maddina Basalt in the upper Fortescue Group, but was clearly reactivated after deposition of the Fortescue Group.

MAFIC DYKES AND QUARTZ VEINS

Four mafic dyke swarms, trending north-northeast (d_1), west-northwest (d_4), northwest (d_5), and northeast to east-northeast (d_7), occur on Roy Hill. All the dykes are dolerite and consist of pyroxene and feldspar with minor quartz, hornblende and biotite.

The d_1 swarm forms part of the Black Range Suite (Hickman, 1983). It cuts Pilbara Craton granite–greenstone rocks in the north of Roy Hill but is overlain by middle Fortescue Group units. Dykes of this suite are also cross-cut by the three other swarms. Results of ion microprobe U–Pb analyses of baddeleyite from four Black Range dykes (Wingate, 1994) indicate that their age of intrusion is within error of the age of the Mount Roe Basalt (2767 ± 6 Ma; Arndt et al., 1991).

West-northwesterly (d_4) and northwesterly (d_5) trending mafic dykes (Tyler, 1990) are seen to cut Hamersley Basin rocks, with the northwesterly set equivalent to the Round Hummock Suite of Hickman and Lipple (1978). Both sets typically infill pre-existing joints and faults (Baldwin, 1975; Bourn and Jackson, 1979). On Turee Creek and Mount Bruce, d_4 mafic dykes that post-date D_{2c} folding (Tyler, 1991; Thorne et al., 1991; Tyler and Thorne, 1994) are thought to pre-date the major period of Proterozoic iron-ore formation (Morris, 1980).

The east-northeasterly trending (d_7) swarm is equivalent to the Mundine Well Suite of Hickman and Lipple (1978) and the Mundine dyke swarm of Myers (1990b). Dykes are continuous over long distances and their intrusion post-dates deformation of the Bangemall Basin on southern Turee Creek (Thorne et al., 1991). A dyke belonging to this suite caused recrystallization of hematite ore at Channar on Paraburdoo (Bourn and Jackson, 1979).

Northwesterly to east-northeasterly trending, essentially monomineralic quartz veins (*q*) are present in the Yule and Shaw Granitoid Complexes in the northern part of Roy Hill. They are cross-cut by the d_5 mafic dyke suite, but their relationship to the older intrusions is unknown.

CAINOZOIC GEOLOGY

A prominent feature of the Cainozoic geology of the Pilbara region is the Hamersley Surface (MacLeod et al., 1963; Campana et al., 1964; Twidale et al., 1985), an elevated and dissected peneplanation surface, probably of late Mesozoic to early Tertiary age. Residual deposits (*Czr* and *Czl*) that formed as part of this surface are lateritic and may be ferruginous. On banded iron-formation, surficial iron enrichment produces deposits of hematite–goethite ore locally (Morris, 1980, 1985; Kneeshaw, 1984).

An early stage of dissection of the Hamersley Surface produced extensive valley-fill deposits. These take the form of partly consolidated and cemented colluvium (*Czc*), and alluvium (*Cza*), calcrete (*Czk*) and associated silcrete breccia (*Czz*). In addition, the Robe Pisolite (*Czp*) is a pisolitic limonite, 15–45 m thick, that forms elevated terraces and mesas above valley fill. It contains limonite and hematite pisoliths, generally small amounts of terrigenous detritus, and scattered fragments of fossil wood. Hocking et al. (1987) suggested a Late Eocene age for the Robe Pisolite.

Thin deposits of quartz, feldspar and lithic sands (*Czg*), overlie granitic rocks in the north of Roy Hill. These deposits are mostly eluvial in origin, although some may have been transported.

Extensive areas of gently sloping sheetwash plain (*Qw*) characterize the valley sides in the Hamersley Range and along the southern flank of the Chichester Range. Alluvium (*Qa*), comprising unconsolidated silt, sand and gravel was deposited along the present drainage channels and colluvium (*Qc*) forms recent talus slopes, adjacent to outcropping bedrock. Small areas of lacustrine deposits (*Ql*) occur in low lying areas of the Hamersley Range and adjacent to the Fortescue River. Areas of wind-blown sand (*Qs*) are confined to the eastern Fortescue River Valley.

ECONOMIC GEOLOGY

IRON

Hamersley Group rocks on ROY HILL lie within the Hamersley Iron Province of MacLeod et al. (1963). The presence of major hematite ore bodies on ROY HILL was recognized during the 1960s (MacLeod and de la Hunty, 1966), the principal associations being with BIF in the Brockman and Marra Mamba Iron Formations, and Cainozoic valley-floor deposits, particularly the Robe Pisolite (*Czp*) and some ferruginous gravels (*Czr*). Marillana Creek, the only operating iron ore mine on ROY HILL, exploits a thick development of Robe Pisolite within the Yandicoogina Syncline.

The formation of hematite ore bodies in BIF has been discussed by Morris (1980, 1985). The occurrence of hematite pebbles containing microplaty hematite, a form of hematite characteristic of the major ore bodies, in the Mount McGrath Formation near Paraburdoo restricts the age of ore formation to early Proterozoic (c. 2000 Ma, the age of the Wyloo Group). The close association of high-grade hematite deposits with areas of structural complexity suggests that hydrothermal fluid flow along large-scale Capricorn Orogen faults was also an important element in the iron-ore enrichment process. The principal ore types are martite–hematite and martite–(hematite)–goethite (Kneeshaw, 1984).

Measured and indicated resources of high-grade ore (>60% Fe) from the Brockman Iron Formation (medium phosphorus) on ROY HILL are 994 Mt, while the equivalent figure for the Marra Mamba Iron Formation stands at 1443 Mt. In addition, the ROY HILL area has measured and indicated resources of 3175 Mt of high-grade pisolitic ore (>55% Fe), associated with the Robe Pisolite and 404 Mt of high-grade (>55% Fe) ferruginous gravel.

ASBESTOS

Several occurrences of crocidolite have been recorded from the Brockman Iron Formation of the Hamersley Group. The main concentrations occur around Dales Gorge (22°29'30"S, 118°34'10"E) where about 30 t of crocidolite was mined from the Dales Gorge Member in 1938 (MacLeod and de la Hunty, 1966; Blockley, 1976). The mineral also occurs in this member at Junction Gorge (22°33'S, 119°01'E), Lamb Creek (22°49'S, 118°55'E), and Fortress Gorge (22°32'S, 118°51'E), and in the Joffre Member, north of Marillana Creek at 22°39'S, 119°05'E, although no production has been recorded from any of these prospects (Trendall and Blockley, 1970).

MANGANESE

Numerous small deposits of manganese dioxide have been reported from ROY HILL, although none has proved to be economic. There are many small patches of manganiferous material on outcrops of the Marra Mamba Iron Formation along the southern edge of the Chichester

Range. The largest of these, occurring at 22°20'20"S, 119°42'10"E, was shown to be low grade and small (de la Hunty, 1963). Other small deposits of medium-grade ore occur at Goodiadarrie Hills (22°20'10"S, 118°56'50"E) and east of Coondiner Pool at 22°42'30"S, 119°42'20"E. These deposits appear to be associated with the Wittenoom Formation, but the manganese has probably been derived from the underlying Marra Mamba Iron Formation or the overlying Brockman Iron Formation (MacLeod and de la Hunty, 1966).

GEMSTONES

Agate occurs in association with siliceous caprock (*Czz*) and calcrete (*Czk*) overlying the Wittenoom Formation in the Fortescue Valley. The only recorded production is from the Marillana Station mine (22°41'40"S, 119°35'00"E) where 68 tonnes of ore worth approximately $54 000 has been processed since 1992.

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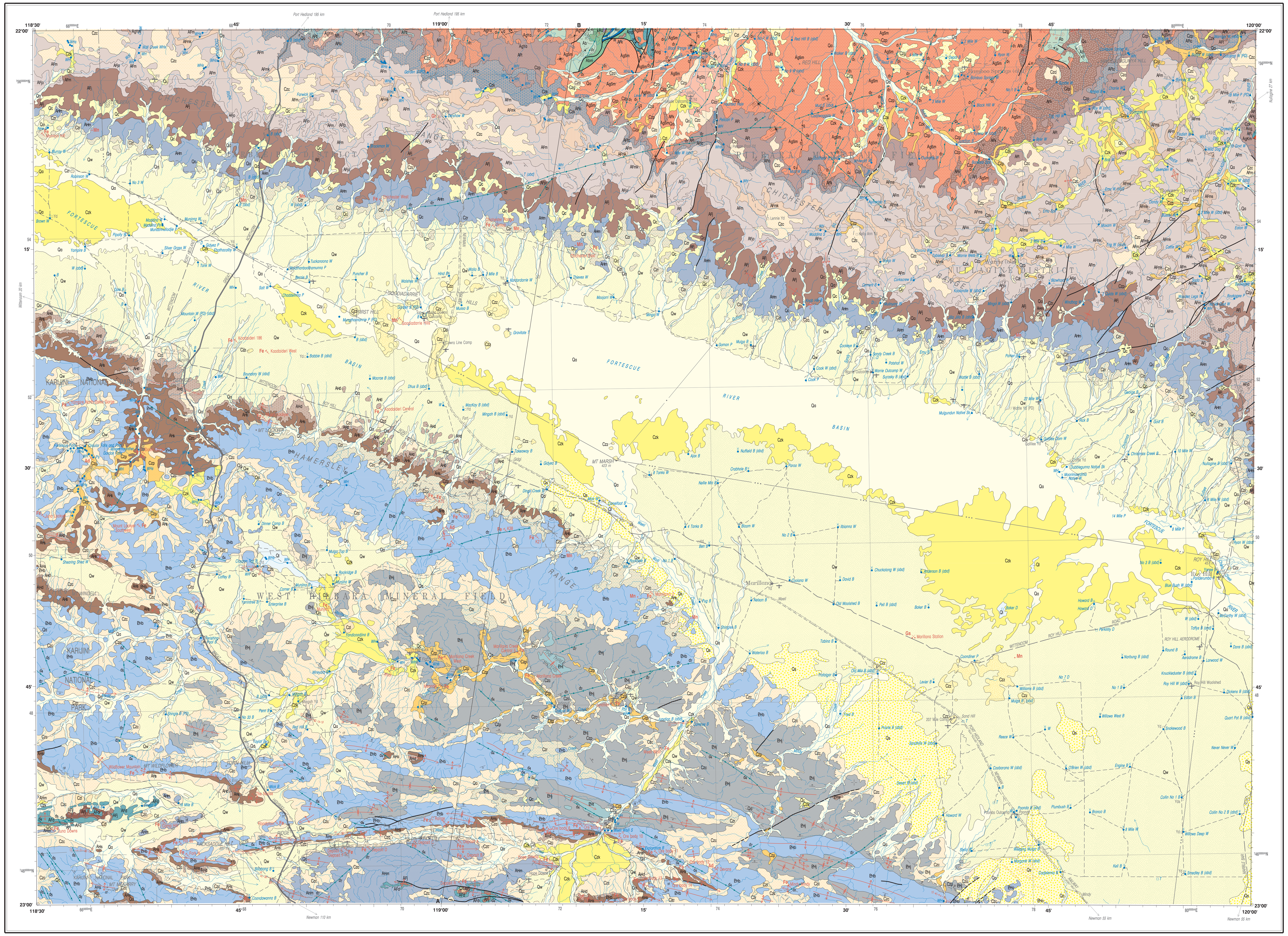


REFERENCE

CAINOZOIC — QUATERNARY

Qa Alluvium—unconsolidated silt, sand, and gravel; in drainage channels and on adjacent floodplains

Ql Lacustrine deposits—clay and silt; claypan (predominantly freshwater) deposits

Qc Colluvium—unconsolidated quartz and rock fragments in soil; locally derived soil, and scree, and talus deposits

Qs Eolian deposit—sand; in sheets and longitudinal dunes

Qw Alluvium and colluvium—red-brown sandy and clayey soil; on low slopes and sheetwash areas

Cza Alluvium—partly consolidated silt, sand, and gravel; old alluvium dissected by present-day drainage

Czc Colluvium—partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits

Czg Sand over granitoid rock—quartzofeldspathic sand; includes areas of low, weathered outcrop

Czz Brecciated siliceous caprock over dolomitic rock; angular chert fragments in a chert matrix; overlies WITTENOOM FORMATION

Czk Calcrete—sheet carbonate; found along major drainage lines

Czl Lateritic deposits—massive and pisolitic ferruginous duricrust

Czr Hematite-goethite deposits on banded iron-formation and adjacent scree deposits

Czp **ROBE PISOLITE:** pisolitic limonite deposits developed along river channels

d4, d5, d7 Dolerite dykes, sills, and small intrusions; numbers identify different suites, lowest number earliest

Mount Bruce Supergroup — Hamersley Group (Hamersley Basin)

c. 2490 Ma

PHt Medium- to coarse-grained metadolerite sills intruded into Hamersley Group

PHo **BOOLGEEDA IRON FORMATION:** fine-grained, finely laminated iron-formation; pelite and chert

PHw **WOONGARRA RHYOLITE:** metamorphosed rhyolite, rhyodacite, rhyolitic breccia, and banded iron-formation

PHj **WEELI WOLLI FORMATION:** banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills

PHb **BROCKMAN IRON FORMATION:** banded iron-formation, chert, and pelite

AHs **MOUNT McRAE SHALE** and **MOUNT SYLVIA FORMATION:** pelite, chert, and banded iron-formation

AHd **WITTENOOM FORMATION:** thin- to medium-bedded metadolomite, dolomitic pelite, chert, and metamorphosed volcanic sandstone

AHm **MARRA MAMBA IRON FORMATION:** chert, banded iron-formation, and pelite

Fortescue Group

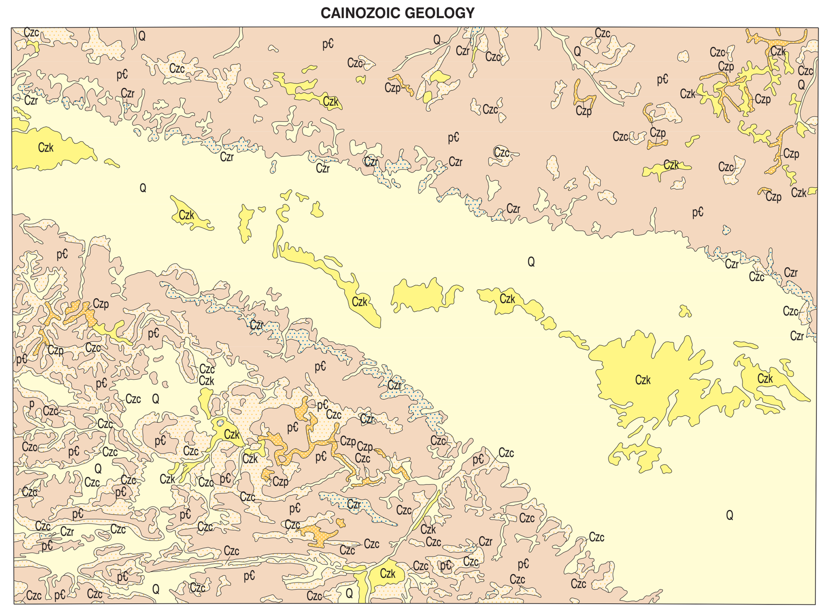
c. 2690 Ma

AFd Medium- to coarse-grained metadolerite sills intruded into Fortescue Group

AFj **JEERINAH FORMATION:** pelite, chert, and thin-bedded metasandstone; intruded by metadolerite sills in the Hamersley Range

AFjl Pillowed and massive metabasaltic flows and metabasaltic breccia

CAINOZOIC GEOLOGY



Q Quaternary alluvium, colluvium, lacustrine deposits, eolian sand, and mixed alluvium and colluvium

Czc Cainozoic colluvium, alluvium, and sand over granitoid rock

Czk Cainozoic calcrete and siliceous caprock

Czr Cainozoic hematite-goethite deposits and laterite

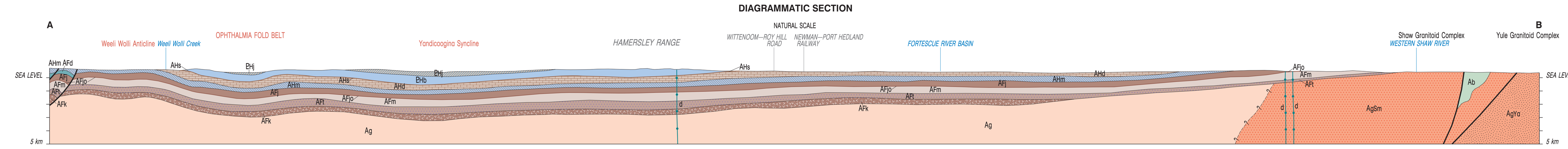
Czp ROBE PISOLITE

p€ Precambrian rock outcrop

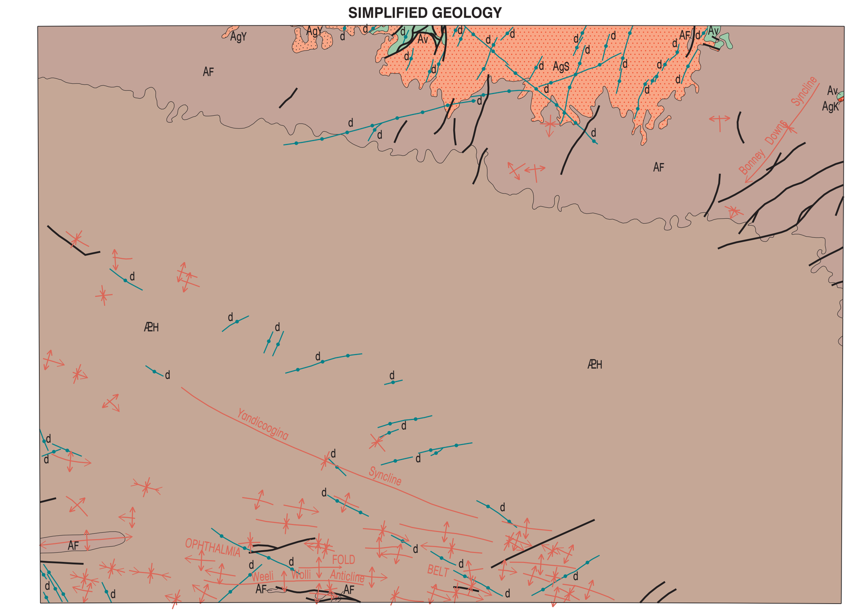
SCALE 1:1 000 000

0 10 20 30 40 50 Kilometres

DIAGRAMMATIC SECTION



Ag Undivided Archaean granitoid rock



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